

Asian-Pacific Aquaculture 2024

Aquaculture - Driving the Blue Economy

2-5 July, 2024

Grand City
Surabaya, Indonesia

The Annual International Conference & Exposition of World Aquaculture Society and Asian Pacific Aquaculture 2024 Annual meeting of Asian Pacific Chapter, WAS

APA24

WORLD AQUACULTURE Society

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WELCOME MESSAGE

Dear delegates,

On behalf of the World Aquaculture Society (WAS) and its Asian Pacific Chapter (WAS-APC), I am pleased to welcome you all to Asian Pacific Aquaculture (APA 2024), which will be hosted in this spectacular location in Surabaya, one of Indonesia's most historic and dynamic cities. Following the 2005 Bali Conference, we hosted another WAS aquaculture conference in Surabaya in 2016, which had an excellent turnout with over 6000 delegates. Since then, the Indonesian aquaculture sector has expanded dramatically, and the country is currently the world's second-largest aquaculture producer, second only to China. This is an impressive achievement, and as the WAS conference returns to Surabaya in 2024, we anticipate it will have a long-term impact on the Asia Pacific aquaculture sector. We are optimistic about this outcome, given the active engagement of the global aquaculture industry and academia in Surabaya, as well as the kind support from Indonesia's Ministry of Marine Affairs and Fisheries.

This year's conference theme, 'Aquaculture - Driving the Blue Economy,' emphasizes our shared commitment to developing new aquaculture approaches, improving collaboration, and addressing global concerns of the blue economy. Surabaya, a city that combines tradition and modernity, provides a unique setting for our discussions. The exchange of ideas and collaborations formed during this conference will signifcantly contribute to the advancement of aquaculture in the Asia-Pacific region and beyond.

I encourage you to make full advantage of the diverse and comprehensive program that we have prepared. APA 2024 is designed to foster meaningful dialogues and collaborations through plenary sessions, three days of technical presentations and a trade show, as well as special sessions and networking events. We've also scheduled field tours to showcase local aquaculture operations, providing great insights into practical applications and innovations. Your participation is critical for shaping the future of aquaculture, and I am optimistic that together, we can make significant strides toward a sustainable and resilient blue economy. I also want to thank all of our sponsors, supporters, and the local organizing team for their contributions to the success of this much-anticipated event.

Thank you for choosing to be a part of APA 2024. Your presence and active participation are greatly appreciated. I hope you have a productive and inspiring conference experience, and that you enjoy the warm hospitality and rich culture of Surabaya.

Warmest regards,

Dr. Krishna R. Salin
President, WAS Asian Pacific Chapter

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ABSTRACTS

EFFECTS OF LIVE AND INACTIVATED BACTERIAL FEED ADDITIVES ON THE GROWTH PERFORMANCE AND MUCOSAL HEALTH OF MIRROR CARP *Cyprinus carpio* UNDER A LOW FEEDING REGIME

Sherilyn T. Abarra*, Mark Rawling, and Daniel L. Merrifield

Fish Health and Nutrition Research Team
University of Plymouth
United Kingdom
sherilyn.abarra@plymouth.ac.uk

Dietary administration of probiotics can modulate the gut microbiota and improve host fish intestinal morphology, digestion, and immune response. Inactivated probiotics, or paraprobiotics, are gaining interest due to their better stability during feed production and longer product shelf life. This study aimed to investigate the effects of potential host-derived probiotics, in live and paraprobiotic forms, on the growth, feed utilisation, and intestinal health of mirror carp.

Bacterial isolates (n = 150) derived from the intestinal mucosa and digesta of carp (n = 5) were tested *in vitro* for haemolytic activity, pathogen antagonism and extracellular enzyme activity. A basal diet was formulated to meet the known nutritional requirements of mirror carp. One of the best performing candidate probiotic from the *in vitro* screening, identified as *Bacillus subtilis*, was top-dressed onto the basal diet to produce the live probiotic diet (BSpro). Another experimental diet was prepared using heat-inactivated version of *B. subtilis* (BSpara). Two commercially available inactivated *Lactobacillus* products (Lpara1 and Lpara2) were used to prepare two further experimental diets. The control diet (CON) was top-dressed with sterile PBS. A 35-day feeding trial was conducted in the Tropical Unit Aquarium of the University of Plymouth within a recirculating aquaculture system (RAS). Mirror carp juveniles (5.59 ± 0.08 g) were distributed randomly into 13 L experimental tanks at 18 fish per tank with three replicate tanks per treatment. Fish were fed at a low feeding regime (2-3.5% biomass per day) to ascertain the effect of the experimental diets on fish reared under suboptimal conditions. At the end of the trial, three fish per tank were humanely euthanised and samples were taken for analysis.

No differences on zootechnical performance were observed between groups (Table 1). Further analyses are being conducted to elucidate the effects of the experimental diets on the molecular microbial ecology, phenotyping intestinal morphology, host gene expression and digestive enzyme activity of carp.

Table 1 *Growth performance of mirror carp fed with experimental diets.*

	CON	BSpro	BSpara	Lpara1	Lpara2
FW (g fish^{-1})	7.64 ± 0.37	7.53 ± 0.23	7.80 ± 0.18	7.69 ± 0.58	7.22 ± 0.37
NWG (g fish^{-1})	2.05 ± 0.40	1.90 ± 0.17	2.24 ± 0.08	2.10 ± 0.52	1.67 ± 0.37
SGR (% day^{-1})	0.71 ± 0.15	0.70 ± 0.04	0.82 ± 0.05	0.79 ± 0.18	0.62 ± 0.12
FCR (g g^{-1})	2.61 ± 0.60	2.57 ± 0.10	2.20 ± 0.14	2.35 ± 0.43	2.98 ± 0.53
PER	0.90 ± 0.19	0.89 ± 0.04	1.04 ± 0.07	0.99 ± 0.20	0.78 ± 0.14
% Survival	100.00 ± 0	100.00 ± 0	100.00 ± 0	100.00 ± 0	100.00 ± 0

Note. Values are expressed as mean ± SD. CON, control; BSpro, live *Bacillus subtilis* supplemented diet; BSpara, inactivated *Bacillus subtilis* supplemented diet; Lpara1 and Lpara2, inactivated *Lactobacillus* spp. FW, final weight; NWG, net weight gain; SGR, specific growth rate; FCR, feed conversion ratio; PER, protein efficiency ratio.

EFFECTS OF HORMONAL TREATMENTS ON TESTIS DEVELOPMENT AND SPERM QUALITY OF HATCHERY CULTURED MALE EELS (*Anguilla bicolor*)

Hanis Abd Mohmin*, Ching Fui Fui and Shigeharu Senoo

Higher Institution Centre of Excellence
Borneo Marine Research Institute
Universiti Malaysia Sabah
Jalan UMS, 88400, Kota Kinabalu
Sabah, Malaysia
hanismohmin@gmail.com

The present study was conducted to identify the effects of hormonal treatment on testis development and sperm quality of cultured males of short-finned eel (*Anguilla bicolor*). A total of 9 male eels were selected (range from 150 and 250 g) with triplicate of each hormone treatments, namely human chorionic gonadotrophin (HCG), pituitary gland (PG), and Ovaprim (OVP). Experiment was conducted for 100 days. Each male was subjected to a total of 20 times hormone injections with five days interval. The initial and final total length and body weight were recorded. Each fish was anesthetized prior to sperm collection. Milt was diluted in seminal fluid plasma for sperm quality assessment. The findings revealed there was no significant difference observed in the final average total length for the HCG, PG, and OVP treatments, with the highest recorded at 48.5±1.6 cm as seen in OVP treatments respectively. In contrast to PG and OVP treatment, the final body weight of male eels treated with HCG was significantly lower (HCG: 185.3±19.4 g, PG: 255.0±43.1 g, and OVP: 260.0±12.6 g). Male eels from PG and OVP were unresponsive to the hormone treatments, but those from the HCG treatment did exhibit a response and a total of 0.8 ml milt with a concentration of $3.12 \pm 0.9 \times 10^9$ spz ml^{-1} and the motility percent was 78.23 ± 5.11 % were recoded. Male eels receiving HCG treatment had well-developed testis, while PG treatment still had growing testis as seen by histology analysis; however, those from OVP treatment did not develop as evidenced by the gonad morphology following surgical incision. This study showed HCG able to induce sperm production and enhance testis maturation which is crucial for artificial production and reproductive investigations.

THE NOVEL RAW MATERIAL *Calanus finmarchicus* IS A RESOURCE OF FUNCTIONAL PRODUCTS FOR GROWTH AND HEALTH OF WHITELEG SHRIMP *Litopenaeus vannamei*

Hogne Abrahamsen*, Rikke Sommerlund, and Isak Bøgwald

Calanus AS
P.O. box 808
9258 Tromsø, Norway
hogne.abrahamsen@zooca.no

The volume of feed necessary to farm whiteleg shrimp (*Litopenaeus vannamei*) has forced the industry to formulate feeds with increasing amounts of plant ingredients, known for lower palatability and sub-optimal nutritional profiles compared with marine ingredients. However, supplementing diets with moderate inclusions of functional ingredients, often of marine origin, can be applied to improve the overall quality of the feeds and ensure growth, health, and high feed intake. A novel raw material for aquaculture feeds and functional ingredients is the zooplankton species *Calanus finmarchicus*, a natural and sustainable resource harvested in the Norwegian Sea, where its annual production is estimated at 290 million tonnes. Products from *C. finmarchicus* include a protein powder that can be used as direct feed for larval stages, complete copepods for replacement of live feed in post-larval stages, and a protein hydrolysate with great potential as a functional ingredient in formulated feeds for both fish and shrimp.

Two separate trials were performed to study the effects of *C. finmarchicus* hydrolysate (CH) inclusion in diets for whiteleg shrimp. The first was performed by SPAROS in Portugal, with aims to document how a 4 % feed inclusion affected growth, survival, and health, compared with other commercially relevant functional marine ingredients. It was run over 64 days with shrimp starting at 2.15 g. and included an acute salinity challenge (drop from 20 to 5 ppt over 24 hours) to study robustness. Results for diets with CH revealed increased growth (Figure 1.a) and significantly higher survival after the salinity challenge (Figure 1.b). The second study was a 24-day specifically designed feed intake study performed by Matís in Iceland, in which various inclusion rates of CH and krill meal were tested to investigate their effect on the attractiveness of diets for whiteleg shrimp starting at 3.67 g. The results showed that feed intake increased significantly with higher inclusion rates of CH, compared with both control and krill meal (Figure 1.c).

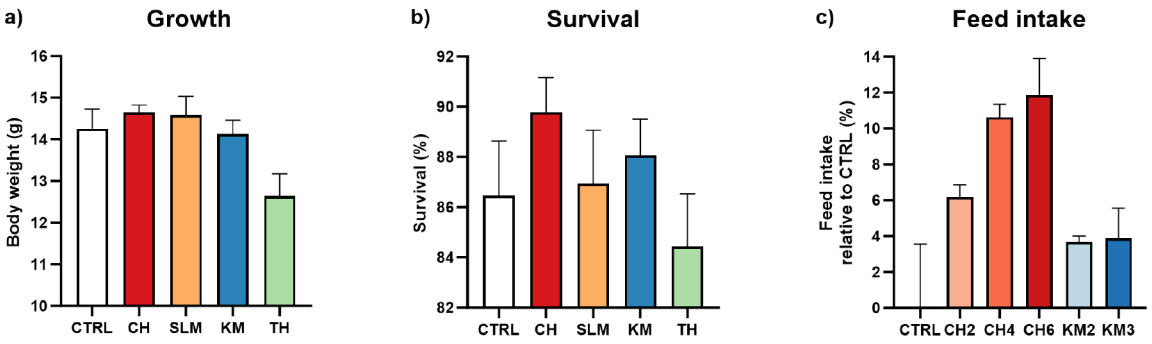


Figure 1. Results from feeding trials with CH inclusion for whiteleg shrimp. a) Body weight at end of trial. b) Survival after salinity challenge. c) Feed intake relative to control. CTRL: Control. CH: Calanus hydrolysate. SLM: Squid-liver meal. KM: Krill meal. TH: Tuna hydrolysate. CH2/CH4/CH6: Calanus hydrolysate 2/4/6 % inclusion. KM2/KM3: Krill meal 2/3 % inclusion.

THE EFFECT OF FERTILIZATION MEDIA pH ON SPERMATOZOA FERTILIZATION PROCESS AS THE RESULTS OF SEXING ON PANGASIUS *(Pangasionodon hypophthalmus)*

Yudho adhitomo[1], Indri astuti1), Maheno sri widodo[2]

1) Freshwater Aquaculture Center of Sungai Gelam, Jambi, Ministry of Marine Affairs and Fisheries
2) Brawijaya University
E-Mail: yudhoadhitomo02@gmail.com

Pangasius (*P. hypophthalmus*) is one of the freshwater commodities of an important economic value. The pH on fertilization media can influence fertilization and affect sex determination (Sandra and Norma, 2009). Sexing with Percoll Density Gradient Centrifugation (PDGC) method can separate X and Y spermatozoa based on their size (Rustidja, 1999). The study analyzed the results of X and Y spermatozoa sexing on Pangasius using the PDGC method and specified the ability of pH in influencing X and Y spermatozoa in the fertilization process. The results showed that, at stage 1, the spermatozoa head on the top layer (La) was larger than that on the bottom layer. The spermatozoa head length (HL) on the top layer was 2.59 ± 0.19 µm with a wide length (WL) of 1.62 ± 0.11 µm. Meanwhile, on the bottom layer, the HL was 2.27 ± 0.12 µm with a WL of 1.44 ± 0.07 µm. Therefore, the top layer was identified as X (female) and the bottom layer as Y (male). The average value of spermatozoa concentration after PDGC at the top layer was 7.11 ± 1.743 x 10^7 cells/mL and at the bottom layer was 3.57 ± 1.075 x 10^7 cells/mL. The average value of motility at the top layer was 61.67 ± 7.637% and at the bottom layer was 46.67 ± 5.773%, and the average value of viability at the top layer was 61.04 ± 7.27% and at the bottom layer was 55.17 ± 2.53%. This study revealed that the effect of pH on the fertilization rate (FR) with Y control spermatozoa was -177.8 + 68.377 x -4.234 x^2, R^2 = 0.603. The finding confirmed that the best treatment for this control was pH 8.07 and FR 98.27%. The assessment on Y top layer spermatozoa resulted in of -100.27 + 40.836 x – 2.568 x^2, R^2 0.637. The finding showed that the best treatment for the top layer spermatozoa was pH 7.95 and FR 62.07%. The examination on Y bottom layer spermatozoa generated an equation of -32.195 + 22.746 x -1.4619 x^2, R^2 = 0.523. It can be said that the best treatment in the bottom layer was pH 7.78 and FR 56.28%. However, the hatching rate (HR) to pH treatment on each treatment did not show significant differences (P >0.05). To sum up, the PDGC method on Pangasius spermatozoa could separate the spermatozoa based on the top and bottom layer size. The PDGC method could produce female seeds on the top layer by 85% and male seeds on the bottom layer by 68%.

VARIATION OF FEED TYPES ON COLOR BRIGHTNESS CLOWNFISH ORNAMENTAL FISH

Adi Hardiyanto* dan Heru Salamet

Balai Perikanan Budidaya Laut Ambon
Jl. Leo Wattimena, Ambon
e-mail: ambonbpbla@gmail.com

When rearing ornamental clownfish, the brightness of the color produced in rearing in marine cages is better than in the recirculation system, where in the recirculation system the color of the fish produced tends to be pale/less bright. However, when the recirculation system is enlarged, the survival value is quite high, namely 70-90%. Meanwhile, in certain months, especially during the rainy season, where the water quality conditions are not good, the survival value resulting from rearing in KJA is quite low, it can even be zero percent.

In this experiment, three types of feed were observed, namely: Aquarium A (copepods), Aquarium B (frozen worms) and Aquarium C (pellets). Feeding was carried out 3 times per day and the fry were maintained for two months. Determination of color brightness is measured using a colorimeter. Brightness measurements were carried out at the end of the treatment when the color of the fish had begun to become clear.

The highest brightness was found in treatment A, namely 208, followed by treatment C at 178 and treatment B at 155. The survival and growth values for the three treatments tended to be the same.

VARIATIONS OF FILTER MEDIA IN BREEDING CLOWNFISH ORNAMENTAL FISH

Adi Hardiyanto* dan Heru Salamet

Balai Perikanan Budidaya Laut Ambon
Jl. Leo Wattimena, Ambon
e-mail: ambonbpbla@gmail.com

The recirculation system used for seven years at BPBL Ambon continues to be developed using simple and affordable technology so that it is easy to apply by cultivators. In order for the recirculation system to be able to provide more optimal results in clownfish rearing, it is necessary to carry out research on the differences in biological filters in recirculation systems so that the components of a good filter media used in cultivation activities can be identified.

In this experiment there were three different filter media treatments, namely Treatment A (Ginger Coral), Treatment B (Kaldness K1) and Treatment C (Bioblock). In this experiment, seeds were spread with a size of 2 cm as many as 900 individuals per recirculation system unit. The feed given is commercial pellet feed, amounting to 5 - 10% of the total biomass. The frequency of feeding is 3-4 times a day and given in the morning, afternoon and evening.

The water quality values in the three treatments tend to be the same and are still within normal limits where the temperature is in the range of 26.1 – 28.2 oC, salinity 32 – 33 ppt, DO 4.31 – 5.91 mg/l, Nitrite 0.038 – 0.576 mg/l, Ammonia 0.002 – 0.130 mg/l, Nitrate 0.01 – 1,080 mg/l. In treatments A and B the pH value was at optimum conditions, however in treatment C the pH value was quite low, namely 6.36. As a result, there was quite high mortality in treatment C. The highest survival value was in treatment A, namely 87.11%, followed by treatment B at 86.67% and treatment C at 53.33%. The value of increase in length during the two month maintenance period tended to be the same as in treatment A namely 1.25 cm, followed by treatment B at 1.3 cm and treatment C at 1.26 cm.

VANAME SHRIMP CULTURE MANAGEMENT IN KEBUMEN DISTRICT

I Gde Budha Adyana Yasa[1)], Herinto[1)], Maskar Jayadi [2)], Suzana Meidwi Ratriningrum [3)]

1. Karawang Aquaculture Production Business Service Center, West Java
2. Jepara Brackish Water Aquaculture Development Center, Central Java
3. Serang Fish and Environmental Health Testing Center, Banten

In 2022-2023, Indonesia was build shrimp culture farming system in Kebumen Regency, Central Java with are total area of 100 ha of land prepared and around 65 hectare of which has been utilized for main and supporting facilities. Kebumen Shrimp Culture Farming System Inaugurated by the President of the Republic of Indonesia Ir. Joko Widodo on March 9 2023. The operational vaname shrimp culture activities will start from March to May 2023, using intensive stocking density technology of 125 ind per m^2. The culture system begins with the preparation of infrastructure, especially maintenance ponds, treatment ponds, reservoirs and installation of cultivated waste water. Preparation of maintenance media water through physical and biological treatment. Protein content of feed 34-36%, application of probiotics, enrichment with feed additives and mineral.

This study used 10 units with a size of 40x40 m (1,600 m^2) with water depth 1.2-1.5 m, one unit of water reservoir (biofilter reservoir) with an area of 2.2 ha and one unit of treatment pond with an area of 1600 m^2 each. Water quality test results showed: temperature 24 – 28 ^oC, pH 7.3-8.6, salinity 20 - 35 mg/l, Dissolved Oxygen 4.3-6.8 mg/l, alkalinity 70-120 mg/l, total bacteria 10^4-10^5 CFU/ml and abundance of plankton >100,000-1,000,000 cells/ml.

PREVALENCE OF *Vibrio parahaemolyticus* IN FARMED SHRIMP *Penaeus vannamei* AND ITS ANTIBIOTIC RESISTANCE PROFILE IN SOUTH SULAWESI

Alfa Astiana Afandy, Srinawati, Herawaty, Nur Muflich Juniyanto

BrackishwaterAquaculture Center Takalar
Takalar, Sulawesi Selatan, Indonesia
amira15102012@gmail.com

Marine bacterium *Vibrio parahaemolyticus* has been identified as an important agent of *vibriois* disease and acute hepatopancreatic necrosis disease in shrimp that can caused a big economic loss for shrimp farming. This bacterium also zoonotic pathogen which can cause gastroenteritis associated with the consumpsion of raw or undercooked seafood. This research aims to provide information related to the presence of *V. parahaemolyticus* in farmed shrimp, and was carried out as a step in ensuring the safety of fishery food products so that they are safe for consumption.

Isolation of *V. parahaemolyticus* is carried out by taking the hepatopancreas from five different shrimp from the same ponds and pooled. Briefly, the hepatopancreas was homogenized in tryptic soy broth with 2% NaCl medium. A loopful of culture was inoculated on CHROMagar and Vibrio TCBS agar and incubated at 37^{o}C for 24 h. Mauve colonies on CHROMagar and green colonies on TCBS agar were picked up and subjected to *V. parahaemolyticus* species-specific PCR targetting the *toxR* with amplicon size 369 bp. Antimicrobial susceptibility test was done using the disk diffusion method. Three antimicrobial agents were used are tetracycline (30 µg), oxytetracycline (30 µg) and enrofloxacine (5 µg). Interpretation of susceptibility test using the CLSI criteria.

A total of 73 shrimp samples were collected from different shrimp farm spread accross 10 districts in South Sulawesi, and 38 (52.05%) *Vibrio* isolates were confirmed as *V. parahaemolyticus* based on *toxR* gene-specific PCR. *V. parahaemolyticus* isolated showed high susceptibility to tetracyclin (100%), oxytetrcycline (100%), and enrofloxacine (92,1%). The result the result indicated that *V. parahaemolyticus* is widely prevalent in shrimp in South Sulawesi but have high susceptibility to antibiotics.

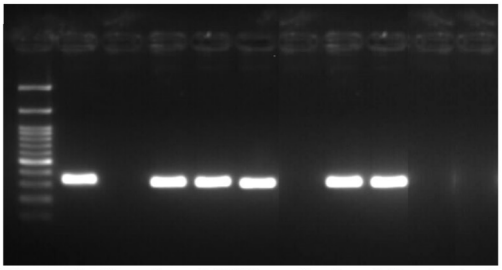


Figure 1. Results of PCR analysis of the typical bacteria V. parahaemolyticus using ToxR specific primers

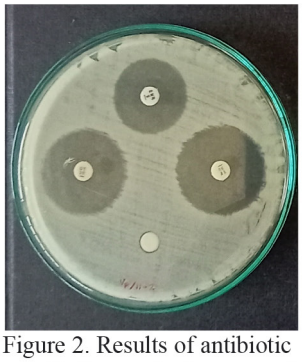


Figure 2. Results of antibiotic sensitivity testing of *V. parahaemolyticus* bacteria to the antibiotics Tetracycline (30 µg), Oxytetracycline (30 µg) and Enrofloxacin (5 µg).

A NATURAL FEED ADDITIVE ENHANCES THE GROWTH AND HEALTH OF WHITE SHRIMP *Penaeus vannamei*

Teresa M. Agulles

PlusVet Qingdao Animal Health Co., Ltd.
Zhengwang Road 2
Environment Protect Industry Park
Jimo, Qingdao, China
operations@plusvet.eu

Vibrio parahaemolyticus is a Gram-negative bacterium commonly found in coastal areas and estuaries. Rising ocean temperatures in recent years have contributed to its global spread. *Vibrio parahaemolyticus* can infect fish, shrimp, shellfish and other aquaculture animals, especially shrimp. It causes acute hepatopancreatic necrosis disease (AHPND), a condition previously known as early death syndrome (EMS). So far the prevention and control of parahaemolyticus vibrio disease is mainly through the use of antibiotics, but the large and long-term use of antibiotics not only causes serious harm to the aquaculture environment, but also makes the resistance of bacteria continue to strengthen. Phytogenics has been widely used in aquaculture because of their antibacterial activity and less pollution to water environment. The feeding and disease challenge trial was conducted to evaluate the impact and efficacy of PhytoAqua based on plant extracts on the growth and health of *Litopenaeus vannamei.*

Four treatment groups were designed, among which, the control group was standard feed; the trial group 1 was standard feed with 0.2% PhytoAqua; the trial group 2 was standard feed with 0.4% PhytoAqua; the negative control group was standard feed with 0.0015% florfenicol which purity is above 98%. First, *Litpenaeus vannamei* was temporarily raised in a 400L tank (200L water) for 4 days. Then 360 shrimps with body weight of (2.3±0.07)g were randomly divided into 12 buckets with 3 replicates in each treatment group and 30 shrimps in each replicate. The water in the bucket was about 100L and then the trial was conducted for 52 days. During the trial, the water was natural seawater after gauze filtration and disinfection, and the water temperature was 29~31°C. The water was changed 4/5 per day, the feed was 4 times per day, the daily feed was 5% ~ 7% of the shrimp body weight, based on the actual food intake, siphon once a day, and clean the residual feed and feces at the bottom of the bucket. After 52 days of the feeding trial, the remaining shrimp after sampling were challenged with Vibrio parahaemolutes (AHPND strain). Shrimp were soaked in a red bucket containing 10^8CFU/ml of *Vibrio parahaemolutes* for 2h, then water was added to the red bucket, diluted 3 times. Shrimp mortality was then monitored for 72 hours.

TABLE 1. Initial weight, final weight, survival, weight gain and specific growth rate (SGR) of the four groups. Means in a column with different letters were significantly different($P<0.05$).

	Control	0.2% PhytoAqua	0.4% PhytoAqua	0.0015% Florfenicol
Initial weight(g)	2.27±0.07	2.33±0.03	2.30±0.03	2.29±0.00
Final weight(g)	$8.29±0.42^{bc}$	$9.24±0.23^{ab}$	$9.84±0.17^{a}$	$7.93±0.22^{c}$
Survival(%)	92.22±4.01	95.56±1.11	91.11±2.22	90.00±0.00
Weight gain(%)	$267.08±27.51^{b}$	$297.25±11.15^{ab}$	$328.27±9.63^{a}$	$245.81±9.56^{b}$
SGR(%/day)	$2.49±0.15^{b}$	$2.65±0.05^{ab}$	$2.80±0.04^{a}$	$2.38±0.05^{b}$

TABLE 2. Mortality of four groups fed with different diet and challenged with AHPND-causing bacteria within 72 hours

	0h	24h	36h	48h	60h	72h
control (%)	0.00	10.37	30.51	30.51	40.88	57.31
0.2% PhytoAqua (%)	0.00	8.46	16.62	16.62	32.68	36.01
0.4% PhytoAqua (%)	0.00	2.78	8.12	14.18	22.77	28.36
Florfenicol (%)	0.00	0.00	32.17	48.95	57.11	57.11

As can be seen from Table 1, there was no significant difference in survival rate between all treatment groups, all of which were over 90%. The final weight, weight gain rate and specific growth rate showed a similar trend, and the administration of 0.4% PhytoAqua was significantly higher than that of control group and florfenicol group ($P<0.05$), indicating that PhytoAqua can promote the growth of *Litopenaeus vannamei*. According to the results of challenge test in table 2, shrimp fed either with 0.2% PhytoAqua (36.01%) or 0.4% PhytoAqua (28.36%) had lower mortality than the control group (57.31%) and 0.0015% florfenicol group (57.11%) after 72 hours.

REPRODUCTIVE CAPACITY AND NUTRITIONAL COMPOSITION OF A CLADOCERAN, *Moina micrura* FED WITH MICROALGAE-BACTERIA DIETS

Umi Wahidah Ahmad Dini*, Fatimah Md Yusoff, Zetty Norhana Balia Yusof, Norulhuda Mohamed Ramli, and Natrah Ikhsan

Department of Aquaculture
Faculty of Agriculture
Universiti Putra Malaysia
43400 UPM, Serdang, Selangor, Malaysia
umiwahidah2013@gmail.com

The rapid reproduction and highly nutritious contents of *Moina micrura* enable this species to become an effective live feed for the aquaculture industry, especially in the early stages of larval development. In order to further enhance its nutritional quality, *M. micrura* they should be fed with high quality food sources, such as beneficial phytoplankton and bacterial species. Therefore, the objective of this study aimed to determine the effect of mono- and mixed-microalgae and bacteria diets on the growth, reproductive capacity, and nutritional composition of *M. micrura*.

Moina micrura was treated with 13 diets including mono (T1-T7) and mixed diets (T8-T13). Mono diets include two green algae species; *Chlorella vulgaris* (T1*)* and *Chlamydomonas reinhardtii* (T2*)*, two diatoms *Cyclotella meneghiniana* (T3) and *Pavlova noctivaga* (T4), two cyanobacteria *Microcystis aeruginosa* (T5*), Planktothrix agardhii* (T6*),* and a bacterium *Ochrobactrum haematophilum* (T7). Meanwhile, mixed diets include the combination of each mono microalgal diet and the bacterium; T8 (T1+T7), T9 (T2+T7), T10 (T3 + T7), T11 (T4 + T7), T12 (T5 +T7), T13 (T6 + T7). Experiments on individual reproductive capacity were observed for fifteen replicates, while, the population growth study was conducted in triplicates for each treatment. The culture conditions were maintained at room temperature 27.0 ± 2.0° under a photoperiod of 12 h light: 12 h dark. Proximate analyses (protein and lipid) and fatty acid profiling were conducted to assess the impact of each diet on the reproductive capacity and population growth. The combination of the bacterium, *O. haematophilum* with high-quality microalgae, especially the T10 diet (*C. meneghiniana* + *O. haematophilum*) significantly ($P < 0.05$) increased the population density (4780.3 ind. L^{-1}) (Figure 1) and reproductive capacities, particularly, eggs (40.2 eggs $clutches^{-1}$ $female^{-1}$) and offspring (36.7 offsprings $female^{-1}$) production.

In terms of nutritional content, the highest polyunsaturated fatty acid (PUFA) (32.4%) and eicosapentaenoic acid (EPA) (5.8%) were obtained when *M. micrura* was fed with the T10 diet. The addition of *O. haematophilum* to poor quality cyanobacterial diets (T12: *M. aeruginosa* and T13: *P. agardhii*) significantly ($P < 0.05$) increased the population density and reproductive capacity of *M. micrura*, but not the nutritional contents. Overall, the selection of a microalgae-bacteria consortium has important implications for improving the production of high-quality cladoceran for sustainable cladoceran cultivation, which can be used as a high-quality live feed in the aquaculture industry.

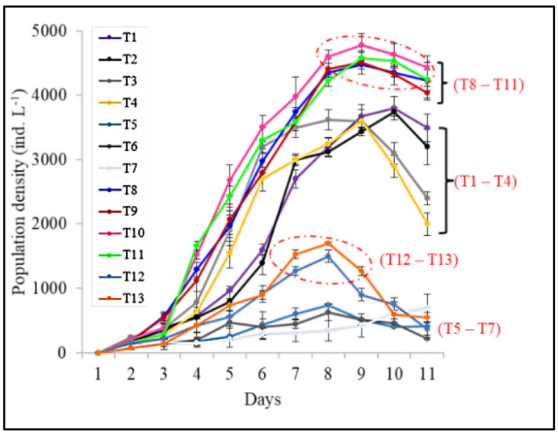


FIGURE 1. Population density of *M. micrura* fed with different diets

AGE, GROWTH, POPULATION DYNAMICS AND STOCK STATUS OF *Perna perna* IN OMANI WATERS

S.M. Al-Barwani*, S.M. Nurul Amin , A. Arshad , A. Govender , H. Al-Habsi , K. Al-Riyami and Jassim A. Al Khayat

Department of Marine Science and Fisheries
College of Agricultural and Marine Sciences
Sultan Qaboos University
Seeb, Muscat, Oman
sharthi@squ.edu.om

The brown mussel, is abundant on rocky shores along the coastal areas of the Arabian Sea of the Sultanate of Oman (Al-Barwani 2013). This species is considered endemic to Yemen, southern India, Sri Lanka, Madagascar, the southwestern Indian Oceans along the east coast of Africa, north of Luderiz Bay, the Mediterranean from Gibraltar to the Gulf of Tunis, the central and southwestern Atlantic Ocean along the coasts of Brazil, Uruguay, Venezuela, the West Indies, and recently colonized much of the Texan coast of the Gulf of Mexico (Hicks and Tunnell, 1995; Hicks ., 2001; Sokolowski 2010). The brown mussel in Oman has little economic value due to limited demands by the local people, and is only consumed by local coastal communities where it is prolific. However, recently the demand for imported mussels from Europe and New Zealand has increased due to the demand from the increasing expatriate communities in Oman. Nowadays, has gained some economic importance due the demand from hotels and seafood restaurants which cater to tourists and the expatriate communities.

The values of various population parameters obtained during the present study are given in Table 1.

TABLE 1. Comparison of population parameters among the three different stations in Oman

Parameters	Mirbat	Ra's Al Had	Ra's Madrakah	Mean
Asymptotic length (L_∞) in mm	71.40	88.20	107.10	88.9
Growth co-efficient (K/yr)	0.84	0.94	0.95	0.91
Growth performance index (ϕ')	3.63	3.86	4.04	3.84
Natural mortality (M/yr)	1.25	1.29	1.23	1.26
Fishing mortality (F/yr)	1.59	1.99	1.25	1.61
Total mortality (Z/yr)	2.84	3.28	2.48	2.87
Exploitation level (E)	0.56	0.60	0.50	0.55
Length range in mm	12-68	12-84	12-104	12-104

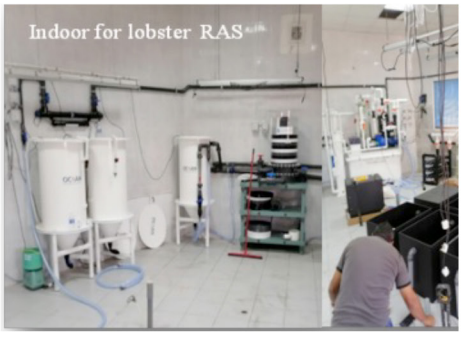
LAND BASED AQUACULTURE; A PROMISING PRACTICE IN JORDAN'S AQABA/RED SEA

Mohammad Al-Zibdah*

School of Basic and Marine Sciences
University of Jordan-Aqaba
Jordan
zibdeh@ju.edu.jo

In the Red Sea region, attention is increasingly focused on support of food security through the development of additional resources, aligning with the principles of the blue economy. A key aspect of this endeavor involves enhancing farming practices, particularly through the adoption of intensive aquaculture food security augmentation. Almost by definition, agriculture in this arid region has to be based on the use of as little freshwater as possible due to extreme sacristy in rainfall at these latitudes. Hence, marine aquaculture or mariculture, offers an excellent solution as it is based exclusively on the use of seawater. At the same time, countries in the region suffer from a deficit of seafood production and face poor fishing conditions. Jordan for example has been importing almost all of its seafood consumption (about 97%). Lately however, concern has been raised regarding the effect of the fish cages on the Gulf of Aqaba/Red Sea coral reef ecosystem. Thus, development of alternative solutions such as Land-based mariculture has the potential to provide an economic efficient and environmentally friendly resource using the technology of recirculating aquaculture systems (RAS).

The strategy of mariculture in Jordan now is based on culture of economically valuable and environmentally non-demanding species and at the same time applies strict management controls for these practices. In environmentally sensitive areas such the Gulf of Aqaba/Red Sea known for its oligotrophic nature in support to coral reefs ecosystem, we attempted practices in land based aquaculture apart from natural water bodies following national regulations. Using RAS in Jordan's aquaculture is specifically calibrated for endemic cultured fish species. This leads to the focus on high value low environmental burden aquaculture under RAS conditions. It allows implementing intensive culture fish species with minimal water consumption. Another approach is the culture of giant clams (*Tridacnidae*) which exploits effective recycling of material between two trophic levels embodied within one organism, animal host with its algal symbionts (zooxanthellae). This enables clams to tap different nutrient sources and achieve high growth rates in spite of low ambient concentrations. Recently attempts were undertaken to domesticate the local shovel Red Sea lobster (*Scyllarides tridacnophaga*) using also a specially designed RAS. These practices of aquaculture will hopefully paves the road for the use of RAS in supporting sustainable marine aquaculture in Jordan's Red Sea. At the same time, avoiding direct exploitation of the limited coast as well as the expanding in intensive land based rearing systems.



TRANSFORMATION OF THE FEED SUPPLY SEGMENT OF THE AQUACULTURE VALUE CHAIN IN BANGLADESH

Hazrat Ali*, Ben Belton, Mohammad Mahfujul Haque and Khondker Murshed-e-Jahan

*Department of Aquaculture
Bangladesh Agricultural University
Mymensingh & WorldFish
Bangladesh
Email: h.ali@cgiar.org

The rapid growth of aquaculture in Bangladesh over the past 3 decades has been facilitated by increasing supplementary feed use and increasing numbers of feed suppliers, but little is known about the organization and behavior of the feed supply segment of aquaculture value chain. We conducted a comprehensive survey with 79 feed suppliers of two types: 'dealers' linked to feed companies (n=34) and independent retailers (n=45), in the seven main aquaculture producing districts of southern Bangladesh in 2021 to address this knowledge gap. We found the following. (1) Over the past 10 years, the number of traders increased 70% and the volume of feed traded almost doubled. (2) Feed supply is shifting from traditional agricultural byproducts to formulated feeds (47% of total feed) (Table 1), and floating feeds as a subset of those (54% of formulated feed), contributing to increasing farm productivity. (3) The formulated fish feed market in Bangladesh is diverse, but quite concentrated. Feed suppliers sold formulated feed produced by 35 companies, with eight companies accounting for 74% of sales. (4) Feed handling practices are efficient. Traders sell feeds quickly (average turnover time 10 days) and storage practices are adequate to maintain quality. (5) No traders reported experiencing any waste or loss of feed during their most recent completed transaction, and only 5% of traders reported losing a small portion of feed (1.7%) during transport. (6) The average profit margin earned by feed suppliers is a modest 6.2%. (7) Feed trading creates substantial employment: 43,937 full time equivalent (FTE) jobs in the seven surveyed districts. In sum, these findings suggest the feed supply segment of the aquaculture value chain in Southern Bangladesh is dynamic, well-developed, and relatively competitive and efficient. This finding is contrary to the conventional wisdom, which often portrays the sector as inefficient and beset by problems.

Table 1: Characteristics of aquaculture feed suppliers

Variables	Dealer	Retailer	Overall
N	34	45	79
Mean volume of feed traded (t/year)	305	130	182
Mean value of feed traded (USD/year)	154,443	53,589	83,331
Formulated feed share in total volume (%)	76	18	47
Mean labor days per ton feed sold	9.2	15	13
Total FTE jobs created	21,495	22,442	43,937
Working capital (USD/year)	42,120	10,593	28,141
Mean operating cost (USD/year)	5,799	2,302	4,248
Mean gross margin (USD/year)	5,349	2,041	3,882
Marketing margin (%)	6.0	6.5	6.2

TRANSFORMATION OF THE FARMING SEGMENT OF THE AQUACULTURE VALUE CHAIN IN BANGLADESH

Hazrat Ali*, Ben Belton, Mohammad Mahfujul Haque and Khondker Murshed-e-Jahan

*Department of Aquaculture
Bangladesh Agricultural University
Mymensingh & WorldFish
Bangladesh
Email: h.ali@cgiar.org

Aquaculture production in Bangladesh has experienced significant growth in the past three decades, but comparatively little is known about the organization and behavior of the farming segment of the aquaculture value chain in Bangladesh. We conducted a comprehensive statistically representative study with 721 farmers representing four categories: only fish (FO), prawn and fish (PF), shrimp and fish (SF), and prawn, shrimp, and fish (PSF) from seven districts in south and southwest Bangladesh between November 2020 and February 2021to address this knowledge gap. Key findings include: (1) A notable 11% increase in the number of aquaculture farmers and a 15% rise in waterbodies over the past decade. (2) On average, farmers cultivated 8.9 different aquatic species per farm, with fish contributing 84% and crustaceans contributing 16% to total production (Table 1). (3) The mean farm output reached 3284 kg/ha, exhibiting a higher ($p \leq 0.05$) level in FO farms compared to others. (4) Shrimp demonstrated susceptibility to diseases compared to fish and prawn; however, only 19% of farmers adopted measures to enhance crustacean survival. (5) The shift from shrimp to prawn and crustaceans to fish resulted in intensified production systems, with supplementary feed usage increased (3.24 t/ha) significantly over the past decade. (6) A mere 0.55% of farmers reported losses, spoilage, or wastage of aquatic products during transportation, with the volume being minimal at just 0.52%. (7) Farming segments are predominantly family-owned and operated enterprise, generating 401,536 full-time equivalent (FTE) jobs in the surveyed districts. (8) The farming segment demonstrates profitability, with an average benefit-cost ratio (BCR) standing at 1.98, signifying an almost twofold return in terms of benefits. The results indicate that the farming segment within the aquaculture value chain in Bangladesh is characterized by dynamism, ongoing transformation, and a relative level of efficiency. The findings from this study provide scientific evidence to support the improvement of aquaculture production interventions by researchers, development partners, and the government.

Table 1: Characteristics of aquaculture farming segment in Bangladesh

Variables	FO	PF	SF	PSF	Overall
N	284	165	61	211	721
Mean farm aquaculture area (ha)	0.35	0.78	1.82	1.05	0.78
Mean sampled waterbody area (ha)	0.29	0.59	1.37	1.00	0.66
Mean species produced (no.)	8.1	9.7	7.8	9.8	8.9
Mean fish stocking density (kg/ha)	761	429	290	259	498
Mean crustacean stocking density (no./ha)	0	19,163	223,336	196,197	80,698
Total feed use (t/ha)	4.71	3.51	0.81	1.77	3.24
Formulated feed use (t/ha)	2.12	1.25	0.26	0.41	1.27
Floating feed in total formulated feed (%)	71	33	26	37	58
Mean aquatic food production (kg/ha)	4,766	2,714	1,947	2,122	3,284
Fish share in total volume (%)	100	88	68	70	84
Crustaceans share in total volume (%)	0	12	32	30	16
Share of aquatic food products sold (%)	61	74	82	80	71
Mean FTE job created per ha	1.32	1.22	1.50	1.81	1.45
Total FTE jobs created in surveyed districts	54,157	67,607	83,221	196,552	401,536
Mean net margin (USD/ha)	3,142	2,253	2,464	3,341	2,939
Benefit-cost ratio (BCR)	1.91	1.73	2.17	2.29	1.98

SEAHORSE SPECIES CULTIVATION *Hippocampus kuda* AND *Hippocampus comes* AT MAIN CENTER FOR MARINE AQUACULTURE (MCMA) LAMPUNG

Ali Hafiz Al Qodri*, Dimas Aditia Putra dan Mulyanto

Main Center for Marine Aquaculture
Main Center For Marine Aquaculture
Marine Affairs and Fisheries Ministry
Email : bbpbl.lampung@gmail.com

Seahorses are one of the fish commodities that have a high selling value because they have a unique shape and are widely used as traditional medicine. The increasing market demand for seahorse exports means that the conservation status of seahorses is currently classified in Appendix II and is restricted in international trade. To prevent this, cultivation efforts are being made to preserve seahorses. Main Center for Marine Aquaculture (MCMA) is the technical implementing unit that carries out seahorse cultivation activities, therefore research was carried out with the aim of comparing the use of two types of seahorses in the production of superior seeds to achieve maximum production. The method for collecting and processing data is by making observations at MCMA. The procedures carried out include container preparation, maintenance, air quality measurements and testing. The results obtained from measuring the *Hippocampus kuda* of female have an average length of 17.9 cm with an average weight of 13.1 grams and males are 18 cm with an average weight of 17.65 grams. The *Hippocampus comes* of females has an average length of 16.05 grams with an average weight of 10 grams and males 16.35 with an average weight of 8.7 grams. The survivalrateof *Hippocampus kuda* parents is 50% and *Hippocampus comes* 96.30%, while the survival of *Hippocampus kuda* seeds is 48.74% and *Hippocampus comes* 90.23%, so the best species to cultivate is the *Hippocampus comes* type.

SEA CUCUMBER RANCHING BY THE COMMUNITIES: HOW TO MAKE IT WORK?

Jon Altamirano*, Raisa Joy Castel, Quenie Montinola and Roselyn Noran-Baylon

Southeast Asian Fisheries Development Center
Aquaculture Department (SEAFDEC/AQD)
SEAFDEC/AQD Brgy. Buyu-an Tigbauan
Iloilo, 5021, Philippines
jaltamirano@seafdec.org.ph

The very high demand and increasing market prices for sea cucumber products has driven many coastal communities especially in resource-rich countries, like the Philippines and others in Asia and Pacific, to exploit sea cucumbers for livelihood. Unregulated collection has led to dwindling numbers and smaller sizes of wild stocks. Fortunately, there are efforts to rebuild sea cucumber populations and alleviate economic stress of coastal people using hatchery-produced seeds in community-based sea cucumber farming.

In this presentation, we describe one aspect of the project supported by ACIAR (FIS/2016/122), aiming to assess the capacity of island-based communities in the production of the tropical sea cucumber or sandfish *Holothuria scabra*. We present the template case of Molocaboc Island, in central Philippines engaged in sandfish aquaculture with technical support from SEAFDEC/AQD.

Baseline results highlighted the collection of even the smallest sandfish around the island, due to low awareness about ecological and economic sustainability, and the absence of harvest regulations. Women and children were the primary sea cucumber collectors, opportunistically gleaning in the shallows. Catch were sold to local traders in gutted or pre-processed form at very low prices proportional to size and processing quality.

During the project, educational campaigns and training activities were conducted in various aspects of sandfish aquaculture – from the hatchery, nursery, grow-out, sea ranching and processing. Actual demonstrations of the best practices in the culture process and value chain of sandfish were effective in enhancing awareness and capabilities of local partners, while local government enacted relevant regulations. Even during the restrictive times of the COVID19 pandemic, sea cucumber stocks were maintained and monitored in the nurseries and ranch. Furthermore, active engagement among partners (i.e. local community, government, technical and funding institutions) in the planning and implementation of activities has ignited the growing interest of many others, including women members, to participate even in tasks originally participated in by men (e.g. guarding duties at night).

Based on our case, the following are key in establishing and sustaining a community-based sea cucumber production venture: (1) environmental suitability of site; (2) committed organized community with strong decisive leadership; (3) sustained long-term commitment from government and financial support institutions; (4) reliable sources of seeds or an on-site hatchery; (5) efficient and updated technical support; and (6) clear trade and market channels.

CRISPR-BASED RAPID ONSITE PATHOGEN (CROP) TEST KIT FOR SHRIMP

Anburaj Amaladoss*, Wan Ying Koh, Kaelyne Tan, Syed Musthaq Syed Khader, Kadamb Patel and Lee Chee Wee

Centre for Aquaculture and Veterinary Science
School of Applied Science
Temasek Polytechnic
Singapore 529757
Email: anburaj@tp.edu.sg

Aquatic animal disease management is crucial to aquaculture, and thus, investment in disease control is vital to success and sustainability. Intensification of shrimp farming has led to the development of several diseases which result in enormous loss in shrimp production within the farm with subsequent significant economic impact to the farmer. The current diagnostic methods used by local farms and regulatory bodies such as Singapore Food Agency (SFA) is real-time polymerase chain reaction (PCR). The real-time PCR is lab based, requires expensive equipment and skilled personnel for data interpretation. Therefore, there is a pressing need to develop a diagnostic tool that is not only sensitive and specific but also simple to execute and capable of providing rapid results either onsite or directly at shrimp farms. In response to this need, we have successfully leveraged Recombinase Polymerase Amplification (RPA) and CRISPR-Cas12a technologies to devise a novel diagnostic test. This test enables the simultaneous detection of three major pathogens affecting shrimp: white spot syndrome virus (WSSV), infectious hypodermal and hematopoietic necrosis virus (IHHNV), and *Enterocytozoon hepatopenaei* (EHP).

Initially, we conducted monoplex RPA assays followed by detection with Cas12a, achieving robust fluorescence signals for all three pathogens. Encouraged by these results, we optimized multiplex RPA (mRPA) assays for simultaneous detection of the three pathogens. The mRPA products, labeled with distinct fluorophores, exhibited intense fluorescence corresponding to WSSV, IHHNV, and EHP. Subsequent limit of detection (LOD) studies revealed a sensitivity of 1 copy per reaction for monoplex RPA/Cas12a assays and 50 copies per reaction for multiplex RPA/Cas12a assays. Furthermore, validation using simulated field samples demonstrated the reproducibility and accuracy of our test in detecting pathogens within the complex genomic background of shrimp.

In conclusion, our CROP test kit offers a rapid, sensitive, and multiplexed approach for diagnosing shrimp diseases. It holds immense promise for improving disease control practices, minimizing economic losses, and fostering the long-term sustainability of the industry. Moving forward, we are working on integrating these technologies into a microfluidic device to facilitate on-farm testing, thereby reducing the need for specialized equipment and expertise. This advancement holds promise for enhancing disease management practices and ensuring the sustainability of shrimp aquaculture.

ESTABLISHMENT OF DISEASE: PATHOGENICITY, LD50 AND CLINICAL SIGNS OF MARINE TILAPIA AGAINST *Vibrio parahaemolyticus*

Amalin-Sofea, AR.* and M. Nur-Nazifah

Kulliyyah of Science
International Islamic University Malaysia (IIUM)
Bandar Indera Mahkota, Jalan Sultan Ahmad Shah
25200, Kuantan, Pahang, Malaysia
amalinsfa46@gmail.com

Marine red hybrid tilapia is a type of tilapia fish that is ideal for both fresh and marine water farming. This fish is popular among both producers and consumers due to its hardy culture natures and its white and red appearances. Due to the demand, the production of this marine hybrid tilapia needs to be increased. However, hybrid tilapia has been facing disease outbreak caused by *Vibrio parahaemolyticus* resulting in mortality in the aquaculture farm. *V. parahaemolyticus* is a pathogenic bacterium that inhabit temperate and tropical estuarine, marine and coastal environments.

Therefore, the objective of this study is to determine the pathogenicity and LD50 of *V. parahaemolyticus* in marine red hybrid tilapia. A total of one hundred marine red hybrid tilapia with the average weight of 5.5 ± 0.5g were used in this experiment. Four different concentrations of *V. parahaemolyticus* used are 1×10^9 cfu/mL, 1×10^8 cfu/mL, 1×10^7 cfu/mL and 1×10^6 cfu/mL and were injected intraperitoneally including phosphate buffer saline or PBS solution as control. Observation of clinical signs and mortality of fish were carried out for 14 days to determine the LD50 and pathogenicity. The earliest clinical sign was observed at concentration of 1×10^9 cfu/mL as early as 4 hours post infection with red eye and passive swimming behaviour as in Figure 1. Other clinical signs that were observed throughout the experiment including haemorrhagic body parts such as operculum, fins and tails, congested kidney, elongated spleen and also patchy liver. The first mortality was recorded at 4 hours post infection in the tank where fish were injected with 1×10^9 cfu/mL and it also accumulated the highest cumulative mortality which was recorded at 100% mortality rate. No mortality was observed from the control tank. From the experiment, the value of LD50 was calculated at $1.2977\text{x}10^8$ cfu/ml (Figure 2). In conclusion, based on the results of pathogenicity and LD50, *V. parahaemolyticus* are pathogenic in marine hybrid Tilapia and could cause mortality.

Figure 1: Red eye (up) and hemorrhagic upper and lower mandible (down)

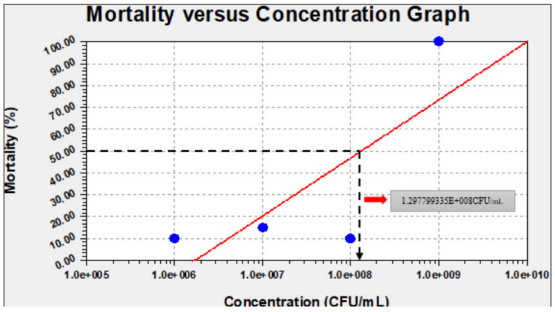


Figure 2: Graph of percentage mortality against concentration

PRODUCTIVITY AND ECONOMICS OF REDCLAW CRAYFISH, *Cherax quadricarinatus* AND HYBRID LEMON FIN BARB (*Barbonymus gonionotus* ♀× *Hypsibarbus wetmorei* ♂) POLYCULTURE WITH OR WITHOUT PHYSICAL SEPARATORS IN A CLOSED RECIRCULATING SYSTEM

S M Nurul Amin*, Azeezat Adenike Junaid, Mohd Salleh Kamarudin, Wahab Puteri Edaroyati, Quazim Olawale Junaid, Nicholas Romano, Ravi Fotedar

Curtin Aquatic Research Laboratories
School of Molecular and Life Science
Faculty of Science and Engineering
Curtin University, Bentley, Perth
Western Australia 6102, Australia
Email: smnurul.amin@curtin.edu.au

The polyculture of benthic and pelagic aquatic animals can enhance sustainability and profitability in aquaculture. For this to be possible, adverse intraspecific interactions must be minimised. In this two-part study, hybrid lemon fin barb (*Barbonymus gonionotus* ♀ × *Hypsibarbus wetmorei* ♂) (HLFB) and red claw crayfish, *Cherax quadricarinatus* were monocultured or polycultured at increasing crayfish densities in an intensive recirculating aquaculture system (RAS) without physical separation (Trial 1) or with separation (Trial 2). In both trials, the two controls were the monoculture of HLFB (C1) and crayfish (C2). The ratios of fish: crayfish were T1 (75:25), T2 (50:50) and T3 (25:75) for trial 1; while T1 (75:25), T2 (75:50) and T3 (75:75) for trial 2, respectively. After 12 weeks, growth, feeding efficiency, and total production of the HLFB and crayfish were measured. In Trial 1, HLFB growth and feeding efficiency were significantly improved with polyculture, but crayfish survival, growth and feeding efficiency significantly worsened when polyculture. Economic analysis revealed the monoculture of crayfish was more profitable in Trial 1, with a loss of profit in T2 and T3. In Trial 2, crayfish survival significantly declined in T3 versus T2, but no significant differences in growth or feeding efficiencies of either species were found across treatments. Economic analysis showed that crayfish monoculture was still the most profitable in net return. Still, the benefit-cost ratio was the highest and similar for HLFB across all treatments. Polyculture can spread risk compared with monoculture, but a physical separator is necessary to eliminate intraspecific competition.

MASS PRODUCTION OF GIANT TREVALLYFISH SEEDS (*Caranx ignobilis*) AT AMBON MARICULTURE DEVELOPMENT CENTER

Hamsah A, R. Subiyanto and Hariyano

Ambon Mariculture Development Center
Jl. Leo Wattimena, Waiheru-Ambon
e-mail: ambonbpbla@gmail.com

The Carangidae family is a group of pelagic fish that has important economic value. Fish from this family are very popular with the people of Maluku, especially the trevally fish. The success of hatching is largely determined by the availability of parents, both in terms of the number and quality of eggs produced. So far, the eggs produced are of very good quality, namely FR 85% and HR 85 to 90%. Meanwhile, activities for handling larvae up to a seed size of 3 cm can reach an SR of 45% of the number of eggs stocked. The method used was an experimental method in which observations were made of the quality of trevally fish eggs, hatchability and survival of the larvae to become 2 cm fry with two egg stocking treatments, where each tank had a capacity of 10 m3 and zooplankton enrichment was carried out. that is: Stocking density 15 grains/liter or 150,000 grains for the first rearing tank (A), Stocking density 20 items/liter or 200,000 items for Second maintenance tank (B). The results obtained were that the hatchability of 150,000 eggs stocked was 86% and the hatchability of 200,000 eggs stocked was 85%. The SR of seed stocked with 150,000 birds is 45% (20,846) and the SR of seed stocked with 200,000 is 40% (20,933).

OVERVIEW OF DANGEROUS CONTAMINATION FROM HEAVY METALS AND BIOTOXINS IN SHELLFISH AND WATERS ON THE NORTH COAST OF JAVA

Sofian Ansori*, Niezha Eka Putri, Tiara Aprina

Center For Fish Health And Environmental Assessment
Ministry of Maritime Affairs and Fisheries of Indonesia
sofian.ansori91@gmail.com

Cultivate of shellfish products that enter the market must meet food safety standards. In order to support the achievement of this system, it is necessary to monitor and analyze the content of dangerous contaminants including heavy metals and biotoxins in shellfish products as well as heavy metal content in waters where shellfish are cultivated. The aim of this activity is to analyze the content of dangerous contaminants in marine waters and sediments for shellfish cultivation activities on the north coast of Java and to analyze the content of heavy metals and biotoxins in shellfish.This review of the shellfish sanitation program can identify locations for developing shellfish cultivation and Aquaculture in other marine and brackish sectors. so as to produce Aquaculture and shellfish products that are safe for consumption and obtain supporting data on which waters are suitable for sustainable Aquaculture programs.

The sampling points are based on shellfish cultivators located along the North Coast of Java with the highest production levels. The samples taken included sea water, sediment and several types of shellfish that could be consumed. Water samples taken at a certain surface and depth. Sediment is taken from the bottom of the waters where the shellfish live. the results of observations and analysis in the laboratory.

Sediment from station 6 had heavy metal Hg levels exceeding the maximum limit. Shellfish samples at stations 4 and 5 had biotoxin contents of 6.86 mg/kg and 3.52 mg/kg, respectively. This value is above the quality standard required in the Decree of the Minister of Maritime Affairs and Fisheries (KEP.17/MEN/2004). Areas whose biotoxin contamination values are above the threshold are included in class D based on existing regulations in Indonesia.

ENSURING SEAFOOD SAFETY AND PREVENTING FRAUD: THE ROLE OF BAP AND BSP CERTIFICATION

Syamsul Arifin

Global Seafood Alliance
Country Coordinator for Indonesia

With the increasing globalization of the seafood industry, ensuring the safety and authenticity of seafood products has become paramount. In response to this challenge, various certification programs have been developed, among which Best Aquaculture Practices (BAP) and Best Seafood Practices (BSP) certifications stand out as leading initiatives.

This abstract explores the significance of BAP and BSP certifications in guaranteeing seafood safety and preventing fraud along the seafood supply chain. BAP certification encompasses a comprehensive set of standards covering aquaculture practices, social responsibility, food safety, and environmental sustainability. Likewise, BSP certification focuses on ensuring the integrity of seafood products by verifying their origin, processing methods, and adherence to quality standards for wild caught species.

By adhering to these certification standards, seafood producers and suppliers demonstrate their commitment to transparency, traceability, and responsible practices. Consumers benefit from increased confidence in the safety and authenticity of the seafood they purchase, while retailers and restaurants can enhance their reputation by offering certified products.

Moreover, these certifications serve as effective tools for combating seafood fraud, which encompasses mislabeling, substitution, and other deceptive practices. Through rigorous audits and inspections, BAP and BSP certifications help to identify and address potential vulnerabilities in the seafood supply chain, thereby reducing the risk of fraud and ensuring compliance with regulatory requirements.

In conclusion, BAP and BSP certifications play a crucial role in safeguarding seafood safety and integrity. By promoting accountability, transparency, and ethical practices, these certifications contribute to building a more sustainable and trustworthy seafood industry for the benefit of all stakeholders.

SUPPLY CHAIN ANALYSIS, CHALLENGES AND OPPORTUNITIES IN THE AQUACULTURE INDUSTRY (CASE STUDY: KARIMUN JAWA, CENTRAL JAVA)

Paramaditya Arismawati*, Ayu E. Wahyuni, Rahaditya D. Prihadianto, Abduh S. Albana, Wahyu A. Prastyabudi and Rahmalia Nurhalissa

Telkom University
Surabaya, East Java 60231
paramadityaars@telkomuniversity.ac.id

Aquaculture with floating net cages off the northern coast is growing industry that benefits coastal communities. Offshore Floating Net Cages (KJA) is a large-scale, high-tech, and modern fish farming method that adopts aquaculture technology from Norway. This technology is effectively used to promote increased production and sustainable utilization of potential farming areas. The purpose of this research is to identify the supply chain, analyze added value, understand the industry status, distribution networks, challenges, and opportunities in the aquaculture industry. The research method employs both quantitative and qualitative descriptive methods with the Food Supply Chain Network (FSCN) approach. This research can advance and add value to grouper fish aquaculture on the northern coast of Java.

EFFECT OF BUFFER PROTECTED SODIUM BUTYRATE IN THE DIET OF *Penaeus vannamei* SHRIMP CHALLENGED WITH NITRITE

Marta Arredondo Luque*, Maria Érica da Silva Oliveira, Joice Teixeira Souza, Matheus Ramalho de Lima, Beatriz Saldaña, Marisela Arturo-Schaan

Novation 2002, S.L. Ctra. Aguilar de Montuenga
km 2. 42250 - Arcos de Jalón, Soria, España
marredondo@novation2002.com

Intensive systems in aquaculture sectors induce stressful conditions and therefore, finding functional feed additives that can counteract the negative performance is one of the the most important issues. Protected sodium butyrate (PSB) has multiple e□ects on the immune system and health status as well as on growth performance The present study aimed to assess the impact of the dose of a PSB on the zootechnical performance and resistance to challenge of *Penaeus vannamei* shrimp.

In this experiment 4 treatments were designed which only differ in the level of inclusion of the PSB (0, 2, 4, and 8kg/t of PSB. PSB was provided by Novation SL 2002 (Spain) with 54% sodium butyrate protected by a physical and chemical matrix of buffer salts. Each treatment was replicated 4 times, except for the Control which was replicated 8 times. Animals were captured from 20% of the initial biomass for weighing and obtaining live weight data (g/shrimp), feed intake (g/shrimp), and feed conversion ratio(g/g). At the end of the experiment, a survival test, and acute nitrite toxicity test was conducted. A preliminary assessment was performed to determine the nitrite dose with minimal lethality and the time required to kill 80-90% of the animals based on exposure to the challenge (DL90). The data were subjected to analysis of variance (ANOVA).

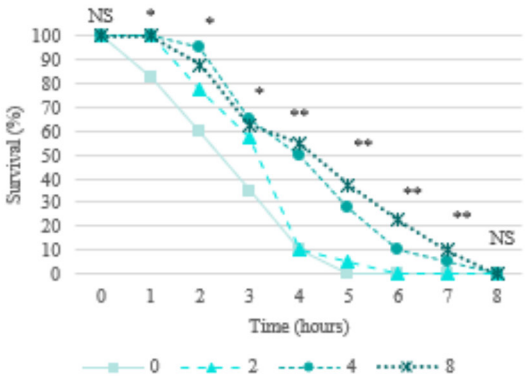
Body weight was increased (P<0.05) as PSB dose increased at all ages estudied. Also, feed conversion ratio was improved as PSB dose increased at all ages estudied (P<0.05). The survival during challenged with nitrite shown an reduction in shrimp fed with diets with PSB.

In conclusion, productive performance has improved linearly as the dose of PSB increased. Similar results have been observed in morbility and survival after nitrite challenge.

Table 1. Effect of different doses of PSB on body weight (BW, g/shrimp) and feed conversion ratio (FCR, g/g) of Vannamei shrimp.

	PL65	PL86	PL100	PL114	PL128	PL145
			BW			
PSB dose (kg/ton)						
0	0.735b	1.779b	3.194b	5.536b	6.913b	11.20c
2	0.835a	2.260a	3.549b	5.666b	8.524b	14.84b
4	0.846a	2.501a	4.442a	6.631ab	9.067a	15.88ab
8	0.853a	2.486a	4.916a	7.467a	9.403a	17.24a
P value	0.0015	0.0002	<0.001	<0.001	<0.001	<0.001
Linear	0.0040	0.001	<0.001	<0.001	<0.001	<0.001
Quadratic	0.0440	0.008	0.153	0.864	0.006	<0.001
CV	3.8700	10.9	8.29	6.03	7.41	5.31
			FCR			
PSB dose (kg/ton)						
0	0.863a	2.056a	1.809a	1.587a	1.750a	1.804a
2	0.718b	1.435b	1.665b	1.549a	1.356a	1.255b
4	0.715b	1.219c	1.259c	1.306ab	1.313b	1.204b
8	0.703c	1.157c	1.056c	1.105b	1.233b	1.067b
P value	0.0005	0.0144	<0.001	<0.001	<0.001	<0.001
Linear	0.0030	0.015	<0.001	<0.001	<0.001	<0.001
Quadratic	0.0130	0.103	0.264	0.988	0.012	0.002
CV	7.7600	29.46	11.9	8.86	10.19	10.75

Figure 1. Effect of DL90 of nitrite determined in a preliminary test on survival of shrimps fed with diets with PSB at different doses, evaluated over 8 hours.



HARNESSING EFFICIENT GENETIC IMPROVEMENT TO MAXIMIZE ECONOMIC RETURN

Adriana Artiles*, John Buchanan, Marcos de Donato, Carlos Pulgarin, Peter Kube, Jeff Prochaska, Panagiotis Kokkinias, Alejandro Gutierrez, Klara Verbyla, Simon Hill

*Presenting author: Adriana Artiles
The Center for Aquaculture Technologies
8445 Camino Santa Fe, Suite 104
San Diego, CA, 92121 USA
aartiles@aquatechcenter.com

Genetic improvement programs play a pivotal role in maximizing productivity and profitability in various industries, including aquaculture. This talk presents a comprehensive analysis of the Investment Returns (IR) for genetic improvement investments in shrimp, specifically focusing on different breeding strategies: mass selection, family selection, and genomic selection.

The findings demonstrate that all three breeding strategies contribute to long-term economic benefits for companies investing in genetic improvement. Mass selection, a traditional method based on phenotypic evaluation, allows for genetic progress over generations, leading to improved performance and profitability but with a lower IR than the other strategies. Family-based selection, which involves selecting and breeding individuals from superior families, provides enhanced genetic gains and economic returns. Genomic selection, a cutting-edge approach utilizing genomic information, enables rapid genetic progress by accurately predicting the genetic merit of individuals and by allowing for within family selection, producing the highest economic and genetic gains.

The comparative analysis reveals that genomic selection outperforms mass and family selection in terms of IR. By harnessing genomic information, companies can make more precise breeding decisions, resulting in accelerated genetic gains and higher profitability. However, mass selection and family selection remain viable options for companies with limited genomic resources or specific breeding objectives. Mass selection, despite having lower accuracy, still offers considerable genetic progress and cost-effective improvement opportunities. Family selection, on the other hand, provides greater control over specific traits and allows for customized breeding goals, making it suitable for specialized markets or niche product lines.

The analysis also reflects the challenges and considerations associated with each breeding strategy. Genomic selection requires substantial investment in genomic technology, data management, and skilled personnel. Mass selection may necessitate larger population sizes to maintain genetic diversity, while family selection demands careful family management and increased record-keeping efforts.

In conclusion, genetic improvement investments utilizing different breeding strategies offer substantial IR in the long term. While genomic selection stands out as the most efficient and accurate approach, mass selection and family selection remain viable alternatives depending on the specific needs and resources of the company. Understanding the economic impact and trade-offs of each breeding strategy enables companies to make informed decisions and optimize their genetic improvement investments.

EFFECT OF LOCAL ISOLATE VACCINE *Edwardsiella ictaluri* FOR PREVENTION OF ESC *(Enteric Septicemia of Catfish)* DISEASE IN STRIPE CATFISH *(Pangasionodon hypophthalmus)* IN JAMBI

Indri Astuti[1*)], Yudho Adhitomo[1*)], Maftuch[2*)], Happy Nursyam[2*)]

1. Balai Perikanan Budidaya Air Tawar Sungai Gelam, Jambi
2. Universitas Brawijaya, Malang

Email : indriavirgo4ra@gmail.com

One of the obstacles in cultivating catfish (Pangasionodon hypophthalmus) is the presence of Enteric Septicemia of Catfish which is caused by infection with the bacteria Edwardsiella ictaluri. One of the control efforts is to use a vaccine that has high compatibility with the agent that causes the disease. Vaccines from local bacterial isolates are generally more effective in controlling bacterial diseases. The isolate came from Siamese catfish which showed symptoms of ESC infection and was identified biochemically and serologically as the gram negative bacterium Edwardsiella ictaluri. Vaccine production is carried out using the heating method (heat killed) and stored in PBS solution. This research used Siamese catfish measuring 50-70 grams/fish with vaccine doses of 10^6 cfu/mL, 10^8 cfu/mL, 10^{10} cfu/mL and PBS (control). The results of the pathogenicity test were virulent bacteria and the LD_{50} value was 0.13 x 10^8 cfu/mL. Observations of fish behavior include vertical swimming, weakness, decreased appetite. Macroscopic observation revealed red spots (hemorrhage) on the skin, swollen abdomen, white spots (nodules) on the liver, kidneys and lymph. Histopathological observations on the liver showed pyknotic, karyorrhexis, necrosis, fatty degeneration and melano macrophage center. The conclusion is that the E. ictaluri vaccine with a concentration of 10^8 cfu/mL can reduce the death of Siamese catfish.

INCREASING FOOD SECURITY THROUGH THE CONTRIBUTION OF FISHERIES IN THE DEVELOPMENT OF THE AQUACULTURE SECTOR

Azwardi* , Paiman Eko Prasetyo, Alghifari Mahdi Igamo, Wahyu Aji Wijaya

Department of Economics Development
Sriwijaya University, Palembang, Indonesia
azwardi@fe.unsri.ac.id
State University of Semarang
Faculty of Economics and Business, Indonesia

Aquaculture is expected to continue at a faster growth rate than other major food production sectors due to increases in average per capita intake of animal protein in the form of fish. Due to its increasing importance, the aquaculture sector faces many challenges to produce fish sustainably and this impacts per capita fish consumption levels. Therefore, we project various ship conditions starting from capture fisheries, such as the number of fisheries with various types of models, the second is the quantity of workers in the fisheries sector, the third is from the type of fishing equipment with manual or modern technology, and the fourth is from the level of fishery productivity produced. and at what level the welfare of fishermen is. The discussion of this research is limited to using data from 34 provinces in Indonesia during 2019-2022.

From the results of descriptive statistics, the value of fish consumption in provinces in Indonesia is relatively uneven, especially in several provinces such as Yogyakarta and Lampung with the lowest levels of fish consumption, namely around 35.57 kg per capita and 37.02 kg per capita in 2022. Apart from that The level of fishing productivity in Jogjakarta is classified as very low, namely 7,066.85 tonnes in 2022 with the fishermen's exchange rate or fishermen's welfare level below 1 percent (Table 1). From the explanation above, it can be concluded that from a social, economic and technological perspective, fish can be consumed as the main food in married life.

Overall, the volume of fisheries productivity, the number of fishing vessels, the number of fishing fishermen and fishing equipment have a significant correlation and influence on the level of fish consumption in Indonesia, except for the level of welfare of fishermen and fishermen's fishing households (Table 2). The government needs to pay attention to how the price index received by fishermen through household consumption, health, transportation, education, as well as rent and other expenses makes fishermen's fishing less prosperous so that it will have an impact on fishermen's ability and desire to consume fish, which is the majority of their fishery products, only limited to buying and selling and does not extend to empowering and cultivating fish.

TABLE 1. Descriptive Statistics

	Mean	Median	Maximum	Minimum
AKI	55.37	55.56	79.49	33.35
NTN	101.72	101.25	117.46	91.45
PRO	213517.0	193841.40	617197.20	6370.40

TABLE 2. Coefficient Results and Significance on Fish Consumption Levels

Variable	Coefficient	Prob.
C	45.211520	0.0203
NTN	0.061970	0.7448
PRO	0.000052	0.0003
RTPN	-0.000079	0.2340
JKP	0.000797	0.0031
JNP	-0.000145	0.0036
JAPI	-0.000458	0.0468

THE SINCERITY OF THE DATA: AN ESSENTIAL CONDITION TO ACHIEVE PRECISION SHRIMP FARMING AND OPTIMIZE COST AND PRODUCTIVITY, ESPECIALLY WHEN USING INTELLIGENT DATA ANALYSIS

Regis Bador

Innov'Aquaculture
BP 1001
98874 Pont des Français
New Caledonia
regis.bador@innovaquaculture.com

In difficult times of rising input costs and declining selling prices, shrimp farmers are looking more than ever to reduce their production costs. Feed consumption represents their highest cost of production, and their productivity is generally summed up in their yield in pounds/kilos per hectare, partially linked to the weekly growth and survival achieved in each pond.

Precision aquaculture has been one of the recently promoted developments. It consists of controlling as precisely as possible the different production parameters that influence costs and productivity. The increase in connected electrical and electronic equipment in recent years has made it possible to generate a large amount of data and many applications. Digital platforms with intelligent data analysis use them. However, even with artificial intelligence, it is difficult to take advantage of this large volume of data if such data is not reliable, and even worse, manipulated or modified for whatever purposes.

A first example is the non-taking into account of the % of "free" postlarvae at the time of stocking, not only for the reason that they were not invoiced and therefore cannot appear in the "inventories" but also for the objective of presenting an apparent false good survival at the end of the cycle. The perverse effects of this behavior are the risks of (a) underfeeding, because they do not appear in the calculations of biomass to be fed, (b) reaching a higher real biomass that the culture system can support, preventing the best development of the shrimp in the right good conditions. They may represent a significant loss of economic efficiency and accuracy, or relevance, of automated production models.

The second example is the manual modification of certain figures of weekly weight samples, just to be able to present a "linear" weekly growth and/or close to the targets to please the hierarchy. It doesn't make much sense since, as everyone knows, due to the moulting stages with variable frequency, the increase in the weight of a shrimp is not the same every day, or every 3 or 7 days. The perverse effects of this behavior are the risks of (a) wrongly estimating the biomass to be fed in the following days and even the biomass to be harvested, (b) wrong feeding growth models and everything related to those data!

The current situation of modern shrimp farming requires a modernization of spirits to keep improving the efficiency of the sector. This will only be possible with as much sincerity as possible from the data generated, especially from data controlled by people.

THE PROVISION OF BEST QUALITY SEA BASS SEEDS (*Lates calcarifer*) IN ORDER TO EMPOWER AQUACULTURE COMMUNITY IN ACEH

Baharuddin*) , Ramelan**) , Bakhtiar Sah Putra***)

Advanced Implementing Fisheries Supervisor at BPBAP Ujung Batee*
Junior Fisheries Supervisor at BPBAP Ujung Batee **
Junior Aquaculture Analyst at BPBAP Ujung Batee ***

Sea bass (*Lates calcarifer*) is one type of carnivorous fish that is in great demand for enlargement efforts both in ponds and in Floating Net Cages (KJA). Apart from its economicvalue, this type of fish is very easy to cultivate because of its predatory nature, so that it canutilize wild fish as a source of feed. The activity of sea bass grows out pond in Aceh have been growing from year to year so that the need for seeds of various sizes has also increased significantly. In line with the increase in seed demand by farmers, the nursery businesssegment has naturally been created in several districts in Aceh Province, namely in Bireun,North Aceh and East Aceh.

In 2019 and below, Farmers generally supply seeds from Bali, Batam and Lampung at relatively expensive prices because they use air transportation, besides that thequality of seeds has decreased due to long transportation distances. This problem is one ofthe obstacles for larval rearing at this time. Therefore,Brackish Water AquacultureCenter (BADC) Ujung Batee Aceh continues to carry out mass seed production as an effortto facilitate the farmers to access to the best quality and quantity at an affordable price for sea bass fish seed breeders in Aceh.

Fulfillment of sea bass fish seeds in Aceh is done by mass producing sea bass fish seeds by observing the rules of Good Aquaculture Practices (GAP). A goodsea bass hatchery method starts from the preparation of broods tock spawning tanks, brood stock selection, brood stock feeding, natural broods tock spawning, harvesting of Sea bass eggs, preparation of larval rearing containers, stocking of sea bass eggs, hatching, larvae rearing and feeding, water quality management, disease prevention management, seed sorting, seed harvesting to seed packing and transportation.

Sea bass seed production at BPBAP Ujung Batee which is distributed to farmers in Aceh has increased from year to year, in 2020 seed production reached 650,000 seeds andin 2021 it increased by 62.23% with total production reaching 1,074,000 seeds and in 2022it increased by 11.68%, reaching 1,199,500 seeds and finally in 2023 it also increased by 87.57% with total seeds reaching 2,250,350 seeds. The distribution of sea bass fish seeds in the last four years has been spread across three districts, namely Bireun, North Aceh andEast Aceh.

With the existence of sea bass fish seeds originating from BPBAP Ujung Batee,the community of sea bass farmers in Aceh is greatly helped in terms of seed prices and seed quality. In terms of seed prices, farmers have received thedifference in purchase prices by buying seeds from BPBAP Ujung Batee and buying seedsfrom outside the Aceh areas, which reaches 20-40 rupiah per fish, while in terms of seed quality, it can be concluded that seeds originating from BPBAP Ujung Batee have a survival rate of 90% comparing with seeds originating from outside Aceh which only have a survival rate of 50%.

WORKING WELFARE INDEX FOR PANGASIUS IN MEKONG DELTA

Tạ Hoàng Bảnh[1], Dr Lê Thanh Hải[1], Dr Phạm Quang Huy[1], Dr Piotr Eljasik[2], Prof. Remigiusz Panicz[2] , Trịnh Thị Thanh Hòa[1], Lê Thi Mai Anh[1], Nguyễn Thị Kim Hương[1], Nguyễn Kim Kha[1], Huê Quốc Hòa[1], Huỳnh Thanh Sơn[3]

([1]): Dong Thap Community College
([2]): organisation: PSCG –LUTREOLA
([3]): Pangasius Farming in Cao Lanh district, Dong Thap province

As consumers in developed countries start to demand fish welfare from their supermarket, we are working toward a technical platform to measure it in our farms. The research program in Community College of Dong Thap also aims at giving our students, who are also involved in the project, an earlier engagement in this new science. An interdisciplinary approach is applied, using from fish behavioral study to human philosophy of concepts, in a try-and-error process. Main tasks include taking photos and intestinal measurement of pangasius widely raised in the Mekong Delta, interviewing farmers and technical observation of farm conditions.

UNLOCKING THE POTENTIAL OF PANGASIUS AND TILAPIA SEED PRODUCTION IN NEPAL: A CASE STUDY ON HATCHERY MANAGEMENT AND TRAIINING (USAID/CRS FARMER TO FARMER PROGRAM)

Amrit Bart

College of Agriculture and Environmental Sciences, ADS
University of Georgia, GA 30602 USA
abart@uga.edu

Over the past decade, aquaculture in Nepal has experienced steady growth, with annual increases of 3-4%. However, the potential for more rapid expansion is constrained by the limited availability and access to high-quality fry and fingerlings for stocking. This assessment aimed to evaluate the status and challenges of fish seed production in Nepal and to provide foundational training on the seed production of *Pangasius hypophthalmus* and *Oreochromis niloticus*.

The three-week assessment comprised a comprehensive desktop review, visits to hatcheries and fish farms, and several focus group discussions with farmer groups, hatchery operators, and government and extension organizations. Seed production training was conducted for 60 participants (across three batches) at the Fisheries Development Center (FDC) in Chitwan, the Aquaculture-Agriculture & Forestry University, and the Institute of Agriculture and Animal Sciences in Bhairahawa. The training covered the breeding of both pangasius and tilapia, incorporating on-farm visits, presentations, and discussions on broodstock management, breeding techniques, larval rearing, and live food production.

Hatcheries primarily produce carp in semi-intensive systems, with only a few producers of pangasius and tilapia fry and fingerlings. Fish seed supply is limited and seasonal, despite increasing demand, with highly variable quality. The quality of tilapia and pangasius fingerlings imported from across the border is inconsistent, with mortality rates ranging from 35-70%. Genetically known strains of broodstock are limited to a few government facilities and are not available to hatcheries. There is a general lack of knowledge and skills in broodstock management, breeding, and hatchery operations, particularly concerning tilapia and pangasius seed production.

The recommendations included establishing centralized national broodstock centers to maintain, improve (through strain selection and selective breeding), and disseminate high-quality broodstock fry and fingerlings to public and private hatcheries. Enhancing the technical capacity of hatchery managers and technicians is crucial. Modernizing facilities, including essential hatchery equipment and management plans, is also necessary. Developing and implementing seed quality assurance mechanisms, such as seed certification, will help ensure the consistency and reliability of fish seed quality.

The key findings and recommendations from this assessment were provided to USAID's Farmer-to-Farmer Program to support further advancement of aquaculture production in southern Nepal.

HEALTHY STARTS: INTEGRATING STRESSCEUTICALS IN FISH AND SHRIMP LARVAL MANAGEMENT

Kartik Baruah*, Sineka M. Pathiranage, Rifat N. Shanta, Mieke Eggermont and Parisa Norouzitallab

Department of Applied Animal Science and Welfare
Faculty of Veterinary Medicine and Animal Sciences
Swedish University of Agricultural Sciences
750 07 Uppsala, Sweden

E-mail: kartik.baruah@slu.se

The availability of high-quality fish and shellfish larvae is crucial for the success of the aquaculture industry, as it directly impacts the performance and survival rates of the animals in the growth-out phase, thereby impacting the industry´s economic viability and sustainability. While many fish and shellfish larvae are produced in the hatcheries, their survival rates are often low or highly variable, and the potential of the (shell)fish to reach their genetically predetermined maximum growth is never fully reached. Stress induced by negative interactions between the larvae, microbial communities, and the environment is the major reason for the poor viability, quality, and even mortality during larval rearing. There has been a continuous effort to develop new and effective strategies to produce high-quality (shell)fish larvae. Over the past decade, our research group has focused on investigating specific nutraceuticals derived from natural and sustainable sources with adaptogenic properties. Here, we present findings from studies conducted in laboratory and semi-industrial settings by our research group and others, highlighting the effectiveness of a nutraceutical formulation in building robustness in both fish and shrimp larvae against stressors arising from environmental and pathogenic factors.

TOWARD SUSTAINABLE BLUE FOODS: ECOSYSTEM-BASED ASSESSMENT OF BIVALVE STOCKS IN A HYPER ARID COASTAL WETLAND

Leila Basti[1,2*], Mouna rifi[3], Fabio Crocetta[4,5]

[1]Department of Integrative Agriculture, College of Agriculture and Veterinary Medicine, United Arab Emirates University, Al Ain, Abu Dhabi, United Arab Emirates
[2]Department of Ocean Science, Faculty of Marine Environment and Resources, Tokyo University of Marine Science and Technology, Minato, Tokyo, Japan
[3]Research Lab Aquatic Ecosystems and Resources, National Agronomic Institute of Tunisia, 43 Avenue Charles Nicolle, 1082 Tunis, Tunisia
[4]Integrative Marine Ecology Department, Stazione Zoologica Anton Dohrn, Villa Comunale, 80121, Naples, Italy
[5]NBFC, National Biodiversity Future Center, Palermo Piazza Marina 61, 90133 Palermo, Italy
bastileila@gmail.com

Food systems are a major driver of climate change, as well as the loss of biodiversity globally. Therefore, the need to transform food systems has never been as urgent as now. Blue Foods - that is algae, macrophytes, shellfish, and fish harvested in marine and freshwater ecosystems - is seen as a sustainable healthy alternative source of proteins and nutrients to over 3.2 billion humans. This is particularly important for coastal communities of low- and middle-income countries, usually working in small scale systems. In the era of climate change, the collapse of fisheries stocks and the environmental issues caused by aquaculture call for the expansion of sustainable food production systems, even better if relying on environmentally friendly, ecosystem-based culture and/or extraction of blue foods, such as shellfish.

Within this global effort to shift food production systems, the present study was undertaken to assess the bivalve stocks available for exploitation and culture in a hyper arid RAMSAR wetland ecosystem in North Africa. We assessed, quantified, and mapped a series of variables, including the general biodiversity as a mirror of the health of the wetland ecosystem, the local pollution as a proxy of the overall water-sediment quality, and the major environmental factors that affect bivalve stocks, such as temperature, salinity, and hydrodynamics.

The results revealed that 9 species of bivalves are available in the area. Their stocks and distributions, however, were variable and depended mainly on temperature, salinity, and hydrodynamics. Among them, 3 species of bivalves had the highest potential for fisheries and aquaculture. All species, however, showed negative allometries, which reflects major perturbations in the environmental factors, i.e. high temperature and high salinities associated with a hyper arid climate, as well as climate change. In addition, altered hydrodynamics favor continuous deposition and shifting of coastal sediments, concomitant to altered water exchange with the Mediterranean open sea at the East and with the Boughrara lagoon at the West of the wetland.

Climate change and coastal ecosystem alterations related to a change in the land use-land cover on the island bordering the wetland in the north are expected to have an impact on bivalve stocks available as a sustainable blue food (fisheries and aquaculture development) for coastal communities, notably women who are engaged in the shellfish industry, living at 20% in acute poverty and poverty in a region battered by climate change and economic instability. Future studies of the feasibility of developing integrated shellfish-based production systems should be undertaken.

IMPLEMENTATION OF UNCLOS 1982 ON CAPTURE FISHERIES BUSINESS IN CASES OF *ILLEGAL FISHING* IN THE WATERS OF THE INDONESIAN EXCLUSIVE ECONOMIC ZONE (IEEZ)

Habson Batubara*, Lisa Mery, Patawari, Sitti Faridah, Mohammad Syaichuddin, Hamzah, Akmal, Abdul Gafur, Iman Sudrajad, Lideman, Yuani Mundaya, Syamsul Bahri, Kamaruddin, Muslimin, Herlina, Elisa Winanda, Joula Sondack, Nani Undap , Suciati, Arfandi

Research Centre for Fishery
National Research and Innovation Agency
Cibinong Bogor
University of Eastern Indonesia Makassar
habs001@brin.go.id

This study aims to determine the status of the Law and its Implementation against Foreign Nationals (FN) Illegal Fishing Business Actors in the waters of the Indonesian Exclusive Economic Zone (IEEZ), based on the Indonesian Positive Law and UNCLOS 1982. The research method used is juridical normative with a qualitative approach to study the Fisheries Criminal Verdict (Tipikan) and the Bitung District Court / Fisheries SIPP from 2019 to 2020. The results show that cases of *Illegal Fishing* by Foreign Nationals (FN) in the Indonesian Exclusive Economic Zone (IEEZ) are examined, tried and decided in accordance with the Fisheries Law, Criminal sanctions are incompatible and contrary to Indonesia's Positive Law, both Criminal Law and Fisheries Law, but follow and are in line with UNCLOS Year 1982. Legal Status and liability are only imposed on the Master as the leader on board the Ship as a representative of the ship owner/Corporation. Meanwhile, the implementation of Indonesia's positive law against Unclos in 1982 is only in the form of fines, confiscation of evidence. As an effort to seek compensation for *Illegal Fishing* Actions in the Waters of the Indonesian Exclusive Zone (IEEZ).

LOWER COST AND MORE SUSTAINABLE PRODUCTION OF HIGH VALUE SINGLE CELL PROTEIN THAT HAS BEEN OPTIMISED AS A FISHMEAL REPLACEMENT

An Grobler*, Geoffrey Bell, Ana Alfaro-Chávez, Paul Attfield and Philip Bell

Microbiogen Pty Ltd
Level 4, 78 Waterloo Road
Macquarie Park, NSW, 2113, Australia
an.grobler@microbiogen.com

As the rapidly growing aquaculture industry expands to meet humanity's ever-increasing appetite for protein, the demand for fishmeal – a primary ingredient in aquafeeds - is on the rise. Unsustainable harvesting practices have depleted wild fish stocks and has led to a surge in fishmeal prices over recent years. Deploying protein alternatives that are more sustainable, higher value to the customer and cost-effective is needed. The protein alternative must be comparable to fishmeal in terms of protein content, amino acid composition, palatability and digestibility and this has posed significant challenges which MicroBioGen is addressing through its deep technology, elite genetics development program.

MicroBioGen leads the world in the development of novel and improved strains of *Saccharomyces cerevisiae.* This yeast is the world's leading microorganism workhorse with over US$2 trillion in products annually relying on it for production. After 20 years of technology development, MicroBioGen has successfully partnered with Novozymes (Novonesis) and now leads the world in supplying superior yeast strains to produce 1st and 2nd generation bioethanol. Billions of litres of extra biofuel are being produced as a result of utilising MicroBioGen developed yeast strains. MicroBioGen's elite genetics technology is now being optimised and deployed in the production of single cell protein+ from large scale biofuel and dairy waste/side streams. These waste/side streams include biodiesel, dairy and bioethanol which are rich in compounds such as glycerol and organic acids.

Some of the additional features that have been added to *Saccharomyces cerevisiae* yeast by the MicroBioGen team to improve sustainability, lower production costs and increase value to the customer, include the following:

- Ability to grow at industrial rates and productivities on glycerol, xylose and various organic acids as well as retain typical C6 sugar yields and productivities.
- Protein content of 15% to 20% higher than typical *Saccharomyces cerevisiae* yeast.
- An excellent amino acid profile (to be disclosed in the presentation).
- Accumulation of enzymes to replace exogenously added enzymes, e.g. phytase.
- Palatability, along with the option to accumulate antioxidants such as glutathione.
- The organism has been 100% developed utilising non-GM technology, thus reducing compliance issues and increasing unit value.

The above features allow single cell protein to be grown on non-sugar waste/side streams at industrial rates, making it cheap to produce and higher value than other single cell protein options. This paper will highlight the value of various added features, amino acid profile and impact on production costs and unit value amongst others.

EVALUATION ON THE EFFECTS OF *Halamphora* sp. ADDITION ON BLACK TIGER SHRIMP (*Penaeus monodon*) POST LARVAE CULTURED IN INDOOR BIOFLOC SYSTEM

Mohd Ihsanuddin Ahmad*, Ikhsan Natrah, Murni Karim, Clement Roy De Cruz, Muhammad Farhan Nazarudin, Hazwani Hanim Hasnan, Ninie Noor Diana

Laboratory of Aquatic Animal Health and Therapeutic (AquaHealth)
Institute of Bioscience
Universiti Putra Malaysia
43400 UPM Serdang
Selangor, Malaysia

Halamphora sp., a benthic diatom has been known to improve growth and nutritional value of aquatic animals. Biofloc, a zero-water exchange system consisting of multiple organism aggregates could act as natural food in an aquaculture system. It could improve aquaculture productivity through enhanced nutritional values leading to increased growth and survival. Biofloc also reduces pathogen proliferation, improving animal immunity and enhancing biosecurity. Addition of probiotics such as microalgae and bacteria in biofloc system can further enhance the nutritional profile and health aspects of shrimp culture. This study aims to assess the impact of adding a microalga *Halamphora* sp. on the growth, water quality, disease resistance, and nutritional composition of the Black tiger shrimp (*Penaeus monodon*) grown in rice bran biofloc system. The evaluation of *P. monodon*'s growth performance such as the final weight, specific growth rates (SGR), feed conversion ratios (FCR), and survival rates were performed weekly. The nutritional composition of both *P. monodon* and the biofloc, including their FAME components, were also determined. Water quality parameters were concurrently monitored each week. Sub-samples of *P. monodon* were also challenged with *Vibrio parahaemolyticus* and mortality rates for each treatment were recorded. The results showed that *P. monodon* treated with rice bran biofloc and *Halamphora* sp. showed higher growth and survival rates compared to controls without any microalga and carbon source addition. The *Halamphora* sp. addition in rice bran biofloc in *P. monodon* culture also improves water quality parameters, including nitrate, nitrite, and orthophosphate level. Enhanced total suspended solids (TSS) and floc volume (FV) was also observed with improved nutrient content such as the essential fatty acids that include PUFA, Omega-3, MUFA, Omega-6, and DHA. Challenge test result showed lower shrimp mortality rates in treatment added with the microalgae and rice bran. In the histological examination of challenged *P. monodon*'s hepatopancreas from the control group, more intense hepatopancreatic cell lesions and necrotic cells were noted while *P. monodon* treated with rice bran biofloc and *Halamphora* sp. were observations of sloughed epithelial cells in the tubule lumens and haemocyte infiltration, with minimal lesions. In summary, *Halamphora* sp. addition to a biofloc system with rice bran improves *P. monodon* post larvae and could potentially lead to the development of more sustainable and cost-effective practices in shrimp farming. Furthermore, the reduction in pathogen proliferation could minimize the reliance on antibiotics, leading to a healthier and safer product for consumers.

FIELD EFFICACY OF GARLIC *Allium sativum* EXTRACT AGAINTS BACTERIAL DISEASE (VIBRIOSIS)

Fahmi, M. F.*, Shaharah, M. I. and Firdaus-Nawi, M, A. Azila

Marine Fishes Aquaculture Research Division
Fisheries Research Institute
Tanjung Demong, 22200, Besut, Terengganu, Malaysia
faisalfahmi2121@gmail.com

Vibriosis is very important disease mainly in the marine culture industry that affects a wide range of farmed and wild fish as the bacteria can cause severe economic losses to the farmer. The use of synthetic antibiotics such as oxytetracycline to control the vibriosis have developed the antibiotic-resistant microorganisms. Herbs are considered the best alternative and one of the herbs with strong antioxidant and antibacterial properties is garlic (*Allium Sativum*). Thus, this study investigates the disease resistance against *Vibrio sp*. infections in Asian sea bass, *Lates calcarifer*, immunity and growth rate effect by garlic (*Allium sativum*) supplemented feeding. A total of 2000 juvenile Asian sea bass at size 2.8 inch were distributed equally into four 10-ton liter tank to represent two group with a replicate. Two group of Asian sea bass juvenile were fed with different feed that were normal feed (control) and feed supplemented with garlic extract 80% concentration. Garlic juices extract supplemented to fish feed were 50ml/kg of fish feed and given two times daily with 5% of fish body weight. The initial of bacterial isolation shows there are wild vibriosis found in the liver and kidney of the fish. After the garlic juice-extract application, the isolation of wild vibriosis found in the liver and kidney of the fish were reduced. Isolation of *Vibrio sp*. in the kidney and liver of treated fish is significantly lower than untreated after one month onwards. There was no significant difference of growth rate between both group after 3 months of application. However, significant increase in the growth rate were observed after 3 months onwards. The results show that garlic juice-extract supplemented to fish feed increased immunity by making Asian sea bass more resistant to wild *Vibrio sp*. infection and enhancing the growth performances. These findings imply that garlic juice-extract, at 80% concentration, might be used as an immunostimulatory supplement in Asian sea bass production and also can replace oxytetracycline to control the Vibriosis. Yet, more extensive research, including a full commercial cost benefit analysis, is required before suggesting the use of garlic juice-extract in aquaculture.

TUNA BY-PRODUCT MEAL ON GROWTH, WHOLE-BODY MERCURY, PHOSPHORUS LOAD AND PLASMA CHEMISTRY IN JUVENILE GREATER AMBERJACK, *Seriola Dumerili*

Amal Biswas*, Shota Shirakawa, Daisuke Nakayama, Satoshi Okimura, Tomoki Honryo, and Hideki Tanaka

Aquaculture Research Institute, Uragami Station
Kindai University
Wakayama 649-5145, Japan
biswas@kindai.ac.jp

In recent years, the search for potential alternatives to fish meal (FM) has been a global issue due to the shortage of supply, and price surge of FM. Although several sources of protein from plant-based and animal by-products have been used in different species, there are several limitations in some of those products and the availability is species-specific. Therefore, it is necessary to continue to look for more reliable alternative protein sources. Although the availability of tuna by-product meal (TBM) has been determined in different species, as far as we know there is no report on this aspect in the greater amberjack, *Seriola dumerili.* Hence, the availability of TBM as a replacement of FM in the diet of juvenile greater amberjack was investigated from its effect on growth, mercury (Hg) levels in fish whole-body, phosphorus (P) load in the ecosystem, and plasma chemistry.

FM was the main protein source in the control diet (C), and FM protein in C was replaced by TBM at 25%, 50%, 75%, and 100% to formulate the diets TM25, TM50, TM75, and TM100, respectively. The experiment was set in triplicate by stocking 30 juveniles (mean weight about 6.7 g) in each 500 L tank.

After a 42-day rearing period, there were no significant differences in growth, nutrients digestibility and productive value between diets C and TM25. However, the quadratic polynomial regression analysis suggests that the optimal dietary levels of TBM against final weight is 14.5%. A significant linear correlation was found between Hg in diet and fish whole-body, but the level was much lower to pose health risk to humans. Due to a lower intake of P from TBM-based diets, P load was significantly reduced compared to the control group. Plasma levels of total protein, total cholesterol and albumin in diets TM75 and TM100 were significantly lower compared to those of diets C, TM25 and TM50. The results suggest that 14.5% of FM protein can be replaced by TBM in the diet of the juvenile greater amberjack and that a significant reduction in P load can be achieved from the TBM-based diet.

LOSS OF GENETIC DIVERSITY DUE TO HATCHERY PRACTICES IN THE HIGH-VALUE SEA CUCUMBER *Holothuria scabra*

Kelly T. Brown*, Paul C. Southgate, Epeli M. Loganimoce, Teari Kaure, Brian Stockwell, Monal M. Lal

Australian Centre for Pacific Islands Research
University of the Sunshine Coast
Maroochydore, Queensland, Australia
and
School of Agriculture, Geography, Environment, Ocean and Natural Sciences
The University of the South Pacific
Suva, Fiji
kelly.brown@usp.ac.fj

Hatcheries are critical for seed production of commercial aquaculture species, and vital in supporting wild population recovery and augmentation efforts, selective breeding programmes and conservation management. For many broadcast and mass-spawning species however, they can be capricious environments where genetic diversity may be lost due to small effective broodstock population sizes, variable broodstock contributions and differential survival of family groups, thus impacting the genetic fitness of offspring cohorts. Assessment of genetic variability in cultured species is therefore critical for addressing these problems and optimising propagation methods. This study used 6,051 genome-wide SNPs to analyse the genetic diversity, parental contributions and kinship of offspring during a commercial-scale hatchery production run of sandfish (*Holothuria scabra*), a high-value sea cucumber grown in mariculture operations across the Indo-Pacific region. Broodstock contributions were found to be highly skewed, with up to 26% of the total parent pool contributing and kinship analyses determined that just two parents sired between 44.4-67.5% of all offspring genotyped. Effective population sizes were reduced as expected between broodstock and offspring groups (N_{eLD}=1,121.2 vs. 19.4, respectively), while losses of allelic diversity but not overall heterozygosity were apparent. Numbers of families surviving (13-16) to the juvenile stage were low, suggesting low effective population sizes among offspring cohorts is an issue for sandfish hatchery operations. To address variability in family compositions and broodstock contributions, pedigree tracking and batch spawning may be used to optimize broodstock management and hatchery protocols, to ensure production of genetically diverse offspring for routine culture and restocking operations. Given that many sandfish broodstock are sourced from the wild, the maintenance of healthy wild populations is crucial as reservoirs of genetic diversity. Furthermore, selecting distantly-related genetically diverse individuals for spawning, is recommended to enhance the genetic fitness of sandfish populations within hatchery settings.

FIGURE 1. A: Selection of broodstock used during spawning run. B: 300 L tank used for broodstock conditioning and spawning. C: Sandfish broodstock spawning. D: tissue sample collection for DNA extraction

APPLICATION OF NUCLEOTIDES IN SHRIMP DIETS BEFORE AND AFTER DISEASE CHALLENGE: EFFECTS ON PERFORMANCE, DIGESTIVE ENZYMES AND IMMUNOMODULATION

Stijn Bruwiere*, Katelijne Bekers

MicroHarvest GmbH
Kasernenstrasse 12
21073 Hamburg, Germany
stijn.bruwiere@microharvest.com

Nucleotides are the building blocks of DNA and RNA and involved in many important physiological processes. In *Penaeus vannamei,* nucleotides can be supplied through the feed to support growth performance and enhance disease resistance. A first study was conducted to evaluate the effect of different inclusion levels of nucleotides on the growth, feed conversion rate, production of digestive enzymes and immunity in shrimp under non-challenged culture conditions. In a second experiment, the mortality and immune gene expression after a disease challenge with White Spot Syndrome Virus (WSSV) was analysed.

In a 8-week feeding trial at Kasetsart University (Thailand), one control diet (CTRL) and three diets with different (LOW, MED, HIGH) inclusion levels of nucleotides (extracted from bacterial cells) were tested, each in 7 replica tanks with 35 juvenile shrimp. Daily weight gain could be significant ($p<0.05$) improved from week 6 onwards for MED and HIGH inclusion levels. At week 8, FCR was 14% ($p<0.05$) lower for HIGH inclusion. Analyses of the digestive enzymes at week 8, showed higher activity of chymotrypsin (+38% for MED) and lipase (+63% for MED) in all nucleotide groups. After 8 weeks of feeding, the nucleotide groups exhibited a higher hemocyte count, hemolymph protein level and superoxide dismutase activity (Figure 1).

At IMAQUA (Belgium), after a 3-week adaptation period, a WSSV challenge test was performed with a control group and a diet containing the LOW level of nucleotides. The mortality after 14 days was reduced by 42% ($p=0.07$) in the nucleotide group. Furthermore, looking at the difference in relative gene expression (qPCR) during the period before and at the end of the challenge, upregulation of SOD (superoxide dismutase) was more pronounced ($p=0.08$) in the nucleotide group (Figure 2). These results suggest that the immunomodulating effect of nucleotides could result in an upregulation of crucial genes, leading to higher survival rates after disease challenges.

FIGURE 1: Effect on immunity parameters after 8 weeks of feeding.

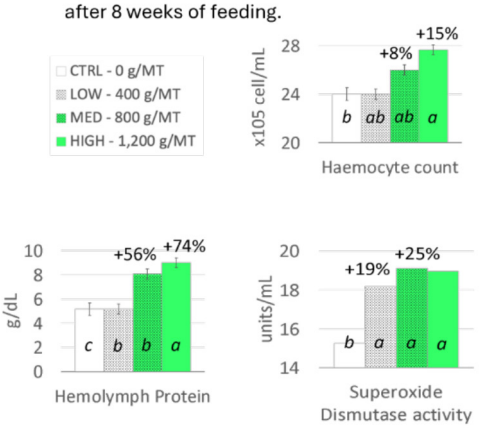
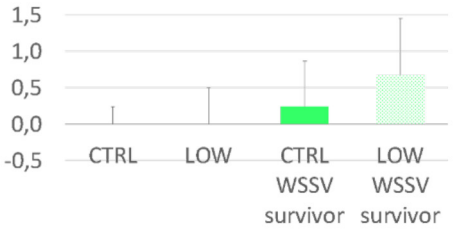


FIGURE 2: Relative expression (log 10) of superoxide dismutase before and after challenge.



PREVENTION, QUICK DETECTION, INTERVENTION AND CONTROLLING GUIDELINES OF *Enterocytozoon hepatopenaei* INFECTION POND

Heny Budi Utari*, Radi, Agung Gunawan, Bambang Indiadie, Guruh Suryawan and Dean M. Akiyama

Animal Health Service
Technology and Shrimp Improvement Division
Central Proteina Prima Company of Indonesia
Heny.utari@cpp.co.id

The emergence of disease in shrimp has governed much concern in biosecurity among shrimp farms with the recent reports on hepatopancreatic microsporidiosis (HPM) caused by *Enterocytozoon hepatopenaei* (EHP). The microsporidians present in shrimp remain a silent pathogen that prevents optimal shrimp growth. However, the biggest threat is in shrimp farm concerns, which is the primary focus in ensuring biosecurity. Hence, the objective of this report is to summarise the current knowledge of EHP and its infection in shrimp with technical guide. First, this paper provides an prevention before stocking fry, quick analysis of the diagnostic methods for detecting EHP infections in shrimp aquaculture. Interventions with controlling biomass, average daily growth and sampling technique would be the second approach to addressing EHP diseases. The third approach is the using probiotics and organic acid for controlling biodiversification microorganisms and preventing Vibrio growth in the shrimp gut. Finally, a systematic guideline for shrimp pond and intervention is proposed. Thus, this study was aimed to shed light on effective methods for the prevention of EHP infection in shrimp. We also include application on enhancing innate immune biomolecules as future targets in the intervention strategies on the microsporidiosis life cycle in shrimp and its environment. Overall, this will result in reduced disease outbreaks in shrimp aquaculture, ensuring the shrimp production in pond by biosecurity and technical application in the future.

PROGENY TEST OF MALE RESULTING FROM SEX TRANSFER IN CLIMBING PERCH *Anabas testudineus*

Bunasir*, Syafrudin, Muhammad Tahir

Balai Perikanan Budidaya Air Tawar Mandiangin
Direktorat Jenderal Perikanan Budidaya
Jl. Tahura Sultan Adam Km. 14 Mandiangin Kec. Karang Intan, Kab. Banjar South Kalimantan- 70661
bbatmandiangin@gmail.com

Climbing Perch fish are thought to have different growth rates related to sexual dimorphism, female Climbing Perch fish grow faster than male fish, so there is potential for monosexual female cultivation.

The activity was carried out at the Mandiangin Freshwater Aquaculture Development Center (MFADC). The results of the masculinization activity by oral of the hormone 17□-methyltestosterone through feed at a dose of 50 mg/kg feed for 30 days in papuyu fish aged 14 days after hatching resulted in a male ratio reaching 94.19% - 100%, the masculinized fry were then raised for 12 months until they became broodstock. , then a progeny test is carried out to determine the functional male sexual status.

Results of the progeny test on 120 male papuyu fish resulting from sex reversal, mated with normal female fish (1: 1) and six functional males were obtained. The sexual status of functional male fish is proven by the female sex ratio value of 81.10% - 93.90% in one population of test fish offspring. This confirms that masculinization techniques in Papuyu fish can produce functional males. If the masculinization process is repeated on the next offspring, it will be certain that the juvenile fish will produce perfect functional males (neomales), which will facilitate the mass production of female Papuyu seeds.

PERFORMANCE PARENT OF SNAKEHEAD *Channa striata* MAINTENED IN CONTROLLED BATS IN THE AQUACULTURE DEVELOPMENT PRACTICES IN THE COMMUNITY

Bunasir*, Rohana Hidayati, Agung Hardika Tahalea, Sarmani

Balai Perikanan Budidaya Air Tawar Mandiangin
Direktorat Jenderal Perikanan Budidaya
Jl.Tahura Sultan Adam Km.14 Mandiangin Kec.Karang Intan, Kab. Banjar Kalimantan Selatan- 70661
bbatmandiangin@gmail.com

Various efforts have been made to increase the production of *C. striata*, one of which is the domestication and aquaculture development practices. Information about the aquaculture series of *C. striata* has been driven by the Mandiangin Freshwater Aquaculture Development Center (MFADC).

This paper discusses the application and sustainability of providing the good quality broodstocks and fingerlings of *C. striata* at MFADC. Furthermore, the performance of fingerlings applied to pond culture at the level of fish farmers also discussed and compared to the result of the previous applied research. Broodstocks production at MFADC is currently available as many as 2700 productive fish with an average size of 278.1 ± 47.34 g/male and 285.4 ±32.77 g/female. The resulting fecundity was 10162 ±296.67 eggs/female with Fertilization Rate 84.65 ±12.35% and Hatching Rate 79.23 ±21.44%. Fingerlings performance in fish farmer's rearing ponds with a stocking size of 19.22 ± 4.60 g/fish and a stocking density of 70 fish/m^2 resulted in a survival rate of 79.6% with a harvest size of 391.33 ± 48.04 g/fish during seven months of rearing period.

Internal and external factors that influence the success and sustainability of *C. striata* farming business are reviewed using a SWOT analysis with eight internal factors and six external factors. This study also produces five technical and non-technical recommendations for increasing production and ensuring the sustainability of the *C. striata* farming business which leads to multi-stakeholder synergy.

EARLY RELEASE OF JUVENILE SANDFISH *Holothuria scabra* IN OCEAN NURSERY PENS

Olivier Josh C. Caasi*, Glaiza S. Ibañez, Marie Antonette Juinio–Meñez

The Marine Science Institute
University of the Philippines Diliman
Quezon City, Philippines 1101
Marine Environment and Resources Foundation Inc.
University of the Philippines Diliman
Quezon City, Philippines 1101
occaasi@up.edu.ph

Expanding the culture of juvenile sandfish *Holothuria scabra* faces limitations due to constrained space and the associated high operational costs. To reduce the hatchery rearing phase, floating fine mesh nets (1 mm) *hapas* (2 m × 1 m × 1.2 m) have been established as a viable ocean nursery system for the mass production of >3 g juvenile *H. scabra* in the eutrophic coastal waters of Bolinao, Pangasinan, Philippines. Subsequently, ocean nursery pens are utilized as an intermediate nursery to grow juvenile sandfish larger sizes (>20 g) prior to release for grow out in the sea ranch or for restocking managed areas. This study explored the possibility of shortening the floating hapa rearing period and use of sea pens in rearing smaller juvenile sandfish (≤1 g; 2.4 ± 0.3 cm). Comparisons on the growth and survival of juvenile sandfish were determined in a 90-day field experiment using two types of pens (2 m^2): covered (n=9) and uncovered (n=9), with the same batch of juveniles maintained in the floating hapa (n=10) as control. Average weights were significantly higher in pens with (27.9 ± 11.1 g) or without cover (27.2 ± 14.8 g) than in the floating hapa (8.2 ± 2.4 g). The burying behavior of juvenile sandfish also did not differ significantly between the type of pens, with most individuals able to bury within a 24-h period. However, juvenile survival was significantly higher (82.9 ± 13.4%) in the floating hapa than both pens, with covered (9.2 ± 19.9%) having significantly lower survival than uncovered (29.7 ± 21.4%) pens. Earlier release of juveniles from the floating hapa to the sea pens produced larger juvenile over a shorter period but fewer numbers. Although pen rearing reduces the vulnerability of juveniles to varying sea surface conditions, juveniles were exposed to benthic predators such as crabs thus, the low survival even in the covered pens. Further studies to improve the survival of small juveniles in the ocean nursery pens may reduce the period to grow the juveniles to release sizes > 20 g; likewise, the costs of ocean nursery rearing compared to floating hapas. This will also allow more batches of juveniles to be reared during the 5–6-month dry season without increasing investments in additional floating hapas and pens. The two phases of ocean nursery systems can be further optimized to increase juvenile production for grow-out and restocking.

SEEKING MICROBIAL BIOMARKERS TO MONITOR THE HEALTH OF PENAEIDAE LARVAE IN HATCHERIES: META-ANALYSES SURVEY OF REARING WITH CONTRASTED LARVAL SURVIVALS IN NEW-CALEDONIA

Nolwenn Callac*, Carolane Giraud, Dominique Pham, Nelly Wabete and Viviane Boulo

Ifremer, IRD, Université de la Nouvelle-Calédonie
Université de La Réunion
CNRS, UMR 9220 ENTROPIE
101 Promenade Roger Laroque
98897, Nouméa, New Caledonia
nolwenn.callac@ifremer.fr

In New-Caledonia, *Penaeus stylirostris* is farmed in semi-intensive mode and is one of the main economic inputs for the territory. However, for the last decades, this sector has been facing huge larval mortalities occurring at all larval stages in hatcheries, for which no causes have yet been found. Dysbiosis of the microbiota of the rearing water and/or of the larvae are suggested as factors leading to larval death. Indeed, aquacultured animals are reared in water hosting various microorganisms with which they are constantly in close relationships. Microbial exchanges between the animal and the water can occur but little is known about the interactions between the shrimp larvae and their environment, especially in shrimp hatcheries Thus, detecting stage specific biomarkers of healthy and unhealthy larvae for later developing monitoring tool of the rearing might be useful to help the farmers.

To highlight specific microbial lineages and biomarkers associated with the larvae, we have studied the daily microbial compositions of the larvae reared in different conditions along with the storage waters. Illumina sequencing of the V4 region of the 16S rRNA gene coupled to zootechnical parameters and statistical analysis allowed us to link microbial lineages and biomarkers to a given larval stage and mortality rate.

Our results underline that the active microbiota associated with the larvae was highly dynamic with 3 main clusters corresponding to the different larval stages: 1) eggs and nauplii, 2) zoea and 3) mysis; irrespective of the survival rate. Deeper analysis exhibited that various active lineages were specifically associated with a given larval stage and survival rate; while several of them were shared between various conditions (Figure 1). When these taxa were compared to the storage waters microbiota, many of them were previously detected in the natural seawater; emphasizing the great role of the natural seawater on the larval microbiota. The biomarker exploration allowed to identify microbial genera that were specific of healthy or unhealthy larvae; biomarkers that might be used as monitoring tool to survey the larval health and to predict the fate of future rearing.

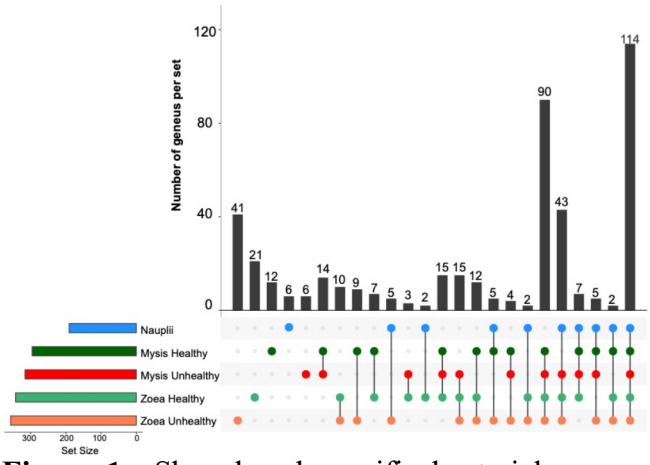


Figure 1 : Shared and specific bacterial genera from the larvae according to their stage and survival. Healthy stands for good survival rate and unhealthy for high mortality rate.

WE DON'T KNOW WHAT WE DON'T KNOW – HOW THE USE OF INFORMATION TECHNOLOGY INTEGRATED WITH OPERATIONAL TECHNOLOGY IS CHANGING AQUACULTURE

Andrew Campbell, CEO AQ1 Systems

Email: andrew@aq1systems.com
AQ1 Systems
2 Mackay Ave, Glenorchy
Tasmania, Australia

Aquaculture operations worldwide are embracing smart farming technology, transitioning from traditional, experience-based practices to precision aquaculture. This shift is fueled by innovations in smart technology, including artificial intelligence (AI), machine learning, smart sensors, cloud computing, and robotics. These advancements allow farmers to collect and analyze vast amounts of data from crops and livestock, revolutionizing the industry.

The convergence of information technology (IT) with operational technology (OT) is a game-changer. The "Internet of Things" (IoT) enables real-time data collection, monitoring, and process automation. For instance, in shrimp farming, emerging technologies automate feeding, monitor environmental conditions, and alert production staff when issues arise. The benefits include reduced costs, improved shrimp health, higher crop yields, increased profits, and greater operational efficiency.

Despite technological advancements, human involvement remains crucial. Augmented intelligence, where humans collaborate with smart machines, represents the next phase of aquaculture technology. Large corporate farms may be better positioned to invest in these technologies, but barriers such as adoption costs and fear of change persist. How each country's farmers adapt to this paradigm shift has the potential to determine the industry's long-term viability.

During this presentation we will explore how information and operational technology can combine to improve our understanding and optimization of the feeding strategy for pond reared shrimp.

THE BLUE ECONOMY COOPERATIVE RESEARCH CENTRE PATH TO SUSTAINABLE INTEGRATED SYSTEMS FOR OFFSHORE AQUACULTURE: PROGRESS IN 2024

Chris G. Carter*, Irene Penesis, Sarah Ugalde, Lindsey White, Angela Williamson, John Whittington

Blue Economy Cooperative Research Centre
Institute for Marine and Antarctic Studies (IMAS)
University of Tasmania, Private Bag 49
Hobart, TAS, 7001, Australia
Email: chris.carter@utas.edu.au

Two expanding and critical parts of the blue economy are the use of marine based renewable energy sources and seafood production from marine aquaculture. Established in July 2019, Australia's Blue Economy Cooperative Research Centre (Blue Economy CRC) is aimed at unlocking the potential of the nation's ocean resources through sustainable development (www.blueeconmycrc.com.au). Australia and New Zealand have some of the world's largest Exclusive Economic Zones, they offer extensive access to offshore locations with unrealised potential for aquaculture (Gentry et al., 2017) and renewable energy. The Blue Economy CRC brings together 44 partners from 10 countries to generate opportunity by using established and new practices to move renewable energy and seafood production offshore safely, economically and sustainably. To facilitate this, the Blue Economy CRC contributes to building effective pathways for offshore development by investing in international and regionally relevant R&D. This activity explores potential synergistic benefits that include shared resources, efficient use of ocean space, less competition amongst other user groups of marine space, reduced operational and maintenance costs from possible shared activities. Key impacts are to increase sustainability and build community trust in blue economy industries. The aim here is to provide a brief overview of national offshore prospects and detail some R&D building blocks, current and required, that address barriers to realising the opportunities for offshore co-location and/or integration of both renewable energy and aquaculture production systems. The focus will be on knowledge gained form current Blue Economy CRC R&D building blocks and recent progress in identifying species and systems to underpin multispecies integrated seafood production in offshore locations.

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SUSTAINABILITY FROM THE SEA: HOW TO SELECT SPECIES FOR INTEGRATED OFFSHORE AQUACULTURE SYSTEMS IN AUSTRALIA AND NEW ZEALAND

Sarah Ugalde, Stewart Frusher, Flavio Ribeiro, Maren Wellenreuther, Lindsey White, Angela Williamson, Chris G. Carter*

Blue Economy Cooperative Research Centre
Institute for Marine and Antarctic Studies (IMAS)
University of Tasmania, Private Bag 49
Hobart, TAS, 7001, Australia
Email: chris.carter@utas.edu.au

In recent years, pressure on global food production has increased alarmingly. The Food Price Index, averaged across meat, dairy, cereals, vegetables, and sugar increased from between 91.9 to 98.1 over 2015 to 2020, to a peak of 143.7 in 2022 (FAO, 2024). There is an urgent need to shift food production toward food types, locations, and production systems that can enhance food security for a growing and increasingly wealthy human population while reducing environmental degradation (Halpern et al., 2022). Operating an offshore food production system poses considerable challenges, but despite this, there is an opportunity in which responsible farming can be developed based on scientifically sound information to ensure long-term sustainability. By moving away from traditional seafood production systems characterised by intensification, specialisation, and geographic concentration that potentially leads to negative anthropogenic impacts (Dumont et al., 2020), complementary layers of seafood production and marine products can be integrated within and between producers and other users. This purposeful integration of multiple species into offshore aquaculture systems could bring sustainability through increased productivity, efficient resource use, and increased farm resilience.

Fundamental to the success of integrated offshore aquaculture systems is systematic species selection. Although it's well understood that the integration of species, such as finfish with seaweed and shellfish, have the potential to improve sustainability, the process in which decisions on species selection should be made is lacking. This presentation will discuss a structured approach to rank species best suited for integrated offshore aquaculture systems across geographic regions, from temperature to tropical, in Australia and New Zealand. By doing so, a species selection process is demonstrated that explores which existing and emerging species could be viably integrated into offshore aquaculture systems thereby creating a pathway for future decision-making to support research or commercial investment.

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MASTERING OPERATIONAL WELFARE INDICATORS WITHIN THE ASC CERTIFICATION

Maria Filipa Castanheira

Aquaculture Stewardship Council
Daalseplein 101
3511 SX Utrecht, The Netherlands

Presenting author: maria.castanheira@asc-aqua.org

Aquaculture serves as a critical contributor to meeting the escalating global demand for seafood. The mission of the Aquaculture Stewardship Council (ASC) embodies this commitment by setting forth standards for responsible aquaculture practices on a global scale. As the aquaculture industry continues to expand, ensuring the health and welfare of farmed aquatic animals emerges as fundamental pillars in the pursuit of sustainable and responsible aquaculture practices, aligning seamlessly with ASC's vision.

ASC advocates for an operational definition of welfare, where operational welfare indicators serve as required tools for assessing and monitoring animal welfare. The implementation of a Fish Health and Welfare Management Plan, rooted in these indicators, ensures the establishment of sound management practices. Rather than imposing fixed values, emphasis is placed on addressing welfare aspects and adopting adaptable management practices that suit various farming contexts. ASC operational welfare indicators include essential factors such as, water quality parameters, morphological characteristics, behavioural patterns, and mortalities.

During this speech, we will delve into the significance of operational welfare indicators within the ASC certification framework and elucidate successful implementation strategies. Through the presentation of case studies and examples, we will showcase how the effective utilization of these indicators not only enhances animal health and welfare but also nurtures sustainable aquaculture practices and contributes to the long-term viability of the industry.

NON-FORMALIN BASED PROPOHYLACTIC TREATMENT OF MUD CRABS

Diana Chan*, Saravanan Padmanabhan, Huang Yun-Tzu, Germaine Lau, Deborah Chua, Md Arefin Rahman and Lee Chee Wee

Aquaculture Innovation Centre
Temasek Polytechnic
21 Tampines Avenue 1
Singapore 529757

*Diana_CHAN@TP.EDU.SG

Singapore is the second largest importer of mud crabs in the world after China as the crustacean is often consumed as part of the local iconic Singapore Chilli crab dish. The local demand for the crab far outweighs the supply that it could get from overseas imports. About 10 tons of crabs particularly Scylla serrata of sizes between 650 g and 1.5 kg are consumed daily. According to trade statistics (as of May 2023 by Volza's Singapore Import data), an average of 3,300 tons of mud crab as both live and chilled crabs are imported by Singapore annually from India, Vietnam and Sri lanka.

Due to the high local demand for mud crab consumption, research and development in mud crab hatchery was initiated by the Aquaculture Innovation Centre, Temasek Polytechnic. Wild caught mud crabs of sizes between 300 and 500 g purchased from mud crab importers are cleaned up and prophylactically treated before they are used for breeding or spawning.

The project aims to develop an alternative prophylactic treatment that is environmentally friendly and also safe for use. A comparative performance on the efficacy of using formalin, oxolinic acid and sodium per carbonate (SPC) in the prophylactic treatment of male and female mud crabs of about 250 g was studied over 3 days. Total coliform count was greatly reduced in SPC and oxolinic treated mud crabs as opposed to those treated with formalin. The preliminary observations would be further investigated using a larger sample size in future study.

IMPROVING SKIN HEALTH OF FISH VIA SUPPLEMENTATION OF A PHYTOBIOTIC-BASED ADDITIVE

I-Tung Chen*, Elissavet Arapi, Maria M. Isern-Subich, Joanne Cable, Antoni Ibarz and Waldo G. Nuez-Ortín

Adisseo Asia Pacific Pte Ltd
16 Raffles Quay, #20-05
Singapore 048581
i-tung.chen@adisseo.com

Fish skin acts as the first line of defense against pathogen invasion. Evidence suggests that skin defenses can be improved by preventive supplementation of health additives. In this study, the mechanisms of a phytobiotic-based additive (APEX®, Adisseo) in supporting fish skin health were investigated using the Guppy-*Gyrodactylus* infection model along with a shotgun proteomics approach. Guppies were fed a diet supplemented with the additive for 14 days, after which each fish was infected with *Gyrodactylus turnbulli* and continued to receive the additive for 17 days. The number of parasites in each fish was counted every 48 hours, and fish were classified based on their susceptibility to infection. Skin samples were collected on days 13 and 17, corresponding to the peak and the end of the infection, respectively. Protein identification and quantification of skin were conducted using nano LC-MS/MS. The differential expression of proteins regulated by additive supplementation in both responsive and resistant fish was assessed to determine the phytobiotic's mode of action in response to infection.

Two primary mechanisms for combating parasite infection were revealed. In responsive fish, the additive induces skin cornification at the peak of infection. However, in resistant fish, the additive activates the complement system. Overall, the results suggest that phytobiotic-based additives can enhance defense mechanisms against ectoparasite infection by strengthening physical barriers and immunocompetence. These findings provide insights into the dual protection effect of the additive, confirming its effectiveness as a preventive strategy to help fish deal with skin infections.

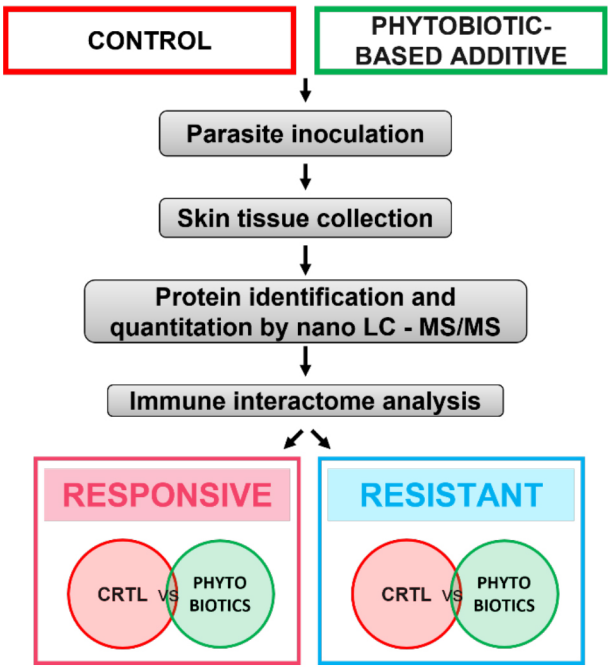


Figure 1 Schematic of using proteomics to reveal the immune regulatory effects of a phytobiotic-based additive.

GAINING INSIGHT INTO THE HEALTH PROMOTING MECHANISMS OF A PHYTOBIOTIC-BASED ADDITIVE IN HEPATOPANCREAS OF WHITE SHRIMP *Penaeus vannamei*

I-Tung Chen*, Carla Anjos Souza, Rayner Gonzalez-Prendes and Waldo G. Nuez-Ortín

Adisseo Asia Pacific Pte Ltd,
16 Raffles Quay, #20-05
Singapore 048581
i-tung.chen@adisseo.com

Phytobiotics are supplemented in functional shrimp feeds due to their potential to enhance disease resistance and promote growth performance. A key target organ for phytobiotics is the hepatopancreas, which is a driver of good health and fast growth. However, information on the molecular mechanisms by which phytobiotics deliver functional benefits is scarce.

This study aimed to investigate the molecular mechanisms by which a phytobiotic-based additive (Sanacore® GM, Adisseo) regulates hepatopancreas function in white shrimp, *Penaeus vannamei*. We compared the transcriptome of hepatopancreas of shrimp (2±0.3g) fed control feed versus 0.3% of the additive after 21 days. The transcriptome was sequenced using the TruSeq Stranded mRNA library on the NovaSeq6000 platform. Paired-end sequencing with 150 base pairs per read yielded approximately 25 million clean reads per sample, facilitating the identification, expression patterns, and enriched pathways associated with 13,022 genes. Comparative analysis between control and additive-supplemented shrimp revealed 1,556 differentially expressed genes (DEGs) ($p<0.05$). Among the 15 enriched pathways in the hepatopancreas of treated shrimp, peroxisome, oxidative phosphorylation, and branched-chain amino acids degradation pathways were upregulated and represented by the majority of DEGs. These pathways are key elements for optimal detoxification, immunocompetence, nutrient utilization, and energy production.

It was concluded that phytobiotics regulate key biological functions that ensure the optimal functioning of shrimp metabolism and, therefore, optimal health and growth performance.

ENHANCING MICROBIAL CONTROL IN ARTEMIA HATCHERIES: EVALUATING THE EFFICACY OF SANOCARE ACE-PRO IN MANAGING VIBRIO LOAD AND IMPROVING LIVE FEED QUALITY

L. Chiappi, S.Calloni, B.Hostins, T. De Wolf, G.Rombaut

INVE Aquaculture Research Center (IARC), 57016 Rosignano Solvay, Italy
INVE Aquaculture, Hoogveld 93, Belgium
l.chiappi@inveaquaculture.com

The importance of microbial control in the hatchery is well-known and it plays a crucial role in lowering the risk of disease outbreaks. In production facilities, bacterial contamination with potential pathogens can be managed by applying firm biosecurity rules and disinfection protocols.

Our study focuses on the microbial management in the artemia sector, with the use of Sanocare ACE-PRO controlling the microbial population developing in the live feed tank during the hatching and the enrichment of Artemia nauplii. Sanocare ACE-PRO has a broad-spectrum action and is active against gram-negative and gram-positive bacteria.

The efficacy of the product was assessed using both traditional plating methods on Marine Agar and TCBS, as well as flow cytometry analysis of hatching and enrichment water samples, analyzing the quantity and the viability of the cells in the microbial community and their activity.

Results demonstrated a significant reduction in bacterial load, with a 5-log reduction in CFU/mL of total bacteria and a 3-log reduction in CFU/ml of Vibrio species during both hatching and enrichment stages. Flow cytometry analyses further supported these findings, revealing a considerable decrease in intact microbial cells, particularly when Sanocare ACE-PRO was applied throughout both hatching and enrichment procedures (see Figure 1).

By enhancing water quality with SanoCare ACE-PRO, notable improvements were observed, including enhanced survival rates during enrichment and elevated HUFA (Highly Unsaturated Fatty Acids) content, reaching 52.2 mg.g-1 DW compared to 35.4 mg.g-1 DW in the control treatment.

These findings underscore the efficacy of Sanocare ACE-PRO in enhancing both the microbiological and nutritional quality of Artemia. This study highlights the significance of implementing robust biosecurity measures, such as utilizing Sanocare ACE-PRO , to optimize the culture conditions and overall health of Artemia populations, offering promising implications for improving shrimp culture practices.

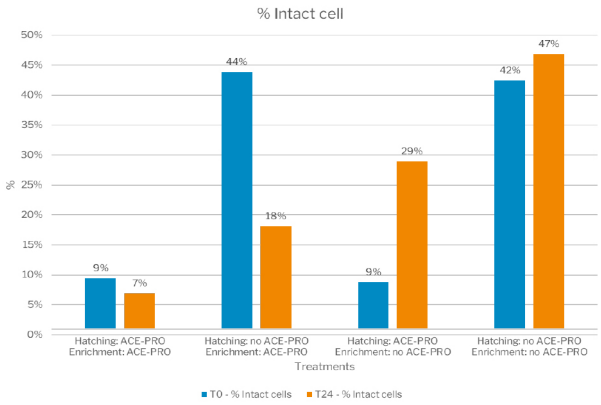


Figure 1. % of Intact cells after the enrichment of Artemia nauplii analyzed with the flowcytometry

BROODSTOCK MANAGEMENT AND POTENTIAL OF SEED PRODUCTION OF NAPOLEON WRASSE, *Cheilinus undulatus*

Ching Fui Fui * and Shigeharu Senoo

Higher Institution Centre of Excellence
Borneo Marine Research Institute
Universiti Malaysia Sabah
Jalan UMS, 88400, Kota Kinabalu
Sabah, Malaysia
cfuifui@ums.edu.my

Napoleon wrasse (*Cheilinus undulatus*) is one of the most high value marine fish in the international live trade market owing to its finest organoleptic qualities. Nevertheless, its endangered status on the IUCN Red List is attributed to unregulated overfishing, highlighting the crucial need to focus on captive breeding efforts through aquaculture. This study emphasized on the years of efforts to establish broodstock management of Napoleon wrasse under controlled condition aimed at producing their seed in captivity. A total of 60 adult Napoleon wrasse were kept in 150 tonnes tank equipped with filtration within a recirculation system and they were fed daily with enriched prey fish and alternately with squid. Hormone was injected to each fish few times in a year within 7 years and its growth and maturation were examined. Findings showed Napoleon wrasse attained an isometric growth pattern (b = 2.9487) with condition factor of above 0.2 indicating its excellent growth under captivity while maturation was seen in several females and fertilised eggs were obtained. Histological analysis had shown female attained maturing and matured stages. However, sperm was unable to obtain in all males hence comprehensive investigation of male Napoleon wrasse need to be highlighted in the future. This study's findings suggest that Napoleon wrasse can be successfully cultured and matured in controlled environments, showing promising potential for seed production through aquaculture.

MOLECULAR CHARACTERIZATION AND FEED INTAKE INCREASE OF GHRELIN IN STARRY FLOUNDER *Platichthys stellatus*

Youn-su Cho*, Hyun-seok Jang, Tae-min Kim, Hye-min Oh, Han-kyu Lim

Smart Aqua Farm Convergence Research Center
Mokpo National University
Muan, Jeonnam 58554
Whdbstn12@gmail.com

Starry flounder (*Platichthys stellatus*) is an important target species of aquaculture that can replace olive flounder, a large portion species of fish aquaculture. To shorten the breeding period of the starry flounder, the growth rate must be fast for high productivity. Among the factors that faster the growth, the increasing feed intake is directly related to growth. Ghrelin, an appetite hormone, has been reported to increase appetite in some fish species, but it is also necessary to confirm that any species did not increase the appetite. At first, the ghrelin genes were sympathized to confirm ghrelin's appetite synergy on the starry flounder. The ghrelin consists of 105 amino acids, including three exons and four introns. The expression of ghrelin mRNA was the highest in the stomach.

To confirm the correlation between the gastrointestinal transit time of the feed and the ghrelin expression, we checked the time that the feed was completely passed through at stomach. As a result, the feed passed completely through the stomach and then entered the intestine 24 hours after feeding. When confirmed by the picture of gastrointestinal dissection, the feeds were completely discharged from the intestine between 40 and 48 hours after feeding. Ghrelin expression was the highest at 48 hours after fasting, and the expression of Ghrelin was matched with gastrointestinal transit time. Based on these results, to maintain ghrelin expression, the gastrointestinal passage time must be considered.

It has been reported to stimulate food intake when Human ghrelin is injected into the goldfish. The food intake and growth were confirmed by injecting the human ghrelin (100 ng/g) into the intraperitoneal cavity of the starry flounder. Human ghrelin injections showed increased feed intake, growth hormone, feed efficiency, and growth rate. Based on the above research results, we confirmed the possibility of improving the growth of recombinant ghrelin and can be used as basic data for application research for improving growth by maintaining the level of ghrelin expression.

PALLIATIVE EFFECT OF ABALONE INSULIN-RELATED PEPTIDE 2 IN PACIFIC ABALONE (*Haliotis discus hannai)* ON THE HYPERGLYCEMIA INDUCED BY EMERSION STRESS

Mi-Jin Choi*, Young Dae Oh, Dian Yuni Pratiwi, Kang Won Kim, Dae-Il Lee, Han Kyu Lim

Smart Aqua Farm Convergence Research Center
Mokpo National University
Muan, Jeonnam 58554
coawlss@gmail.com

Pacific abalones (*Haliotis discus hannai*) are economically important marine mollusks found in East Asia. They are often exposed to harsh environment, such as elevated water temperature during the summer and exposure to air in the process of handling and transportation. These stressful conditions cause hyperglycemia and oxidative stress in the organism, leading to cell damage or apoptosis. To understand the role of insulin-like peptide on the regulation of elevated hemolymph glucose, we investigated hyperglycemia in abalone under elevated water temperature and exposure to air (emersion). Furthermore, changes in the hemolymph glucose level were measured upon bovine insulin injection to demonstrate the existence of a glucose regulatory system in abalone. The results indicated that the hemolymph glucose level in abalones could be lowered by bovine insulin injection during the hyperglycemia caused by high temperature and air exposure. This suggested that abalones have a glucose regulatory system that is functionally similar to that of vertebrates.

There are three abalone insulin-related peptides (AIPs)–AIP1, AIP2, and AIP3–previously reported to be up-regulated with the hemolymph glucose level upon feeding. Among them, the relative mRNA expression level of AIP2 in the cerebral ganglion was correlated with elevated water temperature and emersion stress. Notably, the AIP2 mRNA level reached its peak at 12 hours after the recovery. Based on these results, we then investigated the functions of AIP2 in glucose homeostasis and performed the localization of AIP2 mRNA-expressing cells in the cerebral ganglion using *in-situ* hybridization. Notably, the AIP2 mRNA-sensing probes detected positive signals in the neural cortex cells in the cerebral ganglion. In this study, we demonstrated that the gene expression of AIP2 influences the recovery rate from the emersion stress-induced hyperglycemia through the regulation of glucose levels in hemolymph.

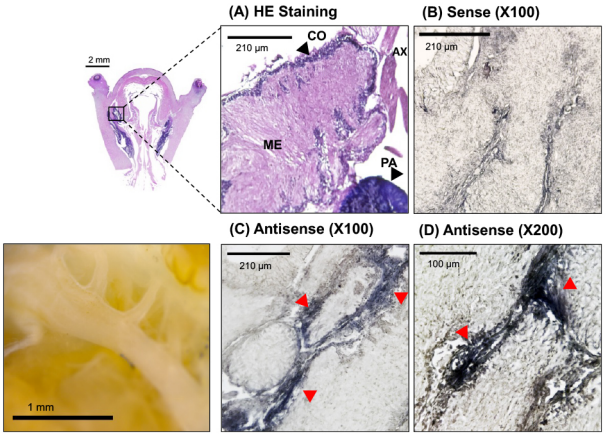


Figure 1. In-situ hybridization of AIP2 mRNA in the cerebral ganglia.

(A) A histological transverse section of the cerebral ganglia of pacific abalone stained with Mayer's hematoxylin and eosin. Abbreviations: CO, neural cortex; ME, medulla; PA, posterior adductor. **(B)** In-situ hybridization results showing positive signals from the AIP2-sensing probes, which were also used on the negative controls shown in **(C, D)**.

NEW ZEALAND YELLOWTAIL KINGFISH LAND-BASED FARMING PROTOTYPE: CURRENT STATUS, CHALLENGES AND OUTLOOKS

Alexander Chong*, Alvin Setiawan, Andrew Forsythe, Steve Pether, Mark Camara, Carly Wilson, Stephen Pope, Dave McQueen, Glen Irvine, Simon Griffiths, Jeremy Singleton, Amanda Cleary

Northland Aquaculture Center
National Institute of Water and Atmospheric Research (NIWA)
Ruakaka, 0116, New Zealand
alex.chong@niwa.co.nz

The yellowtail kingfish (*Seriola lalandi*), characterized by its excellent flesh quality, is rapidly emerging as a commercially viable aquaculture species. Besides rapid growth and efficient feed conversion capability, a key feature of yellowtail kingfish farming is its adaptability to intensive production in recirculating aquaculture systems (RAS). While RAS farming offers numerous benefits over sea-cage farming, there are challenges related to technical proficiency and cost-effectiveness. To address these hurdles, a pioneering commercial-scale RAS system was established at NIWA's Northland Aquaculture Center. The first commercial harvesting began in 2024. This poster presents the prototype farm's status, challenges, and future outlooks.

Over the past two decades, NIWA has been dedicated to researching and developing the yellowtail kingfish as an ideal aquaculture species for New Zealand. NIWA and New Zealand also enjoy a distinct advantage in having an advanced broodstock programme founded on abundant and genetically diverse wild stocks. This comprehensive effort has led to the successful closure of the fish life cycle, enabling captive spawning and larval rearing. As a result, fingerlings can now be supplied for internal research, external collaborations, and commercial clients.

The rapid growth rate of *S. lalandi* in RAS and the climate-related challenges faced by sea-cage operators provided the impetus for NIWA to further explore the commercial potential of land-based yellowtail kingfish farming. A collaborative effort with the Northland Regional Council launched a commercial-scale site with 600 tonnes per year production capacity. This endeavour aims to utilize eight 350m^3 tanks to grow premium kingfish while learning to mitigate commercial production gaps through tailored research. If RAS production of kingfish is proven technically feasible and economically viable, plans include driving a 3000-tonne per annum production. The first commercial harvest was achieved in early 2024, with marketing strategies for the premium, high-valued sashimi market and whole filleting. Currently, concerted efforts aim to harness a selective breeding program, incorporating circularity into production waste and refining feed and feeding practices.

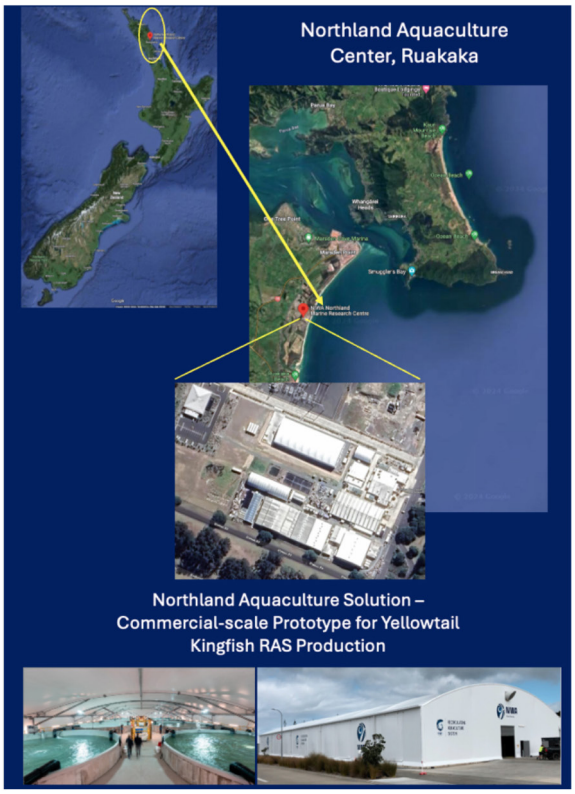


Figure 1: Location of the Northland Aquaculture Center commercial-scale prototype yellowtail kingfish RAS farm at NIWA Ruakaka, New Zealand.

IMPROVING SURVIVAL AND PERFORMANCE – FUNCTIONAL LIPIDS AS ANTIBACTERIAL AND ANTIVIRAL TREATMENT IN AQUACULTURE

Edwin Pei Yong Chow*

Berg+Schmidt Asia Pte Ltd
1 International Business Park,
The Synergy, #09-04. Singapore 609917
edwin@berg-schmidt.com.sg

Aquaculture production from shrimp to support global population growth has increased the production of farmed shrimp globally. The practice of aquaculture intensification is impeded by health and nutrition – affecting growth performance. To untangle these consequences, functional feed additives have been used to stimulate shrimp immune and improve shrimp performance specially to control viral and bacterial pathogens in recent treat shrimp diseases such as V. parahaemolyticus that caused Acute Hepatopancreatic Necrosis Disease (AHPND), or more commonly known as Early Mortality Syndrome, EMS). One of the traditional and widely used shrimp farming practices being the use of antibiotics to reduce the likelihood of the disease breakout, or the use of short chain fatty acids (SCFAs) to directly reduce the GI tract pathogen load.

One of the recent innovations – LipoVital Protect (a functional lipid) includes the use of monoglycerides of short to medium chain fatty acids that combines the benefit of natural bioactive compound, with enhanced performance improvement. Further extending the benefits of organic acids, the composition of the organic acids is optimized by the monoglyceride technology to deliver a more specific approach towards different bacterial pathogens, reducing stress factors and thus increasing performance and yield.

Table 1. Tank trial in shrimps conducted under normal and vibrio challenge that caused AHPND in Ecuador

Day 56, Pre-challenge

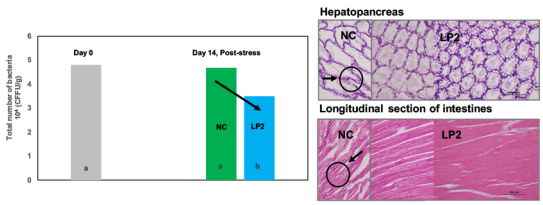
Treatment	Survival Rate (%)	FCR	Biomass (g)
PC	88.9 ± 2.57[a]	2.6 ± 0.14[a]	340.1 ± 9.06[a]
LVPA1	92.2 ± 2.05[a]	2.2 ± 0.11[a]	371.1 ± 16.74[a]

Post-challenge

Treatment	Survival (%)	Approximate survival time (Hr)
NC	37.77 ± 10.03	26.51 ± 1.90
LVPA2	48.89 ± 16.41	30.20 ± 1.94

PC: Positive control, basal diet, no challenge, NC: Negative control, basal diet, challenge, LVPA1: LipoVital Protect group, LipoVital Protect supplemented at 3kg/MT, no challenge, LVPA2: LipoVital Protect group, LipoVital Protect supplemented at 3kg/MT, challenge

Figure 1. Tank trial in shrimps conducted under normal and stress condition (reduced dissolved oxygen) in Thailand



PC: Positive control, basal diet, normal condition, NC: Negative control, basal diet, stress condition, LP1: LipoVital Protect group, Lipovital Protect supplemented at 3kg/MT, normal condition, LP2: LipoVital Protect group, Lipovital Protect supplemented at 3kg/MT, stress condition

FULL REPLACEMENT OF FISH MEAL WITH BLACK SOLDIER FLY MEAL AND ITS IMPACT ON PERFORMANCE, DIGESTIBILITY AND HEALTH IN ASIAN SEABASS *(Lates calcarifer)*

Chung W. [*1], Ng Kai Lin J. [1], Neo Woon Rong B. [1], Tan Shun En L.[1], Lee C.S.[1], Ng T.H. [1], Le Boucher R.[*1]

[1]Temasek Life Sciences Laboratory
Precision Aquaculture Department
1 Research Link National University of Singapore
117604, Singapore
E-mail : richard@tll.org.sg

Amidst the exploration of alternative ingredients, insects are emerging as promising novel protein sources. Among these, the black soldier fly (*Hermetia illucens*) has shown remarkable efficiency in converting various organic materials and black soldier fly larvae meal (BSFM) for animal feed is on the rise. However, it remains unclear whether insect meal can fully replace all fishmeal in aquafeeds and what the potential consequences might be on digestibility and digestive metabolism. The objective of this study was to evaluate the effects of different levels of black soldier fly larvae meal (BSFM) inclusion (5%, 10%, and 15%) as replacements for fish meal. Three experimental diets, all isoenergetic and isonitrogenous and containing yttrium markers, were formulated. These diets were randomly assigned to nine tanks, with three tanks assigned to each diet. Each tank housed 110 fish (90.37 g ± 12.88), which were hand-fed to satiation twice a day for a duration of 28 days. Faecal samples were collected periodically throughout the trial, starting seven days after the initial feeding with formulated diets. Linear decreases in growth and feed intake were observed with increasing levels of BSFM inclusion ($p<0.05$). The feed conversion ratio (FCR) worsened with increasing BSFM inclusion compared to the control diet (0.97±0.04) ($p<0.05$), with values of 1.1±0.0, 1.13±0.02, and 1.3±0.06 for the increasing BSFM inclusion diets. The impact of BSFM inclusion on gut enzyme activity and gut and brain transcriptomics analysis will be presented to explore the interaction between feed intake and fish performance.

Table 1. Mean (n=3) performance of barramundi fed with experimental diets for 30 days[1]

	Control	INS5	INS10	INS15
IBW[2]	90.3±0.4^{a}	90.6±0.8^{a}	90.0±0.3^{a}	90.4±0.7^{a}
FBW[3]	233.7±4.8^{a}	195.4±4.2^{bc}	172.0±8.1^{d}	140.1±10.3^{e}
BWG[4]	143.4±5.1^{a}	104.8±5.0^{bc}	81.9±7.8^{d}	49.7±9.6^{e}
TGC[5]	5.43±0.16^{a}	4.25±0.18^{bc}	3.50±0.27^{d}	2.28±0.38^{e}
FCR[6]	0.97±0.04^{de}	1.1±0.0^{bc}	1.13±0.02^{b}	1.3±0.06^{a}
DFI[7]	5.80±0.06^{a}	4.73±0.15^{bc}	3.85±0.31^{d}	2.67±0.41^{e}
Surv[8]	98.5±1.9^{a}	99.7±0.5^{a}	99.4±0.5^{a}	99.4±0.5^{a}

[1] Values with differing superscripts are significantly different ($P < 0.05$); [2] IBW: Initial body weight (g); [3] FBW: final body weight (g); [4] BWG: body weight gain (g fish^{-1}); [5] TGC: thermal-unit growth coefficient in base 20; [6] FCR: feed conversion ratio (g feed (as fed) / g wet weight gain); [7] DFI: total feed intake (g fish^{-1}); [8] Survival rate (%)

EFFECTS OF DIETS OF DECREASED PROTEIN TO ENERGY RATIOS SUPPLEMENTED WITH STAR ANISE OIL (*Illicium verum*) ON GROWTH OF SMOOTH MARRON (*Cherax cainii* AUSTIN & RYAN 2002) IN COMMERCIAL MARRON PONDS

Anthony J. Cole* & Ravi Fotedar

Curtin Aquatic Research Laboratory
Molecular and Life Science
Curtin University
1 Turner Avenue
Technology Park
Bentley, Perth
Western Australia 6102, Australia
anthony.j.cole@postgrad.curtin.edu.au

The effects of a basal diet and diets of decreased protein to energy ratio and an attractant, star anise oil (*Illicium verum*), on the growth and survival of 1+ smooth marron (*Cherax cainii*, Austin & Ryan 2002) was investigated in commercial marron ponds in Capel, Western Australia. Thirteen ponds were selected for the study; 5 with a control diet, 4 with a control diet + attractant (DietA) and 4 with a higher lipid diet + attractant (DietB). The three diets were isonitrogenous with crude protein content of 27.68% and protein to energy ratios of 19.7 for control, 19.3 for DietA, and 18.3 for DietB. The ambient water temperature of the ponds and climate was also monitored throughout the trial, from March to June 2022. All water quality parameters measured were within optimal ranges for marron culture, and temperature remained above 15°C in March and April, yet fell below 15°C in May and June. Pellet stability of diets was highest with DietB after 75 minutes. There was a strong length-weight relationship found for sampled marron, where weight=0.0000619xOCL$^{3.321}$ and R^2=0.995. Marron numbers and weight were measured at stocking and harvest. However, there was no significant effect of diet on SGR, yield or survival rate of marron (Table 1). The results show that pellet stability of commercial pellets can be improved. Star anise oil can be added to diets without negatively affecting growth, health or survival rate. The protein to energy ratio can be decreased without affecting the marron SGR, yield or survival rate. It is recommended that laboratory trials are carried out to determine if adjusting the protein to energy ratio or adding attractants can improve growth rates and nutrition of marron in controlled conditions.

Table 1. Marron growth and survival from all ponds, by diet.

Diet	SGR	Yield (kg)	Survival (%)
Control	0.098 ± 0.020	87.71 ± 6.56	93.19 ± 1.27
DietA	0.090 ± 0.016	76.36 ± 7.16	79.38 ± 9.82
DietB	0.068 ± 0.015	88.57 ± 10.34	85.37 ±7.16

BACKYARD SMALL SCALE CATFISH (*Clarias sp*) NURSERY TECHNIQUES MANAGEMENT

Dahlan*, Yuliastuti, Agus Dwiono, Nurul Ichsan

Balai Layanan Usaha Produksi Perikanan Budidaya (BLUPPB) Karawang
Desa Pusakajaya Utara, Kecamatan Cilebar, Kabupaten Karawang, Jawa Barat
Satker_bluppb.karawang@kkp.go.id.

The development of backyard Small Scale catfish (*Claris sp*) nursery is considered strategic for producing quality catfish seeds in sufficient quantities. The activity developed to increase the catfish nursery business segmentation so that each nursery unit can focus more on the production process with a more specific output size according to market demand. The small Scale catfish hatchery, which are usually called backyard catfish hatchery (BCH), generally use the backyard/yard of the house as a place of business, assisted by a technician.

The target of this backyard catfish hatchery commonly raising catfish larvae stage to raedy growth up stage seeds. The methods of this Backyards Catfish hatchery consisted of two different methods which are based by nursery time, A) BCH with 60 days of nursery time and B) BCH with 30 days of nursery time. The materials using for this BCH were a simple and low cost materials which are HDPE (*High Density Poly Ethylele*) tanks, covering with plastic net as a shelter. The water inlet and outlet were developed to ensure water supply requirement.

The results of these activity showed that the 60 days of rearing time BCH (A) and also 30 days (B) had the good and almost similar survival rate (>85%). The Feed Convertiaon Ratio (FCR) showed value of 1,08 for 60 days (A) and 0,95 for 30 days (B). Based on the Survival Rate and FCR, the 30 day nursery segment provides better results than the 60 day nursery , which is In accordance in water quality (Dissolved Oxygent) value with 1 - 3 ppm for 60 days nursery and 2 - 3.4 ppm for 30 days nursery. The conclusion for these two nursery time activity at Backyard Catfish Hatchery showed that all the activity had good prospect to developed and fully implemented by market demand of catfish size.

CYTOGENETIC STUDY OF CHROMOSOMAL ABERRATIONS INDUCED BY 0.8 Gy GAMMA RAYS IN FRESH WATER TILAPIA FISH *Oreochromis mossambicus*

[1]Dr. Pranab Kumar Das*, [2]Dr. Pradip Kumar Sur, and [3]Siddhartha Mukherjee

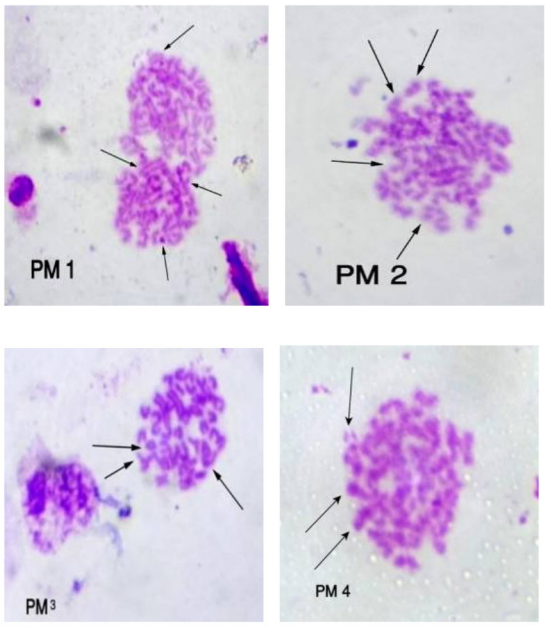
[1]Asstistant Professor, Dept. of Microbiology, Asutosh College (Calcutta University), 92, S P Mukherjee Road, Kolkata-700026, India
pranabkumar.das@asutoshcollege.in
[2]Associate Professor of Zoology (Retired), Kanchrapara College, Kanchrapara, West Bengal. Pin-743145, India
[3]Texas Woman's University, Denton, TX 76204

From time immortal, the living world is exposed to hazardous ionizing radiations [as X-rays and gamma-rays (γ-rays)] and non ionizing radiations (as uv rays from the Sun). The ionizing radiations induce free radical formation within a cell leading to chromosomal damage within living cells and tissues. In our previous studies, we have investigated the effect of such ionizing radiations on a wide range of animal models as grasshoppers, fish, mice and shrew (Sur & Das 2012, Sur, Das & Sarkar 2012, etc.). The present study is undertaken to evaluate the effect of such ionizing radiations on mitotic chromosomes of freshwater tilapia fish *Oreochromis mossambicus*.

Adult healthy fishes were exposed to 0.8 Gy dose of γ-radiations. Mitotic chromosomes from the gill cells were prepared from metaphase stages, and the study was carried out after 5 different time intervals post irradiation exposure, viz- 1 hr, 16 hr, 48 hr, 1 wk & 2 wk. It was observed that higher chromosomal aberration occurred after 16 hr post exposure (16.04%) and there was a gradual decline in aberration and was negligible after 2 wk.

On the other hand, due to the γ-ray exposure, different gaps, brakes, translocation etc. were observed in the mitotic chromosomes. Scoring of the data reveals that seven different types of chromosomal aberrations were encountered, viz- chromatid break, iso-chromatid gap, iso-chromatid break, sub-chromatic gap, centromeric dissociation, translocation and ring chromosome (Fig1). The highest frequency of aberration was scored with centromeric dissociation, while lowest was observed for ring chromosome. Moreover, statistical analysis of the data reveals that the aberrations are non-random in distribution, it is somewhat time dependent and the centromeric regions of the chromosome are most vulnerable to γ-irradiation.

Fig1. Different types of chromosomal aberrations in gill cells of fishes



PM 1: Ring chromosome, sub chromatid gap, translocation
PM 2: Sub chromatid gap, chromatid break centromeric dissociation
PM 3: Ring chromosome, translocation
PM 4: Translocations.

MODELING ENVIRONMENTAL CARRYING CAPACITY FOR CAGE AQUACULTURE: A CASE STUDY OF A SUBTROPICAL HYDROELECTRIC RESERVOIR

Gianmarco Silva David*, Iara Carolina Penariol

São Paulo State Fisheries Institute
Conselheiro Rodrigues Alves Av., 1252
São Paulo, SP, 04014-900
gianmarco.david@sp.gov.br

Cage aquaculture uses the dilution potential of water bodies to assimilate nutrients discharged from cultured fish. Maintaining the physical, chemical, and biological integrity of the water necessitates nutrient emissions to be compatible with the ecosystem's assimilative capacity.

Calculating ecological carrying capacity in large hydroelectric reservoirs employs mass balance models, primarily addressing phosphorus as the key contributor to eutrophication. This study aims to estimate the environmental carrying capacity of an reservoir stretch for nile tilapia grow-out cage aquaculture, contrasting modeling projections with field data. Focused on the Chavantes reservoir in the midstream of the Paranapanema River, in Southeastern Brazil, the study conducted four limnological surveys, evaluating temperature, conductivity, turbidity, pH, total nitrogen, total phosphorus, and chlorophyll-a.

Additionally, bathymetric analysis and water flow data of the study area informed environmental carrying capacity calculations based on phosphorus levels. Utilizing the same model, theoretical tilapia farming impacts on water phosphorus levels were determined using production data. Regression analysis compared model-predicted total phosphorus values with field records. Results indicate the farm's compatibility with the site's environmental carrying capacity. Strong concordance between predicted and observed water phosphorus concentrations downstream of the farm ($r = 0.95$; $P = 0.048$) support the reliability and accuracy of Dillon & Rigler's mass balance model in estimating environmental carrying capacity in hydroelectric reservoirs.

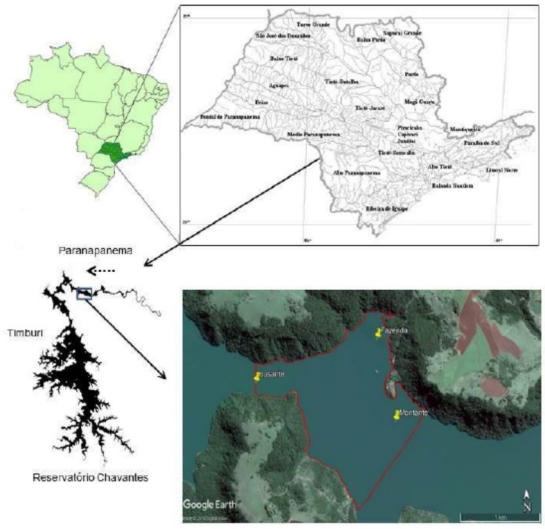


Figure 1: Study area delimited by the red line. Collection points indicated by the yellow marker. Dashed arrow indicates the direction of the Paranapanema River flow.

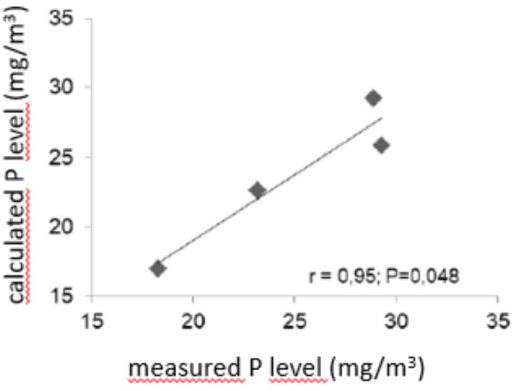


Figure 2. Correlation between total phosphorus concentrations obtained through modeling and measured *in situ*.

PLASTIC APLICATIONS IN BRAZILIAN TILAPIA AQUACULTURE

Gianmarco Silva David*, Marcos Vinícius Bozzo Diorio, Katharina Eichbaum Esteves and Vander Bruno dos Santos

São Paulo State Fisheries Institute
Conselheiro Rodrigues Alves Av., 1252
São Paulo, SP, 04014-900
gianmarco.david@sp.gov.br

Tilapia aquaculture has become a main contributor to Brazil's aquaculture, particularly based on grow-out operations within floating cages sited hydroelectric reservoirs and earthern ponds. Plastics play a important role in optimizing these aquaculture systems, addressing various challenges and enhancing overall efficiency. This study provides an overview of plastic applications in tilapia aquaculture, focusing specifically on their utilization in hydroelectric reservoirs and earthen ponds in Brazil, as these modalities includes more than 90% of Brazilian aquaculture production. Four tilapia cage farms in hydroelectric reservoirs were visited, all located in the Tietê River basin, in the Upper Paraná River region, southeastern Brazil, as well as two tilapia fingerling producers. Five tilapia grow out farms in earthen ponds were also visited, all located in the western region of Paraná state, in the southern region of Brazil. Interviews were conducted with the farm operators to detail quantitative aspects of plastic use, and destinations after use. Subsequently, the farm facilities were visited to record the types of plastics present and to collect materials for the identification of plastics used. Floating devices made from recycled high-density polyethylene (HDPE) cylindrical containers, with capacities ranging from 30 to 50 liters, are widely used, although floats made of polyvinyl chloride (PVC), specifically manufactured for this purpose, are also used. The floating structures are anchored with polyethylene (blue) and polypropylene (white) ropes, and metal meshes of the cages are often coated with PVC. Other plastic uses in this type of cage culture include poliamide nets for fish harvesting, internal structures for feed retention made of PVC, anti-bird screens made of polyethylene filaments. Polyester filaments coated with PVC also used in many other devices for fish manipulation. Juveniles are transported in polyester (fiberglass) tanks installed on trucks and, less frequently, in transparent polyethylene bags. For earthen ponds, it is not common to use geomembranes covering the entire bottom of the tank, but HDPE and PVC membranes are used to prevent erosion by lining the tank edges. HDPE is commonly used for aerators and automatic feeders, with internal hard parts of nylon for greater durability. Water conduits are often made of PVC, although HDPE also be used. Similarly, to cage aquaculture, a variety of plastic materials are used in fish handling and harvesting. Fingerling production tanks visited are placed in greenhouses, with a diverse array of plastic equipment used for water treatment and fish manipulations. Plastics are extensively employed for tilapia farming, offering durability, flexibility, and resistance to harsh environmental conditions prevalent in these settings. Plastics are very important in the establishment of infrastructure for tilapia production in earthen ponds, including tank liners, water pumping systems, filters and aeration devices, used for water management and fish husbandry practices. Ongoing research efforts focus on developing rational plastic alternatives to promote sustainable plastic usage in tilapia aquaculture, thereby supporting the long-term viability of aquaculture operations.

DIETARY RICE MOTH MEAL AS FISH MEAL REPLACEMENT PROMOTES GROWTH AND NUTRIENT RETENTION IN JUVENILE TILAPIA *Oreochromis niloticus*

Mark Henry F. De Leon* and Rex Ferdinand M. Traifalgar

Institute of Aquaculture
College of Fisheries and Ocean Sciences
University of the Philippines Visayas
Miagao, Iloilo, Philippines
mdeleon@up.edu.ph

Intensification and expansion of culture systems in aquaculture have been adapted to meet the increasing demand for fish protein and address diminishing marine fish catch. However, aquaculture is dependent on fish proteins and fish meal is primarily utilized as a major source of protein in diet formulations. Fish meal dependence remains critical for the growth and physiological development of the species being cultured. With its increasing demand, a decline in its production as well as increasing cost was observed. Previous studies have opted for alternative feed sources and the utilization of insects as feed ingredients attracted the most attention for its sustainability and ease of production. In the present study, rice moth meal was utilized which only maximizes by-products of the rice milling industry, specifically rice bran. Thus, this study was conducted to determine the growth and nutrient retention of juvenile tilapia fed with dietary rice moth meal as fish meal replacement.

An 8-week experiment was conducted evaluating the growth performance, feed utilization, and nutrient retention of juvenile tilapia fed with varying levels of dietary rice moth meal as fish meal replacement. The growth trial was done in a completely randomized design with four replicates for each treatment (5 treatments x 4 replicates x 20 fish per tank). Five iso-nitrogenous and iso-lipidic formulated diets with four RMM replacement levels (at 25%, 50%, 75%, and 100%) replacing fish meal (by weight) were fed to Nile tilapia juvenile. Results showed that RMM could replace FM by up to 75% without a significant reduction in growth. However, 25% RMM replacement has growth promotion compared to the control. Weight gain and specific growth rate showed no significant differences between the control and the treated diets (25%, 50%, and 75% RMM replacement) while significantly decreasing in 100% RMM replacement ($p<0.05$). Protein retention efficiency, protein, and lipid retention efficiency tend to decrease with increasing replacement of RMM, however, 25% RMM replacement level reported a higher protein and lipid retention efficiency compared to the control. Moisture, protein, lipid, and ash in carcass composition did not differ significantly in all treatments ($p>0.05$). High survival was observed in all treatments and feed intake showed no significant difference among treatments. The amino acid composition of RMM suggests valine and leucine as the limiting amino acid with chemical scores of 26.36 and 26.76, respectively. Tryptophan, an essential amino acid, was not detected in RMM. Results of the study showed that rice moth meal can replace fish meal up to 75% in the diet of tilapia without compromising effects on growth and feed utilization. However, 25% RMM replacement promotes better growth compared to the control.

MYCOFEED FOR UPV-SALINE TOLERANT POPULATION OF IMPROVED NILOTICA (SPIN) TILAPIA

Rex Ferdinand M. Traifalgar and Mark Henry F. De Leon*

Institute of Aquaculture, College of Fisheries and Ocean Sciences
University of the Philippines Visayas
Miagao, Iloilo, Philippines
mdeleon@up.edu.ph

Presently, aquaculture is expanding due to increasing demand for fish protein. However, feed supply that is dependent on high protein feed ingredients is a constraint in the growth and economic viability of this industry. There is a need to develop a sustainable and plant-based high-protein feed ingredient aquaculture.

A feeding trial was conducted to determine the feed value of higher fungi mycelia (MycoFeed) grown on rice bran substrate for saline tolerant tilapia strain, UPV SPIN reared in seawater. MycoFeed was incorporated in tilapia diet replacing soybean meal at 0%, 25%, 50%, 75% and 100%. The nutritional composition, digestibility of Mycofeeds, effect on growth performance, body nutrient composition, optimum dietary incorporation level, and feed utilization efficiency of SPIN tilapia fed with Mycofeed will be discussed in this presentation.

SHORTENING THE PRODUCTION CYCLE OF *Macrobrachium rosenbergii* BY OPTIMIZING *Artemia* AS LIVE FOOD IN THE LARVAL REARING PROTOCOL

De Wolf Tania*, Kongnuan Pantipa, Calloni Stefano, Charuchai Siriphol, Chiappi Letizia and Rombaut Geert

*INVE Aquaculture Research Center (IARC)
57016 Rosignano Solvay, Italy

The larval rearing stage of the freshwater prawn *Macrobrachium rosenbergii* is highly dependent on live food. Often wild plankton is still used with poor control on the biosecurity and often variable in nutritional quality. From previous nutritional studies, it became clear that HUFAs have a beneficial effect on the growth and metamorphosis of the freshwater prawn. In this study, the effect of using optimized *Artemia* in terms of nutritional and microbiological profile, showed how the production cycle of *Macrobrachium rosenbergii* can be improved.

A 26days larval rearing experiment was carried out in commercial production tanks in Thailand. Three different treatments were compared in duplicate: In treatment 1 (control), non-enriched Separt *Artemia* was fed (M1-PL2) in combination with Moina (M5-PL2). In treatment 2, the same amount of Separt *Artemia* was fed between M1 and PL2 stage, but enriched with Easy DHA Selco in the hatching tank and harvested 30h after incubation of the cysts. The same amount of Moina was fed between M5 and PL stage. In the 3rd treatment, the same enrichment technique was used for *Artemia* as in treatment 2 but the amount of Moina was also replaced by enriched *Artemia*. In all the treatments, Sanocare ACE-PRO was used to prevent *Vibrio* growth during the hatching/enrichment process of the *Artemia*, assuring a biosecure prey for the larvae.

The results of this study showed that feeding enriched *Artemia* instead of non-enriched *Artemia* increases the growth and speed of metamorphosis of *Macrobrachium rosenbergii*. This effect was amplified when wild plankton was fully replaced by short-term enriched *Artemia*, resulting in the highest growth rate and reducing the time for PL production by 4days compared to the control treatment, reducing the labour cost of the larviculture period of this freshwater prawn.

This study confirmed the importance of HUFAs during the larval rearing of *Macrobrachium rosenbergii* and thanks to the additional effect of microbial control, a nutritional and microbiological optimal live prey can be produced, accelerating the production of PL in a cost-efficient way.

COST EFFICIENT MICROBIAL MANAGEMENT OF SHRIMP FARMING

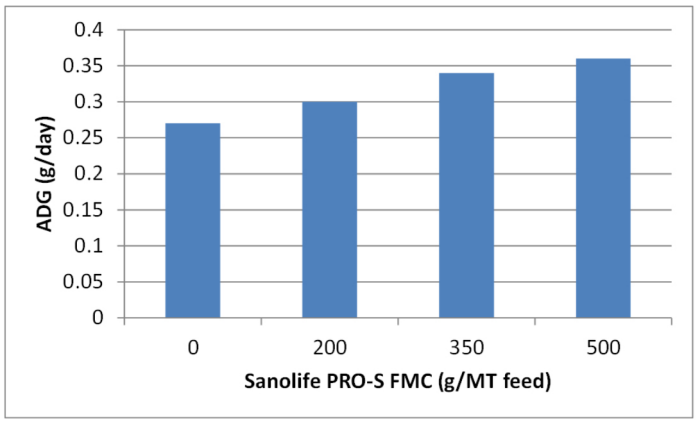
Olivier Decamp*, Barbara Hostins, Peter De Schryver, Marcos Santos

INVE Aquaculture
Nonthaburi, Thailand
o.decamp@inveaquaculture.com

Microbial management is recognized as a critical element for a successful crop. This is achieved through a combination of biosecurity measures, feed and water management and the application of microbial products. With the current low farm gate price impacting profitability, farmers search for ways to improve the cost efficiency of their operation. Applying products of lower unit cost, but also with lower efficiency, or delaying the application of performing products may appear as a valid option. However, these approaches often lead to lower farm performance, and ultimately, lower profitability. For example, there is a dose response effect with the application of performing probiotics in feed (Figure 1). The same observation can be made with the application of water probiotics.

The common on-farm brewing procedure aimed at increasing the number of bacteria before application to the pond may appear as cost saving. However, some key risks must be considered. Growth rates of the different probiotic strains combined in a single product will vary with each strain. This means that when brewed, an original formulation will change during the brewing procedure. For a given product with 3 different strains it can be expected that one of the 3 strains may dominate. The expected benefit of this multi-strain product would then be lost. In addition, there may be overgrowth of non-intended strains that were present as contaminants at the beginning of brewing. The performance of a product depends upon the concentration and the composition, i.e. the strains of the bacterial species. Within a species such as Bacillus sutilis,, there exists major differences between strains regarding their optimal conditions for growth, but also production of enzymes or ability to outcompete pathogens such as Vibrio.

Examples of cost benefits will be presented.



(Figure 1) Effect of the inclusion of Sanolife PRO-S FMC in feed on the shrimp growth rate. Trial carried out at Kasetsart University (Thailand).

GENOTYPE-BY-SEQUENCING (GBS) – AN UNINTENDED TOOL TO BETTER UNDERSTAND PATHOGEN PREVALENCE AND LOAD IN AQUACULTURE BREEDING PROGRAMMES

Celestine Terence, Zhi Weng Josiah Poon, Saengchan Senapin, Ha Thanh Dong, Shannon Clarke, Rudiger Brauning, Ken Dodds, Xueyan Shen, Susan Kueh, Dean R. Jerry, Jose A. Domingos*

Tropical Futures Institute
James Cook University Singapore
149 Sims Drive
387380, Singapore

Genotype-by sequencing (GBS) is commonly used in aquaculture selective breeding programs to acquire SNP genotypes for various purposes including pedigree reconstruction, GWAS, and in the estimation of genetic parameters, genomic relationships, and breeding values. GBS if based on *de-novo* sequencing approaches (e.g., shallow resequencing, ddRADseq) may generate raw sequence data not only from the targeted species, but also from any type of microorganism (such as bacteria, viruses, and fungi) infecting the sampled tissue of the host at the time of collection. Thus, such GBS approaches may unintentionally generate important information on the presence and relative load of pathogens affecting the hosts, which could be a useful epidemiological tool and inform farmers about the health status of their stock.

In barramundi (*Lates calcarifer*), scale drop disease virus (SDDV) is a pathogen responsible for mortality losses of 40-90%. Presently, the detection of SDDV involves qPCR testing of immune competent tissues, such as spleen or kidney, which are sacrificial, labour intensive to obtain and impractical for high-valued broodstock. In this study, we used ddRADseq GBS data from 4,484 barramundi (2,239 clinically sick and 2,249 clinically healthy) from four commercial cohorts genotyped for a breeding program to also identify SDDV DNA in the fish fin clip samples. Here we blasted ddRADseq raw sequences against the SDDV genome and standardized SDDV read counts by the ratio of viral sequences per 1 million sequences (Reads Per Million, RPM) present in each sample (viral load). Results showed a high association between SDDV prevalence and load and fish health status. Sick fish had 88.9% SDDV prevalence with 21.8 ± 0.56 RPM, whereas healthy fish had 0.2% SDDV prevalence with 0.002 ± 0.001 RPM. To validate these findings, qPCR for SDDV copy number was performed on the fin and spleen samples from 172 barramundi (81 sick and 91 healthy) and compared against the ddRADseq GBS sequence read data from the same fish. A strong correlation was found between ddRADseq GBS RPM and the viral load from qPCR of fin and spleen (Fin-ddRADseq Spearman's □ = 0.84; Spleen-ddRADseq □ = 0.76). Higher viral loads were detected in the fin (278 copies/ng DNA), compared to the spleen (185 copies/ng DNA) of sick fish. Furthermore, comparable prevalence was found across the four cohorts, demonstrating that fin samples can be used to reliably test for SDDV. The results demonstrate the ability to use genomic data generated via dd-RADseq GBS as an epidemiological tool to assess SDDV presence and load in barramundi breeding programs.

These findings suggest that breeding programs generating large ddRADseq GBS datasets may also be used for pathogen surveillance purposes in aquaculture breeding programmes where the target pathogen infects the host genotyped tissue.

ASSESSMENT OF SHRIMP FEED DIGESTIBILITY UTILIZING DEFATTED *Hermetia illucens* MEAL TO PARTIALLY SUBSTITUTE FISH MEAL IN JUVENILE *Penaeus stylirostris* FEEDS: *IN VITRO* AND *IN VIVO* METHODS

Dornic Aurélien*, Boulier Audrey, Callac Nolwenn, Mazurais David, Pham Dominique, Wabete Nelly, Zambonino-Infante José-Luis

Station Aquacole de Saint-Vincent
Ifremer New-Caledonia
Boulouparis 98812
aurelien.dornic@innovafeed.com

The past few decades, there has been a noticeable surge in the demand for seafood products, driven in part by the global population growth and increased apparent consumption. To address this escalating demand, shrimp farming has experienced significant expansion on a global scale. This expansion has led to an intensified need for protein in aquaculture animals' feeds and a concurrent reduction in available proteins sources, such as fish meal.

Various alternatives have been explored to replace fish meal in feeds. Insect meals have demonstrated high nutritional value, serving as rich source of proteins, lipids, vitamins and minerals for shrimps. Given these factors, it becomes pertinent to assess whether insect meals could serve as a sustainable candidate for partially replacing fish meal in shrimp feeds.

To assess the influence of Black Soldier Fly (BSF) larvae defatted meal on feed digestibility in shrimp, we conducted a comprehensive evaluation. The digestibility of multiple meal fractions mixtures, each derived through distinct industrial processes and having diverse compositions, was determined. This assessment was based on a dual protocol for digestibility measurement, first *in vitro* (pH-stat method), and then *in vivo* on selected fractions incorporated in experimental feeds. This approach allows for rapidly testing various fractions while minimizing animal testing. The digestibility of the meals and mixtures were all above 85 % apparent protein digestibility and not significantly different (p values > 0.05), even if a trend to improve the digestibility was observed with some mixtures. Two experimental feeds were thus produced (Table 1) from the two best fractions, and their *in vivo* digestibility were determined using Pacific blue shrimp *Penaeus stylirorstris* juveniles for 56 days. Chrome oxide was used as inert marker in the feeds.

This study allowed us to assess whether BSF meal had an impact on feed digestibility compared with a control feed by evaluating the digestibility of proteins, lipids, energy, and minerals, as well as the effect on intestinal and hepatopancreatic microbiotas. This study also demonstrated the relevance of the *in vitro* approach as a simple and rapid way to test new protein sources in aquaculture as potential substitutes for fish meal.

TABLE 1. Feeds formulation for *in vivo* digestibility by blue shrimps

Composition (%)	Control feed	Feed L	Feed M
Fish meal	32.75	13.75	13.75
BSF meal 1	0	20	0
BSF meal 2	0	0	20
Soy meal	16.25	16.25	16.25
Wheat meal	33.75	31.25	31.25
Wheat gluten	8.25	8.25	8.25
Fish oil	4.4	5.9	5.9
Dicalcium phosphate	2	2	2
Vitamin premix	0.5	0.5	0.5
Mineral premix	0.8	0.8	0.8
Vitamin C	0.3	0.3	0.3
Chrome oxide	1.0	1.0	1.0

INCENTIVISING BLOCKCHAIN TRACEABILITY ADOPTION TO ASSESS AND REDUCE FOOD SAFETY RISKS IN SEAFOOD SUPPLY CHAINS

Alistair E. Douglas

Eachmile Technologies Pte. Ltd
160 Robinson Road
Singapore 068914
alistair@eachmile.co

The United States Food and Drug Administration inspects between 1% and 2% of all imported seafood products for contaminants, and tests as little as 0.1%. Of those inspected and tested more than one in five shipments are rejected.

This rejection level is the highest level of any food category, and so are the business risks, not just from import rejections, but also from the loss of quality and shelf-life from the time taken to inspect and get back test results.

These risks are especially high for farmed seafood with residues from antibiotics and antimicrobials used on farms as well as pollutants that can accumulate via aquaculture feeds using plant proteins and fishmeals/fish oils used in those feeds.

Food safety testing is mostly risk-based due to cost and logistical constraints, and one the key determiners of the risk level is whether or not there is traceability back to the source of both the products and its inputs, and whether or not there is any chain of custody certification with third party surveillance audits to verify the veracity of data entered.

Traceability systems and requirements are often only one-up, one-down, and information on suppliers and the products are often limited to one step down in the supply chain. The most common system in developing nations are spreadsheets with raw data often written down onto paper forms and then later inputted into spreadsheets - formats that can easily be duplicated and/or edited, and, therefore open to falsification.

Decentralised Ledger Technologies (DLT), also known as blockchain solutions, have been touted as being applicable for traceability through supply chains as they are secure and immutable. However the adoption of DLT based solutions seems to be limited. Given the ability to build trust, reduce the risk of food safety inspection, what might the barriers to adoption be? How can we overcome those barriers?

EFFECTIVE METHODS TO CONTROL VIBRIO IN THE SHRIMP CULTURE

Liou Hai Hau, Wang Yu Xuan, Wei Che Wen

Uni-President Vietnam Co., LTD
wen.wei@upvn.com.vn

Acute Hepatopancreatic Necrosis Disease (AHPND) is caused by *Vibrio parahaemolyticus*, *Vibrio harveyi*, and *Vibrio campbellii* carrying the AHPND plasmid (pVA) and toxin genes. These pathogenic bacteria proliferate in aquaculture water or the shrimp's digestive tract, producing PirA/B toxins that lead to hepatopancreatic necrosis and subsequent mortality.

Our previous experiments have shown that when the concentration of pathogenic *V. parahaemolyticus* in water reaches 10^4 cfu/ml, it does not cause immediate death in cultured shrimp, and no signs of AHPND are observed within two weeks. However, when the concentration of pathogenic *V. parahaemolyticus* in water reaches 10^6 cfu/ml, the mortality rate reaches 60% within a week. Feeding shrimp with pathogenic Vibrio-infused die shrimp ($5x10^7$ cfu/g) results in AHPND symptoms within 24 hours, and a 50% mortality rate within a week.

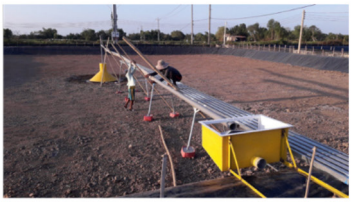
The results suggest that shrimp ingesting dead shrimp containing pathogenic Vibrio have an increased mortality rate and a faster onset of AHPND infection compared to those not directly ingesting them. This study preliminarily indicates that healthy shrimp ingesting infected dead shrimp in the environment is a significant factor in causing AHPND and accelerating disease onset. Reducing the intake of infected dead shrimp in the environment can lower the occurrence of infections.

Group A : AHPND Prawn

Group B : Control

Therefore, for the prevention and treatment of vibriosis, it is necessary to start from the following points:

- Effectively remove dead shrimp. CDSS system effectively remove dead shrimp, reducing the risk of disease cross-infection caused by shrimp ingesting dead shrimp. This is the important point to control the disease risk.
- Maintain stable probiotic bacterial populations to control the Vibrio population in Water.
- Effectively reduce the concentration of Vibrio in shrimp bodies. Regular supplementation of intestinal probiotics to effectively reduce the concentration of Vibrio in shrimp bodies.



CDSS System

24h remove die Shrimp

THE EFFECT OF EM4 PROBIOTICS ON WATER QUALITY, GROWTH PERFORMANCE AND FEED UTILIZATION OF COMMON CARP *Cyprinus carpio*

Christian Maikel Eman*, Debby Dyanessa Saragih, Ni Putu Dian Kusuma

Tatelu Freshwater Aquaculture Center
Manado, North Sulawesi, Indonesia
maikel.djpb@gmail.com

This study was performed to assess the effects of three levels of EM4 probiotic on water quality, growth and feed utilization in *Cyprinus carpio*. Four experimental group were tested: P1, control group, artificial feed without probiotics; P2, probiotics at 5 ml kg^{-1} artificial feed; P3, probiotics at 10 ml kg^{-1} artificial feed; and P4, probiotics at 20 ml kg^{-1} artificial feed. Daily water change was 5%. Fish were fed 32% protein COMFEED SPLA 12 feed three times daily at 3% of body weight for 60 days. NH_3 and NO_2 decreased significantly ($p \leq 0,05$) in probiotics treated groups, especially P4, compared with the control. Water quality, growth, and feed utilization increased significantly ($p \leq 0,05$) in probiotics-treated groups, especially P4, compared with the control. On the survival rate, there was no significant effect due to the influence of probiotics ($p \geq 0,05$). This study confirms the importance of probiotics as a fed to improve water quality, growth and feed utilization of *Cyprinus carpio*.

The application of EM4 probiotics in artificial feed significantly ($p \leq 0.05$) improved water quality parameters in all probiotics-treated groups compared with the control group (Table 1). The lowest NH_3 and NO_2 values were found in group P4. The control group showed higher levels of NH_3 and NO_2. Probiotics the treatment group showed a decrease in the ratio of NH_3 and NO_2 values compared to the control group.

The growth and feed utilization of *Cyprinus carpio* fed different levels of EM4 probiotics are given in Table 2. Final weight, daily weight gain, specific growth rate, and condition factor increased significantly ($p \leq 0.05$) with the increased in probiotics levels. While, there were not significantly different from these parameters in probiotics 5 ml kg^{-1} and 10 ml kg^{-1}. The highest growth was obtained at probiotics level 20 ml kg^{-1} (P4 group), whereas the control group produced the lowest growth. The application of probiotics in level 20 ml kg-^{1} (P4) achieved the best significant results ($p \leq 0.05$) FCR and feed efficiency values compared with the other treatments (Table 2).

Table 1. The effects of three levels of EM4 probiotics on water quality

Parameters	Treatments			
	P1 (Control)	P2	P3	P4
Temp. (°C)	28.22	28.18	28.35	28.58
DO (ppm)	8.07	7.70	7.38	8.22
pH	8.16	8.14	8.13	8.18
NH_3 (ppm)	0.092	0.036	0.033	0.058
NO_2 (ppm)	0.004	0.001	0.001	0.001

Table 2. The effects of three levels of EM4 probiotics on growth and feed utilization

Parameters	Treatments			
	P1 (Control)	P2	P3	P4
WG (gr)	9.89	13.73	14.13	16.24
DWG (gr day^{-1})	0.16	0.23	0.24	0.27
SGR (%)	1.13	1.42	1.45	1.59
FE (%)	53.92	74.64	77.46	88.66
SR (%)	99.80	99.80	99.60	99.80
FCR	0.92	0.77	0.75	0.69
CF	0.97	1.03	0.99	1.02

FAMILY-BASED SANDFISH FARMING: THE CASE IN NORTHERN MINDANAO, PHILIPPINES

Emmylou A. Emperador, Anabelle Dece Espadero, Hanzel Honghong & Wilfredo H. Uy

College of Education and Social Sciences,
Mindanao State University at Naawan
Naawan, Misamis Oriental, Philippines
College of Marine and Allied Sciences
MSU Naawan Foundation for Science and Technology Development, Inc

Email: emmylou.emperador@msunaawan.edu.ph

Sea cucumber is highly valued in local and international markets for its medicinal benefits and uses, and it also supports livelihood in coastal communities. Plaridel, Misamis Occidental is one of the municipalities in the Philippines that engages in sea cucumber trade. However, due to poor fisheries management, the natural population of sea cucumbers in the area, particularly, sandfish *Holothuria scabra*, rapidly declines because of overfishing, commercial fishing, and gleaning. To address this, stock enhancement activities using hatchery-reared juveniles were done in Panalsalan for several years and adopt the family-based sandfish farming intervention to help increase the production of sandfish whilst offer livelihood opportunities to the residents.

Seven (7) family beneficiaries were given 22, 000 hatchery produced early-stage juveniles to start the ocean nursery operation in floating *hapas* for two months, and grow-out productions in sea pens for at least six months, until harvest to recommended harvestable size of approx. 320g. In this approach, family beneficiaries monitored and guard their own hapas and pens, and the wives and children were given many opportunities to help in rearing the sandfish. It also improved livelihood security and reduced the dependence of wild fishery resources through buyback mechanism, a peso (Php 1.00) for every juvenile survived in nursery and Php 30.00/kg for adult sandfish.

However, there were also common key issues identified in all project sites during the farming period - the presence of predators, the recurrence of the poachers, and the lack of knowledge of sandfish farming and some fishery management. Below is the comparison of the lessons learned from the three project sites in Northern Mindanao, Philippines.

Sandfish farming does not provide an instant income to alleviate poverty but gives a substantial financial contribution to the lives of coastal people and contributes something beneficial to the community.

Lessons Learned in Sandfish Farming		
Laguindingan, Misamis Oriental	Kauswagan, Lanao del Norte	Plaridel, Misamis Occidental (This Study)
It started with a community (association)-based sandfish farming, but it failed. Then, the site was introduced to family-based approach but faced with challenges: the recurrence of the poachers and the lack of management of the family beneficiaries. Also, the site turns out to be famous on its tourist attractions. So aside from fishing, fishermen can do a part time work in some establishments, and their attentions were diverted.	In this project site, it also started with the community (association)-based sandfish farming but still did not succeed. It transitioned to Local Government Unit-based sandfish farming. They considered it as more effective than a project run by people's organization. Work assignment in the operation is assigned to a worker of LGU who is paid through Job Order basis. It made the operation smooth - no conflict among association members and no problem in poaching. There was close monitoring of the mesh cleaning, guarding and checking hapa/pen conditions.	Despite the success of the family-based sandfish farming, the beneficiaries also experienced some challenges during the project. These were weather condition that caused the low survival rate of the juveniles, the regular cleaning of the nets, the presence of predators, their minimal knowledge of sandfish farming and some fishery management, and a feeling of distrust to project implementers. Also, fishers who were not identified as beneficiaries felt jealous and created conflict among fishers.

HOW IS BLOOD PERFORMANCE RELATED TO THE ANTIOXIDANT SYSTEM AND LIVER ENZYMES IN FISH?

Noah Esmaeili*

Guangdong Provincial Key Laboratory of Marine Biotechnology
Shantou University
Noah.esmaeili@utas.edu.au

Haematological and blood biochemistry measurements in a repeatable and accurate manner can be a key step toward fish health monitoring. Blood performance (BP) formula (it covers red blood cells, white blood cells, haemoglobin, haematocrit, and total protein) is a reliable indicator of fish health and growth when applied to compare groups in the same experiment or farm. The idea behind this formula is that any single component of this formula separately cannot be reliable enough as a biomarker of fish health, but BP can. Previously, BP had a correlation with improved growth and immune system in fish. Further, in various stressful conditions, the fish exposed to stress had a lower value of BP than the control. This study, as a follow-up from previous data analysis, aimed to investigate how the antioxidant system and liver enzymes in fish can be connected to BP.

After searching in databases such as Scopus, published papers that measured five components of BP formula plus antioxidant system parameters (superoxide dismutase, catalase, malondialdehyde, glutathione, glutathione peroxidase, and glutathione S-transferase) or liver enzymes (alkaline phosphatase, alanine transaminase, aspartate aminotransferase, and lactate dehydrogenase) were selected. In the end, we had nearly 157 papers. Two random numbers were generated based on the reported mean and standard deviation. Then, we monitored the antioxidant parameters and liver enzyme trends to see what relation they have with BP.

The data analysed showed that BP had a strong direct relation with BP (89.5% of articles) in reviewed articles. Further, more than 75% of papers reported a direct relation between BP and liver enzymes. Figure 1a and Figure 1b show the relationship between the type of BP and antioxidant capacity and liver enzymes, respectively. This was further evidence that BP is a great marker for fish health. When we match this output with improved immunity and growth in these studies, BP makes physiologically more sense.

Figure 1a

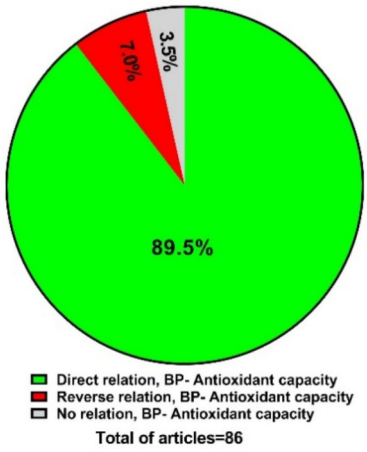
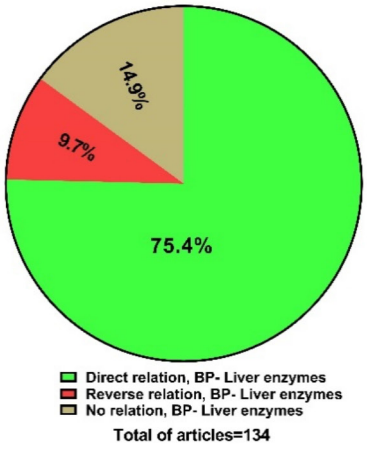


Figure 1b



EARLY MILD STRESS IN OSCAR *Astronotus ocellatus*: WHAT WE HAVE LEARNED SO FAR

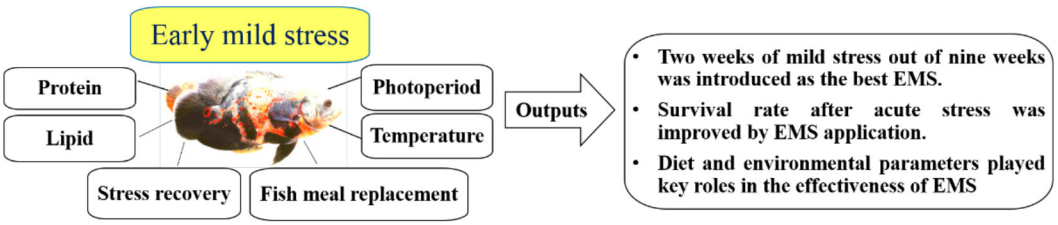
Noah Esmaeili *, Mahyar Zare, Mahsa Hosseini, Sobhan Akhavan, Hossein Hosseini, Michael Salini, Mohammad Kazempour and Artur Rombenso

Guangdong Provincial Key Laboratory of Marine Biotechnology
Shantou University
Noah.esmaeili@utas.edu.au

Early life stress can shape behaviour, physiological metabolisms, stress responses, and immune and antioxidant systems of organisms later in life. While either low or high levels of early stress produce negative impacts (for example, poor immune system responses), the right sort and at the right time of early mild stress (EMS) result in positive outcomes. EMS is like preparedness and might help fish deal with stress appropriately. In this project (six trials: six published papers), we tested scheduled EMS for the first time in farm animals and also its interaction with protein, lipid and fish meal levels in diet and environmental factors (photoperiod and temperature). Oscar *Astronotus ocellatus* (4-9 g), as one of the most traded aquarium fishes, was selected. We ran six trials for nine weeks in the same condition in 100L tanks and fed mostly the same diets to decrease the bias. Fish were fed three times a day to apparent satiation levels. After collecting samples in week 9, the left fish were randomly transferred to the new tanks. Then, fish rested for one week and we applied acute confinement stress (AC) in week 10. More than 40 health parameters were measured.

The output of trial 1 showed consecutive stress and not enough recovery time, which negatively affected the survival rate, stress responsiveness, immune and antioxidant system, and health of oscar. Dietary protein and lipid contents drove changes in growth but not EMS, which was optimum at 51% and 18% (trials 2 and 3). After AC stress, a better survival rate, immune system, stress responsiveness, antioxidant defence and haematology in the 2EMS group resulted in a higher survival rate than others (trials 2 and 3). Fish meal contents in diets (11-25%) did not affect growth, but the number of EMS (0, 2, and 3 weeks) did. Most of the health parameters were affected by Fish meal contents but not EMS numbers (trial 4). Five scheduled photoperiods did not affect the growth and survival of oscar. After AC stress, fish farmed in 24 light hours had the lowest health parameters, while these results were not observed in EMS-exposed fish (trial 5). Too high (32°C) or low (17°C) temperature decreased growth. The EMS did not positively or negatively affect fish physiology in this study (trial 6). There was no significant difference in survival rate before and after AC stress among groups (trial 6).

We understood from this project while EMS can greatly help fish tackle stress, the roles of diet components and environmental parameters are key drivers. While the general trend was improved haematology, immune and antioxidant systems, stress responsiveness, and serological enzymes, no parameter showed the same trend across trials. Although fish welfare must be considered, EMS can result in a greater survival rate after fish are exposed to later acute stress in life.



PROTEIN RESTRICTION CAN REDUCE FEED COST IN AQUACULTURE: EVIDENCE FROM ANCIENT, TELEOST AND CRUSTACEAN SPECIES

Noah Esmaeili*, Ebrahim Sotoudeh, Rahmat Hosseinpour Aghaei, Mehrzad Asadi, Mohammad Ali Yazdani, Fatemeh Jahangiri, Mohammad Khoshraftar, Parvaneh Heidari, Roghayeh Dehghani and Abdolmohammad Abedian Kenari

Guangdong Provincial Key Laboratory of Marine Biotechnology
Shantou University
Noah.esmaeili@utas.edu.au

Protein, undoubtedly, is the most important and expensive part of the aquaculture diets. Any dietary protein manipulation, without impaired animal growth can be a significant step toward aquaculture sustainability. Protein restriction is a feeding strategy in which aquatic animals can be fed with various protein levels (in range of nearby optimum) during the farm period. This approach can reduce the cost of feed and improve water quality. Protein restriction is a less-investigated nutritional strategy in aquaculture species. Therefore, we ran several trials in different species to test which Protein restriction schedule works better. We tested this in rainbow trout *Oncorhynchus mykiss*, Siberian sturgeon *Acipenser baeri*, and whiteleg shrimp *Litopenaeus vannamei*. The sizes of the animals for trials were 27, 75, and 3 g, respectively and were farmed in different conditions based on their optimum requirements. These species fed diets with proteins in a 30 to 45% range during at least eight weeks of the experiment. Growth, body composition, digestive enzymes, fatty acids, amino acids, immune and antioxidant systems and relative genes were measured.

The output of trial 1 (Siberian sturgeon) indicated that feeding fish with 40% and 30% protein every other day did not decrease growth, immunity, and flesh quality compared to those fed the whole period with 40% protein. Other tested strategies were planned every other week and in three- five-week schedules (Article 1). In trial 2 in rainbow trout, growth, immune system, and flesh quality declined by feeding fish with a schedule of 45% and 35% protein every other week. Other treatments were similar to trial 1 (Article 2). To test how whiteleg shrimp respond to protein restriction, we designed trials 3, 4, 5, 6, and 7. The question was raised about how fasting and protein restriction interact. We observed that none of the planned protein restrictions, along with one week of fasting, worked well and there was a significant difference between those fed eight weeks of 40% diets compared with other groups (trial 3). Next, we tested different protein restriction schedules and those fed one day of 40% and two days 35% protein in their diets did not differ from the control group (feeding a diet with 40% protein for eight weeks) (trial 4). In trial 5, this schedule interacted with fish meal replacement. The results showed that we could still use the protein restriction scheme even with reducing 33% of fish meal in diets. In the next experiments, we tested how diets with high lipid and carbohydrate levels interact with protein restriction (trials 6 and 7). The results indicated lipid levels in diets could affect the effectiveness of protein restriction.

We understood from these trials that different species react so differently to protein restriction. Further, the immune system, antioxidant capacity, digestive enzymes, and flesh quality should also be considered. Using protein restriction is a promising approach to reduce feed costs by up to 12% without any negative impacts on biological or physiological indices. More studies on various species are required to see which protein restriction plan can potentially be used, especially in marine species.

ASSESSMENT OF GREEN PROPOLIS AND BOTANICAL BLEND ON GROWTH, IMMUNE RESPONSE, AND SURVIVAL OF PACIFIC WHITE SHRIMPS CHALLENGED AGAINST WHITE SPOT SYNDROME VIRUS (WSSV)

Tran T.T. Hoa[1], M. Siméon Fagnon[2], Tran T.M. Duyen[1], Le Q. Viet[1], Thibaut Chabrillat[2], Sylvain Kerros[2]

[1]College of Aquaculture and Fisheries, Can Tho University, Campus II, 3/2 street, Can Tho City, Viet Nam
ttthoa@ctu.edu.vn
[2]Phytosynthese, 632 00 Mozac, France
simeon.fagnon@phytosynthese.fr

The present study aimed to evaluate the effect of supplementing a blend of two active molecules (PAN : Artepillin C from green propolis and curcuminoids for turmeric) on growth performance, immune parameters, and disease resistance against WSSV in Whiteleg shrimps (*Liptopenaeus vannamei*). Shrimps with an initial weight of 0.9 - 1 g were fed PAN at three different dosages (0.0, 0.5, and 1.0 $g.kg^{-1}$) over a period of 42 days. After the feeding phase, all groups were exposed to WSSV, and daily mortalities were recorded over a 14 days. Additionally, immune parameters were measured in each group.

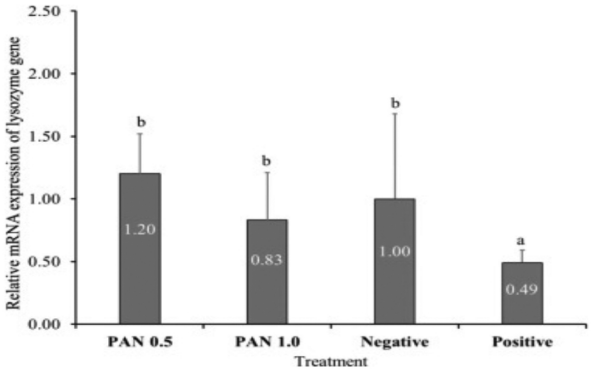
Following the feeding period, a significant improvement was observed for the growth and feed efficiency parameters especially in the group receiving 1.0 $g.kg^{-1}$ ($p < 0.05$). The highest specific growth rate (5.29±0.16 vs 4.98±0.19) and the lowest feed conversion ratio (1.03±0.11 vs 1.15±0.10) were observed in the 1.0 $g.kg^{-1}$ group ($P< 0.05$). Shrimps fed with PAN at the dosage 1.0 $g.kg^{-1}$ exhibited the higher reduction in mortalities (53.3 vs 71.1%), showing the lowest rate compared to the other groups (0.5 and 0.0 $g.kg^{-1}$) and noticing a higher mortality in the positive control group (71.1%). Furthermore, the analysis of lysozyme gene expression was up regulated in groups fed with this blend PAN, with the lowest value observed in the positive group. In addition, a high trend was observed in various immunological parameters under challenging conditions, including total hemocyte counts, granular cell, hyaline cell, phenoloxidase activity, and phagocytic activity.

Overall, the dosage of 1.0 $g.kg^{-1}$ of PAN demonstrated better results in improving growth performance, immune responses, and survival in shrimps challenged with WSSV.

Table 1. Growth performance, feed utilization and survival rate of *L. vannamei* supplemented with PAN (before challenge)

Parameters	Diets		
	Control	PAN 0.5	PAN 1.0
Wf ($g.ind^{-1}$)	8.19±0.45[a]	7.73±0.25[a]	**9.30±0.49** [b]
DWG ($g.day^{-1}$)	0.17±0.01[a]	0.16±0.01[a]	**0.20±0.01** [b]
SGR (($\%.day^{-1}$)	4.98±0.19[ab]	4.87±0.15[a]	**5.29±0.16**[b]
FCR	1.15±0.10[a]	1.19±0.09[a]	1.03±0.11 [a]
Biomass ($kg.m^{-3}$)	0.76±0.04[a]	0.74±0.04[a]	**0.84±0.04** [b]

Figure 1. Lysozyme gene expression after challenges in different groups.



SOLITER SI BLUE, A PRODUCTION MODEL SOLUTION FOR QUALITY CRAB *Portunus pelagicus* SEEDS TO SUPPORT INCREASED EXPORT-ORIENTED PRODUCTION OF LEADING COMMODITIES

Faidar, Hamka, Syamsul Bahri, Nur Muflich Juniyanto

Brackishwater Aquaculture Center Takalar
Takalar, South Sulawesi, Indonesia
faidar25@gmail.com

The main problem in crab hatchery units is the low survival and growth of crab larvae in the zoea to megalopa stages. The high death rate of crab larvae in the zoea stage is thought to be due to inadequate nutrition and an environment that is not supportive for the development of the next stage. The low survival rate of small crablets is due to high cannibalism and an environment that is not supportive for their life. In order to overcome the problem of low survival and growth in small crab larvae and crablets by maintaining the SI BLUE SOLITARY model. This system is expected to become a model for overcoming cannibalism, competition for food between individuals and maintaining water quality when rearing crab larvae and crablets.

The activity was carried out at the Takalar Brackish Water Aquaculture Fisheries Center. The activity stages include: Preparation of containers, Design of SOLITER SI BLUE, rearing of crab larvae, maintenance of Crablet in SOLITER SI BLUE.

The results of the activity showed that zoea survival was 60%, megalopa stage 27% and crablet 12%. The absolute growth of zoea larvae was obtained respectively at 0.01, megalopa 0.07, Crablet 0.15 g and the development of the Zoea to Megalopa larvae stage lasted for 8-10 days. Then the Megalopa to Crablet stage takes 5-6 days. Crablet survival in SOLITER SI BLUE was obtained at 96.54%. The daily weight growth rate was 0.08%/day, carapace width 0.09%/day and carapace length 0.06%/day.

The impact on crablet rearing at SOLITER SI BLUE is to make the process of crablet seed production easier and more efficient, increase the survival and growth of crablets, provide quality seeds ready to be stocked for rearing and restocking in nature and improve the welfare of the crab cultivator community.

Stadia	Continuity life (%)	Absolute growth (g)	Larval Develomen (days)
Zoea	60	0,01	9-10
Megalopa	27	0,07	5-6
Crablets	12	0,15	10

Table 1. Survival, absolute growth, development of larvae and crablets.

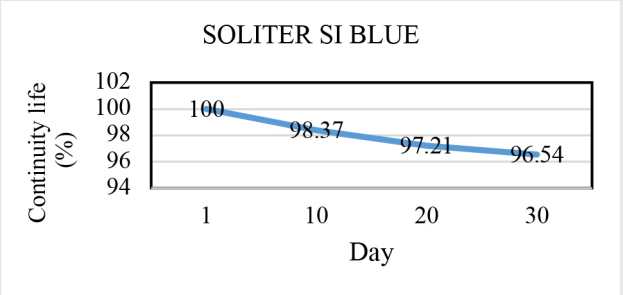


Figure 1. Survival of king crablets

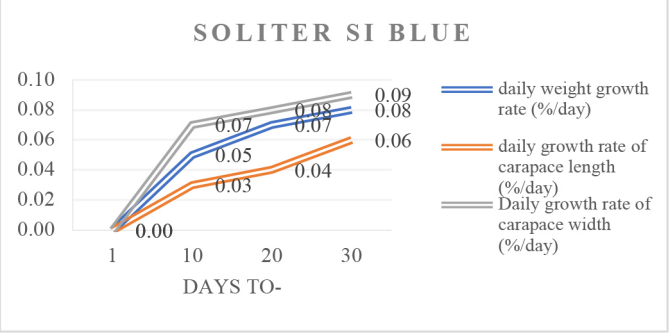


Figure 2. Daily growth rate of crablets

PHOSPHATE ADSORPTION BY BONE COAL BOTTOM ASH ON SHRIMP POND WASTE

Lisa Fandana*, Faisal Abdullah, Abrar Muslim, Suhendrayatna, Hesti Meilina

Brackishwater Aquaculture Centre
Ujung Batee, Aceh
Lisafandana74@gmail.com

Silicified coal (SC) consisting of SiO2 is promising raw material for adsorbent. The present study aimed to utilize the adsorbent of silicified coal bottom ash (SCBA) by calcination of the SC at the temperature of 600, 800 and 1000 oC for 1 hour. The FTIR result showed that the SCBA_600, SCBA_800 and SCBA_1000 had chemical functional groups such as the asymmetric Si-O-Si, the symmetric Si-O-Si and Si-O- Si bond rocking for adsorption of phosphate (PO4) with the lowest percentage of transmittance of SCBA- 1000. The adsorption test showed that a rapid adsorption occurred in the first 10-min of contact time, and it did not change significantly for the rest of contact time until reaching an equilibrium time of 30 min. The PO43− adsorption efficiency and capacity fluctuated over initial PO43− in solution in the range of 60.02–480.29 mg/L. The highest PO4 adsorption efficiency and capacity was at 480.29 mg/L, which was 95.49 % and 45.86 mg/g, respectively using the SCBA-1000. The adsorption kinetic fitted better to pseudo second-order kinetics model (average R2 = 0.999) with the adsorption capacity of 45.454, 45.662 and 45.872 for the SCBA_600, SCBA_800 and SCBA_1000, respectively, and the PO43− adsorption rate was 0.0007, 0.0008 and 0.001 g/mg.min, respectively. The adsorption isotherm followed Langmuir model (average R2 = 0.873) with the adsorption capacity being 2.357, 1.198 and 8.196 mg/g, respectively, and the pore volume being 0.0316,0.0364 and 0.2103 L/mg, respectively.

Based on the analysis results shown in table 1, it can be said that the phosphate in shrimp pond wastewater was absorbed by SCBA at a rate of 90.57 percent absorption efficiency, with an initial phosphate concentration of 7.26 ppm and a final phosphate concentration value of 0.68 ppm. The absorption efficiency was measured at 0.65 mg/g. Thus, it is evident that 90% of the phosphate in shrimp pond effluent can be removed with 1 gram of SCBA adsorbent.

TABLE 1. Results of SCBA Absorption of Phosphate in Shrimp Pond Waste

Parameter	Initial PO_4^{3-} Concentration (mg/L)	Final PO_4^{3-} Concentration (mg/L)	Decreased adsorbate concentration absorbed (mg/L)	Absorption capacity (mg/g)	Absorption efficiency (%)
Phosphate (PO_4^{3-})	7,26	0,68	6,57	0,65	90,57%

THE EFFECT OF GIVING PROBIOTICS TO BLACK SOLDIER FLY LARVAE ON THEIR GUT MICROBIOME COMMUNITY

Tiara Putri Faralovrisya[1]; Senny Helmiati[2]; Tony Budi Satriyo[2]

[1]Master of Fisheries Science, Department of Fisheries, Faculty of Agriculture, Universitas Gadjah Mada
[2] Department of Fisheries, Faculty of Agriculture, Universitas Gadjah Mada
Flora Street, Bulaksumur, Yogyakarta

Corresponding author: tiaraputrifaralovrisya@mail.ugm.ac.id

Alternative feeds are expected to respond to current feed problems, such as rising fish feed prices and pollution of the water environment due to the accumulation of feed residue. Black soldier fly larvae (BSFL), which may be used as an alternative to replace fish meal as feed ingredients. Beside that, supplementation of probiotics to BSFL substrates has shown beneficial effects, such as increasing the amount of lipid and protein content, feed efficiency, feed waste conversion while lowering the level of chitin and affecting the relative abundance of beneficial gut bacteria. A recent study reported that statistical analysis of the gut microbiome in BSFL showed that there are more than 11,000 bacteria, which indicates a high microbial abundance. The microbes indicated a high similarity across taxonomy orders and showed that probiotic supplementation in BSFL substrates affects the whole microbial community. The aim of this study is to investigate the effect of probiotic additions to BSFL substrates on their gut microbiome.

Larvae were 500 g of each treatment and placed into control or treatment containers. Larvae in control containers were fed daily with 250 g waste bread, while treatment containers were fed 250 g of waste bread supplemented with (approximately 1 x 10^7 g/diet) of *Lactococcus* JAL 37 and *Bacillus* PCP 1. After 7 days, DNA from larval guts were isolated and quantified by Wizard® Genomic DNA Purification Kit. The 16S rRNA gene were amplified apply for next-generation sequencing technology using Illumina Miseq PE250 sequencing platform (Illumina, United States).

The result showed in each treatment, there were 98 communal OTUs (26,50%). The bacterial/OTU richness as indicated by Chao1 were ranged from 219.250 to 295.790. the evenness bacterial/OTU index as indicated by Shannon index was ranged from 3.300 to 3.357. Whereas the bacterial/OUT dominance by Simpson's index were ranged from 0.662 to 0.802. The microflora community composition of phyla and genera. The relative abundances of phyla were Bacteroidota, Proteobacteria, Fusobacteria, Firmicutes, Campylobacteria, Desulfobacteria, Actinobacteria was high. The relative abundances of genera Dysgomonas, Morganella, Fusobacterium, Bacteriodes, Sebaldella, Providencia, Phascolarctobaterium, Campylobacter, and Breznakia were high. These results indicate that probiotic addition on Black Soldier Fly larvae substrates affected on their gut microbiome community.

Table 1. Alpha diversity indices of bacteria from the black soldier fly larvae (control) (BSFC) and the black soldier fly larvae with probiotics supplementation (BSFP)

Sample	Alpha Diversity Indices		
	Chao1	Shannon	Simpson
BSFC	295.034	3.300	0.662
BSFP	219.250	3.357	0.802

UTILIZING OPEN SOURCE APPLICATIONS TO BUILD SMART AQAUCULTURE

Arman Faries*, Bambang Hanggono, Fatmawati, Bagus Satria R.

Situbondo Brackish Water Aquaculture Fisheries Center
Situbondo, East Java 68352
armanfaries@gmail.com

Healthy and sustainable intensification of aquaculture is a current trend in aquaculture development. The scale of cultivation will grow bigger and bigger. Automatic control and mechanization are the main requirements to support activities that will become increasingly complex. Water resources and the environment are of great concern. In essence, modern aquaculture has the following characteristics: intensive, high productivity, automatic operation, controlled facilities, and safe and environmentally friendly.

The application of digital technology in an effort to help optimize the shrimp culture process is currently being offered by many start-up companies. With various advantages, they offer tools for monitoring water quality and fish or shrimp health in real time. Apart from that, this application is also able to provide suggestions or warnings if culture parameters are found to be less than optimal. These capabilities can of course be obtained by buying it or renting it.

However, there are also open-source applications that can be used to build your own smart aquaculture and store the data on your own server rather than on the service provider's server. One example is Home Assistant (www.home-assistant.io). Home Assistant is an open-source application for home automation developed by communities spread throughout the world and can be run on a local server. Even though it is intended for home automation, this operating system can be applied in aquaculture because of its ability to be integrated with various devices. Then from the hardware manufacturing side there is ESPhome (www.esphome.io).

Fig. 1. Water quality sensor node made at BPBAP Situbondo

GROWTH OF HYBRID BROODSTOCK CANDIDATE OF AUSTRALIAN STRAIN GENERATION 1 (F1) SEABASS IN THE CULTURE CAGES

Fauzan[1], Ipong Adiguna[2]

Balai Perikanan Budidaya Laut Batam
Jl. Raya Barelang Jembatan III, P setokok
Email: kiagusfn@gmail.com

Seabass (*Lates calcalifer*) is an economical and very important aquaculture commodity. To increase the production of seeds, this is done by producing superior broodstock, this can be done by genetically improving the fish, in general it can be done through hybridization (*outbreeding*). The production of hybrid broodstock candidates is carried out as an effort to meet the needs of superior broodstock candidates for the community. This research aims to analyze the hybrid growth of F1 generation and local broodstock so that it can be seen whether there is an increase in performance in the hybrid . This research was carried out from January to May 2023 at the BPBL Batam Working Unit. This research used 2 treatments and 3 replications, the treatments were (A) hybrid Australian strain; (B) local seabass. This research method uses experimental methods. The parameters taken includes survival, total weight, SGR, FCR, and water quality data as supporting . The results of this study showed that F1 hybrid and local had a significant effect on survival and growth with the highest survival value found in treatment A at 79.5%, in treatment B at 54.2%; The highest total weight in treatment A was 324 grams, in treatment B it was 292 grams; The highest SGR in treatment A was 3.5%; The best FCR was in treatment A with a value of 5.30%. From the data above, it shows good growth parameter values in treatment (A) from all.

BEYOND THE BASICS – BUILDING THE NEW GENETICS

D. Fegan*, C. Luengchaichawange

SyAqua Group
1 Thomson Road
United Square #30-05
Singapore 307591
dan.fegan@syaqua.com
www.syaqua.com

Genetic selection of shrimp has been ongoing since the late 1990's during which time the principal focus has been on either faster growth or greater resistance to disease. This is reflected in the different approaches taken by genetics providers in Asia and the Americas. In Asia, the focus has been on using the SPF (Specific Pathogen Free) approach to breed faster growing lines while in the Americas breeding programmes used survivors of natural disease outbreaks to develop SPR (Specific Pathogen Resistant) lines.

The antagonistic relationship between growth and resistance resulted in a clear divergence over time with Asian lines showing faster growth but lower resistance and lines from the Americas having more resistance with slow growth. This has led to some market differentiation with some markets opting for higher resistance and others for faster growth.

A third option, pioneered by SyAqua, was the "balance line" approach. As shrimp are grown in a wide range of environments, with multiple and changing disease threats and varying stresses, both the growth and resistance lines would have relatively limited application across the industry. The balance line approach, which uses a "selection index" to select families over multiple factors, allows us to select the best families that share multiple traits. Incorporating both fast growth and resistance in the index allows us to select those families that both grow faster and have higher resistance, meeting the objectives of a wider range of farmers.

In the early days, SyAqua's balance line approach was perceived skeptically by farmers who were accustomed to "pure" growth and resistance lines. However, continued application of the selection index approach was seen to give better and more consistent return on investment and now successfully attains performance levels comparable to "pure" lines across a broader range of farming conditions.

The Balance Line approach provides more flexibility since the selection index can be used to develop shrimp that are resistant, robust and with optimal growth while allowing the inclusion of other economically valuable traits without losing performance in other traits. This allows us to tailor the selection of traits that address the needs of specific markets and ever-changing environmental conditions.

IMPACT OF PHOTOPERIOD MANIPULATION ON THE FAST MUSCLE TRANSCRIPTOME AND GROWTH NORMS IN ATLANTIC COD (*Gadus morhua*)

Jorge M.O. Fernandes*§, Lorenzo Colonna, Ioannis Konstantinidis, Prabhugouda Siriyappagouder, Velmurugu Puvanendran and Øyvind J. Hansen

Faculty of Biosciences and Aquaculture
Nord University
Bodø, Norway
Email: jorge.m.fernandes@nord.no

Understanding the effects of environmental factors on the development of aquaculture species is vital for optimizing rearing conditions. In this context, we investigated the influence of continuous and ambient light on the ontogeny trajectory of Atlantic cod (*Gadus morhua*) from 16-months of age leading up to puberty (~22 months). Morphometric analyses revealed significant differences in weight (Fig. 1) and sexual maturation outcomes. Atlantic cod under continuous light exhibited larger yet sexually immature individuals, while those under ambient light displayed smaller sizes with concurrent sexual maturity.

To unravel the molecular mechanisms underlying these observed differences, we compared the fast muscle transcriptome in both experimental groups using RNA-seq. The transcriptomic analysis identified key molecular pathways associated with muscle growth and development. Preliminary findings suggest distinct gene expression patterns between the two light conditions, providing valuable insights into the regulatory networks governing muscle development in Atlantic cod.

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§ Current affiliation: Institute of Marine Sciences, CSIC, Pg. Marítim de la Barceloneta, 37, 08003 Barcelona, Spain

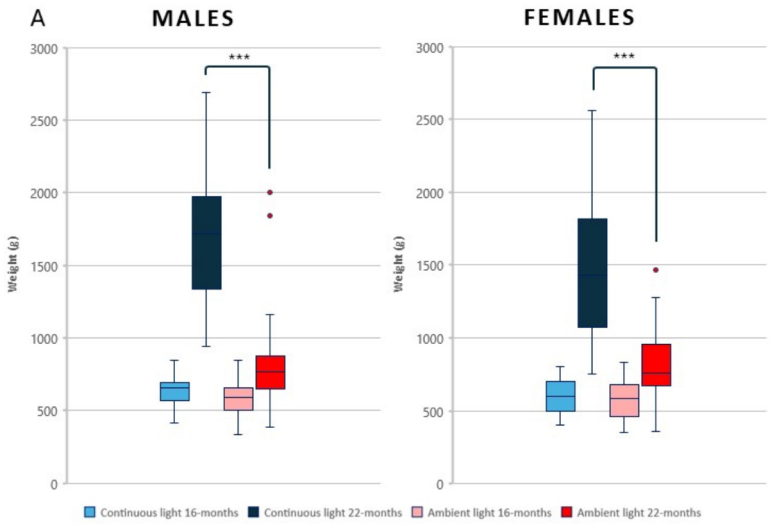

Figure 1. **A**) Morphometric differences of weight between continuous and ambient light for 16-month and 22-month males and females, respectively. Light blue and pink box plots correspond to 16-month Atlantic cod prior to exposure to continuous and ambient light, respectively. Dark blue and red box plots correspond to 22-month Atlantic cod post exposure to continuous and ambient light, respectively.

INVESTIGATING THE EXPRESSION OF miRNAs IN EXTRACELLULAR VESICLES OF ATLANTIC HALIBUT AS MARKERS FOR SPERM QUALITY

Jorge M. O. Fernandes*§, Renan J. C. Appel, Elvira Fatsini, José Beirão, Alexandros Tsakogiannis, Sandra Ramos-Judéz, Catarina Oliveira, Rune Valaker, Tanja Østerbø, Carlos Marrero and Elsa Cabrita

Faculty of Biosciences and Aquaculture
Nord University
8026 Bodø, Norway
jorge.m.fernandes@nord.no

Seminal plasma, known for its crucial role in sperm viability and fertilization, has been found to contain a diverse array of extracellular vesicles (EVs). These EVs, including exosomes and microvesicles, carry bioactive molecules such as proteins, enzymes, and nucleic acids. Previous studies in mammals suggest that seminal plasma EVs play crucial roles in regulating reproductive success by enhancing sperm fertilization ability, promoting sperm motility and survival, contributing to sperm maturation and function and facilitating sperm-egg binding. Atlantic halibut (*Hippoglossus hippoglossus*) is a promising aquaculture species with strong market demand, but its production is challenged by reproductive obstacles that may be partly related to the broodstock diet. Notably, miRNAs can modulate reproductive processes in various species, including fish, but little is known about the miRNAs in sperm EVs in Atlantic halibut.

In the present study, a 6-month feeding trial was conducted with control feed and a diet supplemented with algae to improve the sperm quality of the animals. After the trial, we collected seminal plasma and isolated EVs based on their size range (~30-450 nm), employing size-exclusion chromatography with qEV 35 nm Gen2 single columns from Izon (Figure 1). Subsequently, these EVs were characterized by measuring their concentration and size with tuneable resistive pulse sensing using the Exoid (Izon). Finally, we extracted total RNA (qEV RNA Extraction Kit, Izon) from the concentrated EVs isolates and prepared small RNA libraries to characterize and identify specific miRNAs that may perform as molecular markers for assessing sperm quality in Atlantic halibut.

The findings of this study are expected to have significant implications for enhancing the reproductive success of Atlantic halibut in the cultured industry.

Acknowledgement: This work was funded by the BREEDFLAT project (EEA and Norway Grants, ref. PT-INNOVATION-0080).

§ Current affiliation: Institute of Marine Sciences, CSIC, Pg. Marítim de la Barceloneta, 37, 08003 Barcelona, Spain

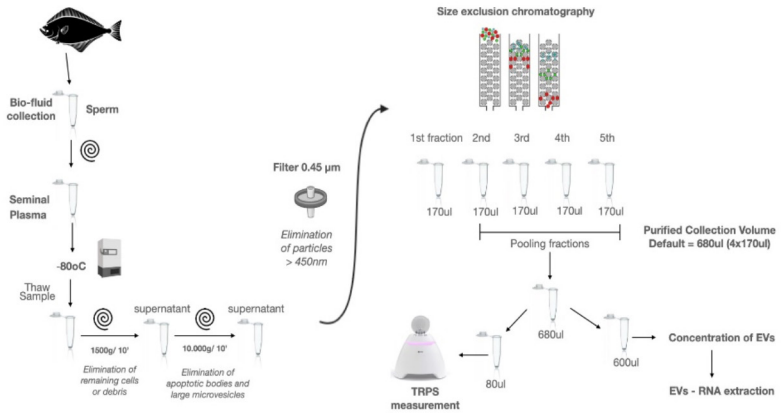

Figure 1. Workflow of extracellular vesicle (EV) isolation and analysis.

EARLY DEVELOPMENT OF STERBEL HYBRIDS *Acipenser ruthenus* x *Huso huso* PRODUCED BY CRYOPRESERVED SPERM

Dorota fop-Bayat[1*], Anna Nitkiewicz, Gyan Chandra, Norbert Bockenheimer

Department of Ichthyology
University of Warmia and Mazury in Olsztyn
Oczapowskiego 5, 10-719 Olsztyn, Poland
foppik@uwm.edu.pl

In the present research, hybridization of the sterlet *Acipenser ruthenus* with the beluga *Huso huso* was carried out using cryopreserved sperm to produce the intergeneric hybrids called sterbel. The percentage of fertilization, survival, embryonic and larval development of sterbel hybrids were analyzed. In the present study, the genetic analysis of sterbel hybrids was performed using species-specific markers to confirm interspecific hybridization.

Sterlet eggs fertilized with cryopreserved beluga semen (E1,E2,E3; experimental groups) or fresh semen collected from sterlets (C1,C2,C3; control groups) were incubated at the Wąsosze fishing farm near Konin. During the incubation of fertilized eggs, the analysis of survival and embryonic development were carried out in all experimental and control groups. The analysis of embryonic development in the experimental groups of sterbel hybrids showed no developmental differences compared to the control groups. The survival of individuals in the experimental groups E1,E2,E3 was similar compared to the control groups C1,C2,C3. After 110 hours of embryo incubation, the larvae hatched. The growth analysis of sterbel hybrids was carried out from 30-89 days post fertilization (dpf), based on the length and body weight (Table 1.) of the fish and the SGR index. This analysis showed faster growth of sterbel hybrids (SGR=10,4%) compared to sterlet from the control group (SGR=9,1%).

Genetic analysis confirmed that the sterbel hybrids inherited the genotypes from sterlet (mother) and beluga (father).

This is the first report that presents the analysis of the growth of sterbel hybrids produced using cryopreserved semen. The proposed research method confirms importance of valuable sturgeon hybrid production using cryopreserved sperm banks.

Table 1. Growth of sterbel hybrids *Acipenser ruthenus* x *Huso huso* produced by cryopreserved sperm compared to sterlet (control group).

Fish age dpf	**Length (mm)**		**Weight (mg)**	
	sterbel	**sterlet**	**sterbel**	**sterlet**
30	$28,6 \pm 1,0^a$	$21,9 \pm 1,6^b$	152 ± 18^a	63 ± 16^b
37	$30,6 \pm 1,9^a$	$24,7 \pm 0,9^b$	257 ± 56^a	117 ± 15^b
44	$39,8 \pm 2,4^a$	$28,9 \pm 2,1^b$	416 ± 35^a	212 ± 61^b
56	$55,1 \pm 2,8^a$	$44,8 \pm 6,3^b$	932 ± 88^a	535 ± 195^b
89	$147,0 \pm 7,5^a$	$98,3 \pm 10,2^b$	20414 ± 1860^a	4491 ± 1535^b

The values in the rows correspond to the average length and average body weight, marked with a different letter index, and are statistically significantly different at the $p<0.001$ level.

AQUACULTURE: UNTAPPED POTENTIAL

Ravi Fotedar

Curtin Aquatic Research Laboratory
Molecular And Life Science
Curtin University, Australia, And Malaysia

The presentation will highlight the current constraints and the potential of aquaculture in the region by discussing some of the untapped technological advances and physical resources that need to be further explored. These resources can be wisely and sustainably used not only to expand aquaculture but also to increase its productivity and value. Though most of us are aware of the availability of these resources, they are not being exploited due to the actual and perceived challenges including different goals, conflicts, and lack of cross-disciplinary communications among various stakeholders. Whereas some other possibilities we are hesitant to discuss and push them under the carpet due to the lack of knowledge, inconveniences, or inability to take calculated risks. The failure to adopt a multidisciplinary approach to this highly sustainable industry that has the potential to meet several Sustainable Development Goals of the United Nations can lead to reduced growth of the industry.

The presentation will cover the possibilities and challenges in expanding aquaculture to non-productive land, improving customers' perception of the farmed species, improving the nutritional quality of the product, and using various new technologies in a balanced and sustainable manner. Attempts have been made in the past to utilise inland saline soil and associated sub-surface water as an important source to generate rural income and produce sustainable food through aquaculture. Though, an important area to convert infertile agricultural land into marine aquaculture by researching the feasibility of farming various marine species, very few species and in only limited regions have been commercially successful due to the lack of vision and communication between various stakeholders. The research and the use of this resource have been scarce with mixed results. It lacks a consolidation of the global data in the form of a detailed review that may lead to a mathematical model that can predict the feasibility of the candidate species to be farmed under an inland saline water environment. The input from artificial intelligence can be a welcomed input to this.

The presentation will also attempt to discuss how aquaculture has the potential to assist in 'mitigation strategies' to tackle climate change due to carbon sequestration and reduction of the methane emissions from the cattle industry. The best feeding and nutritional strategies including fishmeal replacement research will be updated in this presentation. There are several bioremediation products, prebiotics, probiotics, and other dietary immunostimulant supplements available in the market that claim to have positive effects on water quality, nutritional profile, and health of the farmed species. These will be discussed too in the presentation. A pragmatic shift in certain forms of production-based aquaculture to value-based is also an important aspect to be taken into consideration. The cultural background of the consumer also needs to be understood before value addition, diversifying the product line, and marketing strategies are chalked out. Consumer awareness should be incorporated into the marketing of seafood. Ultimately, the gap between researchers and the commercial industry due to several cultural and regional constraints will be discussed. This gap can be bridged by working towards common objectives.

MORE ON THE FINE MECHANISMS OF ACTION OF A NEW PROPHYLACTIC FEED SOLUTION TO CLARIFY ITS IMPACT ON EHP

Stephane Frouel*, Jérémie Potier, Maxime Hugonin, Eloise Galmiche

Mixscience
2, Avenue de Ker Lann
CS 17228
35172 BRUZ CEDEX
stephane.frouel@mixscience.eu

Microsporidian *Enterocytozoon hepatopenaei* (EHP) remains a huge health challenge in our shrimp industry and often leads to the infection of opportunistic pathogens causing different diseases. EHP does not appear to cause high mortality, but it is associated with severe growth retardation and degraded feed conversion ratios (FCRs) leading to economic losses.

To date, no reliable and sustainable solutions have shown real efficacy on the reduction of impact of EHP in shrimp. miXscience (France) developed a specific solution against EHP in shrimp aquaculture. Its efficacy was demonstrated from the laboratory to the field, focusing on the reduction of germination of EHP spores and its associated effect on shrimp performance. These complementary studies have been performed to explore, by microscopy, the fine mechanisms of action of A-Coverost and demonstrate how it disturbs the EHP spores.

The latest experimental studies were performed at the National Center for Genetic Engineering and Biotechnology facilities (BIOTEC, Thailand) involved scanning electron microscopy (SEM) coupled with epifluorescence microscopy (in particular cellular integrity and viability markers).

The effects of four dosis of A-Coverost on EHP purified spores were compared: 2 g/L, 4 g/L, 6 g/L and 8g/L.

Monitoring by SEM showed us the impact of the product on the morphology of the spores, their ability to germinate and therefore their potential in infecting shrimp. In parallel, the impact on spore viability was measured thanks to a marking with acridine orange and propidium iodide.

The trial results indicated that A-Coverost interacted with the membrane of EHP spores, causing disruption ; abnormal morphology of the spores was observed and they were no longer able to germinate and tended to clump together.

A-Coverost also induced a loss of sealing of the spores, involving the marking of the DNA with PI and a reduction in the viability of the spores. A very marked dose effect was observed with an average mortality of the spores of 73% when they were exposed to a dose of A-Coverost of 4g/L and a mortality of 95 and 97% when the spores were respectively exposed with doses of 6 and 8g/L. (Figure 1)

This new study helped us to better understand the fine mechanisms of this preventive solution. It clearly indicated that A-Coverost induces a specific alteration of the membrane of EHP spores leading to an overall disturbance of the EHP biology, stopping its infection cycle. The product has to directly interact with the spore (extracellular phase) is necessary to initiate the inhibition process and to kill the spores. This is why prevention remains key.

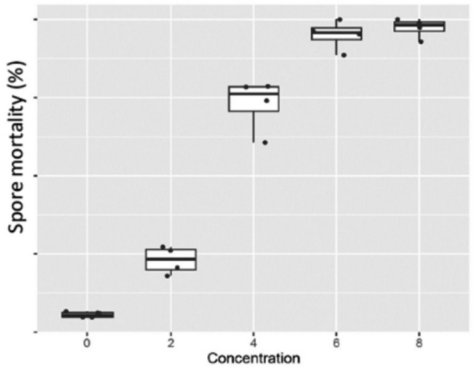

Figure 1: Dose-response effect for A-Coverost concentrations ranging from 0 to 8g/L.

BLUE SWIMMING CRAB INDUSTRY AND CULTIVATION EFFORT FOR SUSTAINABILITY

Yushinta Fujaya

Faculty of Marine Science and Fisheries
Hasanuddin University
Jalan Perintis Kemerdekaan Km 10
Makassar, Indonesia

Email: yushinta.fujaya@unhas.ac.id

Blue Swimming Crab (BSC) is one of the important fisheries commodities in Indonesia. This commodity is a top three of Indonesia's main exports after shrimp and tuna. However, this crab population continues to decline. This study aims to investigate the BSC industry and to determine cultivation efforts for sustainability for the last 10 years. Data was collected from references and analysis using bibliometrics. Every year, Indonesia exports more than 27.000 tons of crabs with a value of 422.000.000 USD. More than hundreds of countries as crab importers from Indonesia and China are the biggest crab importers, followed by the USA, Japan, Canada, and other countries. There was still a high potential for crab markets around the globe. Data from the Ministry of Marine and Fisheries Affairs Republic Indonesia showed that market share in China is just approximately 17%, USA 11,9%, Japan 5%, and Canada 4,7 %. Aquaculture effort was made to support the crab industry, including domestication. Domestication has been done since 2015. Using domesticated broodstock followed by consistently implementing a proper method will produce a high survival and growth rate of BSC. Some challenges that are faced by crab cultivation are the high mortality of larvae and juveniles due to disease and cannibalism. The disease outbreaks occurred when the water quality was poor and low feed nutrition. The high productivity of crab cultivation could be achieved when feed management, nutrition, and water quality are conducted consistently. The other factors that have to be concern, which relate to biosecurity and using a shelter for protecting the crab during cultivation.

MAINTENANCE OF SEABASS LARVAES (*Lates calcarifer*) CLEAR WATER SYSTEM USING BREAD YEAST (Bakery Yeast)

Abdul Gani dan Rochman Subiyanto
Balai Perikanan Budidaya Laut Ambon
Jl. Leo Wattimena, Ambon

e-mail: ambonbpbla@gmail.com

White sea bass (Lates calcarifer) is an economically important fish that has the potential to be cultivated because it grows relatively quickly, adapts easily to the cultivation environment and has a fairly large market share for both domestic and export needs. One of the factors that supports hatchery activities is natural food, both phytoplankton and zooplankton. The problem that is often faced in hatching sea bass is the continuous availability of phytoplankton, the quantity and quality of which are unstable so that other materials are needed that can replace the function of phytoplankton in rearing larvae. When diluted, baker's yeast can become a concentrated solution and is thought to be able to regulate the level of light in the larval rearing medium and bread yeast can also be food for rotifers (zooplankton), so it is assumed that bread yeast can be an alternative substitute for phytoplankton in rearing snapper larvae. white.

The results of the data on rearing white snapper larvae for 20 days with a size of 0.8-1 cm showed that survival was: using phytoplankton, survival was 37%, while using bread yeast, survival was 41%. The results of these data show that the use of 5-7 ppm rosti yeast as an alternative to phytoplankton can be applied in the community as an effort to cut costs, time and energy.

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FISH DISEASES AND ENVIRONMENTAL MONITORING IN LAMPUNG BAY

Andrian Garbono*, Julinasari D, Nana Lestari, Wahyu Widiatmoko and Febri Nugroho

Main Center for Marine Aquaculture
Directorate General of Aquaculture
Marine Affairs and Fisheries Ministry
Email : agarbono@gmail.com
bbpbl.lampung@gmail.com

Fish Diseases and Environment Monitoring in aquaculture areas is one of the efforts made to determine the spread of fish disease attacks as early as possible and to determine the condition of water quality in Aquaculture. Monitoring is carried out at several cultivation locations in Lampung province which carried out in January - December 2023.The 161 fish samples obtained for examination purposes were dominated by Pompano (*Trachinotus* sp.)82%. The results of diagnostics and laboratory examinations show that fish diseases are caused by parasite infestations, bacterial infections and viral infections.

Fish health and the cultivation environment are factors that can support the success of aquaculture businesses. Fish farmers are advised to always monitor the health of fish and the condition of the water quality in the cultivation environment so that the spread of disease and a decrease in the quality of fish farming water can be anticipated before they cause losses to fish farming business actors.

This monitoring carried out in January - December 2023 in several places, namely in the waters of Lampung Bay (Hurun Bay, Pasaran Island, Puhawang Island, Ringgung), East Lampung Regency (Pasir Sakti), South Lampung (Kalianda and Bakauheni).

The purpose of this monitoring is to detect, diagnose and determine the causes and distribution of diseases of fish and shrimp culture, to know the condition of water quality at cultivation locations in ponds, seas, and hatcheries as a complete piece of information for managing fish health and the environment.

The parasites found were *Pyragraphorus* sp., *Trichodina* sp., *Pseudorhabdosynohus* sp., *Benedenia* sp., *Neobenedenia* sp., *Uronema* sp. The infecting bacteria are *Vibrio alginolyticus*, *Vibrio parahaemolyticus* and *Pseudomonas fluorescens*. Virus detection using the PCR method shows that the VNN (*Viral Nervous Necrosis*) virus infects the Grouper and Pompano fish. Vanamae shrimp samples were found to be infected with the WSSV, IMNV viruses, and were positive for EHP.Water quality in the Hurun Bay area, the concentrations of Nitrate and Phosphate have exceeded the quality standard, the phytoplankton composition with an average of 72.6% diatoms; 15.6% dinoflagellates and others 6.1%, as well as the identification of HAB's types of diatoms *Pseudo_nitzchia* with the highest abundance of 25,000,000 cells/L, and dinoflagellates *Protoperidinium* sp. with the highest abundance of 10,852 cells/L, *Cochlodinium polykrikoides* with the highest abundance of 614 cells/L and *Noctilucascintillans* 1,184 cells/L.

A NEW REFERENCE DOCUMENT FOR SECTOR GROWTH: THE GLOBAL AQUABUSINESS INVESTMENT GUIDE

Ruth Garcia Gomez*, Tom Hecht, James McCafferty, Fred Formanek, Rachel Wright, Brett Pringle, Christopher Brett, Harrison Charo Karisa

The World Bank
rgarciagomez@worldbank.org

Recognising that aquaculture is the world's fastest growing agri-food sector, the World Bank Group has established the PROBLUE-funded AquaInvest Platform to develop and disseminate best practices in aquabusiness development, with a view to ensuring economic prosperity, social well-being, and environmental sustainability. By nurturing innovation and collaboration, the AquaInvest Platform seeks to empower aquaculture practitioners, investors and governments to meet the challenges posed by stagnating fisheries production and the increasing demand for food from a rapidly growing human population.

The rapid growth of the aquaculture sector prevents opportunities for investment across the value chain; however, to harness these opportunities while safeguarding against negative social, ecological, and economic impacts and challenges, there is a critical need for a consolidated set of principles to guide sustainable commercial aquaculture development. To address this gap, **The Global Aquabusiness Investment Guide** was developed in collaboration with Advance Africa Management Services as a key component of the AquaInvest Platform. The Guide, which was developed following extensive engagements with a wide range of industry actors, describes the necessary requirements and enabling factors for stimulating aquaculture investment and aquabusiness growth that is socially, environmentally, and economically sustainable. The Guide is global in its geographic scope, and applies to all major aquaculture species groups, production systems, operational scales, and value chain segments. It can be used by a diversity of actors, including national governments, private and public sector investors, private aquaculture operators seeking investment (primarily SMEs), development partners, NGOs, and research organisations. Importantly, the Guide is a "living document" that will be updated periodically as new learnings emerge.

The Guide consists of eight Guiding Principles for Sustainable Aquabusiness, each of which comprises a set of practical recommendations, structured in the form of "Questions to ask" and "Finding the answers". The team is currently in the process of disseminating the Guide to a global audience. Feedback received during the dissemination will be used to inform the revision of the Guide for its next edition.

PILOT OF INTEGRATIVE SANDFISH (*Holothuria scabra*) CULTURE SYSTEMS IN BOLINAO, PANGASINAN, PHILIPPINES

Tomilyn Jan S. Garpa*, Julie Clarice R. Salva, Garry R. Bucol, and Marie Antonette Juinio-Meñez

The Marine Science Institute
University of the Philippines Diliman
Diliman, Quezon City, 1101
tsgarpa@up.edu.ph

Development of innovations in the production of *Holothuria scabra* or sandfish could further address the concern in supply of juveniles for grow-out and enhance the value chain in the development of the sustainable sea cucumber industry in the country. The viability of Integrated Multi-Trophic Aquaculture (IMTA) with sandfish can potentially contribute to the scaling up of the production scheme. Four sandfish integrative culture systems were piloted in three Barangays within Bolinao, Pangasinan for six to seven months. Commercially important species that are locally available such as *Tripneustes gratilla*- sea urchin, *Siganus* spp.- rabbitfish, and *Perna viridis*- green mussels were co-cultured with sandfish. Existing monoculture system of sandfish (CS1) as well as the co-culture of sandfish and caged sea urchin (CS2) were piloted in Brgy. Victory. The co-culture of sandfish with free ranging sea urchins (CS3), and with the addition of siganids (CS4) were piloted in Silaki Island, Brgy. Binabalian. Lastly, the multi-culture of sandfish with mussels and siganids (CS5) was piloted in Rongos, Brgy. Pinairingan. Both sites in Victory and Silaki are seagrass-dominated, whereas Rongos is characterized by a muddy substrate rich in organic matter. Growth performance and survival of the animals in the five culture systems were evaluated. Sediment quality in these sites were also assessed to correlate with growth and positive ecological effect to the surrounding environment. Results revealed that the sandfish juvenile can be co-cultured with sea urchins, siganids, and mussels. Mean body weight and absolute growth rate of sandfish were higher with CS2 (with caged sea urchins) than in CS3 (with free-ranging urchins). It was also observed that the growth of sandfish multi-cultured with siganids (CS4) was higher compared to the co-culture (CS2 and CS3) and monoculture (CS1) systems. In all the piloted culture systems in Victory and Silaki, growth peaked by D120 and started to gradually decline thereafter. In contrast, sandfish in CS5 continued to increase in body weight until D180. Generally, the piloted co-culture and multi-culture systems had better growth of sandfish when compared to the monoculture of sandfish (CS1). Further, this study indicates that seagrass-dominated sites are suitable in the rearing of sandfish during the nursery phase. Once sandfish attain a body weight of ~50 to 60 g, sandfish can be transferred to an organically-rich site for the grow-out phase until a premium-grade size is achieved.

FARMED SHRIMP WELFARE MANAGEMENT FROM A SUPPLY CHAIN PERSPECTIVE

Dominique Gautier*, Shannon Roberts

Seafresh Group
Atlantic House, Oxleasow road
Redditch B98 0RE, UK
dgautier@seafresh-group.com

Animal welfare as a societal concern is not new, but its application to crustaceans is very recent. The awareness and expectations around crustacean welfare has grown in response to NGO campaigns, retailer requirements and more recently, new legislation such as the UK Animal Welfare (Sentience) Act 2022. Guidance on shrimp welfare practices is based on the five freedoms from (1) hunger and malnutrition, (2) discomfort from undue environmental challenges, (3) pain, injury, and disease, (4) behavioural restrictions, and (5) fear and distress (FAWC 2009). The application of some of these concepts in shrimp aquaculture is challenging because the scientific knowledge is lacking and/or difficult to research and implement. For the first three freedoms, science on shrimp nutrition, stress physiology, immunology and disease control is relatively advanced. But there are limited studies of shrimp behaviour in culture conditions, and on the fifth freedom, pain and suffering are immeasurable.

Shrimp producers usually manage the welfare of their animals through the lens of production performance and product quality. It includes providing shrimp with adequate space and facilities, access to sufficient nutritious food, maintaining good water quality, and preventing diseases. Culture conditions are adapted to the stage in life and function, i.e. reproduction, larval development and grow-out. It also involves protocols to minimise stress during harvest and slaughter methods based on the use of ice to induce a drastic decrease in body temperature and quick death. Producers collaborate with academia, retailers, NGOs and certification bodies to define production standards based on Best Management Practices (BMPs). Nonetheless, the shrimp industry is regularly questioned on welfare aspects, including stocking densities, diseases, humane slaughter and mutilations.

The different actors in the supply chain all have a role to play to ensure good shrimp welfare in production systems and drive improvements. Retailers, suppliers, industry organisations, service and technology providers collaborate with academia to support research on specific issues, including emerging diseases and alternative production methods. Good examples are the replacement of eyestalk ablation with protocols to induce natural sexual maturation, and the development of stunning techniques for humane slaughter. Another area of collaborations is the development of welfare indicators and monitoring protocols and tools. Beyond usual environmental parameters and indicators of management practices, organs condition is a direct evaluation of shrimp welfare.

DIETARY ULVAN SUPPLEMENTATION TO EARLY JUVENILE MILKFISH *Chanos chanos* IMPROVED GROWTH PERFORMANCE, IMMUNE GENE EXPRESSION, AND SURVIVAL AGAINST *Vibrio harveyi*

Vyenge Erre D. Gayosa*, Rex Ferdinand M. Traifalgar, Lovelyn Marie Nievales-Naluaran, and Mark Henry F. De Leon

College of Fisheries and Ocean Sciences
University of the Philippines Visayas
Miagao, Iloilo, 5023, Philippines
vdgayosa@up.edu.ph

Milkfish is the top-most-produced and biggest finfish aquaculture industry in the Philippines. However, its nursery aquaculture production is affected by bacterial diseases. Vibriosis disease, caused by *Vibrio* spp. has been linked to low production in milkfish nursery operations. Ulvan, a sulfated polysaccharide known for its bioactive properties such as growth-promoting and immunomodulating, was extracted from *Ulva intestinalis* and used to supplement milkfish early juvenile diets to improve growth performance, increase expression of immune-related genes, and improve survival against *Vibrio harveyi*. Four experimental diets, including a control with no ulvan inclusion and three experimental diets (10, 50, and 100 mg kg^{-1} ulvan inclusion), were formulated and evaluated in milkfish early juveniles (0.0146 g mean weight). The test was run for 30 days following a completely randomized design with four treatments in triplicate. Weight gain (%), feed conversion efficiency (%), specific growth rate (%), and survival (%) were improved by ulvan supplementation, with 10 and 50 mg kg^{-1} inclusion being statistically significant (One-Way ANOVA, $p<0.05$) against the control (Table 1). 10 mg kg^{-1} ulvan inclusion also increased the differential gene expression of immune-related genes (IL6, TLR5, and LEAP2) by 84.5, 91.9, and 75.4 times, respectively, compared with the control (Independent samples T-test, $p<0.01$) (Table 2). The differential gene expression analysis results were also supported by the *V. harveyi* bacterial challenge test, showing that 10 mg kg^{-1} ulvan inclusion improved milkfish survival by 56.7% compared with the control (Independent samples T-test, $p<0.01$) 12 days post-exposure (Table 2). The data from this study suggests that ulvan inclusion at 10 mg kg^{-1} can significantly promote growth, immune activation, and survival of milkfish against vibriosis caused by *V. harveyi*. To our knowledge, this study is also the first to elucidate the effects of ulvan on milkfish growth performance and immunity.

TABLE 1. Growth Performance: weight gain (WG), feed conversion efficiency (FCE), specific growth rate (SGR), and survival (S) of milkfish, *Chanos chanos*, fed with different ulvan inclusions for 30 days (%).

	Diet (mg kg^{-1} ulvan)			
	0	10	50	100
WG	586.1^{b}	645.9^{a}	631.0^{a}	600.7^{b}
FCE	102.3^{b}	135.8^{a}	129.7^{a}	108.4^{ab}
SGR	6.4^{b}	6.7^{a}	6.6^{a}	6.5^{ab}
S	78^{b}	94^{a}	90^{a}	86^{ab}

Note: similar superscript indicate no significant difference ($p<0.05$).

TABLE 2. Differential gene expression of IL6, TLR5, and LEAP2 in milkfish fed with 10 mg kg^{-1} ulvan for 30 days compared with the control and the cumulative survival (CS) of milkfish against *V. harveyi* 12 days post-exposure.

	Diet (mg kg^{-1} ulvan)	
	0	10
IL6	1^{b}	85.5^{a}
TLR5	1^{b}	92.9^{a}
LEAP2	1^{b}	76.4^{a}
CS	20^{b}	76.7^{a}

Note: similar superscript indicate no significant difference ($p<0.01$).

PROBIOTIC LACTIC ACID BACTERIA *Pediococcus* sp. IMPROVED THE GUT MICROBIOTA AND ENHANCED THE SURVIVAL OF MILKFISH *Chanos chanos* EARLY JUVENILES AGAINST THE PATHOGEN *Vibrio harveyi*

Vyenge Erre D. Gayosa*, Issa Ricci L. Fantonalgo, Rex Ferdinand M. Traifalgar, Carmelo S. del Castillo, Fredson H. Huervana, Therese F. Javellana, Josie Mar G. Cabalo

College of Fisheries and Ocean Sciences
University of the Philippines Visayas
Miagao, Iloilo, 5023, Philippines
vdgayosa@up.edu.ph

In the Philippines, milkfish aquaculture industry is a major contributor to the economy and a source of food fish for the people. However, disease outbreaks caused by bacterial infections, notably by *Vibrio harveyi*, impede nursery production of this fish. Gut lactic acid microbiota are important symbionts that modulates the host's innate and adaptive immune responses, as well as supporting the epithelial mucosal barrier to prevent the colonization of gut-associated infectious agents. In the present study, *Pediococcus* sp., a lactic acid bacteria was isolated from a wild milkfish fry digestive tract and utilized as a probiotic dietary supplement for milkfish early juvenile to boost the resistance against the pathogenic *Vibrio harveyi* infection. Two experimental groups of milkfish early juveniles (0.427±0.138 g mean weight), were maintained with the experimental diets for two weeks. The test was done following a completely randomized design with all experimental treatments run in triplicate. One group received the diets supplemented with the probiotics, *Pediococcus* sp. at 10^6 CFU g^{-1} and the other group received a control diet without the probiotic. Evaluation of the gut microbiota were done every three days post-administration. Results showed that after the 2 weeks post-administration of probiotics, *Pediococcus* sp. completely colonized the milkfish gut (Table 1) and completely eliminated *Vibrio* spp. (Table 2). The infection challenge test with *V. harveyi* showed that *Pediococcus* sp. supplementation significantly improved the fish survival compared to the control by 53.33% (Independent samples T-test, $p<0.05$). This study showed that supplementation of lactic acid bacteria *Pediococcus* sp. in milkfish early juveniles diet inhibit *Vibrio* spp. through gut colonization and improve survival against *V. harveyi* infection.

TABLE 1. *Pediococcus* sp. count in MRS agar isolated from milkfish gut fed with control diet and diet supplemented with *Pediococcus* sp. sampled every 3 days post-administration (dpa).

	Control diet		***Pediococcus* sp. diet**	
	10^{-2}	**10^{-3}**	**10^{-2}**	**10^{-3}**
0 dpa	6.17	3	7.5	4.33
3 dpa	8.67	1.17	34.17	4.67
6 dpa	12.17	2.67	90.83	13.17
9 dpa	14.33	2.17	150.8	42
12 dpa	7.8	0	TNTC	123.67

TABLE 2. *Vibrio* spp. count in TCBS agar isolated from milkfish gut fed with control diet and diet supplemented with *Pediococcus* sp. sampled every 3 days post-administration (dpa).

	Control diet		***Pediococcus* sp. diet**	
	10^{-2}	**10^{-3}**	**10^{-2}**	**10^{-3}**
0 dpa	79.33	26.33	86.8	93.67
3 dpa	111.83	24.83	71.33	15.5
6 dpa	115.5	49.5	28.16	5.83
9 dpa	112.5	44.6	4.17	0
12 dpa	167.33	120.5	0	0

GROWTH AND SURVIVAL OF SANDFISH *Holothuria scabra* REARED IN OCEAN AND ADVANCED NURSERY PEN CULTURE PRODUCTION SYSTEMS: EXPERIENCES OF SEA CUCUMBER FARMERS FROM THE PHILIPPINES

Jay R C. Gorospe*, Paul C. Southgate

School of Science, Technology and Engineering
and
Australian Centre for Pacific Islands Research
University of the Sunshine Coast
Sippy Downs, Queensland, Australia

Correspondence:
Jay R C. Gorospe
jgorospe@usc.edu.au

Development of an appropriate nursery culture system is critical in improving the survival of post-release sandfish juveniles within different production systems. This study evaluated the growth performance of sandfish juveniles reared in floating *hapa* enclosures and advanced nursery culture pens by small-scale grouper farmers within rural coastal communities in Bolinao, northwestern Philippines.

Growth performance and survival of sandfish juveniles reared in floating *hapas* were high (Table 1a). From an initial average weight of 0.03±0.002 g, sandfish attained an average weight of 4.28 ± 0.23 by day 66. Highest growth rates of sandfish juveniles reared in floating *hapas* was recorded by day 66 at 0.09 ± 0.02 g day^{-1} while lowest growth rate was recorded by day 24 at 0.04 ± 0.01 g day^{-1}. Additionally, survival of sandfish juveniles at the end of the monitoring period was high at 56.8 %. Likewise, growth performance and survival of sandfish reared in the advanced pens were high (Table 1b). Highest growth rate of sandfish reared in the advanced pens was recorded by day 86 at 0.89 ± 0.1 g day^{-1} while the lowest growth rates was recorded at the end of the study at 0.15±0.3 g day^{-1}. Despite the decreased in growth rates, sandfish attained 102.7±6.2 g after 157 days of rearing in the grow-out pens. This study showed the viability of releasing sandfish juveniles directly into advanced nursery pens as indicated by high growth performance and apparent survival of sandfish reared in the pens. Additionally, results of the study provide basis for the utilization of ocean-based advance nursery and development of a production model involving small-scale aquaculture farmers to increase sandfish juvenile production and ultimately the realization of the socio-economic benefits of sea cucumber mariculture.

Table1. Summary of growth performance and survival of sandfish juveniles in floating hapas and advance nursery culture pens

a. *Floating hapas*

Parameters	Monitoring period		
	D24	D48	D66
Average weight (g)	0.97 ± 0.33	2.67 ± 0.26	4.28 ± 0.23
AGR (g day^{-1})	0.04 ± 0.01	0.07 ± 0.01 g	0.09 ± 0.02
Survival (%)	6970.00%	67.7	56.8

b. *Advanced nursery pens*

Parameters	Monitoring period			
	D18	D86	D128	D157
Average weight (g)	18.03	78.3 ± 7.3	98 ± 2.7	102.7 ± 6.2
AGR (g day^{-1})	0.82	0.89 ± 0.1	0.48 ± 0.1	0.15 ± 0.3
Biomass (g m^{-2})	11.5	400 ± 52.8	528.9 ± 34	517 ± 15.4
Survival (%)	31.5	65.3 ± 9.4	62.6 ± 3.5	61.6 ± 11.8

SUSTAINABILITY OF THE SHRIMP INDUSTRY: PERSPECTIVE FROM A MULTISPECIES ANIMALS GENETICS GROUP

Frédéric Grimaud*

Groupe Grimaud
3 La Corbière
Sevremoine, France
49450
frederic.grimaud@grimaud.com

Groupe Grimaud is a story of breeders, a family business that has gradually developed, internationalized, and constantly innovated while sharing its corporate values at the service of humans.

He joined the family adventure and set out to expand the Group's operations into Asia at the start of the 90s.
Groupe Grimaud diversified into Aquaculture through the creation of the Blue Genetics brand in 2013, considerably strengthened in 2022 by the merger with Sea Products Development based in Texas.

Mr. Grimaud will speak about sustainability in the industry: how do we match the short and long-term challenges of our industry?

The drive from wild catch to domestication to meet global demand. The environmental and health challenges we meet.

Compare hyper intensive vs. extensive systems.

The art of feeding: a unique balance between feed and microorganisms. Followed by an overview of the genetics options and solutions for the shrimp industry.

Finally, he will speak about the impact of climate change, biodiversity and traceability and safety for the consumers to end with the future perspectives and the conclusions for our industry.

NITROGEN REMOVAL PERFORMANCE IN BIOREACTOR FILTERS USING INTENSIVE SHRIMP POND WASTE AS ANAMMOX BACTERIAL INOCULUM

Guno Gumelar, Nur Muflich Juniyanto

BrackishwaterAquaculture Center Takalar
Takalar, Sulawesi Selatan, Indonesia
guno11n@gmail.com

Intensive shrimp farming culture results in a significant amount of waste production, primarily due to the widespread use of intensive technology. Intensive shrimp farming waste contains high amounts of nitrogen so it can reduce water quality and environmental carrying capacity. Anaerobic ammonium oxidation (anammox) is a potential and economical nitrogen removal process. The discovery of the anammox process was a revolutionary change in conventional nitrogen removal from wastewater. Currently, many large-scale bioreactors use anammox systems around the world to treat nitrogen waste. Some of the advantages of using anammox as wastewater treatment are its high nitrogen removal capability, does not require aeration, and does not require additional carbon sources. Compared to conventional nitrification-denitrification processes, anammox can save up to 50% of oxygen requirements, 100% of organic materials, and almost 90% of waste processing operational costs. This research aims to determine the ability of anammox nitrogen removal using intensive pond sludge as an inoculum. This research can be the basis for developing a large-scale anammox bioreactor to process shrimp cultivation pond waste intensively to remove nitrogen.

Intensive shrimp pond sludge was collected at a depth of 0.5 m below the ground surface. The sludge was put into an anammox bioreactor and given high concentrations of ammonium and nitrite, namely 70-120 mg-NL-1 each, with 24-hour hydraulic retention time (HRT) for 134 days. Ammonium, nitrite, and nitrate levels were analyzed every week to monitor the influent and effluent values. The data was analyzed to obtain the values for ammonium conversion efficiency (ACE, %), nitrogen removal efficiency (NRE, %), nitrogen loading rate (NLR, kg-N/m3·d), and nitrogen removal rate (NRR, kg-N/ m3·d).

At the end of the study, the maximum nitrogen removal with parameters ACE, NRE, and NRR was 89.30%, 90.50%, and 0.23 kg-N/m3·d, respectively. The nitrogen stoichiometric ratio was 1:1.22, close to the stoichiometry of the anammox process. The anammox process has the potential to be a new technology for intensive shrimp culture wastewater treatment.

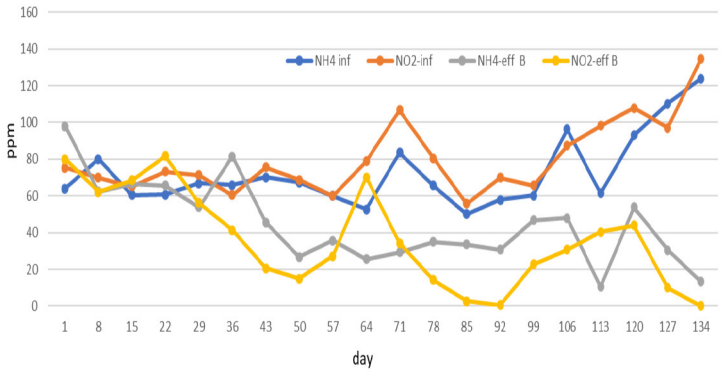

Figure 1. Nitrogen Profile

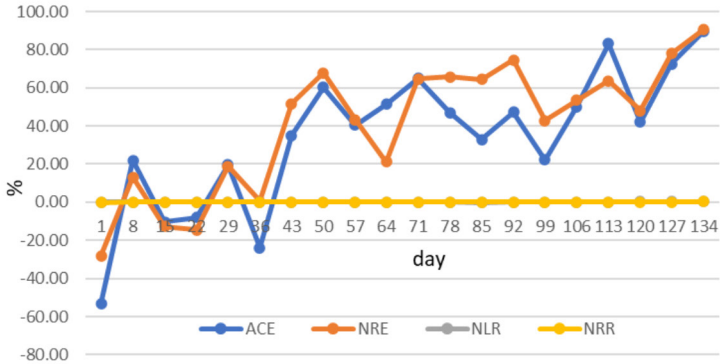

Figure 2. Nitrogen Removal Performance

THE CURRENT FISH PROCESSING AND MARKETING OF LAKE TANA: *REVIEW (SURVEY)*

Tariku Hailu, Minwyelet Mingist, Alemken Berihun, Birtukan Tsegaye and Yibeletal Aynalem

College of Agriculture and Environmental Sciences
Department of Fisheries and Aquatic Sciences
Bahir Dar University
Ethiopia, PO. Box. 79
Email: tahailu21@gmail.com
Phone: +251931165301

SUMMARY
There are three commercially important fish species in Lake Tana; African Cat fish, Nile tilapia and Labeobarbus spp.; which are available in whole fish or in the form of semi-processed products (fillet, gutted and dried fish). The fish from Lake Tana is harvested by motorized boats and tanqua. The fisher men are from different cooperatives /organized groups and individual fisher men. The harvested fish will be collected by traders from different location, cooperatives/Tana No. 1 Cooperative and FPME (Fish Processing and Marketing Enterprise). Tana number 1 cooperative and FPME are the major suppliers and processers of fish from Lake Tana. The major fish processing methods are gutting and filleting. The gutted and filleted fish products are sold in Bahir Dar and Addis Abeba markets while the filleted cat fish is dried for sun drying or salting to be sold for Sudanese market and other regional and outside the region markets in the lowland areas. The traders supply fish for hotels, restaurants, other traders and consumers in the local market, Addis Abeba market, Sudan and other part of the country. As a result of the seasonality of the fisheries practice, the price of fish and fish products depends on season. Not only the season but also the price of fish and fish products fish species and the product type. Nile Tilap

1. INTRODUCTION

Fisheries can provide year round production and income for vulnerable households especially when crop production is stressed due to erratic rainfall or factors beyond national control. Fish is the rich source of protein with an amino acid composition very well suited to human dietary requirements, comparing favorably with eggs, milk and meat in the nutritional value of its protein (Endebu Mengesha *et al*., 2015). The provision of adequate and affordable food (fish) for all is the fundamental basis for food security. Although there is remarkable progress made in increasing fishing worldwide, approximately half of the populations in developing countries do not have access to adequate food (fish) supplies, thus the food security problem is worsening (Adewolu and Adoti, 2010). Artisanal freshwater fishery is one of the most important economic activities in Ethiopia (FAO, 2012). Improvements in fishery sector would contribute to poverty alleviation and environmental sustainability in Ethiopia (GFA, 2010).

Lake Tana is one of the largest inland water lakes in Africa with the total area of 3200 km2, stretching 75 kilometers North and South, 60 kilometer's East-West and having average depth 8 m, and a maximum depth of 14 m. The motorized boat gill net fishery and the reed raft gill net fishery (the dominant) are the two major types of fisheries in Lake Tana. Over 80% of the fishers use reed boats that are made of locally available papyrus (Demissie, 2003). Lake Tana and its surrounding environment have enormous opportunities with respect to fishery production and marketing. Its proximity to the regional state's metropolitan town provides ample opportunity to commercialize and integrate the fishers with markets. If considerable support is rendered to the fishers and to those market actors engaged in the fishery sub-sector, strong institutional support can be easily made available given the fact that the location of Lake Tana is in the regional city. Fish consumption culture of the local population is changing positively, which increased the demand for fish in Bahir Dar. The opening of several hotels and restaurants and the tourist influx to the capital city, will all add to the lists of opportunity to strengthen the fishery sub-sector (Aytegeb Anteneh, 2013).

Lake Tana fisheries give economic and nutritional benefits to the community as well as the country. According to Abebe Ameha *et al*. (2017), Within five years' time alone (2008–2012) USD 1,967,735 (ETB 37,878,892) was generated from export (to the Sudan) fish market; and an income of ETB 59 million was generated in 2009 from domestic market. In areas around the lake and its rivers, fish is the major and important source of animal protein especially for the poor who can't afford buying other animal protein sources.

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Lake Tana fishery is dominated by artisan fishery activities. Private fishers (82.9%) dominate in Lake Tana fishing activity while 17% are members of different fishing cooperatives (Dagninet Amare *et al*., 2018). According to Dereje Tewabe (Personal Communication, 2021), even though there is increase in effort (3100 fisher men in 2013, 5400 fishermen in 2018), there is reduction in fish production in the Lake Tana fisheries (9000 ton in 2013, 7000 ton in 2018). The reason behind the reduction in fish production may be the result of management program, illegal fishing (during spawning season and use illegal mesh size, below 8cm).

Fishing by monofilament gillnet is performed mostly starting from early in the morning up to 10 am by disturbing spawning ground with strong stick to kick surface water for several times and several places until they caught enough catch. The demand of filleted fish by immediate fish traders who export Lake Tana fish mainly to Addis Ababa and Sudan as well as different towns of the country trigger fishers to have catch from small sized fish population by using illegal small sized monofilament gillnets which have never been practiced any years before.

2. FISH PROCESSING AND MARKETING

Woreta, Enfranz, Chuahit, Delgi in Central Gondar Zone, kunzla and Gulf of Bahir Dar are the main areas which are known by high production of fish from Lake Tana but now a day (2021) there is reduction in production. There is semi processing activity in these areas, fillet, gutted and dried fish are the main semi-processed products. The gutted and filleted products distribute to Bahir Dar, Gondar and Addis Ababa market while dried fish is for Sudan market. The gutted and filleted products are from tilapia (fillet), Labeobarbus spp. (gutted) and cat fish (fillet and dried). For dried fish they add 25kg of salt for 100 kg fish. In these sites, the main problem in production is computation between legal and illegal traders, illegal fishing activity, water hyacinth, electricity, market instability and high taxation (1100 birr/kuntal at Metema). In this area there was post-harvest loss because of electric problem for preservation and lack of market link.

The major fish processing methods in Lake Tana are gutting and filleting. The gutted and filleted fish products are sold in Bahir Dar and Addis Abeba markets while the filleted cat fish is dried for sun drying or salting to be sold for Sudanese market and other regional and outside the region markets in the lowland areas where people after two months of fasting use fish as the first meat for the enjoyment season. According to Dagninet Amare *et al*. (2018), Most of the fishers (65.9%) process their fish before selling. This study also showed that 63.89% of the fishers sell fish at landing sites while 36.11% do not sell at landing sites. The major fish marketing places for fishers are nearest towns (41.38%) (Kkunzila, Dengel Ber, Shawira, Delgi, Enfranz, Chuahit, Woreta) and Bahir Dar.

Figure 1. [redacted]

Figure 2. Preserved gutted and filleted fish

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Figure 3. Dried fish ready to Sudan market

3. Fish Processing and Marketing at Gulf of Bahir Dar

3.1 Fish production at Bahir Dar

Including Tana No. 1 cooperative there are nine fishery cooperatives and groups which have a total of 341 member fisher men (Tana No. 1 cooperative only has 208 members). And also there are 514 registered individual fisher men (Bahir Dar City Administration Agricultural Office, Personal communication, 2021). The data that has obtained from Bahir Dar City Administration Agricultural Office below in the table shows the total production of fish in the last 10 consecutive years. According to the data, production increases from the previous years to the resent. In the last 10 consecutive years a total of 8341.5 tons of fish has been produced at Gulf of Bahir Dar (Fig. 6).

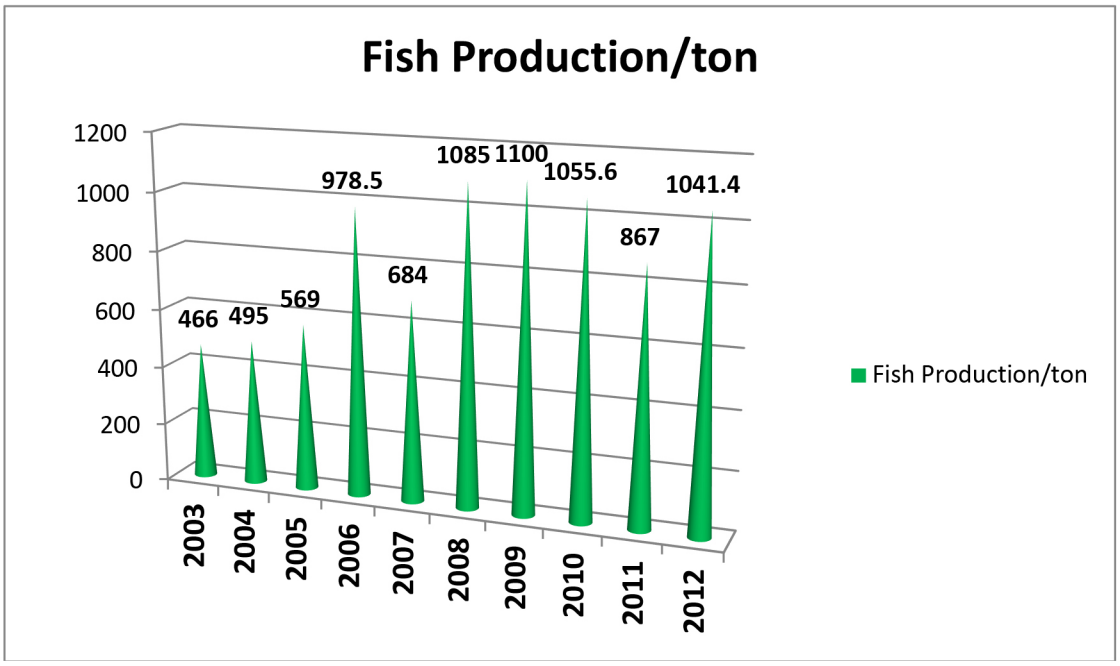

Figure 6. Fish Production at Gulf of Bahir Dar from 2003 to 2012 E.C in tons (Data from Bahir Dar city Administration Agricultural Office), 2021

3.2 Tana No. 1 Fisher's Cooperative Fish Processing and Marketing

The data from Tana number 1 fisher's cooperative showed that *Nile tilapia, Labeoarbus spp*. and *Cat fish* are the major commercially available and semi-processed fish products in the form of filleted and gutted. Among these species *Tilapia* is the first in semi-processed fish production; *Labeobarbus spp*. and Cat fish comes next respectively. The cooperative buys whole fish from its member fisher men and semi-process it into fillet and gutted products. As indicated in **Figure 4.** Below, the production of fish products showed reduction. The reason for the reduction of production is because of the reduction fish catch from the lake which may be lack of proper management of the lake, illegal fishing both in off season and small mesh size (<8cm) and boat price (expensive) (personal communication with the cooperative manager, 2021).

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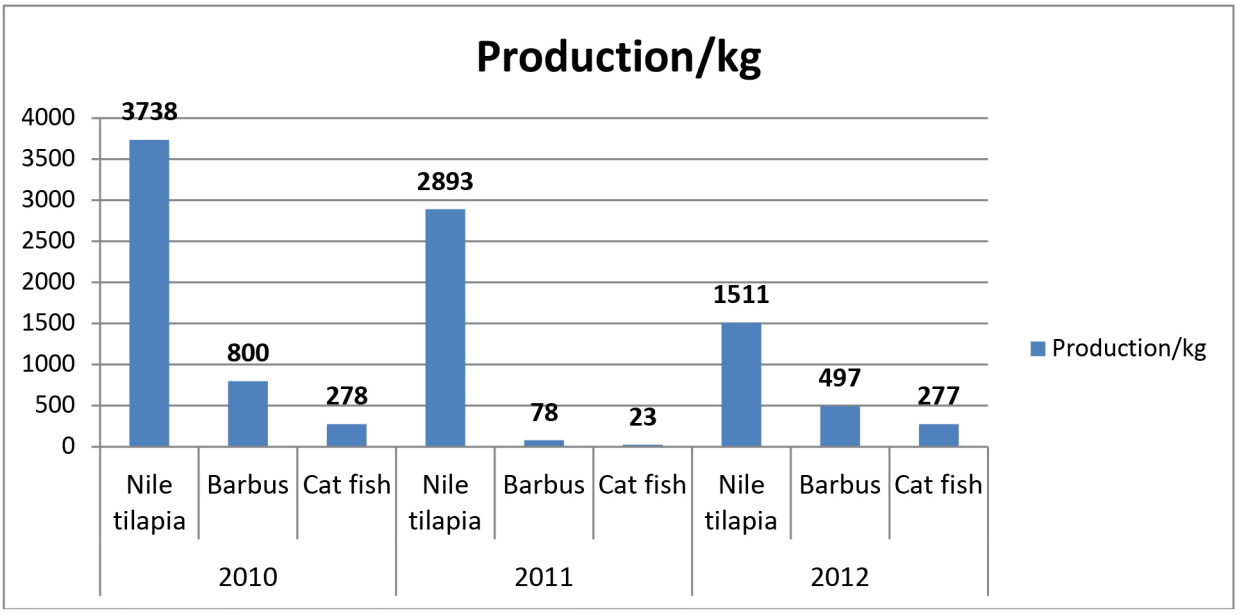

Figure 5. Amount of Processed Fish at Tana No. 1 Cooperative, 2021

The cooperative sells its whole and semi-processed fish product to restaurants, hotels, traders and consumers in similar price for all; but the price depends on season (availability of fish), fish species and type of product (filleted or gutted and/or gutted, **Table 1**.). The fish species that has the highest price is *Nile Tilapia* then *Barbus* and *Cat fish* respectively.

Table 1. Price of Whole and Semi-Processed Fish at Tana No. 1 cooperative

Species	Fish Product	Purchasing Price/Birr	Selling Price
Tilapia	Whole fish	25-50 Birr	60
	Fillet	0	150-200
Barbus	Whole fish	3-5 Birr	20
	Fillet	0	30
Cat fish	Whole fish	5-15 Birr	0

3.2.1. FPME

FPME supply fish to Addis Ababa from Lake Tana. *Tilapia, Labbarbus spp*. and *cat fish* are the main species from Lake Tana to local (Bahir Dar and Gondar) and Addis Ababa Market. And also it supply Nile Perch to Bahir Dar and Gondar from Debre Zeit. **Figure 7** below shows the five year (from 2008-2012 EC) fish product that was distributed to local market, Addis Abeba and other cities from Lake Tana.

FPME sells its semi-processed fish product for hotels, restaurants and consumers by the following price in **Figure 8**, the five years price is registered which is based on the fish species (*Tilapia, Barbus, Cat fish* and *Nile perch*) and type of product (filleted or gutted of different species).

Generally the price of whole and semi-processed fish varies by fish species, type of product and place of market, **Figure 8**. Seasonal pattern of fish consumption affects fish marketing at Lake Tana; and also consumption of fish varies in intensity both in a year, month and a week. Influenced by various factors (tradition, habits and religious custom) (Aytegeb Anteneh, 2013).

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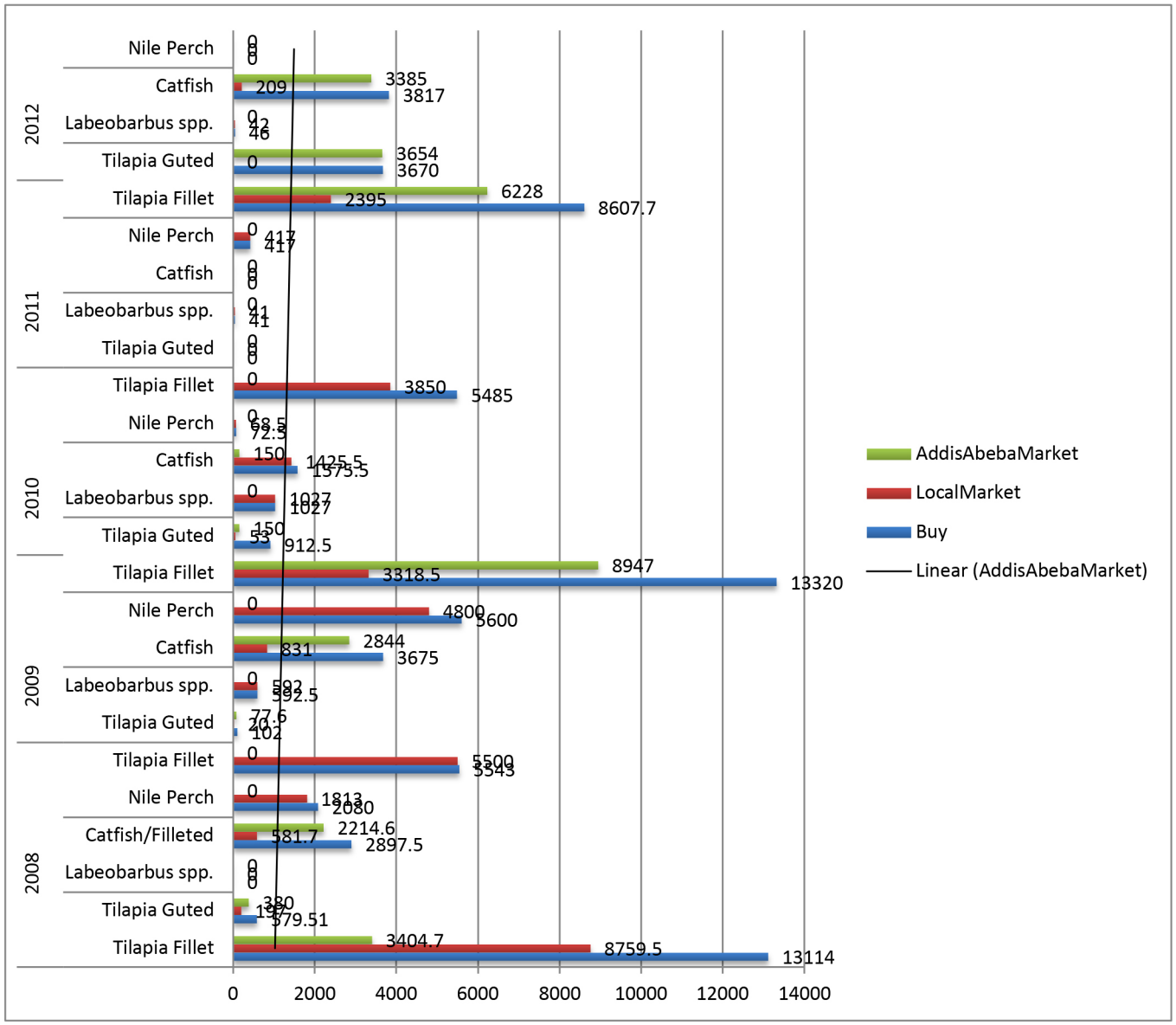

Fig. 7. Semi- Processed Fish for Local (Bahir Dar and Gondar) and Addis Abeba Market From FPME (*Data received from FPME, 2021)*

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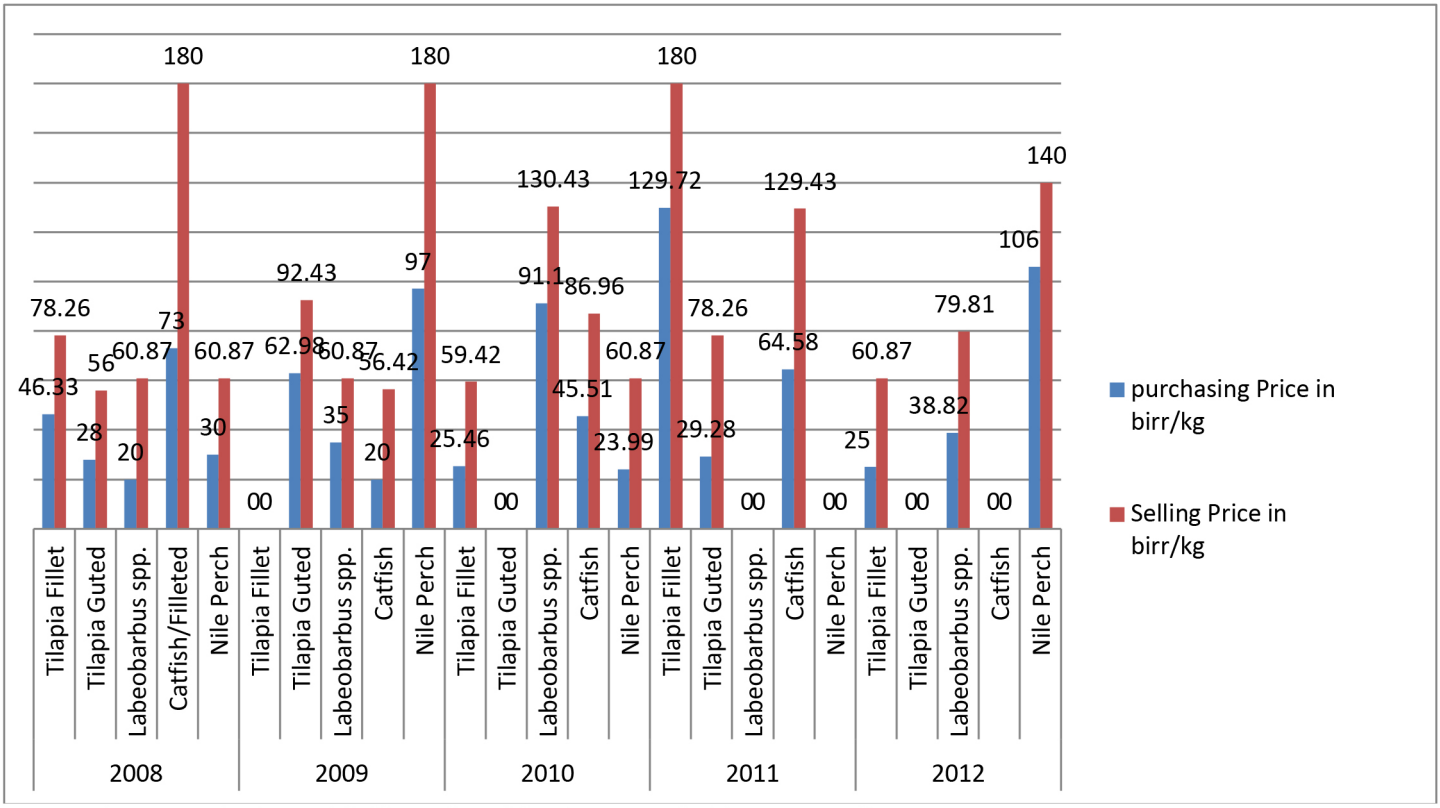

Fig. 8. Purchasing and Selling Price of Semi-Processed Fish at FPME (Source FPME, 2021)

3.2.2. Lake Tana Aquaculture and Processing

Another fish processing organization in Lake Tana at Bahir Dar is "Lake TanaAquaculture and Processing" which is special from all others in our trip sites in handling and processing. They have measuring, scaling, washing, filleting, gutting, cooling, ice producing, laboratory and packing labeling and weighing room. They have 2 cold tracks a capacity of 30 quintal each. They can pack 125 kg once. They produce fillet from *Tilapia, Cat fish* and *Barbus* spp. while gutted fish is produced from *Barbus* spp.. As they told us, their product is preserved at -18 ^{0}C which can stay up to 2.5 years without any quality loss. The company faced electric and water supply problems.

SUMMARY

In Lake Tana there are three commercially important fish species; African Cat fish, Nile tilapia and Labeobarbus spp.; which are available in whole fish or in the form of semi-processed products (fillet, gutted and dried fish). The fish from Lake Tana is harvested by motorized boats and tanqua. The fisher men are from different cooperatives /organized groups and individual fisher men. The harvested fish will be collected by traders from different location, cooperatives/Tana No. 1 Cooperative and FPME. Tana No. cooperative and FPME are the major suppliers and processers of fish from Lake Tana. The major fish processing methods are gutting and filleting. The gutted and filleted are sold in Bahir Dar and Addis Abeba markets while the filleted cat fish is dried for sun drying or salting to be sold for Sudanese market and other regional and outside the region markets in the lowland areas. The traders supply fish for hotels, restaurants, other traders and consumers in the local market, Addis Abeba market, Sudan and other part of the country. As a result of the seasonality of the fisheries practice, the price of fish and fish products depends on season. Not only the season but also the price of fish and fish products fish species and the product type. Nile Tilapia accounts the highest price, the barbus and African cat fish follows respectively.

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PREDICTING VANNAMEI SHRIMP SURVIVAL RATE WITH MACHINE LEARNING: A NOVEL APPROACH FOR OPTIMIZING SHRIMP FARMING

Lukman Hakim[1], Syauqy Nurul Aziz[1]

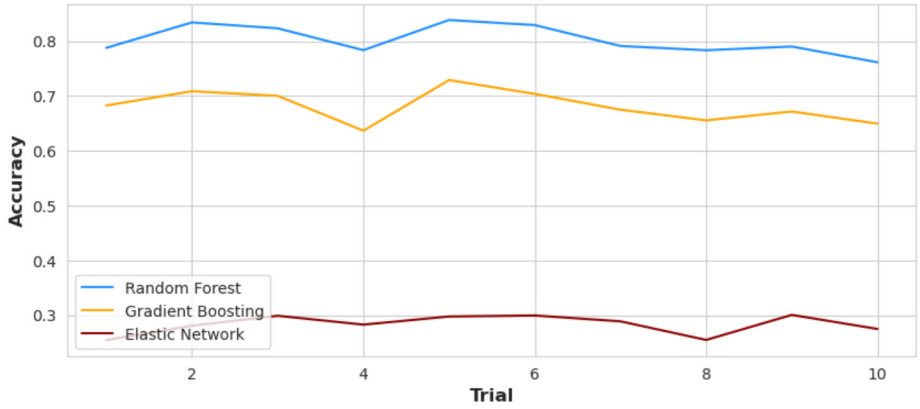
[1]JALA TECH Pte Ltd.
Ground Floor Sahid J-Walk
Jl. Babarsari No. 2
Janti, Caturtunggal, Kec. Depok, Sleman
Daerah Istimewa Yogyakarta, Indonesia 55281

Despite its rapid growth, shrimp farming faces many challenges, such as diseases, water quality and environment, and climate change. These problems cause shrimp farming to have different survival rates and production levels in different ponds. Due to all of the factors that affect it, it is typically characterized by boom and bust cycles. The latter are usually caused by production crashes resulting from disease outbreaks. With all of the factors that increase uncertainty in shrimp farming, it is important to develop reliable methods for predicting the survival rate (SR) of P. vannamei in different scenarios.

In Indonesia, SR prediction is commonly done based on feeding rate or feeding program. The prediction merely considers the ratio of the amount of feed thrown to ponds towards its theoretical feeding that is estimated based on the feeding rate. This condition makes the SR prediction accuracy depend on the feeding estimation accuracy and how disciplined the farmer is in following the feeding program. Further, this method is only able to estimate the current state of the cultivation without giving any forecast. Based on our research, this method is only able to predict SR with an R^2 score of 0.65. This research tries to solve the problem by using machine learning that makes predictions based on more diverse variables such as feed consumption, stocking density, mortalities, feeding control, targeted length of cultivation, moon phase, and shrimp growth to project SR on a specific targeted age of cultivation.

The dataset used in this study was collected from several locations in Indonesia and contains 867 shrimp cultivation cycles from 146 farms. The dataset was cleaned, imputed, and feature-engineered to make the prediction. This research compared 3 algorithms, Random Forest (RF), Gradient Boosting (GB), and Elastic network (EN). The results showed that the random forest model outperformed the other models, achieving an average R^2 score of 0.853 over 10 trials. Meanwhile R^2 for GB and EN model area 0.67 and 0.24. Those results indicate that the RF model can be used as a reliable tool for predicting the survival rate of vannamei shrimp and can help farmers and aquaculture managers optimize their production and cultivation strategies.

Accuracy of SR Prediction on 3 Models



THE NUTRITIONAL VALUE AND EFFECT OF BROMELAIN HYDROLYSED CHICKEN FEATHER MEAL ON *Clarias* sp. GROWTH

Desy Putri Handayani*, Alim Isnansetyo, Senny Helmiati, Muhsin Al Anas

Fisheries Department
Faculty of Agriculture
Universitas Gadjah Mada
*Email: desy.putri.h@mail.ugm.ac.id

The purpose of this study was to examine the nutritional content of chicken feather hydrolysate and its effect on Clarias sp. growth. We used tape yeast, papain, and bromelain to hydrolyse chicken feathers. An examination of proximate and amino acids was conducted after the hydrolysis process. The best hydrolysate product was subsequently utilized as a feed ingredient for fish. Fish feed was created using the Pearson's square method (iso-protein). This study used a fully randomized design with four treatments and three replications (0, 10, 20, and 30%). In comparison to the other treatments, bromelain feather meal was shown to have higher quantities of crude protein and amino acids (lysine, phenylalanine, methionine, valine, and glycine). Bromelain break down and cut feather meal protein, which has a molecular weight of 5–20 kDa. The feeding of 10% bromelain chicken feather meal (P1) boosted the growth of catfish by improving feed efficiency, average daily growth, protein efficiency ratio, percentage weight gain, specific growth rate, relative growth rate, and survival rate. In P1, the value of the feed conversion ratio dropped in comparison to the control. Because it is more nutrient-dense and encourages fish growth, chicken feather meal can be used in reduce of fish meal in catfish feed.

There is currently an urgent need for substitute feed ingredients that can lessen the requirement for fishmeal. Feathers from chickens are an easy and affordable way to get components for feed. Furthermore, since chicken feathers are not an essential food for humans, there is no conflict of requirements. More than 60% of chicken feathers are made of protein. The high protein content of chicken feathers makes them suitable for use as fish feed. Unfortunately, the protein found in chicken feathers is called keratin. Chicken feathers must first be processed before being used as feed ingredients.

Processing of chicken feathers can be done by hydrolysis using enzymes and yeast. Regarding using those enzymes and yeast to hydrolyse chicken feather meal for catfish diet, no information has been provided. This study will address the nutritional content and growth-promoting properties of catfish feed that incorporates hydrolysed feather meal. We conducted several analyses to check nutrition, protein size, amino acids, and its effect of *Catfish* sp. Growth. A fully randomized design (CRD) experiment with four treatments administered in triplicate was used to design this investigation. BCFM was used in place of P0, P1, P2, and P3 at doses of 0%, 10%, 20%, and 30%. 30 fish per tank were used to raise the catfish fingerlings, which were 8 cm (4 g) in weight. The 50 x 50 x 60 cm fiberglass tanks have aeration installed. To maintain standard water quality (28.0 ± 1.0 □C, pH at 7.5 ± 0.4, dissolved oxygen at >5 mg/L, and total ammonia nitrogen at <0.1 mg/L), the fish were maintained for 42 days with 30% water exchange every two days. Research results show that feeding up to 10% chicken feathers can increase growth, nutrition, feed efficiency and reduce feed conversion rate.

The levels of ADG, SGR, PER, and RGR from P0 and P1 in this investigation did not differ substantially from one another. The growth of catfish fingerlings fed a 10% BCFM (P1) substitute showed the same results as feeding them 100% fishmeal. Each fish's tolerance to the protein source had an impact on variation tolerance. In this study, catfish fingerlings fed 0–30% BCFM demonstrated good survival, with SR values above 75%.

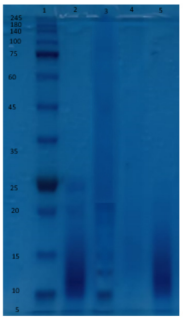


Figure 1. SDS PAGE 10% protein profiles of chicken feather hydrolyzed with bromelain and control. (Lane 1 is protein markers (5-245 kDa), Lanes 2–5 are controls, BCFM, PCFM, and TYCFM.)

(Continued on next page)

Tabel 1. Bromelain (BCFM), papain (PCFM), and tape yeast (TYCFM) hydrolyzed chicken feather meal and its nutritional value.

Sampel	Crude Protein (%)	Crude lipid (%)	Ash (%)	Water Content (%)
Chicken feather (Control)	60.29[a]	2.52[d]	5.12[a]	2.46[a]
PCFM	64.46[b]	1.31[a]	5.46[c]	6.27[b]
BCFM	65.15[c]	1.61[b]	5.78[d]	6.26[b]
TYCFM	60.48[a]	2.20[c]	5.22[b]	9.67[c]

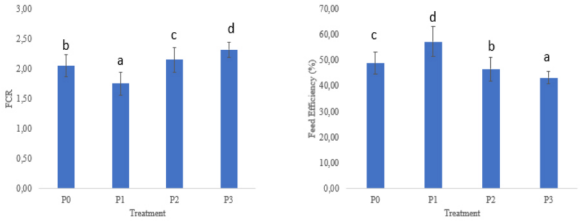


Figure 2. FCR and feed efficiency of catfish fed bromelain hydrolysed chicken feather meal (0–30%)

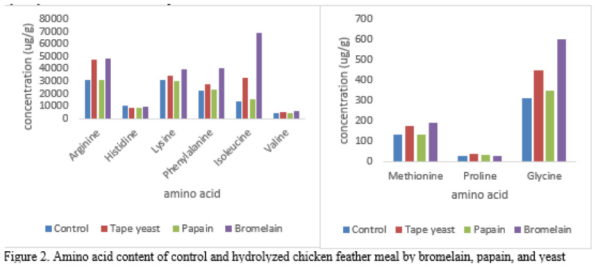


Figure 2. Amino acid content of control and hydrolyzed chicken feather meal by bromelain, papain, and yeast

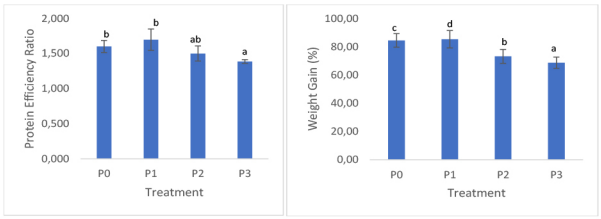


Figure 3. Effects on Protein Efficiency Ratio and Weight Gain of Catfish Fed Bromelain Hydrolysed Chicken Feather Meal (0–30%)

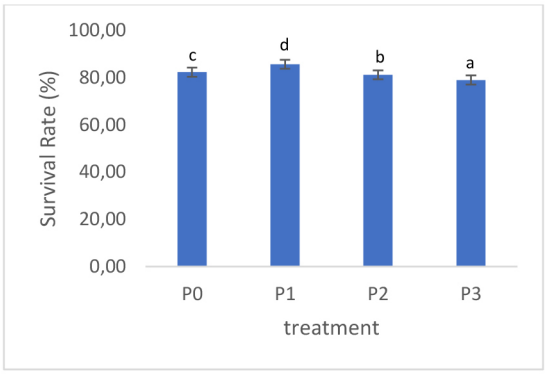


Figure 6. The impact of chicken feather meal hydrolysed with bromelain (0–30%) on catfish survival rate.

SHRIMP HEALTH MANAGEMENT IN PACIFIC WHITE SHRIMP (*Litopenaeus vannamei*) CULTURE USING MILLENNIAL SHRIMP FARMING (MSF) TECHNOLOGY IN INDONESIA (A CASE STUDY AT SITUBONDO DISTRICT, EAST JAVA)

Bambang Hanggono*, Didik Budi Nursanto

Brackishwater Aquaculture Development Center Situbondo
East Java, Indonesia

bambanghanggono@gmail.com

Pacific white shrimp (*Litopenaeus vannamei*) cultivation has been developing in Indonesia since 2002. Currently, vanamei shrimp has become one of the main export commodities for fisheries. The development of shrimp cultivation is supported by various types of cultivation technology. One of the newest technologies is millennial shrimp farming (MSF). Millennial Shrimp Farming (MSF) technology use circular pond with high stocking densities range from 250 to 500 PLs/m^2. This technology is equipped by paddle wheel, aeration, automatic feeder and start up technology for water quality monitoring.

This study was conducted in 40 MSF circular ponds (20 m in diameter and 1.2 m in depth) from 2020 to 2023. Four shrimp disease namely White Spot Syndrome Virus (WSSV), Infectious Myo Necrosis Virus (IMNV), *Enterocytozoon hepatopenaei* (EHP) and Acute hepatopancreatic necrosis disease (AHPND) were observed during this study. Growth and water quality were also monitored during this study.

Our study revealed that WSSV, AHPND, EHP and IMNV were found in shrimp cultured during the study period. However, only AHPND, EHP and IMNV were always found in every cycle of the cultivation. AHPND infected the shrimp under 30 days of culture. EHP and IMNV were found after 60 days of culture. The mortality rate ranged from 50 – 80 %. Productivity ranged from 3 to 5 kg/m2. ADG values in aquaculture ponds ranged from 0.3 – 0.4 g/day. The survival rate ranged from 61% to 90 %, and the feed conversion ratio ranged from 1.2 to 1.3. Water quality including temperature, dissolved oxygen, pH, ammonia, TOM, alkalinity and nitrite indicate the optimal range based on water quality standards for intensive vannamei shrimp culture.

Our study concluded that to increase productivity, we should implement Good Aquaculture Practices including shrimp health management. Several ways can be done to apply shrimp health management in MSF namely strict biosecurity, using SPF PLs, application proper disinfectant, application probiotic to manage the total Vibrio, reduce the stocking density especially during rainy season, reducing mud deposits at the bottom of ponds by siphoning and regular water circulation. In the case that the death rate of shrimp affected by disease cannot be controlled, an emergency harvest must be carried out to prevent the spread of the pathogen.

THE EFFECTIVENESS OF SHRIMP EFFLUENT MANAGEMENT SYSTEM IN MILLENNIAL SHRIMP FARMING (MSF) TECHNOLOGY IN INDONESIA (A CASE STUDY AT SITUBONDO DISTRICT, EAST JAVA)

Bambang Hanggono*, Arif Zaenuddin

Brackishwater Aquaculture Development Center Situbondo, East Java, Indonesia

bambanghanggono@gmail.com

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As the amount of feed increases, the waste produced will also increase. Waste from shrimp cultivation produces approximately 35% organic waste, 15% feed waste and 20% shrimp metabolic waste. As waste increases, it will undergo a decomposition process which will produce nitrites and ammonia, because not all of the feed is consumed by the shrimp.

The aim of study was to determine the effectiveness of shrimp effluent management system in millennial shrimp farming (MSF) technology. This system consists of: (1) inlet or sedimentation pond I; (2) sedimentation pond II; (3) oxygenation pond I; (4) oxygenation pond II or outlet; (5) mud sedimentation pond I and mud sedimentation pond II.

The results of measuring waste water quality parameters in each pond show that the shrimp effluent management system has functioned well for the parameters pH, BOD5 and TSS. However, the parameters Nitrite, Nitrate, TAN, free ammonia, PO4 and organic matter are still not effective because the values are still above the permissible threshold limits.

Based on the observed water quality parameters, the shrimp effluent management system efficiency for BOD5 parameters was 64.71% and TSS was 92%. The efficiency level of the shrimp effluent management system is categorized according to the opinion of Tchobanoglous et al. (1991) in Rachman Syah et al (2017) as follows: Very efficient: $x > 80\%$; efficient: $60\% < x = 80\%$; moderately efficient: $40\% < x = 60\%$; less efficient: $20\% < x = 40\%$; inefficient: $x = <20\%$. Therefore, the shrimp effluent management system in millennial ponds is efficient enough to reduce BOD5 and TSS values.

SMART SILVOFISHERY FOR FOOD SAFETY AND SUSTAINABLE AQUACULTURE

Esti Handayani Hardi

Departement of Aquaculture
University of Mulawarman
East Kalimantan, Indonesia
estie_hardie@fpik.unmul.ac.id

Due to climate change, it is crucial right now to have access to food that is safe to eat, which includes fish and prawn protein. Current restrictions on prawn aquaculture development include diminishing water quality, an increasingly unpredictable environment, declining product quality, and the appearance of pollutants in the manufactured goods, which result in market rejection, particularly for exports. In Indonesia, traditional farming has actually been conducted by a large number of people, although it is unpopular due to its low production (200 kg/ha).

Using plant extracts as prebiotics, antibacterials, immunostimulants, and natural pesticides instead of chemicals, smart silvofishery is a method of raising prawns that are a part of mangrove ecosystems. Each pond contains a mangrove region and a pond area that are divided by water gates. It uses a mangrove region for filtration, sedimentation, cyclic activity, and a biodiversity area made up of natural prawns, fish larvae, and eggs for slow processing. Mangrove litter can also deliver a total nutritional value of 5.28 ppm/ha. In comparison to intensive rearing methods, prawns raised with smart silvofishery can produce yields of 400 kg/ha and have higher concentrations of the amino acids AA, DHA, omega 3, omega 6, and omega 9. Some of the advantages of smart silvofishery to support the blue economy of Indonesia and the world are: 1) Environmentally friendly management. 2) Optimising available natural resources. Can be combined with ecotourism and mangroves. 3) Low operating costs. 4) Partial harvest and can be managed with polyculture. 5) The Revenue Cost Ratio (R/C) value is > 1, which shows that fish and shrimp farming using the Smart Silvofishery concept is feasible from an economic, environmental, and social perspective. 6) The quality of shrimp and fish meat, especially the quality of amino acids and fatty acids, is higher than shrimp that are reared intensively. 7) The cultivation system is carried out in a sustainable manner, prioritising the carrying capacity of the environment and maintaining the existence of functioning mangroves. There are at least two advantages to implementing silvofishery, both on and off the farm.

Benefits of smart silvofishery pond management on the farm:
1. Mangrove litter is a source of nutrients for ponds in the form of nitrogen, phosphorus, and potassium.
2. Nutrients from mangrove litter support the growth of natural food for fish and shrimp, increasing the growth of plankton and klekap.
3. Mangrove litter contains antibacterials, which can reduce the number of pathogenic bacteria.
4. Because of the high availability of natural food, fish and shrimp growth is uniform and high.

Benefits of off-farm smart silvofishery:
1. Fish and shrimp have a higher amino acid content.
2. Fish and shrimp have higher levels of fatty acids.
3. Does not contain antibiotics.
4. Lower Cu heavy metal content
5. Shrimp cholesterol content is lower
6. Uniform harvest size
7. The crabs' molting percentage is higher and more uniform.
8. Shrimp do not rot easily.

In addition, the management of traditional ponds with smart silvofishery has the opportunity for synergistic management in the community; the existence of multi-species that are cultivated will open up opportunities for processing into multi-products, especially involving women on the coast. Of course, this will slowly encourage community economic transfers that were previously passive to become active. The expansion of ponds associated with mangrove ecosystems will have a positive impact on the environment, mitigate climate change, and, of course, be sustainable.

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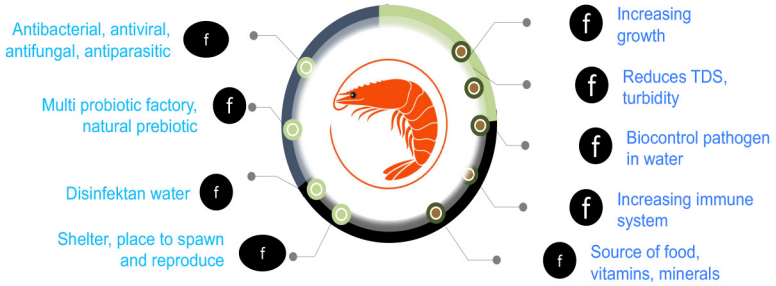
Mangroves serve as hospitals for fish and shrimp



VARIATIONS OF FILTER MEDIA IN BREEDING CLOWNFISH ORNAMENTAL FISH

Adi Hardiyanto* dan Heru Salamet

Balai Perikanan Budidaya Laut Ambon
Jl. Leo Wattimena, Ambon
e-mail: ambonbpbla@gmail.com

The recirculation system used for seven years at BPBL Ambon continues to be developed using simple and affordable technology so that it is easy to apply by cultivators. In order for the recirculation system to be able to provide more optimal results in clownfish rearing, it is necessary to carry out research on the differences in biological filters in recirculation systems so that the components of a good filter media used in cultivation activities can be identified.

In this experiment there were three different filter media treatments, namely Treatment A (Ginger Coral), Treatment B (Kaldness K1) and Treatment C (Bioblock). In this experiment, seeds were spread with a size of 2 cm as many as 900 individuals per recirculation system unit. The feed given is commercial pellet feed, amounting to 5 - 10% of the total biomass. The frequency of feeding is 3-4 times a day and given in the morning, afternoon and evening.

The water quality values in the three treatments tend to be the same and are still within normal limits where the temperature is in the range of 26.1 – 28.2 oC, salinity 32 – 33 ppt, DO 4.31 – 5.91 mg/l, Nitrite 0.038 – 0.576 mg/l, Ammonia 0.002 – 0.130 mg/l, Nitrate 0.01 – 1,080 mg/l. In treatments A and B the pH value was at optimum conditions, however in treatment C the pH value was quite low, namely 6.36. As a result, there was quite high mortality in treatment C. The highest survival value was in treatment A, namely 87.11%, followed by treatment B at 86.67% and treatment C at 53.33%. The value of increase in length during the two month maintenance period tended to be the same as in treatment A namely 1.25 cm, followed by treatment B at 1.3 cm and treatment C at 1.26 cm.

DOMINANCE AND VALUATION OF CLOWNFISH ORNAMENTAL FISH PICASSO VARIANT (*Amphiprion percula*)

Hariyano*, Heru Salamet, Agam T Wibowo

Balai Perikanan Budidaya Laut Ambon
Jl. Leo Wattimena, Ambon
e-mail: ambonbpbla@gmail.com

The Picasso variant of the ornamental clownfish is one of 50 types of clownfish ornamental fish variants that have been produced by the Ambon Marine Cultivation Fisheries Center. The demand for ornamental clownfish is quite high, both for fulfilling the domestic market and shipping abroad with relatively stable prices in the range of hundreds of thousands of rupiah. The relatively stable price of this fish is due to its attractive pattern, good body resistance and agile movements. This activity aims to see the dominance and valuation of the Picasso variant clownfish. The implementation was carried out in the Ornamental Fish Division from January – December 2023 with 20 parent pairs of the Picasso variant (picasso, Davinci, snowflake, frostbite) which were kept in an 80 liter capacity aquarium with anemones and egg collector pipes. The results obtained from clown ornamental fish hatcheries carried out during 2023, Picasso variant ornamental fish seeds, show the dominance of success in their survival rate. The total number of Picasso seeds produced was 1078 or around 15% of the total ornamental clownfish seeds produced. Picasso's sales results are also the largest when compared to the blackphoton and platinum variants as well as other types of variants. The results of the business analysis obtained a B/C ratio = 1.57, Payback Period = 0.6 years and ROI 56.98%.

DOMINANCE AND VALUATION OF CLOWNFISH ORNAMENTAL FIS PICASSO VARIANT (*Amphiprion percula*)

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PRODUCTION OF TREVALLYFISH (*Caranx sp*) ENLARGEMENT SCALE IN FLOATING NET CAGES AS A LOCAL COMMODITY DEVELOPMENT BUSINESS MODEL BASED ON SIMPLE TECHNOLOGY

Hariyano and La Ramlan

Ambon Mariculture Development Center
Jl. Leo Wattimena, Ambon
e-mail: ambonbpbla@gmail.com

Bubara Fish (Local Name) or Kwee Fish (National Name) is a local economic fish from the Carangidae Family which is very popular in Maluku. Almost all restaurants and restaurants in Ambon City always serve this fish. Starting in 2007, the activity of rearing trevally fish in floating net cages has been carried out in floating net cages belonging to the Ambon Sea Cultivation Fisheries Center until now. This technology model for rearing fish in floating net cages has apparently been able to encourage farmers in Ambon Bay and West Seram Regency as well as several other districts in Maluku Province and even other provinces to develop the cultivation of trevally in floating net cages and increase their income. Fish growout in aquaculture activities aims to produce consumption-sized fish. In rearing activities, fish are encouraged to grow optimally until they reach marketable size by providing an optimal fish living media environment, and providing the right amount, quality, method and time of feed as well as controlling pests and diseases. Apart from individual growth, in rearing it is important to reduce the death rate of fish in production containers. So that fish production biomass can be achieved as high as possible. This activity aims to increase the production of trevally in floating net cages using several cultivation approaches and will take place from May - October 2020. The results of the activity show that the growth rate of trevally ranges between 2.88 - 3.23%, the survival rate ranges from 70-82% and FCR ranges from 3.01 – 3.22. The results of the business analysis obtained a B/C ratio = 1.78, Payback Period = 0.8 years and ROI 77.81%. In general, this fish rearing activity is worth doing because it provides benefits during the rearing period. Apart from that, to reduce the seed mortality rate, what must be considered is the adaptability of the seeds, transportation, changing nets and handling when sampling seeds.

MICROALGAL CULTIVATION SYSTEMS AND PHOTOBIOREACTOR DESIGNS

Razif Harun*, Nurul Farahin Abd Wahab, Yoshiki Takayama, Tatsuki Toda, Fatimah Yusoff

Department of Chemical & Environmental Engineering
Faculty of Engineering
Universiti Putra Malaysia
43400 Serdang, Selangor

Although algal technology is a complementary technology that provides sustainability concerning global issues, microalgae-based technology is still incipient and hindered by technical and economic constraints. Major hindrances to the commercial viability of microalgae are the operational and maintenance costs associated with large-scale cultivation. Most microalga cultivation operations rely on improvised photobioreactor designs, of which open-pond systems are frequently considered for large-scale operations. A cost-effective cultivation system is needed to improve the sustainability and economics of microalga cultivation while minimizing space and culture contamination and maintaining the integrity of desired species. Different types of photobioreactors (PBRs) have been developed, and the designs have been improved from time to time to meet the need for commercial production. However, current designs of PBR can still be improved to lower costs, increase efficiencies, and maintain high productivity. More research innovation is required to develop and evaluate new and improved PBR systems with enhanced performance indicators because responses of specific strains cannot be inferred from other PBRs or culture conditions.

ABALONE *Haliotis squamata* MASS REARING USING HANGING COMPARTMENT METHOD IN MARINE AQUCULTURE DEVELOPMENT CENTRE – LOMBOK, WEST NUSA TENGGARA PROVINCE, INDONESIA

Taufan Haryono*, Muhammad Hidayat, Muchamad Amiri, Ni Nyoman Tri Hanayanthi

Marine Aquaculture Development Centre – Lombok
West Nusa Tenggara
Indonesia
Bpbl.lombok@gmail.com

Abalone (*Haliotis sp.*) are one of high economy value commodity in fisheries among others. This is due to the high demand for this commodity in export market, such as Singapore, Hongkong, China, Taiwan, Japan. This high demand for the commodity lead to the excessive caught of abalone in wild, that can cause the scarcity of the stock, hence a preventive action need to be done. Marine Aquaculture Development Centre (MADC) Lombok, as one of Technical Implementing Unit under Ministry of Marine Affairs and Fisheries (MMAF) Indonesia, have a solution to this problem by doing the abalone mass rearing using hanging compartment method.

The high demand for the abalone can only be fulfilled by the high number of productions, thus farmers participation is a must. The idea behind the method is to produce a mass scale of abalone using a method that can be imitate easily by the farmers. This method using a number of perforated plastic bucket, hanged to the floating platform with Poly Ethylene (PE) rope as a suspender (Figure 1).

Observation for data collection was done from July 7th till July 28th 2023 (21 days), in MADC-Lombok Facility. Data that has been collected including the stocking density, specific growth rate (SGR) for weight, Absolute Length Growth, Survival Rate (SR), and Feed Conversion Ratio (FCR). During the rearing phase, the abalone fed only using *Gracillaria sp.* (Figure 2), 3 times a week with feeding dose as much as 30% of biomass, stocking density for each bucket is 200 abalones (*Haliotis squamata*) with average shell length 3,6 cm (Figure 3). The result from the observation for SGR, Absolute Length Growth, SR, and FCR respectively as follows: 0,83%; 0,351; 99,56%; 22,5.

Figure 1. Hanging Compartment

Figure 2. Abalone Feed

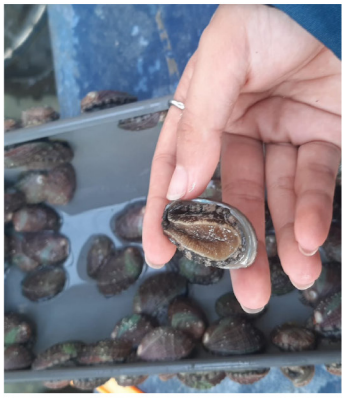


Figure 3. Seedling

EXOGENOUS PROTEASE AND PHYTASE SUPPLEMENTATION IMPROVED GROWTH, FEED UTILIZATION, INNATE IMMUNITY, NUTRIENT DIGESTIBILITY AND PATHOGENIC RESISTANCE OF PACIFIC WHITE SHRIMP *Litopenaeus vannamei*

Mirasha Hasanthi*, Rutchanee Chochikachinda, Kyeong-Jun Lee

Department of Marine Life Science
Jeju National University
Jeju 63243, South Korea
mirasha@jejunu.ac.kr

The study investigated the effects of protease and/or phytase supplementation on growth performance, innate immunity, nutrient digestibility and pathogenic resistance in Pacific white shrimp. A positive (PC) and a negative (NC) control diets were formulated to contain fish meal at 200 mg/kg and 100 mg/kg respectively. Another eight diets were made via supplementing protease at 25 and 50 mg/kg or phytase at 100 and 200 mg/kg and supplementation their combinations. Each diet was fed to quadruplicate groups of 30 juvenile shrimp (initial weight 0.3±0.0 g) for 9 weeks. After the feeding trial, 45 shrimp from each dietary treatment were redistributed into three replicate tanks for the *Vibrio parahaemolyticus* bacterial challenge. A subset of shrimp with similar size (12±0.0 g) (2 tanks/group, N=20 shrimp/tank) were subjected for nitrogen and phosphorus excretion experiment for four days. The result showed that compared to shrimp fed NC diet, shrimp fed protease and phytase supplemented diets had significantly increased (P<0.05) weight gain and specific growth rate. Shrimp survival against *V. parahaemolyticus* challenge was not significantly (P>0.05) affected by the dietary protease or phytase. The water nitrogen and phosphorus concentration of all groups showed an increasing tendency during excretion experiment, and protease and phytase supplemented groups showed lower (P<0.05) nitrogen and phosphorus excretion compared to the NC group. The results on innate immunity, gene expression, nutrient digestibility, intestinal morphology and intestinal microbiota abundance will be further discussed in detail.

Table 1. Growth performance and survival of Pacific white shrimp (*Litopenaeus vannamei*) fed the experimental diets for 9 weeks.

	MBW (g)	WG%	SGR%	Survival%
PC	9.80±0.24^{a}	3162±80^{a}	5.53±0.04^{a}	95.0±1.9
NC	8.36±0.16^{c}	2679±51^{c}	5.28±0.03^{c}	97.5±3.2
H100	8.72±0.21^{bc}	2803±76^{bc}	5.35±0.04^{bc}	96.7±2.7
H200	8.85±0.12^{bc}	2851±40^{b}	5.37±0.02^{b}	97.5±3.2
P25	8.86±0.21^{bc}	2845±77^{bc}	5.37±0.04^{bc}	95.8±3.2
P50	9.09±0.18^{b}	2924±60^{b}	5.41±0.03^{b}	96.7±2.7
H100P25	8.97±0.28^{b}	2888±96^{b}	5.39±0.05^{b}	98.3±1.9
H100P50	9.18±0.18^{b}	2957±61^{b}	5.43±0.03^{b}	96.7±2.7
H200P25	9.07±0.29^{b}	2923±93^{b}	5.41±0.05^{b}	95.8±3.2
H200P50	9.20±0.16^{b}	2962±55^{b}	5.43±0.03^{b}	95.8±1.7

NITROGEN AND PHOSPHORUS: SHORT COMMUNICATION THE DYNAMICS ON THE STATUS OF CHLOROPHYLL-A, BACTERIA AND PLANKTON IN THE SHRIMP *Litopenaeus vannamei* OF ENVIRONMENTAL CULTURE

Yuni P. Hastuti*, Shabrina N. Fatimah, Hardi Pitoyo, Iwan Sutanto, Ahmad R. Kurniawan, Anggi Siregar, Setyo Pertiwi, Usaid A. Anshorullah

*Department of Aquaculture
Faculty of Fisheries and Marine Science
IPB University
Bogor, West Java, ID 16680
yuniha@apps.ipb.ac.id

Aquaculture production is inherently intertwined with its environmental role as a habitat for organisms and the equilibrium of environmental parameters. Maintaining the balance of biogeochemical cycles in aquaculture environments is an adaptive approach that must be upheld from the preparation of the medium, through maintenance processes, to the management of generated waste. The nitrogen (N) and phosphorus (P) cycle are fundamental earth cycles and capable of serving as macro nutrients aquaculture environments that can transform into other compounds, thereby determining the fertility levels in aquaculture pond media. Nitrogen (N) transforms into ammonia, nitrite, and nitrate, while phosphorus transforms into phosphate. This analysis aims to evaluate the transformation status of nutrients within chlorophyll-a and planktonic bacteria in aquaculture environment. Data was analyzed using Canberra distance and Principal Component Analysis (PCA).

Nitrogen and phosphorus serve as limiting factors in aquatic environments due to their significant roles in bacterial and plankton stability. Balancing and controlling the N and P systems in vannamei shrimp aquaculture environment require maintenance primarily through bacterial and plankton remediation technologies. With this technology, it is possible to influence the abundance of nitrifying and denitrifying bacteria. Nitrifying bacteria was found in an abundance of 4.6 x 10^6 CFU/mL, while denitrifying bacteria was found in an abundance of 5.76 x 10^7 CFU/mL. These results showed that the nitrogen cycle is able in its maximum capacity.

The measurement of nitrogen (N) and phosphorus (P) levels from the initial stages within shrimp pond reservoirs is imperative in aquaculture. This is primarily due to their roles as fundamental nutrient sources for organisms such as chlorophyll a, bacteria, and phytoplankton. The results of the analysis showed that these elements had a significant correlation (strong positive) between other parameters, all of which are consistently grouped within quadrant IV during Principal Component Analysis (PCA) (Figure 1). The co-placement of three fishponds within this quadrant suggest shared characteristics in the terms of elemental composition and other analyzed parameters. Strategic emphasis on variables exhibiting low leverage excesses in PCA is essential for spotlighting those with substantial contributions to data patterns while minimizing irrelevant information.

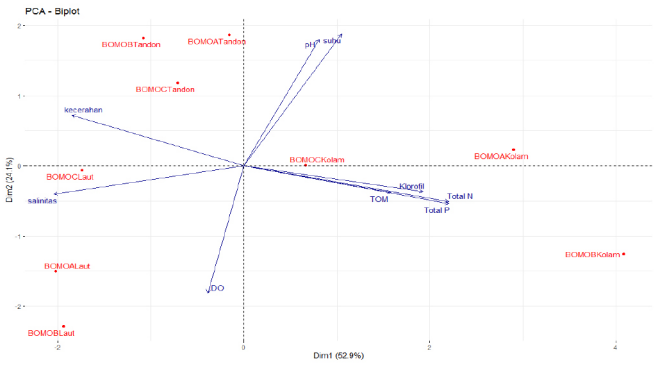


Figure 1 Principal Component Analysis-Biplot

IMPROVING THE QUALITY AND QUANTITY IN SPAWNING AND EGG PRODUCTION OF SILVER POMPANO *Trachinotus blochii* BROODSTOCK THROUGH FEED MANAGEMENT

Uray Hendri Istrada*, Dikrurahman, Agung Darmono, Suyatno, Ikhsan Kamil, Faisal Andre Siregar

Division of Silver Pompano Broodstock
Batam Mariculture Center
Ministry of Marine Affairs and Fisheries
hendriistrada27@gmail.com

The quality and good perform of broodstock is needed in aquaculture activities to get good quality and quantity of spawning and egg production. It can be seen from several aspects such as the origin of the broodstock, the quality of the water where the broodstock lives and the feed given to the broodstock. One of the determining factors in the gonad maturation of the broodstock is maintaining feed management, including the quality of feed, complete nutrition, and feeding technique. This activity aimed to improving the quality and quantity in spawning and egg production of silver pompano *Trachinotus blochii* broodstock through feed management in Batam Mariculture Center, it was done in January-December 2023. The method that was conducted was carried out with good feeding management including the feeding schedule, frequency of feeding, type of feed and additional supplements. The feeding schedule for broodstock was given daily from Monday until Saturday whit the frequency 2 times a day. The types of feed given were fresh fish (frozen fish), fresh squid and moist pellets (consisting of commercial pellet with 42% of protein, rebon/trasi shrimp and squid oil). The supplement given was vitamin E (capsulated, 250 iu per piece). The feed dose given was 2-3% of body weight. The parameters observed were the spawning (type and frequency) of broodstock and fertilized rate (FR, %) of the eggs.

Before this activity was carried out, from the 15 selected silver pompano *Trachinotus blochii* broodstock, 10 were male and 5 were female. Hormonal spawning is carried out, with a spawning frequency once a month or in the full moon with amount of the egg 300.000-500.000 eggs with fertility (FR) < 70%. After improving with feed management in this activity, the quality and quantity of spawning was better with the same broodstock. The result showed that the spawning occured in natural spawning 2 times a month (full and dark moon) with a number of eggs > 500.000 eggs with FR > 90 %. The silver pompano *Trachinotus blochii* broodstock spawning regularly every month for a year. From the results, it can be concluded that feed management was very important and effect to improving the quality and quantity of spawning.

Table 1. Feed Management of Silver Pompano *Trachinotus blochii* Broodstock

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
fresh fish (frozen fish)	fresh squid	Moist pellet + supplement	fresh fish (frozen fish)	fresh squid	Moist pellet + supplement	-

USE OF THE TEMPERATURE SHOCK RECIRCULATION SYSTEM IN SEABASS (*Lates calcarifer*) REARING CULTURE FOR CONTROL OF *VIRAL NERVOUS NECROSIS* OUTBREAKS

Hendrianto*, Andi, Reza Darzona, Endang Wijayanti, Ikhsan Kamil, Faisal Andre Siregar

Mariculture Centre Batam
Barelang Street, 3rd Bridge
Setoko Island, Batam City
Riau Islands Province, Indonesia
Email : hendrianto17@yahoo.com

The rearing of seabass (*Lates calcarifer*) seeds at the Mariculture Centre Batam, Indonesia use a recirculation system with shock temperature of the water in fish tank. Otherside, Viral Nervous Necrosis (VNN) virus disease is one of the deadly infections in mariculture, including seabass. During the VNN outbreak, on June-July 2023, there were mass mortality of seabass seed in the hatchery, within 2-8 cm in size. Clinical symptoms: fish swim weakly, some swim in circles, body color becomes dark accompanied by scratchy wounds on the fins, lack of appetite. Treatment of vitamin C, multivitamins, antibiotics added onto pellets not reduced the mortality. The water temperature of the fish tank using the recirculation system was originally set at 32-33°C. The next treatment was done aim to reduce the mortality due to VNN disease. The water temperature was set till 38°C using the heater in reservoir tank, the hot temperature kept. There was a significant decreased in the mortality within a 2-3 days. Laboratory test for infected fish resulted still positive for VNN using PCR test and confirmed with histopathology test. Next, the water temperature was set again at 32-33°C, nevertheless mass mortality occurred again. So the water temperature was set again at 38°C. Mortality was decrease drastically. Within a week, minimum, the seeds slowly health and normally back in two weeks there was no mass mortality with the survival rate gained 75%. Hot water temperature shock treatment in resirculation system makes fish metabolism increase, increase immunity, natural selection for sicked fished, weaken the pathogens and had effective to decrease the mortality due to VNN outbreak.

EFFECTIVENESS OF WASTEWATER MANAGEMENT IN AREA-BASED VANAME SHRIMP FARMING IN KEBUMEN REGENCY, CENTRAL JAVA, INDONESIA

Herinto[1)], Maskar Jayadi[2)], Suzana Meidwi Ratriningrum[3)], Ita Rizkiyanti[2)], Hasanuddin[4)], I Gde Buddha Adyana Yasa[1)] Miftahul Huda[1)] Ibnu Faturohman [1)] Fajar Anggraeni[5)]

Karawang Aquaculture Production Business Service Center, West Java
Jepara Brackish Water Aquaculture Development Center, Central Java
Serang Fish and Environmental Health Testing Center, Banten
Ujung Batee Brackish Water Aquaculture Development Center, Aceh
Research Center for Fishery, National Research and Innovation Agency

Wastewater management in pond cultivation system units, especially intensive ponds was the main issued related to environmental pollution, social impacts and sustainability of shrimp farming businesses, so that aquaculture waste management techniques are important in intensive shrimp farming. The method used in this research by insitu observations on maintenance ponds and Wastewater Treatment Plants (WWTP). Aquaculture wastewater was released through *the central drain* routinely approximately 1-2% per day, then physical treatment is carried out by settling and filtering on the WWTP plot cluster measuring 1.365 m^2 using limestone piles arranged in pyramids and zigzags as partitions. Then the wastewater was flowed to the final processing plot with a size of 7.215 m^2 which consists of three limestone blocks. Wastewater treatment at the Main WWTP utilizes tilapia and *Gracilaria* sp. seaweed as indicators and 1 unit waterwheel for the oxygenation process. The density of tilapia is 1.4 $ind.m^{-2}$ and seaweed is 0.8-1 $kg.m^{-2}$. The parameters used in this study were *total ammonia nitrogen* (TAN), total vibrio and the number of plankton types of *Dinoflagellates*. The results showed that TAN levels decreased by 0.05 – 0.10 mg / L (20.14 – 28.87 %) or an average of 24.46%. Total vibrio bacteria in the maintenance ponds were 12.572,9 CFU/ml, 12.700 CFU/ml at the WWTP inlet, 9.400 CFU/ml at the WWTP filtration plot and 1.700 CFU/ml at the WWTP outlet. The number of *Dinoflagellate* plankton decreased from 1.988,7 cells/ml in the maintenance ponds to 573 cells/ml at the WWTP outlet. The results showed that wastewater management in vaname shrimp rearing was effective in reducing TAN levels, total vibrio bacteria and the number of *Dinoflagellate plankton*.

GENETIC MAPPING OF STRIPED SNAKEHEAD Channa striata IN INDONESIA; A COMPREHENSIVE STUDY ON FARM AND WILD POPULATION FROM FIVE MAIN ISLANDS

Rohana Hidayati*, Rustadi, Dini W.K. Sari, Bunasir, and Supriani

Directorate General of Aquaculture
Jalan Medan Merdeka Timur Nomor 16
Jakarta 10110 Kotak Pos 4130 JKP 10041
rohana.hidayati@kkp.go.id

Genetic characterization of species is crucial in determining the direction of aquaculture development. The genetic diversity of striped snakehead (*Channa striata*) across five main islands in Indonesia from aquaculture and capture was explored through its partial mtDNA CO1 gene. Twelve populations were assayed and subdivided into four regions following the generated haplotypes resulting into medium diversity (Hd:0.7355) with the largest genetic distance found between the population of Borneo and Sumatera (D:0.95954). Phylogeny studies showed a close genetic relationship among all populations as they share common ancestors. However, the Sumatera population formed a different clade and contributes largely to the high genetic diversity of the examined populations (Hd:1.00; π:0.0024). The findings of this study are fundamental for initiating a selective breeding program and for developing conservation management.

Twenty-six species members of genera *Channa* are native to Malaysia, Indonesia, and Asia peninsular (Courtenay *et al*., 2004). One of them is the striped snakehead *Channa striata* (Bloch, 1793) that is well-known in biomedical fields in many local Asian communities and is an important species in both fisheries and aquaculture. Although the dispersion of *C. striata* quite extensively covers almost all regions of Southeast Asia, knowledge regarding to its development in Indonesia is limited. Previous studies of striped snakehead mainly focused on genetic and phylogeographic features of wild populations in Malaysia and partly Indonesia. Tan *et al*., (2012) found that *C. striata* collected from different regions in Malaysia were structured by natural physical barriers and anthropogenic activities. Another study based on Cytochrome C oxidase subunit I (COI) found similar genetic differentiation among Malaysian and Indonesian (Sumatra island) populations (Siti-Balkhis *et al*., 2011; Tan *et al*., 2015). However, the geographic distance used in the above mentioned studies may not reflect the water distance which is directly involved in the natural migration of fish species.

Field sampling of individuals were collected from a total of 13 populations distributed throughout Sumatera, Java, Borneo, Sulawesi and Papua. Sampling locations were divided into five regions following the main islands of Indonesia.

Identification using the Basic Local Alignment Search Tools (BLAST) program on 24 sequences were confirmed all samples to be *Channa striata* with a similarity percentage of 97 – 100%. Analysis were then performed on the diversity of haplotypes (Hd) and nucleotides (π) using DnaSP V. 5.10 and revealed 9 unique haplotypes. The distribution of haplotypes covered 3 haplotypes for each population of Java and Kalimantan, 1 haplotype for the Papua and Sulawesi population and 2 haplotypes for the Sumatera population. Table 2 shows the genetic characteristic from the total and each population.

EFFECTS OF SALINITY AND TEMPERATURE ON THE REPRODUCTION AND MOULTING PHYSIOLOGY OF FEMALE GIANT MUD CRABS, *Scylla serrata*

Mohammad Amzad Hossain [a, b*], Ventura Tomer [d], Emma Jackson [a], Julie Robins [e], Nicole Flint [a, b]

[a] Coastal Marine Ecosystems Research Centre, Central Queensland University, Gladstone, QLD 4680, Australia
[b] School of Health, Medical and Applied Sciences, Central Queensland University, Queensland, Australia
[d] School of Science, Technology and Engineering, University of the Sunshine Coast, Queensland, Australia
[e] Department of Agriculture and Fisheries (Queensland), Brisbane, Australia.
m.a.hossain@cqu.edu.au

Two separate tank-based trials have been conducted with adult female *Scylla serrata* to disclose the influence of salinity and temperature on their reproduction and moulting physiology. The first trial involved holding adult crabs for 28 days in four different salinity levels ($S_{15\ ppt}$, $S_{25\ ppt,}$ a control $S_{35\ ppt}$ and $S_{40\ ppt)}$. The temperature trial tested four treatments ($T_{20\ °C}$, $T_{25\ °C}$, $T_{30\ °C}$ (control), and $T_{34\ °C}$) for the same time period. Haemolymph ecdysone and Brix index were measured, and the relative expression level of genes related to reproduction (Vitellogenin receptor gene VtgR, Vitellogenin gene VtG, and sulfur oxidation enzyme gene SoxB2) and moulting (Ecdysone receptor gene EcR) were analysed following both trials. Additionally, the expression profile of HSP70 (heat shock protein) and Na^+/K^+-ATPase were analysed, as potential stress biomarkers for thermal and salinity shocks. The specific growth rate (SGR%), hepatopancreatic index (HPI), gonadosomatic index (GSI), and maturation stages at the end of trial have been compared. Major water quality parameters i.e., dissolved oxygen, pH, NH_3, NO_2 and NO_3 were monitored and maintained stable for all treatment groups in both trials. The results of this study provide important information on factors influencing the reproductive physiology of mud crabs (*Scylla* spp.), which have high socio-economic value as a seafood product across the Indo-West Pacific.

RESEARCH PROGRESS OF GENOMIC SELECTION IN AQUACULTURE BREEDING

Hongxia Hu*, Hailiang Song, Ying Dong,Tian Dong, Hua Zhu

Fisheries Science Institute
Beijing Academy of Agriculture and Forestry Sciences & National Freshwater Fisheries Engineering Center
Beijing, China,100068
Email: huhongxia@bjfishery.com

At present less than 10% of aquaculture production is based on genetically improved animals, despite the rapid growth in annual genetic gain of aquaculture species.Although conventional breeding programmes have played a critical role in the genetic improvement of 50 important aquaculture species, low efficiency of this approach can not meet human needs. Since the introduction in 2001, both theoretical and practical breeding studies have revealed the higher accuracy of GS than that of traditional breeding, which can accelerate genetic gain. In recent years, many GS studies have been conducted on aquaculture species, which have shown that GS produces higher prediction accuracy than traditional pedigree-based method. Basic process of genomic selection in aquaculture is described as Fig1. The principles and processes, preconditions, advantages, analytical methods and factors influencing GS should be taken into account before its application in a new species. Furthermore, future directions of GS in aquaculture should be considered, which expand its application in more aquaculture species.

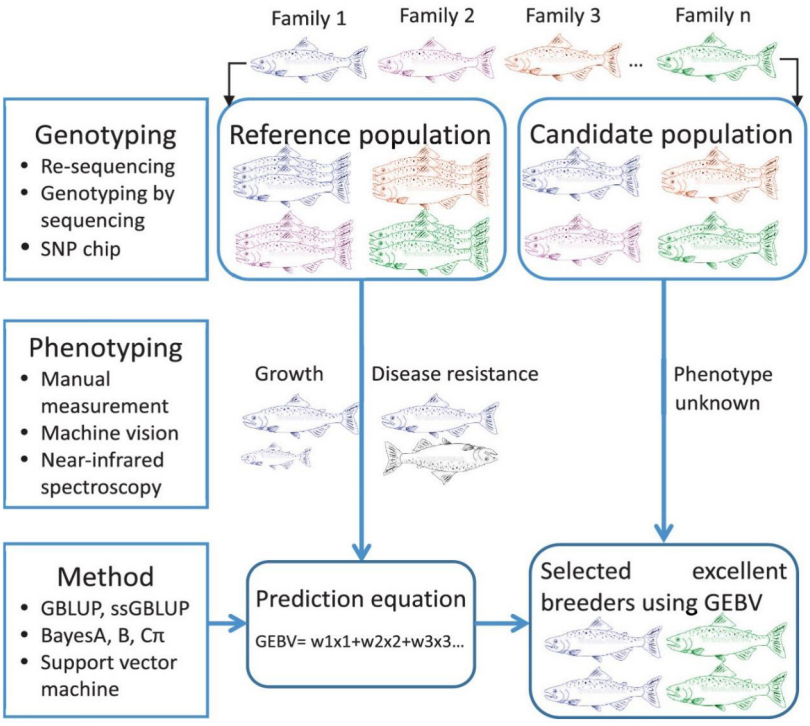


Fig.Basic process of genomic selection breeding in aquaculture.

OPTIMIZING STOCKING DENSITIES FOR NURSERY CAGE CULTURE OF TROPICAL ANGUILLID EEL *Anguilla marmorata* IN PHILIPPINE BRACKISHWATER PONDS

Fredson H. Huervana*, Kelee Ira B. Nodque, Cedric Jay A. Nantong, Rizza Mae T. Guyapale, Michelle Rose M. Fajemolin, and Rex Ferdinand M. Traifalgar

Institute of Aquaculture
College of Fisheries and Ocean Sciences
University of the Philippines Visayas
Miagao, Iloilo, Philippines
fhhuervana@up.edu.ph

In the Philippines, increasing attention has been given to the culture of tropical eel species, such as *Anguilla marmorata*, due to its high potential in the export market. Eels are commonly raised in indoor tanks which entails huge production costs for eel farmers. With the expansion of the industry, other nursery culture systems are explored to accommodate the increasing demand for A. *marmorata*. An emerging nursery technology for eel culture ventures on utilizing brackishwater ponds to reduce reliance on freshwater, as well as to increase production.

One contributing factor for the successful rearing of eels is the stocking density, as it directly influences behavior, water quality, health, and consequently, the growth and survival of the fish. Therefore, the stocking density must be optimized to maximize space utilization without negatively affecting growth.

This study sought to determine the optimal stocking density for the nursery culture of *A. marmorata* in brackishwater ponds (15-20 ppt). *A. marmorata* elvers (ABW = 0.3g) were stocked in hapa nets with a dimension of 1 m^3. The elvers were cultured at different densities (50, 100, and 150 individuals each hapa) with four replicates in a completely randomized design (CRD). The experimental animals were fed with 0.6 mm pelleted feed twice a day. The experiment was conducted for 90 days and the following indices were analyzed: specific growth rate (SGR), percent weight gain (%WG), survival, and average body length.

After 90 days of experiment, it was found that growth and survival of *A. marmorata* elvers in brackishwater nursery ponds was best at low densities.

Figure 1. Pond setup for *A. marmorata* elvers

ISOLATION AND MOLECULAR DETECTION OF VIRULENCE AND ANTIMICROBIAL RESISTANCE GENES OF PATHOGENIC *Escherichia Coli* ISOLATED FROM FARM RAISED CARPS OF FISH FARMS OF KASUR AND MUZAFFARGARH

Talib Hussain[1*], Fayyaz Rasool[2], Matiullah[1], Kashif Manzoor[1], Afaq Younis[1] and Shakeela Parveen[3]

[1]Department of Fisheries and Aquaculture, University of Veterinary and Animal Sciences Lahore, Pakistan
[2]Department of Zoology, Faisalabad Campus, University of Education Lahore, Pakistan
[3]Department of Zoology, Wildlife and Fisheries, University of Agriculture Faisalabad, Pakistan
*Corresponding Author's email: Talibhussaintalib45@gmail.com

Bacterial pathogens pose a significant challenge for fish production. *Escherichia coli* is a Gram-negative bacterium being among the leading contributors of economic loss to fish farmers worldwide. *E. coli* infects a variety of fish species making a concern for public health. In order to gain a better understanding of this issue, a study was conducted to isolate and identify *E. coli* present in *Labeo rohita*, *Catla catla*, *Cirrhinus mrigala*, *Hypophthalmichthys molitrix*, and *Ctenopharyngodon idella* sampled from fish farms of Kasur and Muzaffargarh. *E. coli* was isolated from liver, intestine, stomach and kidney of fish samples using MacConkey and Eosin Methylene blue (EMB) agar media. DNA was extracted using Genomic DNA Purification Kit and *E. coli* was detected by amplification of virulence genes viz. stx2 and eaeA and antibiotic resistance genes viz. tetA and sul1 in *E. coli* by PCR using species-specific primers. *E. coli* was recovered from 103 (41.2% prevalence) fish samples of five species. Phenotypic and morphological characterization revealed pink, smooth, and circular colonies of E. coli on MacConkey agar while dark purple and circular colonies on EMB agar media. Biochemical tests proved *E. coli* positive in catalase, indole, urease, methyl red and motility tests while negative results in Gram-staining, oxidase, citrate, Voges-Proskauer, H_2S and indole production tests. *E. coli* isolates proved to be resistant against pencillin, sulfamethoxazole and tetracycline while sensitive against ampicillin, and erythromycin, and intermediate resistance against amoxicillin and cefotaxime. Maximum prevalence of stx2 gene of *E. coli* was recorded in intestine and liver of *L. rohita* and *C. mrigala*. Phylogenetic tree analysis of our isolated *E. coli* strains revealed 97% similarity with *E. coli* strains isolated in previously studies. The results concluded that shiga toxic gene was the most significant pathogenic gene of *E. coli*. High stocking density, low water quality parameters and unchecked application of antimicrobial agents causes emergence of pathogenic bacteria in fish farms.

EFFECT OF MICROALGAE (*Tetraselmis chui* Butcher 1959) ADDITION ON GROWTH AND SURVIVAL OF NILE TILAPIA (*Oreochromis niloticus* Linnaeus 1758) REARED IN LOW SALINITY BIOFLOC SYSTEM

Wa Iba[1,2]*, Neneng Wahyuni[1], Muhaimin Hamzah[1], Michael A. Rice[2]

[1] Aquaculture Department Faculty of Fisheries and Marine Sciences University of Halu Oleo. Jl. HEA Mokodompit Kampus Bumi Tridharma Anduonohu Kendari 93232 South East Sulawesi Indonesia.
Telp/Fax (0401) 3193782
[2] 9 East Alumni Ave., Department of Fisheries, Animal and Veterinary Sciences, College of Environmental and Life Sciences University of Rhode Island, Kingston, RI 02881 USA
*Corresponding email: wa.iba@uho.ac.id

In this study, the growth and survival of tilapia cultured in a low salinity biofloc system with added microalgae was investigated. Increasing salinity in tilapia culture was done by gradually adding sea water into acclimatization container (618 L, v) on weekly basis for 4 weeks until 9 psu salinity was reached. Tilapia were allowed to adapt to salinity change for one week and fed with commercial feed twice a day until satiation. The biofloc experiment was conducted with 3 microalgal density treatments (5, 15 and 25 × 10^4 cells. mL^{-1}) in triplicates. Average initial weight of experimental fish was 4.82 ± 0.76 g. Tilapia were reared for 40 days in aquaria (35 × 35 × 40 cm, l × w × h, 15 L, v) containing 8 individuals fish in each aquarium. The commercial pellets were delivered twice per day at 5% of tilapia biomass until satiation. *T. chui* was added to the tilapia culture every week. This study showed that the addition of microalgae did not affect the fish weight gain, specific growth rate and survival. However, feed conversion ratio and culture productivity were better in tilapia supplied with weekly addition of *T. chui* at 15 × 10^4 cells mL^{-1} compared to other densities tested.

UTILIZATION OF MACROALGAL JUICE AS AN ALTERNATIVE SETTLEMENT CUE AND POST-SETTLED JUVENILE FEED FOR *Stichopus* cf. *horrens*

Glaiza Ibañez[1*], Rona Soy[1], Marie Antonnette Juinio-Meñez[1]

[1]Marine Science Institute
University of the Philippines Diliman
Quezon City, Philippines 1101
*gsibanez@up.edu.ph

The aquaculture of economically important sea cucumber species is one way of mitigating overexploitation by decreasing dependence on wild catch. For *Stichopus* cf. *horrens*, an emergent aquaculture species harvested for consumption and as source of raw materials in the nutraceutical and pharmaceutical industries, production bottlenecks exist in the hatchery culture phase during settlement and metamorphosis to early juveniles. Primarily, cultured live microalgae (i.e., *Chaetoceros muelleri*/ *calcitrans* and *Navicula ramosissima*) are used as settlement cue and early juvenile feed post-settlement. However, these are costly in terms of maintenance. Preliminary trials have shown the potential of using macroalgal juice as a cheaper and more sustainable alternative to live microalgae. In this study, the effectiveness of three macroalgal juices, *Sargassum* sp. (SRJ), *Gracilaria* sp. (GRJ), and *Ulva* sp. (ULJ), to induce settlement and increase the size of post-settled *S.* cf. *horrens* juveniles were tested against *N. ramosissima* (NR) as positive control. In the settlement experiment, concentrated macroalgal juices were painted on corrugated plastic sheets which served as settlement plates. These were placed in 70-L bins stocked with late auricularia larvae at a density of 0.3 larvae ml^{-1}. In the feeding experiment, post-settled juveniles (~4-10 mm) were fed with SRJ, GRJ, ULJ, and NR. After 30 days of rearing, highest settlement success was recorded in the ULJ (1.58 ± 2.89 %) treatment but was not significantly different than the other treatments. Moreover, sizes of post-settled juveniles were highest in the NR (7.3 ± 3.8 mm) treatment followed by ULJ (7.1 ± 2.7 mm) and these are significantly higher than the GRJ (6.1 ± 2.3 mm) treatment. In the feeding experiment, no significant differences were noted among treatments however, the highest average length was recorded in the ULJ (11.4 ± 2.0 mm) treatment on Day 15. Interestingly, a slight increase in the juvenile length was noted on Day 15 but all lengths decreased on Day 30. Furthermore, survival was significantly lower in the SRJ (46.7 ± 26.9 %) treatment. The comparable settlement success, average lengths, and survival among the four treatments suggest the potential of using macroalgal juice as an alternative to the conventional live microalgae as settlement cue and post-settled juvenile feed prior to release in the ocean nursery. Optimizing the use of juice in terms of feeding concentration/ amount and understanding the nutritional requirements of metamorphosing larvae and post-settled juveniles are pivotal considerations in the development of cost-effective and sustainable macroalgal feeds.

FOOD AND FEEDING HABITS OF THE CICHLIDAE IN TAGWAI RESERVOIR, NIGER STATE, NIGERIA

*Ibrahim, Baba Usman, Balogu, Dennis Odionyenfe And Yunusa, Abdu

*[1]department of Biological Sciences
Faculty of Natural Science
Ibrahim Badamasi Babangida University
Lapai, Niger State, Nigeria
ibrahimsayuti@yahoo.com

Four hundred and seventeen (417) samples comprising of one hundred and eighty-six *Sarotherodon galilaeus* and two hundred and thirty-one (231) *Coptodon zillii* were collected on monthly basis for four (4) months (March, 2021 to June, 2021) from the catches of local fishermen operating on Tagwai Reservoir, in Niger State, Nigeria. The fresh samples were transported in ice - chest box to the Biology Department laboratory of Ibrahim Babangida University (IBB), Lapai, Niger State, where analyses were carried out. Eight (8) different types of items that constituted plant and animal materials were found as food in the stomachs of each of *S. galilaeus* and *C. zillii*. This included detritus, sand, algae, plant material, nematode, plankton, seed and unidentified material. Plant material was highest (30.30%) followed by detritus (17.32%) then algae (16.01%) and lowest was nematode and unidentified material each with 2.16%. Feeding intensity of both species of fish was high due to low percentage of empty stomachs recorded during the period of study. 157 stomachs of *S. galilaeus* out of 186 examined had food while 181 stomachs of *C. zillii* out of 231 examined had food. *S. galilaeus* and *C. zillii* are omnivore and herbivore respectively based on their feeding habits. Diet overlap or similarity showed moderate level of association in diet and less competition for food between the two species. There is need to examine other aspects of biology, such as growth, fecundity, age of these fishes in the reservoir. This study can be used as baseline information for carrying out similar study in other water bodies.

COMPARATIVE GROWTH ASSESSMENT OF AFRICAN CATFISH (*Clarias gariepinus)* FED SWEET POTATO (*Ipomea batata*) LEAF MEAL AND RICE BRAN AS ALTERNATIVE FEED MEAL

*Ibrahim, Baba Usman., Balogu, Dennis Odionyenfe And Yunusa, Abdu

Department of Biological Sciences
Faculty of Natural Science
Ibrahim Badamasi Babangida University
Lapai, Niger State, Nigeria
ibrahimsayuti@yahoo.com

The study compared growth performance of *Clarias gariepinus* fingerlings fed sweet potato leaf meal and rice bran as alternative feed meal. Five diets, that contain 0%, 25%, 50%, 75% and 100% inclusion levels were formulated and designated as SPM_1 SPM_2 SPM_3 SPM_4 SPM_5 and RBM_1 RBM_2 RBM_3 RBM_4 RBM_5. Highest initial weight in $SPLM_3$ (50%) differ significantly ($p>0.05$) from $SPLM_1$ (0%) while RBM4 (75%) can be compared to RBM_1 (0%). Final weight and body weight gain follow similar trend with $SPLM_2$ (50%) recorded highest, which differ significantly ($p>0.05$) with other diets. Decrease of SPLM inclusion level increase fish weight. Highest SGR in $SPLM_2$ (25%) can be compared favorably with $SPLM_1$ (0%) and other diets while RBM_2 (25%) differ significantly ($p>0.05$) with RBM_1 (0%). Diet $SPLM_5$ (100%) can be compared with other diets in SGR with RBM3 (50%) that differ significantly ($p>0.05$) with only RBM1 (0%). Highest FE in $SPLM_1$ (0%) can be compared favorably with $SPLM_3$ (50%) and $SPLM_4$ (75%) in feed acceptability. RBM_5 (100%), which is highest differ significantly ($p>0.05$) with RBM_1 (0%). Apart from RBM4 (75%) other diets were accepted by the fish. It is therefore recommended that 25% inclusion level of SPM should be used in the diet of *C. gariepinus* for better performance than even 75% inclusion of rice bran, study on lower inclusion level of SPM need to be carried out, this type of study need to carried out on other cultured species of fish such as *Heterobranchus* (catfish) and even Tilapia, study on the use of other processing methods of sweet potato leaf and rice bran for feed formulation should be carried out and this type of study need to be carried out in other culture system.

ROLE OF MICROALGAE WITH QUORUM SENSING INHIBITION PROPERTIES TO REDUCE ANTIMICROBIAL RESISTANCE AND CONTROL DISEASE IN AQUACULTURE

Ikhsan Natrah*, Md Yasin Ina-Salwany, Siti Zulaikha, Faridah Abas, Mohd Ihsanuddin

Aquatic Animal Health and Therapeutics Laboratory
Institute Bioscience
Universiti Putra Malaysia
UPM, Serdang, Selangor, Malaysia
*Corresponding author: natrah@upm.edu.my

Intensive farming increases stress on the host and introduces new diseases or pathogens to emerge. This scenario has increased the usage of antibiotics in aquaculture worldwide. Antimicrobial drugs can be very useful in combating pathogenic bacterial infections in humans and animals. However, it has negative implications as it increases the number of anti-microbial resistance (AMR) micro-organisms that can spread from animal to human by direct exposure or consumption of food containing AMR. There is a tight relationship between microalgae and bacteria both as agonist & antagonistic through the release of diverse compounds important for various metabolic functions. One of the mechanisms is through the interference of bacterial cell-to-cell communication or quorum sensing (QS). In this study, the effects of microalgae as quorum sensing inhibitor (QSI) were investigated. This was first done through screening of the algal extracts with different QS reporter strain followed by compound identification through LCMS metabolomics. As quorum sensing has been shown to regulate the virulence of aquaculture pathogens, inhibition of QS from algae could be an interesting option for prevention of bacterial diseases and improves production in larviculture.

THE MASS PRODUCTION OF SNAKESKIN GOURAMI SEEDS, *Trichopodus pectoralis* IN CONTROLLED ROUND TARPAULIN TANKS

Dasu Rohmana, Devi Ilma Handayani*, Ujang Komarudin, Rahmat Hidayat, Ucu Cahyadi, Susi Rosellia, Linda Rahmi

Balai Besar Perikanan Budidaya Air Tawar Sukabumi
Jln. Selabintana No. 37 Kota Sukabumi
Provinsi Jawa Barat
Indonesia
handayanidv@gmail.com

Snakeskin gourami (*Trichopodus pectoralis*) or sepat siam is a fish from the *Osphronemidae* family which is found in fresh waters in Southeast Asia such as Indonesia, Vietnam, Thailand and Malaysia. This fish has a habit when it is about to spawn, the male brood makes a nest in the form of foam that is released from its mouth. After spawning, the eggs will be attached to the foam until they hatch. Spawning and nursery of snakeskin gourami is carried out in round tarpaulin tanks equipped with low pressure aeration. Ten pieces of dried banana leaves are placed into the tanks, which functions as a shelter for the nest or foam to stick to, as well as growing the natural food for infusoria, which is the initial food for the snakeskin gourami larvae.

The broodstocks used were 40 fish per tank with a male to female ratio of 1:1. The total length of the broodstock was more than 15 cm with a weight of around 115 g/fish. In each spawning period, 6-7 broodstocks were found to successfully spawn with a total number of larvae produced around 5,000 individuals/ broodstock. The larvae are left with the broodstocks for 14 days from the time the eggs are released. Next, the larvae are transferred to the nursery tanks.

Five days before seed stocking, the nursery tanks were filled with 40 cm of water high, ten banana leaves were added to grow infusoria as live food and without aeration. Just before stocking, aeration is turned on with low pressure. Larvae around 10 days old harvested from the main spawning tanks are stocked into the nursery tanks at a density of 2,000 individuals/m^3. For 7 days in the nursery tanks, the larvae are also given live food, *Moina* sp.. Starting on the eighth day, the snakeskin gourami larvae are also given additional artificial food, powdered form, until harvest on the ninetieth day.

The survival rate of snakeskin gourami fry during 90 days of rearing was 25.4%, with a total length of 4.51 ± 1.26 cm, standard length of 3.71 ± 1.06 cm and body weight of 1.67 ± 1.34 g. After sorting, 23.7% are into the large criteria and 76.3% are into the medium and small criteria.

INCREASING THE PRODUCTIVITY OF KNIFEFISH SEEDS *Chitala* sp WITH A RECIRCULATION SYSTEM (RAS)

Aulia Ilmi*, Andri Hariadi, Iis Nurmawanti, Fathurrahman

Balai Perikanan Budidaya Air Tawar Mandiangin
Direktorat Jenderal Perikanan Budidaya
Jl. Tahura Sultan Adam Km. 14, Mandiangin-Kalimantan Selatan
bbatmandiangin@gmail.com

Seed production businesses play an important role in providing seeds to be bred. The obstacles to raising knifefish in ponds are the high level of mortality and the availability of natural food, the availability of which cannot be continuous. The aim of this activity is to determine the growth performance of knifefish seeds using a recirculation system as a maintenance medium withh artificial feed. The purpose of this activity is to determine the growth performance of knifefish fry using a recirculation system as a maintenance medium with artificial feed.

The method used in this activity is an experimental method carried out indoors. The eel fish used are post-yolk release eel fry that have a length of 1.5-1.8 cm. In this engineering activity, 2 test treatments were carried out, each of which was repeated 2 times. The first treatment is the maintenance of belida fish fry using artificial feed. While the second treatment is the maintenance of knifefish seeds with artificial feed and silk worms. Each treatment uses a recirculation system with feeding twice a day, morning and evening. Variables observed included absolute growth, specific growth, daily specific growth rate and survival rate.

From the results of these activities, the absolute growth of knifefish seeds with artificial feed and silk worms is better than knifefish seeds with artificial feed, which is 0.82 with artificial feed and silk worms and 0.71 with artificial feed. For relative growth parameters, the results obtained were 2867.95% for artificial feed and silk worms and 1811.33% for artificial feed. The daily specific growth rate was 7.78%/day for artificial feed and silk worms and 6.78%/day for artificial feed. The results for the survival rate parameter also showed that the treatment using artificial feed and silk worms was better than artificial feed with values of 80.50% and 69.75%, respectively.

CHEMICAL PARAMETERS WATER QUALITY MAPING 2023 IN WEST NUSA TENGGARA

Vivi Eka Indrayani*, Joko Santosa, Riky Rismunandar

Marine Aquaculture Development Centre
Ministry of Marine Affairs and Fisheries
Jl. Raya Sekotong, Sekotong Bar
Kec. Sekotong, Kabupaten Lombok Barat
Nusa Tenggara Bar. 83365
vivi.indrayani@kkp.go.id

West Nusa Tenggara has a large sea area for aquaculture development. Monitoring water quality is an important factor in supporting the optimization of results and aquaculture development. One of the parameters that needs to be monitored is chemical parameters.

Monitoring was conducted from January 2023 to December 2023. Samples were taken from West Lombok, Central Lombok, East Lombok, Sumbawa and Bima Districts. Parameters that was tested for water quality monitoring included Nitrite, Nitrate, Phosphate and Ammonia. Data analysis conducted on 992 samples and used Spectrophotometry method. In general, the average value of water quality in West Nusa Tenggara province for Nitrite, Nitrate, Phosphate and Ammonia is respectively 0.036; 0.11; 1.46; 0.24 mg/L.

Table 1. The Average Value Chemical Parameters in West Nusa Tenggara

District	Nitrite (mg/L)	Nitrate (mg/L)	Orthophosphate (mg/L)	Ammonia (mg/L)
West Lombok	0,021	0,03	0,57	0,09
Central Lombok	0,015	0,05	2,44	0,17
East Lombok	0,061	0,40	0,60	0,28
Mataram	0,005	0,04	3,57	0,10
Sumbawa	0,106	0,12	1,10	0,71
Bima	0,006	0,04	0,49	0,08

ENHANCING GROWTH PERFORMANCE OF EARLY JUVENILE SEA CUCUMBER *Holothuria scabra*: THE ROLE OF FERMENTED FEED DIETS

Lisa Fajar Indriana[a,b,c,d,*], Andreas Kunzmann[b], Matthew James Slater[a]

[a] Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, 27515 Bremerhaven, Germany
[b] Leibniz Centre for Tropical Marine Research, 28359 Bremen, Germany
[c] University of Bremen, 28359 Bremen, Germany
[d] National Research and Innovation Agency BRIN, 83352 Lombok, Indonesia
lisa.indriana@awi.de

Developing efficient, economically feasible, and locally obtained diets for high-value early juvenile sea cucumber, *Holothuria scabra*, is crucial for ensuring productive juvenile production in sustainable aquaculture. Seven fermented algal/plant diet formulations (C (control), diet seagrass *Enhalus acoroides*; DH, diet macroalgae *Halimeda discoidea*, DU, diet macroalgae *Ulva lactuca*, DP, diet macroalgae *Padina australis*, DS, diet macroalgae *Sargassum polycystum*, DA, diet green pond algae; DM, diet pond moss) are used in controlled feeding experiments for post-metamorphic juvenile *H. scabra* in the current study. The diet consisting of green pond algae (DA) had the highest average individual growth rate of 0.09±0.023 g d-1, but it also had the lowest individual survival rate compared to the other diets. Acceptable growth rates of 0.03±0.001 g d-1 and 0.03±0.002 g d-1 were observed for diets *E. acoroides* (C) and *P. australis* (DP) with survival rates of 80.63±4.38% and 80.63±2.77%, respectively. The causes of considerable fluctuations in survival rates are unknown. However, these findings suggest that diets with acceptable survival rates may be more suitable for very early juveniles. Diets with the highest long-term individual development rates may be more suitable for larger juvenile in the later stages of nursery production. The overall results show that juvenile *H. scabra* accepted most macroalgae fermented diets well. Conducting diet trials on a bigger scale and with a range of sizes and ages can help identify the best feeding practices for nursery production.

THE EFFECT OF PLANTLET ACCLIMATISATION TIME IN THE GREEN HOUSE ON THE GROWTH OF COTTONI *Kappaphycus alvarezii* SEEDLINGS

Valentina Retno Iriani*, Yuwana Puja and Zahriah Anis

Main Centre for Marine Aquaculture
Directorate General of Aquaculture
Marine Affairs and Fisheries Ministry
E-mail : bbpbl.lampung@gmail.com

Acclimatization of seaweed plantlets in the greenhouse is one of the stages of seaweed cultivation using tissue cultures techniques. Acclimatiation aims to adapt plantlets that were originally cultured in the laboratory under controlled condition to be cultivated in the water.

The purpose of this trial was to determine the optimal duration for acclimatization of plantlets in the greenhouse to produce the best growth of Cottoni seedlings. The trial was conducted in the water around Main Centre for Marine Aquaculture Lampung. The treatments consist of the duration for acclimatization in the greenhouse for 2 weeks, 4 weeks and 6 weeks. The acclimatized plantlets were then cultivated in the water for 1 month.

The results obtained are as follows:

The specific growth rate between acclimatization 2 weeks (2,92%) and 4 weeks (2,93%) was not significantly different but was significantly different from the 6 weeks treatment (2,57%).

The acclimatized plantlets were then cultivated in the water for 1 month and the results showed that the treatment between 2 weeks of acclimatization (7,11%) dan 4 weeks (7,25%) was not significantly different but was significantly different from the 6 weeks treatment (6,43%).

From the results it can be concluded that the most optimal plantlets acclimatization duration in the greenhouse is acclimatization for 2 weeks.

Table 1

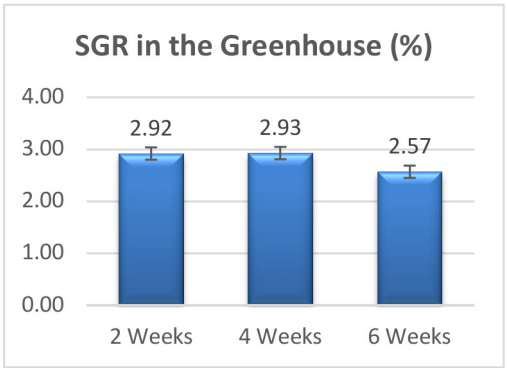
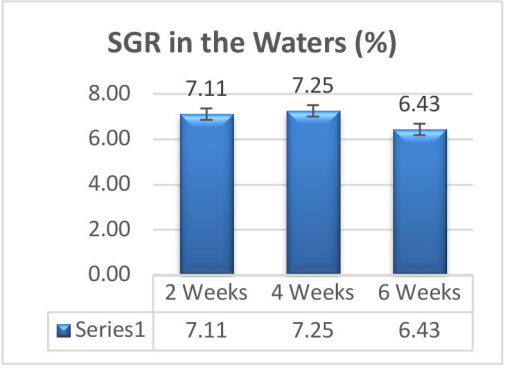


Table 2



SELECTIVE BREEDING OF STRIPED CATFISH (*Pangasianodon hypophthalmus*) IN INDONESIA: SELECTION RESPONSE OF THE FIFTH GENERATION OF GROWTH LINE

Irwan*, Evi Rahayuni, Yusuf Rohman

Sungai Gelam Freshwater Aquaculture Fisheries Center
Muaro Jambi Regency
Jambi Province
irwantanjung78@gmail.com

Striped catfish (*Pangasianodon hypophthalmus*) is one of the important freshwater commodities in Indonesia. Striped catfish production in 2022 will occupy fourth position in the freshwater fish group. Therefore, providing superior broodstock for striped catfish is important so that it can continues to grow and can compete. Selective breeding program of striped catfish by BPBAT Sungai Gelam Jambi have been carried out from 2009 until now. This program aims to produce growth lines of striped catfish using an mass selection method with characteristics selected for body weight. The base population used in this selective breeding program comes from Indonesia (from various regions), Cambodia and Vietnam. The results of this selective breeding program have been obtained for 5 generations (G5) of growth lines until 2023. Comparative tests of G5 with the base population obtained an accumulated selection response for growth lines of 91.66%, or an average selection response per generation of 18.33%. Interestingly, the selection response for the feed conversion character in G5 was -5.15%, this means that G5 is more efficient in utilizing feed compared to the base population. This shows that selection on body weight character has a positive correlation with feed efficiency charater. Realized heritability value is 0.281 for body weight character.

NON-SPECIFIC IMMUNITY, GENE EXPRESSION, AND *STREPTOCOCCUS AGALACTIAE* RESISTANCE IN RED TILAPIA (*Oreochromis* sp.) WITH DIFFERENT FEEDING INTERVALS OF SUPPLEMENTAL SODIUM ALGINATE

Toni Kuswoyo [a, b], Alim Isnansetyo [b*], Murwantoko [b], Amir Husni [b], Indah Istiqomah [b]

[a] Marine Affairs and Fisheries Office, Central Java Province, Jl. Imam Bonjol No. 134, Semarang, Central Java, Indonesia. 50131
[b] Department of Fisheries, Faculty of Agriculture, Universitas Gadjah Mada, Jl. Flora, Bulaksumur, Yogyakarta, Indonesia. 55281
isnansetyo@ugm.ac.id

Alginate is polysaccharide easily extracted from brown algae. The objectives of this study were to evaluate the effects of feeding intervals of sodium alginate (SA) from *Padina australis* on cellular-humoral immunity, the expression of immune genes, and disease resistance against *Streptococcus agalactiae*. Red tilapia was fed with a commercial feed supplemented with SA at a dosage of 2 g kg^{-1} for 60 days, under the supplementation intervals of 0 (control), 1, 2, 3, and 4 days. The blood sample was taken on days 0, 3, 30, and 60 to evaluate the immune parameters. The cellular and humoral immune parameters were evaluated. The expression of immune genes was measured on day 30. Another experiment with the same treatments was conducted to evaluate the resistant of red tilapia against artificial infection of *S. agalactiae*. The fist mortality was observed for 7 days post infection. Results indicated that SA supplementation every 4 days was the most effective to improve the immune parameters of the fish. SA supplementation improved Total Leucocyte Count, phagocytic activity, respiratory burst, Super Oxide Dismutase, lysozyme, and complement. The expression of IL-1□, TNF-□, IFN-□, and Hep genes were elevated, but downregulating the IL-10 and TGF-□1 was occured. Furthermore, the disease resistant of red tilapia against *S. agalactiae* was improved by supplementing SA. The results give the new perspective to utilize SA as immunostimulant by oral administration in practical aquaculture.

INFLUENCE OF DIFFERENT GROUNDWATER SALINITIES ON GROWTH, SERUM STEROID LEVELS AND GONAD DEVELOPMENT IN COMMON CARP (*Cyprinus carpio* LINNAEUS, 1758)

Iffat Jahan*, V.K. Tiwari, N.K. Chadha, A.K. Verma, Annam Pavan Kumar, Babitha Rani A. M, Makamguang Kamei and Sambid Swain

Centurion University of Technology and Management
Uppalada, Gajapati, Paralakhemundi-761 211
Odisha, India
iffat.jahan@cutm.ac.in

A 90-days experiment was conducted on *Cyprinus carpio* in eight rectangular earthen ponds (21 ×10 × 1.50 m) for testing the effect of four groundwater salinities (0, 5, 10, and 15ppt). At the end of the experiment, 100% survival was observed in all of the treatment groups. Somatic growth and reproductive performance were significantly ($P < 0.05$) influenced by salinity.

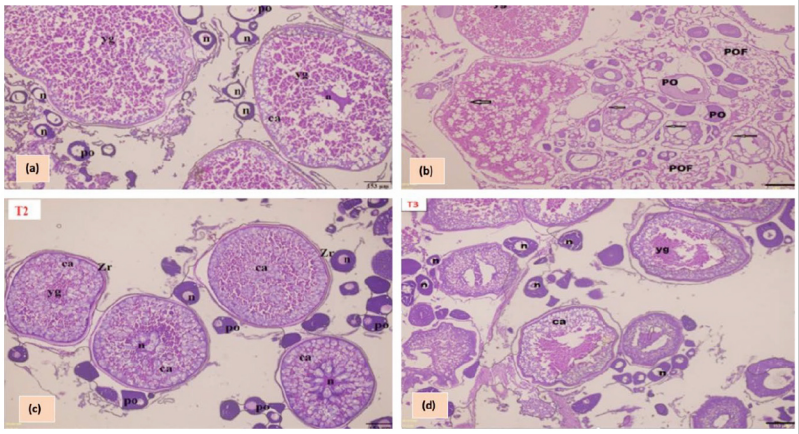
The results showed that average weight of the matured brooders were 370 ± 20 g, 342 ± 26 g, 275 ± 15 g, 167.5 ± 17.50 g at the salinities of 0, 5, 10 and 15 ppt, respectively. Changes in serum concentration of cortisol, 17 β-Estradiol, progesterone; 17α, 20β Dihydroxyprogesterone and androgens were investigated.

Gonadal histology in male and female *C. carpio* was studied at different stages of gonadal maturity till ovulation or spermiation. Serum steroid analysis showed significantly high levels ($p<0.05$) in fish groups reared at 0 and 5 ppt compared to 10 and 15 ppt. In the present study, *C. carpio* was found to mature faster at 5 ppt as compared to higher salinities of 10 and 15 ppt, in inland saline water.

Table.1. Comparative analysis of survival and growth performance of *C. carpio* at different saline water.

Treatment	Survival (%)	Initial weight (g)	Final body weight (g)	Weight gain (%)	Specific growth rate	Feed conversion ratio
Freshwater	100^{a} ± 0.01	181.42^{a} ± 24.28	3706^{a} ± 248	1961.35^{a} ± 139.23	1.459^{a} ± 0.03	0.62^{a} ± 0.18
5 ppt	100^{a} ±0.02	199.99^{a} ± 33.33	3385^{a} ± 60.0	1646.05^{ab} ± 321.03	1.37^{a} ± 0.08	0.67^{a} ± 0.96
10 ppt	100^{a} ±0.01	170.87^{a} ± 3.40	2425^{b} ± 110	1320.42^{ab} ± 63.41	1.180^{ab} ± 0.03	0.66^{a} ± 0.21
15 ppt	100^{a} ± 0.02	172.63^{a} ± 2.59	1835^{b} ± 140	964.83^{b} ± 126.06	1.13^{b} ± 0.04	0.75^{a} ± 0.04

Figure 1. Histological sections showing the maturation stages of *Cyprinus carpio* oocytes of different groups, (a) freshwater (b) 5 ppt (c) 10 ppt and (d) 15 ppt. Peri nucleolar stage shows peri nucleolar oocytes (po) with large central nucleus (n), formation of cortical alveoli (ca) and pink stained zona radiata (zr) are evident. During final maturation stage, cytoplasm is densely filled with yolk granules (yg), cortical alveoli, nuclear migration stage, ovulated oocytes, abundance of peri-nucleolar oocytes and post-ovulatory follicles (POF). Arrows show yolk plates. Scale bar =153 µm.



PRODUCTION AND REARING OF SEAWEED PLANTLETS RESULTING FROM THE GROWTH OF SPORES TO PRODUCE HIGH QUALITY SEAWEED *Gracilaria verrucosa* SEEDS

Khairil Jamal, Nur Muflich Juniyanto, Kasturi, Kasriani

Email: ririkerel@gmail.com

Market demand for Gracilaria *verrucosa* cultivation is increasing, but *G. verrucosa* cultivation often faces obstacles such as difficulty in obtaining quality seeds, slow growth and pest and disease attacks. This activity aims to produce quality *G. verrucosa* seaweed seeds that grow faster, are resistant to disease and can be available throughout the season. Production of seaweed seeds through the development of spores is carried out by isolating the part of the *G. verrucosa* stem that contains spores. *G. verrucosa* plantlets from the laboratory with an initial weight of between 8 – 15 gr/individual were rearing in tanks with a volume of 1 ton. Seaweed plantlets rearing in tanks have a daily growth rate (DGR) of between 1.50% - 2.0%. Faster growth can be achieved when plantlets are stocked in cultivation ponds where the nutrients needed for growth are widely available. Seaweed stocked in ponds has an DGR that is in the good category, namely >3%. Plantlet survival in this activity reached 100%.

ANALYSIS OF KASP GENOTYPING FOR BACKCROSS IDENTIFICATION BETWEEN STARRY FLOUNDER (*Platichthys stellatus*) AND STONE FLOUNDER (*Platichthys bicoloratus*)

Hyun-Seok Jang*, Youn-Su Cho, Tae-Min Kim, Hye-Min Oh, Il-Young Lee and Han-Kyu Lim

Interdisciplinary Program of Biomedicine, Health & Life Convergence Sciences
Mokpo National University
Muan, Jeonnam 58554
Houston7777@naver.com

The starry flounder exhibits strong disease resistance and euryhaline characteristics, positioning it as a promising candidate for marine flatfish aquaculture in Korea. The advancements in aquaculture techniques, including hybridization, selective breeding, and backcrossing, have substantially enhanced genetic and productive traits. However, morphological classification poses challenges in identifying hybrid flounders. Thus, there is a pressing need to develop an analytical method for precise species discrimination to ensure accurate and secure production and research endeavors in the future. To address this, genotypic verification samples comprised starry flounder, stone flounder, starry flounder (♀) × stone flounder (♂) = hybrid (F1), hybrid (F1) (♀) × starry flounder (♂), and hybrid (F1) × stone flounder (♂) backcrosses. Over 50 candidate genes from various sources (Human, Fugu, Nile tilapia, Fish, Olive flounder, Starry flounder, and Stone Flounder) were analyzed to identify Single Nucleotide Polymorphism (SNP) molecular markers capable of distinguishing between starry and stone flounders. Through genomic analysis, 32 SNP molecular markers were selected and subjected to Kompetitive allele specific PCR (KASP®) genotyping. Ultimately, 16 SNP molecular markers (*CSNK2B*, *EDF1*, *HNRNPA2B1*, *MLF2*, *eef1a1*, *egr1*, *gpx1a*, *gpx4b*, *igf1*, *lyg2*, *myh6*, *pitx2*, *rag1*, *rho*, *rp17*, and *txn1*) were identified as capable of distinguishing between hybrid and backcross generations. This method offers a robust species classification technology essential for effective aquaculture management and genetic research.

THE EFFECT OF COMMERCIAL PUERULUS HARVESTS ON ADJACENT LOBSTER FISHERIES IN INDONESIA

Anes Dwi Jayanti*, Caleb Gardner, Rafael León, Emily Ogier, Ingrid Van Putten

Institute for Marine and Antarctic Studies
University of Tasmania
15-20 Nubeena Cres Taroona, TAS 7053 Australia
anes.dwijayanti@utas.edu.au

In the last decade, puerulus harvesting for aquaculture seed has significantly expanded in the Indo-Pacific and delivered substantial economic benefit to coastal communities. Although the puerulus fishery provides local economic benefit, there is concern that it may threaten future lobster stocks and fisheries by reducing the number of puerulus that swim to shallow waters where they can live. We explored this issue by examining: 1) whether commercial puerulus harvesting filters puerulus so that the number reaching inshore collectors, and by inference natural reef, was reduced; and 2) whether wild lobster fisheries were displaced from bays where puerulus fishing occurred. The study was conducted in two adjacent bays, one with puerulus fishing and one without. To answer the first objective, we measured catches on multiple commercial collectors within 3 kilometers of the coast and examined spatial patterns. To answer the second objective, we tracked lobster fishing activities in the locations with and without puerulus fishing. Our research was unable to find evidence of puerulus harvesting presenting a risk to wild stocks or the fisheries that depend on them (Table 1, Figure 1).

TABLE 1. Filtering Effect Test using Spatial Auto Regression (SAR) Models in Popoh Bay and Prigi Bay, with covariate coefficients.

Variables	f (2)		
	Std. Error	test-value	p-value
Popoh (n = 71)			
SAR Modelling results		1.13	0.287
Distance from offshore (x_{1i})	0.003	-2.312	0.020*
Distance to the nearest coastal (x_{2i})	-	-	-
Number of neighbours (x_{3i})	0.227	1.569	0.117
Proximity to the nearest neighbour (x_{4i})	0.033	1.037	0.299
Prigi (n = 34)			
SAR Modelling results		0.006	0.937
Distance from offshore (x_{1i})	-	-	-
Distance to the nearest coastal (x_{2i})	0.002	2.099	0.036*
Number of neighbours (x_{3i})	1.020	-0.041	0.967
Proximity to the nearest neighbour (x_{4i})	0.006	-0.436	0.663

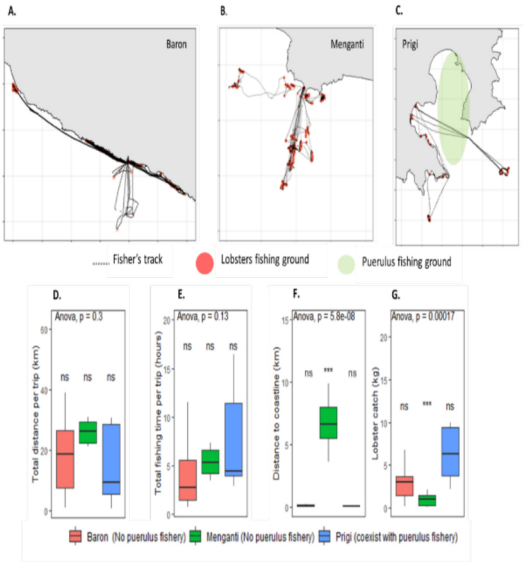


FIGURE 1. Lobster fishing ground in (A.) Baron, (B.) Menganti, (C.) Prigi. (D.) Range of total distance for lobster fishing per trip, (E.) Total fishing duration per trip, (F.) Distance to nearest coastline from identified fishing ground, (G.) Range of lobster catch per trip.

GROWTH PERFORMANCE OF HYBRID GROUPER, (*Epinephelus fuscoguttatus* ♀ × *E. lanceolatus* ♂) FED WITH DIFFERENT PROTEIN LEVEL DIET IN GROW-OUT SYSTEM

Natasha Shanna Jefferson[1*], Annita Seok Kian Yong[1], and Wahidatul Husna Zuldin[1]

[1]Borneo Marine Research Institute
University Malaysia Sabah
Jalan UMS, 88400 Kota Kinabalu Sabah
Malaysia
sjknatasha@gmail.com

The hybrid grouper aquaculture industry is presently constrained by a scarcity of empirical data on growth profiles, particularly during the critical grow-out phase. Concurrently, there is a notable gap in knowledge regarding the optimal protein levels in formulated diets for these stages. With the juvenile phase being the primary focus of existing studies, the grow-out phase remains largely unexplored, leading to suboptimal feeding strategies and potential hinderance of aquaculture productivity. In addressing this informational void, the present study was designed to investigate the impact of varying dietary protein levels on the growth performance of hybrid grouper during the grow-out phase. An 8-month feeding trial was conducted at the grow-out stage to determine the effect of different protein levels (35%, 40%, 45%, and 50%) on the growth of hybrid grouper with low-cost fish was fed to control treatment. Ten fishes with an average initial body weight of 336.0±0.07 g was distributed in 1m X 1m X 1.7m sea net cage in duplicate (n=10). The primary protein sources that were used were fish meal, soybean meal, and corn gluten meal and the primary lipid source were fish oil and sunflower oil. After 8 months of feeding trial, although the control (fed with low-cost fish) shows the highest growth rate, however, among the treatment of different protein levels, T50 shows better overall body weight gain. Moreover, among the treatments with different protein levels, T35, T40, and T45 show no significant difference ($p>0.05$) but there is a significant difference between T35 and T50 ($p<0.05$). As for the specific growth rate (SGR), the value increases accordingly (T35:0.29, T40:0.32, T45:0.39, T50:0.48) as the protein level increases ($p>0.05$). On the other hand, the results for body indices show that there were no significant differences for HSI%, VSI%, and IPF% between treatments ($p>0.05$). By giving industry participants data-driven insights into managing hybrid grouper nutrition, this study lays the groundwork for improving feeding strategies, aiming to make aquaculture more sustainable and profitable.

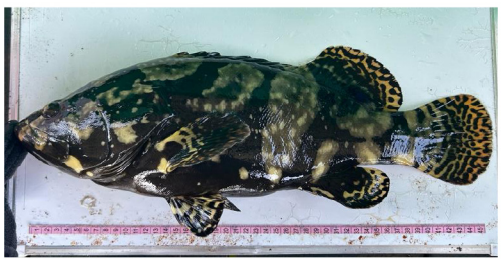


Figure 1. Hybrid Grouper (*Epinephelus fuscoguttatus* ♀ × *E. lanceolatus* ♂) after 8 months feeding trial.

FEED FORMULATION TO MITIGATE SHORT AND LONG-TERM IMPACTS OF STRESSORS ON HEALTH AND PERFORMANCE IN AQUACULTURE

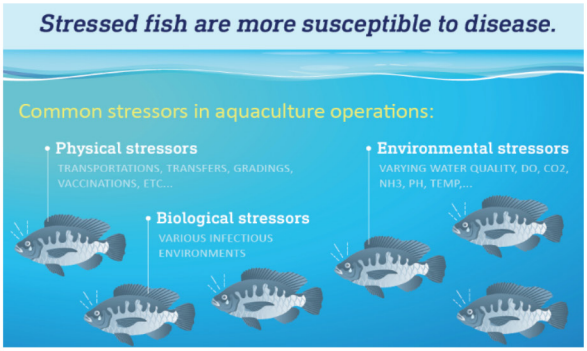
François Jégou, DVM, Archer Daniels Midland (ADM)

francois.jegou@adm.com

Farm management related stressors are common in Aquaculture operations : transportations, transfers, gradings, but also vaccination procedures include fish exposure to hypoxia, injuries, varying water qualities, various infectious environments, and population mixings.

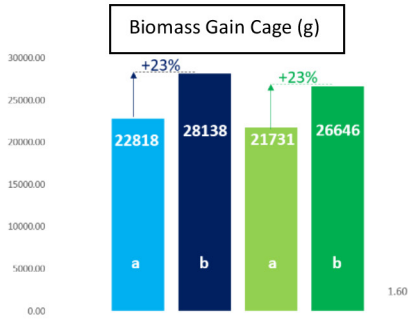
Many stressing events happen especially at juvenile stages, when fish are immature, whether on digestive or immunological aspects.

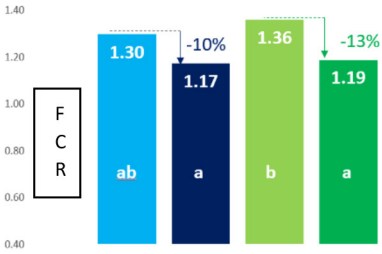
These events may lead to diseases occurrence, mortalities and/or loss of performance, which consequences may impact the entire production cycle.



In response to this global rising concern, a special support feed was formulated and included specific feed additives selected to help juvenile tilapia better cope with such stress. It was then tested in a dedicated R&D trial run in actual field conditions with 8 cages per treatment.

R esults after four weeks feeding this feed showed significant +23% Biomass gain and -13% Feed Conversion Ratio compared to Control, as well as 11% and 22% increased erythrocytes and albumin blood concentrations respectively, within one month post-vaccination (blue charts) or handling stress (green charts). These early growth and physiological advantages led to a significant 5% higher body weight at harvest 6 months later, after only four weeks distribution of the health feed at juvenile stage.





This specific feed was then proposed to a main tilapia producer in Brazil, whose major priority was to reduce the use of antibiotics, particularly as a preventive practice. Resulting performance on the short and long term incited them to increase their orders of this feed until it covered 100% of their juvenile feeding program, totaling 900 MT within nine months. Especially, they have stopped using antibiotics in feeds as a preventive practice, allowing to earn the BAP (Best Aquaculture Practice) certification, thus opening their sales to new markets and countries. In parallel, antibiotic resistance observations on their farm have continuously decreased. These facts encouraged this key producer to re-think his farm health management strategy, and consider it as a lever for performance and sustainability.

These results highlight contributions possibly brought by specific feed formulations and selected feed additives in supporting fish physiology and homeostasis in various stressing conditions. Doing so, such tools help fish producers improve their farming management practices and performance, reduce their use of antibiotics and chemicals, thus decrease their impact on the environment and global health.

SUPPORTING AQUACULTURE EDUCATION AS A COLLABORATIVE IN THE U.S. GREAT LAKES REGION

Lauren N. Jescovitch*, Elliot Nelson, Amy J. Schrank, & the GLAC team

Michigan Sea Grant Extension
Michigan State University
East Lansing, Michigan 48824 USA
jescovit@msu.edu

The Great Lakes Aquaculture Collaborative (GLAC), one of the United States' National Sea Grant supported Aquaculture Hubs, was formed to provide relevant, science-based initiatives that support an environmentally responsible, competitive, and sustainable aquaculture industry in the region. This collaboration has been successful in advancing aquaculture in the Great Lakes region through outcomes such as creating industry advisory groups, providing events and webinars to the community, supporting symposia at national and state aquaculture and fisheries meetings, addressing research questions about aquaculture from the consumer and producer perspective, and generating collaborative projects in the region.

Starting in 2019, GLAC has provided a centralized location for regular discussions, research, and events that are developed to meet the needs of industry as guided by state advisory groups. GLAC has also facilitated collaboration within the Great Lakes Sea Grant network for additional aquaculture work, such as Sea Grant's COVID-19 Rapid Response projects and the Great Lakes Fresh Fish Finder, which led to the creation of more robust industry needs assessments. Moving forward, funding of GLAC will continue to meet the needs of state aquaculture business advisory groups formed under GLAC, as well as be a conductor for coordinating a broader, regionally funded Sea Grant research proposal for aquaculture. These projects have created aquaculture awareness using a regional, diversified, and strategic approach.

DIETS OF ALESTIDAE (TELEOSTEI: CHARACIFORMES) IN TWO RIVERS (BOUMBA AND KADEI) IN EASTERN CAMEROON

Sandrine Jueya*, Gifty A-T Attu, Leandro Castello, Emmanuel Frimpong, David Nguenga, Arnold R Bitja Nyom

Department of Biological Sciences
Faculty of Sciences
University of Ngaoundere
BP 454, Ngaoundere, Cameroon
Email: sandybelljueya@yahoo.fr

As part of a larger research program on the diversity and role of the forest in maintaining the local ichthyofauna of the Congo Basin, a study focused on the diets of Alestidae, a family of many fishes represented in the Boumba and Kadei rivers in eastern Cameroon. Indeed know the diet of savage specie fish can help to make is conservation by aquaculture processes.

106 specimens of Alestidae were captured using dormant gillnets, cast nets, hooks and creels; they were identified using specific determination keys then were labeled, photographed, measured (total and standard lengths), weighed and dissected in order to remove their stomachs which were preserved in tubes containing alcohol at 70%. These stomachs were then emptied and the contents rinsed in Petri dishes, then filtered through a sieve and the retained fractions were sorted, separated, identified, counted and weighed in order to evaluate the rate of food from the riparian forests.

A total of 106 stomachs were collected from six species of Alestidae (*Alestes macrophthalmus*, *Brycinus longipinnis*, *Brycinus macrolepidotus*, *Brycinus imberi*, *Hydrocynus vittatus* and the *Bryconaethiops spp*. complex made up of several species grouped into one due to the low abundance of each). Of 63 individuals sampled in Boumba, 89.7% had full stomachs compared to 7.7% empty stomachs while out of 43 individuals sampled in Kadei, 76.1% had full stomachs compared to 14.9% empty stomachs. The emptiness coefficients were 8.33 in A. macrophthalmus in Boumba and 50 in Kadei while in B. macrolepidotus they were zero (0) in Boumba and 9.09 in Kadei.

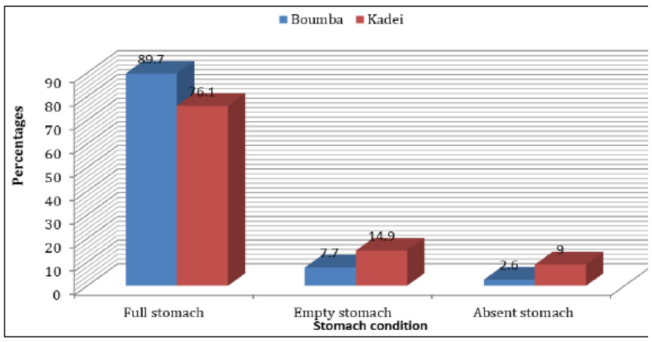


Fig 1: State of the stomachs of fish according to the sampling sites.

Four food categories have been identified in these fish: macroinvertebrates, macrophytes, prey fish and other miscellaneous particles. The frequency of occurrence (Fc) and the preponderance index (Ip), calculated, indicate that Lepidoptera are the very frequent and main prey in the diet of *B. longipinnis* at Bumba, while at Kadei it is rather Orthoptera and prey fish, respectively in *A. macrophthalmus* and *H. vittatus*. Furthermore, it has been observed that the riverside forests provide these prey (leaves, fruits and insects) found in the stomachs of certain species. Thus they mainly contribute to maintaining the balance within the fish food chain.

Table 1: Presence-absence of prey identified in the stomach contents of dissected individuals.

Sites	Prey	Fish			Macroinvertebrates									Macrophytes					Other			
	Species	Wh/Pat			AI			InsT/InvT					Cr	TP				AP			Mis	
		Sf	Fs	Fd	Co	Tr	Od	Or	Le	Hy	Is	My	De	Lf	Fl	Fr	Se	AP	Ib	Ie	Ff	Un
Boumba	*A. macrophthalmus*			+	+			+	+								+	+	+	+		+
	Bryconaethiops sp.		+				+		+									+				
	B. longipinnis								+													
	B. macrolepidotus								+	+				+		+		+				
	H. vittatus																					
Kadei	*A. macrophthalmus*							+														
	B. imberi			+	+	+	+	+	+	+	+							+	+			
	B. macrolepidotus				+	+				+		+	+		+	+		+	+		+	
	H. vittatus	+																				

The study of the stomach contents of Alestidae in Boumba and Kadei reveals that this family of fish is made up of herbivores, carnivores and omnivores. It is obvious that the forests of the Congo Basin constitute an essential source of food for the ichthyofauna of the rivers they shelter. Consequently, deforestation would negatively impact certain taxa of fish such as the Alestidae which depend on them and would inevitably lead to their loss. The improving knowledge on the feeding ecology of this Alestidae fish can help to take best measure of conservation on those of the red list of UINC.

DEVELOPMENT OF FISHERY CULTIVATION ON PEAT LANDS TO SUPPORT THE MINISTRY OF MARINE AFFAIRS AND FISHERIES PRIORITY PROGRAM FOR POVERTY ALLEVIATION AND GERMPLASM PRESERVATION

Juliansyah*,Tulus, Ishak Usman dan Rahmad Hidayat

Instalasi Budidaya Ikan Lahan Gambut
Balai Perikanan Budidaya Air Tawar Mandiangin
Direktorat Jenderal Perikanan Budidaya
Jl. Tahura Sultan Adam Km. 14, Mandiangin-Kalimantan Selatan
bbatmandiangin@gmail.com

The area of peat land in Indonesia is around 20.6 million hectares. If you look at the distribution, most of them are found in Sumatra (around 35%), Kalimantan (around 30%), Papua (around 30%), and Sulawesi (around 3%). Kalimantan is an area with considerable potential and can play a role in increasing fisheries production in Indonesia considering that there are still many marginal lands that have not been utilized, such as peatlands and former mining areas. The aim of this activity is to apply seeding techniques to grow catfish, snakehead and climbing perch in extreme land with a low pH range.

Fish cultivation activities on peatlands are carried out by liming, fertilizing and adding certain probiotics. It is believed that this method will improve the welfare of fish farmers who are the spearhead of the national aquaculture industry.

The results of fish cultivation development activities on peatlands obtained catfish with an FCR of 1,3, Climbing Perch fish and Snakehead fish of 1,5 to 1,7. Apart from that, 150.000 catfish seeds were obtained, 188.000 Climbing Perch fish seeds and 3.000 potential Climbing Perch parent fish, and 53.000 catfish seeds. The fish products are distributed as aid to the community in fish farming villages in Kapuas Regency, in Pulang Pisau Regency, and in Palangka Raya City. Restocking of Climbing Perch fish totally 200.000 fish to conserve germplasm in the Sebangau River, Palangka Raya City are carried from 2022 - 2023. This will really help reduce poverty for the community and preserve germplasm.

EVALUATION OF *Bacillus* spp. CAPABILITY TO DEGRADE THE TOXIN PROTEIN PRODUCED BY AHPND STRAIN *Vibrio parahaemolyticus* M0904

Pande Gde Sasmita Julyantoro*

Faculty of Marine Science and Fisheries
Udayana University
Bali, 80361 Indonesia
pande.sasmita@unud.ac.id

Acute hepatopancreatic necrosis disease (AHPND) is a newly emergent disease that poses significant economic threats to the shrimp aquaculture industry. This disease is caused by toxins secreted by pathogenic strains of Vibrio parahaemolyticus that have acquired a unique 63–70 kb AHPND-associated plasmid (pVA1). The plasmid encodes the binary PirA/BVP toxins that consist of two subunits PirAVP and PirBVP. Our study, with its focus on investigating the ability of Bacillus sp. to degrade these toxins, could potentially lead to the development of a new treatment for AHPND in shrimp aquaculture.

Toxin protein purification was done using MagneHis™ Protein Purification System provided by Promega. A previous study showed that recombinant $PirB^{VP}$ is more toxic to brine shrimp larvae than $PirA^{VP}$ (Kumar et al., 2019). The $PirB^{VP}$ subunit is a lectin that seems to participate in bacterial pathogenicity (Victorio-De Los Santos et al., 2020). Our first experiment with crude AHPND toxin also revealed that $PirA^{VP}$ was more stable and apparently unable to degrade by *Bacillus* strains (data not shown). Based on those facts, in this study, we focused more on investigating the Bacillus strain's ability to degrade pure $PirB^{VP}$ toxin.

In this study, four different strains of Bacillus sp., namely LMG9300, D10, LT12, and L6, were able to degrade PirB toxin as shown by SDS PAGE. Furthermore, we used those strains for the challenge test toward gnotobiotically cultured brine shrimp larvae *Artemia franciscana*, either with the addition of PirB toxin or directly challenged with *Vibrio parahaemolyticus* M0904.

Our *in vivo* challenge test revealed that adding pure PirAVP and PirBVP together significantly decreased the survival of Artemia. The addition of either a single or mixed culture of *Bacillus* strains then improved the survival of the Artemia when exposed to both pure PirAVP and PirBVP.

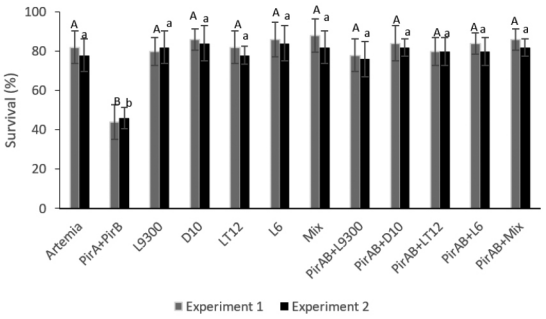


Figure 1. The impact of different *Bacillus* strains on the survival of *Artemia with and without the addition of PirAVP and PirBVP toxins after 48 hours of* incubation. The average values and standard error were obtained from 5 replicates.

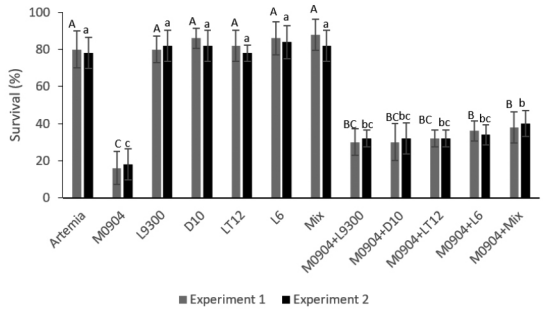


Figure 2. The impact of *Bacillus* strains on the survival of gnotobiotic *Artemia fransiscana* with and without challenged with of *V. parahaemolyticus* M0904 after 48 hours incubation. The average values and standard error were obtained from 5 replicates.

WELFARE SCORING FOR WHOLE FISH POPULATIONS BASED ON BEHAVIOUR, PRODUCTION AND ENVIRONMENTAL VARIABLES USING ARTIFICIAL INTELLIGENCE

Sunil Kadri*[1,2] & Johannes Kvam[1]

[1]CageEye AS, Storgata 11, 0155 OSLO, Norway
[2]Charles Darwin University, 7 Ellengowan Dr, Casuarina NT 0810, Australia

*sunil.kadri@cdu.edu.au

Following on from our presentation at WAS 2023 (Kadri & Kvam 2023) we will describe advances in the WelfareShield fish welfare monitoring system, showcasing a newly developed platform and examples from its deployment on fish farms. This welfare platform aggregates data from hydroacoustics, environmental sensors and the farm's feeding systems.

Welfare indicators are constructed from each of these sources and combined into an overall welfare score, to give farmers an early warning system for changes in welfare status at a cage level (see Fig 1a).

Using hydroacoustic measurements of the whole population we apply advanced pattern recognition and artificial intelligence algorithms to extract behavioural markers (see Fig 1b):

- Activity: Vertical movement
- Stability: Lack of acute stress.
- Rhythm: Distinct day and nighttime activity.
- Feeding response

These behavioural markers are statistically calibrated over a large dataset to establish expected levels. The platform also incorporates environmental parameters such as temperature and oxygen, as well as feeding system data which is used to detect anomalies in appetite levels.

Kadri, S & Kvam, J. (2023) *Monitoring whole population welfare status in cages using hydroacoustics*. World Aquaculture 2023 "Supporting Strength in Aquaculture", May 29-June 1 Darwin, Australia. p. 146 https://wasblobstorage.blob.core.windows.net/meeting-abstracts/WA2023AbstractBook.pdf

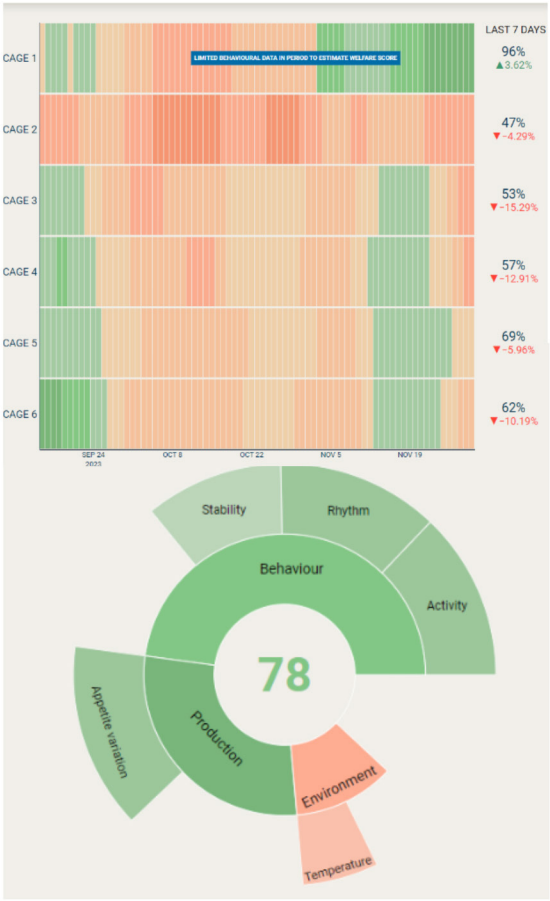


Figure 1a: Heatmap of overall welfare score for several cages over 2 months. Figure 1b: Breakdown of welfare score into individual markers for a single cage. Relative area of each sector reflects weighting of corresponding factor upon overall score. Green reflects good status, darker indicating a higher score; pink to red reflect poor status, darker indicating a lower score.

Co-funded by the European Union

GROWTH PERFORMANCE, APPARENT DIGESTIBILITY COEFFICIENTS, ANTIOXIDANT AND DIGESTIVE ENZYMES, AND IMMUNE ACTIVITIES OF PACIFIC WHITE SHRIMP, *Penaeus vannamei* FED WITH A COMBINATION OF NOVEL FEED INGREDIENTS

Rajalakshmi Kalaivanan, Nathan Felix, Amit Ranajn, Mir Ishfaq Nazir, Sathisikumar Govindfaraj

rajisantha97@gmail.com

An eight-week feeding trial was conducted to evaluate the efficiency of a combination of novel feed ingredients in replacing fishmeal (FM) and also to assess their impact on growth and immune performances, apparent digestibility coefficient (ADC), antioxidant and digestive enzyme activities in Pacific white shrimp *Penaeus vannamei.* Five isonitrogenous (Crude protein: 36.01%) and isolipidic (Crude lipid: 7.5%) diets were formulated using different protein sources. Diet-1 (Control diet): used fishmeal as the main protein source; Diet-2: fishmeal was replaced by poultry by-product meal(PBM), Broken rice (BR) and single cell protein (SCP) (1:1:1); Diet-3: fishmeal was replaced by insect meal(IM), rapeseed meal (RPM) and single cell protein (SCP) (1:1:1); Diet-4: fishmeal was replaced by fish waste(FW), peanut meal (PM) and single cell protein (SCP)(1:1:1); Diet-5, fishmeal was substituted by poultry by-product meal(PBM), Broken rice (BR) and single cell protein (SCP) insect meal(IM), rapeseed meal (RPM) (1:1:1:1:1:1:1). Juvenile shrimps with an average weight of 1 gram has been stocked in different experimental tanks fed with above diet following completely randomized design (CRD) in triplicates. At the end of the feeding trial, it was observed that Diet 5 had significantly improved ($p<0.05$) weight gain (13.55±0.34), and FCR (1.24±0.04) and recorded the best feeding efficiency when compared to other treatments. At the same time, diet 3 has shown an increase in weight gain (12.81±0.19) and SGR (4.55±0.07) than other diets. Diet 5 also showed significantly higher protease activity in both hepatopancreas and intestine tissues. Protein digestibility was significantly higher in diet 5. The results of the present study demonstrated that a composite mixture of IM, RPM, and SCP (1:1:1) might be an effective substitution to replace fishmeal. In the meantime, a combination of PBM, BR, SCP, IM, RPM, PM, and FW (1:1:1:1:1:1:1) is an excellent alternative diet to replace fishmeal in shrimp feeds.

INVESTIGATION ON BIOLOGICAL CHARACTERISTICS AND CAPTIVES MATURATION OF *Lepidocephalichthys berdmorei* (BLYTH, 1860)

Makamguang Kamei*, Sukham Munilkumar, Ch. Basuda Devi, Iffat Jahan Centurion

University of Technology and Management
Odisha, India
makamguang.kamei@cutm.ac.in

The study centers on *Lepidocephalichthys berdmorei*, a vital fish species in South Asia valued for its culinary and ornamental appeal. Population decline, driven by excessive fishing, prompts an inquiry into captive maturation and breeding as a conservation approach.

L. berdmorei were collected from diverse habitats with temperatures averaging 20.67±4.64°C, pH 6.76±0.79, dissolved oxygen 5.70±1.09 mg/l, alkalinity 24.92±5.95 mg/l, and total hardness 71.92±9.27 mg/l. Length-weight analysis indicates negative allometric growth (b=2.85) with a well-fitted relationship (R^2=0.80). The log-linear equation log BW = 2.8474 log TL - 2.0416 describes the relationship between body length (7.79 ± 0.06 cm) and weight (3.30 ± 0.07 gm). Fulton's condition factor (K-value) at 0.676 signifies significant allometric growth in the wild. Gut content analysis reveals a carni-omnivorous diet dominated by Cladocerans, Green algae, nematodes, Diatoms, and Detritus.

Gonadosomatic Index variations highlight peak reproductive activity in March (15.16 ± 0.61) and minimal activity in October (0.58 ± 0.12) during the cold season. Histological studies confirm these findings, showing oocytes in various stages in March. Wild *L. berdmorei* (7.3 ± 0.1 cm and 3.01 ± 0.09 g) were reared for 28 months, with successful induced spawning using synthetic hormones. Eggs hatched at 27.6 ± 0.58ºC, yielding larvae of 186.3 ± 0.7μm, with mouth opening at 40-48 h (mouth gape of 80.21 ± 0.7μm). The study concludes *L. berdmorei* can breed in captivity, shown by induced spawning success (65.67% hatching, 62% larval survival), offering promise for aquaculture and population replenishment.

Fig 1: Gonadosomatic (GSI) and Gastrosomatic (GaSI) indices of Lepidocephalichthys berdmorei in different months, collected from different rivers of Manipur, India

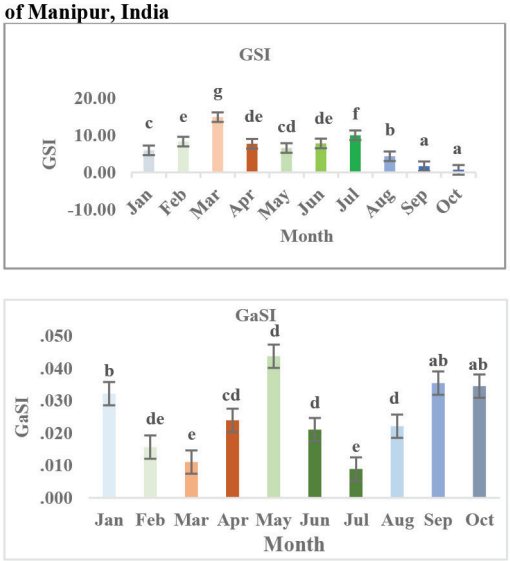
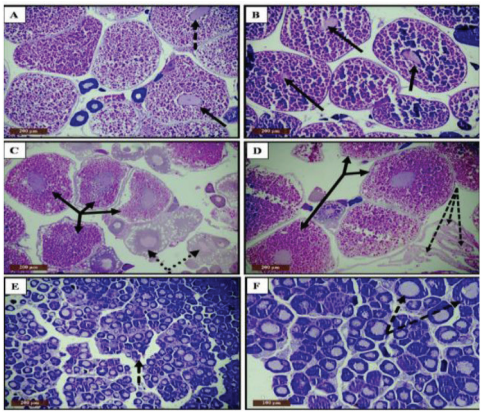


Fig 2: Photomicrographs A and B show L. berdmorei ovary in the developing to spawning capable phase with matured follicles and late vitellogenic oocytes. Solid arrows indicate migrating germinal vesicle in maturing oocytes; broken arrows indicate centric germinal vesicles in immature follicles. Photomicrograph C represents ovary in spawning phase with maturing and late vitellogenic follicles. Photomicrograph D shows ovary with late vitellogenic oocytes and post-ovulatory follicle complexes. Photomicrographs E and F depict regressed ovary with only primary growth oocytes.



PROPERTIES OF MULTI-STRAIN PROBIOTICS FROM MARINE ORGANISMS AS BIOCONTROL OF *Vibrio harveyi*

Murni Marlina Abd Karim*, Puvaneswari Puvanasundram, Chong Chou Min, Suriana Sabri, Md Sabri Mohd Yusoff and Nurhamiza Izwani Baharim

Laboratory of Sustainable Aquaculture
International Institute of Aquaculture and Aquatic Sciences
Universiti Putra Malaysia
70150 Port Dickson
Negeri Sembilan, Malaysia
murnimarlina@upm.edu.my

Multi-strain probiotics (MSP), comprising diverse bacterial strains, have demonstrated enhanced benefits over single probiotics, challenging the traditional view and expanding the understanding of probiotics as modulators of host microbial communities, contributing to improved growth, digestion, immune responses, and disease control in aquaculture.

This study aimed to assess the effectiveness of multi-strain probiotic (MSP) to inhibit the growth of pathogenic *Vibrio harveyi* through *in vitro* and preliminary *in vivo* assay using *Artemia*. This MSP consists of strains derived from various marine organisms, comprising of *Lysinibacillus fusiformis* strains SPS11, A1 and *Lysinibacillus sphaericus* NAS32. The MSP demonstrated significant inhibition of *Vibrio harveyi* as determined by *in vitro* antagonistic assays. In addition, this MSP can produce higher biofilm in comparison to *V. harveyi*. Moreover, the strains in the MSP showed resistance to high temperatures (80, 90, and 100°C) and a wide range of pH (2 to 9). In an i*n vivo* challenge assay using *Artemia* as preliminary host, the survival rate of *Artemia* treated with MSP in both concentrations (10^6 and 10^8 CFU mL^{-1}) was significantly higher ($p<0.05$) compared to *Artemia* without MSP treatment and *Artemia* challenged with *V. harveyi* only. Notably, *Artemia* incubated with MSP at concentration 10^6 CFU mL^{-1} showed higher survival rate when challenged with *V. harveyi*. Therefore, the combination of three isolates from genus *Lysinibacillus* (*L. fusiformis* SPS11, *L. sphaericus* NAS32 and *L. fusiformis* A1) showed potential to be further explored as MSP on selected aquatic species. Besides, at an enrichment level of 10^6 CFU mL^{-1}, *Artemia* can be used as a vehicle to deliver this MSP to aquatic larvae feeding on them. This *in vitro* and preliminary *in vivo* assessment study demonstrates that this MSP has the potential to be further explored as MSP on selected aquatic species.

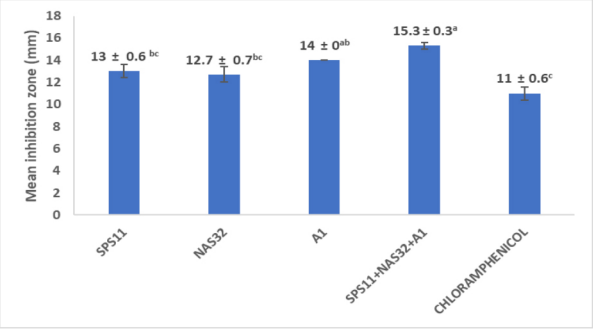


Figure 1: Agar well diffusion assay zone sizes for the inhibition of *Vibrio harveyi* (10^6 CFU mL^{-1}) using single- and multi-strain probiotics. Chloramphenicol = Positive control.

ENHANCING FARMED STRIPED CATFISH (*Pangasianodon hypophthalmus*) ROBUSTNESS USING DIETARY B-GLUCAN

Noor Khan* and Sheeza Bano**

*Institute of Zoology, University of the Punjab, Lahore
**Department of Fisheries & Aquaculture, University of Veterinary and Animal Sciences, Lahore-Pakistan
Email: noor.zool@pu.edu.pk

β-glucan is a well-documented feed additive for its potent immunostimulatory properties in many farmed fish species. This study examined how it can also be a promising growth promoter, modulate antioxidant enzyme activities, and act as an anti-stress agent in striped catfish (*Pangasianodon hypophthalmus*). A 12-week feeding experiment was under taken to determine the effects of dietary β-glucan supplementation at graded levels (0, 0.5, 1.0, and 1.5 g kg^{-1}). Measured indicators suggest that a dietary inclusion level of 1.5 g kg^{-1} β-glucan gave the highest positive responses: weight gain (120.10 g $fish^{-1}$), survival (98.30 %), and lower FCR (1.70) (P<0.05). Whole body proximate analysis had only revealed that crude protein was significantly affected by the dietary inclusion of β-glucan (P<0.05), with the highest protein content (19.70 %) being in fish that were fed with 1.5 g kg^{-1} β-glucan. Although other inclusion levels (i.e., 0.5 and 1 g kg^{-1}) of β-glucan did not enhance body protein content (P>0.05). The assessment of fatty acid composition in muscle, liver, and adipose tissues showed modifications with the inclusion of β-glucan. Antioxidative-related enzyme activities (inc. catalase, glutathione peroxidase, and superoxide dismutase) that were measured in the liver had higher levels when fed with β-glucan inclusion diets (P<0.05). Following the feed trial, fish were subjected to crowding stress treatment. It was subsequently found that catfish fed with β-glucan-based diet groups had lower levels of blood stress-related indicators compared to the control group with no dietary β-glucan. The use of 1.5 g kg^{-1} of dietary β-glucan resulted in the lowest measured levels of cortisol (43.13 ng mL^{-1}) and glucose (50.16 mg dL^{-1}). This study has demonstrated that the dietary inclusion of β-glucan can have functional benefits beyond the immunological enhancements in striped catfish. Furthermore, its use can increase production levels and mitigate the stress associated with intensive farming practices.

BIOPROPESCTING OF MALAYSIAN INDIGENOUS FRESHWATER AND MARINE MICROALGAE FOR HIGH FUCOXANTHIN AND LIPID CONTENT: POTENTIAL FOR AQUACULTURE APPLICATIONS

Yam Sim Khaw*, Ikhsan. Natrah, Fatimah Md. Yusoff and Hui Teng Tan

Aquatic Animal Health and Therapeutics Laboratory, Institute of Bioscience, Universiti Putra Malaysia, UPM 43400 Serdang, Selangor, Malaysia
Department of Aquaculture, Faculty of Agriculture, Universiti Putra Malaysia, UPM 43400 Serdang, Selangor, Malaysia

Currently, aquaculture sector is one of the most significant and rapidly expanding industries in global food production. Ensuring both optimal nutritional content and sustainability of ingredients within commercial aquaculture feed represents primary challenges in meeting the dietary needs of farmed aquatic species. The utilization of preferred fish meal and fish oil can exacerbate sustainability issues attributed to the risk of overfishing and environmental degradation. Hence, aquaculture sector is actively pursuing sustainable alternatives to surrogate fish meal and fish oil, recognizing their crucial nutritional role for farmed aquatic species. Microalgae, particularly those rich in fucoxanthin and lipids, hold promising potential as nutritional supplements for aquaculture feed. Furthermore, Malaysia is a tropical country with megadiverse ecosystems that provides a rich landscape for bioprospecting endeavors, unlocking the vast potential of microalgae for innovative applications in various industries. These indigenous microalgae could be cultivated superior under particular local environmental conditional and meanwhile maintains the balance of native ecosystems. Therefore, this study aimed to bioprospect indigenous freshwater and marine species from Malaysia, focusing on their fucoxanthin and lipids contents for aquaculture purpose. A total of 11 microalgae strains (six freshwater and five marine microalgae) were included in this study. The growth properties and fucoxanthin content of these microalgae were initially evaluated. Then, three of the highest fucoxanthin-producing microalgae from freshwater and marine environments, respectively, were selected for lipid and fatty acid methyl esther analysis. Chaetoceros calcitrans (UPMC-A0010) (marine microalgae) produced the greatest amount of fucoxanthin (11.40 ± 0.38 mg/g DW) and eicosapentaenoic acid (EPA) (13.05 ± 0.23 % total fatty acids (TFA)) than the investigated microalgae. Additionally, one freshwater microalga, Mayamaea permitits (UPMC-A0071) demonstrated substantial amount of fucoxanthin (8.36 ± 1.23 mg/g DW) and EPA (7.25 ± 0.18 % TFA). This work establishes a crucial foundation for the advancing microalgal research and bolstering the economic feasibility of producing these valuable compounds. By leveraging these two Malaysian indigenous microalgae, this study paves the way for their potential application in the aquaculture sector.

EFFECTS OF DIETARY PREBIOTIC, PROBIOTICS AND SYNBIOTIC SUPPLEMMENTATION ON INNATE IMMUNITY AND DISEASE RESISTANT OF OLIVE FLOUNDER *Paralichthys olivaceus*

Wonhoon Kim*, Jongho Lim, Choong Hwan Noh, Kyeong-jun Lee

Department of Marine Life Sciences
Jeju National University
Jeju 63243, South Korea
whkim@jejunu.ac.kr

Prebiotics and probiotics are well known as functional feed additives that can improve growth, immunity and disease resistance enhancing balance of intestinal microbiome. For that reason, dietary utilization of prebiotics and probiotics in various fish species are being studies. Therefore, this study was performed to evaluate the effects of dietary supplementation of mannan oligosaccharides, *Lactobacillus plantarum*, *Bacillus subtilis* and *Bacillus licheniformis* on innate immunity and disease resistance of feeding trial and bacterial infection test of growing olive flounder.

A basal diet (Con) was formulated to meet the nutrient requirements of olive flounder. Dietary starch in Con was replaced with 0.6% of manna oligosaccharides, *L. plantarum*, *B. subtilis*, *B. licheniformis* (Mos, LP, BS and BL, respectively) and each 0.15% of prebiotic and probiotics (Syn). Total 450 fish (initial body weight: 65.9 g) were stocked in 18 tanks (240 L), divided into three replicates for each dietary treatment. Fish were fed ad libitum one of the diets twice a day (08:00, 17:30 h) for 11 weeks. After the feeding trial, bacterial infection test against *Edwardsiella tarda* was performed for 17 days.

After the feeding trial, activity of phagocytic and myeloperoxidase was not affected by the supplementation (Table 1). Lysozyme activity of LP, BL and Syn groups, and immunoglobulin level of MOS, LP, BL and Syn groups were significantly higher than that of Con group. After the bacterial infection, lysozyme activity and immunoglobulin level were also significantly increased in the supplemented groups than in Con group. The disease resistance was significantly increased in the supplemented groups than in Con group (Figure 1).

This study suggests that dietary supplementation of manna oligosaccharides, *L. plantarum*, *B. subtilis* and *B. licheniformis* could increase the innate immunity and disease resistance against *E. tarda* in growing olive flounder.

Table 1. Innate immune responses of olive flounder fed the diets for 11 weeks and after the challenge test against the *Edwardsiella tarda* for 17 days.

Diets	Phagocytosis	Lysozyme activity (μg/mL)	Myeloperoxidase activity (μg/mL)	Immunoglobulin (mg/mL)
After Feeding trial				
Con	0.89±0.03	8.71±1.70^{c}	1.01±0.21	5.60±1.78^{b}
Mos	0.90±0.03	9.29±2.58^{c}	1.12±0.68	9.30±2.31^{a}
LP	0.92±0.04	13.4±1.71^{ab}	1.09±0.50	10.0±1.23^{a}
BS	0.93±0.04	11.3±2.05^{bc}	1.20±0.53	8.50±1.07^{ab}
BL	0.92±0.03	12.7±2.14^{ab}	0.93±0.33	9.17±2.29^{a}
Syn	0.96±0.09	14.6±1.68^{a}	0.99±0.33	11.0±0.93^{a}
After Challenge test against Edwardsiella tarda				
Con	2.64±0.24	10.7±2.07^{b}	0.66±0.30	7.48±1.57^{b}
Mos	2.63±0.13	14.8±5.03^{b}	1.15±0.38	11.2±1.05^{a}
LP	2.60±0.16	20.1±2.96^{a}	0.69±0.21	11.1±2.12^{a}
BS	2.65±0.18	20.7±0.63^{a}	0.51±0.04	10.1±2.31^{a}
BL	2.46±0.09	23.8±3.62^{a}	0.70±0.41	12.0±1.53^{a}
Syn	2.49±0.25	24.7±2.71^{a}	0.55±0.20	10.8±0.24^{a}

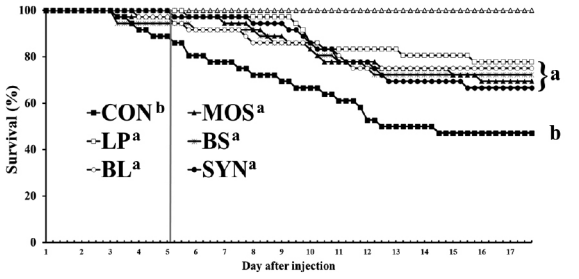


Figure 1. Challenge test against *Edwardsiella tarda* in olive flounder for 17 days

ANALYSIS OF FACTORS INVOLNED IN THE DIRECTION OF THE EYE IN THE METAMORPHOSIS OF THE STARRY FLOUNDER *Platichthys stellatus*

Tae-min Kim *, Youn-su Cho, Hyun-seok Jang, Hye-min Oh, Han-kyu Lim

Interdisciplinary Program of Biomedicine. Health & Life Convergence Sciences
BK21
Mokpo National University
Muan, Jeonnam 58554
Coolktm00@naver.com

Starry flounder, *Platichthys stellatus* is an emerging aquaculture species in Northeast Asia including Korea and is a high value-added flatfish species. Unlike other fish species of Pleuronectiformes, in the case of starry flounder inhabited in the coastal water of Korea, the eyes are located in the same direction as that of olive flounder (*Paralichthys olivaceus*) to the left side. If the eye direction of the juvenile starry flounder is located to the right at the seed production fish farms, fishermen judge it to be malformed and select it for non-sale. However, in waters off Northeast Asia, nearly 100% of starry flounder have a left eye (sinistral), in waters off Alaska the number drops to 67%, and on the west coast of the United States, it has been reported that the number drops to 5-60%. It is not yet known exactly why the eye direction of the starry flounder is different, whether it is caused by genetic or environmental factors. Therefore, in this study, the ratio of the eye direction of starry flounder juveniles was investigated in domestic flounder farms in Korea. To confirm the genetic factors, the ratio of the eye direction of F1 larvae was investigated by crossing the left-eyed and right-eyed broodstocks. In addition, to confirm the environmental factors, the ratio of the eye direction was investigated by breeding larvae at different water temperatures (10, 14, and 18°C) during the metamorphosis period. It was investigated that the right-eyed (dextral) at a rate of 7.4±2.0% of seed production in domestic starry flounder in Korea. There was no significant difference between groups in F1 where left-eyed female and left-eyed male, left-eyed female and right-eyed male, right-eyed female and left-eyed male, right-eyed female, and right-eyed male were crossed, and the ratio of the dextral-eyed juvenile was found to be 25.13~33%. The ratio of the dextral-eyed juvenile according to the water temperature showed a significant difference between groups, which was 32.19±2.66% in the 18°C group.

DIETARY VITAMIN A REQUIREMENT FOR PACIFIC WHITE SHRIMP *Penaeus vannamei*

Sua Kim* and Kyeong-Jun Lee

Department of Marine Life Sciences
Jeju National University
Jeju 63243, South Korea
saddd@jejunu.ac.kr

Vitamin A (VA) is an essential fat-soluble micronutrient that plays a crucial role in various physiological processes such as growth, immunity and gene regulation. However, the dietary VA requirements of pacific white shrimp are still unknown. This study was conducted to determine the dietary requirement of VA and its effect on the growth performance, feed utilization, digestive enzyme activities and gene expression related to antioxidant capacity and non-specific immunity of post-larval pacific white shrimp.

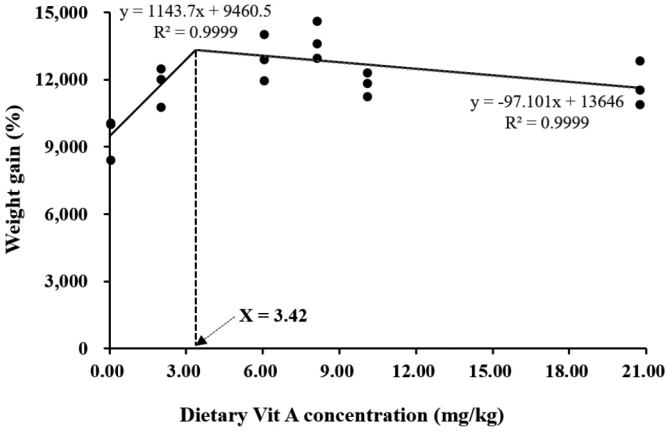
Six diets were prepared by supplementing 0, 2, 6, 8, 10 and 20 mg VA/kg diet (designated as VA0, VA2, VA6, VA8, VA10 and VA20, respectively). A total of 3600 shrimp (initial body weight: 0.95 mg) were randomly distributed in triplicate among 18 tanks (110 L). The shrimp were fed one of the experimental diets four times a day for 30 days.

At the end of the feeding trial, final body weight (FBW) and weight gain (WG) in VA6 and VA8 groups were significantly higher than those in VA0 group. Protein efficiency ratio (PER) in VA8 group was significantly higher than that in VA0 group. Feed conversion ratio (FCR) in VA2, VA6, VA8 and VA10 groups were significantly lower than that in VA0 group. Survival of the shrimp was not significantly different among all the groups. During ammonia stress test, all the VA supplemented groups showed significantly higher survival than that of VA0 group. Based on broken line regression with WG, the dietary requirement of VA level for post-larval Pacific white shrimp is likely to be 3.42 mg/kg.

The results of the gene expression related with immunity and antioxidant capacity will be further presented.

Table 1. Growth performance, feed utilization of Pacific white shrimp fed the experimental diets for 30 days.

Diets	FBW(mg)	WG(%)	FCR
VA0	91.30±9.00^{b}	9485±944^{b}	1.46±0.12^{a}
VA2	112.95±8.52^{ab}	11758±895^{ab}	1.04±0.09^{b}
VA6	124.32±9.85^{a}	12952±1035^{a}	1.02±0.21^{b}
VA8	131.67±8.09^{a}	13724±850^{a}	0.94±0.08^{b}
VA10	113.34±5.14^{ab}	11799±539^{ab}	1.03±0.17^{b}
VA20	112.86±9.61^{ab}	11749±1009^{ab}	1.15±0.07^{ab}



NEWLY DESIGNED PCR-BASED METHOD FOR THE DETECTION OF JELLYFISH IN AQUACULTUR SYSTEM

Sung-Ah Kim*, Sang-Eun Nam, Jae-Sung Rhee

Department of Marine Science
Incheon National University
Incheon, South Korea
ocean_sa-kim@naver.com

Scyphozoa, commonly referred to as jellyfish within the Cnidaria, can lead mass mortality in aquaculture and fisheries through a direct harmful impact with their toxins derived from their nematocysts or indirect effects such as gill malfunctions. In addition, their adhesive polyps can directly attach to aquaculture systems and produce ephyrae and medusae. Jellyfish blooms are becoming more frequent due to global warming and increased anthropogenic activity, which means their impact on an aquaculture and fisheries will become increasingly significant. Efficient and precise monitoring of jellyfish occurrences and blooms is important to prevent subsequent problems and find solutions. Therefore, we designed new COI target primer sets with higher resolution for the detection of jellyfish and conducted an *in silico* evaluation.

Scyphozoa COI sequences were assembled from NCBI search results for "Scyphozoa, complete" and aligned with MEGA-X software. Primers were designed to cover highly variable regions, meeting criteria such as GC%, amplicon size, and primer length. Consequently, primer sets were developed to generate approximately 250 bp amplicons. The accuracy of the newly designed primers was evaluated using BLASTn and ECOPCR in the OBITOOLS package. With these detection methods, we expect rapid detection of jellyfish bloom both in and outside of aquaculture environments.

SUPERVISION OF ENVIRONMENTAL ASPECTS OF THE UTILIZATION OF TELUK LAKE, JAMBI CITY FOR AQUACULTURE IN FLOATING NET CAGE

Janu D. Kristianto[1)], Reni A. Lubis, Prayudha D. Cahyono

[1)] Aquaculture Supervisor at Sungai Gelam Freshwater Aquaculture Center (SGFAC)
Jl. Bumi Perkemahan Pramuka Desa Sungai Gelam RT. 23 Kecamatan Sungai Gelam Kab. Muaro Jambi – Provinsi Jambi
Email: janu4kris@gmail.com

Lake is one of ecosytem form than occupies a relative small area on the surface of the earth as compared to sea and land habitats. For humans, utilization is more important than the expanse of lands. Since 1985, Teluk Lake began to be used as the location of fish cultivation with floating net cage culture (FNCC). The number of FNCC in 2020 reached ± 878 unit of 64 fish farmers and it will increase related to determination of Jambi Province as one of Minapolitan fishery cultivation in order to increase fish production. Utilization of Teluk Lake as media for fish cultivation on floating cage is necessary to encourage the management of common resources is to be kept sustainable. Studies on carrying capacity and utilization of Teluk Lake Jambi City for community-based fish cultivation in FNCC aims to know how the use of this lake that have been implemented by the local community and to find out how the carrying capacity Teluk lake that used to fish farming activities in floating cage. Carrying capacity is determined by calculating water polution load capacity of lake for fish farming activities in floating cage. Data that used are primary and secondary data. Methods used in this study is qualitative and quantitative methods with a descriptive approach.

Result showed that carrying capacity of Teluk lake for fish farming in FNCC is equal 517,617 tons of fish per year with estimate amount of feed given to fish in floating cage is as many as 931,710 ton per year assuming total P were entered into the lake through fish waste as much 20 k P/ton of fish. Ideal number of floating cage based on lake carrying capacity accounting should be 862,695 unit ~ 863 unit. Operating floating cage currently is 878 unit so that it is necessary reduction in the amount of 15 unit and if they want to add a new one, it should be an improvement or replacement of existing floating cage at lake. Utilization of Teluk Lake for fish farming is done simple by local communities and number of existing floating cage already slightly exceed the carrying capacity of lake if related from existing concentration of total P in water.

Tabel 1. LCWP analysis for Teluk Lake for Red Tilapia Aquaculture activities in cage 2020

Lake Characteristics	Symbol	Value	
D. Carrying amount FNC Aquaculture for Red Tilapia in Teluk Lake			
➢ *FCR* Red Tilapia	FCR	1,8	ton feed/ton fish
➢ Total P content in the feed	P_{pakan}	13	Kg P/ ton feed
➢ Levels of P-total in the Red Tilapia	P_{ikan}	3,4	Kg P/ ton fish
➢ Total P coming from fish waste	P_{LP}= FCR*P_{pakan}-P_{ikan}	20	Kg P/ ton fish
➢ FNC Fish production	LI = La_{ikan}/P_{LP}	517,617	Ton fish/years
➢ The amount of fish feed in FNC	LP = LI * FCR	931,710	Ton feed/years
➢ The mean estimate of Harvest Fish in FNC	-	0,6	Ton fish/years/units
➢ Ideal number FNC	La_{ikan}/Estimasi Rerata panen Ikan KJA	862,695	unit

Description :[1)] DLH Kota Jambi, 2020,
[2)] Analisa Laboratorium Kesehatan Ikan dan Lingkungan BPBAT Jambi, 2020

THE CURRENT STATUS OF BIODIVERSITY OF INDIGENOUS FISH SPECIES AND THEIR CONSERVATION STRATEGY IN BIHAR (INDIA)

Bibha Kumari*

*bibhak136@gmail.com

Biodiversity defines an aquatic system's potential and trophic status. It is critical to have a thorough understanding of the constituent biota, particularly to conserve and manage inland water resources such as rivers, reservoirs, ponds, and wetlands. Fish are an important component of these aquatic bodies. A wide variety of fish thrive in these settings, taking advantage of the various niches available. The group promotes other species of animal diversity and serves as an excellent indication of healthy ecosystems.

In Bihar (India) over the past three to four decades, several factors have contributed to the rapid decline in local species of fish populations, including pollution, urbanization, habitat loss, and steady eutrophication of the water body. The threat to the fish population is caused by other activities too, including barrages, wastewater dumping, overfishing, sedimentation, changes in land use patterns, etc.

To preserve the native fish population at the regional level, the aquatic biodiversity conservation process necessitates the identification of certain river segments that are suitable for designation as aquatic reserves. An integrated and sustainable fisheries management plan should be created since the risks to the river's fish biodiversity are steadily getting worse and fish conservation is becoming more and more important. A comprehensive strategy that incorporates the ideas of sustainable development and conservation measures has to be used to preserve these priceless resources.

THE PRESENT POSITION OF WOMEN IN THE FISH MARKETING SECTOR IN PATNA, BIHAR, INDIA

Bibha Kumari[1*] & Abhiniti Vats[2]

1: Department of Zoology, Magadh Mahila College, Patna University, Patna, Bihar 800001, India
*bibhak136@gmail.com
2: School of Law, Christ (Deemed to be) University, Bangalore, Karnataka, India

Patna, situated on the southern bank of the Ganges, serves as the capital of Bihar, one of India's significant states. The wholesale fish market at Bazar Samiti in Patna is where fish are gathered and distributed to various areas within the city. The expenses involved in transporting, loading, unloading, icing, setting up shops, and other miscellaneous costs all add up to the overall cost of moving fish from production to consumption points.

The literature extensively discusses the diverse ways in which gender division of labor manifests in fishing communities. It specifically emphasizes the importance of women's involvement in processing, marketing, and trade within the fisheries sector. Fisherwomen of Patna are actively engaged in post-harvest activities and play crucial roles in marketing within fisheries societies. Despite their significant contributions, they often face challenges such as lack of visibility, support, and recognition. These women are marginalized for advocating for their rights, despite being essential for maintaining the social fabric of the community. The constant harassment they face is worsened by the absence of secure, government-approved platforms in local markets. Furthermore, their involvement in securing credit for fisheries operations on behalf of their husbands is often overlooked.

PRODUCTION STRATREGY ON PANGASIUS (*Pangasianodon hypopthalmus*) NURSERY AT BALAI LAYANAN USAHA PRODUKSI PERIKANAN BUDIDAYA KARAWANG

Budi Kurnia*, Sunardi, Agus Dwiono, Hary Wuwungan

Balai Layanan Usaha Produksi Perikanan Budidaya (BLUPPB)Karawang
Desa Pusakajaya Utara, Kecamatan Cilebar, Kabupaten Karawang, Jawa Barat
budikurnia74@gmail.com

Pangasius or Jambal or Patin *(Pangasianodon hypopthalmus)* is freshwater fish species that has high potential in Indonesia on an industrial scale. This Fish has a high tolerance level to the aquatic enviromental change, non cannibalism fish, advanced seed production and artificial feed, and also has fillet fish of end product at cold storage as an advantage. Nursery is the early stage of fish aquaculture after hatchery phase which producing a ready growth out of seed.

The aim of this activity is to find out the best strategy for two pangasius nursery methods at application scale, especially in small land base ponds. Four units of 450 m^2 ponds covered with *High Density Poly Ethylene* (HDPE) at upper side of ponds was carried out for this activity. The methods of this activity were standard nursery method which the fish were stocking at the pond with the 50.000 fish of density. And the other method were using two units of 15 x 10 x 1,2 m happa net cage installed at the pond with 25.000 fish of each cage. . The average of initial body weight were 1,8 gr/fish. The aquaculture management of these two methods were similar and the parameters of these activities were Average growth rate, Survival rate and the level of body uniformity.

The results of 50 days nursery activity showed that the average relative growth value was not much different, The survival rate of usual stocking pond culture ((91,84%) was better than happa net cage culture (84.6%). The results of the fish body uniformity for standard pond nursery method produce two different size of fish which is better than the happa net cage method (4 different size of fish). The Data Showed that the standard nursery methods with fish stocking fee at pond more recommended than the happa net cage pond method.

No	Kegiatan	Standard Method	Happ netcage method
1	Initial av. Body weight (gr/fish)	1,18	1,21
2	Final Av. Body weight (gr/fish)	14,13	12,21
3	SGR (% Bw/d)	8,63	8,01
4	Initial density (fish)	50.000	50.000
5	Final density (ekor)	45.920	42.300
6	SR (%)	91,84	88,7
7	Uniformity (size)	2	4

PATHOLOGY OF CATFISH (*Pangasius* sp.) IN MORTALITY EVENT IN LEBAK REGENCY, BANTEN PROVINCE

Ratna Amalia Kurniasih*, Suherman, Ellis Mursitorini, Wiwin Wiyani, Joko Suwiryono

Center For Fish Health and Environmental Assessment
Ministry of Maritime Affairs and Fisheries of Indonesia
Email: lp2il.serang@gmail.com

A mortality event of catfish (*Pangasius* sp.) occurred on a farm at Lebak Regency from the end of 2021 until early 2022 with 90-120g weight of fish. Histopathological sampling was conducted three times at one-week intervals to investigate the cause of mortality and monitor the factors influencing disease progression. During the mortality period, the fish became lethargy and had less appetite. Petechial hemorrhages were observed in the head area, around the mouth, fins, ventral abdomen, and body surface. The liver appeared pale with small white nodules, which were also found in the spleen and kidney. These clinical signs persisted until the last sampling. In bacteriological examination, *Aeromonas sobria* and *Edwardsiella ictaluri* were isolated from the liver, spleen, and kidney. The histopathological changes observed during this mortality event were associated with a mixed infection of bacteria, parasites, and water quality alterations. Fish had bacterial necrosis with leukocyte infiltration in the liver, spleen, kidney, and heart in the first and second samplings. At the end of the organ examination, bacterial colonies no longer existed and the feature indicated a chronic condition. The gill tissues showed parasitic branchitis and circulatory disturbances until the end of sampling, which is related to poor water quality. Effective water quality management is important for preventing disease development and supporting the success of fish farming.

SPAWNING AND LARVA REARING OF SPINY LOBSTER (*Panulirus humorus*) AT MAIN CENTER FOR MARINE AQUACULTURE, LAMPUNG

Kurniastuty*, Mulyanto, Muhamad. Firdaus dan Lian Handri

Main Center for Marine Aquaculture
Directorate General of Aquaculture
Marine Affairs and Fisheries Ministry
E-mail : tuty_nr@yahoo.com

Spiny lobster (*Panulirus humorus*) is one of the leading commodities that is currently being developed in Indonesia. The abundant availability of seeds in nature encourages excessive exploitation of seeds. Effort to cultivate lobsters must be made so that the lobster seed population in nature is not disturbed and dependence on seeds from nature can be reduced. The objective of the activity is to obtain technology for spawning and rearing spiny lobster (*Panulirus humorus*) to support the availability of seeds for aquaculture businesses in the community. The method used is to carry out spawning in concrete tanks and rearing lobster larvae in aquariums with a sirculation system. Main Center for Marine Aquaculture Lampung has succeeded in breeding spiny lobsters whose broadstock from aquaculture. produced puerulus from natural which have been reared for two years. The eggs produced were quite good with an average diameter of 478.54 µm. Eggs that have matured gonads hatch into larvae called Phyllosoma. Larvae are given natural food of *Phorphyridium* and *Thallassiosira*. Lobster larvae were successfully reared at Main Center for Marine Aquaculture Lampung for a maximum of 36 days, only reached the third phase.

The broodstocks are reared in spawning tanks measuring 1.5 x 1.5 x 3 m^3 until it lays its eggs and hatches. Broodstock is resulting from natural puerulus that have been reared for two years. The broodstock ready to spawn measures 400 – 900 grams, with a male and female ratio of 3 : 2. The broodstock lobsters feed green mussel meat, fresh fish and squid at a dose of 5 – 7 % / biomass / day, two times /day. Green mussel meat is given whole while fresh fish and squid are cut into small pieces.

The eggs produced were quite good with an average diameter of 478.54 µm. The eggs are incubated for four weeks and undergo several divisions and egg development, visible by changes in color from red-orange to dark or black. After the egg color is dark red or black, the egg hatches into larvae.

Larvae in the form of phylosoma are kept in 100 liters aquarium with a recirculation system. Rearing is carried out in a closed room (indoors) with air conditioning. The room temperature is maintained between 20 – 24 ^oC. Larvae are given plankton ie. *Phorphyridium* and *Thallassiosira* which comes from pure cultures in the natural food laboratory. Plankton are given to the larvae in the amount of 1 liter per aquarium once a day.

During 2023 the broodstock have spawned 51 times, but the number was not too many. Maximum larvae can only survive until 36 days, only reached the third phase.

EXISTING CONDITIONS AND SCALE-UP FOR PEARL OYSTER (*Pinctada maxima*) PRODUCTION IN MARINE AQUACULTURE DEVELOPMENT CENTER (MADC) LOMBOK-INDONESIA

Aprisanto Dwi Laksana*, Oki Setiawan, Januar Hakam, Muhammad Hidayat

Marine Aquaculture Development Center Lombok
West Nusa Tenggara
Indonesia
Bpbl.lombok@gmail.com

Sea pearl oysters (*Pinctada maxima*) are one of the commodities that already become an icon in West Nusa Tenggara Province-Indonesia. Pearls are the only gems produced by living creatures. According to ITC Trademap 2022, Indonesia is the 4th largest pearl exporter in the world after Hong Kong, Japan, and China, with sales value reaching USD 55 million. However, Indonesia has only been able to fulfill around 5-8 percent of the global market. In several studies, pearl oyster aquaculture has several environmental benefits, such as nutrient cycling, remediation from pollutant effects in waters, and mitigation of eutrophication and hypoxia.

Marine Aquaculture Development Center (MADC) Lombok has succeeded in cultivating pearl oysters since 2003, starting with the production of *P. maxima* larvae, broodstock, and farming using the longline method for pearl production. Existing conditions at MADC Lombok including hatchery production with capacity reaches 5 million larvae and 160,000 spats, broodstock candidates and broodstock of as many as 1,067 (10–15 cm) oysters, 1,251 oysters that have been operated to produce pearls, and grow-out production using longline methode that the capacity reaches 11,200 (6–9 cm) oysters with a 2.5% survival rate of spat size.

The survival and growth of pearl oysters are influenced by various factors, including stocking density, diet, environmental conditions, and predation (Pit J. and Southgate P., 2003). Therefore, scaling up the pearl oyster (*Pinctada maxima*) production at MADC Lombok is a solution to increase the production in terms of quantity as a form of an integrated manner from upstream to downstream. The scaling up process needs to be strengthened by technology-based security systems to ensure minimum theft activity that causes major lost in pearl oyster aquaculture. Layout of the scale-up for pearl oyster production can be seen at figure 1.

Figure 1. Layout for the scale-up production

COMPLEX POPULATION GENETIC STRUCTURE IN THE SEA CUCUMBER *Holothuria scabra* IN THE PHILIPPINES: IMPLICATIONS FOR AQUACULTURE AND FISHERY MANAGEMENT

Monal M. Lal*, Deo A. S. Macahig, Marie A. Juinio-Meñez, Jon P. Altamirano, Roselyn Noran-Baylon, Margarita de la Torre-de la Cruz, Janine L. Villamor, Racelle R. Rescordado, Wilfredo H. Uy, Hanzel Mira-Honghong, Paul C. Southgate, Rachel J. Ravago-Gotanco

School of Science, Technology and Engineering
and
Australian Centre for Pacific Islands Research
University of the Sunshine Coast
Maroochydore, QLD 4558, Queensland, Australia
mlal1@usc.edu.au

The sandfish *Holothuria (Metriatyla) scabra*, is a high-value tropical sea cucumber harvested from wild stocks for over four centuries in multi-species fisheries across its Indo-Pacific distribution, for the global bêche-de-mer (BDM) trade. Within southeast Asia, the Philippines has seen overharvesting and declining catch volumes. Sandfish mariculture can potentially supplement BDM supply and assist restocking efforts; however, it is heavily reliant on wild populations for broodstock supply. Consequently, to inform fishery, mariculture, germplasm and translocation management policies for both wild and captive resources, a high-resolution genomic audit of 16 wild Philippines sandfish populations was conducted. Genomic data (8,266 selectively-neutral and 117 putatively-adaptive SNPs) were used to assess fine-scale genetic structure, diversity, relatedness, population connectivity and local adaptation at both broad (biogeographic region) and local (within-biogeographic region) scales. An independent hydrodynamic particle dispersal model was also used to assess population connectivity. The overall pattern of population differentiation at the country level for *H. scabra* in the Philippines is complex, with nine genetic stocks and respective management units delineated across 4 biogeographic regions: (1) Celebes Sea, (2) North and South Philippine Seas, (3) South China and Internal Seas and (4) Sulu Sea. Genetic connectivity is highest within proximate marine biogeographic regions (mean F_{st}=0.016), with greater separation evident between geographically distant sites (F_{st} range=0.041-0.045). Signatures of local adaptation were detected among six biogeographic regions, with genetic bottlenecks at 5 sites, particularly within historically heavily-exploited locations in the western and central Philippines. Genetic structure is influenced by geographic distance, larval dispersal capacity, species-specific larval development and settlement attributes, variable ocean current-mediated gene flow, source and sink location geography and habitat heterogeneity across the archipelago. Data reported here will inform accurate and sustainable fishery regulation, conservation of genetic diversity, direct broodstock sourcing for mariculture and guide restocking interventions across the Philippines.

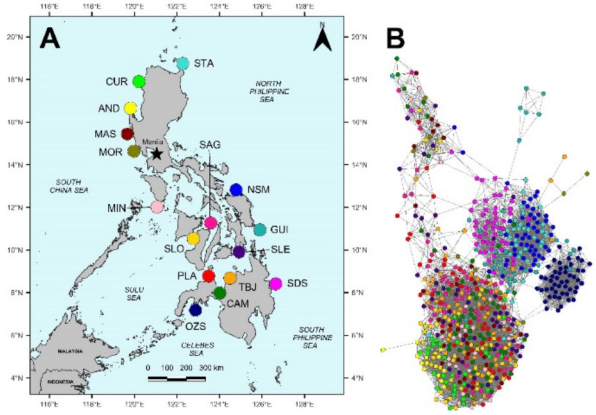


FIGURE 1. (A) Map of locations in the Philippines where *H. scabra* were sampled and (B) high resolution population genetic structure network. Each dot represents a single individual, and population colours correspond with sampling sites in (1A)

EXPLORING THE PREDATORY VERSATALITY OF *B. bacteriovorus* AND ITS POTENTIAL APPLICATIONS IN AQUACULTURE

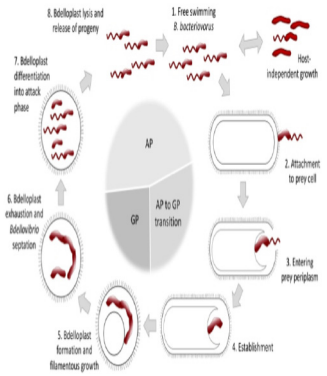
Nand Kumar Lathker
Asif Shaik

Golden Marine Biotechnologies
Beside Akshaya foods
Indira Gandhi co. op. housing society
Kattedan, Hyderabad, India - 500077

Bdellovibrio bacteriovorus, a unique and fascinating bacterium, has distinguished itself for its predatory lifestyle and obligate intracellular life cycle. B. bacteriovorus is an obligate predatory bacterium that selectively prey, invade and consume broad range of gram-negative bacteria including human pathogens. This abstract encapsulates the multifaceted aspects of B. bacteriovorus, highlighting its predatory mechanisms, ecological significance, and potential applications including wastewater treatment, biofilm eradication, and probiotic development. Due to their unique lifestyle, they have been considered as potential therapeutic and biocontrol agents.

Unlike most bacteria, which obtain nutrients through various metabolic processes, Bdellovibrio initially attaches to the surface of its prey bacterium, typically using its polar flagellum for motility. Once attached, it penetrates the outer membrane of the prey bacterium and enters the periplasmic space. Inside the periplasmic space, Bdellovibrio undergoes a developmental cycle, transitioning into a larger, elongated form known as the "bdelloplast." Within the bdelloplast, Bdellovibrio degrades the prey's peptidoglycan layer by releasing enzymes, accessing nutrients for its own growth and replication. Bdelloplast grows inside the periplasm with certain specific growth rate until the prey resources are exhausted and offspring is produced. As Bdellovibrio proliferates within the bdelloplast, it eventually lyses the prey cell, releasing progeny cells into the surrounding environment. This process results in the death of the prey bacterium. following prey lysis, Bdellovibrio progeny are released into the extracellular environment, where they can search for another new prey cells to continue the predatory cycle. Apart from this Bdellovibrio has the ability to effectively penetrate biofilms layers and potential to kill biofilm forming bacteria.

This mode of action distinguishes Bdellovibrio as an obligate predator of other bacteria, particularly Gram-negative species. Its ability to penetrate and consume prey bacteria makes it a potential candidate for biocontrol applications against bacterial pathogens, including those resistant to antibiotics. Additionally, Bdellovibrio's predatory behaviour contributes to the natural regulation of harmful bacterial populations in various environments. It shows promise as a natural agent for controlling bacterial pathogens including antibiotic resistant strains. Among the pathogenic bacteria, species belonging to Vibrio are the most common and widespread disease-causing agents in aquaculture. As highlighted Bdellovibrio bacteriovorus can potentially help us to meet challenges as an effective future control agent in the fight against harmful pathogens like Vibrio in aquaculture.



DOES THE NUTRITION AT THE EARLY STAGE HAVE SUBSEQUENT EFFECTS ON THE LATER STAGE IN THE SHRIMP *Litopenaeus vannamei* CULTURE?

Hoang Thi My Dung Le* and Philippe Dhert

Skretting Aquaculture Innovation
Norway

Although the production cycle of shrimp is relatively short, nutritional and physical property requirements of food are rapidly changing. Rearing protocols are different among hatchery, nursery and grow-out regarding diets and environmental factors. At the hatcheries, shrimp are fed with premium feed with high nutritional composition and quality. Water quality, microbiology, and pathogens are controlled at optimal levels for animals to grow. At the grow-out phase, shrimp are exposed to vulnerable environments in ponds where both the physical (i.e., temperature, pH and oxygen) and biological (i.e., bacteria, live food, and pathogen) factors differ from the hatchery tank condition. Also, grow-out diets often offer lower nutrients than hatchery diets. Hence, the nursery period plays an important role as a transfer phase from hatchery to grow-out, where the postlarvae continue developing their body and get adapted to the vulnerable rearing conditions.

Previous studies on other species reveal that adverse environmental conditions (including nutrition) during critical early development stages may have long-term effects on the performance of animals in the later stage. In this study, we investigated how the diets in the nursery stage affect shrimp in the nursery stage and in the subsequent stage, grow-out. The experiment had two phases: (i) Phase 1: from post-larvae 12 (PL12) to 1.5 g juvenile. In this phase, shrimp were fed with five commercial nursery diets; (ii) Phase 2: when shrim achived 1.5 g, they were restocked and switched to a commercial grow-out diet. All shrimp in the five groups fed with five different nursery diets in Phase 1 were switched to the same grow-out diet in Phase 2. The trial shows that the nutritional and physical properties of the diets exert not only immediate effect during the corresponding rearing stage (nursery) but also their impact can be experienced during the later stages (grow-out) indicating that lifestart sets life performance.

DIETARY PROTEIN LEVEL AFFECT PYRIDOXINE REQUIREMENT OF PACIFIC WHITE SHRIMP *Penaeus vannamei*

Yeonji Lee* and Kyeong-Jun Lee

Department of Marine Life Sciences
Jeju National University
Jeju 63243, South Korea
yeonjilee98@jejunu.ac.kr

Pyridoxine (B_6) is a water-soluble vitamin and involved in amino acid metabolism. Since pyridoxine acts as a coenzyme in protein metabolism, its dietary requirement varies depending on the dietary protein levels. This study was conducted to verify the interacting effects of dietary protein and pyridoxine levels on the growth, innate immunity, antioxidant capacity and digestive enzyme activity of Pacific white shrimp.

Pyridoxine was supplemented at 0, 40, 80 and 120 mg/kg in a low protein (LP, 31.7%) and a high protein (HP, 42.6%) diets (designated as LP0, LP40, LP80, LP120, HP0, HP40, HP80 and HP120, respectively). Total 408 shrimp (6.44 ± 0.03 g) were distributed in 24 tanks (240 L). Three replicate groups of shrimp were fed one of the diets six times daily for 42 days.

In LP group, the growth performance (final body weight, weight gain and specific growth rate) was significantly higher in the pyridoxine–supplemented groups than in LP0 group. In HP group, there was no significant difference in the growth performance among all groups. Trypsin activity was significantly improved in the pyridoxine–supplemented groups (except for LP40) compared to that in LP0 and HP0 groups. Chymotrypsin activity was not significantly different in LP and HP groups. Lipase activity was significantly improved in pyridoxin–supplemented groups regardless of protein levels. LP120 group showed significantly higher antioxidant capacity (glutathione peroxidase, catalase and total antioxidant capacity) than LP0 group. Catalase activity was significantly higher in LP80 group than in LP0 group. In the HP groups, pyridoxine–supplemented groups showed significantly higher antioxidant capacity than HP0 group.

The optimum dietary pyridoxine level in LP diet and HP diet was established to 115.5 mg/kg and 59.4 mg/kg, respectively. Dietary pyridoxine requirement for the shrimp seems related to the dietary protein levels. The results on innate immunity and gene expressions will be further discussed in details. Our results suggest optimal levels of pyridoxine for different dietary protein levels, leading to improved growth, health and cost-effective feeding of Pacific white shrimp.

Table 1. Growth performance of *Penaeus vannamei* fed the experimental diets for 42 days.

Diets	FBW	WG	SGR
LP0	16.1±0.40^{c}	151±3.97^{c}	2.19±2.19^{c}
LP40	17.1±0.21^{b}	166±2.67^{b}	2.33±2.33^{b}
LP80	17.5±0.29^{ab}	172±4.92^{ab}	2.38±2.38^{ab}
LP120	18.1±0.35^{a}	181±6.02^{a}	2.46±2.46^{a}
HP0	20.4±0.16	215±5.01	2.73±2.73
HP40	20.5±0.43	218±6.27	2.76±2.76
HP80	20.5±0.20	218±3.02	2.75±2.75
HP120	20.4±0.29	218±5.81	2.76±2.76
Two-way ANOVA			
Protein	0.000	0.000	0.000
Pyridoxine	0.000	0.000	0.000
Protein× Pyridoxine	0.000	0.001	0.001

A REVIEW IN NANOPARTICLES IN SUSTTAINABLE AQUACULTURE MANAGEMENT: PHYSIOLOGICAL CHANGES IN FISH AND DISEASE CONTROL

Yih Nin Lee* and Ravi Fotedar

Curtin Aquaculture Research Laboratory
Curtin University Malaysia
CDT 250, 98009 Miri
Sarawak, Malaysia
leeyihnin@curtin.edu.my

Recently, the application of nanoparticles (NPs) in aquaculture is increasing. Metal NPs such as iron oxide nanoparticles are often made of one metal, metal oxides, or a combination of different metals through green or chemical synthesis methods. The application of NPs in aquaculture can vary from culturing species to environment. NPs are used to improve fish growth and their health to increase aquaculture production. Furthermore, NPs also used for wastewater treatment in aquaculture to reduce eutrophication. We reviewed that the ways of NPs used in aquaculture, which can be very different: some are directly added as feed addictive, and some are added in water media for treatment purposes. In this review, we explore the influence of NPs as dietary supplementation on physiological changes: histological changes, hematology, and biochemical changes in fish, their limitations, and the type of NPs used. Additionally, it gives a brief idea about NPs used in fish diseases and traditional ways for controlling pathogens. On the other hand, this review provides knowledge on application of NPs in aquaculture management.

EFFECTS OF DIETARY SUPPLEMENTATION OF PROTEIN HYDROLYSATES ON GROWTH PERFORMANCE, FEED UTILIZATION AND DISEASE RESISTANCE AGAINST *Vibrio parahaemolyticus* IN PACIFIC WHITE SHRIMP *Litopenaeus vannamei*

Mirasha Hasanthi[1]*, Mikael Herault[2], Vincent Fournier[2] and Kyeong-Jun Lee[1]

[1]Department of Marine Life Science, Jeju National University, Jeju 63243, South Korea
[2]Symrise Aqua Feed, ZA du Gohelis, Elven 56250, France
E mail: kjlee@jejunu.ac.kr

The study investigated the effects of dietary supplementation of protein hydrolysates on growth performance, feed utilization and pathogenic resistance in Pacific white shrimp. A diet containing 1% krill meal was considered as a control diet. Five other diets were formulated to be isonitrogenous (40% protein) and isolipidic (9.7% lipid) including 2% tuna hydrolysate, 2% tuna+shrimp liquid hydrolysate blend, 1% shrimp powder hydrolysate, 1% fish powder hydrolysate and 2% shrimp liquid hydrolysate. Each diet was fed to quadruplicate groups of 30 juvenile shrimp (initial weight 0.4±0.0 g) for 10 weeks. After the feeding trial, 45 shrimp from each dietary treatment were redistributed into three replicate tanks for the *Vibrio parahaemolyticus* bacterial challenge. The result showed that shrimp fed tuna hydrolysate and shrimp powder hydrolysate supplemented diets had significantly increased (P<0.05) weight gain compared to shrimp fed krill meal diet. Feed conversion ratio was significantly decreased (P<0.05) with all the dietary protein hydrolysates, whereas shrimp powder hydrolysate showed the lowest level. Shrimp survival against *V. parahaemolyticus* challenge was positively influenced by the dietary protein hydrolysates. The survival was significantly higher (P<0.05) in shrimp fed shrimp powder hydrolysate than in shrimp fed krill meal. These results demonstrate that protein hydrolysate supplementations in diets could improve the growth, feed utilization and disease resistance of shrimp.

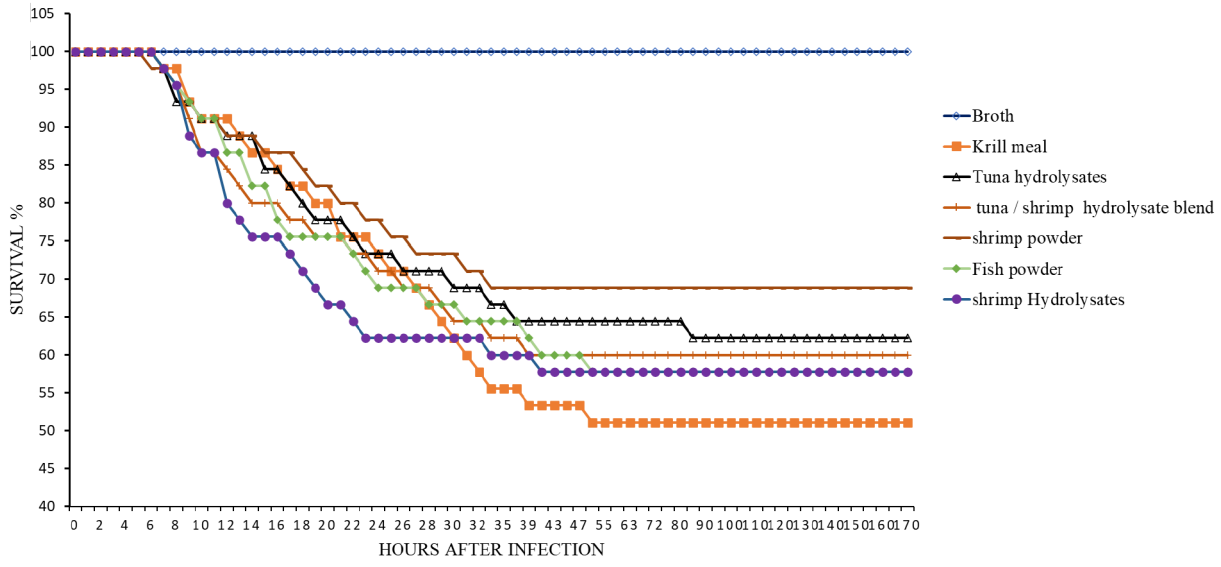


Figure 1. Shrimp survival against *Vibrio parahaemolyticus* (1.83×10^5 CFU/mL) bacterial challenge after 10 weeks of the feeding trial.

EFFECTS OF DIETARY SUPPLEMENTATION OF EGG AND TUNA HYDROLYSATES ON GROWTH, FEED UTILIZATION AND DISEASE RESISTANCE AGAINST *Vibrio parahaemolyticus* OF PACIFIC WHITE SHRIMP *Litopenaeus vannamei*

Nalin Medagoda[1], Mikael Herault[2], Vincent Fournier[2], and Kyeong-Jun Lee[1]

[1]Department of Marine Life Science, Jeju National University, Jeju 63243, South Korea
[2]Symrise Aqua Feed, ZA du Gohelis, Elven 56250, France
Email: kjlee@jejunu.ac.kr

We evaluated dietary supplementation of egg and tuna hydrolysates on the growth, feed utilization and disease resistance against *Vibrio parahaemolyticus*. A control diet was prepared including 4.7% squid liver powder (SLP). Five other diets were formulated including 2% and 4% egg powder hydrolysate type-1 and -2 and 2% tuna liquid hydrolysate. All the six diets were iso-nitrogenous and iso-lipidic. Five replicate groups of treatments, each containing 32 shrimp (0.41±0.00 g) per tank (240 L), were fed one of the diets 6 times daily for 10 weeks. At the end of the feeding trial, shrimp in each tank were counted and weighed individually to assess the growth and feed utilization. The remaining shrimp in each treatment were pooled and redistributed into four replicate tanks (110 L) to contain 15 shrimp per tank. Then, tanks were inoculated with 40 mL of 1.3 x 10^5 CFU ml^{-1} *V. parahaemolyticus* bacteria solution and challenged for 240 h recording the hourly cumulative mortality. Shrimp fed hydrolysate-incorporated diets showed significantly higher growth than shrimp fed SLP diet. Except for the 2% egg powder hydrolysate type-1 incorporated diet fed group, the highest growth was observed in the 4% egg powder hydrolysate type-2 incorporated diet fed group among hydrolysate groups. Dietary supplementation of 2% egg powder hydrolysate type-1 and 4% egg powder hydrolysate type-2 significantly improved feed utilization than control diet. During the bacteria challenge test, tuna liquid hydrolysate treatment showed a significantly higher survival than other treatments. SLP incorporated diet fed group showed the lowest survival. This study indicated that dietary hydrolysate supplementation improves growth, feed utilization and survival against *V. parahaemolyticus*.

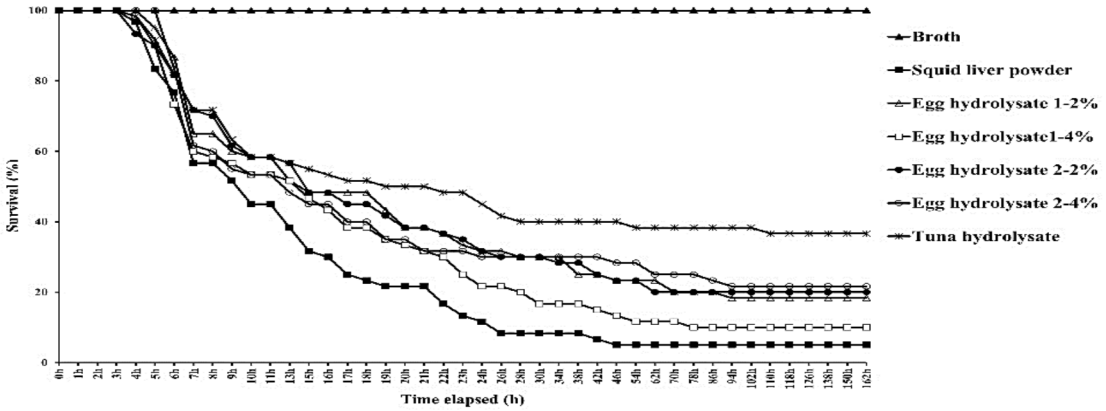


Figure 1. Shrimp survival against *Vibrio parahaemolyticus* (1.3 x 10^5 CFU ml^{-1}) bacterial challenge after 10 weeks of the feeding trial.

EVALUATE THE USABILITY OF LOW-FISH MEAL DIETS FORM OF EXTRUDED PELLET WITH ANIMAL AND PLANT PROTEIN SOURCES FOR OLIVE FLOUNDER *Paralichthys olivaceus* AT FARM SCALE

Hyunwoon Lim*, Nalin Medagoda, Mirasha Hasanthi, Yeonji Lee, Wonhoon Kim, and Kyeong-Jun Lee

Department of Marine Life Sciences
Jeju National University
Jeju 63243, South Korea
hwlim@jejunu.ac.kr

Fishmeal (FM) has been considered as the main protein source for aquaculture species because it contains essential nutrients such as protein, lipids, minerals and vitamins for fish. However, continuously rising the demand for FM causes problems such as ecosystem destruction and supply and price instability. Replacing FM with other protein sources is essential for the development of a sustainable aquaculture industry. Therefore, our study was designed to evaluate the availability of low-fish meal (LFM) diets for olive flounder at farm scale.

The main protein source of the control diet was sardine and anchovy FM (1:1; w:w) and contained 70% FM. Two experimental diets replaced FM with tankage meal, wheat gluten and soy protein concentrate and the FM level was reduced to 30 and 25%, respectively (designated as FM30 and FM25). The formulation of the experimental diets is presented in Table 1.

At the end of the feeding trial, final body weight (FBW) and weight gain (WG) showed no significant difference among all experimental groups (Table 2). Feed intake (FI), feed conversion ratio (FCR) and survival were not affected by dietary treatments. In biological indices, condition factor (CF), viscerosomatic index (VSI) and hepatosomatic index (HSI) were no significant different among all experimental groups.

In conclusion, even though the LFM diets were fed for 6 months, there was no adverse effects on growth performance or biological indices and the FM levels in the diet could be reduced to 25%. We found that tuna byproduct meal, tankage meal, wheat gluten, and soy protein concentrate can successfully replace FM in juvenile olive flounder diets. Further studies are recommended to develop diets with lower FM levels.

Table 1. Dietary formulation of the experimental diets for juvenile olive flounder *Paralichthys olivaceus* (% of dry matter).

	Diets		
Ingredients	FM70	FM30	FM25
Fish meal, sardine	350	150	125
Fish meal, anchovy	350	150	125
Soybean meal	114	90	90
TBM[1]		150	175
Tankage meal		165	190
Wheat gluten		50	50
SPC[2]		30	30
Starch	107	107	107
Fish oil	42	42	42
Etc.[3]	37	66	66

[1]Tuna byproduct meal. [2]Soy protein concentrate. [3]Lecithin, monocalcium phosphate, choline chloride, vitamin premix, vitamin C, vitamin E, mineral premix, methionine, taurine, lysine and betaine.

Table 2. Growth performance, feed intake, feed conversion ratio and survival of juvenile olive flounder *Paralichthys olivaceus* (initial mean body weight: 28.9 g) fed the experimental diets for 6 months.

Diets	FM70	FM30	FM25
FBW	385±3.91	340±26.1	377±13.6
WG	1232±13.2	1078±90.2	1205±47.1
FI	213±44.5	197±20.0	241±10.8
FCR	0.60±0.11	0.62±0.14	0.68±0.07
Survival	61.8±11.7	63.8±14.1	53.7±3.44
CF	0.96±0.07	1.01±0.09	0.98±0.06
VSI	6.23±1.01	6.13±12.9	5.67±0.88
HSI	1.58±0.30	1.58±0.47	1.49±0.40

MAKE TOMORROW BETTER; CURTIN UNIVERSITY MALAYSIA HAS VENTURES INTO AQUACULTURE RESEARCH, COLLABORATION, AND EDUCATION TO RAISE AWARENESS, SUPPORT, AND DEVELOP THE CURRENT STATUS AND DEVELOPMENT OF AQUACULTURE IN SARAWAK

Simon C. Leunig*, Han Kiat Chin, Yih Nin Lee, and Ravi Fotedar

Pro Vice-Chancellor, Curtin Malaysia
Curtin Aquaculture Research Laboratory (CARL)
Curtin University Malaysia
CDT 250, 98009 Miri, Sarawak, Malaysia
www.Curtin.edu.my

In Malaysia, aquaculture showed a significant increase from less than 80,000 MT in 1992 to more than 427,000 MT in 2017, valued at MYR 3 billion. According to the Regional Corridor Development Authority (RECODA), aquaculture and fisheries could generate up to 44,000 new jobs for the people of Sarawak by 2030, adding USD800 million to GDP. Forecasts show that Sarawak's current aquaculture production of just over 11,500 MT a year has the potential to increase by a factor of 25 to hit 300,000 MT a year by 2030. Based on the annual fisheries statistics, the total number of freshwater aquaculturists in Sarawak is about 24% of Malaysia's total aquaculturists in 2021. Furthermore, Sarawak recorded the second-highest production through aquaculture in Malaysia after Sabah in 2021. One way to improve the aquaculture sector sustainably is to develop the human capacity to have a strong knowledge of aquaculture management. Therefore, universities can play an important role in developing sustainable aquaculture in Sarawak.

Curtin University Malaysia has been conducting a significant aquaculture program since early 2021, comprising teaching and research into the establishment of Sarawak's first major aquaculture research facility. The journey begins with free webinars titled "Aquaculture in Sarawak: Challenges and Opportunities" and "Challenges and Opportunities of Aquaculture in Malaysia and Indonesia" featuring aquaculture experts from Curtin University in Perth, the Sarawak Department of Agriculture and Sarawak Regional Fisheries Biosecurity Centre, the Department of Fisheries Malaysia, the Aquaculture Laboratory at Universitas Diponegoro, Indonesia, and Indonesia's Agency for Marine and Fisheries R&D.

Curtin University Malaysia will launch a two-year Master of Science in Sustainable Aquaculture course, focusing on aquaculture principles and factors affecting aquatic animal farming and food production systems.

This course, designed from a global aquaculture perspective, equips graduates with knowledge that allows them to be industry-ready specializing in aquatic animal biology, environmental issues, nutrition, reproduction, genetics, disease, and health management. In addition, a Diploma in Aquaculture is also proposed. In December of 2023, Curtin Aquaculture Research Laboratory (CARL) held a soft opening to acquire research grants, purchase necessary equipment etc.

Photo 1 & 2: Posters of the Webinars.
Photo 3: The Soft Launching of CA

GENERATION OF GOLDEN GOLDFISH *Carassius auratus* VIA TYROSINASE GENE TARGETING BY CRISPR/CAS9

Huijuan Li, Xiaowen Wang, Rong Zhang, Lili Liu, and Hua Zhu*

Fisheries Research Institute
Beijing Academy of Agriculture and Forestry Sciences
Beijing, China 100068
zhuhua@bjfishery.com

Goldfish (*Carassius auratus*), regarded as one of the world's earliest ornamental fish, has garnered significant attention from researchers due to its diverse range of color patterns and unique morphological variations. In our study, we have successfully developed a highly efficient and precise genome editing technology for *Carassius auratus tyr*osinase (*tyr*), resulting in the creation of a strikingly golden goldfish. The duplicated *tyr* genes (*tyrA* and *tyrB*) were first identified in *C. auratus*, and the CRISPR/Cas9 was used to disrupt both *tyr* genes. The edited albino mutants displayed a complete absence of melanocytes in both their eyes and body surface, whereas mosaic mutants exhibited varying degrees of melanin reduction. Notably, disrupting only *tyrA* or *tyrB* failed to yield a reduction in melanin content.

Six sgRNAs were designed to target the exons 1 and 3 of *tyr* gene using an online tool CRISPOR (Fig.1). The results of Sanger sequence revealed that *tyr*-sgRNA1 and *tyr*-sgRNA2 were effective in guiding Cas9-induced mutagenesis, showing evident multiple peaks near PAM sites of *tyr*A and *tyr*B (Fig.2). The color phenotypes of these edited fish were continuously monitored and documented at the time points of 10, 180, and 360 dpf (Fig.3). The observed phenotypes of the edited fish can be classified into two categories based on body and eye coloration: albino mutants and mosaic mutants. Complete albino mutants exhibited a complete absence of melanocytes both in their eyes and on their body surfaces. The mosaic mutants, also known as incomplete albino mutants, were characterized by varying degrees of decrease in melanin on the body surface and eye. Co-injection of the *tyr*-sgRNA1/*tyr*-sgRNA2/Cas9 mixture into embryos resulted in a phenotypic rate of 44.1% for albino mutants and 40.9% for mosaic mutants.

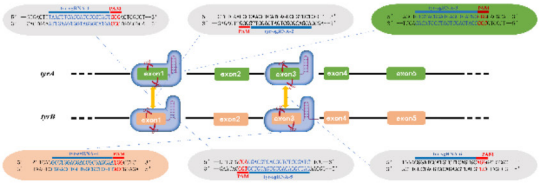


FIGURE1. The schematic diagram of *tyr*-sgRNAs.

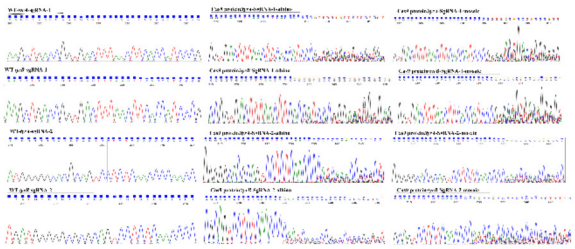


FIGURE2. The Sanger sequencing of PCR products in the injected embryos.

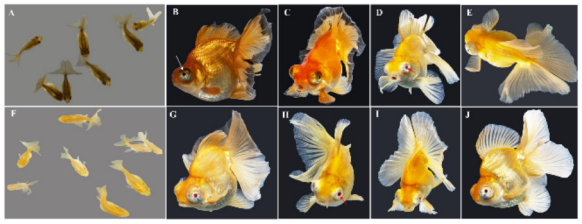


FIGURE3. The albino mutants injected with the mixture of *tyr*-sgRNA1/*tyr*-sgRNA2/Cas9 protein.

GENETIC PARAMETERS AND GENOTYPE BY ENVIRONMENT INTERACTION OF HARVEST TRAITS FOR MALABAR RED SNAPPER (*Lutjanus malabaricus*) USING A 70K RED SNAPPER SNP ARRAY

Bing Liang*, Dean R. Jerry, Xueyan Shen, Celestine Terence, Maura Carrai, Vu Nguyen, Maria G. Nayfa, Kathiresan Purushothaman, Grace Loo, Shubha Vij, Jose A. Domingos

Tropical Futures Institute
James Cook University Singapore
149 Sims Drive
387380, Singapore

One of the major aquaculture species farmed in Singapore and the region is Malabar red snapper (*Lutjanus malabaricus*), which is attracting increasing interest due to its favourable taste, unique red colour and premium prices. However, the quality of fingerlings supplied to the industry is inconsistent. Selective breeding for genetic improvement of production traits has been widely adopted in many key aquaculture species as an approach to increase the quality and productivity of fingerlings. However, currently there are no selection programmes for Malabar red snapper and to inform future breeding programs it is essential to understand genetic parameters related to commercial traits of interest. Therefore, the present study estimated genetic parameters of harvest traits for Malabar red snapper with the objective of providing useful information on future genetic improvement programmes of the species.

In total 2,580 Malabar red snapper cultured at three different rearing sites (tanks in floating barge, sea-cages and tanks in land-based facility) were genotyped using a newly developed Axiom 70k Red Snapper SNP array, and their body weight (BW), total length (TL) and intensity of red colouration (CIELAB *a values) were measured before harvest when fish were 18 months old. The mean (± SD) of BW, TL and *a values of all fish samples were 632.2 ± 233.3 g, 321.8 ± 68.4 mm and 5.2 ± 6.6, respectively. Heritabilities (h^2), genetic correlations (r_g) and genotype by environment interactions (GxE) were estimated using BLUPF90 with an animal model and using the genomic relationship matrix. The h^2 for BW, TL and *a were 0.32 ± 0.04, 0.33 ± 0.04 and 0.03 ± 0.02, respectively. The phenotypic and genetic correlations between BW and TL were 0.94 ± 0.00 and 0.95 ± 0.01, while there was no genetic correlation between BW (nor TL) and red coloration**.** These results indicated that the harvest growth traits of Malabar red snapper can be improved via selective breeding programs. In contrast, the very low h^2 of red colour suggests that environmental factors (e.g. dietary carotenoids) rather than genetic effects may be primarily responsible for the phenotypic variation observed in skin redness. Moderate GxE interactions were observed BW (0.50-0.60) and TL (0.14-0.65) among the three rearing sites, suggesting that that a single breeding program may not deliver equal genetic gains for all farms alike, and that genomic selection algorithms should be trained on the rearing site where animals are to be farmed (sea-cages or tank-based systems). In conclusion, the present study provided valuable information for the design of future selective breeding programs for Malabar red snapper.

SPATIAL AND TEMPORAL VARIATION IN INFESTATION OF PORTUGUESE OYSTERS BY MACROBORERS IN FARMING AREAS IN TAIWAN

Chih-Ching Lin, Chung-Wei Yang, Pi-Jen Liu, Li-Lian Liu*

Department of Oceanography
National Sun Yat-sen University
Kaohsiung, Taiwan
lilian@mail.nsysu.edu.tw

Shell-boring organisms burrow into the shells of cultivated and wild bivalves, weakening the shell structure. Hence, bivalves spend extra energy to repair the drilled parts and allocate less energy for growth and reproduction. This issue is a severe concern, especially for economically important species. This study investigated temporal and spatial differences in macroborers' infestation of Portuguese oysters in Taiwan's farming areas. Macroborers (>100 μm), such as polychaetes and sponges, as well as microborers (<100 μm), have been found in oyster farming areas on the west coast of Taiwan. The most abundant macroborers were polychaetes. These boring polychaetes had U-shaped drilling channels and 8-shaped external openings.

The infection by boring polychaetes on oysters cultured for eight months could reach 100%. Two boring polychaete species exist in the cultural areas, i.e., *Polydora lingshuiensis* and *Polydora haswelli*. The infection rate was higher in the right valve. Sponge-drilled areas appeared as dense holes on the shell surface, and reticular canals were within the shell. In Qigu, the infestation rate of boring sponges on farming oysters was <33%, and a higher infestation rate on the left valve. The infection of farming oysters by macroborers was higher in 2022 than in 1990 in Qigu. We found negative correlations between shell-boring degree (i.e., 0, 1, 2) to shell density (1.86 – 1.66) and standardized condition index (0.84 – 0.64). Boring algae was also observed, but their impact on the oyster industry deserves further evaluation.

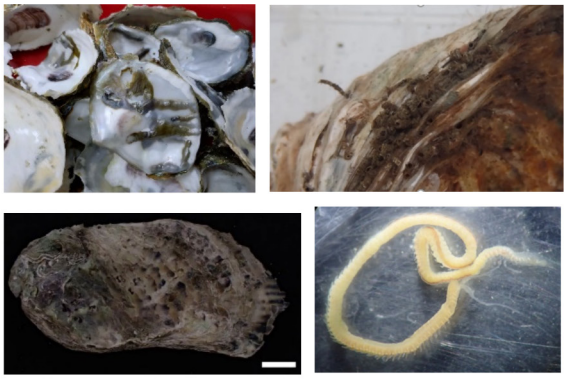


Fig. 1. Boring polychaetes in oyster shell.

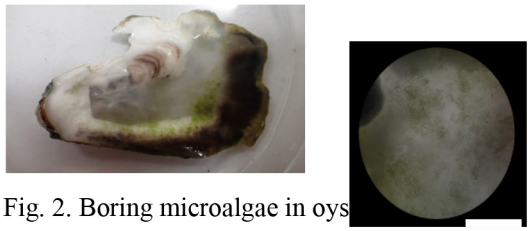


Fig. 2. Boring microalgae in oys

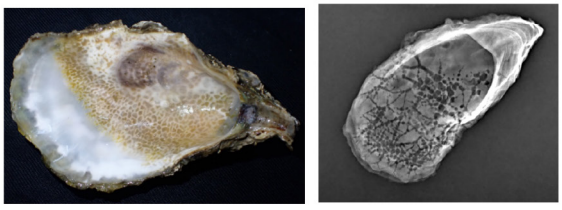


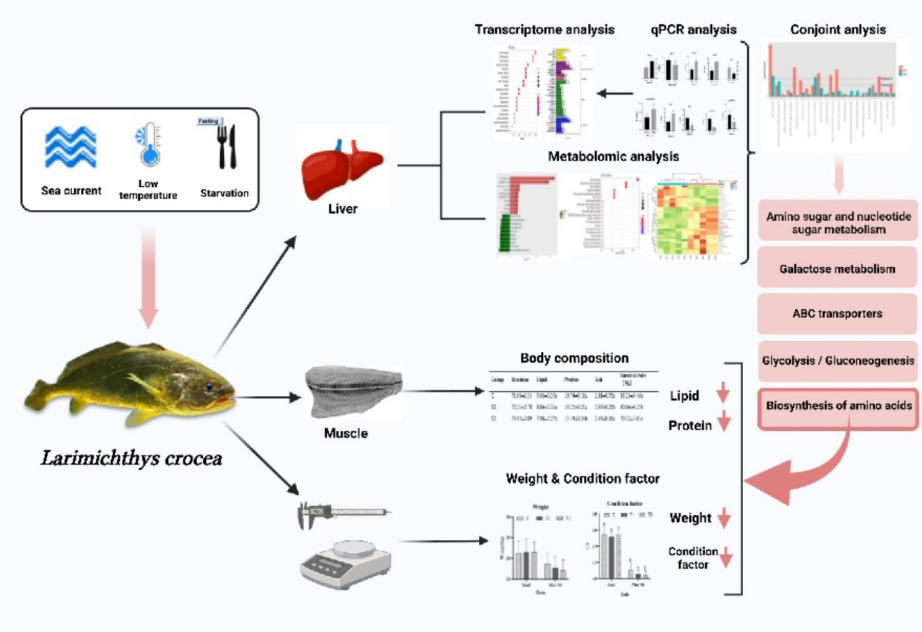
Fig3. Boring sponges in oyster shell.

INTEGRATION OF TRANSCRIPTOMICS AND METABOLOMICS ANALYSIS REVEALS THE EFFECTS OF SEA CURRENT ON OVERWINTERING OF LARGE YELLOW CROAKER *Larimichthys crocea* IN CAGE CULTURE

Huirong Lyu[1]*, Yang Gao[2],Jung-Yeol Park[1], Junwook Hur[1]

Department of Aquaculture and Aquatic Science
Kunsan National University
Gunsan 573-701, Korea
Lvhuirong1215@gmail.com

Three different mesh sizes: 0.5cm, 1.0cm and 2.0cm were set up, and 500 fish were put in each cage. The group with 0.5 cm mesh was used as the control group, and the other two groups were set as the experimental group T1 and T2. During the experiment, the water temperature was monitored daily and the water flow rate was monitored at the highest tide point of each month. At the end of the experiment, the body weight and length of the large yellow croaker were measured, muscles were taken for body composition analysis, and liver tissues were taken for transcriptome and metabolome analysis. The water temperature ranged from 8.5 to 12.5°C during the experiment period. The average sea current velocity in the three groups was 0.049m/s, 0.167m/s, and 0.286m/s respectively. The survival rates of large yellow croaker in the control, T1 and T2 groups were 85.25%, 80.66% and 70.32% respectively. The weight and condition factor of the fish decreased significantly in all groups. The lipid and protein contents of the fish in T2 group decreased obviously compared to the other two groups. Transcriptome analysis showed that the insulin pathway and FOXO pathway were related to the regulation of glycolysis/gluconeogenesis. PPAR signaling pathway was related to the regulation of lipid metabolism. The metabolome analysis revealed 663 significantly different metabolites in the two groups, of which 10 were significantly down-regulated, and 51 were significantly up-regulated. The combined analysis of transcriptome and metabolome showed that metabolites and genes were both significant in the ABC transporter pathway. This study indicated that lipids and proteins were consumed to provide energy. Insulin and PPAR pathway played important roles in regulating glucose and lipid metabolism. ABC transporter pathway may play an important role in the transport of small molecule substances and participation in energy metabolism during low-temperature exercise in large yellow croaker.



THE EFFICACY OF *Azolla pinnata* AS BIOFILTERS IN A RECIRCULATING AQUACULTURE SYSTEM

Norulhuda Mohamed Ramli*, Nursyafiqah Saji, Khairudin Nurulhuda, and Hazreen Harith

Department of Biological and Agricultural Engineering
Faculty of Engineering
Universiti Putra Malaysia
43400 UPM Serdang
Selangor, Malaysia
m_nurulhuda@upm.edu.my

A Recirculating Aquaculture System (RAS) represents an intensive aquaculture practice designed to minimize water changes by recirculating water, thereby ensuring optimal water quality for high-quality fish production. At the core of RAS is the biofilter, responsible for converting ammonia into nitrate through nitrification, contributing to the maintenance of favourable water conditions for fish culture. *Azolla pinnata*, a floating aquatic fern, serves as a phytoremediator in wastewater by assimilating inorganic nitrogen. As such, *A. pinnata* can serve as an additional biofilter in RAS, with added benefits for the agriculture industry as livestock feed.

This study aims to (1) measure the growth performance of *A. pinnata* in RAS and (2) assess the water quality in RAS with *A. pinnata* (RAS + AP) against RAS without *A. pinnata* (RAS - AP). Results from the experiments reveal a notable increase in biomass for *A. pinnata* within the RAS environment compared to a controlled setting. Meanwhile, the water quality in both (RAS + AP) and (RAS - AP) exhibits no significant difference ($P > 0.05$).

PROGRESS ON SEX DETERMINATION AND DIFFERENTIATION OF THE MUD CRAB (*Scylla paramamosain*)

Hongyu Ma *

Marine Biology Institute
Shantou University
Shantou 515063, China
mahy@stu.edu.cn

The mud crab (*Scylla paramamosain*) is a traditional marine fishery resource and mariculture crab species in China. It plays an important role in China's marine economic industry. There are significant differences between female and male crab, not only in morphological characteristics, nutritional value and market price, but also in genome and transcriptome.

We carried out a systematic study on the sex determination and differentiation of the mud crab, in order to reveal the differences between genders and the genetic mechanism of sex determination and differentiation. The phenotypic differences between male and female in the early stage were clarified by microscopic observation, which laid a foundation for the study of gender differentiation. The whole genome of mud crab was sequenced, and the chromosome level genome map was drawn (Figure 1). Thirteen female-specific SNP markers (female heterozygous and male homozygous) were identified, and a molecular technique for rapid identification of genetic sex was established. High-density genetic maps were constructed with the first-generation and second-generation families of *S. paramamosain* as the mapping populations, which located the sex determining region and sex-specific SNP markers. At the same time, another genetic map was constructed with the hybrid F_1 generation of hybrid family (*S. serrata* ♀ × *S. paramamosai*n ♂), which also located the sex determining region. The above findings suggest a ZZ/ZW chromosome sex determination system in the mud crab, and they could be helpful for better understanding the sex determination and differentiation mechanism of crabs.

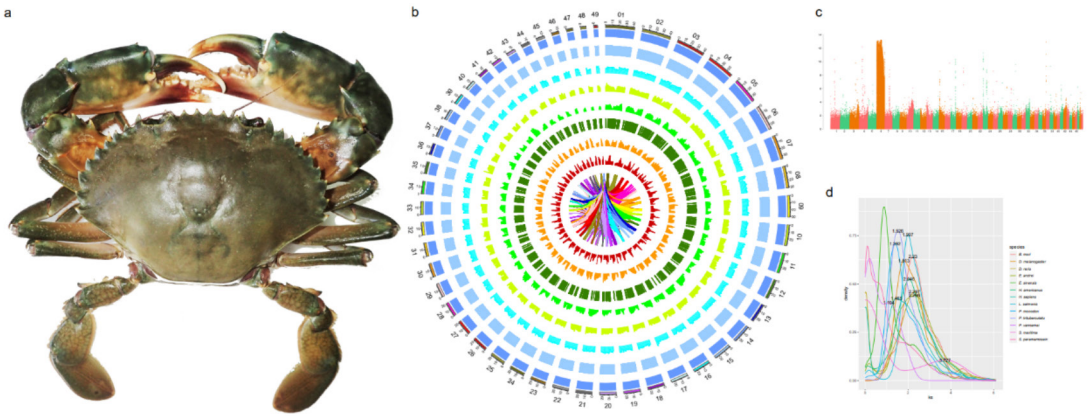


Figure 1 the mud crab and the chromosome level genome

MULTIPLE BENEFITS IN ONE SUPPLEMENT: PEPTIDOGLYCAN SUPPLEMENTATION PROMOTES GROWTH, CELLULAR ENERGY ALLOCATION, IMPROVES DIGESTION, AND ENHANCES WHITE SPOT SYNDROME VIRUS RESISTANCE OF JUVENILE *Penaeus monodon*

Emelyn Joy G. Mameloco*, Maila V. Pan, and Rex Ferdinand M. Traifalgar

Institute of Aquaculture, College of Fisheries and Ocean Sciences
University of the Philippines Visayas
Miagao, Iloilo, Philippines
egmameloco@up.edu.ph

The present work evaluated the immune-enhancing and growth-promoting effects of dietary peptidoglycan on black tiger shrimp (*Penaeus monodon*). Peptidoglycan was supplemented at levels of: 0.00, 0.10, 0.20, 0.40 g peptidoglycan kg^{-1} diet. The first feeding trial was conducted for 30 days to evaluate peptidoglycan supplementation on *P. monodon* immunological responses and disease resistance. Results showed that groups with 0.20 g peptidoglycan kg^{-1} diet exhibited highest survival in white spot syndrome virus challenge test which is linked to higher immunological responses. Another 60-day feeding trial was conducted to evaluate peptidoglycan influence on shrimp growth, nutrient retention, diet digestibility, digestive enzyme activities, and cellular energy allocation. Results indicate that supplementation of 0.20 g peptidoglycan kg^{-1} diet enhanced shrimp growth attributed to better feed conversion efficiency and lipid retention resulting from improved apparent dry matter digestibility of the diet, digestive enzyme activities, and cellular energy allocation. Collectively, the present data suggest the immunoprotective effects against WSSV infection and the elucidation of growth-promoting effects of 0.20 g peptidoglycan kg^{-1} diet in juvenile *P. monodon*.

SUPPLEMENTATION OF *Padina* POLYSACCHARIDE EXTRACT (PPE) PROMOTES GROWTH AND ENHANCES THE SURVIVAL OF JUVENILE *Penaeus vannamei* AGAINST *Vibrio parahaemolyticus* INFECTION

Emelyn Joy G. Mameloco*, Jenny Vi G. Odonzo, and Rex Ferdinand M. Traifalgar

Institute of Aquaculture
College of Fisheries and Ocean Sciences
University of the Philippines Visayas
Miagao, Iloilo, Philippines
egmameloco@up.edu.ph

The emergence of Early Mortality Syndrome (EMS) or Acute Hepatopancreatic Necrosis Disease (AHPND) has impacted the shrimp industry severely affecting *Penaeus vannamei* and *Penaeus monodon* production. This study evaluates the effect of *Padina* polysaccharide extract (PPE) as dietary immunostimulant in juvenile *Penaeus vannamei*. Shrimps were distributed to twelve 54 L aquaria at a density of 20 shrimps per container and were fed with experimental diets. Test diets were added with the following test concentrations: Control (no inclusion), T1 (0.05 $g.kg^{-1}$ PPE), T2 (1.0 $g.kg^{-1}$ PPE), and T3 (2.0 $g.kg^{-1}$ PPE). The 30-day feeding trial resulted to improved growth and survival in treatments fed with PPE. Infection challenge test with *Vibrio parahaemolyticus* through oral administration showed that shrimps fed with PPE has elicited higher survival particularly the treatment that received 2.0 $g.kg^{-1}$ PPE. The control group exhibited the lowest survival (28%) after the challenge test. Immune indices such as total hemocyte count (THC), pro-phenoloxidase activity (pro-PO) and serum antibacterial activity was significantly high in groups receiving PPE. The present results suggest that supplementation of Padina polysaccharde extract (PPE) can enhance resistance of juvenile *Penaeus vannamei* against *Vibrio parahaemolyticus* infection.

HEPATOPANCREATIC MICROSPORIDIASIS CONTROL USING ALBENDAZOLE IN VANNAMEI SHRIMP (*Litopenaeus vanname*) CULTURE AT BALAI LAYANAN USAHA PRODUKSI PERIKANAN BUDIDAYA (BLUPPB) KARAWANG

Endah Mardiastuti *, Atri Triana K. , Widya Puspitasari

Balai Layanan Usaha Produksi Perikanan Budidaya (BLUPPB) Karawang
Desa Pusakajaya Utara, Kecamatan Cilebar, Kabupaten Karawang, Jawa Barat
Satker_bluppb.karawang@kkp.go.id.

Hepatopancreatic Microsporidiasis disease caused by *Enterocytozoon hepatopenei* (EHP) has attacked several world shrimp producing countries such as Thailand, China, Vietnam, Malaysia and Indonesia. The presence of EHP can cause shrimp to experience growth disorders until death. If not treated properly, this disease can cause considerable economic loss for farmers. Until now the right treatment has not been found, the control can be done are aplication of biosecurity and giving vitamins and maintaining stable water quality.

Albendazole was chosen as a trial material because in the fisheries sector and also in human health, this drug has been used for the treatment of microsporidia. This trial was conducted to determine its effect on shrimp infected with EHP. The trial of giving Albendazole with a dose 2 gr/kg of feed given to vannamei shrimp that was positively infected with EHP was carried out for 80 days of rearing and 1 pond as a control without Albendazole administration. Observations were made on the parameters of growth weight, length, uniformity, behavior and response of shrimp. In addition, PCR test and water quality tests were also carried out.

Albendazole administration had a significant effect on shrimp. Shrimp weight and length were better than control shrimp. The PCR results against EHP also showed a decrease in the attack rate seen in the PCR band, where at the beginning of stocking (PL 10) 3 DNA bands were read and at the end of the rearing period only one DNA band was visible. From the trials conducted, Albendazole can be used to suppress the development of EHP, but further, more comprehensive studies on albendazole are needed to treat EHP.

ASSESSMENT OF FOUR INERT DIETARY MARKERS FOR THE ESTIMATION OF APPARENT DIGESTIBILITY COEFFICIENTS IN PRACTICAL DIETS FOR WHITE LEG SHRIMP *Litopenaeus vanamei* Boone, 1931

Raquel Serrano, Yosu Candela, Ana Tomás-Vidal, David S. Peñaranda, Ignacio Jauralde, Miguel Jover-Cerda, Laura Carpintero, Juan S. Mesa, José L. Limón, Javier Dupuy, Andrés Donadeu, Guillermo Grinday, Judit Macías-Vidal, Silvia Martínez-Llorens*

*silmarll@dca.upv.es
Cm de vera, s/n. 46022. Spain
Universitat Politècnica de València

The validity of using inert markers in digestibility studies must not metabolized, absorbed or disrupt in the digestive process or gut microbiota; and should have the same kinetics through the gut, as the rest of nutrients of diet. The identification of P sources and their bioavailability in *Litopenaeus vannamei* diets assumes critical importance due to consequences of excessive phosphorus loads, but to assess the bioavailability of N or P, first it is necessary to establish the ideal marker for each species. Previous studies in fish (Fernandez et al., 1999) reported that Ca or P differed according the chromic oxide dietary concentrations. Furthermore, dietary chromic oxide has been reported to pass through the gastro-intestinal tract at a different rate than nutrients. Thus in present study four inert markers were compared to select the optimal to evaluate the digestibility in shrimp feeds and then to validate to evaluate the digestibility with different P sources dicalcium (DCP), monocalcium (MCP), monoammonium (MAP), and monopotassium phosphates (MKP) in practical diets.

With this aim four trials were carried out: First and second trials were developed to establish the best inert marker (IM) for digestibility evaluation using four inert markers in a standard diet (Cr, Y, La and Ce) analyzing the diet digestibility and the inert marker retention in whole body, cephalothorax, and muscles (with and without intestine). Some accumulation of Cr was detected in the shrimp whole body, particularly in the cephalothorax. Furthermore, following a square Latin design it can observed an accumulation of Cr in the different tanks. Clear differences were observed in the accumulation of the inert marker in the shrimps with and without intestine. The third and fourth trial were carried out to assess the P use of three P sources: monoammonium phosphate (MAP, $NH_4H_2PO_4$), monosodium/monocalcium phosphate (SCP-2%, $NaH_2PO_4/Ca(H_2PO_4)_2 \cdot H_2O$ in proportion 12/88) and monosodium phosphate (MSP, NaH_2PO_4) using a Control diet without P supplement.

Regarding the IM results, Y resulted the best option to establish the digestibility due to the high solubility after acid digestion and the lowest Y retention in the shrimp whole body when was compared with the other markers. In the digestibility trial (*Table 1*) Control diet obtained the lowest P digestibility, because raw materials had lower P digestibility than the P from inorganic phosphates. Likewise, diet SCP-2% presented the best Ca digestibility values. The excretion of N or P did not present significant relevant differences, but when P and N excretion and retention was evaluated jointly with P and N digestibility the SCP-2% diet generated the lowest N waste in relation to the N intake. The MAP diet presented the highest amount of N residues due to N excretion, that was greater than in the rest of the diets, followed by the control diet.

Fernandez, F., Miquel, A.G., Martinez, R., Serra, E., Guinea, J.,Narbaiza, F.J., Caseras, A. & Baanante, I.V. (1999) Dietarychromic oxide does not affect the utilization of organic compo-nents but can alter the utilization of mineral salts in gilthead seabreamSparus aurata.J. Nutr.,129,1053–1059

Table 1. Apparent digestibility of diets (%) and inorganic phosphates used.
Values are the mean (n=4) ± standard error (SE). Different superscripts in the same row indicate significant statistical differences with p<0.05. Newman-Keuls test.

ADC (%)	**Control**	*SE*	**MAP**	*SE*	**SCP-2%**	*SE*	**MSP**	*SE*
Dry matter	75	3	77.2	1.4	74.7	1.4	75	2
Protein	67.2	1.0	67	2	66.6	1.1	66.3	1.9
P	75.4^{a}	1.2	84.3^{b}	0.3	84.3^{b}	0.4	86^{b}	0.4
Ca	34^{a}	3	40^{ab}	0.9	55^{c}	0.6	42^{b}	4
P source digestibility								
P			96.1^{a}	0.6	96.1^{a}	1.0	100.0^{b}	1.0
Ca					93.1	0.8		

EFFECT OF FISHMEAL SUBSTITUTION ON INTESTINAL TRANSCRIPTOME OF *Liza aurata* REARED IN RECIRCULATION AQUACULTURE SYSTEM (RAS)

Ruben Olivares-Perona, Jessica Brol, Ignacio Jauralde, Miguel Jover, Ana Tomás-Vidal, David S. Peñaranda, Silvia Martínez-Llorens*

Universitat Politècnica de València
Camino de Vera s/n, 46022
*Presenting author's: silmarll@upvnet.upv.es

Introduction: The current challenge in aquaculture revolves around the quest for new, economically, and environmentally sustainable species. Species occupying lower trophic levels, such as *Liza aurata*, may represent promising candidates for aquaculture. Nevertheless, when formulating diets with high or total fishmeal substitution, it can potentially influence their growth and health status (Estruch et al. 2015). Thus, in this study the growth and health status through the transcriptome of posterior intestinal section was assessed in *Liza aurata* fed with two experimental diets containing 15% and 0% of fishmeal.

Material and Methods: Sixty *Liza aurata* (9.14 ± 1.52 g) were randomly distributed in 6 tanks of 600 L (0.9kg/m^3) under recirculation system. Two different diets, with 15% (HP15) and 0% (HP0) fishmeal inclusion, were tested in triplicate. Monthly sampling was carried out to analyse fish growth and survival and specific growth rate (SGR), daily feeding rate (FIR) and feed conversion ratio (FCR) were calculated. Once was finished the trial, 5 fish from each treatment were slaughtered, beyond 5 initial fish, in order to assess the transcriptome of posterior intestinal section (FISABIO, Spain). We focused on transcripts with a padj value of less than 0.05. Enrichment analysis of GO and KEGG terms was conducted using the Fisher Exact Test.

Results and discussion: Fish weight Gain, SGR and FCR showed significant differences (Table 1), indicating improved growth in the diet with higher fishmeal content. Despite being an omnivorous species, juvenile stages exhibited more carnivorous feeding habits.

Confirming these results, the intestinal transcriptome provided a total of 321 differential expressed transcripts (DETs). From the comparison HP0 vs HP15, 207 and 114 were were down and up-regulated, respectively. After GO enrichment analysis, results showed that 4 biological processes (BP) were significantly affected by the rearing conditions, mainly related to cell proliferation. Besides, KEGG analyses revealed 7 disturbed pathways, related to cellular proliferation and metabolism, particularly, protein digestion and absorption (ko04974). Therefore, a differential intestine expression was reported based on rearing conditions. In conclusion, relative high fishmeal requirements seem to be necessary in *Liza aurata* at juvenile state.

Acknowledgments
This work was supported by Generalitat Valenciana (GVA AICO/2021/198). J. Brol has a predoctoral grant from Generalitat Valenciana (Programa Santiago Grisolía 2021; CIGRIS/2021/109). R. Olivares-Perona has a technician contract was funded by European Union Next Generation-Plan de Recuperación-Ministerio de Ciencia e Innovación-Gobierno de España (TED2021-129272B-C21).

REARING OF *Mugil cephalus* IN BIOFLOC SYSTEM WITH LIGHT RESTRICTION AND USE OF PROBIOTIC: EFFECT ON ZOOTECHNICAL PERFORMANCE

Jessica Brol, David S. Peñaranda, Tatiana Cascales, Mikel Girotto, Xavier Lekube, Markel Sanz-Latorre, Ana M. Marhuenda, Pablo Sánchez-Jerez, Joao Rito, Ruben Olivares-Perona, Wilson Wasielesky, Ana Tomás-Vidal, Silvia Martínez-Llorens*

Universitat Politècnica de València
Camino de Vera s/n, 46022
*Presenting author's: silmarll@upvnet.upv.es

Introduction: To achieve a sustainable Mediterranean aquaculture production, it is necessary to increase the production of low trophic species, such as *Mugil cephalus*, combined with aquaculture systems with low environmental impact, like Biofloc Technology (BFT). BFT is characterized by its minimal use of water, in which bacteria and other aggregates of microorganisms recycle nutrients, maintain water quality, and provide food for the animals. The objective of the present study was to evaluate the light restriction (24h darkness), use of probiotics, and interaction between these variables on the zootechnical performance of *M. cephalus* reared in BFT.

Material and Methods: For the experiment, 180 animals with an initial weight of 91.73 ± 22.4 grams were randomly distributed in 12 circular tanks of 800L of water (initial:150-200 mg/L of total suspended solids (TSS)). In order to study the light restriction and use of probiotics (Sanolife PRO-W *Bacillus subtilis* and *B. licheniformis*, 1g/m^3 per week), 4 treatments were proved: 12-hour photoperiod (Light); light restriction (24h darkness; Dark); 12-hour photoperiod + probiotic (Light+Prob); and light restriction + probiotic (Dark+Prob). A commercial feed (DIBAQ - 3.5 mm for tilapia) with 30% crude protein and 7% crude fat was provided three times daily at a 2 %/d feeding rate.

Results and discussion: The results of the zootechnical parameters are described in Table 1. The different treatments showed no effect on the survival of *M. cephalus*, which was around 100% in all of them. Moreover, the treatments with the presence of light showed the highest feed conversion ratio (FCR), 12.42 ± 1.80 and 11.04 ± 2.25, and lowest specific growth rate (SGR), 0.18 ± 0.03 and 0.19 ± 0.04 to Light and Light+Prob, respectively.

On the other hand, although no significant differences were found in TSS among light and dark conditions, in general, higher values were registered in dark groups, what may have contributed to the better FCR and SGR of these treatments. Probiotics can stimulate the activity of digestive enzymes and thus promote better weight gain. This aspect, combined with the greater bacterial growth (higher TSS values) due to the darkness conditions, may have contributed to the good performance of the animals in the Dark+Prob treatment.

Acknowledgments: This work was supported by European Union Next Generation-Plan de Recuperación-Ministerio de Ciencia e Innovación-Gobierno de España (TED2021-129272B-C21), and Conselleria d'innovació, Universitats, Ciència i Societat Digital of Generalitat Valenciana (GVA AICO/2021/198). J. Brol has a predoctoral grant from Generalitat Valenciana (Programa Santiago Grisolía 2021; CIGRIS/2021/109). R. Olivares-Perona has a technician contract was also funded by TED2021-129272B-C21. T. Cascales contract was supported by European Union Next Generation-Plan of Conselleria d'innovació, Universitats, Ciència i Societat Digital of Generalitat Valenciana (INVEST/2022/434).

EFFECT OF *S. platensis* AS AN ADITIVE IN EXPERIMENTAL DIETS ON THE GROWTH OF WHITELEG SHRIMP (*L. vannamei*)

Yosu Candela Maldonado, Wilson Wasielesky, Marcelo Borges Tesser, Ivanilson Lima Santos, David Sánchez Peñaranda, Ignacio Jauralde García, Silvia Martínez-Llorens*, Luís Henrique Poersch

silmarll@dca.upv.es
Universitat Politècnica de València

In aquaculture, feed additives have proved to be a more than useful tool as immune stimulants to improve intestinal health, stress, and disease resistance among other effects. Furthermore, *S. platensis* as an additive it has been shown to reinforce the immune system of shrimp and improve nutrient bioavailability. Microalgae, in particular *Spirulina platensis*, possess high protein content and an ideal amino acid profile, comparable to the amino acid profile of marine protein sources origin such as fish meal (Li *et al*., 2022). Thus, present study aims to investigate the use of extract spirulina additive inclusion of standard commercial shrimp diets and the effect on their shrimp growth.

Considering the goal of the experiment, a 35-day growth trial was carried out using a *Spirulina platensis* extract as an additive in 4 different diets (SP05, SP1, SP2 AND SP4) with 4 spirulina dietary inclusion (0.5 %, 1, 2 and 4 % of spirulina extract, respectively) and with a control (CON) diet without additive. All diets were assayed in triplicated tanks (15 animals per tank) in an open system with clear water. Diets were designed using a standard commercial formulation with a protein percentage of 33%. Sampling was carried out every 15 days and the increase in biomass and survival of each treatment were monitored. Also, water quality parameters were measured and stable in all experimental tanks.

At the end of growth trial, no significant differences were only found in final average biomass (Table 1). On the other hand, in the statistical analysis of survival, no significant differences were found either. The dietary inclusion of spirulina did not have significant effect on survival data. Nevertheless, a quadratic trend has been observed between *S. platensis* dietary inclusion and growth and nutritive parameters, being the optimal microalgae inclusion around 0.5%.

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PRODUCTION EFFICIENCY OF QUALITY KOTONI SEAWEED (*Kappaphycus alvarezii*) SEEDS THROUGH TISSUE CULTURE SEED MAINTENANCE MANAGEMENT WITHOUT ADDING FERTILIZER

Marwa*, Kalasum Tuankotta dan Suwirda

Balai Perikanan Budi Daya Laut Ambon
Jl. Leo Wattimena, Ambon
e-mail: ambonbpbla@gmail.com

Seaweed seeds resulting from tissue culture are quality seeds because they have a fast growth rate, are tolerant of environmental changes such as salinity, have a high carrageenan content and are more resistant to disease than conventional seeds. However, the cost of producing tissue culture seaweed seeds is very expensive, one of which is the use of chemicals as fertilizer as a source of nutrition for growth because in controlled cultivation generally fertilizer is added to the media to optimize growth. Meanwhile, sea water as a cultivation medium naturally contains nutrients needed by marine organisms. Therefore, seaweed seed culture was carried out without adding fertilizer to produce efficient seaweed culture management in the laboratory and to determine its durability in the acclimatization phase outside the laboratory. This activity uses young seaweed seeds (Planlets) kotoni (K. alvarezii) resulting from tissue culture which are cultured with 3 treatments and 3 replications, namely: 1) 7 Day Sub Culture Fertilizer, 2) Without Fertilizer, 3 Day Sub Culture and, 3) Without Fertilizer Sub Culture 7 Days. Stocking density is 10 individuals per liter for 9 weeks in the Lab. BPBL Ambon Seaweed Kuljar, then the plantlets were transferred to the aquarium in the greenhouse as seeds from using fertilizer (P20) and without fertilizer (P0) to determine the resistance of the seeds during acclimatization outside the laboratory. The results of variance analysis showed that the highest LPH in the laboratory was obtained in the 3 day Without Sub Culture Fertilizer treatment, namely 7.04 ± 0.25% which was significantly different ($P<0.05$) from the 7 Day Sub Culture Fertilizer treatment (4.67 ± 0.18%) and Without Fertilizer 7 Day Sub Culture (3.19 ± 0.27%), and efficiency occurred because the highest LPH occurred in cultures that did not use chemicals during culture. However, for seedling survival in the acclimatization phase, seedlings from cultures without fertilizer only survived for 2 weeks because they all experienced death/bleaching, while seedlings from those using fertilizer survived until harvest (6 weeks) with a growth rate of 3.47%. Thus, plantlet culture without fertilizer with a sub-culture time of 3 days is a culture management that increases the efficiency of tissue culture seed production. However, to move to the next phase, treatment is needed to increase SR in the acclimatization phase.

TREATMENT OF KOTONI SEAWEED SEEDS (*Kappaphycus alvarezii*) RESULTS OF PRE-ACCLIMATIZATION TISSUE CULTURE IN THE GREENHOUSE FOR CONTINUITY PRODUCTION OF QUALITY SEEDS

Marwa* dan Kalasum Tuankotta

Balai Perikanan Budidaya Laut Ambon
Jl. Leo Wattimena, Ambon
e-mail: ambonbpbla@gmail.com

Seaweed seeds are really needed to meet the needs of seeds for community cultivation activities, both in terms of quantity and quality in a sustainable manner. Tissue culture seeds are quality seeds produced in the laboratory, and one of the factors that determines the continuity of production is the ability of the seeds to adapt to the acclimatization phase outside the laboratory. Based on the results of previous trials, the culture of young seaweed seedlings resulting from tissue culture (plantlets) without fertilizer in the laboratory gave the highest LPH, namely 7.05 ± 0.25%, but was weak when acclimatized in the greenhouse, while culture without fertilizer in the laboratory was more efficient than using fertilizer. Therefore, this activity was carried out to find a method for pre-acclimatization treatment of cultured plantlets without fertilizer that can increase the growth and survival of plantlets in the acclimatization phase to ensure the continuity of quality seeds for cultivation. This activity uses kotoni plantlets (K. alvarezii) cultured without fertilizer in the laboratory, where the plantlets are divided into two for treatment, namely: A1. Culture was continued without fertilizer and A2. The culture was given additional fertilizer, which was carried out for 2 weeks in the laboratory. After that, the culture was continued in 2 aquarium units in the greenhouse for acclimatization, where both cultures were given the same treatment, namely the circulation system. The results obtained showed that the LPH of plantlets that were given additional fertilizer during the treatment period (2 weeks) was higher, namely 4.64% and during acclimatization in the greenhouse for 6 weeks, had an LPH of 4.10% with an SR of 100%. Meanwhile, the LPH of seedlings without the addition of fertilizer during the treatment period was 1.94%, and experienced bleaching/complete death in the 2nd week of acclimatization in the greenhouse. Thus, the treatment method of adding fertilizer to plantlet culture without fertilizer for 2 weeks in the laboratory before acclimatization in the greenhouse, has been proven to increase the growth and SR of seaweed seedlings in the acclimatization phase, thereby supporting the efficiency and continuity of production of quality kotoni seaweed seedlings.

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OPTIMIZATION OF CALANOID COPEPOD, *Pseudodiaptomus* sp. MASS CULTURE IN DIFFERENT SALINITY AND TEMPERATURE

N.Nadiah Masrialah,* F.M. Yusoff, I. Natrah, W.A.D. Umi, S.A.R Balqis, M.Z. Hassan, F. Mohamat-Yusuff

International Institute of Aquaculture and Aquatic Sciences (I-AQUAS)
University Putra Malaysia
Lot 960 Jln Kemang 6
71050 Port Dickson
Negeri Sembilan. Malaysia
nurulnadiahmasrialah@gmail.com

Copepods, a member of zooplankton group, hold a critical role in aquaculture due to their varied sizes and valuable nutritional attributes. A calanoid copepod, *Pseudodiaptomus* sp. is widely used as live food for the rearing of various economically significant fish larvae. Nevertheless, the density and overall biomass of *Pseudodiaptomus sp*. in aquaculture ponds often remain low.

The objective of this study is to investigate the optimal culture conditions for the growth *Pseudodiaptomus* sp. at different salinity and temperature. The species was exposed to different ranges of salinity (15ppt, 20ppt, 25ppt, 30ppt, 35 ppt and 40ppt) and temperature (14, 18, 22, 26, and 30 □) using the Heat Exchanger Fouling Test Unit System that was facilitated from Japan by SASTREPS-OTEC Project in I-AQUAS as the culture water. All copepods were reared in 1-litre beakers over 21 days, under a 12-hour light and 12-hour dark photoperiod, stocked at a rate of 20 gravids per litre. Throughout the experiment, the copepods received twice-daily feedings of *Pavlova* sp. for 21 days. The population density of *Pseudodiaptomus* sp. was monitored and assessed based on the number of nauplii, copepodites, and adults every two days.

At a salinity level of 25ppt (Table 1), *Pseudodiaptomus* sp. exhibited a significantly higher total population and specific growth rate. Changes in salinity levels had a profound impact on the speed of population growth among calanoid copepods. At 40 ppt, it was observed that copepod population reduced to only 10 individuals per liter. On the other hand, the temperature experiment showed the greatest population density observed at 26°C (Table 2). High copepod mortality was observed in the treatment of 30°C on the 12th day, while at 14°C, survival was limited to only 8 days. These findings suggested a combination of 26°C water temperature and 25ppt salinity as the optimum parameter for the development of a sustainable mass culture of this calanoid species as live food in hatcheries.

Table 1: Mean±SE of Population Density, Specific Growth Rate, and Doubling time of *Pseudodiaptomus* sp. Growth under different salinities.

Salinity (ppt)	Parameters measured		
	Total Population Density (ind/L)	Specific Growth Rate (K)	Dt (days-1)
15	67±12	0.0555±0.0399	12.5±0.07
20	203±37	0.1302±0.0045	5.3±0.17
25	560±30	0.2588±0.0046	2.6±0.05
30	217±42	0.1568±0.0195	4.4±0.04
35	17±3	0.1108±0.0231	6.3±0.02
40	10	*	*

* denotes no data

Table 2: Mean±SE of Population Density, Specific Growth Rate, and Doubling time of *Pseudodiaptomus* sp. Growth under different temperature.

Temperature °C	Parameters measured		
	Total Population Density (ind/L)	Specific Growth Rate (k)	Dt (days-1)
14	0	*	*
18	10	*	*
22	253±33	0.0629±0.0356	11.0131±0.67
26	1679±60	0.1325±0.0269	5.2314±0.14
30	0	*	*

* denotes no data

ANTIBIOTIC RESISTANCE GENE-FREE PROBIONT ADMINISTRATION TO TILAPIA FOR GROWTH PERFORMANCE AND *Streptococcus agalactiae* RESISTANCE

Mira Mawardi*, Agustin Indrawati, Angela Mariana Lusiastuti, and I Wayan Teguh Wibawan

Main Center for Freshwater Aquaculture
Ministry of Marine Affairs and Fisheries
Jl. Selabintana No. 37, Selabatu, Kec, Cikole
Kota Sukabumi, Jawa Barat 43114, Indonesia
miramira@apps.ipb.ac.id
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The rapid development of aquaculture as a major food sector is accompanied by challenges, including diseases that affect tilapia farming worldwide. One such infectious disease caused by *Streptococcus agalactiae* poses a serious threat to tilapia populations. Probiotics have emerged as a potentially safe preventive measure against *S. agalactiae* infection. However, antimicrobial resistance from antibiotic-resistant bacteria remains a concern because it can lead to the spread of resistant bacteria and serve as a reservoir of antibiotic-resistant genes in fishes and the surrounding environment. This study aimed to identify candidate probiotic bacteria capable of promoting tilapia growth, providing resistance to *S. agalactiae* infection and free from antibiotic resistance genes. *Lactococcus garvieae, Priestia megaterium, Bacterium* spp., *Bacillus megaterium, Bacillus subtilis,* and *Bacillus pumilus* were examined to assess their antibacterial properties, hemolytic patterns, and antibiotic resistance genes. The specific primers *tetA*, *tetB*, *tetD*, *tetE*, *tetO*, *tetQ*, *ermB*, and *qnrS* that were used for antibiotic resistance gene detection. *In vivo* probiotic efficacy was evaluated by administering probiotic candidates in tilapia feed at a concentration of 1×10^6 colonies/mL/50 g of feed over a 60-day maintenance period. Resistance to *S. agalactiae* infection was observed for 14 days after the challenge test. The selected probiotic candidates, *L. garvieae*, *P. megaterium,* and *Bacterium* spp. demonstrated the potential to enhance tilapia growth, exhibited no pathogenic tendencies, and were free from antibiotic resistance genes.

Probiotics, particularly *L. garvieae, P. megaterium*, and *Bacterium* spp., enhance growth and resistance against *S. agalactiae* infection, without harboring antibiotic resistance genes. Selecting probiotic candidates based on antibiotic resistance genes is essential to ensure the safety of fish, the environment, and human health. This study concludes that *L. garvieae*, *P. megaterium,* and *Bacterium* spp. fulfilled the requirements to be considered probiotic candidates. These candidates have antibacterial properties, do not have the potential to become pathogens, and do not contain antibiotic-resistant genes. *Bacterium* spp. and *L. garvieae* supplemented in tilapia feed demonstrated improved growth, hematological parameters, non-specific immune system parameters, and increased resistance to *S. agalactiae* infection in tilapia.

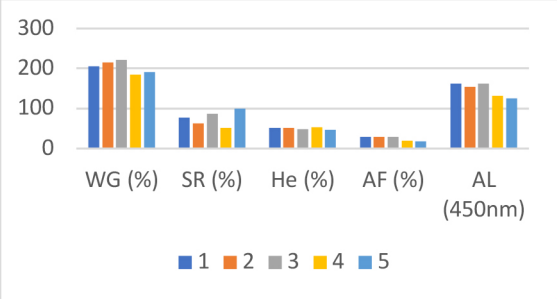


Figure 1. WG: Weight gain, SR: Survival rate, He: Hematocrit, AF: Phagocytic activity TL: Total leukocyte. (1) L. garvieae (2) P. megaterium (3) Bacterium spp (4) Negative control (5) Positive control

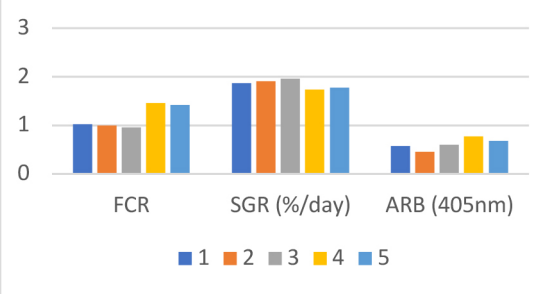


Figure 2. FCR: Feed conversion ratio, SGR: Specific growth rate, ARB: Respiratory burst activity

ANTIMICROBIAL SUSCEPTIBILITY TEST AND ANTIMICROBIAL RESISTANCE GENE DETECTION OF EXTRACELLULAR ENZYME BACTERIA ISOLATED FROM TILAPIA (*Oreochromis niloticus*) FOR PROBIOTIC CANDIDATES

Mira Mawardi*, Agustin Indrawati, I Wayan Teguh Wibawan, and Angela Mariana Lusiastuti

Main Center for Freshwater Aquaculture
Ministry of Marine Affairs and Fisheries, Jl. Selabintana No. 37
Selabatu, Kec, Cikole, Kota Sukabumi, Jawa Barat 43114, Indonesia
miramira@apps.ipb.ac.id
www.doi.org/10.14202/vetworld.2023.264-271

Antimicrobial resistance (AMR) is a global problem that can increase mortality and morbidity rates and adversely affect health. Therefore, AMR control must be carried out in various sectors, including the fisheries sector, using probiotics. Bacteria can become resistant to antibiotics, including bacteria used for probiotics. This study aimed to isolate bacteria as potential producers of extracellular enzymes, phenotypic characterization, and antibiotic-resistant gene patterns. In this study, 459 bacterial isolates were isolated from the stomach of tilapia in Indonesia. Tilapia was obtained from Sukabumi, Ciamis, Serang, Banjarnegara, Jayapura, Sorong, Manokwari Selatan, Takalar, Lampung, Batam, and Mandiangin. Enzymatic bacteria were identified. An antimicrobial susceptibility test was conducted by agar disk diffusion, and genotypic detection of encoding genes was performed using a molecular method. This study obtained 137 isolates (29.84%) that can produce extracellular enzymes.

The highest number of erythromycin sensitive isolates was found, including 130 isolates (94.89%). Six isolates (6/137) can produce four enzymes (amylase, protease, cellulose, and lipase), and they were sensitive to antibiotics. A total of 99 isolates can produce extracellular enzymes, and they were sensitive to antibiotics. Such isolates serve as a consortium of probiotic candidates. The isolates that are resistant to oxytetracycline (OT), erythromycin (E), tetracycline (TE), and enrofloxacin (ENR) included 15 isolates (10.95%), seven isolates (5.11%), three isolates (2.19%), and one isolate (0.73%), respectively. In addition, four isolates (2.92%) were detected as multidrug-resistant. The *tet*(A) gene obtained the highest result of detection of resistance genes in isolates that were intermediate and resistant to TE and OT. Isolates that serve as ENR intermediates have a high *qnr*(S) resistance gene. The data in this study provide the latest update that bacteria can serve as a consortium of potential probiotics with antibiotic-resistant genes for the treatment of fish. Bacteria that are intermediate to antibiotics may contain resistance genes. The results of this study will improve the policy of probiotic standards in Indonesia. This study indicated that the potential bacteria as producers of extracellular enzymes that could be used as candidates for the probiotic consortium were detected to be antibiotic-resistant; TE, OT, ENR, E, and multidrug resistance were found. Bacterial isolates can be used as extracellular enzymes and candidates for probiotic consortium, and they are sensitive to antibiotics. Probiotics that contain bacteria that are not resistant or intermediate to antibiotics can be applied for the future safety of aquaculture and the environment. Future studies must include pathogenesis testing, acid resistance, bile testing, and the application of a consortium of probiotic candidate bacteria obtained from this study to fish.

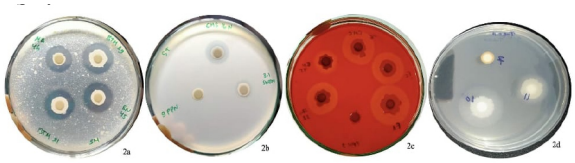


Figure of zone diameter of isolated bacteria (mm) (a) proteolytic, (b) amylolytic, and (c) cellulolytic is the diameter zone seen after incubation and then stained with Congo red (d) lipolytic activities.

CHARACTERIZATION OF SPORE-FORMING BACTERIA ISOLATED FROM TILAPIA (*Oreochromis niloticus*) AND THEIR POTENTIAL FOR A PROBIOTIC CANDIDATE

Mira Mawardi* , Agustin Indrawati , Angela Mariana Lusiastuti and I Wayan Teguh Wibawan

Main Center for Freshwater Aquaculture
Ministry of Marine Affairs and Fisheries
Jl. Selabintana No. 37, Selabatu, Kec
Cikole, Kota Sukabumi, Jawa Barat 43114, Indonesia
miramira@apps.ipb.ac.id
http://dx.doi.org/10.15578/iaj.18.2.2023.105-114

Gram-positive spore bacteria are widely used as probiotics in general sectors. However, there are still limited bacterial isolates as probiotic candidates available from indigenous isolates, especially in aquaculture. This study aimed to obtain potential spore-forming isolates as probiotic candidate for tilapia. Tilapia fish samples were collected from Sukabumi, Ciamis, Serang, and Papua. Bacterial isolates were isolated from the digestive tract of tilapia. Bacteria were identified based on their morphological, molecular characteristics, complete genome composition, and cell surface identification based on hydrophobic properties. In this study, six bacteria were isolated and identified by molecular characteristics using 16S rRNA sequences. Based on the phylogenetic analysis, the 9 PP isolate was *Priestia megaterium* basonym: *Bacillus megaterium*, CMS 16N isolate was *Brevibacillus halotolerans*, PPN 10 isolate was *Bacillus* sp., 3.1 SKBM isolate was *Bacillus mycoides*, CMS 22 N and SRG32 isolate were *Bacillus subtilis*. Six bacteria had different phenotypicals, ATGC sequence compositions, and a higher proportion of total G~C sequence composition above 50%. The coherent cell surface hydrophobicity test was positive on the SAT, SA, AA, and compact growth patterns in soft-agar media for 9 PP, CMS 22 N, and SRG32 isolates. From our study, the indigenous spore-forming bacteria isolated from tilapia stomachs are enzymatic bacteria, which have a strong attachment to host tissue and high potential as a probiotic candidate for fish. Various hydrophobicity test results from each isolate indicate that the protein composition in the cell surface is different.

Based on the characteristics of the hydrophobic cell surface and complete genome discovered in this present study, six bacteria are qualified as probiotic candidates for fish by having SAT, SA, AA, and polystyrene materials specific.

The complete sequence composition of six isolates showed the different amount of ATGC. The results demonstrated the highest G~C sequencer composition of six isolates above 50% where, the CMS 22N and SRG 32 isolates had the highest value of 55.3%. According to Garg & Sharma (2020), the C phosphodiester G Island (CpGI) sequence is a DNA sequence region in DNA that has a minimum concentration of G~C of 50%. The CpG DNA is well-known as adjuvant immunity (Xue et al., 2019).

Table 1. Characterization of ATGC, % G~C and identification of bacteria

Isolate	A	T	G	C	% G~C	Genotypic identification	
9 PP	314	389	347	464	53.6	*Priestia megaterium*	100% OM910720.1
CMS 16 N	301	376	359	476	55.2	*Brevibacillus halotolerans*	99.07% LT745980.1
3.1 SKBM	317	387	341	469	53.5	*Bacillus mycoides*	99.86% JN9998441
PPN 10	300	372	357	471	55.2	*Bacillus mycoides*	95.32% MW959783.1
CMS 22 N	301	376	361	476	55.3	*Bacillus subtilis*	99.60% CP009748.1
SRG 32	377	300	478	360	55.3	*Bacillus subtilis*	99.60% CP009748.1

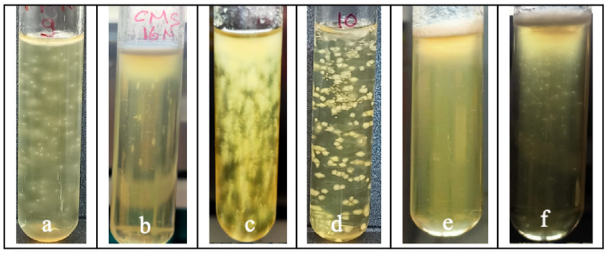


Figure 1. Pattern of bacterial growth in soft agar media culture. (a) 9 PP, (b) CMS 16N, (c) 3.1 SKBM, (d) PPN 10, (e) CMS 22N, and (f) SRG 32 isolates.

ANTIBIOTIC-RESISTANT THREADS OF *Aeromonas hydrophila* AS A MAJOR PATHOGEN IN INDONESIA FRESHWATER AQUACULTURE

Mira Mawardi* , Ayi Santika, *Setiadi* Setiadi, *Annisa* Wening *Maharani* Putri, *et al*.

Main Center for Freshwater Aquaculture
Ministry of Marine Affairs and Fisheries
Jl. Selabintana No. 37, Selabatu, Kec
Cikole, Kota Sukabumi, Jawa Barat 43114, Indonesia
miramira@apps.ipb.ac.id.
https://doi.org/10.1051/e3sconf/202344202027

Aeromonas hydrophila is a zoonotic, important primary fish pathogen in many economic fish species. Aeromonas acquires and exchanges antimicrobial resistance genes (ARG) and has been widely studied as a potential reservoir of ARGs. This research aims to observe the impact of antibiotics used through the role of *Aeromonas hydrophila* as a pathogenic bacteria in aquaculture. The tested antibiotics are based on the Minister of Marine Affairs and Fisheries No. 1/2019 Decree, namely tetracycline, oxytetracycline, and enrofloxacin, which the Indonesian government allows to be used in aquaculture. Random sampling was conducted using four to five fishes per farm in West Java, namely Bogor (17 farms) and Sukabumi (10 farms), Central Java at Banyumas (38 farms), and Magelang (25 farms). The test method used is CLSI-2020, an Antimicrobial Sensitivity Test disk diffusion with standard bacteria ATCC *Escherichia coli* 25922. The results show that *A. hydrophila* is resistant to tetracycline by 15,06% and oxytetracycline by 54,54%. However, *A. hydrophila* is sensitive to enrofloxacin by 84%. The aquatic environment acts as a reservoir for antibiotic-resistant *A. hydrophila* and emphasizes the importance of prudent antimicrobial use and timely AMR surveillance in aquaculture.

In Sukabumi Regency in 2019, *A. hydrophila* showed resistance to OT, 55%, and to TE, 48%. Meanwhile, *A. hydrophila* against ENR is still very sensitive, namely 84%. However, in 2022 *A. hydrophila*, its sensitivity to ENR decreased to 22% from the previous 84%. The freshwater fish cultivated in Sukabumi include catfish, carp, tilapia, and ornamental koi fish. Potential coastal and marine resources include marine fish, coral reefs, mangrove forests, seaweed, turtles, mining materials, and minerals.

Banyumas is known as a center for Gourami cultivation, which can contribute about 20% of Gourami production in Central Java Province. In Banyumas Regency in 2020, *A. hydrophila* in fish samples was still sensitive to OT and ENR of 60%, respectively. The condition of the Banyumas district in 2021, *A. hydrophila*, sensitive to OT and ENR decreased to 21% respectively. In 2021, *A. hydrophila* bacteria in fish samples in the Bogor district appeared to show a low sensitivity, only around 9%, to the three types of antibiotics, namely TE, OT, and ENR. Risk management begins with preliminary activities in the form of an AMR survey by FAO (FAOTCP/RAS/3702 Support mitigation of AMR risk associated with aquaculture in Asia) cooperating with the Indonesian government. At that time, sampling was carried out at four locations: one location in West Java (Subang), two locations in Central Java (Banyumas and Sleman), and one location in East Java (Blitar). Aeromonas hydrophila dominates in the four areas, respectively, 48%, 31%, 60%, and 46%. From the results of this study, it can be seen that there are additional resistant areas, namely Sukabumi, Bogor, and Magelang. In addition, *A. hydrophila* in Banyumas, which FAO surveyed, seems to have decreased sensitivity to OT and ENR.

Due to the uncontrolled use of antibiotics in West and Central Java fish farming, the sensitivity of *A. hydrophila* has decreased to OT, TE, and ENR antibiotics. Therefore, in the future, monitoring these three types of antibiotics needs to be carried out carefully. Antimicrobial resistance (AMR) surveillance activities must be carried out to identify, control, and take early action against bacteria in the culture environment. The results of this study can be used as a policy recommendation for the type of antibiotic used for the treatment of fish. Planning for future surveillance activities is essential to expand the area of sampling point locations in fish farming production areas in Indonesia.

POTENTIAL INPUT AND MOBILITY OF RESISTANCE GENES IN AQUACULTURE

Mira Mawardi*, Ayi Santika, Ciptoroso, Zakki Zainun, Anis Dzakirah

Main Center for Freshwater Aquaculture
Ministry of Marine Affairs and Fisheries
Jl. Selabintana No. 37
Selabatu, Kec, Cikole
Kota Sukabumi, Jawa Barat 43114, Indonesia
miramira@apps.ipb.ac.id.

Antimicrobial resistance is a problem in all sectors of life, including aquaculture. The mobility and distribution of resistance genes in aquatic environments result from exposure to contamination from various sectors constituting a complete chain, including industry, household, hospital, and agriculture. The spread of resistance genes and bacteria in aquatic environments occurs rapidly through direct sewage streams or groundwater infiltration from contamination sources. Furthermore, the number and diversity of these bacteria in aquatic and soil environments is higher than for sources due to the vertical and horizontal proliferation and spread of resistance to the genes. This study discusses the potential for the input and distribution of resistance genes in aquatic environments, where water is the primary requirement for fish farming. The contribution of resistance genes and resistant bacteria from various sectors significantly affects the diversity and differences in the aquatic environment. The development and diversity of these genes have accumulated into a potential for multidrug resistance to bacteria in the aquatic environment, potentially contaminating aquaculture products.

The contribution of resistant bacteria, resistance genes, and their spread to the aquatic environment from various sectors such as industry, households, hospitals, and agricultural waste was potentially observed. Many studies showed resistant bacteria due to the use of antibiotics in various sectors. The following are some results that identify bacterial resistance genes in the industrial, household, hospitals, and agricultural waste. Figure 1 shows the graphical representation of resistance gene mobility from various sectors to the aquatic environment. Resistant bacteria and genes from the household, industrial, hospital, and agricultural sectors can penetrate the public water environment through direct waste disposal or potentially through water infiltration into the soil. In addition, public waters are one of the sources of cultivation activities. Contamination of resistance genes in waters is a very complex obstacle. Its land source is very high, as is evident from the research results reviewed. This contamination introduces resistant bacteria to public waters used in the aquaculture sector. The potential inputs for contamination of resistance genes and bacteria from various sectors were studied. The impact and distribution of resistance genes in the aquatic environment show that epidemiological studies in the aquaculture sector are urgently needed. Furthermore, cooperation and collaboration in various sectors significantly affect bacterial resistance in the aquatic environment as it has a negative impact on the aquaculture sector. This review concluded that the contamination of resistance genes from various sectors affects their abundance in the aquatic environment. Additionally, its contribution to the aquatic environment is direct contamination of resistant bacteria or antibiotic waste. This affects the abundance and diversity of resistant bacteria in the aquatic environment. Since water is used for fish farming; hence, it can be polluted by resistance genes, affecting human health.

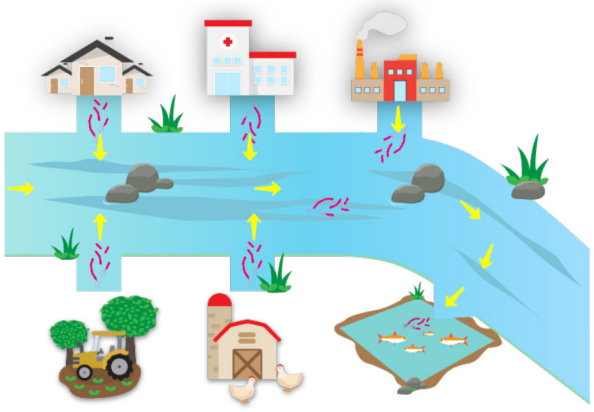


Fig 1. Shows the graphical representation of resistance gene mobility

THE FUTURE OF SHRIMP FARMING: UNLOCKING FINANCIAL SERVICES THROUGH DATA TECHNOLOGIES

Ciaron McKinley*, Daniel Penalosa Martinell

Shrimpl Pte Ltd
160 Robinson Road
#24- 09 Singapore, 068914
ciaron@shrimpl.com

Seafood is the most traded food commodity in the world, with an estimated value of over 236 billion USD in 2023. Shrimp and prawn aquaculture is the fourth most valuable and the second most traded group of aquaculture species worldwide, boasting a production value of over 40 billion USD. Despite this, financial services, such as lending and insurance, do not adequately serve the shrimp aquaculture industry. The main reason for this is the significant catastrophic losses associated with diseases that occurred during the 1990s and 2000s.

The opacity of the data and the uncertainty of pond conditions increased risk for financial parties, leading them to significantly reduce their exposure to the sector. However, new technologies focusing on automated data collection, structuring, and management have enabled farms to enhance their decision-making processes, thereby allowing for better risk management and profit optimization.

Utilizing technologies that facilitate real-time data estimation and forecasting on biomass and water quality paves the way for data-driven decision-making, enabling the creation of fairly priced insurance products that will foster a suitable lending environment. Overcoming this hurdle will initiate a new revolution in the shrimp aquaculture industry, ensuring more secure and sustainable growth to benefit all stakeholders involved.

A real case is described in this work, presenting how good farm data, combined with close and remote sensing data, modelled with Shrimpl's bioeconomic and risk models, enable financial services to the underserved shrimp aquaculture industry.

ASSESSMENT OF VIRULENCE FACTORS AND ANTIMICROBIAL RESISTANCE OF *Vibrio* SPECIES ISOLATED FROM CULTURED SHRIMP IN MALAYSIA

Md Yasin Ina-Salwany[*a,b], Wan Omar Haifa-Haryani[a], Mohd Zamri-Saad[a], Mohammad Noor Amal Azmai[a] and Ikhsan Natrah[a,b]

[a]Aquatic Animal Health and Therapeutics Laboratory, Institute of Bioscience, Universiti Putra Malaysia, UPM 43400 Serdang, Selangor, Malaysia
[b]Department of Aquaculture, Faculty of Agriculture, Universiti Putra Malaysia, UPM 43400 Serdang, Selangor, Malaysia

Shrimp are major seafood in the aquaculture industry, particularly in Southeast Asia. However, *Vibrio*-related infections frequently occur in shrimp farms. Antibiotics are widely used in shrimp farming both preventative and therapeutic purposes in the fight against bacterial growth. However, overuse of antibiotics in aquatic environment has resulted in the establishment of antimicrobial resistance (AMR). Therefore, the study aims to provide a comprehensive database on the distribution of *Vibrio* spp. as well virulence genes and antimicrobial resistance patterns in Malaysian shrimp farms. Briefly, a total of 225 presumptive *Vibrio* isolates were isolated from seven farms cultured shrimp which were subjected to molecular detection using *pyrH* gene analysis. Eventually, 13 different *Vibrio* spp. were successfully isolated and characterized. The isolates were then analyzed with virulence genes resulting in eight of the eleven virulence genes were detected, including *pirA*, *pirB*, *tlh*, *flaC*, *toxR*, *chiA*, *luxR*, and *hlyA*. Other virulence genes, such as *tdh*, *trh*, and *ctxA*, were not detected in any isolates. From the virulence gene assessment, three *Vibrio* isolates were chosen for the pathogenicity test based on highest number present in each of the species. Meanwhile, the majority of the species tested were resistant to penicillin G (100%), but susceptible to norfloxacin (96%). According to the multiple antibiotic resistance (MAR) index, 84% of *Vibrio* spp. exhibited a MAR index value of more than 0.2. As a result, the findings suggested that a large number of *Vibrio* spp. were resistant to several antibiotics and had been exposed to antibiotics on a regular basis at the farms. In conclusion, ongoing monitoring of antibiotic-resistant microorganisms as well as understanding the genetic basis of resistance are essential to implement a strategy for minimizing AMR strain yet to improve shrimp farming management in Malaysia.

DIETARY THIAMINE REQUIREMENT AND ITS EFFECTS ON GROWTH, INNATE IMMUNITY AND DIGESTIVE ENZYME ACTIVITY OF PACIFIC WHITE SHRIMP *Penaeus vannamei* POST-LARVAE

Nalin Medagoda*, Udith Wijemanna, Mirasha Hasanthi, Kyeong-Jun Lee

Department of Marine Life Science
Jeju National University
Jeju 63243, South Korea
nalinm@jejunu.ac.kr

This study investigated the dietary thiamine (vitamin B_1) requirement of *P. vannamei* post-larvae and its effects on growth performance, feed utilization, innate immunity, digestive enzyme activity and ammonia stress tolerance. High-performance liquid chromatography of the test diets revealed that the thiamine concentration of T0, T20, T40, T60, T80 and T100 experimental diets at 6.14, 28.5, 48.1, 73.3, 85.7 and 106 mg/kg of diet, respectively. A total of 1200 post-larvae (5 mg) were randomly distributed into 24 acryl tanks (50 shrimp/tank, 10 L) with four replicates per treatment. Daily feed requirement was divided into six equal portions and the feeding was done at 08:00, 10:00, 12:00, 14:00, 16:00 and 18:00 h for 30 days. After the feeding trial, 60 shrimp from each dietary treatment were captured, pooled and redistributed into three replicate tanks (10 L) for the ammonia stress challenge test. Thiamine supplemented groups showed a significant improvement in growth performance and feed utilization. Final body weight of T40, T60, T80 and T100 dietary groups were significantly higher compared to the T0 group and both weight gain percentage (WG%) and specific growth rate followed a similar trend. Significant enhancements in feed conversion ratio were observed in T40, T60, T80 and T100 groups and protein efficiency ratio was significantly elevated in thiamine supplemented groups (T60, T80 and T100) compared to the control group (T0). Survival percentage was not significantly different among the experimental groups. Thiamine supplementation significantly enhanced the activity of digestive enzymes (amylase, lipase and pepsin) and the significantly lowest activities were observed in T0 group. Compared to the thiamine deficient group, relative gene expression of insulin-like growth factor (IGF)-1 and IGF-binding protein gene expressions were significantly upregulated in thiamine supplemented groups. Antioxidative gene expressions (catalase, superoxide dismutase and glutathione peroxidase) were significantly upregulated through thiamine supplementation. Similarly, innate immune-related genes (prophenoloxidase and crustin) were significantly expressed in thiamine supplemented groups. In the challenge test, after 48 h, a significantly higher survival rate was observed in T80 dietary group while thiamine deficient group manifested the significantly lowest survival. A broken line regression of WG% estimated the dietary thiamine requirement of *P. vannamei* post-larvae at 72.9 mg/kg of diet.

MULTI LOCATION TEST OF TISSUE CULTURE SEAWEED CULTIVATION TO IMPROVE NURSERY GARDENS IN COASTAL LAMPUNG

Maya Meiyana[1,*], Arief Rahman Rivaie[1] Silfester Basi Dhoe[1], Suryadi Saputra[1], Suciantoro[1]

[1]Researcher on National Research and Innovation Agency
Jl. Raya Bogor KM 47
Cibinong Bogor, West Java, Indonesia
[*] Corresponding author:mmeiyana@yahoo.com

Eucheuma cotonii cultivation has been widely carried out but is still limited to the use of vegetative seeds, the use of Eucheuma from tissue culture is still considered lacking, because the number of tissue culture seed stocks at the cultivation site or seaweed seed garden owned by the community is insufficient and the low quality of seaweed from tissue culture. The different characteristics of seaweed cultivation locations are expected to be able to overcome the needs of fulfilling the seedling garden. This research was conducted to improve the fulfillment of the needs of Eucheuma cotonii seaweed seed gardens from tissue culture for the needs of Lampung coastal communities. Research on seaweed cultivation from tissue culture was conducted in three different locations on the coast of Lampung for 30 days using the RAL method with 3 repetitions. The cultivation method used is the Long Line method with 20 points as many as four lines with an initial weight of 50 grams of seedlings per planting point. The study results show that the growth of seaweed Eucheuma cotonii characterized by weight gain, absolute growth and specific growth rate was significantly different ($P<0.05$), at each treatment site. The results obtained by the Ruguk location are the best location with a total harvest of 114.96 kg and growth rate is 5.35±0.30% and followed by Hurun location is 66.24 kg with an average daily growth rate of 6.32±0.15%. the lowest location of Pahawang with a production yield of 54 kg and an average daily growth rate of 5.35±0.30%.

ESTABLISHMENT AND MANAGEMENT OF COMMUNITY-BASED SEA CUCUMBER CULTURE PRODUCTION CLUSTERS IN BOLINAO, PANGASINAN

Rona C. Soy, Olivier Josh C. Caasi, Jeraldine O. Bigcas, Marie Antonette Juinio-Meñez*

The Marine Science Institute
University of the Philippines Diliman
Quezon City, Philippines 1101
ajmenez@msi.upd.edu.ph

Sea ranching of sandfish (*Holothuria scabra*) was established to help rebuild depleted stocks and increase the harvest for premium-size grade sea cucumbers through restocking of cultured juveniles and harvest size regulation. Community-based sandfish culture production cluster is being piloted in three adjacent villages in Santiago Island to scale-up the economic and ecological benefits of sea ranching. In each village, there is an ocean nursery area and a 1-ha no-take zone for grow-out. Each area is managed by members of the local people's organizations (PO). Key activities to facilitate the establishment include creating a partnership agreement, culture orientation, site assessment, budget allocation, and construction of a rearing system were undertaken prior to start the culture production in each site. A non-government organization and the Local Government Unit (LGU) provided financial support to each PO to set-up the production area and enforcement of the managed areas respectively. Researchers provided training on ocean nursery and grow-out culture of sandfish, including growth and survival monitoring. Each PO was also given 6,000 post-settled juveniles from the hatchery to rear. Juveniles (>3 g) produced from respective floating hapas were released and reared in a 100 m^2 circular pen positioned inside a 1-hectare culture production site. An average survival rate of 26.4% across site was attained after the floating hapa phase. During the initial 8-month rearing period in pens, Pilar had the highest number of juveniles released in pens (2,756) followed by Dewey (1,200) and Victory (791). The average percent survival in Pilar was 1.97%, Dewey with 4.60% and Victory with 6.70%. The survival rate in each site varied on the stocking density. Meanwhile, the highest growth rate was also noted in Barangay Pilar (0.94 ± 0.23 g day^{-1}) followed by Dewey (0.74 ± 0.17 g day^{-1}) and Victory (0.50 ± 0.25 g day^{-1}). Among the major challenges during the establishment of community-based cluster production include local environmental conditions such as isopod infestations, predation, damage in the culture set-ups, and harsh weather conditions primarily affecting growth and survival. Social challenges included delays in stocking of sandfish due to fund availability in purchasing materials for the culture set-ups and maintenance, conflicts among members due to the lack of coordination and participation in agreed upon activities, and poor leadership. Essential in addressing these concerns and promote cooperation were regular group meetings and activities such as monitoring and guarding their respective culture production area. Joint meetings of the different POs and periodic assessment of progress and plans for coordination in relation to enforcement of permits and size limits to manage the wild stocks in the broader sea cucumber reserve encompassing the sandfish culture production areas.

LEVERAGING PUBLIC INVESTMENT IN THE OCEAN GROW-OUT AND CULTURE OF SANDFISH *Holothuria scabra* IN NORTHWESTERN LUZON PHILIPPINES

Marie Antonette Juinio–Meñez*, Tirso O. Catbagan[2], Olivier Josh C. Caasi[1,2]

The Marine Science Institute
University of the Philippines Diliman
Quezon City, Philippines 1101
ajmenez@upmsi.edu.ph

Sea cucumber mariculture has become a significant area of research in coastal tropics, driven by the diminishing sea cucumber fisheries supplying the Asian dried seafood market. In the Philippines, the culture of sandfish (*Holothuria scabra*) has been adopted in small-scale community–based efforts in restocking and stock enhancement, despite limited technical and financial resources. With the rise of global sea cucumber aquaculture, examining the most effective organizational structures for sea cucumber mariculture is a crucial aspect of research in this field, given the diverse arrangements currently being utilized. In the Philippines, municipal waters (15 km from shore) are under the management of the local government unit (LGU). This study provides an overview of an LGU–led approach in the establishment of the two sandfish restocking sites. Trials were conducted in Pilar, Bolinao and Bayambang, Infanta over a two–year period to develop demonstration sites that can facilitate adoption of sandfish culture in nearby localities. Within this period, local cooperators designated by the LGU were trained in ocean nursery and grow-out of sandfish including growth and survival monitoring. The process undertaken and culture technology used in both sites were similar, but the outcomes varied substantially due to the differences in implementation and sustainability approaches by the two LGUs. Qualitative assessments across economic, ecological, and social dimensions were analyzed to compare the two sites. Ecological and social aspects were positive in Infanta, while the willingness to engage and motivation to collaborate between the two sites largely differed. The restocking site in Bayambang, Infanta is now a continuing site for juvenile release and grow out due to sustained financial support and manpower resources from the local government unit. However, economic outcomes are yet to be realized for Infanta. To sustain and improve the potential benefits of an LGU-led restocking site, governance structures aimed at enhancing operational efficiency, increased integration with fisheries management and government support will be essential. Co-management arrangements with local community organizations and external partners is important to scale-up sustainable sandfish culture production and stock restoration. In conjunction with improved management of the multi-species sea cucumber fishery, sea cucumber resources can be restored or enhanced and become a sustainable source of supplemental income for fisher households. This can incentivize and promote the management of nearshore ecosystems and other associated invertebrate resources therein which contributes substantially to domestic food security.

BIOLOGICAL PERFORMANCE OF SAND SPINY LOBSTER *Panulirus Homarus* GROWTHOUT WITH DIFFERENT STOCKING DENSITY AT 7 M DEPTH

Herno Minjoyo[1], Arief Rahman Revaie[1], Suryadi Saputra[1], Yuwana Puja[2], Dwi Handoko Putro[1], Silfester Basi Dhoe[1], Maya Meiyana[1] dan Suci Antoro[1]

[1]Research Center for Fishery – National Research and Innovation Agency, Indonesia
[2]Lampung Main Center of Marine Aquaculture - Ministry of Marine and Fisheries Affairs, Indonesia
hernominjoyobbpbl@gmail.com

Spiny Sand Lobster (*Panulirus homarus*) is one of the lobster species that has hight price in the local and international market and is economically valueable.The objective of this study is to know the biologically performance the Lobster such as; the survival rate, Specific daily growth rate, feed conversion ratio, and physiological responses. These studies were done with three different treatments of stocking density at 7 m water depth. The observation were treatment A: 10 lobster/m²; treatment B : 15 lobster/m²; and treatment C : 20 lobster/m². The design of study was completely randomized design with 3 treatments and 3 replicates. The results of the study showed that there were not significant in term of food conversion ratio and daily specific growth rate as well as weight gain but was significant in term of survival rate between both treatments A (91,50 ± 0,25 %) and B (93,30 ± 0,51 %) with treatment C (86,05 ± 0,45 %) (Table 1). Physiologyical response (Table 2) between treatment A and B in term of THC hemolymph was not significant but both treatment A and B was significant with treatmen C. In term of glucose hemolymph treatment A was significant with treatment C but not with treatment B.

Table 1. Weight gain, survival (SR) and specific daily growth rate (SGR) in rearing of spiny pearl lobsters in floating net cages at a depth of 7 m during 90 days.

Parameters	Treatments		
	10 ekor/m^3 (A)	15 ekor/m^3(B)	20 ekor/m^3(C)
Initial weight (g)	74,56±2,06	76, 21±2,81	75,35±5,10
Final weight (g)	129,06 ±6,54	126,25 ± 6,25	123,78 ±3,23
Weight gain (%)	73,10^a	65,66^a	64,27^a
Survival rate (%)	91,50 ± 0,25^a	93,30 ± 0,51^a	86,05 ± 0,45^b
SGR (%/BW/day)	0,47± 0,07^a	0,44± 0,07^a	0,44± 0,13b^a
FCR	16,57 ± 2.21^a	16,93 ± 1.90^a	17,00 ± 2.73^a

Table 2. Physiological response to rearing of spiny sand lobsters with different stocking densities at 7 m depth.

Parameters	Treatments			
	10 ekor/m^2 (A)	15 ekor/m^2 (B)	20 ekor/m^2 (C)	Initial
THC hemolymph (10^6 sel/ml)	2,46^b	2,48^b	3,79^a	2,44^b
Glucose hemolymph (mg/dL))	23,75±2,25^b	24,45±2,75^{ab}	28,85±3,85^a	23,55^b

STATUS OF AQUACULTURE IN FRENCH POLYNESIA

Matangi Moeroa*, Georges Remoissenet, Moana Maamaatuaiahutapu, Marc-André Lafille, Thierry Tamata, Tuani Toussaint, Stanley Flohr, , Mike Teissier

Marine Resources Department
BP 20 Fare Ute, Papeete 98713
Tahiti, French Polynesia

With nearly 118 islands and atolls spread over 5 archipelagos, French Polynesia extends over a vast maritime area like Europe (5 million km²), housing a population of around 280,000 inhabitants, deeply linked to the ocean. After tourism, which occupies a preponderant place, marine resources represent the cornerstone of the Polynesian economy, notably with exports of pearls and fishing products.

In a context where marine resources constitute an essential component of the Polynesian economy, aquaculture is emerging as a promising strategy to meet the growing demand for seafood products while preserving the region's fragile ecosystems. With its vast maritime expanses comparable to those of Europe and a population largely oriented towards the ocean, French Polynesia is positioned as a key player in this area.

Under the leadership of a committed government, concerted efforts are being made to support the development of sustainable aquaculture sectors, in collaboration with private partners and research institutes, under the lead of the Department of Marine Resources. The main objective is to promote native species, thus promoting local, responsible and environmentally friendly aquaculture.

WOMEN EDUCATORS SHAPING THE FUTURE OF SUSTAINABLE AQUACULTURE

Nurliyana M.

School of Biology, Faculty of Applied Sciences
Universiti Teknologi MARA
Negeri Sembilan Branch
Kuala Pilah Campus
Pekan Parit Tinggi
72000 Kuala Pilah
Negeri Sembilan
mnliyana@uitm.edu.my

The role of women in aquaculture is multifaceted and crucial. Currently, women are engaged in nearly all stages of the aquaculture chain, from production to processing, marketing, and research. According to World Bank estimates, women hold approximately 1.4 million of the total 17.8 million jobs in the industry. In Malaysia, an increasing number of women are assuming leadership roles in aquaculture enterprises, managing fish farms, and contributing to overall business strategy. Beyond these roles, the significance of women as educators and their contribution to the current and future aquaculture sectors cannot be overstated.

Worldwide, including Malaysia, emphasis has been placed on the importance of the blue economy. Among the challenges that hinder effective development of Malaysia's blue economy is the shortage of labor and technical expertise. As educators, women play a vital role in disseminating knowledge and skills related to aquaculture through various educational platforms, formal or informal. Imparting knowledge and skills is necessary to equip future generations of aquaculturists, researchers, and industry professionals with the requisite expertise. More importantly, the educational programs must align with industry needs, and women educators should play an active role in the curriculum development.

In addition, recognizing that aquaculture often lacks popularity among the youth, educators should strive to cultivate interest in the field among students. This can be achieved by introducing students to various sub-fields within aquaculture, organizing visits to aquaculture-related sectors, and sharing personal experiences. By fostering a deeper understanding of aquaculture's contribution to food resilience, young individuals can become advocates for sustainable practices, driving innovation and adaptation in this vital industry. Through such awareness and engagement, we can empower the next generation to contribute meaningfully to building a more food-secure and sustainable future.

Moreover, while traditional perceptions have often depicted the aquaculture industry as male-dominated, the reality is that women constitute half of the overall workforce throughout the fisheries and aquaculture value chains, occupying critical roles. However, they are disproportionately represented in the informal, lowest paid, least stable, and least skilled segments of the workforce. Education serves as a potent catalyst for empowering women, and women educators can play a pivotal role in promoting gender equity and inclusivity within the aquaculture industry.

In conclusion, the role of women in aquaculture as educators is indispensable if we are to achieve a blue economy. Women educators will be one of the important individuals, shaping the future of the industry and paving the way for inclusive and equitable development, thereby fostering resilience and prosperity in aquaculture communities and beyond.

DEVELOPMENT OF GONADOTROPIN-RELEASING HORMONE AGONIST (GnRHa) IMPLANT TO REGULATE HYPOTHALAMUS-PITUITARY-GONADAL (HPG) AXIS OF PATIN BUAH, *Pangasius nasutus* (Bleeker 1863)

Zarirah Zulperi[1,2*], Amirah Syafiqah Zamri[2], Fatin Nabilah Sahadan[1], Yuzine Esa[2], Annie Christianus[1,2], Fadhil-Syukri Ismail[2] and Ina-Salwany Md Yasin[1,2]

[1]Aquatic Animal Health and Therapeutics Laboratory, Institute of Bioscience, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia
[2]Department of Aquaculture, Faculty of Agriculture, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia
zarirah@upm.edu.my

Patin Buah, *Pangasius nasutus* is one of the most promising native catfish species for aquaculture due to its high market value and popularity among locals. The popularity of this species has raised concern as the supply of this species is still dependent on wild catch, and the number of landing specimens has declined from 32.60 tonnes in 2018 to 16.49 tonnes in 2021. Gonadotropin-releasing hormone (GnRH) one of the important reproductive hormone in vertebrates, and is widely used in hormonal therapy due to its advantages in lower species-specificity and targeting at a high level in the hypothalamus-pituitary-gonad (HPG) axis, which play important roles in stimulating the release of the sex steroid hormones. This research was conducted to assess the effect of GnRH agonist (GnRHa) implant to activate HPG axis of *P. nasutus.* Preparation of a slow-release delivery system loaded with GnRHa was conducted to evaluate the effect of hormonal induction through the slow-release implant using ethylene-vinyl acetate (EVAc). In this experiment, juvenile *P. nasutus* were allocated into four treatment groups (n=6, 2 replicates): Group 1 = empty EVAc (control), Group 2= GnRHa+domperidone (DOM)+EVAc, Group 3= GnRHa+EVAc, and Group 4= Ovaplant. Each treatment group received two administrations of the implant, one on Day 0 and another on Day 15. Data were collected at specific intervals (Day 0, 7, 17, and 22) after treatment, including blood sampling, and fish were sacrificed to collect pituitary and gonad. Histological observation of the gonad development of GnRHa-treated fish (GnRHa+DOM+EVAc, GnRHa+EVAc, Ovaplant) showed continuous development in the oocyte and spermatogenesis stages until day 22 compared to the control group. The plasma level for 17□-estradiol (E2) showed a gradual increase until day 22 post-implantion with GnRHa+DOM+EVAc, followed by GnRHa+EVAc and Ovaplant. The plasma levels of testosterone (T) and 11-ketotestosterone (11-KT) marked a peak higher level at day 17 post-implantion in the GnRHa-treated group than in the control and decreased until day 22. The results showed that GnRHa treatment has a significant effect on the prolonged release of GnRH. The mRNA expression level of the □, FSH□, and LH□ subunits showed the rapid burst of pituitary FSH was seen to have a greater fold change in the GnRHa-treated (GnRHa+DOM+EVAc, GnRHa+EVAc, and Ovaplant) fish compared to the control fish. This reveals the role of GnRH in stimulating the pituitary to produce FSH in response to the GnRH implant successfully activated endocrine axis in juvenile *Pangasius nasutus*. The use of GnRHa slow-release delivery systems has the potential to facilitate captive breeding, enhance reproductive efficiency, and promote sustainability in aquaculture practices for *Pangasius nasutus* and catfish species.

ON-FARM EPIDEMIOLOGICAL SURVEILLANCE OF RED HYBRID TILAPIA IN BIOFLOC-BASED CULTURE

Mohd Syafiq Mohammad Ridzuan*, Azila Abdullah, Nur Nazifah Mansor, Muhamad Faizal Mohd, and Mohd Firdaus-Nawi

National Fish Health Research Centre (NaFisH)
Fisheries Research Institute (FRI) Batu Maung
Department of Fisheries Malaysia
11960 Batu Maung, Penang
Malaysia
syafiq@dof.gov.my

Biofloc technology, initially developed to combat the spread of disease in shrimp aquaculture, has only recently been used with promising outcomes in tilapia culture. Given the scarcity of assessments of biofloc-based systems, it is unclear whether the positive characteristics of biofloc technology make it a viable approach in tilapia farming, especially concerning disease management. Therefore, six months of farm-level epidemiological surveillance were conducted at a private farm from July to December 2023 to ascertain the prevalence of *Streptococcus agalactiae,* tilapia lake virus (TiLV), and parasites in red hybrid tilapia reared using biofloc-based culture.

Throughout the study, a total of 180 tilapias were sampled and subjected to bacteriology, parasitology, and TiLV detection. Water quality parameters, fish weight and length, and associated clinical signs were also noted. Overall, the prevalence of bacteria was considered low. For instance, *Bacillus* sp. was isolated in July, November, and December and ranged between 3.33 and 10%, whereas *Plesiomonas shigelloides* was successfully identified in September, October, and December with 3.33 and 6.67%, respectively (Figure 1). More importantly, *Streptococcus agalactiae*, TiLV, and parasites were not identified throughout the study period. Interestingly, a slow increment in the fish weight of cultured tilapia was noted, with a calculated specific growth rate of just 1.65%. Significant variation in dissolved oxygen readings was observed, displaying a downtrend pattern from August to November and being inversely correlated with total suspended solids. Additionally, total ammonia and nitrate concentrations were elevated throughout the culture period. This finding suggests that the closed nature of the biofloc system reduces the likelihood of pathogen entry. However, much attention should be directed to water quality maintenance.

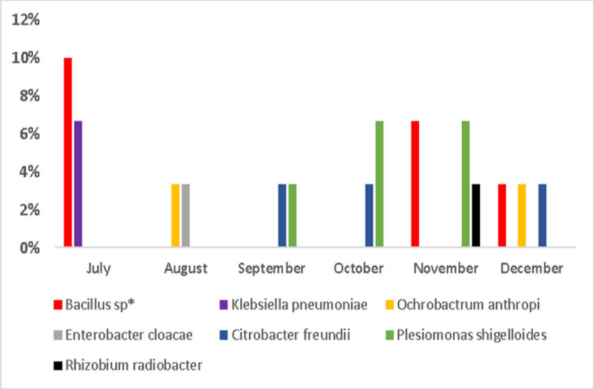


Figure 1. Bacteria species isolated from sampled fish.

BIO-FLOC TECHNOLOGY: IMPACT AND EFFECT OF WATER QUALITY TOWARDS BACTERIAL ISOLATION FROM *Oreochromis spp.* CULTURE IN CHINI, PAHANG

M Muhamad-Faizal*, M Nur-Nazifah, M Alif-Hamli,R Irfan-Hakimi, S Syafiq-Syauqi, AR Amalin-Sofea, N. Amira-Syahidah

Department of Marine Science, Kulliyyah of Science
International Islamic University Malaysia
Bandar Indera Mahkota, Jalan Sultan Ahmad Shah
25200 Kuantan, Pahang, Malaysia
faizalmohd_94@yahoo.com

Tilapia is the third important finfish species group cultured worldwide in terms of production. The bio-floc culture system is a technology to manage the water quality and cultivation of beneficial microorganisms to support the cultured life. In this study, we report the impact and effect of water quality on bacteria diversity from bio-floc cultured *Oreochromis spp*. in Chini, Pahang. 30 tilapias from bio-floc farm in Chini, Pahang were randomly sampled monthly over an 8-month culture period. The eye, brain and kidney were sampled for bacterial isolation, following identification of bacteria using biochemical test and commercial identification API kits. Water temperature, depth, pH, iron, sulfide, ammonia, nitrite, phosphate, and dissolved oxygen at each sampling site were also measured and recorded.

The results showed that *Plesiomonas shigelloides* is the most abundant bacteria species present in the fish sample with 20% followed by *Sphingomonas paucimobilis* with 18%. Other identified bacteria were *Micrococcus spp*., *Citrobacter freundii*, *Alcaligenes spp*., and *Actinobacter baumannii* with 8% for each bacterium. The lowest identified bacteria abundance were *Staphylococcus hominis*, *Staphylococcus epidermidis*, *Kocuria varians*, and *Burkholderia pseudomallei* with abundance percentage of 2% each bacterium (Figure1).

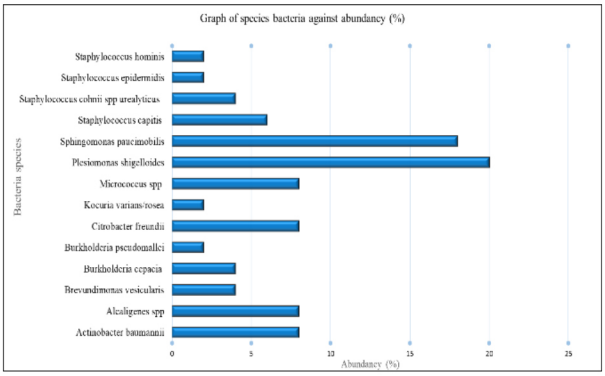


Figure 1: Graph of bacteria species against abundancy

Multivariate analysis showed that ammonia was positively associated with the presence of high abundance bacteria *Plesiomonas shigelloides, Alcaligenes spp*., and *Actinobacter baumannii*. Meanwhile, iron and nitrite were strongly associated with *Micrococcus spp*., and *Citrobacter freundii* (Figure 2). Understanding the association between bacteria and their environment, especially water quality will strategize in prevention and diseases management caused by fish pathogens in the future.

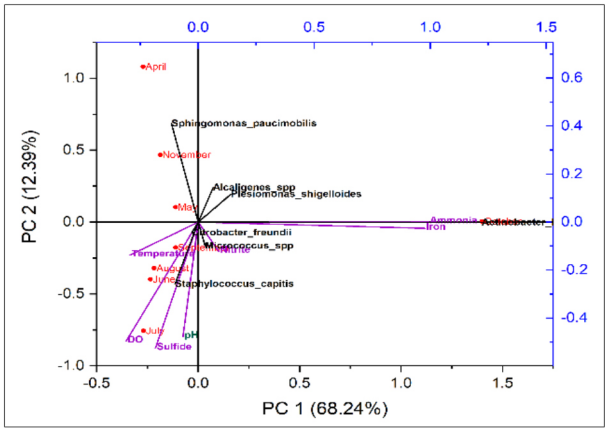


Figure 2: Principal component analysis showing the effect of water quality parameters on the presence of bacteria in bio-floc

EFFECTS OF FEEDING FREQUENCY ON THE PRODUCTION OF ROTIFER *Brachionus plicatilis* USING AUTOMATED BATCH CULTURE SYSTEM

S. M. S. Adriana*, Sitti Raehanah Muhamad Shaleh

Borneo Marine Research Institute (BMRI)
Universiti Malaysia Sabah
Jalan UMS, 88400
Kota Kinabalu, Sabah, Malaysia
adrianashaz@gmail.com

Rotifer, *Brachionus plicatilis* is very important in live food aquaculture, namely in early larvae feedings. The high nutritive value of rotifers provides a stable diet for culture species in the early life cycle. However, rotifer production is low and very unstable due to unsuitable culture systems and water quality. Feeding rotifers with unsuitable live feed may provide insufficient nutrients that are needed by the rotifers. The study aims to identify the optimum feeding frequencies to produce high rotifer production in an automated batch culture system.

The study used two feeding frequencies: non-continuous (NC) and continuous (C) feeding using *Nannochloropsis oculata* in a seven-day trial period to produce the highest amount of rotifer. An automated system was implemented to control the water parameters of the tank using various equipment that was integrated with Internet of Things (IoT) smart aquaculture concept; an automated feeder pump, multiparameter sensors, and oxygen concentrator. Figure 1 shows C treatment produced the highest population, (297 rotifers/mL) whereas the lowest rotifer density was produced by NC treatment, (220 rotifers/mL) by the end of the 7-day trials. There is a significant difference ($P<0.05$) in rotifer density between the C and NC treatments.

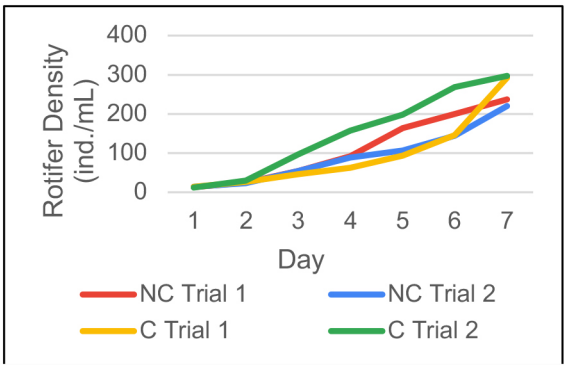


Figure 1 Growth curve of daily culture *B. plicatilis* for each treatment and trial during a 7-day study period. NC: non-continuous; C: continuous.

Additionally, rotifer egg production is sampled during the 7 days of the study. Figure 2 shows the total number of eggs for each rotifer and the total number of eggs for each sample are taken. Water parameters were monitored throughout the study, and although there were a few disturbances due to drastic weather and water shortage, it was observed to be stable.

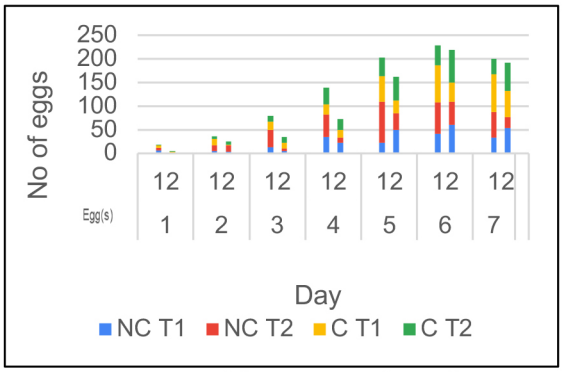


Figure 2 Rotifer *B. plicatilis* egg production during the 7-day feeding trial period. NC: non-continuous; C: continuous.

In conclusion, feeding frequency is important in providing sufficient nutrients to rotifer throughout the day. Ammonia and temperature directly affect the rotifer density and rotifer egg production. A more established automated system, as well as increasing the nutrient intake would positively affect the production of rotifers and rotifer eggs daily.

CAN A SMALL-SCALE TROPICAL SEA CUCUMBER HATCHERY BE PROFITABLE?

Quenie S. Montinola*, Jon P. Altamirano, and Jesus C. Rodriguez Jr.

Southeast Asian Fisheries Aquaculture Department (SEAFDEC/AQD)
SEAFDEC/AQD Brgy. Buyu-an Tigbauan
Iloilo, 5021, Philippines
qsmontinola@gmail.com

Sea cucumbers are considered overfished worldwide, due to its high economic value. Fortunately, alleviating pressure on wild stocks is now possible through sea cucumber farming in some countries, especially in Asia, West Pacific, and Indian Ocean. This is being realized through the development of hatchery technologies and methodologies for commercially important sea cucumbers like the tropical sandfish *Holothuria scabra.* Unfortunately, the adoption of such hatchery technology and the establishment of hatchery facilities have been slow because of many concerns and apprehensions from potential investors. The primary limitation is the profitability of the hatchery operations and the market accessibility of sea cucumber seeds.

In this study, we aim to assess the economic viability and resilience of a small-scale hatchery with 10 units of 3-ton capacity larval tanks, as a template for developing countries like the Philippines. Data for the economic assessment was taken from actual records of hatchery construction and more than 10 years of sea cucumber *H. scabra* seed production operations at the Southeast Asian Fisheries Development Center, Aquaculture Department (SEAFDEC/AQD) hatchery facility in Iloilo, Philippines.

Cost and return analyses (CRA) were performed based on existing hatchery protocols and current set of technical assumptions to assess the viability of operations at varying survival rates (SR) and selling price levels. The liquidity of the technology over a 10-year period was analyzed through financial investment analyses. Our main results suggest that maximizing the use of all 10 tanks (3-ton capacity each) per spawning run and conducting 5 runs per year is the most viable operation frequency, which can conservatively produce a total of 450,000 sandfish seeds (5 mm spats or early juveniles) per year at 1% SR. However, 1% SR will yield a negative return on investment (ROI) when seeds are to be sold at PhP1 each (1US$=PhP56). At this SR, selling at PhP2 can yield a modest ROI of 25.31%. An improvement in SR to 2% will result in 25.31% ROI at PhP1, and a robust ROI of 105.82% at PhP2.

The economic analysis suggests very good prospects for profitability even at small-scale operation of a sandfish hatchery. However, it may be challenging to maintain even the low SR target of 2% in a practical and non-environmentally controlled facility. Additionally, it will be important to maintain a stable market willing to pay PhP2 per spat of sandfish, at a minimum volume of 90,000 spats every 2-3 months.

This study provides useful information about the economic feasibility of constructing and operating a small-scale sandfish hatchery, using realistic selling prices and production efficiencies to improve its economic performance.

HAB's of *Margalefidinium polykrikoides*, A CHALLENGE FOR FISH FARMER IN LAMPUNG BAY

Muawanah*, Arief Prihaningrum, Lydia Erawati, Wahyu Widiatmoko, Febri Nugroho and Kurniastuty

Main Center for Marine Aquaculture
Directorate General of Aquaculture
Marine Affairs and Fisheries Ministry
Email : awanah_tj@yahoo.com
bbpbl.lampung@gmail.com

In a period of almost twelve years, the distribution of blooming *Margalefidinium polykrikoides* in Lampung Bay has expanded even almost all small bays in Lampung Bay, especially those on the left side coastline become pockets of beds sleep. Blooming dinoflagellate of *M. polykrikoides* have been reported to occur in Lampung Bay since mid-October 2012. That problem is still one of the challenges as well as a scourge for fish farmers with floating cages net systems in Lampung Bay until now. They cells blooming occurs in the transition season from dry to rainy, and in rainy seasons interspersed with hot days. The impact of blooming causes the color of sea water to become reddish-brown and has an impact on mass deaths and increased disease attacks on farmed fish, so that farmers experience considerable losses.

Anthropogenic activities, such as municipal waste water discharge, shipping, and aquaculture, has led to the accumulation of nutrients in Lampung Bay become triggers Harmful Algal Blooms (HAB's) outbreaks, One of the species includes *Margalefidinium polykrikoides*.

The Main Center for Marine Aquaculture of Lampung as a Technical Implementation Unit Directorate General Aquaculture has the main task one of which is to carry out fish health and environmental monitoring activities in aquaculture areas. That program is carried out regularly and continuously. One of the goals is to provide an early warning system to farmers.

Blooms of *M. polykrikoides* that were recorded in twelve locations (Pasaran Island, Lempasing, Mutun, Hurun Bay, Tegal Island, Ringgung, Cikuyiyi, Maitam Island, Northeast of Puhawang Island, Ratai Bay especially in Durian village and Piabung waters, Tarahan, and Legundi. A total of 72 *M. polykrikoides* outbreaks were recorded in Lampung Bay during October 2012- March 2024.

The results of the latest routine monitoring known that *M. polykrikoides* was observed blooming from November 2023 to March 2024 in floating cages net areas in Durian Village, Piabung and Cikuyiyi waters with an abundance of 104 - 107 cells / liter and has caused fish deaths in large quantities with an estimated loss of IDR 78 million. They cells are slippery where at the time of blooming the cells will cover / coat the gills of the fish causing the fish difficult to take oxygen in the water so that it suffocates.

IN VITRO AND IN VIVO TESTING SIMPLICIA OF PURPLE STEPANOT LEAVES (*Pseudocalymma alliaceum*) AGAINST THE BACTERIA *Vibrio parahaemolyticus* WHICH IS SUSPECTED TO CAUSE ACUTE HEPATOPANCREATIC NECROSIS DISEASE (AHPND) IN VANNAME SHRIMP

Sri Murti A*, Ita Rizkiyanti

Jepara Brackish Water Aquaculture Development Center
Jl. Cik Lanang, Rw. IV, Bulu
Kec. Jepara, Jepara Regency
Central Java 59418, Indonesia
Phone: (0291) 591125
Fax: (0291) 591724

Corresponding Author:
utamabbpbapjpr@gmail.com

Vanamei shrimp is one of the shrimp commodities that is now popularly cultivated in Indonesia. However, as time goes by, vanamei shrimp are now susceptible to disease. One type of disease that often attacks vanamei shrimp is Acute Hepatopancreatic Necrosis Disease (AHPND). The use of herbal medicines for fisheries is now a new alternative to the use of chemical medicines, one of which is Purple Stepanot (*Pseudocalymma alliaceum*) leaves. Based on the technical data report for Ajos Sacha 2006, purple stepanot leaf simplicia (*Pseudocalymma alliaceum*) is effective as an immunostimulant because it contains sulfur compounds that are similar to those of garlic, which are dominated by alline and allyl sulfide compounds. This study aims to determine the antibacterial power of purple stepanot leaf simplicia against Vibrio parahaemolyticus bacteria and its effectiveness as an immunostimulant.

The methods used are the agar diffusion method (in vitro) and Bioassy (in vivo). The test results showed that purple stepanot leaf simplicia was antibacterial against Vibrio parahaemolyticus at all concentrations tested (100%, 50%, 25%, 12.5% and 6.25%. Application to vannamei shrimp shows that the compound content contained in purple Stepanot leaf simplicia is able to increase the body's defense system of vannamei shrimp, which is characterized by an increase in the total immune parameters of hemocytes (THC) and phagocytic activity with the most effective and efficient dose being 6.25%.

SURVIVAL RATE OF SILVER POMPANO *Trachinotus blochii* LARVAE IN DIFFERENT REARING TANKS

Muslimin*, Dikrurahman, Saipul Bahri, Mutia Nur Hayati, Ikhsan Kamil, Faisal Andre Siregar

Division of Silver Pompano Production
Batam Mariculture Center
Ministry of Marine Affairs and Fisheries
muslimin.amdpi@gmail.com

Determining the type of rearing tank (container) is an important aspect in aquacultur activities, including the production of silver pompano *Trachinotus blochii* larvae. This activity aims to compare the use of different types of tanks (concrete tank and fiberglass tank) on the survival rate of silver pompano *Trachinotus blochii* larvae. These observations were carried out during three cycles (October – December 2023) at the Batam Mariculture Center. The treatment applied was larval rearing using concrete tank and fiberglass tank. The concrete tank used has an effective volume capacity of 8 m^3 in the form of a square, while the fiberglass tank has an effective volume capacity of 5 m^3 in the form of a tube/cylinder. The larval rearing period is 20-25 days per cycle. The main parameter observed was the survival rate of silver pompano *Trachinotus blochii* larvae each cycle. Other parameters observed were the average larval length (initial and final of observation) and the water quality of the rearing media consisting of temperature (°C), salinity (‰), dissolved oxygen/DO (mg/L), and pH.

The results showed that the survival rate of silver pompano *Trachinotus blochii* larvae in concrete tank was 23.33% - 26.39%, while in fiberglass tank was 16.00% - 22.22%. The final length achieved for the two treatments did not have a significant difference, with values of 1.52 cm - 1.58 cm (concrete tank) and 1.53 cm - 1.65 cm (fiberglass tank). The water quality parameter values in each treatment were still within the range of safe and optimal values for larval growth during three rearing cycles. The values for temperature: 29.5°C – 31.2°C (concrete tank) and 28.0°C – 30.1°C (fiberglass tank); salinity: 29.0‰ – 30.2‰ (concrete tank) and 29.0‰ – 29.9‰ (fiberglass tank); DO: 5.0 mg/L – 5.5 mg/L (concrete tank) and 4.6 mg/L – 5.6 mg/L (fiberglass tank); and pH: 7.01 – 8.32 (concrete tank) and 7.20 – 7.98 (fiberglass tank). From the results of this activity, it can be concluded that silver pompano *Trachinotus blochii* larvae reared in concrete tank have a higher survival rate (SR) than fiberglass tank.

Table 1. Length, Amount, Density, and Survival Rate of Silver Pompano *Trachinotus blochii* Larvae in Different Tanks

	Cycle No.1		Cycle No.2		Cycle No.3	
	Concrete	Fiberglass	Concrete	Fiberglass	Concrete	Fiberglass
Initial length (cm)	0.22	0.22	0.22	0.22	0.22	0.22
Final length (cm)	1.52	1.53	1.55	1.58	1.58	1.65
Initial amount (Ind)	216,000	135,000	150,000	90,000	200,000	125,000
Density (Ind/L)	27.000	27.000	18.000	18.000	25.000	25.000
Final amount (Ind)	57,000	30,000	35,000	15,000	50,000	20,000
Survival rate (%)	26.39%	22.22%	23.33%	16.67%	25.00%	16.00%

AQUACULTURE: QUANTITY OR QUALITY

Ahmed Mustafa, Ph.D.

Professor, Department of Biological Sciences
Purdue University Fort Wayne
Fort Wayne, IN 46805
Email: mustafaa@pfw.edu

The world's population is rising and the subsequent demand for high protein sources of food is rising with it. A push for healthier sources of protein is also an increasing demand. Hence, aquaculture is rising in prevalence and importance in today's society with the increase in fish consumption and the limitations imposed by normal fishing methods. Aquaculture offers a solution to these issues by providing high quality protein foods that require less space to farm, a lesser time to harvest, and a lower cost to produce, and it is lesser detrimental to the environment. However, current aquaculture techniques involve the use of chemicals in order to reduce disease and mortality within the crops, caused by crowding, handling, transportation etc. In order to provide solutions to the problems of farming and the needs of the people without the use of potentially harmful substances many researchers are looking in to the use of nutraceuticals (functional food) in order to decrease stress responses, increase immune responses, increase growth, and increase the nutritional value of farmed aquatic animals – both fish and shellfish. In this presentation, I will highlight all these issues and suggest solutions.

STUDIES ON SOME BIOLOGICAL ASPECTS AND PREVALENCE OF GASTROINTESTINAL PARASITES OF *Schilbe mystus* FROM ZOBE RESERVOIR KATSINA STATE, NIGERIA

*Abdulsalam Sani Nababa, Armaya'u Hamisu Bichi, and Gambo Aliyu Umar

Department of Fisheries and Aquaculture
Federal University
Dutsin-ma, Katsina
Email: naababa77@gmail.com

Biological aspects of an African Butter Catfish (*Schilbe mystus*) was studied from Zobe reservoir in Dutsin-Ma, Katsina State, Nigeria between the April and July, 2023. A total of 240 fresh fish samples of *Schilbe mystus* were collected from fishermen at the research locations, fish samples were randomly collected weekly from three (3) selection locations from fish folk using various fishing gears (Long line, nets and Traps). Understanding the ecological aspects of this species is crucial for effective fisheries management and conservation efforts. This study was carried out to provide a baseline data of the biological characteristic of the specie by studying the feed and feeding habits, growth pattern, length-weight relationship, condition factor, and prevalence of intestinal parasite associated with the specie. The stomach score/fullness was observed using five scale of of 0, 25, 50, 75 and 100 representing Empty, ¼, ½, ¾, and full respectively. Results revealed that this species exhibits a diverse diet, primarily composed of aquatic insects, planktons, algae, and detritus. Their feeding activity displayed omnivorous, feeding on plant and animal materials. The length-weight relationship of *S. mystus* was examined using meter rule and sensitive scale and with the equation $W = aL^b$, where 'W' represents weight, 'L' represents length, 'a' is the intercept, and 'b' is the exponent. The b values of 3.48, 3.37, and 3.37 for males, females, and combined samples respectively were obtained, indicating positive allometry growth pattern. The analysis also demonstrated a significant positive correlation between length and weight. The K factor was determined using the formula $K = (W / L^3) \times 100$. The average condition factor for the combined sexes, males and females was 0.71, 0.72, and 0.72 respectively, indicating that the species are thriving well in the reservoir. The endoparasitic fauna found (29.05%) were recovered mainly *Gyrodactylus sp, Diplostomum Spathaceum, Acanthosentis tilapiae* and *Ascaris sp.* Female fish samples had a comparatively greater number of infestations 23(25.84%) whereas the male fish samples documented 11(39.28%) *Schilbe mystus* sampled obtained from Zobe indicated that fish samples within the length of 21-25 cm sheltered more parasites 20(74.07%), followed by 15.1-20.0cm 9(25.71%), while those within the length of 10-15 cm had smaller parasitic load 5 (9.09%). These findings can contribute to a better understanding of the biological attributes of this species and can be instrumental in the development of effective conservation and management strategies for sustaining its populations in African freshwater ecosystems.

Table 1: Length-weight Relationship Parameters, Condition factor and Growth Pattern of *Schilbe mystus* from Zobe Reservoir, Dutsin-Ma, Katsina State.

Sex	N	Regression Coefficient		Correlation Coefficient (r)	Condition factor (K)	Growth Pattern
		a	b			
Male	57	-2.73	3.48	0.99	0.72	**A+**
Female	183	-2.58	3.37	0.99	0.72	**A+**
Combined	240	-2.59	3.37	0.99	0.71	**A+**

USING MONITORING EQUIPMENT FOR REAL-TIME ANALYSIS OF WATER QUALITY CONSTITUENTS

Kerry Caslow

hrisatti@in-situ.com

Constant changes are taking place in any aquaculture facility, whether indoors or outdoors, and it is vital that these systems are monitored for changes that could negatively affect organisms living in them. Technology improvements allow users to collect data directly on site using single or multiparameter instrumentation instead of being required to collect a sample for laboratory analysis. In addition to collecting periodic data, real-time data is available using telemetry systems that can feed data into nearly any data hosting platform. Data provided by a monitoring instrument in this application should at a minimum include temperature and dissolved oxygen, but additional parameters of interest can also be monitored, such as turbidity, nitrate, algae, and more. Having data available instantaneously allows users to make real-time decisions on operational adjustments including feeding and aeration timing. As the push for larger and higher quality yields continues to increase due to population growth and demand, the risk of losing harvests becomes more of a financial detriment to farms than ever before. An easy-to-use piece of monitoring equipment can allow users to rest easy knowing that tanks and pens are being accurately sampled – possibly without even being physically present.

EVALUATING THE DIETARY TRANSITION OF TROPICAL ANGUILLID EEL *Anguilla marmorata* ELVER FROM DOUGH TO CRUMBLE DIETS

Cedric Jay Nantong*, Kelee Ira B. Nodque, Fredson H. Huervana, Rizza Mae T. Guyapale, Michelle Rose M. Fajemolin, and Rex Ferdinand M. Traifalgar

Institute of Aquaculture
College of Fisheries and Ocean Sciences
University of the Philippines Visayas
Miagao, Iloilo, Philippines
fhhuervana@up.edu.ph

Typical anguillid eel diets in the nursery stage are primarily prepared as dough-type feeds. However, using dough-type feeds deteriorates the water quality and requires more intensive water management measures. Moreover, nutrient leaching is highly observed on dough-type feeds. Alternatively, dry feeds can be used for a more efficient eel culture due to ease of handling and are also reported to have positive effects on fish growth performance. However, as eels are not adept at consuming dry feeds, the introduction of a crumble diet during their early life stage can facilitate better weaning to pelleted feeds. Hence, this study evaluated the effect of different weaning strategies from dough to crumble of *A. marmorata* larvae.

Four different weaning strategies (25% and 10% daily replacement of dough by crumble, 100% dough, 100% crumble) were evaluated for the growth performance of *A. marmorata* elvers (ABW = 0.19g, mouth gape = 1.31mm). Crumble diet was sieved to a size of 0.5 mm. Treatments were done in triplicates in a completely randomized design (CRD). The study lasted for 14 days.

Results from the study showed that the highest specific growth rate (SGR) and percent weight gain (%WG) were recorded for elvers in treatment with 25% replacement of dough per day. Meanwhile, poorest SGR and %WG was observed for elvers fed with 100% dough. This indicates that earlier feeding of crumble is more efficient and utilization of crumble diet promotes higher growth in the brackishwater nursery culture of *A. marmorata*.

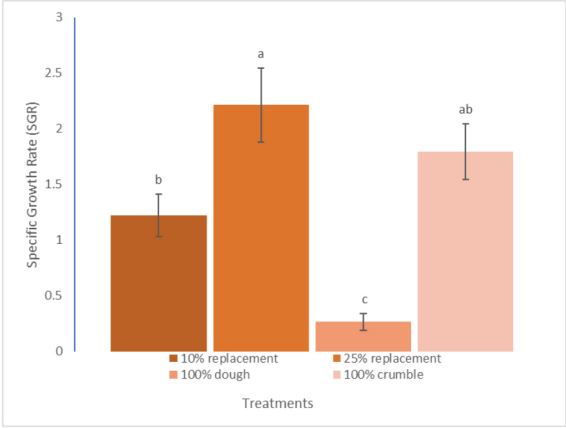


Figure 1. Specific growth rate (SGR) of *A. marmorata* elvers reared under different treatments. Values are the means of the replicates ± SEM (n=3). Bars with different superscript letters are significantly different from each other ($p < 0.05$).

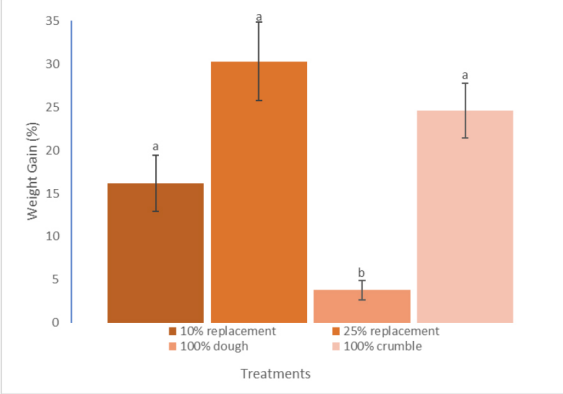


Figure 2. Weight gain (%) of *A. marmorata* elvers reared under different treatments. Values are the means of the replicates ± SEM (n=3). Bars with different superscript letters are significantly different from each other ($p < 0.05$).

DIETARY SUPPLEMENTATION OF MIXED BACILLUS SPECIES PROBIOTICS IMPROVED SURVIVAL OF WHITE SHRIMP *Penaeus vannamei* EXPOSED TO PATHOGENIC *Vibrio harveyi* AND *Vibrio parahaemolyticus*

Mark Rowel Napulan[*1], Ramir Lee[1], Craig L. Browdy[1], Carmelo del Castillo[2], Rex Ferdinand Traifalgar[2], Fredson Huervana[2], Rowena Cadiz[2] and Emelyn Joy Mameloco[2].

[1]Zeigler Bros., Inc.
400 Gardners Station Rd. Gardners, PA 17324
mark.napulan@zeiglerfeed.com
[2]Institute of Aquaculture, College of Fisheries and Ocean Sciences
University of the Philippines Visayas

Vibrio species are among the primary disease-causing agents of cultured fish and shrimp. *Vibrio harveyi* and *Vibrio parahaemolyticus* are two species reported to cause significant losses in penaeid shrimp hatchery and grow-out cultures. The use of probiotics has been documented as a promising strategy in preventing and controlling vibriosis infection in shrimp aquaculture.

The present study evaluated the effect of prefeeding a Bacillus probiotic (Rescue Zeigler USA) on growth and pathogenicity of *V. harveyi* and *V. parahaemolyticus* in juvenile white shrimp *Penaeus vannamei*. To evaluate gut colonization, Rescue was fed to shrimp at a dose of 0, 100, 1000, and 5000 mg kg^{-1} feed followed by periodic bacillus agar counts. Bacillus colony numbers in shrimp gut fed 1000 and 5000 mg kg^{-1} feed reached 6.39×10^5 and 5.69×10^5 cfu ml^{-1} respectively after 144 hours. To evaluate the effect of probiotics on vibrio pathogenicity, shrimp were pre-fed a commercial shrimp feed top coated with Rescue at a dose of 1000 mg kg^{-1} feed for 6 days prior to the challenge. Shrimp continued to receive Rescue top-coated feed during the 21-day challenge phase. From the seventh day forward, *V. parahaemolyticus* and *V. harveyi* were administered by top-coating feed at a predetermined LD50 of 1×10^7 cfu ml^{-1} once daily for the duration of the trial. The challenge trials were repeated twice, with vibrio challenge doses top coated on morning or afternoon feedings. Vibrio numbers in shrimp guts were determined daily by TCBS plate counts.

Although in vitro testing demonstrated significant bacteriocidal activity, in vivo results showed variation in Vibrio colony numbers over time, with no clearly significant differences between treatment groups. Mortality curves indicated that *V. harveyi* exposed shrimp fed Rescue probiotic exhibited a 33% to 44% improvement (morning 66%, afternoon 60%) in survival as compared to the control group (morning 44%, afternoon 46%). Groups exposed to pathogenic *V. parahaemolyticus* showed that the treated group receiving the Rescue probiotic exhibited 28% to 40% improvement in survival (morning 51%, afternoon 66%) as compared to the control group (morning 40%, afternoon 47%). It may be hypothesized that the significant improvement in survival of the Rescue treated groups following *V. harveyi* and *V. parahaemolyticus* exposure may be attributed to a reduction in the virulence of these bacterial shrimp pathogens in vivo. Further research will be needed to better elucidate the mode of action. Pond trials with 3 replicates resulted in a 31% reduction on average total vibrio count in shrimp's gut. Collectively, supplementation of *P. vannamei* feeds with Rescue probiotics at a dose of 1000 mg/kg diet significantly reduced mortalities following infection with pathogenic *V.harvey*i and *V. parahaemolyticus*.

CREATING WORKFORCE PATHWAYS BY EDUCATING YOUTH THROUGH AQUACULTURE

Elliot Nelson*, Dr. Barbara Evans

Center for Freshwater Research and Education
100 Salmon Run Way
Sault Ste Marie, MI 49783
Collaboration Suite 201D
elliotne@msu.edu

Aquaculture is the fastest growing sectors of food production worldwide and is vitally important to obtaining sustainable food security in the future. However, in the United States aquaculture continues to grow at a sluggish pace and is often misunderstood or completely unknown to many U.S. consumers.

In an effort to increase awareness for the next generation of seafood consumers and create defined pathways into the aquaculture workforce many extension educators and academics are creating K-12 aquaculture programs and working closely with K-12 schools to help integrate aquaculture curriculums into classrooms. A model initiated in Michigan that consists of three core initiatives geared toward creating a new aquaculture work force and an educated consumer base has arisen. The core tenants of this program include 1) K-12 Teacher trainings and assistance with teacher networking 2) K-12 curriculum development and a high school aquaculture competition and 3) Post-secondary programs identified and/or created.

The efforts that have been taking place in Michigan and the Midwest are centered around the Youth Education in Aquaculture Initiative (http://ncrac-yea.org/), an effort funded through a variety of funding partners including the North Central Regional Aquaculture Center, Michigan Sea Grant and the Center for Great Lakes Literacy. This program was started by Lake Superior State University Professor Dr. Barbara Evans, and is now co run by Dr. Evans and Elliot Nelson with Michigan Sea Grant. Through this effort a network of schools is being created to allow for cross school collaboration. In addition teacher trainings and curriculum resources are being compiled and offered. The keystone of the program is the Aquaculture Challenge, a competitive high school competition aimed towards engaging high schools in an integrative STEM and business competition. In addition new post-secondary programs have been created and are now seeing graduates who come through the high school programs and enter into post-secondary programs. This session will focus on these efforts and how they are leading to a clear and defined pathways into the aquaculture workforce.

MANAGGING SHRIMP DISEASE OUTBREAKS VIA BEST FARM-MANAGEMENT PRACTICES AND PREMIUM AND/OR FUCNTIONAL FEEDS

Nguyen Duy Hoa, PhD.

Technical Director
Empyreal Products
Cargill Inc.
Tel: +84 - 703515168
Email: Duyhoa_nguyen@cargill.com

Shrimp disease outbreak has tremendously impacted shrimp farmers worldwide with blooming of several vibriosis and fungal disease, and also microsporidian disease (EHP). Polluted environment and the usage of the antibiotics and different chemicals in shrimp farming practices have resulted in more challenges for shrimp industry. High-quality postlarvaes, best farm management practices together with premium and/or functional feeds and top-dressing health additives as well as innovative culture system need to be addressed & developed all together to provide more sustainable solutions and approaches for shrimp industry.

As shrimp is very primitive animal that is highly sensitive to all stress triggers. Therefore, combined solutions and approaches will be provided and discussed with focusing more on managing the water-quality parameters & vibriosis sp. in the optimal ranges to reduce shrimp stress as well as the health nutrients from different additives and novel proteins to formulate premium and/or functional feeds for enhancing stress resistant will also be discussed as well.

MOTIV – a bioactive corn protein concentrates produced by Cargill Inc. in North America through a proprietary fermentation process to unlock more potential from protein and to provide additional health nutrients for shrimp gut health and antistress enhancement to improve on shrimp growth, feed conversion, shrimp color and survivability will also be introduced and highlighted with results of the research trials for shrimp feed industry as well.

EMPOWERING AQUACULTURE: INNOVATIONS IN APPLIED ANIMAL WELFARE TECHNOLOGY AND EDUCATION

Marius Nicolini*, Murilo Quintiliano, Pau Badia

FAI Farms Ltd
The Barn
Wytham, Oxford, OX2 8QJ, United Kingdom
marius.nicolini@faifarms.com

FAI Farms has been dedicated to advancing aquatic animal welfare since 2018, when they initiated the development of a welfare assessment protocol specifically tailored for tilapia[1], drawing upon existing scientific literature in conjunction with practical insights from farmers. This approach ensures that operational welfare indicators are not only scientifically sound but also resonate with the everyday realities of farming. By empowering farmers to view their production through a welfare lens, it enable them to adapt their practices to ensure the well-being of their fish.

Reflecting on the work done from 2018, FAI Farms has focused on disseminating this knowledge and assessment methodology widely. This effort has culminated in the creation of two key resources: the Tilapia Welfare App and an the Aquaculture Welfare Course Modules

The Tilapia Welfare App seamlessly integrates well-established animal welfare science into farmers' daily routines. It serves as a comprehensive tool for monitoring progress, identifying areas for improvement, and offering real-time insights to users. Whether used for self-assessment or as a third-party evaluation tool, the app enables farmers to share results with stakeholders, including certification bodies, thereby ensuring adherence to good production practices and promoting positive outcomes.

FAI Farms Aquaculture Welfare Course Modules are delivered both by a dedicated e-learning platform or in person trainings covering welfare principles for three different species: tilapia, white-leg shrimp, and grass carp. These modules delve into the fundamental aspects of assessing nutritional, environmental, health, and behavioral needs of tilapia, offering practical guidance on feed selection, feeding routines, husbandry practices, and utilization of Nutrition Welfare Indicators.

The response to FAI Farms initiatives has been overwhelmingly positive, with over 5000 aquaculture stakeholders currently enrolled in the courses platform and more than 300 farmers actively utilizing the Tilapia Welfare App. This growing user base underscores the industry's keen interest in leveraging online solutions and new technology to farm sustainably, highlighting a collective commitment to responsible aquaculture practices.

Pedrazzani AS, Cozer N, Quintiliano MH, Tavares CPDS, Biernaski V, Ostrensky A. From egg to slaughter: monitoring the welfare of Nile tilapia, Oreochromis niloticus, throughout their entire life cycle in aquaculture. Front Vet Sci. 2023 Sep 21;10:1268396. doi: 10.3389/fvets.2023.1268396. PMID: 37808101; PMCID: PMC10551173.

DIETARY TRANSITION OF TROPICAL ANGUILLID EEL *Anguilla marmorata* LARVAE FROM FISH MEAT TO FISH MEAL BASED FORMULATED FEED: A PRELIMINARY EVALUATION

Kelee Ira B. Nodque*, Fredson H. Huervana, Cedric Jay A. Nantong, and Rex Ferdinand M. Traifalgar

Institute of Aquaculture
College of Fisheries and Ocean Sciences
University of the Philippines Visayas
Miagao, Iloilo, Philippines
fhhuervana@up.edu.ph

Anguilla marmorata is one of the species of anguillid eels mainly cultured in the Philippines. As they are known to be predatory, eels are primarily fed with carnivorous diets during their early life stages. Due to this behavior, weaning to an artificially formulated diet during the nursery stage is challenging. As weaning strategies on brackishwater nursery culture of *A. marmorata* are not highly tackled, this study focused on the development of an effective weaning strategy on the brackishwater nursery culture of *A. marmorata* elvers. Specifically, this study aimed to evaluate the growth performance of *A. marmorata* elvers when transitioning from fish meat to fish meal-based formulated feed.

Different weaning strategies on the dietary transition of *A. marmorata* elver (0.15g) from fish meat (70% fish meat, 23% potato starch, 5% yeast, 2% vitamins and minerals) to fish meal-based (70% fish meal, 23% potato starch, 5% yeast, 2% vitamins and minerals) formulated artificial diet were tested. Treatments include feeding with a combination of fish meat and fish meal (10% and 5% reduction of fish meat per day) and feeding with 100% fish meat and 100% fish meal-based formulated diet throughout the experiment.

After 28 days of culture, results revealed that a gradual reduction of 5% fish meat per day led to a significantly high specific growth rate (SGR), percent weight gain (%WG), and survival ($p < 0.05$) of *A. marmorata* elvers. Conversely, the lowest growth performance were observed with elvers fed with 100% fish meal and lowest survival was observed with elvers fed with 100% fish meat. These results indicate that combining fish meat and fish meal as feed ingredients could aid in the effective weaning of elvers to artificially formulated diets. Moreover, a longer weaning period can efficiently facilitate their weaning during the nursery stage.

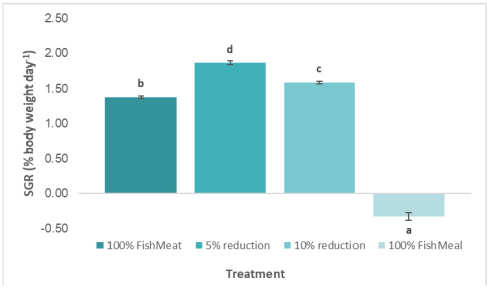


Figure 1. Specific growth rate (SGR)

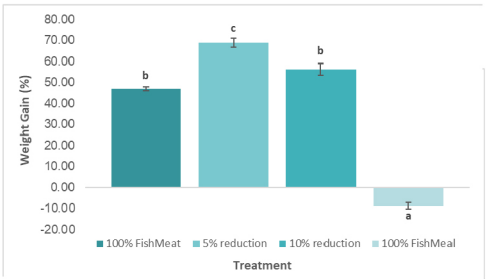


Figure 2. Weight gain (%) of *A*

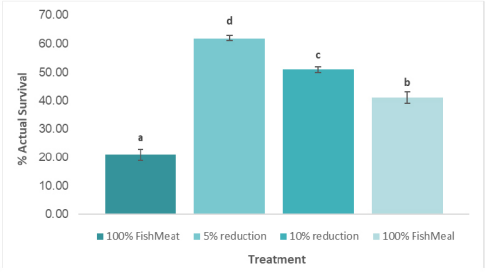


Figure 3. Actual survival (%) of *A.*

CO-INFECTIONS OF *Edwardsiella ictaluri* AND *Aeromonas hydrophila* IN CAGE CULTURED *Pangasianodon hypophthalmus* IN PAHANG RIVER, MALAYSIA

N Amira-Syahidah*, M Nur-Nazifah, R Rimatulhana, AA Sabuti

Department of Marine Science, Kulliyyah of Science
International Islamic University Malaysia
Bandar Indera Mahkota, Jalan Sultan Ahmad Shah
25200 Kuantan, Pahang, Malaysia
amirasyahidahnordin@gmail.com

Striped catfish, *Pangasianodon hypophthalmus* is significant species cultured in Malaysia. One of the major threats to striped catfish is bacterial disease. Two major bacterial species that cause disease in striped catfish are *Edwardsiella ictaluri* and *Aeromonas hydrophila*. This study was conducted to simultaneously identify both pathogens in cage-cultured *P.hypophthalmus* in the Pahang River using multiplex PCR (M-PCR) during an 8-month culture period. Sampling of *P.hypophthalmus* was conducted at two local farms in Pekan, Pahang i.e., Kampung Tanjung Pulai and Kampung Acheh. Thirty fish were sampled monthly from each farm, and four organ tissues were taken, which were the liver, spleen, kidney, and brain, for further analysis. DNA was extracted from all tissue organs and pursued for M-PCR to detect the presence of *A.hydrophila* and *E.ictaluri*.

The prevalence rate of *E.ictaluri* at Kampung Tanjung Pulai was highest in May and June, which was 6.67%, and the lowest in April, which was 3.33%. Whereas the prevalence rate of *A.hydrophila* was high in April and September, which was 10% (Figure 1). At Kampung Acheh, the prevalence rate of *A.hydrophila* was the highest, with 13% in September. Meanwhile, *E.ictaluri* appeared only in May and June with 6.67% and 3.33% of prevalence, respectively. The susceptible size of *P.hypophthalmus* against *E.ictaluri* is 1 gram to 200 grams. Meanwhile, the most vulnerable size of *P.hypophthalmus* against *A.hydrophila* is between 350 grams to 400 grams (Figure 2).

In conclusion, *E.ictaluri* and *A.hydrophila* were successfully identified simultaneously using multiplex PCR where the prevalence and susceptible size towards *Pangasius hypophthalmus* had been determined. Fast detection of multiple pathogens in different life stages of fish is very important in prevention and disease management which can reduce mass mortality.

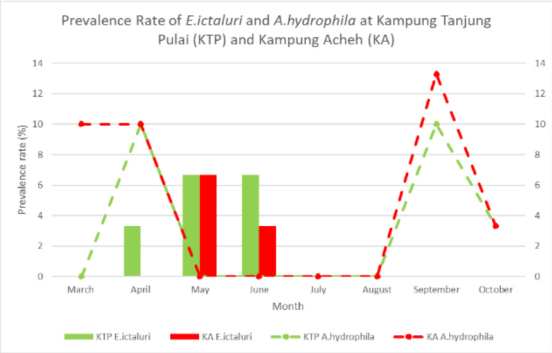


Figure 1: Prevalence rate of *E.ictaluri* and *A.hydrophila* at Kampung Tanjung Pulai and Kampung Acheh

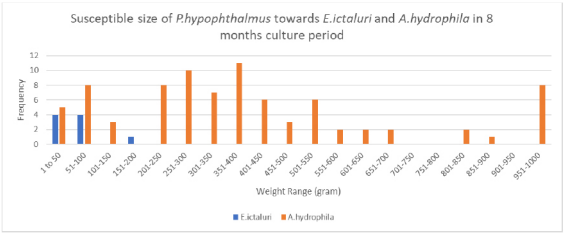


Figure 2: Susceptible size of *P.hypophthalmus* towards *E.ictaluri* and *A.hydrophila*

BUFFER-PROTECTED SODIUM BUTYRATE PROTECTS BRINE SHRIMP *ARTEMIA* AGAINST *Vibrio campbellii*

Parisa Norouzitallab*, Kartik Baruah, Marta Arredondo, Beatriz Saldaña, Marisela Arturo-Schaan

Department of Applied Animal Science and Welfare
Faculty of Veterinary Medicine and Animal Sciences
Swedish University of Agricultural Sciences
750 07 Uppsala, Sweden

In the past few years, shrimp culture has constantly evolved into more intensive production to meet the rising demand for animal protein. However, intensification has introduced a variety of challenges, including the occurrence of disease outbreaks. One such disease that continues to cause profound impact on the farmed shrimp sector globally is vibriosis, caused by bacterial species, such as *Vibrio campbellii, V. harveyi and V. parahaemolyticus*. To control vibriosis in farmed shrimp like *Penaeus vannamei,* there has been a continuous effort in developing more effective antimicrobial strategies as an alternative to antibiotics. In this study, we evaluated the potential of a protected sodium butyrate (PSB) in controlling vibriosis in shrimp. We used germ-free brine shrimp *Artemia* nauplii and *V. campbellii* as a host-pathogen model organism.

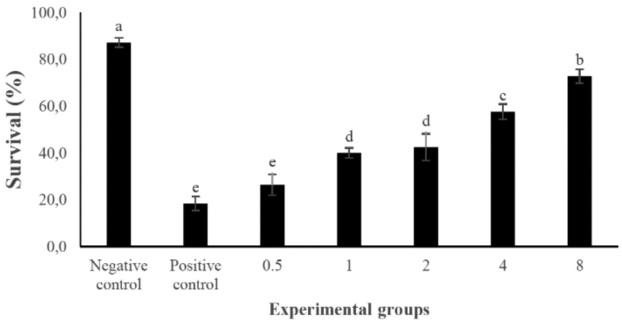
In this experiment, 5 treatments with different inclusion levels of PSB (0.5, 1, 2, 4, and 8 g/L of PSB) were used. PSB was provided by Novation SL 2002 (Spain) with 54% sodium butyrate protected by a physical and chemical matrix of buffer salts. Germ-free *Artemia* nauplii were obtained following decapsulation and hatching. Groups of 25 nauplii were transferred to sterile glass tubes that contained 25 ml of sterile artificial seawater. The tubes were added with PSB in different doses, and simultaneously inoculated with the *V. campbellii* pathogen at 10^7 cells/ml. The *Artemia* therein were also fed with autoclave LVS3. After feeding and the addition of PSB, the glass tubes were incubated. The survival of *Artemia* were scored 2 days after the addition of the pathogen. As control groups, untreated larvae that were not challenged with *V. campbellii* (negative control) or challenged (positive control) were used.

Results showed that PSB caused a significant effect on the survival of *Artemia* challenged with *V. campbellii*. The nauplii that were exposed to PSB at a dose of 8 g/L had a maximum survival of over 70%, whereas the positive control recorded survivals of around 18%.

To ensure the reproducibility of the results, we repeated the challenge test using the most effective doses. Reproducibility tests showed that the higher dose of PSB (8 g/L) exhibited a significantly higher survival of 84.0 % and 88.0 % in the first and second repeats, respectively.

In conclusion, PSB was highly effective in protecting brine shrimp *Artemia* against pathogenic *V. campbellii*. Validation trials conducted in Brazil using the dose optimized (4 and 8 g/Kg) in *Artemia* assay in *Penaeus vannamei* had shown to improve the performance indices and an improvement in the resistance of the shrimp towards nitrite challenge.

Active ingredient	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5
PSB (dose based on shrimp; kg/ton)	0.5 kg	1kg	2kg	4kg	8kg
Dose for artemia (g/L)	0.5g	1g	2g	4g	8g



SESSION I. BROODSTOCK MANAGEMENT, MATURATION AND SPAWNING

FROM GENES TO TRAITS: EPIGENETICS IN FISH AND SHELLFISH BROODSTOCK MANAGEMENT

Parisa Norouzitallab*, Farid Ghazian, Michelle Warren, and Kartik Baruah

Department of Applied Animal Science and Welfare
Faculty of Veterinary Medicine and Animal Sciences
Swedish University of Agricultural Sciences
750 07 Uppsala, Sweden

parisa.norouzitallab@slu.se

In an aquaculture hatchery, the main goal is to maximize the production of high-quality larvae. The quantity and quality of these larvae are largely influenced by the condition of the broodstock and the management practices followed. Broodstock, which are the breeding individuals responsible for producing offspring in aquaculture operations, play a key role in the success of culture production. Thus, broodstock condition is vital for achieving successful breeding outcomes. Conditioning the broodstock principally involves providing them with optimal environmental conditions and a balanced diet to enhance reproductive performance. In recent years, interest in epigenetics has been gaining ground in leveraging it to manage fish and shellfish broodstock effectively, aiming to improve their health, reproductive success, and the quality of their progeny. Epigenetics is the study of heritable changes in gene expression that do not involve alterations to the underlying DNA sequence. In aquaculture animals, epigenetic modifications such as DNA methylation, histone modifications, and non-coding RNAs have been identified as key regulators of gene expression patterns. These modifications can be influenced by various environmental cues, including feed, nutraceuticals, and temperature. By modulating gene expression, epigenetic mechanisms can impact traits relevant to broodstock management, such as growth, robustness, and reproductive performance. Here, we discuss various epigenetic-based interventions and their potential contributions to improving broodstock health and reproductive success, enhance offspring quality, and ultimately fastening the continued growth and success of the aquaculture sector.

ANTIBIOTICS SENSITIVITY OF *Vibrio alginolyticus* INFECTED MARINECULTIVATION IN RIAU ISLANDS PROVINCE IN 2023

Tanjung D.O. Nugraheni*, Fitria, and Sitta AprianingBatam Station for Mariculture

Directorate General of Aquaculture
Ministry of Marine Affairs and Fisheries of Indonesia
Barelang, Jembatan 3, Pulau Setokok, Bulang
Batam, Riau Is lands Provincetanjungdon@gmail.com

The misuse of antibiotics promotes antimicrobial resistance. This has been a matter of concernin aquaculture. Marine cultivation could contain antimicrobials once they had been given in the feed, medicine, then got into the water. Antimicrobials Susceptibility Test (AST) needs to be conducted in order to perform sensitivity of bacteria to certain antibiotics. The purpose of this research is to examine the sensitivity of *Vibrio alginolyticus* infected marine cultivation in Riau Islands Province in 2023 to Tetracycline, Oxytetracycline, and Enrofloxacine.

Purposive random sampling of marine cultivation had been conducted at Batam Station for Mariculture and its surrounding in Riau Islands Province on January to August 2023. Biochemical tests and API 20 E kit were used to identify *Vibrio alginolyticus*. Disc Diffusion Agar method had been applied to perform Antimicrobials Test Susceptibility of *Vibrio alginolyticus* on Oxytetracycline (30 μg), Tetracycline (30μg), and Enrofloxacine (5μg). Inhibition zone was measured to determine the level ofantibiotics sensitivity.

The results show that 30 bacteria of *Vibrio alginolyticus* are susceptible to Enrofloxacine, 26 bacteria of *Vibrio alginolyticus* are susceptible to Tetracycline, and 21 bacteria of *Vibrio alginolyticus* are susceptible to Oxytetracycline. Among them, 4 bacteria of *Vibrio alginolyticus* are intermediet to Tetracycline, 8 bacteria of *Vibrio alginolyticus* are intermediet to Oxyetracycline, and 1 bacteria of *Vibrio alginolyticus* is resistant to Oxytetracycline. All of the samples are not resistant to Enrofloxacine and Tetracycline. Therefore Enrofloxacine, Tetracycline, and Oxytetracycline can be used to overcome *Vibrio alginolyticus* infected marine cultivation. However, Enrofloxacine is more recommended to overcome *Vibrio alginolyticus* infected marine cultivation since its inhibition zone is wider than others. Antibiotics should be used prudently in a long time to prevent antimicrobials resistance on marine cultivation.

MINIMUM DIETARY LEVEL AND MIX RATIO OF KRILL MEAL AND FISH MEAL TO ELICIT FEED INTAKE AND GROWTH PERFORMANCE IN JUVENILE *Penaeus vannamei*

Alberto J.P. Nunes*, Jordana Leite, Caio Gomes, Ragnhild Dragøy, Lena Burri

LABOMAR - Instituto de Ciências do Mar
Universidade Federal do Ceará
Avenida da Abolição, 3207 – Meireles
Fortaleza, Ceará, 60.165-081, Brazil
alberto.nunes@ufc.br

Global production of farm-raised shrimp has significantly increased in recent years leading to oversupply and unfavorable market shrimp prices. As the industry aims to adapt, seeking production and economic efficiency, feeds become a crucial element for cost rationalization. This study determined the minimum dietary level of fish meal (FML) and krill meal (KRM) and their mix ratio to elicit feed intake and growth performance in *Penaeus vannamei*. Ten diets were formulated with graded FML (90, 60, 30 g kg^{-1}) in combination with 15, 30, and 45 g kg^{-1} KRM, and a control diet with 120 g kg^{-1} FML. Shrimp (1.28 ± 0.08 g body weight, BW) were stocked in seventy 1-m^3 tanks (135 animals m^{-2}) and after 88 days their growth performance was determined. Feed preference was assessed through two-by-two comparisons in twenty 0.5-m^3 tanks over four weeks. No significant differences in survival (93.9 ± 4.5%), gained yield (1,235 ± 92 g m^{-2}), and feed conversion ratio (1.47 ± 0.09) were observed. Diets with 60 g kg^{-1} FML led to faster growth and higher feed intake than 30, 90 and 120 g kg^{-1} FML. Shrimp on 30 g kg^{-1} FML diets had the lowest BW, especially with 30-15 (FML-KRM) and 30-30 diets. Diets with 90 g kg^{-1} FML outperformed 30 g kg^{-1} FML. The control diet had higher body weight than diets 30-15 and 30-30, showing similar results to other diets except 60-15. Feed preference was influenced by KRM inclusion, with 15 g kg^{-1} KRM resulting in higher apparent feed intake than 30 and 45 g kg^{-1}. The findings indicate that higher levels of KRM and FML in combination do not contribute to greater feeding stimuli or enhanced growth performance. These results enable the reduction of their utilization, from 120 to 60 g kg^{-1} FML and from 45 to 15 g kg^{-1} KRM, while still stimulating feed intake and growth performance in whiteleg shrimp.

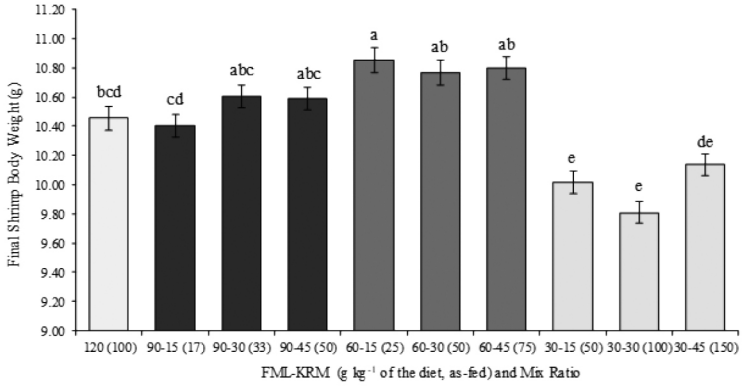


Fig. 1: Mean (± standard error) body weight (BW) of P. vannamei after 88 days of rearing under 135 shrimp m^{-2}. Shrimp were raised with diets with different dietary levels of fish meal (FML) and krill meal (KRM) and mix ratio. Each column is the mean BW obtained from seven rearing tanks. Common letters indicate non-statistically significant differences according to Tukey's test at $\alpha = 0.05$ significant level.

WATER QUALITY, IMMUNITY AND PRODUCTION PARAMETERS OF BANANA SHRIMP *Fenneropenaeus merguiensis* CO-CULTURED WITH SEAWEED *Caulerpa lentillifera* UNDER LABORATORY CONDITIONS

Abidin Nur*, I Rizkiyanti, L Ruliaty, E K M Kontara, A Taslihan, M Soleh, D Suwoyo and D Soeharmanto

Fisheries Research Centre
National Research and Innovation Agency
Indonesia
*abidinnoer2@gmail.com

Disease prevention and control is a top priority in an effort to maintain the resilience of the shrimp farming industry. In an integrated culture system, seaweed is widely used and reared together with shrimp and is a cheap and easy remedy at the farmer level. Seaweed is rich in bioactive compounds and produces various types of secondary metabolites with broad-spectrum of biological activity. This activity aims to determine the effect of co-cultured of shrimp *F. merguiensis* and *C. lentillifera* on water quality, production, and immune parameters.

Shrimp post larvae (14.3±0.3 mg) were raised in six concrete tanks measuring 5.6 x 1.8 x 0.8 m (water depth 0.6 m) with a density of 50 ind/m2. These shrimps were co-cultured with *C. lentillifera* (CL) at two densities: 0.1 kg/m^2 and 0.2 kg/m^2, with one control as a treatment (no CL). Each treatment has two replications. Animal studies were fed a commercial diet (CP 42%) three times per day. At the termination of the experiment, a shrimp blood sample (n=4) from each experimental unit was collected for further examination of total hemocytes count (THC), phagocytic activity (AF), and phenoloxidase activity (PO).

Water quality for TAN-N (Total Ammonia Nitrogen) showed significant differences ($P<0.05$) after 8 weeks of cultivation, but not for PO4-P or organic matter (OM) (Table 1). *F. merguiensis* can tolerate dissolved oxygen (4.5-5.6 ppm), temperature (29.2-32.5 °C), salinity (30-32 ppt), and pH (7.9-8.5). Shrimp immunological parameters showed any improvement after co-cultured with CL (Figure 1).

Shrimp co-culture with CL had higher survival (80.7-84.1%) and biomass (564-566g) than the control, which were 65.3% and 371g, respectively. Furthermore, it can improve immunological parameters tested at a minimal CL density of 0.1 kg/m^2.

TABLE 1. TAN-N, PO4-P and organic matter concentration (ppm) during the experiment.

CL	TAN-N	PO_4-P	OM
0.0 kg/m^2	0.21±0.48	0.23±0.19	195±55
0.1 kg/m^2	0.11±0.30	0.18±0.16	185±78
0.2 kg/m^2	0.02±0.07	0.19±0.18	166±90

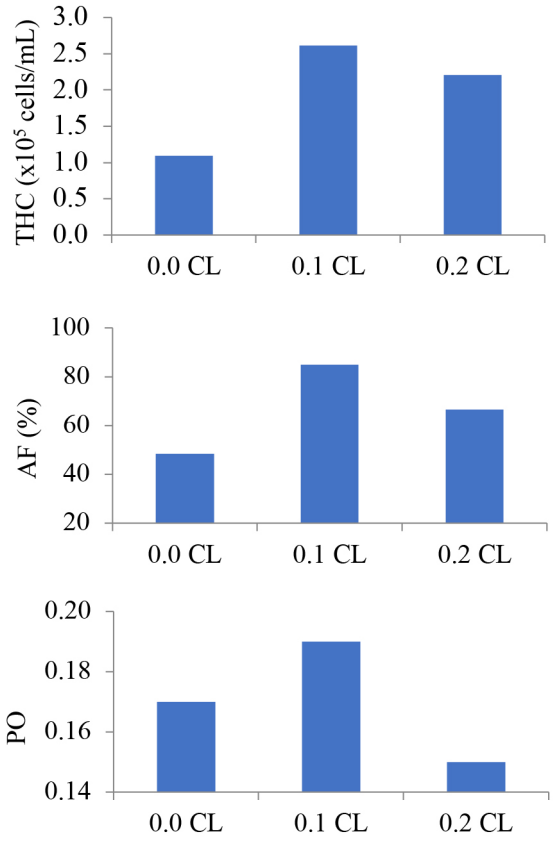


FIGURE 1. Effect of shrimp co-cultured with CL on THC, AF, and PO.

SERAPOH LEAVES *Chromolaena odorata* AFFECTS THE IMMUNE RESPONSE, RESISTANCE AND HISTOPATHOLOGY OF ASIAN SEABASS *Lates calcarifer* AGAINST *Vibrio alginolyticus* INFECTION

Nurbariah*, Sukenda, Sri Nuryati, Dinamella Wahjuningrum, and Widanarni

Brackishwater Aquaculture Centre
Ujung Batee, Aceh
nur.chy14@gmail.com

One of the challenges for the production process in fish farming is diseases, especially infectious diseases, resulting in lost productivity and economic losses. Numerous researchers have carried out the use of medicinal plants to treat fish diseases. This study aimed to evaluate the efficacy of Serapoh *Chromolaena odorata* leaf ethanolic extract in treating *Vibrio alginolyticus*-induced vibriosis in Asian Seabass *Lates calcarifer* using various frequencies and immersion times of the extract. The research examination involved a factorial completely randomized design in which immune response, survival rate, relative percent survival (RPS), and histopathology were evaluated as therapeutic efficacy markers.

The Asian Seabass (8.88±0.46 cm) was previously challenged with *V. alginolyticus* (10^7 CFU mL^{-1}) intraperitoneally, up to 0.1 mL $fish^{-1}$. As the therapeutic phase, Asian Seabass are immersed in an ethanol extract of serapoh leaves (86.3 mg L^{-1}) with a combination of various immersion treatments in frequency (every 1, 2, and 3 days) and duration (15, 30, and 60 minutes) for seven days each. Blood samples were collected to evaluate lysozyme activity and respiratory burst before the challenge test (H-0); as well as on the second (H-2); fourth (H-4) and seventh (H-7) days after the challenge test. The survival score of Asian Seabass after the challenge test with *V. alginolyticus* was used to determine resistance and treatment efficacy against Asian Seabass was measured by the relative percent survival (RPS) at the end of treatment. Liver samples were collected for histopathology at the end of treatment.

The results showed that the interaction between the frequency and duration of immersion in Serapoh leaf ethanolic extract was able to stimulate the immune system components, resulting in improved immunological response and survival rate (80%) of Asian Seabass following the challenge test. Based on an RPS value of 60% (Table 1) the most effective immersion treatment for overcoming vibriosis in Asian Seabass is 30 minutes every two days (P2.30). Histopathological analysis revealed image changes in liver tissue, indicating that Serapoh leaf ethanolic extract improves the immunological response of Asian Seabass, reducing the pathogenicity of *V. alginolyticus*.

Table 1 Mortality Percentage and Relative Percent Survival Asian Seabass

Treatments	Mortality (%)	RPS (%)
P1.15	45.0	10.0
P2.15	45.0	10.0
P3.15	35.0	30.0
P1.30	30.0	40.0
P2.30	20.0	60.0
P3.30	35.0	30.0
P1.60	35.0	30.0
P2.60	45.0	10.0
P3.60	40.0	20.0
Control (+)	50	0

SEAWEED ECOSYSTEM BASED ON INCLUSION SOCIO ECONOMIC VALUE FOR COASTAL COMMUNITY

Atikah Nurhayati [1], Titin Herawati [1], Budi Wardono [2]

1. Faculty of Fisheries and Marine Science, Universitas Padjadjaran
2. National Research and Innovation Agency,Indonesia
Email : atikah.nurhayati@unpad.ac.id

The potential for developing seaweed *Gracillaria* sp aquaculture in West Java is carried out by considering ecosystem aspects, the suitability of seaweed aquaculture and market potential. This research aims to analyze the factors that influence seaweed aquaculture in West Java and sociolect-economic inclusion for coastal communities. This research was carried out August 2023 - January 2024. The research method used was a mixed method. The data used is primary data using questionnaires to respondents and secondary data. The technique for taking respondents was using purposive sampling of 40 respondents. The analytical tools used are multiple linear regression and a sociolect-economic contribution matrix based on seaweed farming income. The production variables analyzed include: seeds (X_1), land area (X_2), labor (X_3), seaweed aquaculture business experience (X_4), capital (X_5), weather (X_6).Based on the research results of variables that influence simultaneously, namely; seeds (X_1), land area (X_2), capital (X_5) and weather (X_6). Socioeconomic inclusion for coastal communities from the results of seaweed cultivation, includes the poly-culture system of seaweed cultivation with milk fish, poly-culture cultivation with vaname shrimp, and processed milk fish which absorbs labor for coastal communities.

FORMULATION OF PROBIOTIC-DEVELOPMENT OF ENRICHED FEED FOR RAS NURSED HYBRID GROUPER

Ahmad Daud Om*, Ain Zulkurnain, Noordiyana Mat Noordin and Shumpei Iehata

Fisheries Research Institute Tanjung Demong
22200 Besut
Terengganu, Malaysia
daudom@dof.gov.my

Probiotics are being explored as an eco-friendly alternative to antibiotics in response to the growing demand for sustainable farming. A feeding trial was conducted to assess the impact of the probiotic, Bacillus cereus on the growth performance of hybrid groupers in a RAS system. The study involved isolating Lactic Acid Bacteria (LAB) from the gut of hybrid groupers, screening and identifying LAB isolates, and performing DNA extraction and sequence analyses to develop suitable probiotics for RAS. The potential candidates underwent gram staining and catalase tests, followed by antagonistic and enzymatic activity tests.

Subsequently, 5000 pcs of hybrid grouper (Initial BW 5.0 g) nursery feeding trial with using Bacillus cereus with a concentration of $4x10^9$ was supplemented in the diet during a 50-day feeding trial for juvenile hybrid groupers at CENTS-RAS facilities. Final body weight (BW) 49.39 g±7.36 (probiotics) vs 39.10 g±10.56 (BW) (control) were recorded effected by used probiotics. Survival was 85% for probiotics and 73% from control. The results indicated a 19% increase in biomass, rising from 27.29 kg/ton to 33.7 kg/ton (Fig 1). Proximate analysis of fish body composition revealed a significant increment in protein and lipid content with the probiotic's treatment compared to the control (Table 1).

That results demonstrated that B. Cereus supplemented as probiotics to hybrid grouper for 50 days improved growth performance, leading to enhanced biomass in this fish species nursed in RAS.

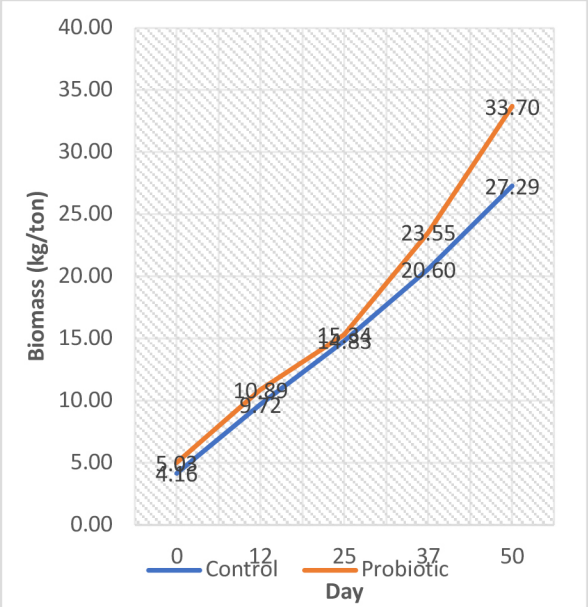


Fig.1 Growth performance of probiotic treatment compare with control in RAS facilities

That results demonstrated that B. Cereus supplemented as probiotics to hybrid grouper for 50 days improved growth performance, leading to enhanced biomass in this fish species nursed in RAS.

Nutrient	Control	Probiotic
Protein	74.47±4.72	80.35±2.17*
Lipid	7.34±1.40	11.17±2.64*
Moisture	6.45±0.08	5.47±0.39
Ash	8.00±0.42	8.93±0.46

Table 1. Body proximate composition of hybrid grouper juvenile fed in treatment probiotics vs control. Means in a column with star were significantly different (P>0.05)

WHAT CAUSE SHRIMP IMMNUNE SYSTEM CRIPPLE?

Si Mon Ong

HP Multi-lines, Inc
HGL Bldg.
554 EDSA Cor.
Biglang Awa St.
Caloocan, Metro Manila
ongsimon79@yahoo.com

Stress is the pressure that happen in shrimp that make them fall sick and later outbreak with disease that cause farmer losses all their investment. Shrimp is also a smart biological being; they also have it own mechanism to counter stress and has the ability to supress pathogen like virus and bacteria. One or two stresses, not a problem for the shrimp to counter it but what happen the stress prolong and with additional stress build up, for sure will break the shrimp immunity and outbreak pursue. Combination of stress factor like C:N ratio, vibrio, minerals, feed quality and plankton will break the shrimp immune respond beyond no return. When we understand how to overcome the stresses, we can have a better chance to harvest profitably.

GROWTH PERFORMANCE OF VARIOUS STRAINS OF SALINE TOLERANT TILAPIA REARED IN COASTAL SALINE PLASTIC-LINED PONDS

Mary Jessa Bell B. Pagapulan* and Rex Ferdinand M. Traifalgar

Institute of Aquaculture, College of Fisheries and Ocean Sciences
University of the Philippines Visayas
Miagao, Iloilo, Philippines
mbpagapulan1@up.edu.ph

Tilapia farming plays a crucial role in the aquaculture sector of the Philippines. In terms of production quantity tilapia ranked as the 2nd farmed fish species in the country. The Philippines has seen a consistent increase in tilapia production, ranking it among the top tilapia-producing nations globally. However, as an archipelagic country with limited freshwater resources, tilapia production has stagnated and the only way for its expansion is to utilize high-salinity production areas for tilapia culture. The present study was conducted to evaluate the culture performance of saline-tolerant tilapia strains, developed in the Philippines, for cultivation in coastal seawater ponds.

A 90-day rearing experiment was conducted to assess the growth, feed utilization, and survival of three different strains of saline tilapia including Brackishwater Enhanced Selected Tilapia (BEST), Molobicus, a hybrid of (*O. nilotica* X *O.mossambica*), and Saline-tolerant Population of Improved Nile tilapia (SPIN) cultured a pond system with at a salinity range of 28-30ppt. Each of the tilapia strains was reared in triplicate ponds with a culture volume of 200 cubic meters. Juvenile fish with an initial weight of 2.04 g ± 0.2 (SE) were stocked at a density of 10 fry per cubic meter. The fish were fed a commercial diet containing 30% protein (4% of biomass). The findings indicated that the SPIN and BEST strains exhibited superior growth performance metrics (Final weight, Weight gain, Survival, Specific growth rate and lower feed conversion ratios compared to the Molobicus strain. There were no significant differences among the groups in terms of somatic indices (P□0.05) or levels of body proteins and lipids. In conclusion, cultivating the UPV and BEST strains in saline water is recommended as they demonstrate optimal growth, feed efficiency, and survivability in this environment.

EVALUATION OF GOLDEN APPLE SNAIL FOOT TISSUE MEAL *Pomacea canaliculata* AS AN INGREDIENT IN THE GONAD MATURATION DIET OF *Litopeneaus vannamei* FEMALE BROODSTOCKS

Mary Jessa Bell B. Pagapulan* and Rex Ferdinand M. Traifalgar

Institute of Aquaculture, College of Fisheries and Ocean Sciences
University of the Philippines Visayas
Miagao, Iloilo, Philippines
mbpagapulan1@up.edu.ph

The Pacific white shrimp *Litopenaeus vannamei*, was the leading aquatic species in global aquaculture in terms of value, reaching $18,460 million in 2014. This species is highly significant commercially, accounting for over 76% of all farmed shrimp and more than 45% of global shrimp production. Despite facing a decline in production due to disease outbreaks in the past decade, the demand for farmed white leg shrimp remains robust. To enhance shrimp farming success, utilizing domesticated broodstock instead of wild broodstock can help produce disease-free larvae. Various factors such as broodstock age, origin, endocrine manipulation, genetic variation, and nutrition significantly influence egg quality and quantity. Providing a well-formulated maturation diet that meets the nutrient requirements of shrimp broodstock is crucial, as highlighted by research. While fresh feeds like clam, squid, and worms have been shown to support successful reproductive performance, they also pose risks such as disease transmission and water quality issues. Compound diets offer advantages in terms of manageability and storage, although formulating diets for shrimp broodstock remains challenging due to the lack of defined nutritional requirements. Animal protein sources, such as golden apple snail foot tissue meal, are being explored as alternatives to expensive squid meal in shrimp diet formulations. The golden apple snail, originally from South America and introduced to the Philippines in the 1980s, is rich in protein and considered a cost-effective substitute for squid meal. Thus, the study was conducted to evaluate the impact of golden apple snail meal on the reproductive performance of *Litopenaeus vannamei* female broodstocks.

A 32-day study was carried out to evaluate the impact of incorporating Golden Apple Snail foot tissue meal into the diets of female Pacific white shrimp broodstocks on their ovarian maturation. Five diets with increasing levels of Golden Apple Snail foot tissue meal were compared, alongside positive and negative control diets. Shrimp broodstocks at early ovarian development stages were fed these diets, and their ovarian development was monitored every 4 days. The results showed that the maturation response (MR=proportion (%) of female shrimp broodstocks achieving ovarian maturity within each treatment) had some distinctive trends during the course of the maturation trial. The results also showed that the diet containing 75% Golden Apple Snail foot tissue meal was the most effective for ovarian maturation in Pacific white shrimp, followed by the diet with 50% of this ingredient. Overall, incorporating Golden Apple Snail foot tissue meal in diets during early maturation stages improved ovarian maturation and reproductive performance in *Litopenaeus vannamei* shrimp broodstocks.

SUPPORTING REVITALIZATION OF COMMUNITY BREEDING UNITS (CBU) ON CARP (Cyprinus carpio) CULTURE IN PASAMAN DISTRICT, WEST SUMATERA PROVINCE

Paino, Suratno, Miftahul Jannah, Reni Agustina Lubis

Email: hafidz1207@gmail.com

CBU Revitalization is one of the national programs of Indonesian government assistance implemented by the technical implementation unit, namely the Balai Perikanan Budidaya Tawar Sungai Gelam Jambi. Along with the community's need for protein is increasing so that the government is trying to find alternatives in improving the quality of community nutrition, especially in terms of protein needs. Carp is one type of consumption fish that has important economic value. The purpose of the CBU revitalization activity is to build and improve facilities and infrastructure for fish hatchery units in the community so that they can increase their production. This activity is carried out from central government budget in 2023. The implementation of this activity goes through several stages, namely technical and non-technical verification, location determination, implementation of improvements and construction of hatchery unit locations, implementation of fish hatcheries according to established SOP (Standard Operational Procedure), evaluation of results and recommendations for improvement. Two group of CBU revitalization was determined in Pokdakan Mina Sukses group and pokdakan Putri Tunggal group. Some activities has been done like repairing and building hatchery facilities and infrastructure including increasing the number of broodstock, feed and other hatchery facilities. Assistance in improving the technical and non-technical systems of carp hatcheries related to SOP, namely the management of broodstock and carp seed rearing. There are three production cycles by producing ready-to-sell seeds with a size of 3-5 cm in 2023 activities. Pokdakan Mina Sukses Bersama group produces a total of 1,650,000 carp seeds, while Pokdakan Putri Tunggal group produces a total of 1620,400 seeds. The average survival rate of carp seeds is around 60-75%. The conclusion of this activity is that CBU revitalization activities can increase fish seed production by improving carp hatchery production facilities and infrastructure both technical and non-technical way.

Table 1. Carp production in Pokdakan Mina Sukses Bersama group cycle 1

Description	Mina Sukses Bersama		Increase (%)
	Before	After	
Female	3	3	
Male	9	28	
fecundity	686800	1000000	145,6
Fertility Rate	357143	893000	275,2
Hatching Rate	150000	530400	353,6

Table 2. Carp production in Pokdakan Putri Tunggal cycle 1

Description	Putri Tunggal		Increase (%)
	Before	After	
Female	6	3	
Male	18	28	
fecundity	630420	1000.000	158,6
Fertility Rate	340425	876.000	261,3
Hatching Rate	160000	545.000	331,5

BACTERIAL REMEDIATION OF FISH SCALE BIOWASTE: A SUSTAINABLE APPROACH FOR ECO-FRIENDLY WASTE MANAGEMENT

Ashmita Pandey, * Manjusha L., B.B. Nayak, Sanath Kumar H. and Amjad Balange

ICAR-Central Institute of Fisheries Education
Mumbai, India - 400061
ashmita.phtpb101@cife.edu.in

The exponential growth in fisheries has led to a concurrent surge in global fish production, reaching approximately 178 million tonnes by the year 2020. This increase in fish production, however, results in huge quantities of fish waste being generated throughout the processing stages, raising serious concerns related to its disposal. Estimates suggest that 27% of globally produced fish is lost as bio-waste during processing, which can result in adverse environmental effects if not managed scientifically.

Among the various forms of fish waste, fish scales constitute a substantial portion but have received limited attention in terms of valorization and management strategies. Despite being biodegradable, fish scales exhibit recalcitrance to enzymatic degradation due to their rigid structural and chemical properties, posing obstacles to their efficient disposal. In this context, a study was carried out to seek an eco-friendly yet simple method for managing fish scale bio-waste using bacteria. The presence of scale-degrading bacteria in the marine and terrestrial environment was investigated, which yielded a total of 83 bacterial isolates, with 19 isolates from seawater and 13 from fish scale and soil samples exhibiting gelatinase activity. Notably, 13 seawater isolates and 11 isolates from fish scale and soil samples demonstrated promising fish scale-degrading capabilities. Three isolates among them displayed efficient scale degradation across media containing varying concentrations of peptone.

Furthermore, two isolates of *Lysinibacillus fusiformis* (KT02 and KT05) were examined for their efficacy in degrading scales from mixed carp and pink perch. Both strains efficiently degraded the fish scales within five days, with KT02 demonstrating superior degradation capability. The biochemical analyses of the fish scales before and after degradation by *Lysinibacillus fusiformis* KT02 revealed significant differences ($p < 0.05$) in protein and ash contents, indicating successful degradation. Furthermore, changes in amino acid, mineral, and fatty acid compositions underscore the transformative potential of bacterial remediation in converting fish scale waste into useful bioactive compounds. These results highlight the promising role of bacterial remediation in mitigating the environmental impact of fish scale biowaste. The efficient degradation of fish scales by *Lysinibacillus fusiformis* isolates shows potential of this approach for sustainable waste management in the fisheries industry. Thus, bacterial scale degradation holds promise for yielding valuable bioactive compounds, eventually contributing to circular economy strategies. Future research endeavours should focus on elucidating the mechanisms of scale hydrolysis, optimizing bacterial degradation processes, and studying bioactivities of scale degradation products to understand their potential biomedical applications in order to maximize resource utilization and minimize environmental pollution.

Figure 1. Mixed carp and Pink Perch Scales degraded with *L. fusiformis* KT02

FROM SUPPORTING ROLES TO LEADERS: WOMEN DRIVING CHANGE IN ODISHA'S FISHERIES SECTOR

Ashmita Pandey*, Shubham Soni, B.B. Nayak, and Amjad Balange

ICAR-Central Institute of Fisheries Education
Mumbai, India - 400061
ashmita.phtpb101@cife.edu.in

The world has been experiencing remarkable growth in the fisheries and aquaculture sector. The sector plays a vital role in shaping socio-economic development on account of its contribution to food and nutritional security, national income, and employment opportunities, as well as generating livelihood options for people, especially in rural areas. India currently ranks 3rd in fisheries and 2nd in aquaculture production in the world, contributing 6.3% to the total global fish production. Odisha is one of the major fish-producing states in India, producing 1.06 million tonnes in 2022-23. The state's favorable environmental conditions make it ideal for aquaculture of commercially important species in its vast inland and brackishwater resources. Aquaculture is often seen as a male-dominated sector due to the significant investment and physical labor required, with women's roles and participation primarily considered supportive. Despite this perception, many developmental projects and programs by the central and state governments in the Balasore district of Odisha have created numerous opportunities for fisherwomen and women entrepreneurs to gain meaningful employment in the field.

A study conducted in the Balasore district of Odisha explored women's participation in Aquaculture and allied activities. It was found that several programs such as 'One District One Product,' 'One Gram Panchayat (GP) One Product,' and 'Input assistance to Women Self Help Groups (WSHGs) for pisciculture in GP Tanks' under the umbrella scheme 'Mukhyamantri Maschyajibi Kalyan Yojana (MMKY)' have led to women's empowerment in the region. The study showed that when a group of 15 women or more come together and form a WSHG, they can solve their problems together and generate income through various fisheries enterprises. Women of the Balasore region are actively participating in aquaculture activities such as pond site selection and preparation, collection, sorting, and stocking of fingerlings, feeding, harvesting, transportation, ornamental fish rearing and breeding activities, and fish feed plant operation. The SHG members reportedly earn between 200000 and 300000 Indian rupees per annum from these enterprises. Women's participation in aquaculture is increasing, and empowering women through WSHGs enhances their economic status and contributes to broader societal goals such as food security, poverty reduction, improved livelihood opportunities, and sustainable development. Despite these significant contributions, women face gender disparities and limited access to resources, training, and markets compared to their male counterparts. Multifaceted approaches like training and capacity-building initiatives, targeted policies, and investments are required to empower women in the sector. The women can further come forward to undergo scientific training on several post-harvest technologies scientific training from institutes like the Central Institute of Fisheries Education and Central Institute of Freshwater Aquaculture. The evolving role of women in fisheries and aquaculture represents a promising avenue for promoting gender equality and inclusive growth in Odisha. By leveraging their knowledge, skills, and entrepreneurial spirit, women can drive innovation, resilience, and prosperity in the sector, ultimately benefiting communities and ecosystems alike.

A PROPER EARLY LIFE NUTRITION PROGRAM IMPROVES PERFORMANCE OF TILAPIA IN INTENSIVE FARMING SYSTEM

Minh Anh Pham, Truong Ngoc Thao, Marc Campet

ADM Aquaculture Research and Development Center
Nha Be District
Ho Chi Minh City, 700000, Vietnam
Anhminh.pham@adm.com

Early life nutrition can have significant impacts on the development of tissues and organs, and consequently affect growth and health status of fish in later life stages. It is reported that tilapia larva develop faster when the adequate density of fish per tank and the proper quantity of food per fish are provided (Fujimura and Okada, 2007). In this series of trials, we demonstrate the effects of stocking density on growth rate and feed utilization of tilapia fry, and the impacts of a proper nutritional program on growth performance and economic profitability in tilapia farming. In the first trial, tilapia fries were stocked into 48 tanks (200 L/tank) at densities of 0.5, 1.0, 1.5, 2.0, 2.5, and 3.0 fries/L, and fed to apparent satiation twice per day for 8 weeks. In the second trial, tilapia fries were stocked at a density of 0.5 fry/tank, and fed with two different diets. After nursery period, the fish were transferred into grow-out cages in ponds and raised until harvestable size. By the end of each trial, survival, final live weight, and feed conversion ratio (FCR) were calculated and compared between the treatment groups. Results of the first trial show that no obvious impacts of stocking density on survivability of the fish (Survival of all groups is greater than 95%.), but final live weight gradually decreased and feed conversion ratio significantly increased when stocking density increased. And the highest weight gain and the lowest FCR were obtained at the stocking density of 0.5 fry/L (or 100 fries/tank). Results of the second trial demonstrate that feeding a proper nursery feed, not only improve growth performance of the fish during nursery stages, but also increase harvestable size and economic profitability of tilapia farming.

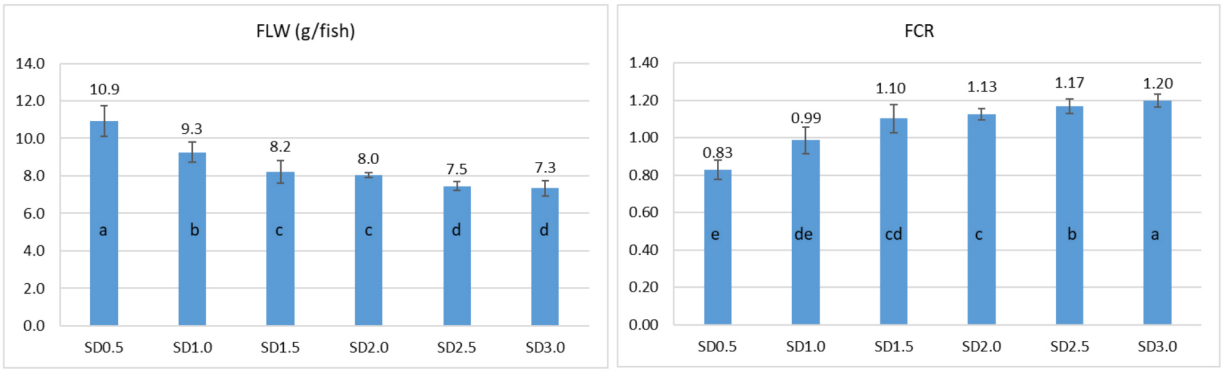


Figure 1: Average final live weight (FLW, g/fish) and feed conversion ratio of different stocking densities at the end of the first nursery trial

EFFECTS OF MICROALGAE AND SALINITY ON GROWTH AND SURVIVAL OF PEARL OYSTER (*Pteria penguin* Roding, 1798) LARVAE

Phung Bay[1*], Pham Viet Nam [1] and Ton Nu My Nga[2]

[1]Research Institute for Aquaculture No. III, Vietnam
[2]Institute of Aquaculture, Nha Trang University, Vietnam
Email:bayphg@yahoo.com

This paper reports improved techniques for seed production of the winged pearl oyster, *Pteria penguin,* by evaluating the effects of various microalgae mixtures and salinity on growth and survival of oyster veligers. In the first experiment, D-stage veliger larvae were reared in conical fiberglass tanks and fed various combinations of microalgae: (1) *Dicteria* sp. and *Nannochloropsis oculata* (1:1); (2) *Isochrysis galbana* and *Dicteria* sp.; (3) *Isochrysis galbana* and *Nannochloropsis oculata*; and (4) *Nannochloropsis oculata, Isochrysis galbana* and *Dicteria* sp. (1:1:1). The experiment was conducted for 19 days with three replicate tanks per treatment. In the second experiment, 1-day old veliger larvae were reared at salinities of 24‰, 27‰, 30‰ and 33‰ for a period of 19 days. Each salinity was randomly assigned to 3 replicate tanks. The larvae were fed once a day with a combination of *Nannochloropsis oculata*, *Isochrysis galbana* and *Dicteria* sp. at a concentration of (3,000 cells/ml of each species of algae). Results of the first experiment showed that larvae fed *Nannochloropsis oculata, Isochrysis galbana* and *Dicteria* sp. (1:1:1) obtained the largest length (199.94 ± 0.01 µm), a mean daily growth rate (DGR) of 13.14 ± 0.26 µm/day and survival of 19.5 ± 1.6 %) ($P<0,05$). In the second experiment, salinity significantly affected growth (shell length), DGR and survival of pearl oyster larvae ($P< 0.05$), with larvae cultured at 30‰ gaining the highest shell length, DGR and survival. Larvae cultured at 24‰ had the lowest shell length, DGR and survival.

CURRENT AND NEW TECHNOLOGIES FOR SHRIMP BREEDING INDUSTRY

Cédric Pincent*, Florian Herry, Anastasia Bertin

Groupe Grimaud
3 La Corbière
Sevremoine, France
49450
cedric.pincent@grimaud.com

Cédric Pincent has been involved in the genetic development of shrimp for the aquaculture since 2001, first as a breeding program advisor in aquaculture with SYSAAF (www.sysaaf.com) after what time he joined Groupe Grimaud as Director R&D for their Swine breeding activity. Since 2018 he has joined the Blue Genetics team where today he is in charge of all R&D activities in France, Mexico and USA. In this position he is responsible for the continuation and improvement of both the Golden Line and the Texas Line, and he is key in the continued improvement of these lines.

Breeding programs in Aquaculture have evolved a lot in the last decades. From mass selection to handle a single trait in the past to present day programs where we can benefit from molecular tools and powerful phenotyping instruments to handle more traits with a much higher accuracy.

The development of these molecular tools that include a high number of markers allows to drive breeding schemes pooling all families and challenging them in a commercial environment. In addition, we can add the genomic information of genotyped animals to increase accuracy and considerably advance the efficiency of the yearly genetic progress.

In the future, some recently developed sequencing techniques will allow to access an even larger number of markers, once again improving accuracy.

Meanwhile techniques evolution allows to measure and select more and more traits simultaneously: traits related to reproduction, feed efficiency, robustness and quality traits like morphology, tail/ meat yield, colour of animals, flesh composition.

We should also mention a large panel of image analysis tools (colorimetry, hyperspectral imaging, X Ray) that are becoming more and more accessible for further analysis of the whole animal.

These advanced techniques open a few doors to shrimp breeding companies with a strong genetic team to handle, and improve, a broad scope of traits, helpful for the shrimp industry evolution. This is a major asset in the development of more efficient shrimp lines, and breeding companies will have to master at least some of these tools to stay competitive in the future.

GENETIC IMPROVEMENT OF BARRAMUNDI *Lates calcarifer* FOR SCALE DROP DISEASE VIRUS RESISTANCE

Zhi Weng Josiah Poon*, Xueyan Shen, Nguyen Thanh Vu, Susan Gibson-Kueh, Shubha Vij, Marie Tan, Maura Carrai, Sarah Priyanka Nelson, Celestine Terence, Joseph Angelo Uichanco, Saengchan Senapin, Ha Thanh Dong, Sunita Awate, Gerald Lui, Andy Tan, Ying Quan Tan, Dean R. Jerry, and Jose A. Domingos

Tropical Futures Institute
James Cook University Singapore
149 Sims Drive
Singapore 387380

Barramundi is an important tropical aquaculture marine food fish with well-established culture techniques. Despite genetic improvement efforts for growth traits and now looking towards resistance to various pathogens, barramundi farmed in Singapore face mass mortalities of 40-90% due to Scale Drop Disease Virus (SDDV). Although vaccines against SDDV are currently being developed, it is important to adopt a multi-pronged approach to the management of this disease. Given the moderate heritability (0.33 ± 0.01) for SDDV resistance, selective breeding presents as a long-term solution. To achieve this solution, we are applying genomic selection and integrating data from over 17,000 animals across multiple batches from both laboratory and natural challenges across multiple farm environments to begin to select for increased resistance to this devastating pathogen.

An Axiom 70k Barramundi SNP array was developed for this project based on millions of SNPs available in public repositories and on our group's unpublished sequence databases. The array was designed to cover high-quality and evenly distributed SNPs across the barramundi genome, taking into account the genetic diversity of different farmed and wild populations across Southeast Asia and Australia. Additionally, the array includes SNPs from previously published QTLs for commercially important traits, as well as probes for 10 pathogens and parasites known to infect barramundi.

We developed a laboratory SDDV infection model for barramundi juveniles (~60-80g) which identified the SDDV LD50 dose from intraperitoneal injections. This dose represents the level at which approximately 50% of the more susceptible individuals within the population succumb to the infection within 2 weeks, and 50% of the more resistant individuals exhibit full recovery by the end of the 3rd week. Currently, we are conducting five separate laboratory challenges, each involving approximately 1,000 juveniles sourced from different batches. These fish are communally reared within a single tank to ensure that the data remains unbiased by environmental or husbandry variables, as well as potential co-infections. At the same time, barramundi juveniles from the same batches were distributed to commercial farms across Singapore and sampled during SDDV outbreaks and subsequently at the time of harvest. Long-term growth data is also being collected for incorporation in the genomic selection algorithms. The outcomes of this project are currently being translated into selection of broodstock improve growth rates and survival of farmed *L. calcarifer* against SDDV.

THE MODELLING OF SALINE TILAPIA AQUACULTURE (BINS) AT BLUPPB KARAWANG

Ari Prakoso, M.Tahang, Y. Heru Nugroho, Atri Triana K.

Balai Layanan Usaha Produksi Perikanan Budidaya (BLUPPB) Karawang
Desa Pusakajaya Utara
Kecamatan Cilebar
Kabupaten Karawang
Jawa Barat
Satker_bluppb.karawang@kkp.go.id.

Saline tilapia is a variety of tilapia fish that was developed from freshwater tilapia species so that it can tolerate higher levels of water salinity. This fish has been widely developed and is used to utilize land in coastal areas that was previously less suitable for freshwater fish culture. The development of the modelling saline tilapia in Karawang was carried out on an area of 80 hectares which was divided into four pond areas, namely pond blocks A, B, C and D. The facilities in modelling Saline Tilapia consist of production ponds, Waste Water Management Installations (IPAL), inlet outlets, reservoirs, and laboratories. Production facilities also use the latest technology, one of which is the use of automatic feeding machines. The rearing process is carried out for 8 months with a final weight target of 1 kg/fish to meet the export market. Stocking is carried out at a density of 25 ind/m2. The total ponds that have been spread are 66 ponds for 2000 m2 and 75 ponds for 4000 m2. Monitoring and management of fish health and the environment is carried out to maintain the condition of the water quality and prevent the emergence of disease. The development of Saline Tilapia culture is expected to be an alternative for the economic development of coastal communities, especially in the Pantura Region.
Keywords : Saline Tilapia, modeling, Karawang

THE SOCIAL IMPACT OF DEVELOPING SALINE TILAPIA AQUACULTURE MODELLING AT BLUPPB KARAWANG TO SURROUNDING COMMUNITIES

Ari Prakoso, Y. Heru Nugroho, Syofan

Balai Layanan Usaha Produksi Perikanan Budidaya (BLUPPB) Karawang
Desa Pusakajaya Utara
Kecamatan Cilebar
Kabupaten Karawang
Jawa Barat
Satker_bluppb.karawang@kkp.go.id

The positive impact of developing a saline tilapia cultivation model around Karawang is its contribution to the economy of the local community. This development is carried out on an area of approximately 80 hectares, with a production target of reaching 5,000 tons per cycle. Every month the daily workforce employed for the improvemnent construction and infrastructure can reach 400 people per month. Empowering local communities as daily workers has had a positive impact on them. Apart from that, the impact of this development is also to improve road access to BLUPPB, which was previously damaged to make it better. In addition, many people use the Saline Tilapia Aquaculture development as a tourist destination with their families.

A MULTI-STAKEHOLDER INITIATIVE TO IMPROVE SHRIMP AQUACULTURE ACROSS A WHOLE JURISDICTION: THE SHRIMP IMPROVEMENT PROGRAM IN BANYUWANGI, INDONESIA

Budiati Prasetiamartati, Burhanuddin, Kenidas Lukman Taufik, Agus Fani Faisol, Viga Ananda Wicaksono, Victor Nikijuluw, Deddy Poerba Anggara, Anton Immink, Dane Klinger

bprasetiamartati@konservasi-id.org

Aquaculture improvement programs have been slow to transition global shrimp production towards responsible production – currently only 13% of shrimp farms are certified and most small farmers can't get certified. The Shrimp Improvement Project (SIP) in Banyuwangi, East Java, Indonesia, is a novel initiative that seeks to improve shrimp farming across a whole jurisdiction, bringing benefit to all stakeholders – including the environment. Government, industry, academia, and NGOs have collaborated to create a shared vision for a more sustainable, profitable, and resilient shrimp aquaculture sector in Banyuwangi. This vision is being executed through a time-bound road map that addresses critical aspects of improvement, such as water quality management, capacity building of shrimp farmer organization, access to finance and markets, disease management, and national and international certification. In this presentation we will discuss progress to date, including the opportunities and challenges for implementing this model in other regions across Indonesia and Asia.

REDUCED pH IMPACT ON EARLY LARVAL DEVELOPMENT OF PACIFIC ABALONE *Haliotis discus hannai*

Dian Yuni Pratiwi*, Irfan Zidni, Kang Won Kim, Mi Jin Choi, Young Dae Oh, Han Kyu Lim

Department of Biomedicine, Health & Life Convergence Sciences, BK21
Mokpo National University
Muan, Jeonnam 58554
dianyunipratiwi@yahoo.com

Abalone is an economic and ecologically valuable calcifying organism, providing food for humans and other organisms, balancing the ecosystem, and offering a microhabitat for other benthic organisms. A reduction in marine pH caused by increasing atmospheric CO_2 absorption by the ocean poses a significant threat to abalone, particularly during the development of early life stages, which are more vulnerable to pH stress. Therefore, this study aims to examine the effect of reducing pH on the early life stages of Pacific abalone (*Haliotis discus hannai*). We exposed abalone eggs and larvae to five pH levels (8.2, 7.9, 7.6, 7.3, and 7.0) and examined the hatching rate, hatching time, larval development, malformation rate, larval length, and oxygen consumption rate. The hatching rate was observed 24 hours post fertilization, and the larvae were collected at 24 hpf and 30 hpf to observe larval development, larval length, and oxygen consumption rate. In addition, the malformation rate was observed in 30 hpf larvae. The hatching rate showed no significant difference among the pH treatments. A decrease in pH of 0.6–1.2 units (pH 7.6, 7.3, and 7.0) increased hatching time and delayed the development of larvae. Veliger larvae could still form a normal shell at all pH treatments. Larvae lengths of 24 hpf did not differ significantly among the pH treatments. However, the larval length of 30 hpf at pH 7.0 and 7.3 was significantly shorter than that of the control. Furthermore, the percentage of malformation rate in 30 hpf larvae under pH 7.0 and 7.3 conditions significantly exceeded that in the controls. The oxygen consumption rate of 24 hpf larvae significantly decreased at pH 7.0 and 7.3, while the oxygen consumption rate of 30 hpf larvae significantly decreased at pH 7.0, 7.3, and 7.6. Overall, decreasing the pH to 1.2 units did not impact the hatching rate. However, the early larval development of *H. discus hannai* was highly sensitive to a pH reduction of 0.6–1.2 units from the ambient pH. This may have negative consequences for the persistence of abalone populations in natural and aquaculture environments in the near future.

ENHANCING MARKET VISIBILITY AND ACCESS FOR SEAFOOD SMALLHOLDERS: THE NEXUS OF SUSTAINABLE SOURCING AND LEADING IMPROVEMENT PROGRAMS

Trini Pratiwi

triniprati wi@gmail.com
eFishery

Numerous improvement programs, often categorized under value chain development or improvement initiatives, have been introduced in various aquaculture sectors. However, long-term success and sustained support remain exceptionally rare. To understand the factors behind successful projects, this study analyzes key takeaways and value propositions from leading seafood value chain development programs. The analysis includes the Asian Seafood Improvement Program, the jurisdictional approach of the Shrimp Improvement Program, the Global Sustainable Seafood Initiative's Seafood MAP, the Seafood Watch Improvement Program using the IVF Tool, and the ASC Improver Program. These programs are examined to identify their values, continuity, challenges, and success factors.

Programs should be anchored in premium sustainable products that integrate environmental and social values, with sustainability performance being achieved incrementally. Shifting away from commodity products is essential. Although buyers often prioritize cheap and certified products, combining place-based initiatives with sustainable sourcing to support specific areas could be a viable strategy. The success of improvement programs hinges on their connection to buyer engagement and sustainable sourcing. This underscores the crucial role of continuous, step-by-step farm assistance, enhanced sustainability performance, and strong buyer relationships in achieving lasting success.

Key Focus

- Key takeaways, value proposition and success of seafood value chain development programs comprising from following programs:
    - Consortium of IDH, Conservation International, Sustainable Fisheries Partnership, Longline Environment in jurisdictional approach and $100M investment fund 2018-2024
    - Asian Seafood Improvement Collaborative, a localized seafood standards and executor of improvement program specific for smallholders with environmental and social gender standards 2021-2023
    - Seafood MAP, a digital platform built to help revolutionize the fragmented system into an equitable, resilient, and sustainable one, anchored by 2 years of Aquaculture and Fisheries Activator Programs led by The Lexicon of Sustainability with support of Google Food and Global Sustainable Seafood Initiative (GSSI) 2021-2024
    - Seafood Watch Improvement Program using IVF Tool and ASC Improver Program 2023-2024
- Success indicators and connecting to end buyer for sustainable sourcing
- How market perceives and what improvements needed

IMPROVING FISH POND PRODUCTIVITY THROUGH THE APPLICATION OF AQUAPONICS SYSTEM: A COMPREHENSIVE STUDY ON THE SYMBIOTIC RELATIONSHIP BETWEEN CATFISH *(Clarias sp.)* AND HERBAL PLANT, INDIAN PENNYWORT *(Cantella asiatica)*

Yohanna R. Widyastuti[1*)], Tri Heru Prihadi[1)], Endhay K.M. Kontara.[1)], Lies Emmawati Hadie.[1)], Yuani Mundayana[1)], Adang Saputra[1)], Taukhid[1)], Kusdiarti[1)], Tutik Kadarini[1)], Siti Murniasih[1)], Edy F. Wadjdy.[1)], Sirodiana[1)], Sudarmaji[1)], Yoga J. Satria[2]

[1)] Fisheries Research Centre-National Research and Innovation Agency (BRIN), Indonesia
[2)] Fisheries polytechnic (alumny)
*yohanna.retnaning.widyastuti@brin.go.id

Aquaponics technology represents a symbiosis between hydroponics and aquaculture, integrating both systems into a unified food production model involving plants and fish. It has emerged as a sustainable food production approach, underpinning its ecological principles to mimic natural habitats and preserve environmental integrity. A key advantage of aquaponic systems is their ability to yield organic produce free from pesticide, antibiotic, and inorganic fertilizer residues. The technology's application, which combines fish culture with vegetables (Yumina) and/or fish with fruits (Bumina), is steadily gaining traction among communities.

The findings indicate a tendency towards better conditions compared to the control, and most notably, significant improvements are observed in the survival rates, with averages exceeding 98% compared to controls below 75%. Bioactive elements released by *Centella asiatica* have a significant impact on the health status of catfish which includes response to feed, growth, and survival, as well as the expression of relatively normal functional blood picture values. This suggests that the aquaponics system, especially when combined with herb plants, can effectively promote fish health and enhance overall productivity.

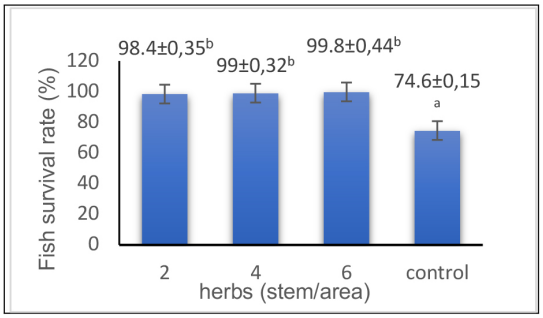


Figure 1. Fish survival rate (%)

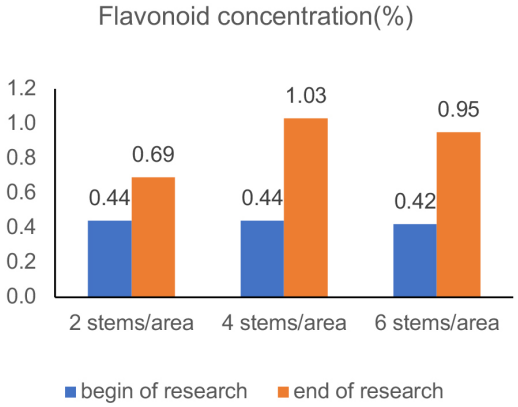
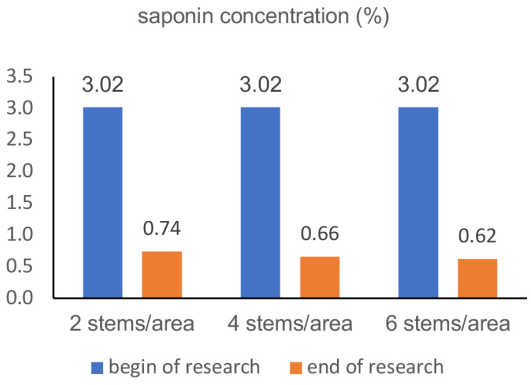


Figure 2. Bio active content of Indian pennywort (*Centella asiatica*)



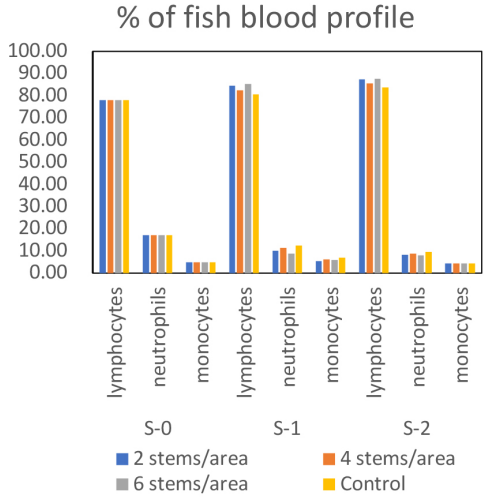


Figure 3. Blood profile of the fish

THE CURRENT STATUS, CONSTRAINTS, AND OPPORTUNITIES OF ESTABLISHING SPINY LOBSTER AQUACULTURE INDUSTRY IN INDONESIA

Bayu Priyambodo*
A/Prof Clive Jones**

*Lombok Marine Aquaculture Development Center of Indonesia
**James Cook University Australia

Indonesia has a unique opportunity to establish the world's largest lobster aquaculture industry, based on a significant natural resource of settling pueruli which is more than 100 times greater than that of Vietnam. However, its development faces substantial technical and non-technical constraints that require resolution. Solutions to these constraints are presented in the context of data on the puerulus resource, species composition, seasonality, and capture methods.

The location identified as having substantial puerulus abundance comprises the southern coast of Java, Bali, Lombok and Sumbawa covering a distance of 1,500 km. Puerulus abundance is highest in enclosed bays with distinct currents, relatively high turbidity attributable to terrestrial inflows, and muddy/sandy substrates. Aerial geographic mapping identified all such suitable locations for puerulus settlement and the area, to estimate a total puerulus catch of more than 100 million pueruli per year. This estimation has since proved accurate in the recorded catch of pueruli in recent years. The composition of puerulus fished consists of two species, *Panulirus homarus* and *P. ornatus*. A new fisheries policy has been issued to provide a regulatory framework to manage the puerulus fishery and support lobster farming. Lobster aquaculture is a major opportunity for high-value aquaculture production for the Indonesian economy.

DEVELOPMENT OF JICA TILAPIA (*Tilapia* sp.) BROODSTOCK WITH LOCAL ISOLATE VACCINE FOR STREPTOCOCCOSIS CONTROL AND UTILIZATION IN SMALL SCALE HATCHERY (ANALYSIS USING AHP-SWOT)

Padel Purnama*[1], Mubinun*[2]

*[1] senior Fish Health and Environmental Supervisor,
*[2] senior Aquaculture Analyst at
Jambi Freshwater Aquaculture Development Centre (JFADC)
https://kkp.go.id/djpb/bpbatjambi

JICA Tilapia (*Tilapia* sp.) is one of the tilapia strain that originally from Japan. This species is main commodity of Jambi Freshwater Aquaculture Development Centre (JFADC) (Balai Perikanan Budidaya Air Tawar Jambi-BPBATJ). It was chosen because of its good adaptability in acid or swamp waters and fairly good growth. Some problems arose in its development efforts, especially fish diseases problem. Until now, *Streptococcu*s infection is serious disease for tilapia, causing economic losses. Prioritized control efforts by vaccination to prevent disease and reduce mortality. In general, most effective vaccine from similarly isolate or close with bacteria pathogen, in this case local isolates.

Challenge test with pathogen injection to observe vaccination impact on JICA tilapia. Isolates choice for vaccine acquired from disease monitoring in BPBAT working area. Vaccinated fish are kept at small scale hatchery (UPR) to establish broodstock production cooperation. SWOT (Strength, Weakness, Opportunity, and Threats) analysis conducted on UPR respondent to understand main factors influence vaccinated fish. Afterwards to determine development strategy for sustainability uses SWOT-AHP analysis (combination of hierarchical analysis (AHP) and SWOT analysis).

Post challenge result for vaccinated fish, survival rate (SR) 76,67 % and relative percent survival (RPS) 71,07 %. This result is similar as the result at UPR. In farm 90-days production period, survival rate of JICA vaccine is 69,92%, which differs significantly with non-vaccinated fish (SR 45,66%). Therefore, vaccine significantly reduced fish mortality. SWOT analysis result shows that internal factor for succeedss production at UPR is strength factor i.e., quality of JICA Tilapia parents' stock and resistance from disease. Meanwhile, greatest external factor impact is opportunity i.e., several UPR are capable of producing JICA tilapia brood stock according standards. Furthermore, chosen main strategy for future development is SO (Strength-Opportunity) strategy, which is increase production for vaccinated fish and maintaining fish quality (priority of importance 42,82 %).

THE EFFECTIVENESS OF AUTOMATIC FEEDER UTILIZATION IN SALINE TILAPIA AQUACULTURE AT BLUPPB KARAWANG

Widya Puspitasari, Ari Prakoso, Agus Dwionoo

Balai Layanan Usaha Produksi Perikanan Budidaya (BLUPPB) Karawang
Desa Pusakajaya Utara
Kecamatan Cilebar
Kabupaten Karawang
Jawa Barat
Satker_bluppb.karawang@kkp.go.id.

Tilapia is a aquaculture commodity whose demand increases every year, both in fresh and processed form. This increase in demand along with convenience of rearing has made tilapia a commodity that many fish farmers are looking for. In the context of aquaculture, an important aspect that needs to be considered is providing appropriate feed. Even though it is generally considered an easy task, feed management is crucial to increasing fish production targets. Fish feeding is generally still done manually. This method has disadvantages, especially in terms of dependence on labor and scheduling which is often forgotten when that have many ponds. As an alternative, BINS (*Budidaya Ikan Nila Saline*) at BLUPPB Karawang adopts the use of an automatic feeding machine that can be controlled via a mobile device. However, using this automatic feed machine also has its own advantages and disadvantages. The use of this technology must be accompanied by good management in order to provide optimal results. By implementing this automatic feeding system, it is hoped that future production of saline tilapia can be increased.

REVIEW OF GROWTH AND SURVIVAL RATE OF SALINE TILAPIA WITH DIFFERENT INITIAL STOCKING WEIGHT

Widya Puspitasari, Atri Triana K., Ari Prakoso

Balai Layanan Usaha Produksi Perikanan Budidaya (BLUPPB) Karawang
Desa Pusakajaya Utara
Kecamatan Cilebar
Kabupaten Karawang
Jawa Barat
Satker_bluppb.karawang@kkp.go.id.

Saline Tilapia Culture is an alternative comodities in coastal areas which has high potential for development. This review was carried out to obtain an overview of the growth and survival of fish if stocked with different seed sizes during the 100 day rearing period. Fish are stocked in three different sizes, weight < 5 g, 10-20 g and 20-30 g. The density was 25 ind/ m2 with ad satiation feeding and observations were made over a period of 100 days. Sampling is carried out every 10 days. The results showed that stocking fish with an initial weight of 20-30 g provided a daily growth rate of 5.7 grams/day and a highest survival rate of 89.8%, with a size at 100 days of rearing reaching 532 g.

IDENTIFICATION OF A POTENTIAL WSSV-RESISTANT SNP AND ITS POSSIBLE APPLICATION TO SELECTION OF WSSV-RESISTANT PACIFIC WHITE SHRIMP (*Litopenaeus vannamei*)

Bagus Rahmat Basuki[1*], Alimuddin Alimuddin[2], Dinar Tri Soelistyowati[2], Sri Nuryati[2], Wendy Tri Prabowo[1]

[1]National Broodstock Centre for Shrimp and Mollusk, Ministry of Marine Affairs and Fisheries, Karangasem, Bali, 80811. Indonesia
[2]Department of Aquaculture, Faculty of Fisheries and Marine Sciences, IPB University Bogor, West Java, 16680. Indonesia
*) E-mail: bagus.basuki@kkp.go.id

The Pacific white shrimp (*Litopenaeus vannamei*) is Indonesia's main export commodity, but its production is constrained by the white spot syndrome virus (WSSV). Selective breeding of disease-resistant broodstock based on single nucleotide polymorphism (SNP) in the anti-lipopolysaccharide factor (ALF) gene is an alternative strategy for solving the disease problem. This study aimed to detect the SNP g.455 A>G in the anti-lipopolysaccharide factor (ALF) shrimp gene, evaluate the correlation of SNP with WSSV-resistance trait, analyze genotype frequencies of the WSSV-resistance population shrimp and analyze the SNP inheritance in the first generation of selected shrimp. A total of 120 individuals from 4 families were used to detect the SNP marker using tetra-primer amplification refractory mutation system-polymerase chain reaction (ARMS-PCR). The correlation of the SNP marker with survival rate (SR) was analyzed using a general linear model (GLM) between genotype frequencies and SR. Genotypic similarities between broodstock and pedigree were analyzed using Chi-square. SNP g.455 A>G was successfully detected using the ARMS-PCR method and had a strong correlation between the marker and SR (p-value of AA = 0.012; AG = 0.359, and GG = 0.001). The resistant population has significantly higher AA genotype frequency. The SNP marker was inherited, so the broodstock and pedigree have the same genotype frequencies according to chi-square analysis ($\chi 2 = 0.46$ and p-value = 0.497). These results suggested that the g.455 genotype AA could be selected to produce WSSV-resistant Pacific white shrimp.

IMMUNE GENES EXPRESSION PATTERN OF PACIFIC WHITE SHRIMP (*Litopenaeus vannamei*) RESISTANT TO WHITE SPOT SYNDROME VIRUS

Bagus Rahmat Basuki[1*], Alimuddin Alimuddin[2], Dinar Tri Soelistyowati[2], and Sri Nuryati[2], Wendy Tri Prabowo[1]

[1]National Broodstock Centre for Shrimp and Mollusk, Ministry of Marine Affairs and Fisheries, Karangasem, Bali, 80811. Indonesia
[2]Department of Aquaculture, Faculty of Fisheries and Marine Sciences, IPB University Bogor, West Java, 16680. Indonesia
*) E-mail: bagus.basuki@kkp.go.id

The pacific white shrimp (*Litopenaeus vannamei*) is one of the most cultivated aquaculture species with high economic value. It also dominates the main export commodity of cultivated shrimp in Indonesia. Vannamei cultivation is still constrained by disease attacks, especially the white spot syndrome virus (WSSV) infection. The selection of shrimp that are genetically resistant to WSSV is one of the effective ways to prevent infection. Immune genes that related to WSSV infection can be used as molecular marker for selection program.

This study aimed to compared the expression of immune genes (ALF, SOD, and ProPO) between WSSV-resistant and WSSV-susceptible shrimp families to identify potential genes as molecular marker. The 140-day-old selected vannamei shrimp (140-day of culture; DOC140) obtained from the National Broodstock Centre for Shrimp and Mollusk in Karangasem from 10 families were used to get the WSSV-resistant and WSSV-susceptible famili by comparing the survival rate (SR) after the LD70 WSSV challenge test. The expression level of immunity genes was analyzed in families with the highest and lowest SR after LD70 WSSV infection. Total RNA was extracted triplicate from gill tissue at 0 hours (before WSSV infection), 20 hours, 40 hours, 60 hours, 80 hours, and 100 hours after infection.

The ALF gene expression in shrimp with the highest SR (FI) was significantly higher ($p<0.05$) than in the lowest SR (FC) at 40 and 60 hours after WSSV infection (Figure 1). The expression level of the SOD gene in the FI family was also significantly higher ($p<0.05$) at the 40th hour, 60th hour, 80th hour, and 100th hour compared to the FC family. The expression level of the ProPO gene did not show significant differences between the FI family and the FC family. These results suggested that the ALF gene can be applied to select vannamei shrimp that are resistant to WSSV.

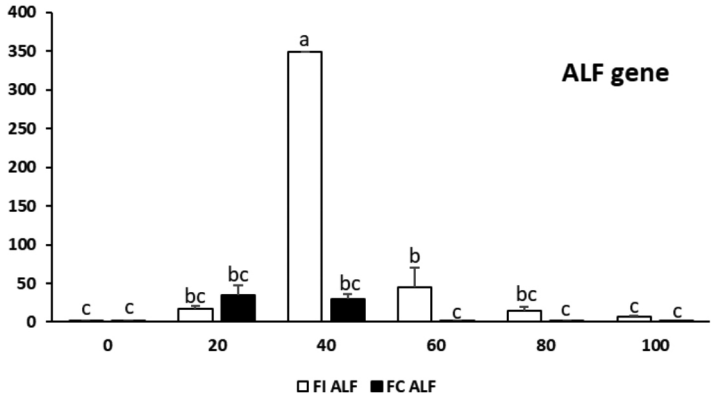


FIGURE 1. The expression level of ALF genes after WSSV infection in the FI and FC shrimp families.

USE OF RESULT MAGGOT BIOCONVERSION AS GROWTH MEDIA FOR MOINA SP IN FRESHWATER

Putri Ramdhani [(1),] Akhmad Rivai [(2),] Sarifin [(2)]

1. Analis Aquaculture Muda pada BPBAT Mandiangin
2. Pengawas Madya pada BPBAT Mandiangin

Aquaculture starting from fish larvae up to consumption fish. In the larval rearing stage, natural food is required which corresponds to the size of the fish's mouth opening. One of the natural foods fulfilling these criteria is Moina sp. To grow Moina sp Fertilization is required from organic materials containing the elements N, P and K. These ingredients are found in "KASGOT" or the abbreviation of "Maggot Ex". Kasgot contains an N value of 1.91%, Pospat is 0.23 and Potassium of 1.90. Meanwhile, in accordance with the decision of the Minister of Agriculture Republic of Indonesia Number 261/ KPTS/SR.310/M/4/2019 concerning Requirements Minimum Technical for Organic Fertilizer, Biological Fertilizer and Soil Improver, that is fertilizer organic must have a total N, P and K value of 2%.

INTRODUCTION

One way to solve the organic waste problem is by bioconversion, namely using the help of living organisms to break down waste. One of the organisms that can do that is a maggot (Black Soldier Fly Larvae). Apart from being a waste decomposer, Maggot itself is widely used by breeders and cultivators fish as an alternative feed for livestock and fish. Meanwhile the result of maggot bioconversion or what is commonly known as "KASGOT" can be used as fertilizer for plants, because has N.P and K values that comply with standards.

Moina sp. is a natural food for fish and shrimp larvae because having a size that corresponds to the size of the mouth opening, has value high nutrition, can reproduce and grow in environments with low dissolved oxygen content and high ammonia concentration, has a rate reproduction. Moina sp. an important type of plankton as an alternative natural food because the size matches the mouth opening of the fish larva.

METHODOLOGY

The material used is 3 kg of Kasgot. Then put it down into a tarpaulin tub with a diameter of 2. With a water height of 1 meter. Next Preparation of the container includes cleaning the container. Cleaning the tank carried out after the water recedes, by suction using a water hose Pull the outlet pipe to the side and wait for the water to recede. After the water in the tub has reduced, the tub is ready to be washed using a floor cleaning rush, after the floor and all walls have been scrubbed, The tub is sprayed and watered so that the remaining dirt falls and enters the channel water disposal. Cultivation media can be used after drying and filling tank water is 80% of the tank volume. Then fertilize Cultivation containers aim to grow phytoplankton in containers cultivation used by Moina sp. as food for it to grow and breed. The fertilization process is carried out before stocking, the media It has been filled with water up to 80% of the volume of the tub, given cassava as fertilizer It has been fermented in water by stirring until the cashew fertilizer is dissolved. After a day of Fertilization, spreading can be done. In cultivating Moina sp. After maintenance for 5-10 days then the process of harvesting Moina sp. can be carried out.

During maintenance, water quality observations are carried out including pH, temperature, and D.O. Quality measurements are intended to determine the quality of water media, as one of the supporting factors in the successful maintenance of Moina sp is water quality.

Apart from that, laboratory testing was carried out on Kasgot media for Sodium, Phosphate and Potassium. As a confirmation material that kasgot media has nutrients as the basic material for growing phytoplankton is a natural food from Moina, Sp.

RESULT

Maggot comes from the Black Soldier Fly (BSF). Maggot maintenance carried out at BPBAT Mandiangin ranges from 38 – 60 days starting from egg stage. BSF flies will lay eggs in the gaps in the wood provided. After that the eggs will hatch in 2 – 4 days. This is in accordance with Tomberlin 2002 which says that eggs are stored at 30°C at Maggot cultivation will hatch in 3.5 days. At 2.5 days, the eye spot was red begin to appear in the embryo (seen with the help of binoculars or a hand lens). At 3 days the red eye spot was well defined. These eggs hatch inside 24 hour time. After the BSF fly eggs hatch, they will turn into fly larvae BSF which is called maggot. Maggots grow well in density 2.5 larvae per cm2 of surface area, and each requires 1–1.5 g.

(Continued on next page)

Media Black Soldier Fly is able to extract energy and nutrients from vegetable remains, food waste, animal carcasses, and other waste residues, such as feces and waste water domestic as food. The larvae or maggots of the black soldier fly can recycles solid and liquid waste, and is suitable for bred in monoculture because it is easy to spread, safe and easy bred in all conditions. Moreover, it is not easily affected by microorganisms and are not easily infected by parasites. Black Soldier Fly is also capable survive in extreme conditions and are able to cooperate with microorganisms to degrade organic waste. Black Soldier Fly is not a pest (Popa, 2012), but it is a type of fly that has a greater risk of spreading disease low compared to other types of flies (Bullock, et al, 2013).

The final result of the bioconversion process, namely changes in the composition of organic materials waste resulting from decomposition by black soldier fly larvae into organic compounds which is simpler. The bioconversion results from black soldier fly larvae produce stable materials, such as compost. Compost is the final form of materials organic waste after undergoing decomposition or conversion.

"Kasgot" that has been harvested is soaked in a 2-diameter tarpaulin tub it was given aeration for 15 days of maintenance. After 15 days of maintenance harvesting is carried out. The results of the abundance of Moina sp were 932,000 ind/tub.

Moina sp. in the waters can be seen with the naked eye. Therefore for Calculating the abundance of Moina sp can be counted one by one without using tools magnifier or microscope. The use of cassava fertilizer can increase the growth of water fleas (Moina sp.) is the same as with bran fertilizer where fertilizer Kasgot has very good properties for the growth of water fleas (Moina sp.) This is in accordance with Sianidar's statement in Nurjanah (1997), that fertilizing a body of water so that it is not given too much or too much A little.

"Kasgot" is tested in a soil laboratory Faculty of Agriculture, Lambung Mangkurat University. As for the test results as in the table below:

No	Sampel	N	P	K
		-------%-------		
1	Kasgot	1,91	0,23	1,90

CONCLUSION

KASGOT or result maggot bioconversion media has N, P and K values which corresponds to the standards required for phytoplankton growth. Phytoplanton is the food of Moina sp, so "kasgot" can used as a natural feed for growing Moina sp which is used as natural food for fish larvae because their size fits the fish's mouth opening. This aquaculture analyst activity report can be used as a publication from maggot cultivation activities at BPBAT Mandiangin. But it needs to be done research in the socio-economic field such as the use of wastewater in efficiency use of manure in the fisheries sector.

MANAGEMENT OF WHITE FECES DISEASE IN LITOPENAEUS VANNAMEI WITH THE APPLICATION OF PROBIOTICS AND WATER QUALITY MANAGEMENT IN BUBK POND CULTURE, KEBUMEN DISTRICT, CENTRAL JAVA PROVINCE, INDONESIA

Suzana Meidwi Ratriningrum[1)], Herinto[2)], Maskar Jayadi[3)]), Ita Rizkiyanti[4)], Fajar Anggraini[5)] Hasanuddin[6)] Ibnu Faturohman[7)]

Serang Fish and Environmental Health Testing Center, Banten
Karawang Aquaculture Production Business Service Center, West Java
Jepara Brackish Water Aquaculture Development Center, Central Java
Jepara Brackish Water Aquaculture Development Center, Central Java
Research Center for Fishery, National Research and Innovation Agency
Ujung Batee Brackish Water Aquaculture Development Center, Aceh
Karawang Aquaculture Production Business Service Center, West Java

The main problem in the vanamei shrimp culture (*Litopenaeus vannamei*) is how to prevent disease. One type of disease that can attack vanamei shrimp is White Faces Disease (WFD). Control efforts carried out to deal with the disease are [(1)] Application of fermented probiotics at a dose of 10 ppm for 3 consecutive days continuously, [(2)] replacement of new sterile water as much as 50%, when WFD symptoms attacked, [(3)] fasted of shrimp and reduction of feed doses to 70% of normal feed.

This study was conducted on intensive vanamei shrimp culture pond in BUBK (Shrimp Cluster Farming System) in Kebumen District, Central Java Province. With number of pond 9 units of size 1600 m2.

The probiotics used contain *Bacillus spp, Lactobacillus bulgaricus and Yeast*. The treatment results showed the survival of vaname shrimp culture by 73.83%.

POPULATION GENOMICS REVEALS GENETIC DIFFERENTIATION ACROSS SMALL SPATIAL SCALES AMONG SANDFISH *Holothuria (Metriatyla) scabra* POPULATIONS ALONG THE WESTERN LUZON COAST, PHILIPPINES

Rachel Ravago-Gotanco*, Deo Angelo S. Macahig, Monal M. Lal, and Marie Antonette Juinio-Meñez

Marine Science Institute, College of Science
University of the Philippines
Diliman, Quezon City 1101, Philippines
rrgotanco@msi.upd.edu.ph

The sea cucumber or sandfish *Holothuria (Metriatyla) scabra* is a high-value commodity widely traded in dried form (*bêche-de-mer*). Considered as overexploited throughout much of its distributional range, local declines have been reported for natural populations, highlighting the need for management options for the species. This study examines genetic connectivity of sandfish populations across the western Luzon coast using genome-wide single nucleotide polymorphism (SNP) markers generated from high-throughput DNA sequencing (DArT sequencing). Population genomic analysis based on 7,898 putatively neutral SNPs revealed significant genetic differentiation among populations sampled across 7 sites (F_{ST} = 0.0125, $p < 0.05$), indicating limited gene flow along the western Luzon coast spanning a distance of ~450 km. Multivariate and Bayesian approaches consistently identified four distinct genetic clusters concordant with geographic location. Migration networks suggest asymmetric northward gene flow across the western Luzon coast. However, genetic differentiation is not consistent with a pattern of isolation-by-distance, with the northernmost sites in the Ilocos region inferred as a potential admixture zone, serving as sink populations even from more distant southern sites. Population genomic analysis provides useful baseline information on sandfish stock structure and connectivity which are crucial for the development of resource management strategies such as stock restoration and enhancement from hatchery-produced animals, and conservation of genetic diversity, for this valuable fishery resource and aquaculture species.

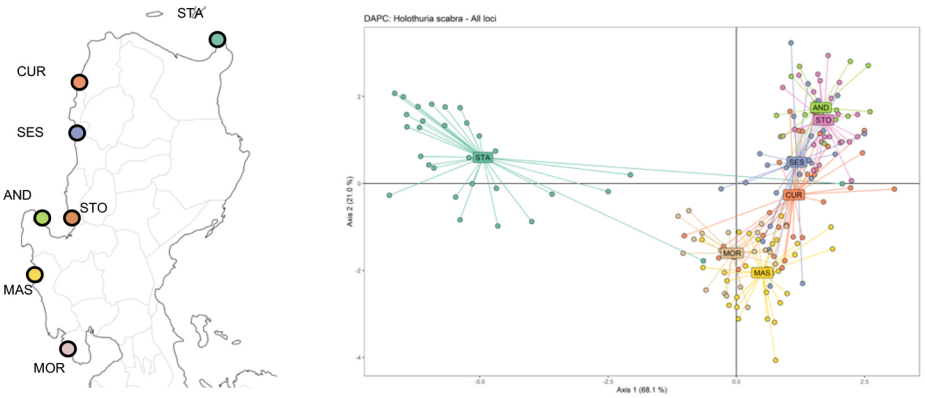


Figure 1. Map showing collection sites for *H. scabra* across the western Luzon coast (A), and scatterplot of discriminant analysis of principal components (DAPC) analysis showing spatial patterns of genetic structure. Each dot represents an individual, colors correspond with sampling sites.

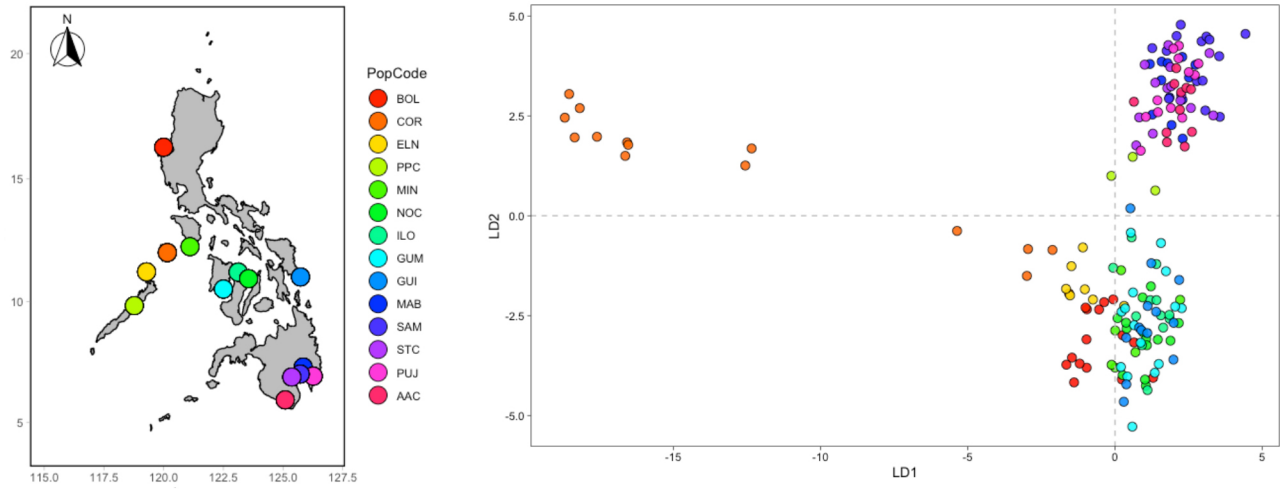
DELINEATING GENETIC STOCKS OF THE SANDFISH *Holothuria (Metriatyla) scabra*: REGIONAL AND FINE-SCALE GENETIC STRUCTURE OF PHILIPPINE POPULATIONS REVEALED BY GENOME-WIDE SNP MARKERS

Rachel Ravago-Gotanco*, Joselito A. Tabardillo Jr., Deo Angelo S. Macahig, Marie Antonette Juinio-Meñez

Marine Science Institute
College of Science
University of the Philippines Diliman
Quezon City 1101, Philippines
rrgotanco@msi.upd.edu.ph

The sandfish *Holothuria scabra* is one of the most widely-traded and in-demand sea cucumber species, with the dried form commanding steep prices in global markets. In the Philippines, the species is considered overharvested with declining capture production. Delineation of genetic stocks is important to guide the development of sustainable management and conservation interventions. This study used a genotyping-by-sequencing approach based on double-digest restriction site associated DNA sequencing (ddRADseq), to assess regional and fine-scale genetic structure of Philippine populations of *H. scabra*. Sandfish were sampled from 14 natural populations across the Philippine archipelago. Population genomic analysis of 163 individuals genotypes at 3,646 single-nucleotide polymorphism (SNP) markers reveals significant genetic differentiation (overall F_{ST} = 0.0342, p < 0.05). Across broad spatial scales, patterns of genetic structure were broadly concordant with marine biogeographic regions. Genetic structure was further detected within regions, indicating that gene flow and dispersal of sandfish may be limited even at smaller spatial scales (< 200 kms). Outlier loci analysis also suggests that some genetic clusters may be under local, adaptive selection warranting further investigation. These findings provide insights on sea cucumber stock boundaries and present baseline information useful for establishing spatially-explicit fishery resource management strategies.

Figure: Map showing *H. scabra* collection sites (left) and ordination plot following discriminant analysis of principal components (DAPC) analysis illustrating spatial patterns of genetic clustering (right). For the DAPC plot, each point represents an individual, with colors corresponding to the collection sites.



EFFECT OF PROBIOTICS ON PATHOGENIC *Vibrio* BACTERIAL POPULATIONS IN CULTURE PONDS OF *Litopenaeus vannamei* AT MOPHUS BANDER, SRIKAKULAM DISTRICT, ANDHRA PRADESH, INDIA

[*]Rayaprolu Srinivas

[*]Zinpro Animal Nutrition India Pvt Ltd
Visakhapatnam, Andhra Pradesh, India

Corresponding author email Id: rsrinivas@zinpro.com

The current study was carried out for 147 days to assess the pathogenic *Vibrio* count of *Litopenaeus vannamei* culture ponds and the influence of probiotics from Mophus Bander, Srikakulam District, Andhra Pradesh, India. Three ponds were selected, one is control and other two were experimental (Pond A and B). The physico-chemical parameters of the culture ponds were recorded by adopting standard methods. During summer crop the control ponds were harvested at 24.0 gm on 107th day and at 31.0 gm on 121st day for the year 2022 and 2023 respectively due to the incidence of *Vibriosis* disease. Where as in winter crop during 2023 the control pond was harvested at 5.5 gm on 47th day because of *Vibriosis* but in 2023 the control pond was harvested normally at 32.5 gm on 145th day, as this pond is free of *Vibriosis.* Experimental ponds were harvested normally in summer season at 30.5 gm on 124th day & 31.0 gm on 127th day during 2022 and 34.0 gm on 127th day & 35.5 gm on 127th day in the year 2023 respectively.

Where as in winter season of 2022 the experimental ponds were harvested normally at 28.0 gm on 124th day as well as on 127th day. In the year 2023 winter, the experimental ponds were harvested at 36.0 gm at 146th day and 35.5 gm at 147th day respectively. This study suggests that the probiotics are the key agents which have a great impact on the reduction of total pathogenic *Vibrio* count in culture ponds of *Litopenaeus vannamei*.

EPIPHYTIC MICROALGAE AS BIOLOGICAL INDICATORS FOR CARBON MONOXIDE CONCENTRATIONS IN DIFFERENT AREAS OF PENINSULAR MALAYSIA

Siti Aisyah Razli*, Azlan Abas, Asmida Ismail, Murnira Othman, Anis Asma Ahmad Mohtar, Nor Hafizah Baharudin, Kadaruddin Aiyub, and Mohd Talib Latif

Department of Earth Sciences and Environment
Faculty of Science and Technology
Universiti Kebangsaan Malaysia
43600 UKM Bangi, Selangor, Malaysia
aisyah.razli93@gmail.com

Microalgae are microorganisms with unique features of carbon sequestration and can act as biological indicators for air pollutants. Microalgae have been found to flourish in polluted environments. This study investigated the effect of carbon monoxide (CO) levels on the density of microalgal cells in different locations in Peninsular Malaysia, which has tropical climates. The species composition of microalgae influenced by different CO levels was also investigated. Microalgae samples were collected from four selected study sites, chosen based on average CO readings for 2015 in different categories which are low (Jerantut), medium (Banting, Kuala Lumpur), and high (Petaling Jaya) levels of CO. The findings of this study demonstrated a positive correlation between the CO concentration and the number of microalgal cells (Figure 1). This study also discovered that *Desmococcus olivaceus* is the most prevalent species found in the study areas and *Trebouxia arboricola* is the most dominant species. *Trentepohlia rigidula*, *Coccomyxa confluens*, *Keratococcus bicaudatus*, and *Klebsormidium flaccidum* can be classified as non-tolerant to high concentrations of CO as they are only found in areas with low concentrations of CO. Data from the Jaccard Similarity Index indicates a low similarity in species composition between Jerantut and; Banting, Kuala Lumpur, and Petaling Jaya with Jaccard coefficients of 0.2857, 0.1250, and 0.1250, respectively. The outcome of this study is important to understand the relationship between air pollutants and microalgae. Species distribution of microalgae suggests the use of epiphytic terrestrial microalgae as ecological indicators for air pollution. In addition, the species composition of microalgae influenced by air pollutants serves as a consortium for efficient bioremediation by utilizing microalgae species with high tolerance towards air pollutants.

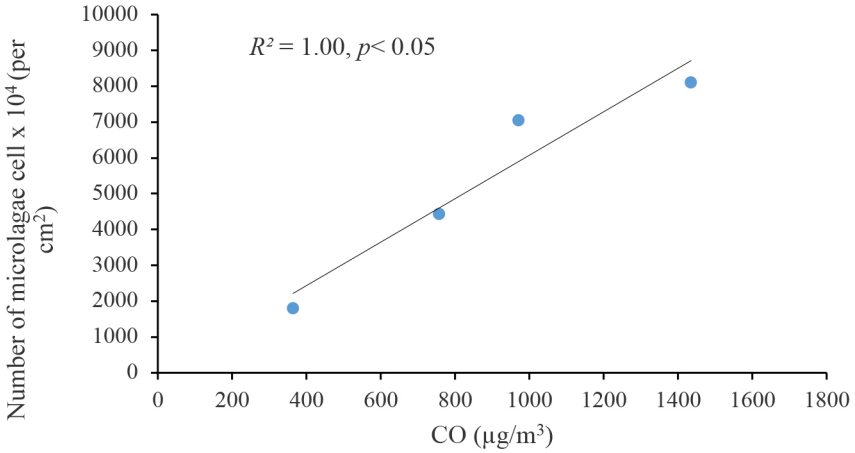


FIGURE 1. Correlation between the number of microalgae cells and CO concentration. Value of correlation coefficient where r = 1.00 proves the perfect positive correlation.

CAGE PRODUCTION OF BLUE SHRIMP *Penaeus stylirostris* IN OLIGOTROPHIC CORAL REEF LAGOONS OF FRENCH POLYNESIA : REMARKABLE AND PROMISING RESULTS FOR FAMILY-SCALE FARMS

Georges Remoissenet*, Marc-André Lafille, Thierry Tamata, Stanley Flohr, Nick Atger, Matangi Moeroa, Rarahu David, René Bernardino, Gilles Le Moullac and Jean Goguenheim

Direction des Ressources Marines
BP 20 Fare Ute, Papeete 98713
Tahiti, French Polynesia

While world aquaculture production of blue shrimp (*Penaeus stylirostris*) is very low, its taste is much appreciated, and its requirements and performance are quite similar to those of *Penaeus vannamei*. In Tahiti, the lack of suitable areas has led to develop intensive shrimp farming. Thus, biofloc system made it possible to obtain average yields of 20 t/ha/year for both species. Then, blue shrimp has been targeted from its performance and after control of its year-round reproduction. Local specific conditions probably contributed to the absence of pathogens requiring declaration to the World Organization for Animal Health, which has been demonstrated, while an import risks analysis made it possible to protect wild and farmed French Polynesia decapod crustaceans.

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This exceptional health status and blue shrimp characteristics have strongly contributed to the performance of shrimp culture in lagoon cages. Although carried out in an oligotrophic coral reef environment, the rearing conditions, and in particular natural nutrient supply conditions, made it possible to obtain remarkable performances. Indeed, if the sites must be well chosen (oxygenation, natural contributions …), the yields obtained in 50 m² cages are 10 to 15 kg/m² per production, at a rate of 2 to 2.5 productions per year. The average survival obtained varies from 50 to 70% depending on the season and the contribution of the natural environment. Food conversion ratio can reach 1.2 for 20g harvested shrimp. Farm-scale trials are described along with cages and rearing conditions. This technique could allow family-scale shrimp farming in the pristine coral reef lagoons of the Pacific Islands, the profitability conditions of which are described in Tahiti's conditions.

CENSUS OF POTENTIAL PREDATORS AND COMPETITORS OF JUVENILE SANDFISH *Holothuria scabra* IN SEA RANCHES IN EASTERN SAMAR, PHILIPPINES

Racelle R. Rescordado*, Jonh Rey L. Gacura, Margarita de la Torre-de la Cruz

Guiuan Development Foundation, Inc.
Guiuan, Eastern Samar, Philippines
racellerescordado@gmail.com

Sea ranching is an effective aquaculture method that cultivates marine species in their natural habitat promoting the sustainable use of marine resources and reducing pressure on wild populations. Sea ranching stimulates local economies by producing high-value species like *Holothuria scabra* (sandfish). In the Philippines, sandfish sea ranching utilizes second-stage juveniles of ≥3 to grow in sea ranches. However, predation threatens the stocked juvenile sandfish populations to reach harvestable size. Effective exclusion strategies for specific predators without affecting biodiversity are lacking. This study seeks to identify potential predators and competitors of sandfish in sea ranches during wet and dry seasons, explore the size most vulnerable to predation, and assess their abundance based on lunar phase variation.

This study was conducted in Eastern Samar specifically in Mercedes in Brgy. Cabungaan and Salcedo in Brgy. Maliwaliw during the wet and dry seasons at different lunar phases. A total of 90 traps (30 traps per set) were tethered with varying sizes of sandfish. Each set was soaked for 24 hours, and 12 hours (day and night) inside the sea ranch during the new moon and full moon on different seasons. The results of the study revealed the presence of more potential predators and competitors during the dry season and at the new moon. A total of 491 potential predators and competitors, belonging to 35 families and 50 species, were collected (Table 1). Predation marks (pinch-like lesions) were observed in juvenile sandfish (3-5 g) caused by *Thalamita crenata* indicating the vulnerability of small sandfish.

The identification of potential predators and their abundance variations throughout the year, as influenced by lunar phases, provides valuable insights into understanding local environmental conditions in managing sea ranching operations effectively. The dominance of crabs, filefishes, and cardinal fishes highlights potential challenges for sandfish cultivation and emphasizes the need for targeted predator exclusion strategies as well as the need to develop effective predator management techniques tailored to specific sea ranch sites.

TABLE 1. List of potential competitors collected during the experiment.

	Wet Season		Dry Season		
Family Name	Full Moon	New Moon	Full Moon	New Moon	TOTAL (indiv.)
Ambassidae				2	2
Aplysiidae	1				1
Apogonidae	8	9	25	13	55
Batillariidae		1		7	8
Centrogenyidae	2	5	2	2	11
Cerithiidae	15	6	27	8	56
Conidae			1		1
Gobiidae			1	4	5
Labrisomidae		1			1
Lethrinidae		6			6
Lutjanidae	1	1	1	1	4
Muraenidae	1	1		1	3
Siganidae		4	2	3	9
Holothuridae		2		3	5
Penaeidae		5			5
Pinguipedidae			4	1	5
Pomacentridae	1		1	1	3
Scaridae			6	2	8
Scorpaenidae		2			2
Strombidae	14	10	20	44	88
Trochidae	1				1
TOTAL	44	53	90	92	279

TABLE 2. List of potential predator collected during the experiment.

	Wet Season		**Dry Season**		
Family Name	**Full Moon**	**New Moon**	**Full Moon**	**New Moon**	**TOTAL (indiv.)**
Coenobitidae	11	10	12	4	37
Diogenidae	12	42	24	17	95
Gonodactylidae				1	1
Grapsidae			1		1
Scorpinidae		6			6
Monacanthidae	21	18	11	11	61
Oreasteridae	1		1	1	3
Ophiocomidae	1	1			2
Pinnotheridae		1			1
Portunidae		1			1
Toxopneustidae				1	1
Tonnidae	1				1
Tegulidae			1		1
Varunidae		1			1
TOTAL	47	80	50	35	212

DIGESTIBILITY OPTIMIZATION OF SINGLE-CELL PROTEIN INGREDIENTS IN ASIAN SEABASS (*Lates calcarifer*) AND SALINE TILAPIA (*Oreochromis mossambicus*)

Le Boucher R.[*1], Chung W.[1], Tan Shun En L.[1], Ng TH [1], Neo B. [1], Ng Kai Lin J. [1], Lee K.C. [1], Wu C. [1], Lee C.S.[1]

[1]Temasek Life Sciences Laboratory
Precision Aquaculture Department
1 Research Link National University of Singapore
117604, Singapore
E-mail : richard@tll.org.sg

In recent years, the aquafeed industry has witnessed the introduction of several new ingredients derived from food by-product upcycling, particularly from Single-Cell Protein (SCP). SCP are bulks of dried cells, produced by algae, yeast, bacteria and fungi, that have been progressively tested as protein rich supplements or ingredients in aquafeed. Bacteria meals are especially promising ingredients but their digestibilities have only been estimated in salmonids and data is missing for tropical fish species.

This study gathers the learning of three trials conducted on 2700 (48.2g) and 225 (48.9g) Asian seabass (*Lates calcarifer*) and 225 (48.7g) saline tilapia (*Oreochromis mossambicus*). Fish fed with experimental diets containing 30% of various bacteria meals and diets were produced either with a twin-screw extruder or a screw-press, and 0.1% Yttrium oxide was added to estimate digestibility. In small and large fish trials, thermal-unit growth coefficient (TGC), feed conversion rate (FCR) and nutrient retention efficiency were measured. Fish faeces were collected in each tank, diet and ingredient digestibility were estimated for protein, energy, and amino acids. The impact of extrusion parameters on gut enzyme activity and gut transcriptomics analysis was also explored. In saline tilapia, the bacteria meal ADC's for were 62.8±13.3% for dry matter and 77.6±4.1% for protein. In barramundi, the bacteria meal ADCs were 70.1±1.0 for dry matter and 79.1±0.7% for protein. Finally, the strategy for optimizing extrusion parameters is discussed to improve SCP digestibility.

Table 7. Mean digestive enzyme activity (n=3) in the intestine of barramundi when fed experimental diets containing 30% soy ingredients (Soy) or single-cell protein meal (SCP), extruded at 100°C or at 140°C, with 23% incorporated moisture rates [1]

	100 °C		**140 °C**	
	Soy	**SCP**	**Soy**	**SCP**
Lipase	0.1[a]	0.1[a]	0.1[a]	0.1[a]
Leucine amino peptidase	13.2[a]	14.2[a]	14.4[a]	11.1[a]
Chymotrypsin	127.6[a]	101.8[a]	143.4[a]	85.7[a]
Trypsin	3.7[a]	1.5[a]	3.5[a]	1.7[a]

ARTIFICIAL FEED ENRICHMENT WITH BIOACTIVATORS FOR BUSINESS SCALE EFFICIENCY AND EFFECTIVE

Akhmad Riva'i*, Samsul Bahrawi, Sunyoto

Balai Perikanan Budidaya Air Tawar Mandiangin
Direktorat Jenderal Perikanan Budidaya
Jl. Tahura Sultan Adam Km.14 Mandiangin Kec. Karang Intan Kab.Banjar Kalimantan Selatan
bbatmandiangin@gmail.com

Feed is one of the components that really supports aquaculture business activities, so the available feed must be adequate and meet the needs of the fish. The use of feed for fish production can consume 70 percent of the total production costs. Using Artificial feed is the right solution to reduce dependence on commercial feed by utilizing raw materials that are cheap but meet nutritional content to reduce production costs.

This study aims to determine the use of artificial feed with bioactivators on the growth of catfish and the target to be achieved, namely producing a percentage of feed with efficient FCR. This activity was carried out at BPBAT Mandiangin for 8 months of maintenance by stocking 500 catfish seeds in each treatment, namely treatment A (Artificial feed + Biofactivator) and treatment B (Artificial feed). The parameters observed include relative growth. survival, feed conversion, water quality, and business analysis.

The results of the activity showed that treatment A obtained better results than treatment B with an FCR value of 1,61, Relative Growth 99,03%, SR 88,10%, average weight 826,06 grams, and condition factor 28,15, while in treatment B Independent feed without bioactivator obtained an FCR value of 1,82, growth 98.89%, SR 82,80%, average weight 722,84 grams, and condition factor 25,38.

THE PRODUCTION OF MICROALGAE *Nannochlropsis oculata* FOR MARINE FISH HATCHERY IN THE LOMBOK MARINE AQUACULTURE DEVELOPMENT CENTER

Muhammad Rizal*

Sunarty
Titik Hartani
Rusmini
Abu Abas

Lombok Marine Aquaculture Development Center of Indonesia (Lombok MADC)

One of the most important sources of nutrition for the early life stages of marine larvae is the availability of microalgae from the species of *Nannochloropsis aculata*. This microalga is used as a main feed for rotifers, which are directly consumed by the larvae of two major marine finfish species that are farmed in the Lombok MADC, i.e Barramundi (*Lates carcarifer*) and Silver Pompano (*Trachinotus blochii*).

The study aims to find out the best management practices and the obstacles to the cultivation of *Nannochloropsis aculata.* Results were presented with a quantitative descriptive method with the data collection obtained from direct observation and literature reviews. In general, the growth rate of this microalgae showed a great performance that finally it can be directly harvested by flowing it through to the larvae tanks in the hatchery.

DOMESTICATION OF AMBERJACK FISH (*Seriolla dumerili*) AS AN EFFORT FOR SUSTAINABLE SEED PRODUCTION

Rochman Subiyanto*, Hamsah Amiruddin, Sunarto dan Hariyano

Balai Perikanan Budidaya Laut Ambon
Jl. Leo Wattimena, Ambon
e-mail: ambonbpbla@gmail.com

Amberjack fish or what is called rock pompano and is a deep water fish characterized by a dark yellow color with a bright yellow stripe from the eyes to the tail and is a pelagic fish which is a type of predator that preys on small fish, squid and other types. Taxonomically it is included in the Family Carangidae. The market demand for this fish is quite high due to its extraordinary versatility; either served as sashimi, cured, smoked, grilled, fried or roasted as a cutlet or boiled as a fillet in broth. This type of fish hatchery has not been widely practiced in Indonesia, even though the available market demand is quite high. Hatchery efforts were carried out by the Ambon Mariculture Fisheries Center with structured broodstock domestication steps starting in June 2023. Handling of broodstock was carried out in fiber tubs with a capacity of 15-20 tonnes with a density of 10-12 fish per tub. Improvements in feed quality and vitamins are carried out in stages with dose adjustments of 3-5%. During 4 months of domestication, the number of eggs ranging from 1,400,000-2,400,000 was obtained with a total of 8,450,000 eggs. Apart from that, a spawning interval of 3-7 days per month is also obtained with a hatching rate of 10-60% with 6 fry.

IN-FEED PROBIOTICS AND WATER BIOREMEDIATION IMPROVED GROWTH, BIOMASS, SURVIVAL, WATER CHEMISTRY AND MICROBIOTA IN WHITELEG SHRIMP *Litopenaeus vannamei* IN VIETNAM

Rodiles, A.[1*], Leclercq, E.[1], Castex, M.[1]

[1]Lallemand Animal Nutrition
Blagnac, France
arodiles@lallemand.com

The use of probiotics in water (bioremediation) and in-feed are progressively replacing the prophylactic use of antibiotics in the culture of shrimp. This study compared the benefits of probiotic- or antibiotic-based prophylactic strategies and their combination to a non-supplemented control under commercial-like conditions. Shrimp performance and resilience to abiotic stressors were addressed, together with water quality and microbiota to estimate the mechanisms at play and the benefits at farm level.

A 42-day grow-out trial was performed in Vietnam using whiteleg shrimp juvenile (0.5g) reared at high density (150 shrimp/m^3) in 16 outdoor tanks (50m^3), low water exchange using pumped-ashore pre-treated natural brackish water (7 to 14 ppt; 30 to 8°C). Animals were fed to apparent satiation 4 times/day with feeding tray. Four treatments were applied in quadruplicate: Control group (CON) used non-supplemented commercial feed (basal feed; Lion feed, Sheng Long; Vietnam); antibiotic group (ABX) supplemented with Oxytetracycline from day 10 to day 20 (OTC, 5g/Kg feed); Probiotic group (LAL) supplemented with Lalpack Probio and Lalpack Immune (5g/Kg feed each; Lallemand) and rearing water conditioned with Lalsea Biorem (1.2Kg/ha every 4 days; Lallemand); Antibiotic+Probiotic group (ABX+LAL) combined feed and water conditioning. After zootechnical performance analysis at day 42, shrimp from each tank were randomly selected and exposed to an abrupt salinity challenge to assess shrimp robustness (50 shrimp/500L tank; 6 replicates /groups).

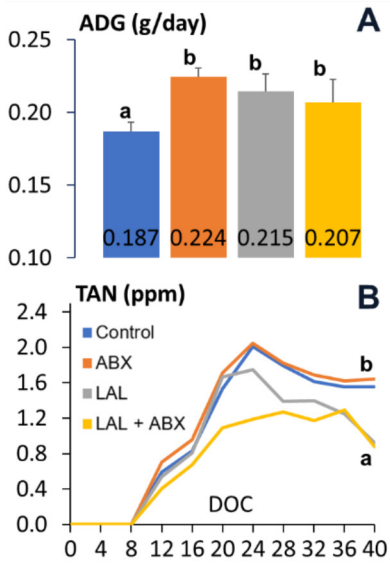

***Fig.1**. ADG at day 42 (A); TAN during the trial (B) (P<0.05).*

Results showed biomass gain and average daily growth (ADG) were sig. higher in all suppl. groups compared to CON (**Fig.1A**; $P<0.05$), both ABX groups had a sig. lower condition factor (K). Resilience to the abiotic challenge were higher in all suppl. groups compared to CON, increasing time to 50% mortality: ABX (+6%), LAL (+14%), LAL+ABX (+29%). During the trial, ammonia and nitrite levels remained lowest for both LAL groups (**Fig.1B;** $P<0.05$). Post-intervention levels of lactic acid bacteria (LAB) in water and gut were sig. higher in both LAL groups (+1.0 log), ABX promoted higher total heterotrophic bacteria in water. Water microbiota was significantly clustered by Flavobacteriia (*NS3a marine group*; Bacteroidota) in CON (20%) and ABX (26%), and by *Candidatus Aquiluna* (Microbacteriaceae; Actinobacteriota) in LAL groups (45%). Interestingly, the functional potential of the microbial water modulation revealed, in both LAL groups, a lower prevalence of the N-metabolism enzymes glutamate dehydrogenase (L-glutamate deamination), Nitronate monooxygenase (nitrite-forming), and an enzyme involved in Carbon-fixation (MCEE).

In conclusion, on-growing of *L. vannamei* using an in-feed probiotic and water bioremediation strategy improve shrimp growth, biomass gain and resilience to abiotic stressors to similar or higher levels than that achieved by the prophylactic use of antibiotic. This was associated with a higher LAB prevalence in the gut, as well as with a distinctive modulation of the water microbial community supporting enhanced organic matter and nitrogen-cycling.

THE MASS PRODUCTION OF SILVER RASBORA *Rasbora argyrotaenia* SEEDLING IN THE TANKS AND PONDS

Dasu Rohmana*, Ucu Cahyadi, Astri Ayuningtias, Susi Rosellia, Linda Rahmi, Ujang Sujana

Balai Besar Perikanan Budi Daya Air Tawar Sukabumi
Jln. Selabintana No. 37 Kota Sukabumi
West Java, Indonesia
rohmanadasu@gmail.com

Silver Rasbora (*Rasbora argyrotaenia*) is a small fish type from the Cyprinidae family which is generally found in clear water rivers or lakes. In a hatchery system which is carried out in tanks or ponds, it can be spawned massively throughout the year with just a little environmental manipulation. In the spawning system tank, the broodstock rearing tank is cleaned and the water media is replaced with new water. The broodstocks will spawn from night to morning and the eggs are harvested and hatched in a cone-shaped tank. The eggs will hatch into larvae after 30 hours of ovulation and will be harvested and stocked in larval rearing tanks on the third day after the eggs hatch at a density of 2-3 individuals/liter. Larvae is reared for 2 months successively and is given with infusorio, Moina sp. and artificial feed. In the spawning pond, the broodstocks are placed in happas. The pond functions as a place for spawning, hatching and rearing of larvae. In this system, the number of eggs and larvae cannot be known. The larvae in the pond are fed with powdered feed after the larvae begin to appear on the pond surface, generally after 10 days of spawning and the larvae are kept for the next 2 months.

Silver rasbora broodstocks with a total length of more than 10 cm will produce around 5,000 eggs per parent. Hatching of silver rasbora eggs is carried out in cone tanks containing 12 liters of water with egg density of 300, 450, 600 and 750 eggs/ liter. The degree of egg hatching can be seen in Figure 1. The higher the egg density, the lower the egg hatching rate will be.

The results of rearing larvae for 2 months showed an average survival rate of 83.9 ± 14.8% with a daily growth rate of 7.4%. The increase in weight and total length of silver rasbora during 2 months of rearing is presented in Figure 2. The advantage of hatching in tanks is the number of egg, larvae and fish fry is more measurable. Meanwhile, spawning fish in ponds with maintenance in happas makes the work more practical. There is no need to harvest and hatch eggs, as well as rear and harvest larvae.

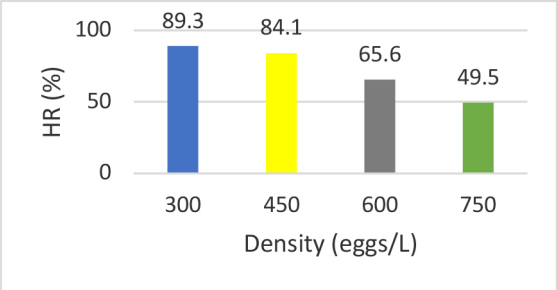

Figure 1. Hatching degree of silver rasbora eggs at several density levels

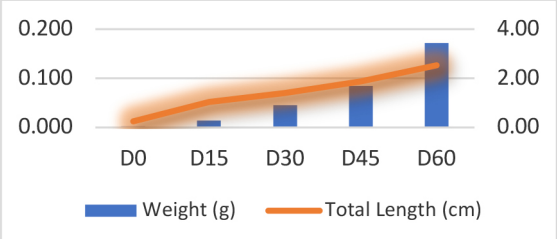

Figure 2. Increase in length and weight of silver rasbora during 2 months of maintenance

TECHNIQUES FOR IMPROVING POND PRODUCTIVITY THROUGH JUVENIL SHRIMP STOCKING

Bayu Romadhona*, Hendra Gunawan, Supito

Jepara Brackish Water Aquaculture Development Center
Jl. Cik Lanang, Rw. IV, Bulu
Kec. Jepara, Jepara Regency
Central Java 59418, Indonesia
Phone: (0291) 591125
Fax: (0291) 591724

Corresponding Author:
utamabbpbapjpr@gmail.com

The potential for traditional Indonesian shrimp ponds reaches 247. 803 Ha or 82.4% of the total pond area of 300.501 Ha. The area of traditional farms in Sidoarjo district, East Java is around 10.871 Ha, with the main commodity being tiger prawns. The decreasing yield of tiger prawn ponds due to disease attacks results in the death of shrimp at an early age which is suspected to reduce environmental quality, so technical efforts are needed to shorten maintenance. This paper aims to determine the productivity of extensive shrimp farm through stocking of juvenile tiger prawn seeds (tokolan = in local name). Observational technical data was obtained from 6 traditional pond locations in the Sidoarjo area (table 1), with 2 different seed stocking methods, 3 locations of PL-12 size stocking ponds (Post Larva = length 0.8-0.9 cm), and 3 stocking locations with PL-30 (from nursery ponds/juvenile size = length 1.2-1.5 cm).

Materials used at each activity location include PL and Juvenile (tokolan) foraged shrimp seeds, active lime, dolomite lime, molasses (cane molasses, EM-4 probiotics, rice bran, filters (happa/filter from net). Equipment used includes diesel pumps, water quality equipment (reflaktometer, water scale, water pH), harvesting tools, stationery. Cultivation stages include land preparation, water intake, stocking, artificial feed and water management, harvest. Land preparation includes drying, repairing leaks, raising pond bottom sludge, liming doses 300-500 kg/Ha, making dry fermentation for the soil base. Water intake source from river by gravity and diesel pump, equipped with filter. Initial height 40-50 cm from the yard. Next application of 15 ppm saponin and making probiotic culture. Distribution of tiger prawn seeds comes from a clear source, uniformity > 80%, maximum salinity difference of 10 ppt, stocking density of PL-12 with stocking 3-5 seed/m² and juvenile 1-2 seed/m², temperature adaptation is carried out (bags are floated plot ±15 minutes) and salinity (adding pond water to the bag). Maintenance stage, checking water quality periodically, adding water, liming, probiotic culture. Management of natural food (water algae) is regulated by a percentage density of 60% space for shrimp and 40% aquatic plants, as well as adding milkfish at 0.25 fish/m². Partial and total harvesting stages using prayang/bamboo trap tools as well as drying the pond plots. Survival Rate (SR) using tokolan seed stocking method is higher (average 26/-27%) compared to PL 12 stocking SR 6,8-8.5%), technically also tokolan/ juvenile stocking shortens maintenance from 4 months to 2.5 In the month a partial harvest can be done, the soil conditions are better and economically more profitable.

MICROPLASTIC CONTAMINATION IN GREEN MUSSELS CULTIVATED ON PASARAN ISLAND, LAMPUNG

Ulfanida Romaskila, Julinasari Dewi, Andrian Garbono, Rakhmat Hadi, Nana Lestari

Main Center for Marine Aquaculture
Directorate General of Aquaculture
Marine Affairs and Fisheries Ministry
Email : ulfanida.romaskila@kkp.go.id
bbpbl.lampung@gmail.com

Microplastic have a negative impact on aquatic biota and the environment. This research aims to determine the type and abundance of microplastics found in green mussels cultivated around Pasaran Island. Sampling was carried out by taking samples of cultivated green mussels in small, medium, and large sizes. Based on the research, there was microplastic contamination in the types of fragments, films, fibers, granul, and foam in green mussels. The lowest value of microplastic abundance in green mussels was found in large mussels (15 ± 0.1 particles/individual) and the highest value was 21 ± 0.1 particles/individual in small mussels.

Most of the trash in the sea comes from plastic waste. Plastic waste will decompose into smaller fragments with a size of ≤ 5 mm which are called microplastics. Microplastic have a negative impact if they are ingested by marine organisms or interact with other environmental pollution, and will accumulate in other organisms through the food chain (Dwiyatno*et al*., 2018).

This research was carried out on March 2022 and aims to determine the type and abundance of microplastics found in green mussels cultivated around Pasaran Island.

Based on research results, there ware 5 types of microplastics found in green mussels (*Perna viridis*). They are fragments, films, fibers, granules, and foams. Green mussels can eat whatever is around them by filtering out the particles in the surrounding waters. Green Mussels taken from Pasaran Island are divided into 3 classes based on shell length. The highest abundance of microplastics was found in the small mussels and the lowest abundance was in the large mussels. Microplastic fiber was found in the highest quantities compared to other types in each size of green mussel. Microfiber with the highest abundance was found in small mussel at 11 ± 0.10 particles/individu, while microfiber with the lowest abundance at 9 ± 0.10 particles/individu was found in large mussel.

EFFECT OF LOW TEMPERATURE ON PATHOGENCITY AND $TCID_{50}$ OF *Oreochromis spp.* AGAINST BETANODAVIRUS INFECTION

R.Irfan-Hakimi*, M.Nur-Nazifah, Azila Abdullah, M.Firdaus-Nawi, MK Hazreen-Nita

Kulliyah of Science
International Islamic University Malaysia
Bandar Indera Mahkota
25200 Kuantan
Pahang, Malaysia
irfanhakimi374@gmail.com

Oreochromis spp. is one of the most common cultured fish in the 21st century. It has been introduced into over 90 countries, and increasingly worldwide in aquaculture. In Malaysia, due to its high growth rate, *Oreochromis spp.* were favoured by farmers. Its production increase from 25,199.89 tonnes in 2018 to 27,926.90 tonnes in 2022. Meanwhile, Betanodavirus is a pathogenic virus and causative agent of Viral Nervous Necrosis (VNN) affecting more than 120 species of marine and freshwater farmed fishes. However, the prevention measures against this serious disease are still unknown due to the lack of research and information, particularly on disease development itself. Therefore, the objective of this study is to determine the degree of Betanodavirus infection in *Oreochromis spp*., under temperature fluctuation as a stress factor. The surrounding temperature was randomly modulated within the range of 18°C to 26°C. In this study, a total of 100 *Oreochromis spp*. were selected and divided into five different groups with duplicate tanks. There are four different concentrations of Betanodavirus used (10^4TCID_{50}/ml, 10^3TCID_{50}/ml, 10^2TCID_{50}/ml, 10^1TCID_{50}/ml) that were injected intraperitoneally including phosphate buffer saline (PBS) as control.

Observation of pathogenicity, mortality and clinical signs were carried out for 30 days and $TCID_{50}$ value was determined. The earliest clinical sign was observed at concentration of 10^4TCID_{50}/ml at 10 hours post-infection (pi) while erratic swimming was observed at 20 hours pi. Internal clinical signs (Figure 1) such as congested kidney, enlarged spleen and white nodule spleen were observed for highest concentration group (10^4 $TCID_{50}$/mL) at 7 days pi. The highest cumulative mortality was recorded at concentration 10^4TCID_{50}/ml with 75% mortality rate (Table 1). Data analysis showed that the $TCID_{50}$ value of Betanodavirus was 8.254 x 10^2TCID_{50}/ml (Figure 2). Overall, this study showed that Betanodavirus infection does affect the survivability of *Oreochromis spp.* under temperature fluctuation stress factor.

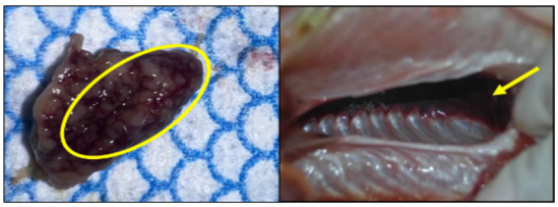

Figure 1: Internal clinical signs observed in *Oreochromis spp*.

Table 1: Cumulative mortality of *Oreochromis spp.*

Group ($TCID_{50}$/mL)	Control	10^1	10^2	10^3	10^4
Cumulative Mortality (%)	0	20	30	45	75

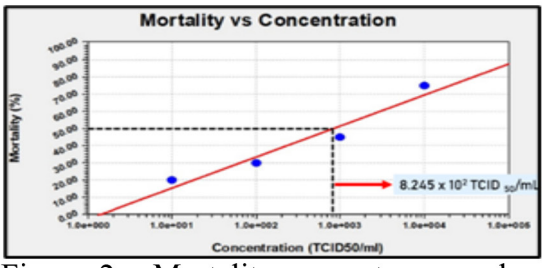

Figure 2: Mortality percentage graph of *Oreochromis spp*. against different concentration of Betanodavirus.

OPTIMIZING THE STOCKING DENSITY OF TILAPIA (*Oreochormis Niloticus*) BY USING NITROBACTER AS A COMPLEMENTARY BACTERIA IN TILAPIA CULTURE ACTIVITY USING THE BIOFLOC SYSTEM

Rusel
ruselwong89@gmail.com

Tatelu Freshwater Development Center
Jln Pinilih, Jaga VI Desa Tatelu Kecamatan Dimembe

Tilapia is a freshwater fish with high economic value, so many tilapia are cultured intensively to increase production value. To maximize production using the biofloc technique generally uses 2 types of bacteria that are commonly found in probiotic products. They are namely *lactobaccilus sp* and *baccilus sp* because they are considered sufficient to maximize the application to optimize tilapia fish production. In this activity , *Nitrobacter* was included to complete the function of *Lactobaccilus sp* and *Bacillus sp*.

Culture intensification , especially increasing stocking density, has an adverse impact on environmental . The decrease in environmental quality is caused by organic waste from leftover feed and manure, this waste is generally dominated by toxic organic nitrogen compounds.

Biofloc tehcnology is an alternative solution to the problema of intensive cultivation waste. This technology is considered the most profitable beacuse apart from being able to reduce organic nitrogen waste and feed residue, it can increase fish growth and feedefficency. Biologically, in nature, ammonia can actually be converted into nitrate (NO^3), a form that is not dangerous in the nitrification process, however , the high levels ofammonia in intensive culture give and idea that the amount of Nitrobacter present is still no table to balance the amount of amonia produced. The refore, the addition of *Nitrobacter* in intensive culture systrem is expected to improve water quality due to high fish density so that it can increase fish growth and production.

In this activity, 3 biofloc tanks with a diameter of 3 meters were used using different types of bacteria and stocking dendensities , in the first tank , the types of bacteria used were *Lactobaccilus sp* and *bacillus sp* with a density of tilapia sedes of 120 fish/m^3, in the second tank apart the type of bacteria used *Lactobacillus sp* and *Bacillus sp* with density of 200 fish/ m^3 and in 3rd tank apart from the bacteria *Lactobacillus sp* and *Bacillus sp* there was the adition of *Nitrobacter* and the stocking density of Tilapia sedes was 200 fish/ m^3.

STUDY OF THE DECLINE OF GROUPER CULTIVATION IN FLOATING NET CAGES PESAWARAN REGENCY, LAMPUNG PROVINCE

Emy Rusyani* and Supriya

Main center For Marine Aquaculture
Directorate General of Aquculture
Marine Affair and Fisheries Ministry
Email : 71emyrusyani72@gmail.com
Supriyawijaya1970@gmail.com

This study aims to examine and analyze the decline in grouper cultivation activities in floating net cages in Pesawaran Regency, Lampung province. The study results are based on survey methods. Primary data collection is based on/by means of observation and interviews. Secondary data collection was obtained based on the relevant government agencies.

Data analysis uses quantitative descriptive analysis and SWOT analysis. The results of the research show that the problems with developing grouper cultivation in floating net cages in Lampung Province are (1) micro problems including limited grouper seed size in logs, death of grouper caused by disease, poor water quality management, limited trash feed, high price of seed and (2) macro problems include limited capital, low knowledge of cultivation technology, and limited market access.

The results of the Internal Factor Evaluation (IFE) and External Factor Evaluation (EFE) matrix analysis show that the internal and external position of grouper cultivation in floating net cages in Pesawaran Regency, Lampung Province is in quadrant I (2.692; 2.946), where this condition is a very favorable situation. The business of cultivating grouper fish in floating net cages in Pesawaran Regency, Lampung Province has opportunities and strengths so that it can take advantage of existing opportunities by minimizing threats and weaknesses.

PROPHYLACTIC EFFECT OF GARLIC JUICE EXTRACT AGAINST *Edwardsiella Ictaluri* INFECTION IN *Pangasianodon Hypophthalmus*

S. Syafiq-Syauqi[1], M. Nur-Nazifah[1], Shaharah, M., I.[2], Firdaus Nawi, M.[1]

[1]Kulliyyah of Science, International Islamic University Malaysia (IIUM), Bandar Indera Mahkota, Jalan Sultan Ahmad Shah, 25200 Kuantan, Pahang, Malaysia
[2]Fisheries Research Institute (FRI), Department of Fisheries, Tanjung Demong, 22200 Kampung Besut, Terengganu, Malaysia
Author: safiqshawky@gmail.com

Garlic (*Allium sativum*) has several bioactive compounds that provides various biological properties such as growth promotion and antimicrobial properties which can increase fish resistance to diseases. *Pangasianodon hypophthalmus* is a predominant finfish which originated from Mekong Delta region, Vietnam and has been cultured widely in Malaysia. The common pathogenic bacteria which can infect this species is *Edwardsiella ictalurid.*

The objective of this study is to investigate the prophylactic effect of garlic juice extract against *Edwardsiella ictaluri* infection in *Pangasianodon hypophthalmus* at control environment. Garlic juice extract was obtained by grinding with juicer and considered as 100% stock solution. Medicated pellet was prepared by spraying 80% concentration of garlic juice extract onto the pellet and allowed to air dried before use. Variable used in this experiment is the treatment duration, which are 5 days, 10 days, 15 days, positive control (fed with commercial pellet and challenged with bacteria), and negative control (fed with commercial pellet but not challenged with bacteria). The concentration of *Edwardsiella ictaluri* used to challenge the fish was 10^8 cfu/ml. Ten fish were used in each group with duplicates. The feeding ratio was 3% from total body weight. Fish were fed with 80% concentration of garlic juice extract before challenged with *Edwardsiella ictaluri* through intraperitoneal injection method. Clinical signs and mortalities were observed and recorded for 30 days of experiment. The results showed that no mortality observed in tank treated with garlic (5 days,10 days,15 days) throughout 30 days of experiment with mild clinical signs such as pale body, hemorrhagic fin, and hemorrhagic tail. For positive control, 5 mortalities were recorded with several severe clinical signs such as pale body, hemorrhagic tail, hemorrhagic fin, erratic swimming, and bilateral exophthalmia (Figure 1). As for statistical analysis, ANOVA test showed that average mortality of *Pangasianodon hypophthalmus* was significantly difference ($P < 0.05$) between 5 different groups of treatment. In conclusion, garlic juice is very effective to prevent *Pangasianodon hypophthalmus* against *Edwardsiella ictaluri* infection in the control environment.

Figure 1: Bilateral exophthalmia

ANOVA

Mortality

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	5.000	4	1.250	25.000	.000
Within Groups	.750	15	.050		
Total	5.750	19			

Table 1: ANOVA analysis for 5 different group of treatment for *P. hypophthalmus*

BIOFLOC CONSERVATION: ASSESSMENT OF PRESERVATION PROTOCOL AND RE-INOCULATION

Javier Gómez-Aguilera, Sara Ferrando-Juan, Macarena M. Jurado, María J. Estrella-González, Miguel Rodilla, Silvia Falcó, Silvia Martínez-Llorens, Ana Tomás, Miguel Jover, David S. Peñaranda*, Francisco J. Moyano, Juan A. López-González

Universitat Politècnica de València
Camino de Vera s/n, 46022
*Presenting author's: dasncpea@upv.es

Introduction: Systems utilizing Biofloc technology (BFT) exhibit the capacity to rear specific aquatic species, notably shrimp and tilapia, at remarkably high stocking densities. The maturation process of biofloc is characterized by a prolonged duration before achieving full functionality. Initialization of a biofloc system typically involves a low initial density of aquatic organisms, coupled with an input of feed and an external carbon source. Drawbacks associated with this method encompass extended waiting periods, fluctuating water quality, and limited animal densities.

Material and Methods: To expedite the maturation process, a comparative trial was conducted to evaluate different preservation methods for Biofloc. Microbiological preservation tests were performed on concentrated iofloc samples to ascertain the most effective preservation techniques. Assessment of cell viability and growth of heterotrophic and nitrifying bacteria ensued subsequent to subjecting the samples to diverse preservation methodologies. Experimental groups included a positive control (concentrated and unpreserved Biofloc) and five experimental groups: refrigerated (RF), frozen with 15% glycerol (F-GLI), frozen with 15% glucose (F-GLU), frozen (F), and freeze-dried (LF). Notably, the F-GLI and F-GLU groups exhibited the highest levels of heterotrophic and nitrifying bacteria growth, with the F-GLI group demonstrating superior cell viability among the experimental cohorts (Figure 1).

Subsequently, an experiment was conducted utilizing *Penaeus vannamei* shrimp to assess the efficacy of preserved biofloc samples. Experimental groups encompassed refrigerated in vacuum bags (V), frozen at -80°C with 15% glycerol (F-GLI), and dried (D). Control groups included a negative control (C-), devoid of Biofloc, and a positive control (C+), inoculated with fresh Biofloc. Utilizing 80L tanks with an initial biomass of 80 grams and an inoculum concentration of 1g/L conserved for 5 days, water quality was periodically analyzed via chemical assessment of ammonium and nitrite concentrations.

Results and discussion: After 21 days, observations indicated complete transformation of ammonium to nitrite in groups V and F-GLI. While nitrite accumulation was absent in group V, group F-GLI exhibited minimal nitrite accumulation albeit at very low concentrations. Conversely, group D displayed higher nitrite accumulation compared to the negative control, albeit with a more rapid stabilization of ammonium. These findings suggest the feasibility of short-term (one-week refrigeration) and long-term (freezing) preservation of biofloc to expedite the maturation of biofloc tanks accommodating high animal densities.

Acknowledgments: The study was funded by the Research Project: "Optimizing shrimp feeding and nutrition in biofloc system (BioFlango)" (PID2020-114574RB-C21). S. Ferrando-Juan contract by MICIN Research Personnel Training Grant (PRE2021-098367). J. Gómez-Aguilera contract was supported by European Union Next Generation-Plan of Conselleria d'innovació, Universitats, Ciència i Societat Digital of Generalitat Valenciana (INVEST/2022/434).

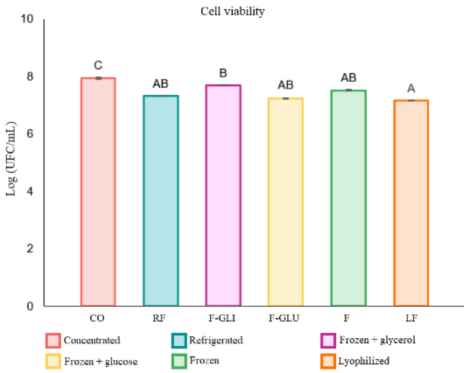

Figure 1. Cell viability after submitting to different conservation protocols

FISHMEAL REPLACEMENT BY ALTERNATIVE PROTEIN SOURCES IN DIETS FOR *Pennaeus vannamei* UNDER BIOFLOC TECHNOLOGY PRODUCTION

Sara Ferrando-Juan, J. Gómez-Aguilera, Silvia Falcó, Silvia Martínez-Llorens, Ana Tomás-Vidal, Miguel Jover, Yosu Candela, Wilson Wasielesky, Miguel Rodilla, David S. Peñaranda*

Universitat Politècnica de València
Camino de Vera s/n, 46022
*Presenting author's: dasncpea@upv.es

Introduction: The main limiting factor in shrimp aquaculture sector is the use of fishmeal (FM) in feed formulation, which account for 50-70% of the production cost. In previous studies in *Penaeus vannamei* (*P. vannamei*), relative high FM substitution can be achieved using plant or animal raw ingredients as alternative protein source. The ingredients choice and % substitution limits the growth performance, generally >50% replacement (animal or vegetal) results in lower growth rates. Therefore, the present study aims to evaluate the effect of total or high FM substitution by a combination of animal and plant by-products on productive parameters of shrimp under biofloc technology.

Material and Methods: The present study consisted of two experimental phases of shrimp growth. **Phase I**, diets with 100% or 92% of by-products inclusion as alternative protein source from animal (A92 and A100), plant (V92 and V100) or a combination of animal and plant origin (AV92 and AV100) were assayed in *P. vannamei* from 2.5 to 8 g in tanks of 1 m^3 (n= 3 replicates/group). Additionally, a control group with a 15% of FM inclusion were also tested to be compared with the experimental diets (Table 1). All diets were isoproteic and isolipidic, with a total 38% and 10%, respectively. In a **Phase II**, the two experimental groups from Phase 1 that provided the best growth performance were compared with the control from 5 to 14-15 g in tanks of 3.3 m^3. All diets in Phase 2 were isoproteic and isolipidic, with a total 34% and 10%, respectively, according to Ferrando-Juan *et al.* (2022). The growth assays were performed under intensive conditions, with densities of 350 shrimp/ m^3.

Results and discussion:
In Phase I, better growth performance was observed in the experimental diet A92 and AV92, with the lowest values of FCR (Table 2). Therefore, it was determined that a 92% of FM substitution with alternative animal and plant/animal by-products was possible without compromising growth performance, with no differences with control group. In Phase II, A92 registered a lower growth but without significant differences. In both phases, the results confirm that a high FM substitution is feasible in *P. vannamei* thanks to a combination of animal and plant by-products as alternative protein source. Previous studies have shown that it is possible to substitute fishmeal with alternative plant protein sources, such as soybean meal, up to 95%, or with animal protein sources, such as poultry by-products, up to 66%. Therefore, the present study provides an alternative and sustainable diet formulation for shrimp production without compromising production.

Table 1. Feed ingredients (g/kg) used in fishmeal replacement diets for P.vannamei

Feed ingredients (g/kg)	Control	A92	A100	V92	V100	AV92	AV100
Fishmeal	150	75	0	75	0	75	0
Eco wheat	344	405	382	333	324	348	322
Eco soy	210			215	218	163	188
Porcine hemoglobin		100	120			20	37
Meatmeal							
Wheat; Soy hydrolyzed; potato protein	150			210	270	165	180
Fish oil	20	28	36	28	36	28	36
Soy oil	46	32	22	39	32	36	27

	Feed	Final Weight (g)	SGR (%/day)	FI (g/100g fish day)	FCR
Phase I	**Control**	7.55 ± 0.33	1.46 ± 0.02	3.32 ± 0.1	3.04 ± 0.1^{ab}
	A92	8.29 ± 0.55	1.58 ± 0.09	3.13 ± 0.05	2.67 ± 0.12^{b}
	A100	7.41 ± 0.16	1.45 ± 011	3.36 ± 011	3.07 ± 0.19^{ab}
	V92	7.57 ± 0.41	1.46 ± 0.05	3.35 ± 0.13	3,07± 0.15^{ab}
	V100	7.22 ± 0.34	1.43 ± 0.09	3.46 ± 0.18	3.22 ± 0.2^{ab}
	AV92	8.20 ± 0.32	1.56 ± 0.07	3.19 ± 0.07	2.76 ± 0.15^{b}
	AV100	6.74 ± 0.4	1.31 ± 0.09	3.61 ± 0.16	3.75 ± 0.3 ^{a}
Phase II	**Control**	12.02 ± 0.48	2.41 ± 0.52	2.65 ± 0.44	1.20 ± 0.091
	A92	10.84 ± 0.4	2.25 ± 0.42	2.91 ± 0.36	1.42 ± 0.074
	AV92	12.10 ± 0.4	2.27 ± 0.42	2.52 ± 0.36	1.24 ± 0.074

Acknowledgments: The study was funded by the Research Project: "Optimizing shrimp feeding and nutrition in biofloc system (BioFlango)" (PID2020-114574RB-C21). S. Ferrando-Juan contract by MICIN Research Personnel Training Grant (PRE2021-098367). Y. Candela and J. Gómez-Aguilera contract was supported by European Union Next Generation-Plan of Conselleria d'innovació, Universitats, Ciència i Societat Digital of Generalitat Valenciana (INVEST/2022/434).

STUDY OF THE PROBIOTIC POTENTIAL EFFECT ON *Penaeus vannamei* PERFORMANCE IN BIOFLOC TECHNOLOGY (BFT)

Tatiana Cascales, Silvia Martínez-Llorens, Wilson Wasielesky, Ana M. Marhuenda, Pablo Sánchez-Jerez, Yosu Candela, Mikol Girotto, Joao Rito, Jessica Brol, Miguel Jover, Ana Tomas-Vidal, David S. Peñaranda*

Universitat Politècnica de València
Camino de Vera s/n, 46022
*Presenting author's: dasncpea@upv.es

Introduction: Currently, research studies are being focused on microalgae and bacterial probiotics inclusion in Biofloc Technology (BFT). Both have demonstrated a beneficial effect on *P. vannamei* performance, particularly, the inclusion of *Chlorella vulgaris* reported an improvement in terms of water quality, shrimp growth and health status. Therefore, this study aims to investigate the probiotic effects of including and modulating the growth of *Chlorella sp*. on the production of *P. vannamei* in BFT, and to compare it with commercial probiotics.

Material and Methods: In tanks of 1 m^3 (n=3), a biofloc Control (C) and Probiotic (P) group were reared in dark conditions. Both will be compared with a Microalgae (M) and Microalgae + Probiotic (MP) group under BFT and photoperiod of 12:12h (Light:Dark, respectively). Before starting the assay, microalgae were inoculated to achieve a final absorbance of 0.3 AU (□= 680 nm) into a biofloc system with a total suspended solids (TSS) of ~150 mg/L. Commercial probiotic (Sanolife PRO-W, INVE) was weekly added at 1g/m^3 dosis. The animals (□= 205 animals/m^2) were fed twice per day with a commercial feed (Le Gouguessant Aquaculture, France), and partial weekly sampling was performed to control the feeding intake ratio and gain weight. After 60 days a final sampling was performed, and the animals were undergoing a density stress test. Density challenge consisted in submitting the shrimp for 6 hours at a density of 2200 animals/m^3, evaluating afterwards their survival at 6 and 24 hours.

Results and discussion: Significant differences in chlorophyll concentration are observed between treatments with microalgae addition (0.200±0.02) and without (0.035±0.01), what demonstrates that was possible to achieve a stable *Chlorella vulgaris* population under biofloc conditions. However, lower growth and survival were registered in microalgae groups (M and MP), likely caused by the high nitrates and phosphates levels present from the outset (Table 1), stemming from the NO_3^- and PO_4^{3-} within the microalgae inoculum. In fact, microalgae was able to reduce NO_3^- and PO_4^{3-}, but not enough to achieve non-microalgae group levels.

There were no differences found in survival for the density stress challenge (~90%), then bacteria or microalgae probiotic effect did not provide a major resilience to environmental challenge.

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Table 1: Concentration increase (mg/L) of nitrates and phosphates (Final concentration - Initial concentration) (below). Different letters in rows indicate statistical differences between treatments.

	M	MP	P	C
NO_3^-	286,49±1,56^a	276,04±58,17^a	181,32±13,12^b	180,09±11,24^a
PO_4^{3-}	20,84±2,63^a	21,19±0,14^b	12,89±2,08^c	13,99±0,70^c
Δ [NO_3^-]	16,64±31,58^a	-1,05±17,04^a	179,68±77,32^b	179,53±105,11^b
Δ [PO_4^{3-}]	-16,87±2,51^a	-17,53±3,99^a	8,83±9,31^b	8,30±2,94^b

PREVALENCE OF BLOOD PARASITES *Trapanosoma spp* IN NILE TILAPIA *Oreochromis niloticus,* Linnaeus, 1758 FROM ZOBE RESERVOIR, KATSINA STATE, NIGERIA

*Sadauki, M. A., Dauda, A. B. & Badamasi, M.

Department of Fisheries and Aquaculture
Federal University Dutsin-Ma
Katsina State, Nigeria
*Corresponding authors' email: masadauki@fudutsinma.ed.ng
Phone: +234 8076501743

The study was conducted to investigate the prevalence of blood parasites, specifically *Trypanosoma spp*, in Nile tilapia (*Oreochromis niloticus* Linnaeus, 1758) from Zobe Reservoir, Katsina State. A total of 108 Nile tilapia from the four major landing sites of the reservoir, comprising male and female were purchased between July and September 2023. The fish were transported alive to the fish biology laboratory, Federal University Dutsin -Ma, for the blood parasites collection and examination. Sampled fish were measured for length and weighed. The study employed a microscopic examination of blood smears, to accurately identify and characterize the *Trypanosoma* species present. Microscopic examination revealed the presence of *Trypanosoma* parasites in a significant proportion of the sampled fish. Blood parasites were identified and counted. Male samples had higher per cent of infestation (6.82**%**) than female samples (5.00**%**). The highest prevalence was recorded in samples location C while the lowest was recorded in sample location B. Experimental fish (*O. niloticus*) samples obtained from samples location A were free from trypanosome, this could be due to the absence of leeches in the samples location. In conclusion, *Oreochromis niloticus* obtained from Zobe reservoir were infected by blood parasites (*Trypanosoma sp*p) that are of economic importance. The findings suggest that the observed parasitic infections may badly affect in Nile tilapia populations in Zobe Reservoir.

Table 1: Prevalence of Blood parasite of *Oreochromis niloticus* in relation to sex in Zobe reservoir

Sex	No examined	No of infected	% of infection
Male	88	6	6.82%
Female	20	1	5.00%
Total	108	7	6.48%

Table 2: Prevalence of Blood parasite of *Oreochromis niloticus* in relation to sample location in Zobe reservoir

Location	No examined	No of infected	% of infection
A	36	0	0%
B	36	3	8.33%
C	36	4	11.11%
Total	108	7	6.48%

A CASE STUDY OF THE SUSTAINABLE IN-POND RACEWAY SYSTEM (IPRS) PRINCIPLES IN TANZANIA

Sherif Sadek[1,2*], Baraka Kalangahe[2], Peter Mrope[2], Farida Buzohera[2], and Hervé Lucien-Brun[2,3]

1: Aquaculture Consultant Office, Cairo, Egypt
2: Tanlapia, Bagamoyo, Tanzania
3: Aquaculture & Qualité, France
* E-mail: aco_egypt@yahoo.com

Tanlapia Ltd ("Tanlapia") is a large-scale aquaculture project in Bagamoyo. Since breaking ground in 2020, Tanlapia has grown rapidly, starting to produce fish in 2021 and in 2024 is targeting to harvest around 100 metric tonnes (MT) of tilapia per month, making today Tanlapia the largest producers of Tilapia in the country.

One of Tanlapia's key advantages is its location based on a 600-hectare fish farm in Kingani, Bagamoyo, on the floodplains of the perennial Ruvu River around 30 km from the Indian ocean and less than two hours from downtown Dar-es-Salaam.

Tanlapia farm uses a hybrid system consisting of:

- Open semi-intensive ponds for low-tech reliable production of fry in hapa (12-18 fish/gm), followed by a first nursery stage to reach 3-5 gm/fish.
- Semi-intensive ponds with aeration for a second nursery stage, growing, (3-5g to 25-50g).
- In-Pond Raceways System (IPRS) or semi-intensive ponds with aeration for grow-out from 25-50g to market size (usually 330g -350g), with a final production at harvest (50 to 65 kg.m^3) during 200 days.

IPRS is a state-of-the-art aquaculture technology. Fish are held in 'cells' which are cement-sided, mesh-ended cages within larger earthen ponds. Water is circulated through the cells and earthen pond with the help of electrically powered aerators. This simulates a river, allowing the areas outside of the cells to act like a large biofilter. This keeps the fish healthy and allows them to be closely monitored for any signs of disease or stress. It also keeps water quality stable, reduce water consumption and feed loss, reducing environmental impact and optimizing operating cost which is key for a successful farm.

Main advantages of the IPRS to Tanlapia are to keep water quality stable in earthen ponds in case if salinity will increase seasonally and during high tide and or flood in Ruvu River. Meanwhile to be a reducing environmental impact and optimizing operating cost. In addition to decrease water consumption as be an ecofriendly aquaculture system.

Without releasing water or waste into nearby waterways, IPRS technology has the potential to significantly outperform traditional ponds in terms of yields. With high yields and minimal environmental impact, IPRS is a more manageable and controllable approach. The system lowers risk, increases yields significantly, and lowers production costs per unit.

Tanlapia primary product is whole, gutted tilapia for the domestic market. Processing is carried out on site in Bagamoyo. Tanlapia team currently harvest four to five times a week and sell out the same day locally or to Dar es Salam area.

Tanlapia employ 24 full time employees, with a variety of skills and qualifications. Only one full time employee is not a Tanzanian national. They also employ approximately 50 casual labourers hired from the local area, both men and women. Women predominate in hatchery and plant processing tasks, but some are also in charge of grow-out operations.

THE BENEFICIAL ROLE OF CACTUS ON THE CULTURE OF SHRIMP AND FISH: A SUMMARY OF INDUSTRIAL APPLICATIONS IN VARIOUS SPECIES

Charles Saliba[1,*], Michael Saliba[1], Kartik Baruah[2]

[1]Nutri Biotech Services Ltd, 44 The Catacombs Rabat, Malta
[2]Department of Applied Animal Science and Welfare, Faculty of Veterinary Medicine and Animal Sciences, Swedish University of Agricultural Sciences, 750 07 Uppsala, Sweden

charles@nutribiotechmalta.com

The farming of fish and shrimps is a prominent and valuable activity, contributing significantly to various aspects of the economy and food supply. Fish and shrimp farming operations are widespread, ranging from small-scale operations to large commercial ventures. Owing to the increasing demand for animal protein, farming operations are taking place in a highly intensive way, which has resulted in causing stress affecting the performance, health and welfare of farmed animals, and hence the economic and sustainability of the sector. Nutri Biotech Services is a private research laboratory undertaking research in the area of specialised animal nutrition. The company focuses on developing nutritional products derived from natural sources to address issues associated with the economic and sustainable production, health, and welfare of farmed aquatic animals. In the framework of research and development projects conducted in collaboration with Universities like the Swedish University of Agricultural Sciences and others, the company has identified a specific biological activity that is extracted from an edible cactus *Opuntia ficus indica. In vitro* and *in vivo* studies showed that part of the fruit of this cactus allows organisms to elevate their level of Heat Shock Proteins (HSP) in a short time and maintain high levels of HSP if ingested during periods of physical, physiological, and biological stress. Several industrial-scale studies have been carried out in different parts of the world using different farmed species including shrimp, warm water species, and cold water species. These studies demonstrate the benefits of high levels of HSP associated with the ingestion of this cactus in aquatic and terrestrial organisms. Here, we present a comprehensive review of the studies highlighting the effects of ingestion of cactus on the production of stress proteins at the genetic and protein levels, and how this stress protein contributes to a better and enhanced performance of organisms in terms of growth, survival, and overall performance.

INTEGRATIVE SANDFISH CULTURE SYSTEMS: CHALLENGES AND LESSONS LEARNED ON THE PILOT TRIALS IN BOLINAO, PANGASINAN, PHILIPPINES

Julie Clarice R. Salva*, Tomilyn Jan S. Garpa, Garry R. Bucol, and Marie Antonette Juinio-Meñez

The Marine Science Institute
University of the Philippines Diliman
Diliman, Quezon City, 1101
jrsalva@up.edu.ph

Holothuria scabra, also known as sandfish, is a deposit-feeding sea cucumber. It has the remarkable ability to ingest particulate waste excreted by other organisms, making it an excellent candidate for Integrated Multi-Trophic Aquaculture (IMTA). Growth of sandfish in the pilot trials with other low trophic species (i.e. sea urchins, green mussels, and siganids) demonstrated positive prospects for implementation in three sites (Victory, Silaki, and Rongos) in Bolinao, Pangasinan. However, the four integrative culture systems each presented novel challenges that required swift interventions and urged the need for design modifications necessary for scaling-up. Strong wave exposure and high influx of freshwater during the rainy season are among the external forces that have jeopardized the structures and survival of the animals in certain sites. While all pilot sites are suitable for sandfish culture based on established indicators (i.e. sediment grain size, penetrability, seagrass cover), some sites are not suitable during the typhoon season. Stocking time, stronger culture structures, and culture phase (i.e. nursery or grow-out) are essential to mitigate setbacks in the production process. Environmental conditions optimal to source and stock wild juveniles of the other species are also important. The sheltered location of Rongos constrained natural mussel spatfall which required the relocation of the nylon ropes in a different area within the channel. The free-ranging siganids in multi-culture systems were difficult to monitor and required refinements in pen design with the addition of an inner net to confine these finfishes and allow supplemental feeding of seaweeds to improve growth. Despite these challenges, the harvest of sea urchins and mussels in the respective sites demonstrated the feasibility of these integrative culture systems to supplement the income of coastal households. Recognizing and addressing these opportunities and challenges are vital in optimizing operational strategies for the adoption and expansion of these sustainable sandfish IMTA systems. Further assessment on the viability of these culture systems from social and ecological perspectives aside from income generation are likewise essential.

TIME SERIES OF FISH AND SHRIMP DISEASES IN NTB PROVINCE 2019 – 2023

Joko Santosa, Luluk Widiyanti, M. Budianto*

Fish Health Officer
MADC Lombok Testing Laboratory
Marine Aquaculture Developmen Center of Lombok
Ministry of Marine Affair and Fisheries
jekewae@gmail.com

Nusa Tenggara Barat (NTB) Province is one of the largest producers of fishery products in Indonesia. Aquaculture areas in NTB spread over Lombok and Sumbawa islands, with their main comodities are shrimps, lobster, tilapia, baramundi and pompano. Disease analysis based on random sample of 1,950 samples of shrimps, lobster, tilapia, baramundi and pompano that were taken from 2019 to 2023, using molecular method at the Marine Aquaculture Development Center (MADC) of Lombok Laboratory. Results showed the distribution of WSSV positive peaked in 2021 in Sumbawa district. The highest IMNV cases were in 2020 and 2022 in Sumbawa and East Lombok districts. Vibriosis had the highest cases in 2021 and 2022 in East Lombok and Sumbawa districts. The highest EHP disease occured in Sumbawa district in 2023. These figures are described as below:

The same paterns of fish diseases are predicted to recur in the folowing years. Biosecurity programs should be implemented to prevent a masive loss on aquaculture businesses in NTB.

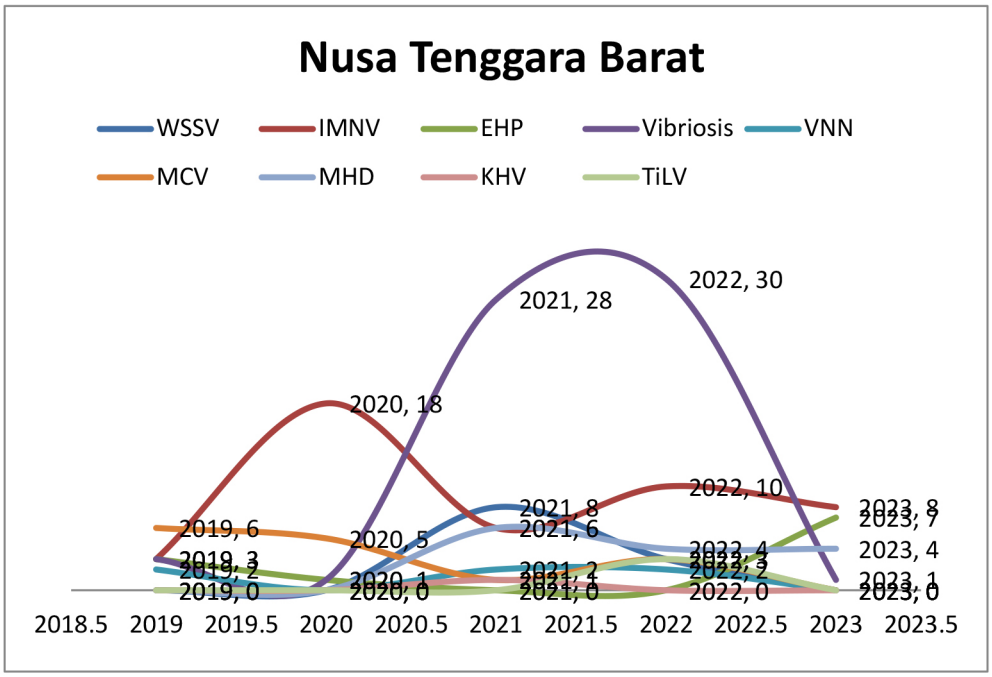

Figure 1. Time series of fish disease in NTB province 2019-2023

SEXUAL DIMORPHISM AND GONADAL OBSERVATION OF SHORT-FINNED EEL, *Anguilla bicolor* REARED UNDER CONTROL CONDITION IN INDONESIA

Sari Asfarina Sariat*, Stefanie Maria Ayu, Annisa Apriliani Wahyudi, Ching Fui Fui and Shigeharu Senoo

Borneo Marine Research Institute
Universiti Malaysia Sabah
Jalan UMS, 88400
Kota Kinabalu, Sabah, Malaysia.
Email: sariasfarinasariat@gmail.com

This study investigates sexual dimorphism and gonadal development in the short-finned eel, *Anguilla bicolor*, reared under controlled conditions in Indonesia. Understanding sexual dimorphism and gonadal observation is crucial for effective aquaculture management and conservation efforts. Over a 1.5 years of culture period, a total of 25 tails of *A. bicolor* were carefully selected, consisting of 10 tails with body weight ranging from 100 to 200 g, 10 tails with body weight ranging from 200 to 500 g, and 5 tails weighing from 500 to 1000 g were selected. All specimens were sacrificed and dissected to determine the body indices and sex determination. Results reveal distinct sexual dimorphism where *A. bicolor* that are weigh from 150-300 g are male and above 300 g are all female. Oocyte observation was also done to confirm the sex which involved capturing microscopic images of gonadal tissue. This research will contributes essential data for the aquaculture industry and informs conservation strategies aimed at preserving this economically and ecologically significant species.

PRODUCTION STATUS PACIFIC WHITELEG SHRIMP (*Litopenaeus vannamei*) RESULTS OF IMPROVEMENT CLUSTER-BASED PONDS FROM EXTENSIVE CULTURE IN ACEH

Sarifuddin, Ahmad Supriatna, Manijo, and Bakhtiar Sah Putra

dhaenk_echa@yahoo.co.id

Aquaculture sector is expected to be able to increase national economic growth, so that many efforts have been made to encourage increased national shrimp production through contructing or revitalizing cluster-based traditional pond areas. This is in link with the government's target of increasing national shrimp production by 2 million tons by 2024. In general, national shrimp production is not directly proportional to the area of pond land owned by Indonesia. Pond management is still very extensive without appropriate technology so the risk of disease attacks is quite high. The dilemma of disease attacks in extensive shrimp culture has resulted in the majority of farmers no longer managing their ponds seriously, resulting in many being inattentive or idle. The production of extensive managed shrimp ponds is only capable of producing a maximum of 0.25 tons/ha/cycle (2 cycles per year reaching 0.5 tons/ha/year) with the shrimp farmer profit of only IDR. 1,783,000/month. Revitalization of extensive pond areas through the implementation of strict standard operational procedure, increasing stocking densities, maximizing cultivation support and technological intervention, is able to increase profits to the maximum with production achievements of 18.5 tons/ha/cycle or 74 tons/ha/year with 2 cycles per year, so that the shrimp farmer's profit increases to Rp. 16,660,000/month.

MULTI LOCATION TEST OF SEAWEED SEEDS (*Eucheuma cottonii*) TISSUE CULTURE ON GROWTH IN SOUTHEAST MALUKU DISTRICT AND TUAL CITY

Sarwono* dan I G Pattipeilohy

Balai Perikanan Budidaya Laut Ambon
Jl. Leo Wattimena, Ambon
e-mail: ambonbpbla@gmail.com

Indonesia has a water area of 3.25 million km2, with an exclusive economic zone of 2.55 million km2, and a land area of only around 2.01 million km2. The vastness of its territorial waters means that Indonesia has great potential in the maritime and fisheries sector. Seaweed cultivation is one of the businesses carried out by many coastal communities. The seaweed that is cultivated is the Eucheuma cottonii type, this type of seaweed has fast growth, high economic value and produces carrageenan. One of the areas that produces Eucheuma cottonii seaweed cultivation in Eastern Indonesia is Southeast Maluku Regency and Tual City, which is the center for seaweed cultivation in Maluku Province.

Seaweed cultivation faced by society today is the use of seaweed seeds whose quality is not good. The availability of seaweed seeds used comes from the production of previous seaweed cultivation which has been used repeatedly, so its growth is slow and it is easily attacked by disease. This results in less than optimal seaweed production. One effort to increase seaweed production is to use quality seeds from tissue culture results.

Based on these problems, a multi-location test of tissue culture seaweed (Eucheuma cottonii) seeds was carried out on the growth produced by the Ambon Sea Cultivation Fisheries Center in Southeast Maluku and KotaTual districts. This aims to help increase seaweed cultivation production in Southeast Maluku Regency and Tual City.

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RELEASE WILD HOVEN'S CARP *Leptobarbus hoevenii* (Ikan Jelawat) IN THE PUBLIC WATERS OF THE ISLAND OF SUMATRA AS AN ADDITION TO THE STOCK OF CAUGHT FISH ANDPRESERVING THE DIVERSITY OF FISH RESOURCES

Catur Setiowibowo*, Mubinun*, Salali*

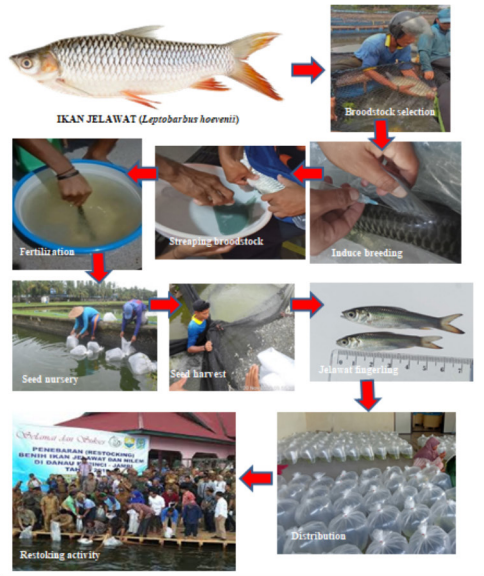
Jambi Freshwater Aquaculture Development Center Research
Jambi, Indonesia
Catur4ok@gmail.com

Indonesia's public waters cover an area of 54 million hectares, and are the largest in ASEAN, consisting of 11.95 million ha of river waters and flood exposures, 39.4 million ha of swamp waters and 2.1 million ha of lakes and reservoirs and other bodies of water. such as ponds, reservoirs and lakes. It is estimated that there are 950 species of fish that inhabit Indonesia's fresh waters and the results of research from the Palembang Public Water Fisheries Research Institute show that the waters of South Sumatra are inhabited by 233 species of fresh water fish, including economically important types for both consumption and ornamental fish. One of the fish endemic to public waters in Sumatra and Kalimantan is the hoven's carp (*Leptobarbus hoeveni*) (Kottelat *et al*., 1993).

Problem jelawat fish farmers are currently facing is the increasingly difficult time of obtaining seeds from nature due to uncontrolled intensification. One effort to maintain fish stocks in public waters is by restocking fish in their habitat. From 2016 until now (2023) the Sungai Gelam Jambi Freshwater Aquaculture Fisheries Center (BPBAT) has played an active role in providing the availability of Hoven's carp seeds by cultivating and spawning with innovative and adaptive technology and then the seeds produced will be released into public waters.

The aim of this activity is to provide fish seed assistance to stimulate fish cultivation activities, support increased production of aquaculture and to increase the stock of fish resources in public waters. Implementation includes brood care, spawning, seed care and seed distribution. The location for seed distribution in public waters must comply with applicable laws and regulations and be designated as a seed distribution location by the local government.

From the results of activities during 2020-2023, as many Hoven's carp seeds have been released into the wild 3327000 fries. Distribution and release activities into public waters are carried out together with the relevant provincial services, members of Commission IV DPR and the Ministry of Maritime Affairs and Fisheries (Directorate General of Aquaculture)



Restocking Benih	Tahun			
	2020	2021	2022	2023
Aceh	-			
Sumatera Utara	-	50.000	50.000	
Sumatera Barat	-	60.000		
Riau	290.000	130.000	50.000	
Jambi	460.000	185.000	129.000	25.300
Bengkulu	-	80.000		
Sumatera Selatan	660.000	540.000	30.000	
Bangka Belitung	-			
Lampung	200.000	50.000	310.000	575.000
Total	**1.610.000**	**1095000**	**569000**	**600300**

EFFECTS OF BILE ACIDS ON GROWTH PERFORMANCE, METABOLISM AND GUT MICROBIAL COMPOSITION OF *Penaeus vannamei*

Tan Peng,[1] Shao Qingjun[2]

1. Zhejiang Marine Fisheries Research Institute, Zhejiang, China
2. The College of Animal Science, Zhejiang University, Zhejiang, China

Experiment 1: This experiment effectiveness of bile acids in the diet of white Penaeus vannamei. Each treatment was carried out in six replicates, and each replicate contained 50 shrimp (IBW: 0.16 ± 0.01g). The culture period was 8 weeks, and the shrimp were fed three times a day. Experimental feed formulation six experimental feeds were prepared according to the nutritional requirements of Litaaeus vannamei and added separately 0 mg/kg (A0), 50 mg/kg (A1), 100 mg/kg (A2), and 150 mg/kg (A3), and 200 mg/kg (A4) and 250 mg/kg (A5). No disease occurs during the experiment, the average survival rate > 90%. The final body weight, weight gain rate and specific growth rate of 200 mg/kg (A4) and 250 mg/kg (A5) bile acid supplementation groups were significantly higher than those of the control (A0) and 50 mg/kg (A1) groups without bile acid supplementation (P<0.05. Compared with A0 group, dietary bile acid supplementation reduced the crude fat content of whole shrimp, and the crude fat content of A2, A3, A4 and A5 groups was significantly lower than that of A0 group (P<0.05). 200 mg/kg (A4) and 250 mg/kg (A5) bile acids significantly reduced serum triglyceride content (P<0.05), and supplementation of 200 mg/kg (A4) bile acids significantly reduced serum free fatty acid content (P<0.05). Feed add 250 mg/kg (A5) bile acid significantly increased serum high density lipoprotein cholesterol (P < 0.05),200 mg/kg (A4) and 250 mg/kg (A5) bile acids significantly increased serum total antioxidant capacity (P<0.05), and dietary supplementation of 250 mg/kg (A5) bile acids significantly increased serum lysozyme activity (P<0.05).Addition of 200 mg/kg (A4) and 250 mg/kg (A5) bile acids significantly increased the hepatopancreatic protease activity (P<0.05), and addition of 100-250 mg/kg (A2, A3, A4 and A5) bile acids significantly increased the hepatopancreatic lipase activity (P<0.05). Feed add 150 to 250 mg/kg (A3, A4 and A5) bile acid increased significantly in the intestinal lipase vigor (P < 0.05). The structures of hepatopancreas in each group were clearly visible and arranged neatly, indicating that bile acids did not cause obvious damage to the hepatopancreas of litopenaeus vannua. Intestinal epithelial cells connect closely, not seen obvious epithelial cell falls off, showing that the bile acid, achieved in intestinal tissue structure did not produce obvious injury. In conclusion, supplementation of bile acids (200-250 mg/kg) significantly improved the growth, antioxidant indices and lipase activity of litopenaeus vanna. Combined with the actual production, the recommended amount of bile acid in the feed of shrimp is 200 mg/kg (200 g/T). Experiment 2: Bile acids used in the diet of white prawn tolerability. A4 growth performance is significantly higher than A0 and AP group (P < 0.05). AP group sedimentary and protein efficiency rate was significantly lower than group (P < 0.05). The serum level of total cholesterol in group AP was significantly higher than that in group A0 and group A4 (P<0.05), and the serum level of low-density lipoprotein cholesterol in group AP was significantly higher than that in group A0 and group A4 (P<0.05). There was no significant difference in the height of intestinal microvilli among the groups. Hepatopancreas H&E staining biopsy and transmission electron microscopy showed that each structure is clearly visible, neat rows. 1000 mg/kg bile acid did not cause obvious damage to the midgut and hepatopancrea. The serum total antioxidant capacity in group A4 and AP was significantly higher than that in group A0 (P<0.05), and the serum lysozyme activity in group AP was significantly higher than that in group A0 (P<0.05). Bile acid significantly increased serum antioxidant capacity and serum lysozyme activity, has promoting effect on nonspecific immunity. The protease activity of hepatopancreas in group A4 was significantly higher than that in group A0 (P<0.05). The lipase activity of hepatopancreas and midgut in group A4 and AP was significantly higher than that in group A0 (P<0.05). The similarity and difference of species composition among the samples were shown by using the sample hierarchical clustering tree, and combined with the stacked bar chart, it was found that the intestinal microbial composition of the groups was highly similar, and no obvious clustering difference was formed between the groups. The results of principal component analysis (PCA), principal coordinate analysis (PCoA) and dimensionless multidimensional calibration (NMDS) analysis showed that, The differences between the sample groups were small, and the microbial composition of each group showed high similarity. Differences between microbial components analysis found between groups, each group differences of P values were 0.474 and 0.012, show significant differences between groups of microbial components. At the genus level, there were significant differences in the abundance of the genera Planktotalea, Photobacterium and Pseudahrensia in the intestinal tract of the three groups of litopenaeus vannamei. In conclusion, dietary supplementation of 1000 mg/kg bile acid had no adverse effects on the survival rate, growth performance, body composition, digestive enzyme activity, antioxidant and immune indexes, and intestinal and hepatopancreas morphological structure of the shrimp, indicating that dietary supplementation of bile acid had a good tolerance to the shrimp.

EVALUATION OF THE EFFECTIVENESS OF BILE ACIDS IN THE DIET OF WHITE *Penaeus vannamei*

Tan Peng[1], Shao Qingjun[2]

1. Zhejiang Marine Fisheries Research Institute, Zhejiang, China
2. The College of Animal Science, Zhejiang University, Zhejiang, China

Introduction

Bile acids have an important role in the degradation of molecules during the process of digestion of nutrients by animals and are abundantly present in foods of animal origin. It also plays an important role in nutrient digestion, absorption of lipids and fat-soluble vitamins, and shaping of intestinal flora. Studies have shown that bile acids have specific metabolic effects in the liver, which can directly reduce liver damage and promote liver regeneration by activating receptors.

Therefore, the purpose of this study was to evaluate the effects of bile acids supplementation on growth and performance, body composition, and parameters related to liver function and metabolism in shrimp.

Materials and Methods

1800 juveniles of white Penaeus vannamei, with average initial weight of 0.16 ± 0.01g, carried out in the running water system of Xixuan Fishery Science and Technology Island, located in in Zhoushan City, Zhejiang Province, randomly distributed in 36 boxes of 150 L, stock density of 50/box.

During the experimental period, the parameters of water quality such as average temperature, dissolved oxygen concentration 7. Performance data were analyzed using the SAS program. Data were analyzed by one-way ANOVA ($P<0.05$).

Result and Discussion

Table 1. Effects of dietary bile acid supplementation on growth performance and feed utilization of *Litopenaeus vannannae*

index	Group - Bile acids (mg/kg)					
	A0（0）	A1（50）	A2（100）	A3（150）	A4（200）	A5（250）
SR（%）	91.33±4.13	91.00±2.76	94.33±5.13	94.00±3.79	93.67±3.44	93.00±3.29
FBW（g）	5.16±0.19^{c}	5.22±0.29^{c}	5.35±0.38^{bc}	5.43±0.17^{bc}	5.87±0.18^{a}	5.66±0.19^{ab}
WGR（%）	3127±118^{c}	3159±180^{c}	3246±241^{bc}	3295±103^{bc}	3570±111^{a}	3439±117^{ab}
FR(%BW/d)	4.19±0.23	4.25±0.39	4.16±0.13	4.12±0.13	4.04±0.11	4.16±0.17
FCR	1.33±0.06	1.35±0.11	1.28±0.09	1.27±0.08	1.24±0.06	1.29±0.05

Bile acid is added to the feed, 200 mg/kg (A4) and 250 mg/kg (A5) final body weight, weight gain rate was significantly higher than that of not adding the control group (A0) and 50 mg/kg (A1) group ($P < 0.05$)

Table 2. Effects of serum physiological and biochemical indexes and immune antioxidant indexes in shrimp.

index	Group - Bile acids (mg/kg)					
	A0（0）	A1（50）	A2（100）	A3（150）	A4（200）	A5（250）
TG（mmol/L）	3.47±0.38^{ab}	3.59±0.19^{a}	3.35±0.16^{abc}	2.98±0.35^{bcd}	2.82±0.27^{cd}	2.56±0.38^{d}
NEFA（μmol/L）	142.90±41.34^{a}	139.50±29.57^{ab}	114.33±17.6^{ab}	120.17±13.18^{ab}	94.92±18.20^{b}	108.00±22.21^{ab}
T-AOC（mmol/L）	1.15±0.08^{c}	1.23±0.16^{abc}	1.18±0.13^{bc}	1.35±0.25^{abc}	1.41±0.15^{a}	1.36±0.15^{ab}
LZM（U/mL）	72.73±10.92^{b}	73.93±13.67^{b}	69.40±12.4^{b}	72.30±9.86^{b}	83.36±15.07^{ab}	94.30±5.14^{a}

Supplementation of 200 mg/kg (A4) and 250 mg/kg (A5) bile acids significantly reduced serum triglyceride content ($P<0.05$), and supplementation of 200 mg/kg (A4) bile acids significantly reduced serum free fatty acid content ($P<0.05$). Dietary supplementation of 250 mg/kg (A5) bile acid significantly increased serum high-density lipoprotein cholesterol content ($P<0.05$). Dietary supplementation of 200 mg/kg (A4) and 250 mg/kg (A5) bile acids significantly increased serum total antioxidant capacity ($P<0.05$), and dietary supplementation of 250 mg/kg (A5) bile acids significantly increased serum lysozyme activity ($P<0.05$).

Table 3. Effect of dietary bile acid supplementation on digestive enzyme activities of Hepatopancreas

index	Group - Bile acids (mg/kg)					
	A0（0）	A1（50）	A2（100）	A3（150）	A4（200）	A5（250）
Protease(U/mgprot)	209.3±12.6^{c}	240.7±19.4^{abc}	241.8±23.9^{abc}	231.1±27.1^{abc}	253.3±15.4^{ab}	259.6±11.19^{a}
lipase（U/gprot）	1.00±0.18^{c}	1.10±0.14^{bc}	1.50±0.14ab	1.55±0.17a	1.64±0.33a	1.65±0.33^{a}

Addition of 200 mg/kg (A4) and 250 mg/kg (A5) bile acids significantly increased the hepatopancreatic protease activity ($P<0.05$), and addition of 100-250 mg/kg (A2, A3, A4 and A5) bile acids significantly increased the hepatopancreatic lipase activity ($P<0.05$). Dietary supplementation of 150-250 mg/kg (A3, A4 and A5) bile acids significantly increased lipase activity in the midgut ($P<0.05$).

(Continued on next page)

Conclusion

Supplementation of bile acids (200-250 mg/kg) significantly improved the growth, antioxidant indices and lipase activity of Litopenaeus vanna. Combined with the actual production, the recommended amount of bile acid in the feed of shrimp is 200 mg/kg (200 g/T).

Bile acids used in the diet of white prawn tolerability

Compared with control group, 1000 mg/kg bile acid is added to the feed, for everyone who achieved the survival rate, growth performance, body composition, digestive enzyme activity, antioxidant and immune indexes, gut and liver there were no adverse effects and morphological structure of pancreas injury, show, achieved the bile acid is added to the feed, has good tolerance.

SUSTAINABLE *Moina* sp. MASS CULTIVATION ON *Chlorella* sp. MEDIA WITH *Rotifera* / *Brachionus* sp. COMPETITORS CONTROL MANAGEMENT

Taufik Shidik Adi Nugroho*, Evi Rahayuni, Ikbal

Jambi Freshwater Aquaculture Development Center, Jambi, Indonesia
Ministry of Marine Affairs and Fisheries Republic of Indonesia
shidik2fix@yahoo.com

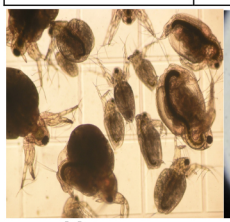
Mass cultivation of *Moina* sp. has overcome dependence on imported products such as brine shrimp and *tubifex* worms which come from wild catches and not available throughout the year. However, in the implementation of cultivation, there is a main factor causing harvest failure because of the competitors organism namely *Brachionus* sp. The cultivation containers using 12 concrete tanks with size 1.8x3.8x1 m^3. Cultivation conducted 5-7 days on outdoor area with an initial population of *Moina* sp. about 100 ind L^{-1} (50 g) at 3000 L of media volume with the fertilizer composition in Table 1. At the end of cultivation, the biomass of *Moina* sp. is calculated with digital scale.

The *Brachionus* sp. as competitors organism controled by using 0.25 – 0.50 ppt of salt in the *Moina* sp. cultivation media. Based on the research that already carried out, the composition of the fertilizer in Table 1 and the dose of salt has been proven to be able to eradicate and inhibit the hatching of *Brachionus* sp. eggs without inhibiting *Moina* sp. and *Chlorella* sp. development. The *Moina* sp. mass production using *Chlorella* sp. as media through innovation in controlling *Rotifera* / *Brachionus* sp. as a competitors and the technology innovation for mass cultivation of *Chlorella* sp. in the open areas ($2x10^7$ cell mL^{-1} abundance) throughout the year without carrying out pure culture in laboratory has multiple production yields (harvest between 2 - 4 kg per 3000 L media per 5-7 days) and reducing the limiting factor for harvest failure due to *Rotifera* / *Brachionus* sp.

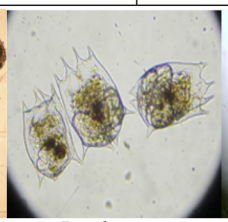
Cultivated *Moina* sp. can be used in live/fresh (52.4% of proteins) or frozen form which can be used as nursery food in hatcheries or livefood ponds preparation for freshwater fish larvae such as striped catfish, snakehead, gouramy, mad barb, green catfish, etc. The using of *Moina* sp. can increase the uniformity of fish larva size and minimize the risk of fish disease attack thereby increasing the survival rate up to 80%. The application of this technology can be carried out efficiently and effectively using containers, fertilizers and media that are cheap, easy to obtain, can be carried out independently and sustainably throughout the year in the dry and rainy seasons in open areas alongside fish cultivation activities.

Tabel 1. Compotition of *Moina* sp. dan *Chlorella* sp. cultivation fertilizer

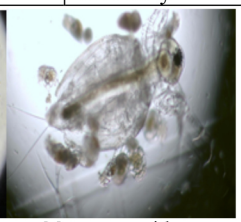
Component	Cultivation		Remark
	Chlorella sp. (g 1000 L^{-1})	*Moina* sp. (g 1000L^{-1})	
Urea	1000	100	-
TSP	250	25	-
Salt	-	250-500	-
Dolomite	100	100	-
Fish meal/trash fish/shrimp	100	100	±45% of protein
Soybean meal	100	100	±32% of protein
Rice bran	200	300	±8% of protein
Chlorella sp.	200 L	200 L	Min. $1x10^6$ cell mL^{-1} of density
Moina sp.	-	50-100	Min. 100 ind L^{-1} of density



Moina sp.



Brachionus sp.



Moina sp. with *Brachionus sp.* competitors

ASSESSING THE IMPACT OF PAPAYA LEAF EXTRACT SUPPLEMENTATION IN DIET FOR RED HYBRID TILAPIA *Oreochromis niloticus* × *Oreochromis mossambicus*

Peace Onas Somdare * and Khalidah Abdul Hamid

Department of Zoology
Federal University Lokoja
260101, Lokoja
Kogi, Nigeria
peace.somdare@fulokoja.edu.ng

The aim of this study was to investigate the potential effects of incorporating *Carica papaya* leaf extract into practical diets for red hybrid tilapia to enhance growth and optimize feed utilization. Five diets were formulated with similar protein (35 %) and lipid (8 %) levels. While the compositions of raw materials in all diets were similar, they varied in papaya leaf extract (0.0, 0.5, 1.0, 2.0, and 4.0%) inclusion. The diets were fed to triplicate groups of the fish (mean initial weight, 2.30 ± 0.01 g) for twelve weeks.

Results showed that fish fed diet containing 2% papaya leaf extract (PLE) had the highest final weight of 31.14 ± 1.47 g, followed by those fed diet containing 1% PLE (27.27 ± 1.75 g). These two diets (1% and 2% PLE) had significant enhancements in weight gain, specific growth rate (SGR), and feed efficiency compared to the control group ($p < 0.05$). The inclusion of papaya leaf extract did not have a significant impact on hepato-somatic index (HSI), viscero-somatic index (VSI), protein efficiency ratio (PER), activity of digestive enzymes, blood composition, or survival rate of the fish ($p > 0.05$). Notably, supplementation with papaya leaf extract led to a reduction in serum urea levels.

The findings of this study suggest that incorporating papaya leaf extract into red hybrid tilapia diets can improve growth and feed efficiency without adverse effects on hematological parameters. Therefore, it is recommended to include papaya leaf extract at a level between 1% and 2% as a feed additive to enhance the growth of red hybrid tilapia fingerlings.

APPROACHING CIRCULAR ECONOMY: UTILIZING FISH SKIN WASTE FOR NOVEL LEATHER PRODUCTION

Shubham Soni*, Arpita Sharma and Martin Xavier

ICAR-Central Institute of Fisheries Education
Mumbai, India - 400061
Presenting author: shubham.fexpb105@cife.edu.in

The fisheries sector has seen appreciable growth in the last few decades, with global fish production reaching as high as 178 million tonnes in 2020. With this growing demand for aquatic foods, it becomes imperative to focus on the negative impacts the sector leaves on the ecosystem. Estimates show that 30-35% of the world's annual fish production is lost as substantial waste or loss throughout the value chain stages. It is being highlighted that the sector that currently functions through linear economic model needs a shift towards the adoption of circular economy (CE), which prioritizes continuous resource use and minimizes waste generation. Transitioning from a linear economic model to CE is challenging because it involves reshaping our existing patterns of production and consumption and can be brought in by adopting 'use waste as resource' strategy of CE. In this context, it is observed that fish skins, which constitute 3-10% of the fish's body, are typically discarded as waste from the filleting industry. A study was conducted to utilize these discarded fish skins to develop a novel fish skin leather within the CE framework, which demonstrated appreciable physical characteristics, with tensile strength falling within the range of 10 N/mm^2 to 25 N/mm^2, tear strength 55 N/mm to 80 N/mm, elongation at break between 25% to 50%, and 0.5 to 1 mm thick and was at par with the Bureau of Indian Standards for leather watch straps, book binding leather, leather gloves etc. The novel fish skin leather so developed was also assessed for its consumer perception based on sensory evaluation among leather professionals, textile designers, leather craftspersons, leather consumers, and fisheries professionals. All sensory attributes constituting visual, olfactory, auditory, and tactile attributes had high to very high acceptance scores, with the highest ratings for tactile attributes. Likewise, the market research revealed high to very high acceptance range ratings for overall liking, market acceptability, product acceptance, and consumer acceptance. The study underlines that fish skin waste has the potential for premium-grade leather development while demonstrating the efficacy of employing 'use waste as a resource' strategy of the CE. This approach towards CE can be adopted by countries worldwide through incentive-based programs as it will be a win-win situation while directly linking with the Sustainable Development Goals (SDGs).

Figure1. *Shubh Leather* and some products made from it.

EFFICACY TESTING OF ENROFLOXACIN AGAINST *Aeromonas hydrophila* IN CATFISH (*Clarias* sp.)

Swastika Dita Soraya*, Sofian Ansori, Rismelsy

Center For Fish Health And Environmental Assessment
Ministry of Maritime Affairs and Fisheries of Indonesia
Swasti.soraya@gmail.com

Aeromonas hydrophila is a Gram negative bacterium that widely distributed in aquatic environments and an opportunistic pathogen for fish, reptiles, amphibians and humans, which is capable of causing severe hemorrhagic septicemia and skin ulceration in aquatic animals. It was known that *A. hydrophila* caused motile Aeromonas septicemia (MAS. To overcome this problem, fish cultivators usually use chemical drugs or antibiotics. Antibiotics can be grouped based on chemical formula, spectrum of activity and mechanism of action. Its use must be based on the accuracy of disease diagnosis so that it has a positive effect on healing the disease. Antibiotics with the active ingredient enrofloxacin are antibiotics with bacteriocidal properties, this antibiotic can be used on Gram-negative and Gram-positive bacteria. The aim of this study was to evaluate the administration of enrofloxacin in the treatment of *A. hydrophila* infections in catfish (*Clarias* sp.).

An initial experiment showed that the LD50 dose obtained was 5.42 x 10^8 cfu/ml and then will be used in efficacy testing. The treatment's fish feed were prepared by mixing enrofloxacin in feed and Feeding were 2 times a day for 5 days experiment. The experimental method consisted of three groups and three replications with each container using 30 fishes. Control negative groups were those without antibiotics, control positive were those with *Aeromonas hydrophila* innjection dan treatment groups were those with bacteria injection and with antibiotics. Efficacy testing was carried out by calculating the fish survival rate for 5 days and calculating the reduction in *Aeromonas* sp at 24, 72 and 120 hours after treatment.

The result showed that the fish survival rate in negative control groups were 98.9%, in positive control groups were 15,6% and in treatment groups were 57,8%. While the decreasing number of *Aeromonas* sp. were 90%. This indicates that administration of enrofloxacin in feed at a dose of 10 mg/kg biomass can reduce the mortality rate of catfish infected by *Aeromonas hydrophila*

GROWTH PERFORMANCE AND LIVABILITY OF WHITE LEG SHRIMP *(Litopenaeus vannamei)* FED POSTBIOTIC AND CHALLENGED WITH *Vibrio parahaemolyticus*

Stefani[1]*, Alex Makol[2], and Orapint Jintasataporn[3]

[1] Cargill Animal Nutrition, Micronutrition and Health Solutions, Spain
[2] Cargill Animal Nutrition, Micronutrition and Health Solutions, SSEA
[3] Nutrition and Aquafeed Laboratory, Department of Aquaculture, Faculty of Fisheries, Kasetsart University, Bangkok, Thailand
Email: Stefani_stefani@cargill.com

Whiteleg shrimp (*Litopenaeus vannamei*) is a fishery commodity that has seen a significant increase in production since the early 1970s (Ihsanario & Ridwan, 2021). However, to meet the global market demand, vannamei shrimp farmers face numerous challenges dependent on climate and seasons. The discovery of several types of Vibrio bacteria are known to cause a wide variety of diseases in shrimp, such as red disease, shell disease, septic hepatopancreatic necrosis, luminous vibriosis, zoaea II syndrome, acute hepatopancreatic necrosis disease (AHPND), and many others. Postbiotics play a pivotal role in this study as a nutritional supplement for shrimp which are believed to enhance growth and immunity (Priyanka & Dhanasekaran, 2023). The primary aim of this study was to investigate the impact of postbiotics on the development and health of juvenile white-leg shrimp.

The experiment involved six hundred juvenile white shrimps weighing approximately 1-1.5 g. These shrimps were divided into three groups, with eight replications for each treatment. They were placed in 240 L tanks containing 120 L of 10 ppt saline water at 200 shrimp/m^3 density. The shrimps were fed for eight weeks with different treatments: a control group (basal diet) and two groups receiving Postbiotic (DVAQUA™) at inclusion rates of 0.25% and 0.5% of feed, respectively.

In terms of performance, after eight weeks of feeding, shrimp fed DVAQUA™ at both inclusion rates showed an increase of weight of 10% and 18% (Figure 1), respectively, being significantly higher ($P < 0.05$) with the highest inclusion rate. Feed conversion ratio and survival of shrimps at eight weeks were significantly improved ($P < 0.05$) by both inclusion rates of DVAQUA™.

After being challenged with *Vibrio parahaemolyticus*, shrimps fed DVAQUA™ at both inclusion rates showed significantly ($P<0.05$) improved survival (Figure 2). Different immune parameters like phenoloxidase (PO), superoxide dismutase (SOD) and lysozyme activities were significantly improved ($P < 0.05$) at both inclusion levels of DVAQUA™. This study indicated that postbiotics positively supports juvenile white-leg shrimp growth performance and enhanced immune parameters under a bacterial challenge.

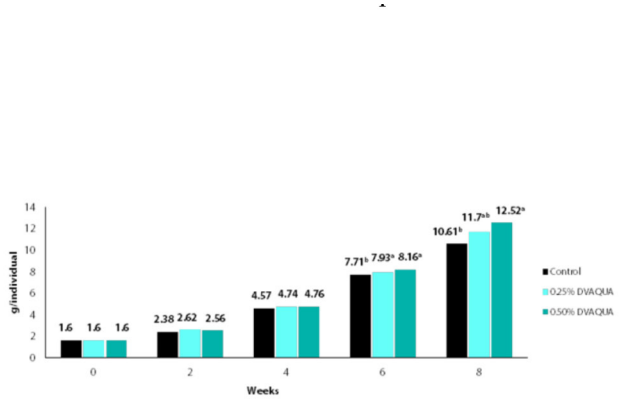


Figure 1. Weight of shrimps fed DVAQUA for 8 weeks. Different letters means significant differences ($P<0.05$).

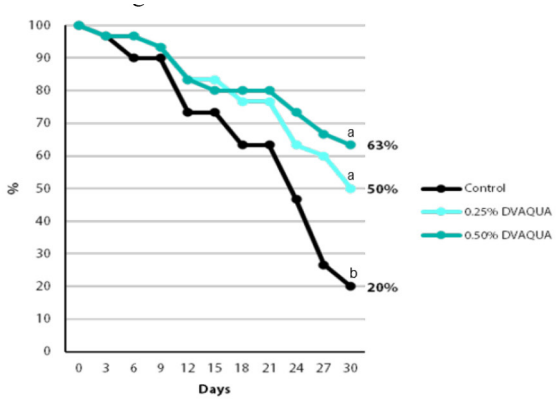


Figure 2. Survival of shrimps fed DVAQUA after bacterial challenge. Different letters means significant differences ($P<0.05$).

IMPROVED GROWTH PERFORMANCE OF NILE TILAPIA *Oreochromis niloticus* JUVENILES USING A PHYTOGENIC FEED ADDITIVE

Alex Makol*[1], Tobias Aumiller[2] and Karola R. Wendler[2]

[1]Cargill Animal Nutrition, Micronutrition and Health Solutions, Spain
[2]Delacon Biotechnik GmbH, Langwiesen 24, 4209 Engerwitzdorf, Austria
Email: alex_makol@cargill.com

Nile tilapia (*Oreochromis niloticus*) is one of the most aquacultured fish species worldwide, mainly due to its rapid growth performance and market value. However, as occurs in other farmed species, growth performance, feed efficiency and disease resistance are usually challenged by stressful situations derived from common culture practices. Phytogenic feed additives (PFA) have been demonstrated to be potential tools to improve production performance. Three studies were conducted to determine the efficacy of a new phytogenic feed additive (saponins, spices and essential oils) on Nile tilapia juveniles growth performance and feed efficiency. Diets were formulated to contain different levels of Syrena® Boost (0, 200 & 400 mg/kg) and fed for 8 weeks to Nile tilapia juveniles in triplicates. Experimental tanks were 100 L & 350 L tanks, depending on the study.

After 8 weeks of dietary PFA supplementation, similar results were obtained in all three studies. In the first one, fish fed the different levels of the product showed a 11.6% & 9.7% increase in weight gain, 6.4% & 6.2% increase in specific growth rate (SGR) and 7.6% increase in total feed intake, depending on the dose, without compromising feed conversion ratio (FCR), compared to fish fed with the control diet.

In the second study, fish fed PFA supplemented diet showed a significant ($p \leq 0.05$) increase of weight gain compared to fish fed the control diet by 7.2%, an increase in SGR by 6.7% and a significant ($p \leq 0.05$) improvement in FCR by 6.9% compared to fish fed the control diet (Figure 1). In the third trial, fish fed PFA supplemented diet showed a significant ($p \leq 0.01$) increase in feed intake by 6 & 6.2%, an increase in weight gain by 9.6% & 9.9% and a significant ($p \leq 0.05$) improvement in SGR by 4.8% & 7.9%, depending on the dosage.

In summary, these studies indicate the benefits of supplementing Syrena® Boost, a specific formulation of selected phytogenics, being efficient to promote tilapia growth performance, to stimulate feed intake and to optimize feed conversion ratio. All this supporting Syrena® Boost as an ideal phytogenic product to enhance the profitability of tilapia production in a cost-effective way.

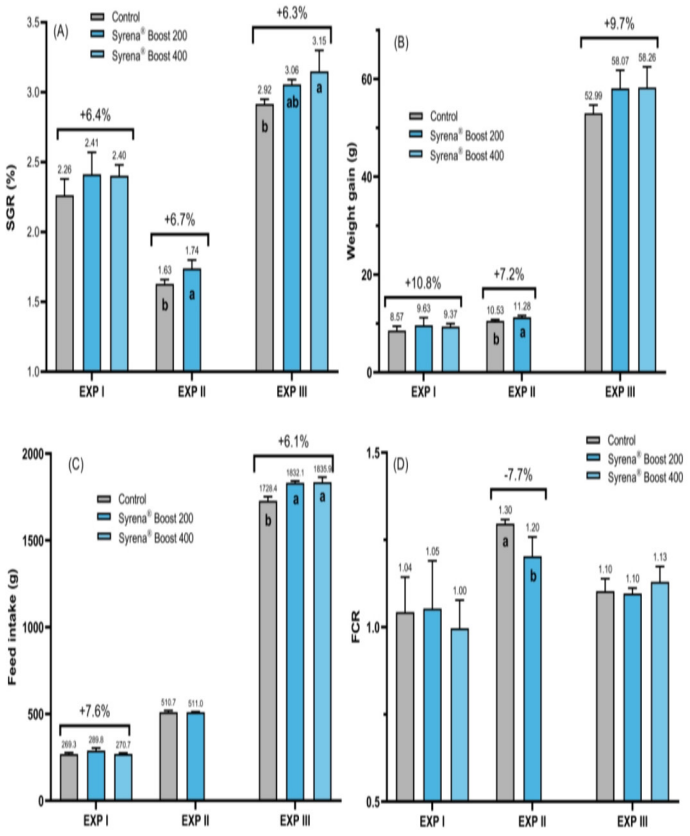


Figure 1: Nile tilapia biological and feed utilization parameters at the end of feeding trials. (A) Specific growth rate, (B) Weight gain, (C) Feed intake and (D) Feed conversion ratio. Different letters means statistically significant difference at p≤0.1.

INNOVATION OF THE 3 IN 1 (THREE IN ONE) CRAB BOX MODEL FOR CULTIVATING MUD CRAB WITH AN APARTMENT SYSTEM

Imam Subali*, Muhammad Kukuh Prihardianto

Jepara Brackish Water Aquaculture Development Center
Jl. Cik Lanang, Rw. IV, Bulu, Kec. Jepara, Jepara Regency
Central Java 59418, Indonesia
Phone: (0291) 591125 Fax: (0291) 591724

Corresponding Author:
subalio.ran@gmail.com

Mud crabs are a fishery commodity that has a wide market share for domestic needs and export market needs, especially in the form of soft shell crab (soka). Currently, the development of mud crab businesses has been carried out both on a household scale, in ponds and in open waters. Even though cultivation activities are now starting to attract a lot of attention from the fish farmer, the fact is that they still face various problems in their development. The main problems faced in cultivating mud crabs include the low survival rate; Production inefficiencies still occur due to long cultivation times to consumption size, and this affects efficiency from the business aspect. Therefore, to solve this problem, efforts are needed to develop innovative cultivation systems that are effective, efficient and capable of increasing the survival rate of cultivated mud crabs.

Currently, the Jepara Brackish Water Aquaculture Development Center has succeeded in finding a technique for cultivating mud crabs with high efficiency, namely through apartment system cultivation. This vertical aquaculture technology is the third evolution in mud crab cultivation after cultivation in nature and horizontal system cultivation which generally uses ponds. The innovation that was successfully created was the Crab Box 3 in 1 (three in one) product with an apartment system. The objectives of implementing the Crab Box 3 in 1 (three in one) apartment system product are: (1) increasing the survival rate of mud crabs; (2) increasing the efficiency of space utilization and water utilization; (3) ensuring that cultivation business activities are more sustainable; and (4) to ensure economic continuity because it is able to accommodate two business segments, namely the business segment for the production of soft shell crab (50-60 grams); and the business segment for the production of crabs weighing more than 1,000 grams. The design of the Crab Box 3 in 1 (three in one) apartment system has been designed starting in January 2023, starting from design planning, making molding (printing machines), to producing crab boxes using an injection machine. Production of 1 unit of crab box requires a circle time of 80 seconds, so that in one day (24 hours) it can produce 1,080 pcs.

The performance test results of the Crab Box 3 in 1 (three in one) apartment system innovation show that this innovation has significantly made crab farming activities easier, including being more efficient in land and water utilization by implementing the RAS (Recirculating Aquaculture System) system. Apart from that, this innovation is able to produce quality mud crabs with a high crab survival rate, which can reach 90-95% by using local seeds. This innovation is very feasible to be developed on a massive scale in order to meet the national need for mangrove crabs.

BACTERIOPHAGES- A NATURAL ALTERNATIVE TO ANTIBIOTICS FOR THE CONTROL OF BACTERIAL INFECTIONS IN AQUACULTURE

Dr.C.R.Subhashini

Director
Aristogene Biosciences Pvt Ltd
Bangalore, India

Vibriosis is one of the major bacterial diseases of shrimp larvae in hatcheries and juveniles in farms causing huge economic loss of up to 30 % decrease in gross production leading to losses.

The misuse of antibiotics to control infections in aquaculture has resulted in the development of resistant strains, which have rendered antibiotic treatments ineffective. Moreover, the horizontal transfer of resistance determinants to human pathogens and the presence of antibiotic residues in aquaculture products for human consumption constitute important threats to public health.

The application of phages in aquaculture has good advantages over the use of antibiotics.

- This includes the targeted attack of vibrios by phages, phages are abundant in nature, no serious side effect;
- Self-replicating therapeutic
- Self-limiting -Phages thrive in the presence of bacteria, and die out in their absence
- One phage/bacterium is sufficient
- "Green Natural Alternative" to antibiotics
- No damage to normal (beneficial) flora
- **Removal of the biofilms formed by the bacteria**
- **Enhances the probiotic performance.**

The use of phages for the biological control of pathogens of cultured fish and shrimp has developed interest in recent years since no drugs residues, drug toxicity is associated with this type of therapy.

Bacteriophage therapy will be a major breakthrough in the treatment of vibriosis

The advantage of phage therapy in vibriosis are:

- Increase in shrimp production by avoiding loss due to vibriosis.
- Increase in acceptance of the shrimp in global market due to the decrease in use of antibiotics.
- A major social advantage is prevention of spread of antibiotic resistant bacteria and residual antibiotics in the meat consumed by human.

In our facility several phages have been isolated, characterized and formulations have been made and has been widely used in the Indian market.

CHALLENGE STUDIES

100 Post larvae were challenged with the bacteria and the respective phages. All the tanks with phages shows marked survivability when compared to control tank which contained only bacteria. A cocktail of phage 1a, VH20, VH3 and phage 1a, VH19 and VH3 were also used in the above study and 3 trials of challenge studies were conducted at Aristogene and 2 at NCAAH, Cochin. All these studies prove that protection by phages was as good as antibiotics.

Field Trials:

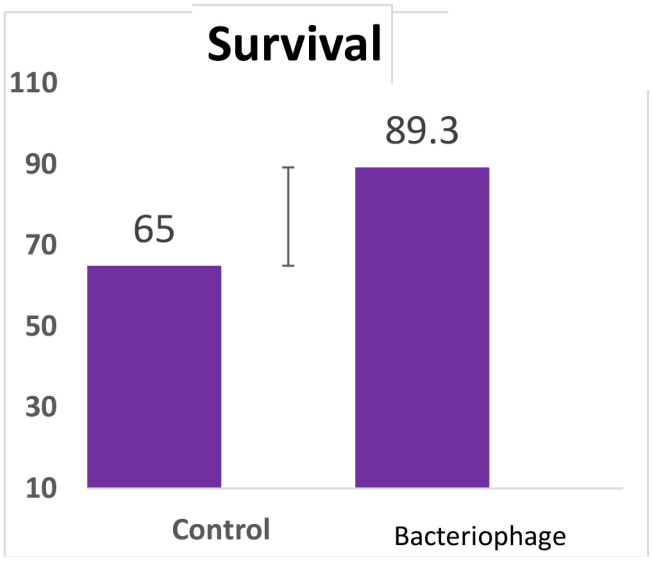
- Several trials showed that the larval survivability increased markedly with the bacteriophage therapy.
- Commercial hatchery results: Bacteriophage cocktail has been used for over one year in Andhra Pradesh, India and the survival results are reportedly 10-15 % higher than the best probiotics available.
- Use of phage therapy in grow-out culture: Phage cocktail against vibriosis was also mixed with feed and fed to animals which showed that there is a decrease in the vibrio counts in the gut of animals, increase in survival and increase in Average daily weight gain.
- Field trials in nursery in Costa Rica has shown that phages were able to control EMS (early mortality syndrome)

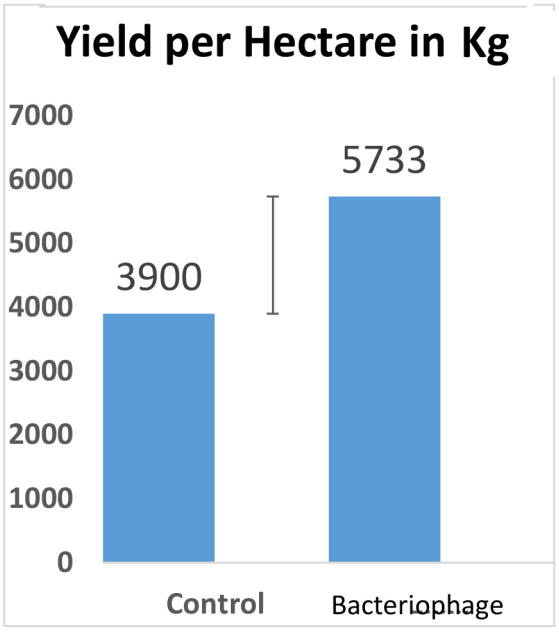
(Continued on next page)

Results:

- Drastic reduction of total vibrio counts
- Reduction of Running mortality syndrome
- Control of White faecal disease
- Protection against EMS
- Bacteriophage therapy can be stand alone therapy or can be used in adjunct with probiotics.
- There has been increase in survival, better FCR and protection from vibriosis.

The results of treatment trial in a farm affected with running mortality syndrome.





DOMESTICATION OF AMBERJACK FISH (*Seriolla dumerili*) AS AN EFFORT FOR SUSTAINABLE SEED PRODUCTION

Rochman Subiyanto*, Hamsah Amiruddin, Sunarto dan Hariyano

Balai Perikanan Budidaya Laut Ambon
Jl. Leo Wattimena, Ambon
e-mail: ambonbpbla@gmail.com

Amberjack fish or what is called rock pompano and is a deep water fish characterized by a dark yellow color with a bright yellow stripe from the eyes to the tail and is a pelagic fish which is a type of predator that preys on small fish, squid and other types. Taxonomically it is included in the Family Carangidae. The market demand for this fish is quite high due to its extraordinary versatility; either served as sashimi, cured, smoked, grilled, fried or roasted as a cutlet or boiled as a fillet in broth. This type of fish hatchery has not been widely practiced in Indonesia, even though the available market demand is quite high. Hatchery efforts were carried out by the Ambon Mariculture Fisheries Center with structured broodstock domestication steps starting in June 2023. Handling of broodstock was carried out in fiber tubs with a capacity of 15-20 tonnes with a density of 10-12 fish per tub. Improvements in feed quality and vitamins are carried out in stages with dose adjustments of 3-5%. During 4 months of domestication, the number of eggs ranging from 1,400,000-2,400,000 was obtained with a total of 8,450,000 eggs. Apart from that, a spawning interval of 3-7 days per month is also obtained with a hatching rate of 10-60% with 6 fry.

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CAN ORGANIC ACIDS BE AN EFFECTIVE DIETARY INTERVENTION TO COMBAT VIBRIOSIS INFECTION IN SHRIMP?

Saravanan Subramanian[2*], Sathish Kumar Thangaraj[1], Naveen Rajeshwar[1], Sivaramakrishnan Thiruganamurthy[1], Sujeet Kumar[1], Shiva Kumar[3], Lane Pineda[2], Morvarid Rezvani[2]

[1]ICAR-Central Institute of Brackishwater Aquaculture, Chennai, TamilNadu, India
[2]Trouw Nutrition, Nutreco, Amersfoort, The Netherlands.[3]Nutreco, Hyderabad, India
saravanan.subramanian@selko.com

Diseases are the major biological challenges for sustainable growth of shrimp farming. The diseases like White Spot Syndrome, EHP and Vibriosis caused by *Vibrio sp*. are resulting in severe shrimp mortality and adverse economic impact in shrimp farming. The annual economic loss due to Vibriosis in Indian shrimp farms during 2018-19 was estimated to be 39.93 million USD. Unfortunately, antibiotics are the most widely used treatment measures against Vibriosis. The uncontrolled use of antibiotics may lead to increased risk of antibiotic residues and antibiotic resistant bacteria. This study aims to evaluate the dietary effect of organic acid-based product Selacid GG (0.1%, 0.2%, and 0.3%) in shrimp challenged with *Vibrio sp*. For each treatment, triplicate tank (30 shrimp/tank) were fed respective diets 7 days before and 7 days after *Vibrio sp*. challenge by immersion. At the end of experiment, all the Selacid diet fed group (0.1%, 0.2%, and 0.3%) showed significantly lower Vibrio load in hemolymph than the Positive Control. Shrimp fed Sel 0.2% and Sel 0.3% diet group showed significantly lower Vibrio load in the hepatopancreas. Also, by qPCR all the Selacid diet fed group (0.1%, 0.2%, and 0.3%) showed significantly lower Vibrio load than the Positive Control. Shrimp fed Sel 0.2% and Sel 0.3% group showed significantly higher activity of phenoloxidase enzyme. In total haemocyte count all the Selacid (0.1%, 0.2%, and 0.3%) diet fed group were showed significantly higher count. Whereas, in growth parameters such as final body weight, weight gain, specific growth rate, and survival rate Sel 0.2% diet fed group had a significantly higher values than the Positive Control group. Similarly in histology, relatively less degeneration and necrosis of HP tubules and HP epithelial cells and inflammatory response such as haemocytic infiltration, encapsulation and granuloma were observed with Sel 0.2% diet fed group. Overall, the Selacid GG at 0.2% in the diet significantly reduces the Vibrio load and simultaneously improves the immunity, growth and survival of Vibrio challenged shrimp. Hence Selacid GG can be used as the alternative dietary intervention against Vibriosis in shrimp aquaculture.

Treatment	Shrimp survival, %	Total Vibrio load in hepatopancreas, CFU
Negative Control (Sel 0%)	95.56 ± 1.92	$2.6 \times 10^4 \pm 8.4 \times 10^3$
Positive Control (Sel 0%)	78.89 ± 1.92	$1.2 \times 10^5 \pm 2.7 \times 10^4$
Sel 0.1%	84.44 ± 1.92	$1.1 \times 10^5 \pm 4.5 \times 10^4$
Sel 0.2%	93.33 ± 0	$4.1 \times 10^4 \pm 9.9 \times 10^3$
Sel 0.3%	87.78 ± 1.92	$5.4 \times 10^4 \pm 4.1 \times 10^4$
P value	*< 0.05*	*< 0.05*

SYNTHESIS OF CARRAGEENAN, GELATIN, AND STARCH BIOPOLYMER FILMS WITH LECITHIN-EMULSIFIED ESSENTIAL OIL FOR SUSTAINABLE FOOD PACKAGING APPLICATIONS

Romnick A. Sulit*, Kristine P. Caoagas, Arbynne C. Dorado, Steve P. Janagap, Cathrina F. Bagarinao, Ann Selma C. Morata, and Jay O. Martizano

Department of Chemistry, College of Arts and Sciences
University of the Philippines Visayas
Miagao, Iloilo 5023 Philippines
rasulit@up.edu.ph

The annual plastic waste production in the Philippines is staggering at 2.7 million tons. About 20% of which, are found being wind up in the ocean. Along with this rising problem is the similarly growing interest in the use of alternative packaging materials to address the issue. This study aims to synthesize and evaluate antifungal carrageenan-gelatin-starch (CRG-GEL-STA) polyelectrolyte complex (PEC) films loaded with Lemon Grass Essential Oil (EO).

Carrageenan is a water-soluble polysaccharide that is commonly synthesized from red seaweeds. Gelatin, on the other hand, is a natural water-soluble protein obtained from the partial hydrolysis of collagen. Meanwhile, cassava starch is a water-soluble polysaccharide produced by wet milling fresh cassava roots. These three biopolymers, through the electrostatic interaction of the negatively charged sulfonic groups of the CRG, the positively charged residues of gelatin, and the hydroxyl groups of starch, comprise the PEC film matrix.

The fabricated films were then added with lecithin-encapsulated EO emulsion to incorporate active ingredients into the films. Optical micrographs revealed discontinuity and heterogeneity in the surface film layers as EO concentration was increased. The addition of starch caused an increase in tensile strength (TS) and a decrease in the elongation-at-break (EAB) of the films, while the opposite is observed upon the addition of EO, whereas a TS reduction and a better EAB were observed (Table 1). Moreover, the FTIR analysis reported a narrowing of the spectral bands in the OH functional group region upon the addition of EO emulsions at increasing concentration (Figure 2). However, structural changes were not observed in the films upon EO loading at any concentration. Meanwhile, the antifungal effect of the sample films was also determined based on the fungal growth proliferation on white bread samples packaged with the sample films of varied treatments and a control group (Table 1). Overall, the CRG-GEL-STA-PEC films have retarded the fungal growth on the bread surface, and films with EO have inhibited mold formation within the 14-day experimentation period.

FIGURE 1. Generated CRG-GEL-CS PEC films with (a) 0.0 v/v % (b) 0.5 v/v % (c) 1.0 v/v %, and (d) 1.5 v/v % LGEO emulsion.

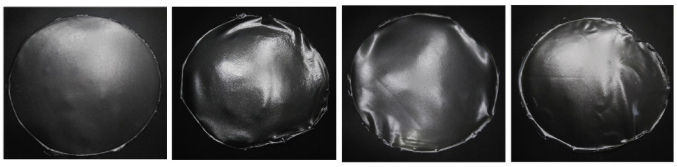
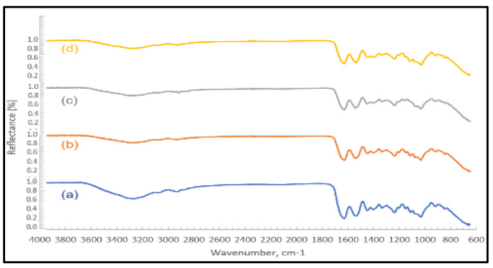


TABLE 1. Mechanical Test Results and Fungal Growth Observation of the Fabricated Films with EO Emulsions.

EO Emulsion Concentration	Tensile Strength (mPa)	Elongation at Break (%)	Surface Fungal Growth Observation at Day 14 (%)
Control	-	-	70-100
0.0 v/v %	12.37	21.81	0
0.5 v/v %	11.20	4.21	0
1.0 v/v %	8.88	21.53	0
1.5 v/v %	8.82	29.99	0

FIGURE 2. FTIR Spectra of the CRG-GEL-STA PEC Films with varying concentrations of EO emulsion.



CORRELATION OF WATER QUALITY TO THE LEVEL OF ECTOPARASITIC INFECTION IN DUMBO CATFISH (*Clarias sp*)

Suratno, Naswir M, Suryono

Jambi Freshwater Aquaculture Development Center (JFADC)
Jambi, 36363

Dumbo catfish (*Clarias sp*) farming activities certainly have obstacles and problems, namely the existence of fish disease attacks which result in fish death. The need for information on how to prevent and treat fish diseases is needed to increase the knowledge of fish cultivators. This study aims to analyze water quality and then correlate it with the intensity of ectoparasites in catfish, analyze the duration of aeration of ectoparasites in infection in Dumbo catfish (Clarias sp) including intensity, fish survival and fish condition factors. This study used a completely randomized design (CRD) with 5 treatments and 4 replications. The treatments included aeration P0(0 hours/day), P1(6 hours/day), P2(12 hours/day), P3(18 hours/day) and P4 (24 hours/day). Data analysis used the Windows version of the SPSS application version 16.0 with ANOVA analysis at a significance level of 5%. If there is a significant difference from each treatment, proceed to the DUNCAN test.

The correlation value of oxygen solubility on the intensity of ectoparasites is 0.828, the degree of acidity (pH) is 0.849, ammonia is -0.888, nitrite is -0.592. The prevalence value of P0 and P1 is 0%, P2 is 89%, P3 and P4 is 100%. The intensity of ectoparasites in Dumbo catfish (Clarias sp), at P0 was 2, P1 was 13, P2 was 75, while at P3 and P4 it was >100. The dominance of the infecting ectoparasites were Trichodina sp of 71.7-100% and Dactylogyrus sp of 0-28.4%. The conclusion of the study is that the longer the aeration is given, the solubility of oxygen increases which results in the intensity and prevalence of ectoparasites increasing, the water pH becomes neutral and the content decreases. ammonia and nitrites. there is a moderate to very strong correlation between water quality and ectoparasite intensity, namely the longer aeration is given, the prevalence, intensity of ectoparasites and mortality will increase so that it can reduce survival and condition factors for African catfish (*Clarias sp*).

Table 1. Coefficient value of water quality correlation to ectoparasite infection

	Parameter	Nilai (r) korelasi (x-y)
1	DO ($x_{1)}$	0,828
2	pH($x_{2)}$	0,849
3	Amonia($x_{3)}$	-0,888
4	Nitrit (x_4)	-0,592

Table 2. Average and Standart deviation on intensity and prevalence of ectoparasitic infection after aeration

P	Intensitas (Ekor)	Prevalensi ektoparasit (%)
P0	2,3±0,23[a]	0±0[a]
P1	12,6±1,00[a]	0±0[a]
P2	75±12,95[a]	89±0,11[b]
P3	344±54,23[b]	100±0[c]
P4	375,1±28,94[b]	100±0[c]

Different superscrips in the same column show very noticeable differences ($p<0.01$)

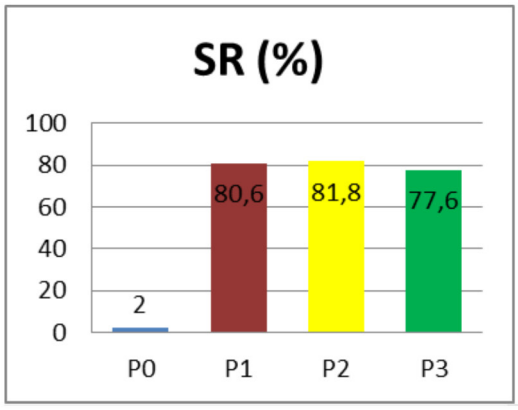
THE 'PROPACK" APPLICATION SUPPORTS THE RATE OF SEED LIFE TILAPIA (OREOCHROMIS NILOTICUS) IN A CLOSED TRANSPORTATION SYSTEM

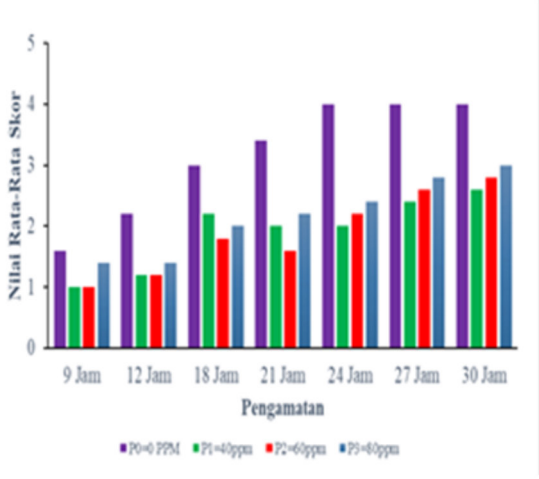
Suratno, Andy Artha Donny Oktopura, Dedi Fazriansyah Putra, Sutikno

Jambi Freshwater Aquaculture Development Center (JFADC)
Jambi, 36363

The fish seed transportation system must consider the length of the trip, costs and safety to the destination. The risk of fish mortality in seed transportation can be detrimental to both seed producers and consumers. In this study, we have conducted trials and developed the use of a self-concocted chemical called 'Propack' to maintain ideal water quality so that when fish are transported in plastic bags they do not experience stress and death. The purpose of this study was to determine the effect of the addition of 'Propack' tablets on the survival rate of seeds transported at a certain time.The object of this study used tilapia (Oreochromis niloticus) with a size of 3-5 cm. The experiment used 4 treatments and 5 repetitions as follows: P0 is water media with only supplemental oxygen "Propack" tablets, while P1 water media with oxygen is added 40 ppm Propack, P2 water media with oxygen added 60 ppm propack, P3 water media with oxygen 80 ppm of oxygen was added by propack. The Propack consists of lime, clay and zeolite.

The results showed that the quality of fish after 12 hours of travel was significantly different from that between treatments P0 and P1, P2 and P3. At 21 hours P0 experienced a lot of death of the fry while P1, P2 and P3 still survived and experienced a few fish deaths. After 30 hours, the survival rate of the seeds was calculated to produce P0(2%), P1(80,6%), P2(81,8%), and P3(77,6%). The seed level was then tested for a 5% ANOVA level of significance which resulted that the P1, P2 and P3 treatments were significantly different from the P0 treatments. It can be said that the administration of the 'propack' tablet material at a dose of 40-60 ppm gave the highest results for the survival rate of tilapia fish, namely 80.6% and 81.8%, respectively. Based on these findings, the application of 'propack' tablets to fish water media during transportation is a new finding that is useful in the transportation process of tilapia (Oreochromis niloticus).





IMPLEMENTATION OF A FLOWTHROUGH WATER REPLACEMENT SYSTEM IN THE CULTIVATION OF WHITE SHRIMP (*Litopenaeus vannamei*) IN THE SUMBAWA REGENCY SHRIMP FARM CLUSTER

Agus Suriawan* dan Didik Budi Nursanto

Brackishwater Aquaculture Development Center Situbondo
PO. BOX 5
Panarukan Situbondo
suriawan1975@gmail.com

The flowthrough water replacement system is a water management system for white shrimp (*Litopenaeus vannamei*) cultivation with water replacement of up to 30% per day when the DOC is above 30 days. The aim of this method is to ensure the quality of shrimp cultivation water in an effort to improve shrimp growth and health.

A shrimp pond unit in Buer District, Sumbawa Regency, West Nusa Tenggara has been built, consisting of 6 square cultivation ponds, (@ 1,225 m^2) 2 reservoir ponds (@ 1,400 m^2), 1 settling pond and Waste Water Treatment Pond unit. The flow of cultivation activitiesincludes: pond preparation (pond cleaning, checking HDPE plastic, installing 6 paddle wheels,installing biosecurity fences), water preparation, application of probiotics: *Lactobacillus* sp.),Stocking density of fry 250 PL/m^2, Shrimp feeding using automatic feeder with Index value:

0.5 – 0.75 and Water exchanges up to 30%). Observation parameters: Average Daily Growth (ADG), Survival Rate (SR), and Feed Conversion Ratio (FCR).

The results of the activity show that the ADG value ranges from 0.35 – 0.58 (Sampling DOC 30 – DOC 80). The average weight of DOC 80 is 25.72 grams; Size 38; SR 78.36%; FCR 1.58. At theend of cultivation (DOC 104) an average weight of 37.04 grams was obtained with size 27 . The total harvest obtained was 33,335 tons and FCR 1.25. The production cost per kg of shrimp is Rp. 33,300.

The implementation of the flowthrough water replacement system in water quality management has had a significant impact on increasing the white shrimp vannamei production in Sumbawa Regency.

Table 1. Results of cultivation activities at DOC 80

Pond	Stock (pcs)	Size (pcs/kg)	MBW (gram)	ADG (g/d)	Feeding Rate (%)	Total Feed (Kg)	Biomassa (Kg)	SR (%)	FCR
A	160.980	41,56	24,06	0,48	2,4	5.141	3.246	83,80	1,58
B	153.000	39,39	25,39	0,60	2,39	5.198	3.259	83,91	1,59
C	172.857	38,36	26,07	0,58	2,38	5.198	3.268	72,53	1,59
D	188.602	34,44	29,04	0,63	2,35	5.198	3.351	61,20	1,55
E	160.291	38,35	26,08	0,63	2,38	5.198	3.245	77,64	1,60
F	146.185	41,11	24,32	0,37	2,4	5.198	3.239	91,10	1,60
	981.914	38,88	25,72	0,51	2,38	31.131	19.609	77,65	1,59

NURSING OF SEA BASS FINGGERLING (*Lates calcalifer* Bloch 1970) ON EARTHEN POND

Agus Suriawan* Jaka Wiyana, Sugeng Asmoro

Brackishwater Aquaculture Development Center Situbondo
PO. BOX 5 Panarukan Situbondo
suriawan1975@gmail.com

The provision of Seabass feed which economical, good quality, and abundant in the nursery area is a very important requirement in supporting increased production. The aim of this study was to compare commercial seabass feed with fresh feed on the nursery phase (7.5 to 15 cm) (growth, SR, FCR and production cost).

This research design was carried out using a completely randomized design (CRD) with 3 treatments and 3 repetitions, namely: A. 100% commercial feed (Protein 42%), B. 100% fresh feed (white mussel) and C. both of commercial feed and mussels (50: 50 %). The stocking density for each treatment was 100 fish/m^2 with a fingerling size of 7.5 cm. Observation parameters include: Average Daily Growth (ADG), Survival Rate (SR), Feed Conversion Ratio (FCR), Size distribution, Water quality (temperature, pH, salinity, DO, Ammonia, Nitrite, Phosphate, Alkalinity, Organic matter), and economic analysis.

The results of 46 days rearing showed that there was no significant difference in ADG and SR in the 3 treatments. The ADG values and SR percentages were A. 0.907 ± 0.023 g/day; 95.15 ± 0.61%, B. 0.953 ± 0.083 g/day; 96.97 ± 1.69 % and C. 1.008 ± 0.078 g/day; 97.12 ± 0.15%, respectively. The size distribution data showed a significant difference with the highest level of uniformity was treatment C (90.17 ± 2.36 %), followed by treatment A (86.46 ± 0.45%) and treatment B (77.25 ± 2 ,29 %). Water quality data shows that pH, DO, temperature, salinity, ammonia and nitrite are still in a good range, in accordance with SNI 6145.4:2014 concerning the production of sea bass fingerling in ponds. The FCR value in each treatment was different, with the smallest value in treatment C. 4.52, then B. 5.16 and A. 5.32. The lowest cost of feed produced by treatment B, followed by C and A. The use of a both of fresh feed (mussel) and commercial feed for fingerling production of seabass (7.5 to 15 cm) is more profitable and efficient compared to 100% commercial feed or fresh feed.

Table 1. Length measurement data (cm) during maintenance

Treatment	Day of Culture			
	D - 0	D - 14	D - 28	D - 46
A	7,70 ± 0,06 a	10,72 ± 0,10 ab	13,52 ± 0,12 b	14,94 ± 0,04 a
B	7,70 ± 0,06 a	10,49 ± 0,08 a	12,47 ± 0,28 a	14,84 ± 0,34 a
C	7,70 ± 0,06 a	10,93 ± 0,03 b	13,58 ± 0,21 b	15,43 ± 0,34 a

Table 2. Weight measurement data (grams) during maintenance

Treatment	Day of Culture			
	D - 0	D - 14	D - 28	D - 46
A	7,27 ± 0,20 a	18,22 ± 0,53 a	40,65 ± 1,16 b	49,01 ± 1,06 a
B	7,27 ± 0,20 a	17,13 ± 0,28 a	27,92 ± 2,10 a	51,12 ± 3,83 a
C	7,27 ± 0,20 a	18,28 ± 0,57 a	37,58 ± 1,64 b	57,31 ± 3,59 a

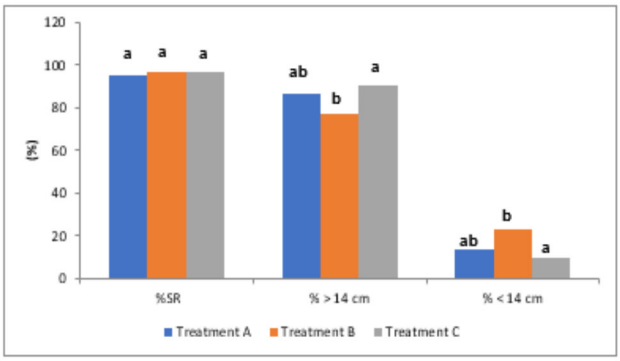


Figure 2. Comparison of average survival rate (SR%) and percentage size distribution of seabass fingerling

SUCCESSFUL PRODUCTION OF MANGROVE JACK (RED SNAPPER MANGROVE) (L. argentimaculatus Forsskal, 1775) SEEDS AT BRACKISHWATER AQUACULTURE DEVELOPMENT CENTER SITUBONDO

Boyun Handoyo, A.B. Muslim, Eko Sutrisno, Zeny Widiastuti[1]*

[1]Brackishwater Aquaculture Development Center Situbondo

Mangrove Jack (red snapper mangrove) is one of marine fish as classified ornamental fish at small size and fish for consumption when adult size. The selling price is still high because it cultivation has not yet developed among farmers. Brackishwater Aquaculture Development Center Situbondo has been able cultivate mangrove red snapper since 2023. The broodstock spawning in 2023 has been able to produce (8-9) x 10^6 eggs from 52 broodstock. Hatching rate is aroud 40.2% - 91.2% and it hatch after 16-20 hour depending on temperature. Newly hatched larvae was not given food because they still absorbing the nutrients from the egg yolk. After 3 days, they was given small rotifer (*Brachionus plicatilis*) and liquid food. Brine shrimp (artemia) was given at 18-20 days after hatch. Larvae become seed after around 60 days and grading must be carried out to seperate the sizes. Survival rate was still low, only around 1.02%-2.77%. Successful of larval rearing is starting point for developing mangrove red snapper cultivation by increasing larval survival through improved cultivation systems.

STUDY ON THE SUSTAINABILITY OF ANTIMICROBIAL USE (AMU) AND ANTIMICROBIAL RESISTANCE (AMR) IN MARINE FISH CULTIVATION IN AMBON BAY

Syaripuddin dan Wa Nuraini

Balai Perikanan Budidaya Laut Ambon
Jl. Leo Wattimena, Ambon
e-mail: ambonbpbla@gmail.com

Various efforts have been made to prevent attacks by Vibrio sp bacteria, including the use of chemicals and antibiotics, which if used excessively will cause bacterial resistance. Another problem that arises is the risk of damage to the environment around farmed fish and human health, for this reason the use of these materials must be effective and efficient. The aim of the research was to determine the inhibitory power of antimicrobials when treating fish diseases in floating net cages and to determine the level of resistance to antimicrobial agents (Antimicrobial Resistance/AMR) to obtain recommendations for the continued use of antimicrobials. The disc diffusion test method with the antibiotics Oxytetracyine, Enrofloxacin and Tetracyline in the form of paper discs was used in the inhibition test. To identify bacteria, biochemical tests using bacterial culture media (TCBS) are used as well as biochemical tests using the API 20E kit. Inhibition of sensitivity in white sea bass with antibiotics oxytetracycline 60%, enrofloxacin 80%, tetracycline 60%, bullfin fish oxytetracycline sensitive 60%, enrofloxacin sensitive 100%, tetracycline sensitive 100%, tiger grouper oxytetracycline sensitive 60%, enrofloxacin sensitive 100% , tetracycline sensitive 60%, duck grouper sensitive 60%, enrofloxacin sensitive 80%, tetracycline sensitive 80% intermediate inhibition can be seen in sea bass intermediate 40%, enrofloxacin intermediate 0%, tetracycline intermediate 40%, oxytetracycline intermediate 40% , enrofloxacin intermediate 0%, tetracycline sensitive 0%, tiger grouper oxytetracycline intermediate 40% enrofloxacin intermediate 0%, tetracycline intermediate 40% while duck grouper oxytetracycline intermediate 40%, enrofloxacin intermediate 20%, tetracycline intermediate 20%, results of research on the use of antibiotics oxyitetracycline, endrofloxacin and tetracycline can be recommended for disease management in aquaculture, the results show that the inhibitory power of the use of the three types of antibiotics is capable of providing sensitive and intermediate responses to the bacteria Vibrio sp. For general bacteria, two types of bacteria have been found, V. parahaemolyticus and Vibrio alginolyticus.

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BREEDING OF LEMON CICHLID, *Neolamprologus leleupi*

Michael Tahalea* and Edy L, Marpaung

hairycockle@gmail.com
Tatelu Freswater Development Center
Jl. Pinilih Jaga VI Desa Tatelu Kec
Dimembe, Minahasa Utara

Lemon cichlid, *Neolamprologus leleupi* is one among the interesting fresh water ornamental fish. It's transported from Java and sold from IDR 5,000 to 6,000 in Manado, North Sulawesi due to no breeding operator exist. This condition could be the reason to breed the fish locally.

A simple method of breeding of lemon chiclid was done. Male (61.6 – 90.4 mm; 9.35 – 23.07 g) and female (55 – 93.0 mm; 6.59 – 13.61 g) were selected and reared separately in a 2.0 x 1.0 x 0.85 M concrete tank (1.5M3) at 1 – 2 ind/M density (1:2/m/f ratio). Broodstocks were fed with 1 mm pellet (32 % protein level) at satiation diet each day for 28 – 30 days. Larve was collected after for weeks of rearing by mouth selected method.

The result showed that lemon chiclid produce egg and/or larva in 3 – 4 weeks onwoard. Average 5.8 to 23 larve was produce per female, but on any case only egg produced. The result of three breeding conducted are summarised as follows:

Larve of Lemon Chiclid is then cultured in the new culture tank until for weeks until reaching 2-3 cm fry before cropping.

The tank is cleaned and fertilized with manure at 500 g/M2 to enhance the growth of live food for larve. On 5 day onward larve was weakened to crumbled food (32 % protein) at satiation. Table 2 summarized water quality on culture tank.

Growth rate of larve was calculated along the culture period as follows; average growth in length was 0,08 (% per day) and 0,026 (% per day) in weight. While survival of larve was 100 % with no mortality recorded.

Table 1. Summarized result of three time breeding of Lemon Chiclid, *Neolamprologus leleupi*

No	Male	Female	Broodstock	Sex ratio (m/f)	Larve	Larva/female	G		Remarks
1	61,6	55	15	01:02	58	5,8	0,08	0,26	
2	95	93	19	01:07	23	23	0,05	0,12	
3	90,4	66,78	18	01:01	0	0		-	Only egg
Total	**247**	**214,78**	**52**	**0,13**	**81**	**28,8**	**0,13**	**0,38**	
Ave	**82,33**	**71,59**	**17,33**	**0,04**	**27,00**	**9,60**	**0,07**	**0,19**	
SD	**18,10**	**19,45**	**2,08**	**0,00**	**29,21**	**11,96**	**0,02**	**0,10**	

Table 2. Temperature (C), pH and Dissolved Oxygen (mg\L) on larval rearing tank

Water parameter	Unit	Range
Temp	ºC	24,2- 25,1
pH	-	7,84 - 8,0
DO	Mg/L	7,1 - 7,5

Fig. 1. Male broodstock
Fig. 2. Female broodstocks

Fig. 3 Cropping larve in the mouth (left)
Fig. 4. Larve of Lemon Chiclid, *Neolamprologus leleupi* (right)

ENHANCEMENT OF GROWTH AND ASSOCIATED COMPOUND OF *Spirulina* sp. FOR AQUACULTURE PURPOSE THROUGH SYMBIOTIC BACTERIA-MICROALGAE INTERACTION

Hui Teng Tan*, Ikhsan. Natrah, Fatimah Md. Yusoff and Yam Sim Khaw

Aquatic Animal Health and Therapeutics Laboratory, Institute of Bioscience, Universiti Putra Malaysia, UPM 43400 Serdang, Selangor, Malaysia
Department of Aquaculture, Faculty of Agriculture, Universiti Putra Malaysia, UPM 43400 Serdang, Selangor, Malaysia

The aquaculture sector stands as the fastest-growing food production industry globally. Nutrition and diseases are two significant challenges that must be tackled to propel the industry forward. An intensive aquaculture system required aquafeed that enhances fish immunity and health to mitigate the stress effects induced by high density. Spirulina, a widely recognized microalga, has garnered attention as a nutritious feed for aquaculture due to its elevated protein content and valuable bioactive compounds. Besides, certain Spirulina species lacking a cell wall result in improved digestion and absorption. Spirulina also exhibit phycobiliproteins that possess various bioactives with health-related properties. These phycobiliproteins have gained attention and are commercially used in various sectors, including pharmaceuticals, cosmetics, food and beverages as well as animal feed. In aquaculture, phycocyanin, one of the phycobiliprotein has been shown to intensify the coloration in goldfish and improve the antioxidant status, immune response and disease resistance of Nile Tilapia (Oreochromis niloticus). Yet, the current production of phycobiliprotein is insufficient to meet the growing market demand and fluctuations in production hampers its feasibility and sustainability.

To address these issues, this study was conducted to improve the growth, biomass and phycobiliprotein production in Spirulina sp. (UPMC-A0087) using an eco-friendly approach that involved utilising associated bacteria. Spirulina sp. was selected as the host for bacterial diversity and phycobiliprotein relationships as it is known to have higher phycobiliproteins than other blue-green microalgae. Thirteen bacteria were successfully isolated and each bacterium was co-cultured with the axenic Spirulina sp. The growth, biomass productivity and phycobiliprotein contents of axenic culture and bacteria co-culture were analyzed. Spirulina sp. co-culture with Bacillus cereus exhibited significantly higher specific growth rate and biomass productivity than other bacteria co-cultures. In terms of phycobiliproteins, co-culture with Aeromicrobium sp. showed significant higher phycocyanin (PC), allophycocyanin (APC) and total phycobiliprotein contents than other bacteria cultures. Highest phycoerythrin (PE) content was found in xenic culture followed by co-culture with Achromobacter sp. This study illustrated that some bacterial species are associated with enhancing growth, biomass and phycobiliprotein production in microalgae. The findings hold promise for advancing the efficiency and sustainability of Spirulina-based aquafeeds, thereby supporting the goal of aquaculture industry to enhance nutritional quality and minimizing environmental impact.

EVALUATING THE EFFECT OF ECONOMIX ON THE GROWTH PERFORMANCE AND HEALTH CONDITION OF PACIFIC WHITE SHRIMP *Litopenaeus vannamei* FED WITH DIFFERENT LEVELS OF PALM KERNEL MEAL

Nicolas Tanrattana*, Sophie Reys, Romi Novriadi and Pierre Fortin

Techna France Nutrition
41 Rte de St Etienne de Montluc
44220 Couëron, France
nicolas.tanrattana@groupe-techna.com

Considering the current context of high raw materials prices due to Ukraine's war and low fishmeal (FM) availability, the need to find alternative ingredients is crucial in aquafeed. This is all the more important given that farmers, in particular shrimp farmers are facing high production costs and low selling prices.

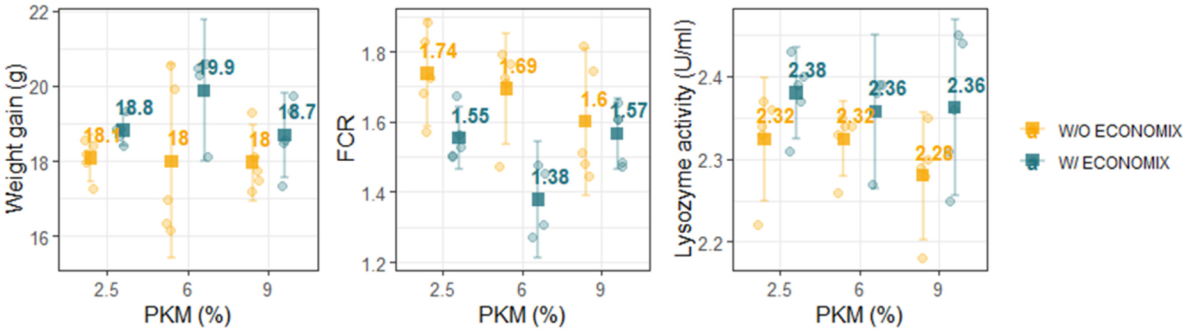
Indonesia produced 46 million tons of crude palm oil in 2021, making it the world's largest palm oil producer. The production of palm oil generates palm kernel meal (PKM) which is its main by-product. PKM could be a promising alternative ingredient to substitute fish meal and reduce feed costs, as it is locally available and cheap. Though, solutions should be founded to overcome its high fibrous (~19%) and medium grade protein (~16%) content and make it more digestible for shrimps.

Economix is a plant-based feed additive produced by TECHNA FRANCE NUTRITION (Couëron, France) that aims at improving protein digestibility, increasing palatability and balancing the amino acid profile within the diet. It could be a solution to overcome the unbalanced nutritional profile of PKM and lower the protein content of shrimp diets.

This study held at Jakarta University investigates for 90 days the effect of Economix on the growth performance and health condition of Pacific white shrimp *Litopenaeus vannamei* (mean initial weight 0.7 g) fed with different PKM levels (2.5, 6, 9%) in substitution of FM, cereals, soybean meal and poultry meal, with protein contents ranging from 34 to 35%.

The results showed that the inclusion of 0.2% Economix significantly increased the growth ($p < 0.05$), significantly reduced the FCR ($p < 0.01$) and significantly increased the lysozyme activity ($p < 0.05$) of shrimps fed diets that include PKM. Survival rates were in the range of 88-92% with no significant difference between treatments.

To conclude, using Economix supplementation improved growth performance, feed efficiency and health status of shrimps fed with diets including PKM.



Effect of Economix on weight gain, feed conversion ratio (FCR) and lysozyme activity of Pacific white shrimp *Litopenaeus vannamei* fed with different levels of PKM

PARENTAGE ASSIGMENT USING SNP MAKERS EFFICIENTLY IMPROVES THE MANAGEMENT OF GENETIC DIVERSITY IN MASS SPAWNED HATCHERY SPAT OF THE BLACK LIPPED PEARL OYSTER *Pinctada margaritifera* IN FRENCH POLYNESIA

Vaihiti Teaniniuraitemoana*, Laura Benestan, Julie Fievet, Oriane Chevalier, Cédrik Lo, Mereani Bellais, Seiji Nakasaï, Dominique Devaux, Pierre Boudry, Romain Morvezen, Guillaume Mitta, Jérémy Le Luyer, and Pierrick Haffray

Ifremer, ILM, IRD, UPF, UMR 241 Secopol
Centre Ifremer du Pacifique – Vairao
Ressources Marines en Polynésie Française (RMPF)
BP 49 – 98725 Vairao – Tahiti – Polynésie française
vteanini@ifremer.fr

The production of black-lipped pearl oyster in French Polynesia is based on wild spat collection in closed or semi-enclosed lagoons. The recent highly variable and limited supply of juveniles and the perspectives to improve pearl quality using selective breeding encourage the development of hatcheries and the domestication of the species. As internationally recommended, the management of genetic variability in stocks in domestication is crucial to avoid potential negative effects of inbreeding. We report a first analysis in *P. margaritifera* of inbreeding risk by analyzing the conservation of genetic variability in two cohorts produced by Regahiga Pearls hatchery (Rikitea, Gambiers Archipelago), estimating their effective size (*Ne*) and inbreeding coefficients.

Broodstock from two cohorts and their progenies were genotyped using a recently developed 70k SNP array. Briefly, 18 sires and 13 dams (cohort B1) and 15 sires and 13 dams (cohort B2) were mated by mass spawning. Parents pooled in a maturation tank (MT) were thermally stimulated to spawn. Females emitting eggs were transferred after their cleaning in a spawning tank (SP) and aliquots of water and sperm from the MT tank were regularly added in the SP tank for fertilization, the duration between 1st male emission and the last spawn being less than 45'. Juveniles transferred in the lagoon were collected and phenotyped for growth and morphology in last summer 2022 and genotyped. After filtration, 1969 SNP were selected and used for DNA parentage assignment in using APIS genetic software.

Our main results show that the estimated inbreeding coefficient *F* when cumulating data from the two cohorts will increase by 2.05% per generation if the pedigree is unknown (*Ne* = 24.4) but only of 1.09% if the pedigree is traced by DNA parentage assignment (*Ne* = 46) (Figure 1). It is concluded that at least 4 cohorts per generation (*Ne* = 92 et *F* = -0,54 %) would be needed when using DNA parentage assignment and 8 cohorts if pedigree is unknown (*Ne* = 98 et *F* = -0,51 %) to match FAO's international recommendations to manage inbreeding in livestock.

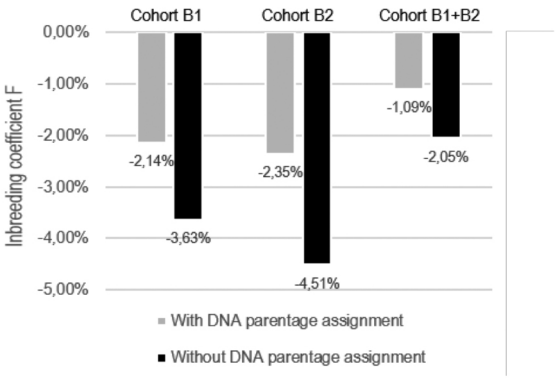


FIGURE 1. Estimated increase of coefficient of inbreeding (*F*) in the two studied cohorts with or without pedigree parentage assignment to manage genetic variability.

NOVEL WATER TREATMENT FOR PATHOGENS USING COTTON COATED ANTIMICROBIAL PEPTIDE

Glendon Teo* , Yu Jie Ong and Daiwen Yang

Centre for Aquaculture & Veterinary Science
School of Applied Science, Temasek Polytechnic
21 Temasek Ave 1
Singapore 529757, Singapore

Antibiotics or chemicals such as bleach are used for water treatments to remove potential pathogens in aquaculture reservoirs or holding tanks. Antibiotic or chemicals run offs are an ecological and environmental problem, resulting in antibiotic resistant bacteria or chemical buildups in marine ecosystems. Furthermore, antibiotics or chemical treatments can be costly in the long run. A antimicrobial peptide synthesized to kill bacteria while not harming seafood or food fish that could be coated on filter floss or sponges is a novel solution that could eliminate pathogens, while not harming the environment. Furthermore, this method of treating water could be more sustainable as the sponge is reusable for farmers to a certain extent before replacement.

Novel peptide E poly lysine was provided by Professor Yang Daiwen by National University of Singapore. The antimicrobial efficacy was of two pathogens: *Salmonella spp*. and *Vibrio harveyi*. E poly lysine coated cottons were also exposed to 10L quarantine tanks via a hang on back filter with the two pathogens introduced into the water system for 24 hours. Pathogen detection was analyzed via PCR and agar spread plating. 1 month old tilapia fry were then added to the different quarantine tanks and left for 14 days for observation. The survival rate and water quality were recorded after the 14 days. Finally metagenomics sequencing of the water was performed to analyzed the microbiome diversity of the treatment groups exposed to the peptide coated cotton.

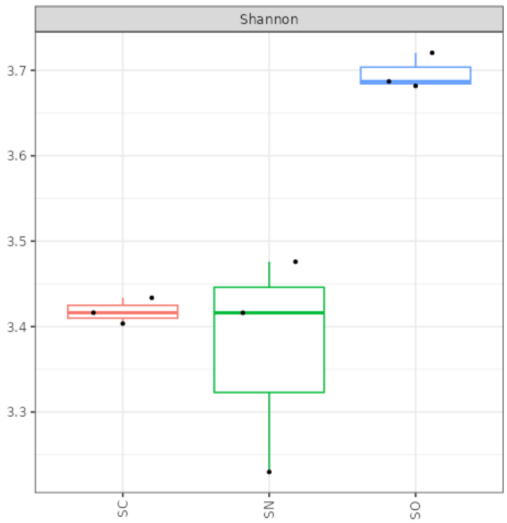
Preliminary results show the peptide MIC and MBC for *Salmonella spp*. and *Vibrio harveyi* were comparable to previous studies using *E. coli*.

Metagenomics sequencing also noted that the bacteria biodiversity of the tanks exposed to the peptide have the least diverse bacterial diversity, hypothesizing that the peptide is unbiased in removing bacteria regardless pathogen or not.

Table 1: MIC and MBC of the pathogens exposed

Pathogen	MIC	MBC
Salmonella spp.	120ppm	120ppm
Vibrio harveyi	60ppm	75ppm
E. coli (Hyldgaard *et al, 2014)*	75ppm	75ppm

Table 2: Alpha diversity of bacteria for water samples exposed to different stages of peptide



REVOLUTIONARY AQUACULTURE PATHOGEN DETECTION, DIET OPTIMIZATION, SELECTIVE BREEDING, IN AQUACULTURE USING BIOMARK™ X9 SYSTEM AND IFC TECHNOLOGY

Ganesh Babu, Ph.D.

Standard BioTools, Singapore
Ganesh.babu@standadrdbio.com

Abstract

In aquaculture, pathogen detection, diet optimization and selective breeding may employ Real time PCR and Targeted Next-Generation Sequencing (NGS) workflows. These conventional methods pose limitations on productivity and cost-effectiveness. The Biomark ™ X9, an advanced benchtop platform employing microfluidics technology, substantially elevates throughput in Real time PCR and NGS library preparation. With an impressive capacity to process up to 9216 reactions per run, it accommodates diverse assay configurations, including 96 samples against 96 targets and 192 samples against 24 targets. This feature significantly enhances scalability and cost-efficiency while necessitating minimal manual intervention. X9 offers ground-breaking prospects for the aquaculture industry, and we propose various workflows demonstrating how it can revolutionize the industry.

Aquaculture pathogen detection

X9 offers a unique capability to simultaneously analyze up to 96 aquaculture pathogens in a single run, representing a significant advancement over traditional real-time PCR methods limited to a multiplexing capacity of only 5 targets and typically require sequential testing based on initial findings.

The high throughput, multiplexing approach of X9's comprehensive screening ability not only accelerates the process but also substantially reduces resource usage. Moreover, it dramatically lowers the cost per test, making it significantly more cost-effective than conventional qPCR methods.

Diet optimization

A specialized IFC PCR array can be designed to gain insights into the effects of diet and supplements on essential biological processes, thereby enhancing feed efficiency and growth. This array outperforms traditional RT-qPCR methods in efficiency, providing a swift means to evaluate how different diets, supplements, and environmental conditions impact fish culture.

Selective Breeding

SNP genotyping is widely utilized in animal breeding to identify specific traits. The X9 system, offering medium multiplexing (ranging from tens to hundreds of SNPs), ensures high throughput, exceptional call rates, and accuracy, at an affordable cost. This combination makes it an ideal choice for genotyping a vast number of samples in selective breeding programs.

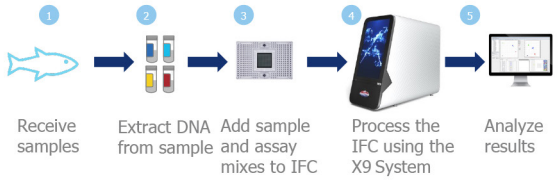
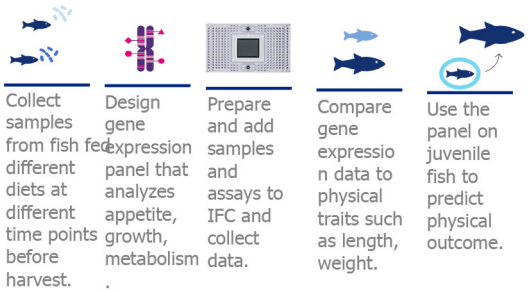
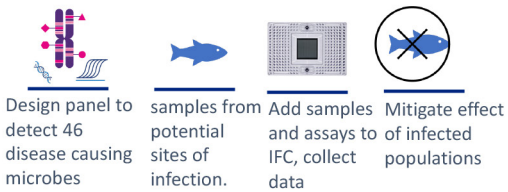
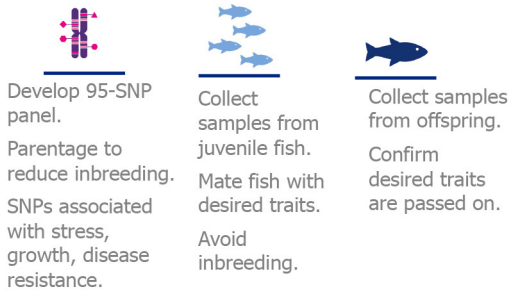


Figure 1: X9™ system, and aquaculture







PATHOGENICITY OF RSIV-II and ISKNV-I and CROSS PROTECTION EFFICACY OF RSIV-II VACCINE AGAINST ISKNV-I IN GIANT GROUPER *Epinephelus lanceolatus*

Kittipong Thanasaksiri*, Chiho Taniguchi, Sumire Mitarai, Kohei Fukuda, Bambang Hanggono, Ujang Komarudin Asdani Kartamiharja

Advanced Technology Development Center
Kyoritsu Seiyaku Corporation
Takamihara, Tsukuba, Ibaraki
Japan
*kittipong.thanasaksiri@kyoritsuseiyaku.com

Giant grouper is one of the main marine cultured fish species in several Asian countries. In Indonesia, an outbreak of RSIV and ISKNV has been reported in farmed groupers. Here, we investigated the pathogenicity of RSIV genotype II (RSIV-II) and ISKNV genotype I (ISKNV-I) in giant grouper *Epinephelus lanceolatus*. Evaluation of cross-protective efficacy of inactivated RSIV-II vaccine against ISKNV-I was also studied. Infectivity tests showed that both RSIV-II and ISKNV-I caused 100% mortalities in 16.5 g fish by either intraperitoneal or intramuscular injections at a dose of $10^{2.5}$ $TCID_{50}$/fish. Intramuscular injection of 200 g fish with ISKNV-I at the same infectious dose induced 60% mortality. In the efficacy trials, 8 g fish intramuscularly vaccinated with PISCIVAC™ Irido Si, an inactivated non-adjuvanted bivalent vaccine containing RSIV-II and *Streptococcus iniae* antigens, had 100% and 80% survival rates at 14 days post vaccination (dpv) after challenge with ISKNV-I at doses of $10^{-0.5}$ or $10^{1.5}$ $TCID_{50}$/fish, respectively. The vaccine could also provide significant protection (100% survival rate) against challenge with $10^{3.5}$ $TCID_{50}$/fish of ISKNV-I in 37 g fish at 28 dpv. These results indicate that giant grouper is highly susceptible to RSIV-II and ISKNV-I, and inactivated RSIV-II vaccine can effectively protect giant grouper against ISKNV-I infection.

EVALUATION OF *Schizochytrium* SP. AS A NUTRITIONAL ENRICHMENT SOURCE FOR ROTIFER AND ARTEMIA ON THE GROWTH AND IMMUNITY OF PACIFIC WHITE SHRIMP (*Penaeus vannamei*)

Kasun Tharaka*, Hyunwoon Lim, Suhyeok Kim, Yeonji Lee, Youngmi Lee, Kookjin Cho and Kyeong-Jun Lee

Department of Marine Life Sciences
Jeju National University
Jeju 63243, South Korea
kasuntj@stu.jejunu.ac.kr

Schizochytrium sp. (Sch), as a microalgae, has attracted considerable attention as a feed ingredient or additive due to its high lipid and DHA levels. This study was performed to investigate the effect of feeding Sch-enriched *Brachionus rotundiformis* (Exp-1) and *Artemia nauplii* (Exp-2) on the growth and immunity of the Pacific white shrimp. For Exp-1, a non-enriched *Brachionus rotundiformis* control group (Con) and four other rotifer groups enriched with Sch, Sch+0.1% taurine, Sch+0.1% inosine monophosphate (IMP) and *chlorella* powder (designated as Sch, SchT, SchI and CP, respectively) were used. Four replicate groups of early-larval stage shrimp (body length: 0.67±0.03 mm) fed one of the diets three times a day for 9 days. At the end of the trial, final length, length gain, survival, the expression of LGBP1 (lipopolysaccharide and □-1,3-glucan-binding protein) and penaeidin-3a genes were significantly improved in shrimp fed Sch, SchI and SchT diets compared to those fed Con and CP diets (P<0.05). Lysozyme and crustin gene expressions were significantly upregulated in all the enriched groups compared to the Con group (P<0.05). Based on Exp-1 results, the growth performance, survival and immune responses of the early-larval shrimp can be improved by feeding Sch-enriched rotifer and its utilization could be increased by adding taurine or IMP. For Exp-2, a non-enriched *Artemia nauplii* control group and four other *Artemia nauplii* groups enriched with the same Sch, SchT, SchI and CP were used. Four replicate groups of post-larvae shrimp (Body length: 9.12±0.38 mm) fed one of the diets three times a day for 12 days. Final body weight and weight gain were significantly higher in Sch groups than in Con group (P<0.05). Length gain and gene expression of crustin and LGBP1 were significantly increased in SchT and SchI groups than in Con and CP groups (P<0.05). Lysozyme gene expression was significantly upregulated in SchT group than in Con and CP groups (P<0.05). Gene expression of penaeidin-3a was significantly upregulated in SchI group than in Con and CP groups (P<0.05). Based on Exp-2 results, the findings indicate that feeding Sch-enriched *Artemia nauplii* could promote the growth and non-specific immunity of Pacific white shrimp post-larvae.

INTEGRATED AQUACULTURE OF THE SEA CUCUMBER SANDFISH (*Holothuria scabra*) WITH SNUBNOSE POMPANO (*Trachinotus blochii*) FOR INCREASED PRODUCTION AND NUTRIENT RECYCLING

Mai Nhu Thuy*, Quang Dai Thanh Phuong, Nguyen Dinh Quang Duy, Monal M. Lal, Paul C. Southgate

Department of Fisheries Biology
Institute of Aquaculture
Nha Trang University
Nha Trang, Khánh Hòa, Vietnam
thuymn@ntu.edu.vn

Snubnose pompano *Trachinotus blochii*, and the sandfish *Holothuria (Metriatyla) scabra*, are a high-value marine finfish and sea cucumber, respectively, both with Indo-Pacific distributions. The potential for integration of sandfish and snubnose pompano culture was assessed in two experiments in Vietnam, due to the bioremediation and nutrient cycling capabilities of the former. Experiment 1 examined the effect of varying pompano:sandfish stocking density ratios (1:0.5, 1:1, 1:1.5 and pompano monoculture control) on growth, survival and sediment quality (measured by Total Organic Matter: TOM and Sediment Total Nitrogen: STN content) over 75 days in concrete tanks. Experiment 2 applied the best density (1:1) determined from Experiment 1 to commercial-scale co-culture in 2×500 m^2 earthen ponds over 8 months. Mean pompano weight gain during Experiment 1 was 11.9% higher on average in co-culture across all treatments (70.49±5.15 g cf. control: 59.67±4.81 g), while sandfish performed better (11.6 % increase) at density ratios of 1:0.5 and 1:1. Survival remained high (>91%) in all treatments. Absolute growth rates were 14.9% higher in co-culture for pompano, whereas fastest sandfish growth occurred at density ratios of 1:0.5 and 1:1 (10.3% and 11.2% higher cf. control, respectively). Sediment TOM and STN content reduced with increasing sandfish density (TOM: 55.6-46.1% and STN:62.3-34.5% lower cf. control). During Experiment 2 pompano and sandfish reached 494.5±1.83 g and 393.0±20.9 g, respectively. Specific growth rates averaged 2.16±0.02 and 1.75±0.03%/day. Sediment TOM and STN both increased over the culture period. Results demonstrate high feasibility for co-culture of these species with improved pond sediment quality, with benefits including improved productivity of mariculture systems, higher economic resilience of pompano-sandfish farmers and reduced environmental impacts arising from cleaner pond sediments and effluent water discharge.

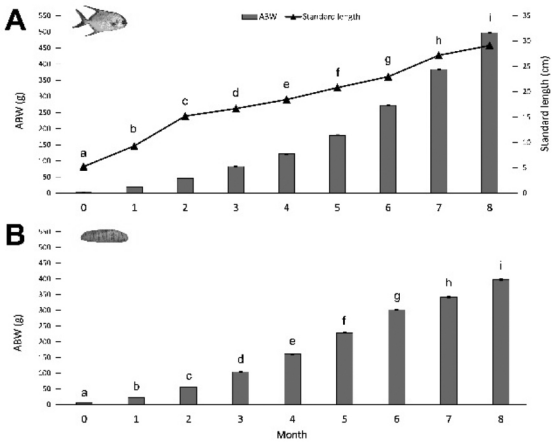


FIGURE 1. Average body weights (ABW) and standard lengths for snubnose pompano (A) and ABW for sandfish (B) during commercial-scale pond-based culture (Experiment 2). Error bars denote standard error (±SE). Superscript letters indicate significantly different ($p<0.05$) means between treatments at each time point following Tukey's HSD tests.

SOYBEAN LECITHIN SUPPLEMENTATION INCREASES THE REPLACEMENT OF SOYBEAN MEAL WITH FERMENTED COPRA MEAL IN THE DIET OF NILE TILAPIA *Oreochromis niloticus* (Linnaeus 1758) REARED IN SEAWATER

Rex Ferdinand M. Traifalgar* and Modesto Melden B. Intoy

Institute of Aquaculture
College of Fisheries and Ocean Sciences
University of the Philippines Visayas
Miagao, Iloilo, Philippines
rmtraifalgar@up.edu.ph

A 50-day feeding trial was conducted to assess the effects of dietary lecithin addition to increase the replacement of soybean meal with fermented copra meal (FCM) in the diet of a saline tolerant juvenile Nile tilapia strain, A factorial experiment was conducted comprising seven iso-nitrogenous and isolipidic diets. Two dietary levels of soybean lecithin at 0% and 3% comprises the first independent factor and soybean meal replacement levels (50%, 75 %, and 100%) with FCM as the 2nd experimental factor. Juvenile tilapia (size: 0.87 ± 0.21 g) were group into triplicate tanks per treatment with 10 fish per tank and fed the experimental diets for 50 days. Results indicate a significantly higher ($P < 0.05$) percent weight gain in Trt 6 (100% FCM, 3% lecithin) and the positive control. Results showed that the addition of 3 % dietary soybean lecithin, promoted complete replacement of soybean meal with FCM without significant reduction on feed utilization, blood biochemistry, villi length, enterocyte height, muscle fiber count, serum transaminase levels, digestive enzyme activity and fatty acid composition of the tilapia. Other parameters measured, such as protein retention, somatic indices, and recovery rate from air exposure test were not influenced by the treatment. Moreover, a substituted 100% FCM and 3% SBL diet could be considered viable FCM and lecithin replacement level for saline tolerant strain Nile tilapia juveniles.

HOLISTIC MANAGEMENT STRATEGIES FOR TRANSLUCENT POST LARVAE DISEASE (TPD) IN WHITELEG SHRIMP CULTURE

Loc Tran*, Robert Mutunga, Yin Min Thant, Phuc Hoang and Thanh Chau

ShrimpVet Laboratory (Minh Phu AquaMekong Co., LTD)
Ho Chi Minh City, Vietnam
+84-913-210-290
thuuloc@arizona.edu

Translucent Post Larvae Disease (TPD) has emerged as a significant threat to whiteleg shrimp aquaculture, with initial cases reported in China (2019) and subsequent occurrences in Vietnam (2023), as reported by the Vietnam Fisheries Department after ShrimpVet Laboratory's research showing presence of novel *Vibrio parahaemolyticus* strain in shrimp hatchery samples. TPD is characterized by a pale, translucent hepatopancreas in post-larvae stages. Following detection, the disease results in significant mortality rates exceeding 90% within 24-28 hours. Investigations have attributed TPD to a novel *Vibrio parahaemolyticus* strain, exhibiting heightened virulence and distinct from strains implicated in Acute Hepatopancreatic Necrosis Disease (AHPND). Epidemiological scrutiny of hatchery shrimp samples revealed a TPD prevalence exceeding 50%, underscoring the need for efficacious management strategies.

This study employed histopathological examination and Polymerase Chain Reaction (PCR) diagnostics to elucidate TPD pathology and inform management protocols. The advent of TPD continues to necessitate immediate intervention to avert potential industry-wide repercussions as ShrimpVet's internal research has also shown TPD can also infect whiteleg shrimp at their grow out stages.

A management protocol encompassing rigorous sanitation, probiotic deployment, and continuous pathogen surveillance has demonstrated efficacy in mitigating TPD dissemination at ShrimpVet. This protocol can help reduce cases of TPD outbreaks and significantly protecting farmers from unforeseeable huge financial losses. The ShrimpVet-devised management framework constitutes a pivotal step towards TPD prophylaxis, thereby bolstering industry fortitude and contributing to global food security. Future research is focusing on genetic analysis to understand TPD's mechanisms and develop targeted treatments. ShrimpVet is continuously investigating potential preventative measures against TPD through in-vitro and in-vivo trials.

BE A SUCCESSFUL AQUA FARMER THROUGH CARRYING CAPACITY

Henry Cuong, Julius Benaqua, Marc Campet, Pham Anh, Truong Thao

ADM Animal Nutrition
Floor 7th, Saigon Centre (Tower 1)
65 Le Loi Street
Ben Nghe Ward, District 1
Ho Chi Minh City, Vietnam
cuonghuynh.tran@adm.com

Like any other businesses, aqua farmers often ask for the maximum profitability without knowing their farm capacity and potential risks. This causes many issues including e.g. unstable performance results, and farmers do not often know the root cause of the problem in order to improve in their next cycles. To be more efficient, aqua farmers should follow four steps including (1) Gather sufficient data about their farm location (site selection, water source quality or soil, weather/season...); (2) Run the blank trial under the basic culture condition; (3) Increase your farm biomass over the years based on farming experience and technology applied (high water exchange or limited water exchange/RAS); (4) Based on experience gained, optimize farm biomass to ensure long-term sustainability of the business.

The water and soil quality degrade as culture time goes by. Keeping your soil and water at optimum condition is key to stabilize your farming business. Exceeding the capacity and limit will result in unsustainable farming practice and longer rehabilitation in the future.

DEVELOPMENT OF SUPERINTENSIVE VANAME SHRIMP FARMING AT BALAI LAYANAN USAHA PRODUKSI PERIKANAN BUDIDAYA (BLUPPB) KARAWANG

Atri Triana K*. , Agus Dwiono, Ari Prakoso, Widya Puspitasari

Balai Layanan Usaha Produksi Perikanan Budidaya (BLUPPB) Karawang
Desa Pusakajaya Utara
Kecamatan Cilebar
Kabupaten Karawang
Jawa Barat
Satker_bluppb.karawang@kkp.go.id

Vannamei shrimp is an aquaculture product that is very popular because it has quite high selling power. Efforts to increase production are often carried out either by extensification or intensification. The Aquaculture Production Business Service Center in Karawang is trying to develop superintensive vaname shrimp farming technology with an indoor system. Rearing is carried out in fiber tanks with a volume of 1,500 ltr and the initial number of shrimp is 650 (A), 520 (B), and 400 (C). The initial seeds used have an initial weight of $\pm$ 10.54 gr. Shrimp rearing was carried out for 28 days using a recirculation system and the parameters observed were the weight and survival of the shrimp as well as testing water quality as supporting parameters. The highest survival result was tank C (85%), then tank B (80%) and the lowest was tank C (78%). The high density in tank A caused high mortality at the beginning of rearing. The results of the final weight of the shrimp were not much different, namely 15.91 gr (A), 15.04 gr (B) and 15.04 gr (C). The ammonia concentration increased in the third week but returned to normal in the fourth week. The range of ammonia for each tank was 0.008-0.05 mg/L (A), 0.005-0.059 mg/L (B) and 0.002-0.041 mg/L (C). This activity is a preliminary test for development on a larger scale in the following year.

SUPPORTING THE SHRIMP INDUSTRY TO ADOPT HIGHER WELFARE PRACTICES

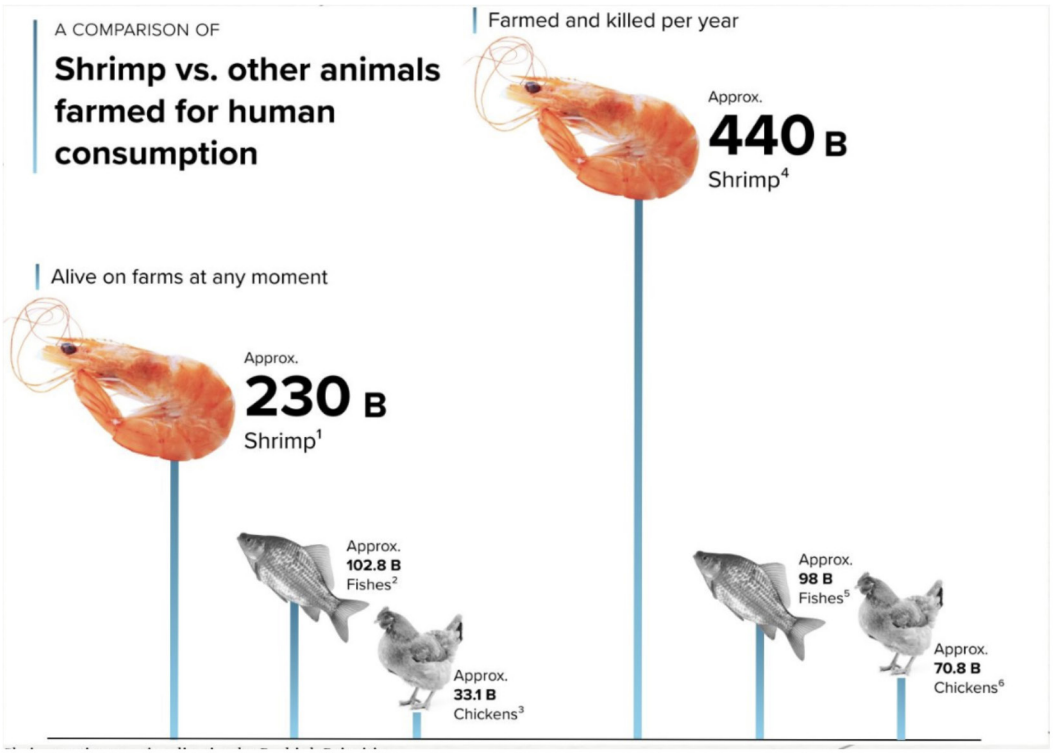
Lien-Huong Trinh*, Krzysztof Wojtas, Andrés Guillermo Jiménez Zorrilla

Shrimp Welfare Project
A 13.09 Block A Wilburn Basin
Ordsall Lane, Salford
England, M5 4XQ
lienhuong@shrimpwelfareproject.org

Shrimp sentience has been established in scientific literature and recognized in legislation in various jurisdictions. With approximately 440 billion shrimp farmed annually, shrimp is the most extensively farmed animal on the planet. However, the cultivation of shrimp often faces welfare challenges, including inhumane slaughter methods, poor water quality, overcrowded conditions, eyestalk ablation, and prevalent diseases. These issues are crucial not only for the ethical standing of aquaculture but also for its overall integrity and sustainability.

Shrimp Welfare Project is the first nonprofit exclusively focusing on improving the welfare of farmed shrimp. As a pioneering non-profit dedicated to the welfare of farmed shrimp, we work closely with farmers, retailers, and food industry stakeholders worldwide to implement welfare improvements.

This presentation will provide insights into our initiative focused on raising shrimp welfare standards through technical innovations, cooperative efforts and partnerships. By detailing how we improve farming and harvesting conditions, we aim to highlight the ethical advancements in aquaculture and underscore the importance of partnerships and progressive strategies in promoting welfare.



CONTROL OF PARASITIC DISEASES IN JAYASAKTI COMMON CARP (*Cyprinus carpio*) NURSERIES IN A CONTROLLED CONTAINER)

Eka Trisnawati*[1], Padel Purnama*[2]

*[1] Junior Fish Health and Environmental Technician,
*[2] Senior Fish Health and Environmental Technician at Jambi Freshwater Aquaculture Development Centre (JFADC)
https://kkp.go.id/djpb/bpbatjambi

Jayasakti common carp (*Cyprinus carpio*) is a local variant of common carp produced by Jambi Freshwater Aquaculture Development Centre (JFADC), this variety has been widely accepted by people on the island of Sumatra. Jayasakti common carp nursery activities are often conducted in the local community and in small hatcheries using extensive facilities, especially during rearing phase of nursery larvae. In open ponds / containers care fish disease problems are often occurred, besides that it requires a large area of land. To optimized land area and water resources efficiently, the larval rearing of Jayasakti common carp larvae conducted in a controlled container with round tub shape from water resistance tarpaulin.

This rearing system is an alternative nursery for common carp larvae with controlled fish health management. Rearing activities using controlled containers are conducted to suppress fish disease attacks. The diseases always had a negative impact for the production of Jayasakti common carp at Jambi Freshwater Aquaculture Development Centre (JFADC) are parasitic pathogens, it often encountered when rearing activities are carried out both in open ponds or public waters. The use of controlled tanks will make it easier to implement fish and environmental health management. By using the controlled tank, the parasitic diseases will be easier to control, if it left unchecked, will open up opportunities for secondary infections. Rearing activities are conducted on a round tarpaulin tub recirculation system (10 tons volume), with 3 different density levels. B1: 100,000 fish, B2: 150,000 fish and B3: 200,000 fish. The test fish used in this activity were Jayasakti common carp larvae that were 1 day old from hatching with a weight of between 0.06 ± 0.015 gr which were reared in round tanks for one month with given natural and artificial food for 3 times a day. Fish are sampled every week to measure the length and weight of larvae, then fish diseases is monitored periodically. Disease control activities are counducted by giving commercial probiotics in a container (dose 1 ppm) and using salt (dose 1 ppt). Larvae were sampled are collected for statistical analysis.

The test results showed that nursery of Jayasakti carp larvae in B1 provided 50% survival (50,000 individuals) for 30 days, better than treatments of B2 and B3. The health status of the fish that attacked the disease was relatively low in B1 tank, with moderate ectoparasite attacks (prevalence 45.55-68.45%) and moderate intensity (50.35-72.25 parasite/fish) during rearing period.

PHARMACOKINETIC AND TISSUE DISTRIBUTION OF SINGLE ORAL DOSE ENROFLOXACIN IN NILE TILAPIA (*Oreochromis niloticus*)

Ezra Yuni Tyastutiningsih , Yasinthya Inggariyanti*, Siti Mutho Mimah**

* Center For Fish Health And Environmental Assessment
**Department of Fish and Marine, Faculty of Agriculture
Lampung University
Jurusan Perikanan dan Kelautan Fakultas Pertanian Universitas Lampung
yuniatuti@gmail.com

The pharmacokinetic of a drug describes a changes concentration of a drug per unit of time after a following medication of a specific dose of the drug, resulting from four kinetic processes: absorption, distribution, metabolism, and elimination. The pharmacokinetic and tissue distribution of Enrofloxacin were investigated in Nile tilapia (Oreochromis niloticus) following oral administration of a single dose of 12.5 mg/kg body weight (mixed with feed). Plasma and tissue samples, including liver and muscle, were collected at predetermined time points (0.25, 0.5, 1, 2, 4, 8, 12,16, 24 hours post-dosing). Enrofloxacin concentrations were determined using High Performance Liquid Chromatography (HPLC). The maximum concentrations (Cmax) in plasma, liver, and muscle were 1.1527, 19.7427, and 4.3230 µg/ml, respectively, with corresponding times to reach these concentrations (Tmax) of 4, 8, 8 hours, these results indicate widespread distribution of Enrofloxacin in tissues. After oral medication, Enrofloxacin concentrations in plasma and tissues were above the Minimum Inhibitory Concentration (MIC) for Aeromonas hydrophilla bacteria isolated from Nile tilapia (MIC = 0.060 mg/L). Based on Pharmacokinetic/Pharmacodynamic (PK/PD) index calculations for fluoroquinolone antibiotics using AUC/MIC or Cmax/MIC ratios, the Enrofloxacin regimen of 12.5 mg/kg body weight exhibited a positive therapeutic effect against Aeromonas hydrophilla infection.

PHARMACOKINETIC AND TISSUE DISTRIBUTION OF SINGLE ORAL DOSE ENROFLOXACIN IN NILE TILAPIA (*Oreochromis niloticus*)

Ezra Yuni Tyastutiningsih , Yasinthya Inggariyanti*, Siti Mutho Mimah**

* Center For Fish Health And Environmental Assessment
**Department of Fish and Marine, Faculty of Agriculture, Lampung University Jurusan Perikanan dan Kelautan Fakultas Pertanian Universitas Lampung
yuniatuti@gmail.com

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BEHAVIORAL CHANGES AND GILL HISTOPATHOLOGICAL ALTERATIONS OF RED HYBRID TILAPIA (*Oreochromis* sp.) EXPOSED TO GLYPHOSATE HERBICIDE

Abubakar Muhammad Umar*, Nur Adeela Yasid, Hassan Mohd Daud and Mohd Yunus Abd Shukor

Department of Biological Sciences
Faculty of Science
Gombe State University
Gombe, Nigeria
muabubakar@gsu.edu.ng

A 49 days experiment was conducted under laboratory condition to ascertain the effects of technical grade glyphosate on behaviour and histopathological conditions in the gills of red hybrid tilapia using light inverted microscope. Air gasping, erratic swimming, fin movement, mucus secretion, hemorrhages and loss of scales were observed in the exposed fish. There was no any histopathological complication observed in the gill of the control fish, but various level of alterations were seen in the gills of the fish exposed to glyphosate herbicide. These include lifting of primary lamella, congestion of secondary lamella as well as hyperplasia in both primary and secondary gill lamella and hypertrophy of secondary gill lamella. Based on the findings of this study, glyphosate herbicide exerts behavioural and histopathological changes in the gill of red hybrid tilapia, and therefore the fish is considered as good bioindicator in aquatic environment monitoring.

The lethal concentration (LC_{50}) was determined and found to be 215 mg/L, the mean water quality parameters were temperature, 26-29°C, dissolved oxygen, 5.3-9.3 mg/L, and pH, 6.5-7.3 respectively. Three (3) concentrations of glyphosate were prepared for the purpose of the experiment (0, 50, and 150 mg/L). Behavioral changes was constantly recorded at daily basis. At the end of exposure period, the gill of the fish was removed and prepared for histopathological evaluation using light inverted microscopy.

The outcome of the study revealed various behavioural changes such as air gasping, erratic swimming, fin movement, mucus secretion, hemorrhages and loss of scales were observed. There were also many histopathological alterations in the gills of the fish. There was no histopathological changes observed in the gill of the control fish (**Figure 1A**). Fish exposure to glyphosate concentration of 50 mg/L caused the lifting of primary and congestion of the secondary gill lamellae (**Figure 1B**). A further increase in glyphosate concentration to 150 mg/L resulted in hyperplasia and hypertrophy of primary and secondary gill lamella and vacuolation of the secondary gill lamellae (**Figure 1C**).

Table 1: Behavioral and physical changes of red hybrid tilapia due to glyphosate exposure

Behavioral and physical observation	Glyphosate concentration (mg/L)		
	0	50	150
Air gasping	-	+	+++
Erratic swimming	-	++	++
Fin movement	-	+	++
Mucus secretion	-	-	++
Hemorrhages	-	-	++
Loss of scale	-	-	+

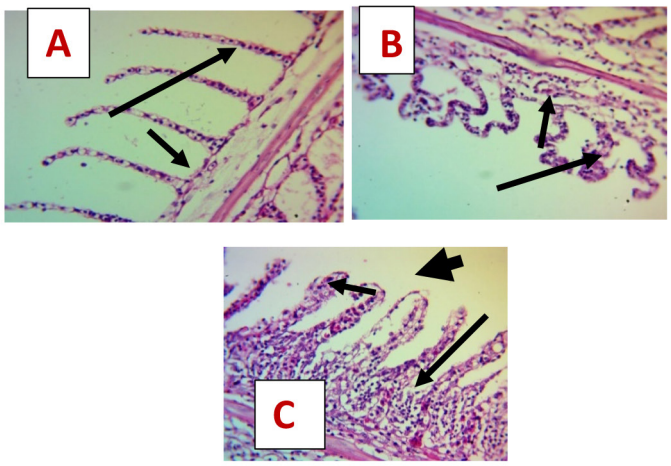


Figure 1: Micrograph of red hybrid tilapia gills exposed to glyphosate herbicide (H & E stain, 400x, scale bar=100 µm). Control group (A), fish exposed to 50 mg/L (B) and Fish exposed to 150 mg/L (C).

GROWTH PERFORMANCE OF THE SANDFISH *Holothuria Scabra* (JAEGER 1833) IN A COMMUNITY-MANAGED NURSERY SYSTEM IN NORTHERN MINDANAO, PHILIPPINES

Wilfredo H. Uy[1,2], Anabelle Dece Espadero[1,2] and Hanzel Honghong[2]

[1] College of Marine and Allied Sciences, Mindanao State University at Naawan, Poblacion, 9023 Naawan, Misamis Oriental, Philippines
[2] Sea Cucumber R&D Center, MSU Naawan, 9023 Naawan, Misamis Oriental, Philippines

Email: Wilfredo.uy@msunaawan.edu.ph

Sea cucumbers are marine invertebrates that can be found in many parts of the world; from the shallow or to the deep regions, and even from the tropics to the Antarctic. Not only are sea cucumbers good for the environment, they are also believed to heal wounds, reduce pain, rejuvenate the skin, and used as an aphrodisiac as well as traditional food tonic in China, Korea and Taiwan for thousands of years. One of the most commercially important sea cucumbers is the sandfish or scientifically known as *Holothria scabra*, locally known as *balat kagisan*. Sandfish enters the international market in processed form known as *beche-de-mer* or *trepang*. Due to overharvesting, its natural stocks have depleted significantly which in turn poses a threat to marine biodiversity, human livelihood and economy. To combat this, efforts in cost-effective sandfish production, such as setting up ocean nurseries are being explored with the local coastal community to be used as intermediates between hatchery production and grow out. This study was conducted in 3 pilot sites in Northern Mindanao to assess growth performance and suitability of growing sandfish in a community-managed ocean nursery system.

THE EFFECT OF DIFFERENT DIETARY SELENIUM SOURCES ON GROWTH PERFORMANCE AND DISEASE RESISTANCE IN WHITE LEG SHRIMP

V. Vandendriessche*, F. Atienza, J. Giovanni, O. Jintasataporn, J. Van Soest

Vandendriessche@orffa.com
Orffa Additives BV
Minervum 7032
4817 ZL Breda, The Netherlands

Shrimp aquaculture has experienced decades of exponential growth, and the expectation is that this growth will continue in the coming years. However, because of the increased intensity and volume of production, challenges arise for the sector to maintain this steady growth. For example, the increased disease pressure is endangering shrimp farming practices. Whilst in the past a lot of antibiotics were used to tackle diseases, the increasing concerns of antimicrobial resistance created a need to develop alternatives. One viable way to improve disease resilience of shrimp is by supplementing the diet with additives that can improve the overall health status of animals. Selenium is an important component of the diet and can play a vital role in the antioxidant and immune system. However, knowledge about the inclusion levels and the effect of different sources is still limited in shrimp aquaculture. The goal of this experiment was to evaluate the efficacy of different selenium sources on growth performance, feed efficiency and disease resistance against a *Vibrio parahaemolyticus* challenge.

Shrimp were fed three different diets; 1. Control diet, without any added selenium; 2. Diet SS, control diet + 0.5 ppm selenium from sodium selenite, 3. Diet SM, control diet + 0.5 ppm selenium from L-selenomethionine (Excential Selenium 4000, Orffa Additives BV). During the 8-week feeding trial, the fish were analyzed for growth performance and feed efficiency every fortnight. Additionally, immune and antioxidant parameters were measured after 8 weeks of feeding, and at the same time, the *Vibrio* count in the hepatopancreas and intestine was measured. After the feeding trial, the shrimp were challenged with *Vibrio parahaemolyticus*. Over the next 15 days, the shrimp were monitored and mortalities were determined. At the end of this challenge period (d15), immune-and antioxidant parameters, as well as *Vibrio* count, were determined. All parameters were statistically compared by one way ANOVAs.

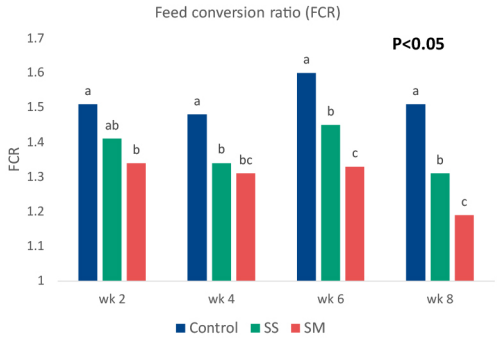


Figure 1: FCR of shrimp fed different sources of selenium.

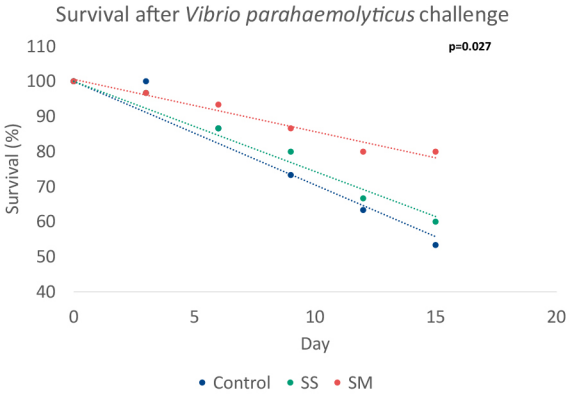


Figure 2: Survival of shrimp fed different sources of selenium after a challenge with *V. parahaemolyticus*

Growth performance was significantly improved (P<0.05) by inclusion of L-selenomethionine but not sodium selenite. Both sources of selenium significantly improved the FCR of white leg shrimp (P<0.05) with organic selenium, in the form of L-selenomethionine, leading to significantly lower FCR compared to sodium selenite (Figure 1).

Selenium, regardless of the source, improved the immune and antioxidant capacity of white leg shrimp. L-selenomethionine in the diet was shown to significantly reduce the *Vibrio* count in the shrimp (P<0.05), whilst sodium selenite did not. Survival rate after the challenge was significantly higher for shrimp receiving the L-selenomethionine addition (P=0.027) compared to control and sodium selenite addition (Figure 2).

In conclusion, the addition of selenium can be beneficial for shrimp growth performance, feed efficiency and health. However, it is important to pick the right, organic source. In this experiment. L-selenomethionine is shown to be significantly more efficient compared to sodium selenite.

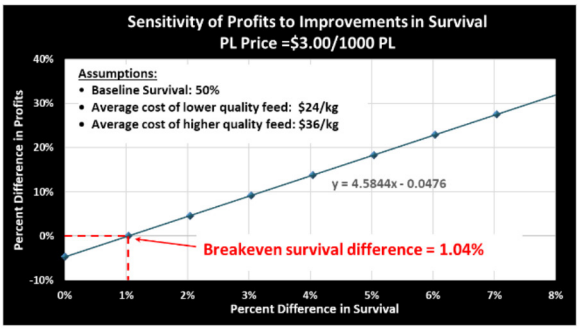
ARE HIGH-QUALITY HATCHERY FEEDS STILL A GOOD VALUE IN AN ERA OF HISTORICALLY LOW PL PRICES?

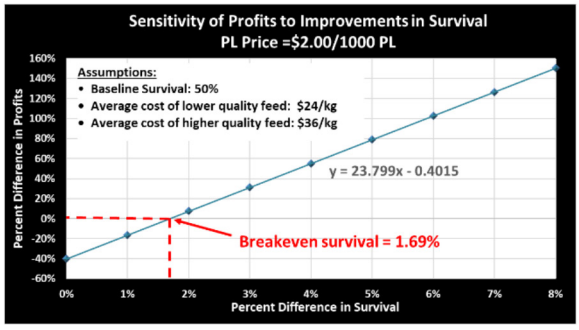
Peter M. Van Wyk

Zeigler Bros. Inc.
400 Gardners Station Rd.
Gardners, PA 17324
peter.vanwyk@zeiglerfeed.com

In 2022 and 2023, global farmed shrimp prices dropped to near historic lows due to high inventories of frozen shrimp, overproduction, and weak demand in key markets. Shrinking margins forced shrimp hatchery managers to cut costs in an effort to remain profitable. With feed costs representing a significant portion of overall production expenses, many producers switched from high-quality, expensive feeds to cheaper, lower-quality alternatives. However, this raises the question: Is substituting cheap, low-quality feeds for expensive, high-quality feeds a wise strategy for maximizing profits during price slumps? To answer this, an economic model was used to evaluate the sensitivity of hatchery profits to feed price and survival.

Shrimp postlarvae prices ($/1000 PL) are based on numbers rather than weight. In the short term, PL producers are not penalized for selling undersized PLs. This tempts hatchery managers to replace higher-cost feeds that support higher growth rates and improved PL vigor with lower-cost, lower quality feeds. However, lower quality feeds negatively impact PL survival and growth and undersized PLs perform poorly on the farms and are less tolerant of environmental and disease challenges. An economic model was used to study the impact of feed price and survival on shrimp hatchery profitability under two PL price scenarios ($3.00/1000 PL and $2.00/1000 PL). The model compared the profitability of a hatchery using lower-cost feeds ($25/kg) to that of a hatchery using higher-cost feeds ($35/kg), with improvements in survival associated with the use of the more expensive high-quality feed ranging from 0% to 8%. When PL prices were $3.00/1000 PL, only a 1.04% improvement in survival was needed to cover the difference in feed price, and profits increased by 4.6% for each 1% improvement in survival. When the price received for PLs was reduced to $2.00/1000, a 1.69% improvement in survival was required to break even, while profits increased by 23.8% for each 1% improvement in survival. This demonstrates that when margins are low, investing in quality feeds to improve survival is more important than ever.





JURISDICTIONAL JOURNEYS: LEGAL CHALLENGES AND OPPORTUNITIES IN TRANSBOUNDARY AQUACULTURE MANAGEMENT

Abhiniti Vats*

School of Law, CHRIST (Deemed to be University)
Bangalore, India
*abhinitivats01@gmail.com

Transboundary aquaculture, spanning across multiple jurisdictions, presents a myriad of legal challenges and opportunities in its management. This study delves into the intricate legal landscapes governing transboundary aquaculture, examining jurisdictional issues, cooperative frameworks, and dispute resolution mechanisms.

Drawing on empirical data from a comprehensive global survey of aquaculture regulatory frameworks across 50 countries, this research quantifies the prevalence of transboundary aquaculture ventures and identifies key legal challenges faced by stakeholders. The survey revealed that 78% of countries surveyed reported involvement in transboundary aquaculture activities, indicating the widespread nature of cross-border aquaculture initiatives.

Analysis of cooperative frameworks demonstrates varying degrees of institutionalization and effectiveness, with only 42% of countries having formal agreements or mechanisms for transboundary aquaculture management. Moreover, the study highlights disparities in regulatory approaches, with 62% of surveyed countries reporting challenges related to conflicting regulations and jurisdictional disputes.

This research identifies best practices and opportunities for enhancing transboundary aquaculture governance through case studies and comparative analysis. Utilizing regression analysis, we assess the impact of cooperative agreements on production levels and environmental outcomes, revealing a significant positive correlation between formalized cooperation mechanisms and aquaculture productivity. Furthermore, the study explores the role of international law and institutions in facilitating transboundary aquaculture management, emphasizing the need for harmonized legal frameworks and enhanced cooperation mechanisms. Leveraging stakeholder perspectives and expert interviews, this research offers actionable recommendations for policymakers, practitioners, and international organizations to address legal challenges and capitalize on opportunities in transboundary aquaculture management.

Data Point	Percentage/Statistic	Example/Context
Prevalence of Transboundary Aquaculture Ventures	78%	In Southeast Asia, the Mekong River Delta hosts numerous transboundary aquaculture operations, spanning Cambodia, Laos, Thailand, and Vietnam.
Formal Agreements or Mechanisms for Transboundary Aquaculture Management	42%	The European Union has formal agreements under the Common Fisheries Policy to regulate transboundary aquaculture in shared waters, like the North Sea and the Mediterranean.
Challenges Related to Conflicting Regulations and Jurisdictional Disputes	62%	Overlapping territorial claims in the South China Sea create jurisdictional disputes, complicating regulatory efforts for transboundary aquaculture between countries like China, Vietnam, and the Philippines.
Impact of Cooperative Agreements on Production Levels and Environmental Outcomes	Significant positive correlation	Norway and Sweden's bilateral agreement on salmon farming in shared fjords has boosted production and improved environmental management, fostering healthier ecosystems.

AQUAGUARD, A PLATFORM TECHNOLOGY FOR SUSTAINABLE DISEASE MANAGEMENT IN AQUACULTURE

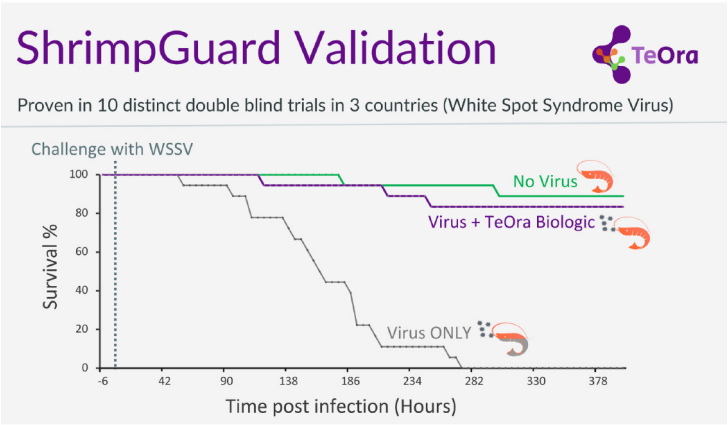
Konstantinos Vavitsas, Suruchi Sharma, Abhijith E K, Rishita Changede

TeOra Private Limited
79 Ayer Rajah Crescent
05-03, Singapore 139955, Singapore
kostas.vavitsas@teora.life

One in three calories in aquaculture are lost to disease. However, disease management solutions in hatcheries and farms are limited, where limited vaccination, antibiotics, pesticides, and biological control remain unable to prevent losses that can reach up to 90% of the grown fish or shrimp. TeOra aims to revolutionize disease management in aquaculture, using cutting-edge synthetic biology and bioinformatics. Our programmable platform can biomanufacture prophylactic and therapeutic solutions, customized to individual disease for multiple fishes and shrimps. We offer a solution that is easy to store, simple in use, and cost-competitive.

TeOra's technology has been previously validated in shrimps, targeting the White Spot Syndrome Virus. We have delivered the prophylactic peptides to shrimps in animal challenge trials and have observed an increase in survival from 0% in untreated shrimps to 83% in treated shrimps. The trials also confirmed the safety of our product in shrimps (no adverse health effects, no weight loss). We also have a product pipeline to address other shrimp and fish diseases.

We aim our products bring cutting edge biotechnology to managing disease challenges with a wide spectrum of customizable solutions. Our solutions are natural, sustainable and safe, with which, we aim to replace/reduce harmful chemicals. We envision a more sustainable aquaculture and TeOra an integral part of this success story.



ORAL DELIVERY OF A VACCINE AGAINST STREPTOCOCCISIS IN NILE TILAPIA

Regis Vialle[1]*, Sarah Kharief[2], Juliette Ben Arous[2], Nicolas Versillé[3], Eakapol Wangkahart[4]

[1] Seppic Singapore
No.2 Venture Drive - #22-28 Vision Exchange
608526 Singapore
Email: Regis.Vialle@airliquide.com

The injection route is the most common method used for the administration of commercial vaccines but it presents some drawbacks; it is time consuming, requires qualified personnel and may induce local reactions at the injection site. Mucosal vaccination is a good alternative and allows to develop local immunity in order to protect against infectious diseases. Oral administration of vaccines is particularly suitable for protection of breedings with high density of animals like in fish farming. The main challenge linked with this route of administration is to preserve the integrity of the antigen from the harsh environment created by the digestive system to reach gut associated lymphoid tissue (GALT) in order to induce a potent local immune response. This issue could be gotten around by using an adapted adjuvant.

The Montanide™ GR 01 (GRA) adjuvant tested here is able to provide a matrix protecting the antigen from gastric-route. A first study in tilapia was performed on a *Streptococcus agalactiae* vaccine formulated with GRA adjuvant and mixed at 2% or 20% with feeding pellets. The tilapia were orally vaccinated under 2 periods one week apart as follows : first, during 4 consecutive days, then during 3 other days. Each vaccine group was constituted with 3 replicates of 40 tilapia. At D49, the tilapia were challenged with *S. agalactiae* serotype III by intraperitoneal route. The protective rate of GRA groups has reached 91.1% and 88.9% for vaccines formulated at 2% and 20% respectively while it was only 73.3% in the control group (vaccination with non-formulated antigen).

A second study was conducted at a larger scale on 9000 fishes in farming standard conditions to evaluate vaccine potential. The tilapia were orally vaccinated with *Streptococcus agalactiae* vaccine, whether with antigen alone or formulated with the Montanide™ GR 01 adjuvant and compared to an unvaccinated control group, under two 5 day-periods, 5 days apart for the priming. Oral boost was then given during a 5 day-period at day 95. Immune response of fish was followed by measuring specific IgM antibody levels at different time points (up to day 128). The use of the vaccine did not affect survival rate and appeared to improve economic performance of this fish farming. The group receiving the Montanide™ GR 01 based vaccine also showed significantly higher specific antibody titer than the non vaccinated control group from day 44.

Taken together, these results show that the Montanide™ GR 01 is well adapted for the oral administration of safe and efficient vaccines in tilapia.

SCIENTIFIC & MARKET TRENDS FOR MARINE CHITIN/CHITOSAN AND COLLAGEN VALUE CHAINS - IMPLICATIONS FOR AQUACULTURE CO-PRODUCTS VALORISATION

Helena Vieira*, Mariana Almeida, Miguel Leal, Ricardo Calado, Ana Lillebø

*CESAM - Centre for Environmental and Marine Studies
Department of Environment and Planning
University of Aveiro
Campus Universitário de Santiago
3810-193 Aveiro, Portugal

Collagen and chitin, and its derivative chitosan, stand out among the rich blue bioresources due to their unique properties and wide-ranging applications. Collagen is among the most abundant biomaterial in the animal kingdom and in marine organisms, collagen is particularly interesting due to its biocompatibility, biodegradability, and low antigenicity. These properties make marine-derived collagen a sough-after material for the biomedical, pharmaceutical, and cosmetic industries.

Chitin, a polysaccharide found in the exosqueletons of crustaceans and insects, and its derivative chitosan, are known for their biodegradability, non-toxicity, and antimicrobial properties. These characteristics render chitin and chitosan valuable in water treatment, biomedicine, and food packaging, among other uses.

In addition to their valuable features, collagen and chitin/chitosan are abundant in underutilized sources from fisheries and aquaculture, particularly non-edible parts of fish and shellfish and fisheries by-catch. The valorisation of these seafood co-products, often discarded, represent a sustainable biomass for polymer extraction that adds economic value to the seafood production sector.

The goal of this research was to assess the global trends of intellectual property (IP) associated with collagen and chitin/chitosan value chains and compare them to the trends observed in scientific peer-reviewed publications in the same topics. An evaluation of current bottlenecks and misalignments between academic research and industrial usage of these knowledge was made. A systematic review of 1215 scientific publications and scoping of 4007 patent documents that fit the scope of this study was performed. Geographical distribution of authors/applicants, biomass source and type, extraction processes and sustainability concerns and current versus expected market usage was assessed.

The results allowed drawing of guidelines to better align these stakeholders' efforts, but also pinpoint opportunities for the aquaculture sector to leverage their business into the circular biobased economy development models now flourishing worldwide.

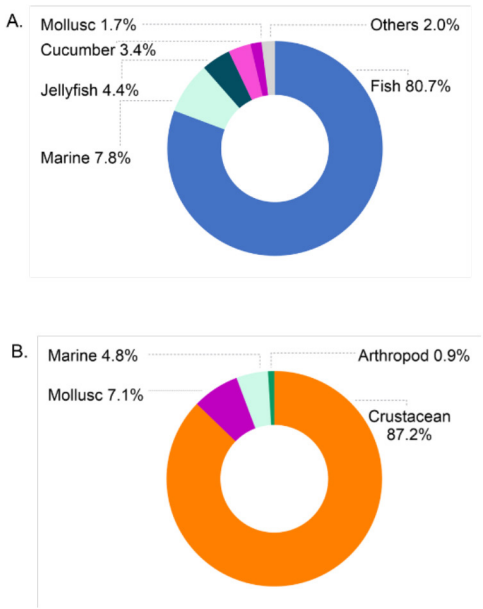


Figure 1: Biomass origin in collagen (A) and

Funded by the European Union

SANDFISH SEA RANCHING: CATALYST FOR THE RECOVERY OF SEA CUCUMBER DIVERSITY

Janine L. Villamor*, Joyce T. Laurente, and Margarita de la Torre- de la Cruz

Guiuan Development Foundation Inc.
Guiuan, Eastern Samar, 6809, Philippines
ja9villamor@gmail.com

In the 1970s, the shallow waters of Maliwaliw Island in Salcedo, Eastern Samar, Philippines host a rich sea cucumber stock. However, in the early 1990s, unregulated gathering of the resource resulted to depletion of the wild sea cucumber populations adversely affecting the livelihood of the subsistence fishers in the island. Anecdotal account from the community tells of the disappearance of commercially important species, including the high-value *Holothuria scabra* (sandfish). In 2013, a sandfish sea ranching project was implemented in an attempt to re-establish the sea cucumber population. Prior to the project implementation, a rapid survey of the area was conducted to assess the suitability of the site for sandfish sea ranching. The area was found to be almost devoid of sea cucumbers except for *Synapta* sp. Hence, this study was conducted to investigate the ecological impact of sandfish sea ranching in the nearshore waters of Maliwaliw Island. A 5-ha ranch along the south-eastern coast of Maliwaliw Island was established following a community-based sea ranch development model. In July 2023, ten years after the project implementation, sea cucumber population in the nearshore waters including a portion of the sea ranch site was reassessed. Rapid survey of the area was done during the day and night at low tide employing a zig-zag survey design to cover wide area. Crevices and rocks were hand-searched, and all sea cucumbers encountered were identified, counted, measured (length), and photographed. The time spent in gathering was recorded and the area covered was noted using a Garmin GPS unit.

The survey covering 2.7 ha. recorded a total of 507 sea cucumber individuals, belonging to five genera and 15 species (Figure and Table 1). While *Synapta sp.* still comprised the highest number of individuals, the presence of species with high commercial value were now also evident in the area.

The significant recovery in the sea cucumber population shown in this study, demonstrates the potential of sea ranching in reviving the sea cucumber biodiversity in Maliwaliw Island. Active community involvement in and support for the project are important factors for the sustainable conservation of not just sea cucumbers but also of other coastal resources.

Figure 1. Sea cucumber species encountered in Maliwaliw Island during the rapid survey conducted in July 2023. Top (L-R): *A. echinites, A. lecanora, H. albiventer, H. coluber, H. fuscocinerea, H. impatiens, H. scabra, S. maculata, Synapta sp.* Bottom (L-R): *B. mamorata, B. vitiensis, S. hermanni, S. monotuberculatus, S. naso, S. ocellatus, Stichopus sp.*

Table 1. Species count and measurement of sea cucumbers encountered in Maliwaliw Island, Eastern Samar, Philippines covering an area of 2.7 hectares during the rapid survey conducted in July 2023.

Species	Count	Average Size (cm)	Density/ha	Relative Abundance (%)
Actinopyga echinites	3	10.3	21	11.24
Actinopyga lecanora	54	6		
Bohadschia marmorata	128	11	48	25.64
Bohadschia vitiensis	2	17		
Holothuria albiventer	2	11	24	12.82
Holothuria coluber	1	41		
Holothuria fuscocinerea	44	13		
Holothuria impatiens	3	13		
Holothuria scabra	15	13		
Stichopus hermanni	2	15	14	7.50
Stichopus monotuberculatus	30	9		
Stichopus naso	2	7		
Stichopus ocellatus	1	14		
Stichopus sp.	3	14		
Synapta maculata	212	56	80	42.80
Synapta sp.	5	37		
TOTAL	**507**		**188**	**100**

THE IMPORTANCE OF THE DESIGN STEP IN SHRIMP FARM INVESTMENT AND OPERATION IN VIETNAM

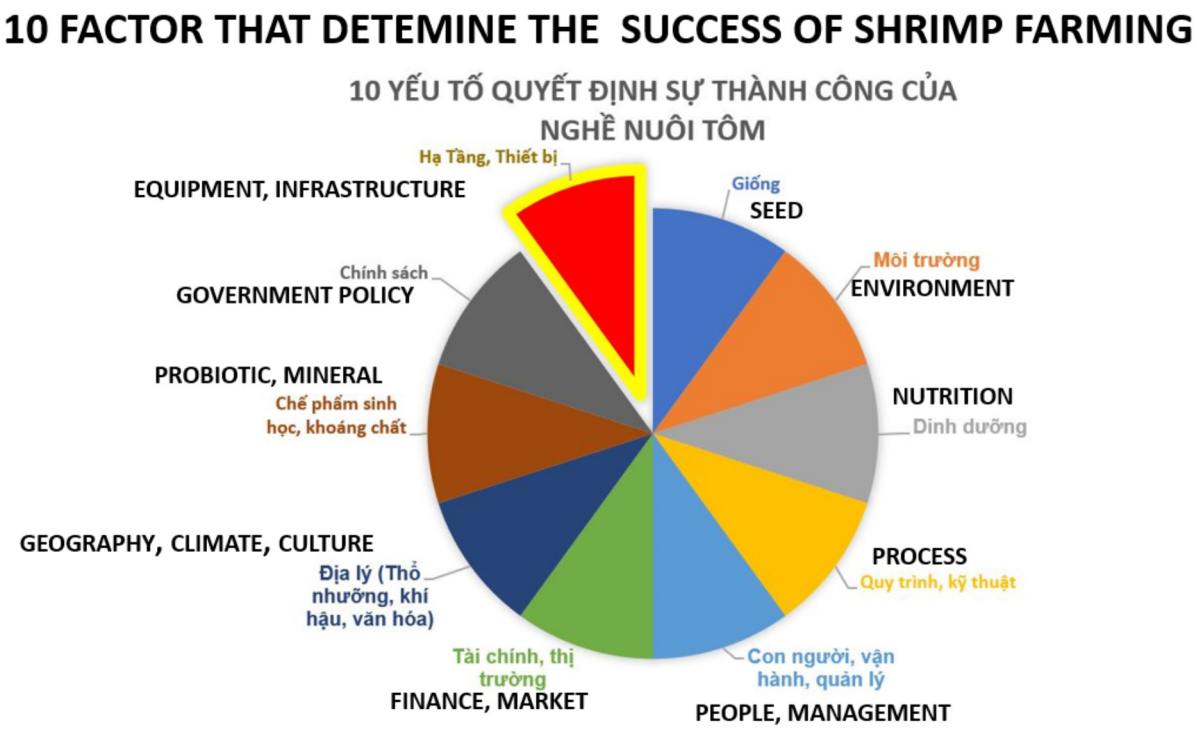
Thai Vu Hong* (Tommy Vu)

Aqua Mina Co. Ltd
No 685 Highway 1A
Binh Hung Hoa Ward
Binh Tan District
Ho Chi Minh City, Vietnam 70000
thai.vu@aquamina.com.vn

Shrimp farming in Vietnam has changed a lot in the past 10 years. There are many factors that determine career success from an economic perspective. According to Aqua Mina, there are 10 main factors as follows: Animal, nutrition, microbiology and minerals, finance, geography, technical infrastructure, process, environment, legal, people and management. Aqua Mina is doing a good job supporting the design and supply of shrimp farming equipment in Vietnam.

Geographically, Vietnam has 3 typical climate zones, so the design and operation of shrimp farms are very different: The north is cold, the central region is hot, and the south has a temperate climate.

We think that geography and culture will directly impact the way shrimp farms are operated. Therefore, people need to understand clearly in order to construct and invest, but should not learn or copy successful models.



EFFECT OF SEAWEED EXTRACTS ON GENE EXPRESSION AND GROWTH PERFORMANCE OF WHITE LEG SHRIMP *Penaeus vannamei* AT THE COMMERCIAL PONDS

Vu Anh Tuan*, Maria Garcia Suarez, Catherine Joyce Eusebio, Chris Mitchum D. Ganacial, Virna Fe Subere, Ferdinand M. Traifagar, Rowena E. Cadiz

*Olmix Group Representative Office
167 Luong Dinh Cua Street
Thu Duc Town
Ho Chi Minh City, Vietnam
Email: tuanvu@olmix.com

The extracts from seaweeds, *Ulva spp*. and *Solieria chordalis,* were incorporated in the commercial shrimp feed at 3g/kg to feed for shrimp (*Peneaus vannamei*) from stocking to harvesting at the commercial ponds. There were six ponds with sizes from 4400 m2 to 5616 m2 each including 3 ponds with seaweed extracts (treated pond) and three ponds without seaweed extracts (control pond). The stocking densities and the day of culture (DoC) were 155 and 157 postlarvae/m2 and 115 days and 112 days for treated pond and the control pond, respectively. For gene expression, the samples of hepatopancreas and hemolymph of 3 shrimps per pond were taken at 30 days of culture (DoC 30) and 60 days of culture (DoC 60). These samples were analyzed for anti-lipopolysaccharide factor (ALF), crustin; penaeidin 3, prophenoloxidase, heat shock proteins (HSP 70 and HSP 90). The muscle samples were determined for alpha- actin and myosin heavy chain. The relevant primers were as references to measure the relative gene expression of those proteins. Survival rate, yield, and feed conversion ratio (FCR) were also determined.

The result showed that at DoC 60 the ALF of the treated pond was 158 % and 75% higher than that of the control pond in hepatopancreas and hemolymph, respectively. The crustin of shrimp at the treated pond were 100% higher at DoC 30 and 182% higher at DoC 60 than those of shrimp at the control group in hepatopancreas. In hemolymph, crustin values of the treated shrimp was 203% higher than that of the control shrimp. At DoC 30, the Penaeidin 3 values of the treated shrimp in hepatopancreas improved 108% higher than that of shrimp at the control pond. At DoC 60, the Penaeidin 3 in hemolymph of the treated shrimp was 225% higher than that of the control shrimp. Particularly, the prophenoloxidase of the treated shrimp were 340% and 1172% higher than those of the control shrimp at DoC 60. The values of HSP 70, HSP 90, alpha- actin and myosin heavy chain were higher in the treated shrimp compared to the control ones. The FCR was 1.4 at the treated pond but was 1.5 in the control pond. The survival rate of treated shrimp (90.6%) was 7.4% higher than that of the control ones (83.1%). The yield of the treated pond (33.3 ton/ha) was 2.8 ton/ha higher than that of the control pond (30.5 ton/ha).

Based on the immune related genes, the stress response genes, the muscle growth genes, the survival rate, the yield, and the feed conversion ratio, it concluded that the seaweed extracts could improve better health and better growth of white leg shrimp at the commercial ponds in this study.

BRIDGING FISH FARMERS FOR SUSTAINABLE FISHERIES IN ACEH

Hendro Wahyudi[*)] , Cut Ruhul Muthmainnah[**)] , Bakhtiar Sah Putra[***)]

Salted tilapia is a commodity with high economic value and potential for sustainable development. To support Indonesia's priority fisheries programs, empowering tilapia farming communities will provide positive impact on the independence and development of local economy in Aceh.

The supply of 1 to 2 cm tilapia seeds is a crucial stage in the ongoing nursery business segmentation. As a result, nurseries P1, P2, and P3 (which address the needs of farmers for saline tilapia seeds) are now more self-sufficient.

The aim of this activity is to empower the local community's economy and support pond revitalization activities in Aceh to increase national fisheries production with saline tilapia commodities through: increasing the ability of fish farmers in managing risk factors and diseases in tilapia, increasing the quality and quantity of saline tilapia seeds in Aceh, strengthening advanced nurseries, strengthening partnerships between the government, private sector and the community in developing saline tilapia cultivation.

COMPARISON OF GONAD DEVELOPMENT OF SHORTFINNED EEL *Anguilla bicolor* REARED IN FRESHWATER AND SEAWATER

Annisa Apriliani Wahyudi,* Stefanie Maria Ayu Raganata, Sari Asfarina Sariat, Ching Fui Fui, Shigeharu Senoo

*) Borneo Marine Research Institute
Universiti Malaysia Sabah
Jalan UMS, 88400
Kota Kinabalu, Sabah, Malaysia
annisaapriliani02@gmail.com

Broodstock management, including the development of reproduction in captivity to achieve sustainable eel aquaculture is vital. The aim of this study is to compare gonadal development of freshwater and seawater female eel, *A. bicolor*. Female broodstock of *A. bicolor* with an average body weight of 2030±476 g were reared in freshwater and seawater for 4 months. Morphological features of the broodstock after four months rearing were described. The gonadal development and visceral condition were observed. Freshwater eels had bigger stomachs and more visceral fat compared to seawater eels. Both freshwater and seawater eels showed non-significant differences in egg size, measuring 0.21±0.03 mm and 0.21±0.04 mm, respectively. There were no specific morphological changes between seawater and freshwater eels. The condition factor for the freshwater and seawater group was 1.86 and 1.67, respectively. In conclusion, this study demonstrated that freshwater eels have more gonads, suggesting that broodstock management in freshwater may be beneficial. Further research on the spawning response and peak ovulation time in both groups should be conducted.

DEVELOPMENT OF A NOVEL IMMERSION VACCINE AGAINST SCUTICOCILIATOSIS IN OLIVE FLOUNDER

Qiang Wan* and Jehee Lee

Gidang Marine Science Institute & Center for Genomic Selection of Korean Aquaculture
Jeju National University
Jeju Self-Governing Province
63333, Republic of Korea
oneqiang@msn.com

The olive flounder holds paramount importance in Korean aquaculture as a finfish species. However, in recent years, olive flounder aquaculture has faced significant challenges from parasitic diseases such as scuticociliatosis. Despite advancements in injectable vaccines, they are not applicable for juvenile fish less than 10 cm in length. Therefore, there is an urgent need to develop a novel and effective immersion vaccine to combat scuticociliatosis during the juvenile stage. In this study, we aimed to develop an innovative and effective mucosal adjuvant system for use in an immersion vaccine formulation to prevent scuticociliate infection in olive flounder. Screening of immersion vaccine adjuvant candidates was conducted with six different adjuvants, and the selection of the most effective mucosal immersion adjuvant for olive flounder was based on a comprehensive evaluation of mucosal immune biomarkers. Following the optimization of adjuvant dose and vaccine formula, juvenile flounders were immunized with the developed immersion vaccine, and immersion challenges with live *M. avidus* were performed, alongside antibody titration, to evaluate the vaccine's protective efficacy. Our results demonstrated that the vaccine containing killed *M. avidus* cells encapsulated within chitosan and alginate microspheres, along with a complex adjuvant of PEI and saponin, exhibited the highest mucosal parasiticidal activity, survival rate in immersion challenges, and antibody production. In conclusion, the novel immersion vaccine developed in this study provides a fundamental strategy for preventing scuticociliatosis and contributes to improving the production of olive flounder aquaculture.

THE ANTIBACTERIAL ACTIVITY OF GELENGGANG (*Cassia alata)* PLANT AGAINST FISH PATHOGENIC BACTERIA

Mustafa, W. M. I. W*, Idris, S. M, Mansor, N. N, A. Azila

[1]Fisheries Research Institute (FRI) Tanjung Demong, 22200, Besut, Terengganu
[2]Department of Marine Science, Kulliyyah of Sciences, International Islamic University Malaysia, 25200 Kuantan, Pahang, Malaysia
wanmuhammad111@gmail.com

Recent advancements in the field of natural therapeutics have consistently highlighted the potent antibacterial properties of medicinal plants, unveiling new pathways in the fight against bacterial pathogens. This emerging knowledge is particularly relevant in aquaculture sector, where the search for effective, natural, and sustainable treatments against fish pathogens is importance. Within this context, the aim of this research is to evaluates the antimicrobial effectiveness of methanolic extracts from the Gelenggang plant (*Cassia alata*), focusing on its action against the Gram-negative bacteria *Vibrio alginolyticus* and *Edwardsiella ictaluri*, both of which pose notable challenges in aquaculture. Agar disc diffusion method for an initial evaluation of antibacterial activity was carried out. This was followed by determining the minimal inhibitory concentration (MIC) and minimal bactericidal concentration (MBC) of the extracts. The extracts exhibited antibacterial activities against tested microorganisms. Methanolic Gelenggang extract showed significant antibacterial activity against *E. ictaluri*, while a low inhibitory effect on *V. alginolyticus* was observed. The methanolic extracts of Gelenggang with different concentrations showed antibacterial effects against *E. ictaluri* with diameter zone of inhibition ranging from 14 mm to 8 mm. Through MIC and MBC determination, *E. ictaluri* also appears to be the most sensitive to the methanolic extract of Gelenggang with a MIC value at 200 mg/ml concentration. However, for *V. alginolyticus*, no MIC and MBC value is shown. According to these findings, methanolic gelenggang extract is inefficient for treating bacterial infections in aquaculture because it has low efficacy in inhibiting the growth of bacteria *V. alginolyticus* and *E. ictaluri* compared to commercial antibiotic oxytetracycline.

THREE TRIAL METHODS TO TEST PROBIOTIC PRODUCTS' INHIBITION AGAINST *Vibrio parahaemolyticus* IN SHRIMP FARMING

Jimmy C. M. Wang*

Jade & Gold Agriculture Products Company
258, Zhongzheng Road, Xinhua
Tainan City, Taiwan

Vibrio parahaemolyticus poses a significant threat to shrimp farming, leading to substantial losses in the global shrimp industry over the past decade. This study investigates three probiotic trial methods aimed at assessing the efficacy of probiotic products in inhibiting V. parahaemolyticus in shrimp farming environments.

In Trial 1, a sewage water sample was obtained from central drainage and divided into tanks. 20 liter each tank. One tank served as the control without any probiotic product added, while others received 20 grams of various aerobic probiotic products. Aeration was conducted for 48 hours, and the green Vibrio count was tested before and after aeration to evaluate inhibition.

Trial 2 focused on inhibiting Vibrio parahaemolyticus in shrimp hepatopancreas and gastrointestinal tracts. Shrimp were fed with probiotic feed containing a 1% dosage of probiotic product for three consecutive days through auto-feeder feeding. Green Vibrio count tested before and after probiotic feed treatment.

In Trial 3, following the successful inhibition of V. parahaemolyticus in shrimp tissues in Tial2, the selected probiotic product was applied to fermented rice to cultivate two benefit groups: probiotic strains for enhancing biosecurity pond and copepods, a natural food source for postlarvae. The water stocking and zooplankton expansion procedure includes three steps: 24 hours of liquid expansion, 24 hours of wet expansion, and 5-7 days of expansion in the pond. These steps were initiated two weeks before seed stocking and continued for two weeks after seeding, once per week for a total of four applications. Green Vibrio count (V. parahaemolyticus) levels in pond and shrimp tissues were monitored throughout the process.

The Comprehensive approach aims to assess the efficacy of probiotic products' inhibition against V. parahaemolyticus in shrimp farming, contributing to enhanced biosecurity and productivity in the industry.

CHANGING FROM CONVENTIONAL *Penaeus vannamei* SEMI INTENSIVE CULTURE SYSTEM TO SUPERINTENSIVE BIOFLOC CULTURE SYSTEM: A REVIEW OF IMPORTANT POINTS

Wilson Wasielesky*, Luis Poersch, Dariano Krummenauer, Geraldo Fóes, Lucas Silveira, Silvia Martínez-Llorens, and David Peñaranda

Marine Shrimp Culture Laboratory
Federal University of Rio Grande, Brazil
Grupo de Acuicultura y Biodiversidad
Universitat Politècnica de València, Spain
manow@mikrus.com.br

The increases in shrimp production in conventional semi-intensive culture systems have been limited by several factors such as disease, weaknesses of the systems or competition by culture area with other industries. Several studies have focused on improving the new technologies necessary to increase shrimp production. The Biofloc Technology Culture Systems (BFT) is considered a revolutionary system in aquaculture, because its production of microorganisms helps in the maintenance of water quality, reduces feed conversion rates, and increases biosecurity, resulting in high production multiples crops. Additionally, BFT is considered environmentally friendly, with an ability to reuse the same water multiple times, thus avoiding pollution of coastal waters. Technological innovation permits increases in shrimp production capacity per unit area. The addition of new management tools such as air injectors (nozzles), artificial substrate, clarifiers and some procedures may allow unprecedented increases in the load capacity of these systems.

For example, the demand for dissolved oxygen (DO) by shrimp is one of the main concerns as culture systems intensify. In intensive or super-intensive culture of shrimp can be possible if the system's aeration devices can meet the organism's oxygen demand. The number of devices to be used will depend on the water's salinity and temperature, stocking density, shrimp size, and in the BFT systems the amount of suspended solids. For this reason, studies and evaluations of the support capacity of each new aeration technology is important to maximize its effect.

Therefore, several researchers have evaluated the influence of the limitation of different parameters and procedures. These are important challenges to overcome the production when working in BFT with high densities, and different devices and other procedures (Table 1), that can have significant impacts on shrimp development in super-intensive system.

In the present study we evaluate these important changes from conventional to BFT systems, and we discuss the influence of high stocking densities on water quality and on the growth performance of *P. vannamei* in a BFT system with the adoption of these new tools and procedures.

Table 1: Main modifications from conventional shrimp culture systems to Biofloc Technology super-intensive shrimp culture systems.

MAIN CHANGES TO BFT SYSTEMS
FACILITIES: SIZE, FORMAT, MATERIALS
THE USE OF MICROBIAL LOOP: BIOFLOC
NITRIFICATION PROCESS
HIGH PRODUCTION OF BACTERIAS
MANAGEMENT OF ALKALINITY/PH/CO2
HIGH CONCENTRATION OF TSS
AERATION SYSTEMS
USE OF VERTICAL SUBSTRATES
WATER MANAGEMENT
HIGH STOCKING DENSITIES
FEEDING MANAGEMENT
USE OF PROBIOTICS
LOW OR ZERO WATER EXCHANGE
REUSE OF WATER
DENITRIFICATION PROCESS
OTHERS

APPLICATION OF THE DENITRIFICATION PROCESS TO REMOVAL NITRATE DURING THE CULTURE OF *Penaeus vannamei* IN A BIOFLOC SYSTEM

Wilson Wasielesky*, Maria de Fátima Gomes Silva, and Hellyjunyor Brandão

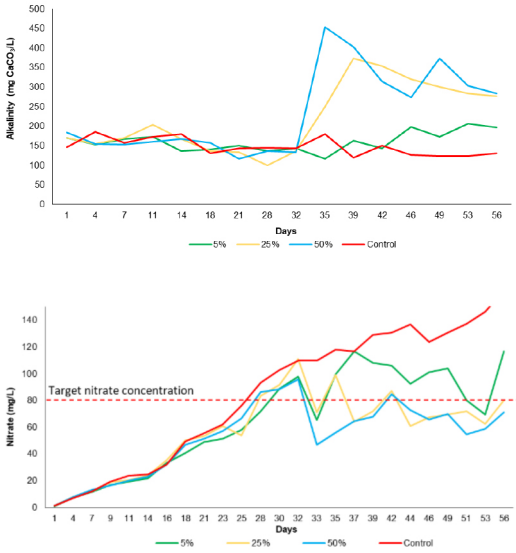
Marine Shrimp Culture Laboratory (IO-FURG)
Federal University of Rio Grande
Rio Grande, RS, Brazil, 96201-030
wasielesky@gmail.com

Biofloc technology system is used for the purpose of preserving water quality in intensive aquaculture systems. In this system, the production of heterotrophic bacteria helps in the formation of bioflocs. The nitrifying bacteria transform ammonia into nitrite and nitrite into nitrate. Nitrate tends to accumulate reaching high concentrations (>100 mg/L), which can cause a decrease in growth and even cause mortalities. To solve this problem, several strategies are applied that involve biological processes such as the denitrification process. Therefore, the present work aimed to evaluate the effectiveness of denitrification in reducing nitrate levels concomitantly with the culture of *Penaeus vannamei* in a biofloc system in 8 weeks.

The experiment consisted of 1 control treatment, where the no denitrification process was carried out, and 3 experimental treatments which denitrifications were carried out in bioreactors of different volumes relative to the volumes of the culture tanks (5%, 25% and 50%). Each treatment was done with 3 replications. *P. vannamei* juveniles were stocked at a density of 400 shrimp/m^3 in 500-liter tanks. Water quality parameters were evaluated daily, such as pH, alkalinity, temperature, salinity, dissolved oxygen, total ammonia nitrogen, nitrite, nitrate, total suspended solids, and settleable solids. Biometrics were performed weekly to estimate shrimp growth. The shrimp were fed twice a day with extruded commercial feed. To carry out the denitrification process, water from each experimental units was pumped to bioreactors without aeration, where organic carbon (sugar) was added in a carbon/nitrogen ratio of 3/1 to stimulate the process. Calcium hydroxide was used to maintain pH levels above 7.4. Denitrification was considered complete when nitrite and nitrate concentrations achieved around 0 mg/L, in denitrification tanks. At the end of the experiment, water quality and zootechnical parameters were submitted to statistical analysis (ANOVA).

Significant differences ($p<0.05$) were observed among the water quality parameters and zootechnical performance in the different treatments. It was confirmed that is possible to denitrify nitrate during trial and keep nitrate in target concentrations.

Figure 1: Alkalinity (a) and Nitrate (b) concentrations in different treatments during experimental period.



BOOSTING RESISTANCE OF SHRIMP POSTLARVAE AGAINST STRESS AND DISEASE

Eva Werbrouck*, Arfindee Abru, Roeland Wouters, Olivier Decamp

INVE Aquaculture
Dendermonde, Belgium
e.werbrouck@inveaquaculture.com

Low prices and low demand in shrimp markets impact how hatcheries manage their production. The first reflex is often to switch to low-end feeds to cut costs. This practice reduces PL quality and resilience and puts culture success at risk during hatchery-, nursery- and grow-out, especially considering EMS and WFS disease challenges. A temporary compromise needs to be put forward to help farmers surpass the current economic challenges.

The proposed cost-beneficial approach is to replace 15-30% of the feeding regime with Sano S-PAK health booster, packed with nutraceuticals and essential nutrients to upgrade the protocol quality. Sano® S-PAK is available in 4 sizes for hatchery and nursery applications and has a long successful track record in preparing shrimp for dealing with stress. Sano S-PAK booster formula is built on 4 principles:

- Immune stimulants prepare the shrimp for dealing with stress and infection
- Antioxidants protect immune cells, enhance osmotic regulation, and ensure high survival
- Structural components of cell membranes compensate for the negative effect of stress on growth and ensure fast recovery
- Premium protein sources and attractants ensure good palatability, digestion, and growth under stressful conditions

A recent trial evaluated Sano S-PAK during commercial culture of *L. vannamei* in six 17-MT tanks stocked with 200,000 postlarvae stage PL12. The treatment with booster feed supplementation had 6% higher survival and 11% higher biomass than the control treatment (**TABLE 1**).

TABLE 1. The effect of diet supplementation with Sano S-PAK

	Control	Sano® S-PAK
Survival (%)	85 +/- 3	91 +/- 5
Body weight (g)	0.44 +/- 0.05	0.47 +/- 0.04
Biomass (kg)	75 +/- 9	83 +/- 3

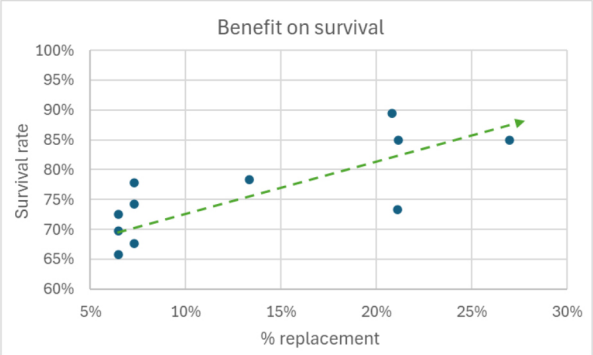


FIGURE 1: The effect of increasing Sano S-PAK replacement levels on survival

SEA GRAPES (*Caulerpa* spp.) CULTURE IN A CONTROLLED TANK AS A CULTURE DEVELOPMENT EFFORTS IN THE KARAWANG REGION, WEST JAVA PROVINCE, INDONESIA

Dadan Kurnia Wibawa*, Dasep Hasbullah, Agus Heri Purnomo, Endah Soetanti, Agus Dwi Saputro, Muhammad Ali Hizam

Balai Layanan Usaha Produksi Perikanan Budidaya (BLUPPB)Karawang
Desa Pusakajaya Utara, Kecamatan Cilebar, Kabupaten Karawang, Jawa Barat
Satker_bluppb.karawang@kkp.go.id

Seaweed culture become an important activity in Indonesia because it has good economic value and continues to increase from year to year. Several factors that encourage this development include large market potential, government support in developing seaweed culture, and farmers awareness for environmental sustainability. One genus of seaweed that has the potential to be developed is sea grapes (*Caulerpa*.spp). Apart from domestic purposes, marketing opportunities for sea grapes are also wide open for various international destinations, including Japan, China, Korea and Malaysia. In the future, it is estimated that the market potential is large and tends to increase and will not be met by the supply of fishermen who harvest it from nature (the sea). Some people have tried culture sea grapes, but so far the results have been less than satisfactory. This research was carried out to respond to these challenges, namely through culture studies in semi-indoor hatcheries, which focused on experiments involving different rearing media and planting containers (spot collectors). The aim of this activity is to obtain the best cultivation technology so that it can increase optimal production performance. During the test, the productivity of each treatment is measured, including absolute growth rate and specific growth, and at the end of the test, the level of business feasibility is measured. The results showed that controlled tanks with different spot collectors produced an average daily growth of 16.34% with a multiple of production compared to planting weight of 4.37 times on average. This technical data is converted into economic value and produces information that culture sea grapes in controlled tanks using the spot collector method is profitable, so that it can be developed to support government programs related to the Green Gold movement in the maritime and marine and fisheries sectors.

MULTIVARIAN PRODUCTION OF CLOWNFISH MARINE ORNAMENTAL FISH (*Amphiprion* sp) IN SUPPORTING THE GOVERNMENT AID PROGRAM AND FULFILLING THE NEEDS OF THE MARINE ORNAMENTAL FISH MARKET

Agam T Wibowo*, Heru Salamet dan Hariyano

Balai Perikanan Budidaya Laut Ambon
Jl. Leo Wattimena, Ambon
e-mail: ambonbpbla@gmail.com

The development of nemo ornamental fish at the Ambon Marine Cultivation Center is increasingly showing variations. To date, 50 variants have been successfully developed, both pure original species and existing hybrid species (a cross between species). The Amphiprion sp clownfish has a more beautiful shape and color than the two species, and the price is also higher. This activity aims to produce multivariate hybrid Nemo ornamental fish. This activity took place at the Outdoor Ornamental Fish Hatchery of the Ambon Marine Cultivation Center. The parent used is to produce new variants, among others. percula ordinary, halfblack, Onyx, Ocellaris ordinary, Balong ordinary, pellet orange, pellet pink, giro sand, tomato, mocha, percula misbar, percula black misbar, black platinum, davinci, Picasso helmet, extreme snowflake, frostbite, black ice, lightning maron, bonet, midnight, black storm, Nuget percula, mocha davinci, premium davinci, black Picasso, premium maron, premium lightning maron white nuget, gold nuget, glodflake maron, misbar black ocellaris, black lightning, black snowflake, black frostbite, domino , platinum snow, Extreme black misbar, black extreme black misbar ocellaris, nuget ocellaris, platinum storm, orange storm, mocha storm, snow storm and Picasso storm. He has utilized the potential of fisheries resources as a source of livelihood by working as a cultivator of ornamental clownfish so that it can be applied by the wider community. In addition to cultivating clownfish, small and medium scale communities can cultivate clownfish on a household scale using a recirculation system (RAS). Marketing of clownfish in big cities such as Jakarta, Surabaya, Yogyakarta, Denpasar, Semarang, Makassar, Medan and almost all big cities in Indonesia. The biggest potential for clownfish is to meet the exporter market in Jakarta, Banyuwangi and Denpasar with the biggest absorption being for export purposes. Because the biggest market currently is the foreign market.

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EFFLUENT IN SHRIMP FARMING PREDICTION WITH SATELLITE IMAGERY AND MACHINE LEARNING

Prabowo Yoga Wicaksana[1], Lukman Hakim[1], Syauqy Nurul Aziz[1]

[1]JALA TECH Pte Ltd.
Ground Floor Sahid J-Walk, Jl
Babarsari No. 2, Janti
Caturtunggal, Kec. Depok
Sleman, Daerah Istimewa Yogyakarta
Indonesia 55281

Despite the significant progress in shrimp farming and aquaculture, there is a tendency to overlook the crucial aspect of managing pond wastewater, which poses environmental risks due to untreated effluent release and the associated threat of water pollution. The quality of water plays a vital role in shrimp cultivation outcomes, and the conventional methods for assessing water parameters involve labor-intensive field measurements, introducing time and spatial limitations to the evaluation process. To address these challenges, our proposed solution involves leveraging Sentinel-3 data and utilizing machine learning algorithms for predicting diverse water quality parameters.

We incorporated two types of in situ data sources: in-house and external data. The in-house dataset comprises 23 shrimp ponds from our collection situated along the coastal lines of Java and Sulawesi in Indonesia. For the external data, we included 22 coastal sites sourced from the European Environment Agency (EEA). We used spatial and temporal matching for the in situ data and its corresponding satellite data. The modelling techniques included Support Vector Regression (SVR), Random Forest Regression (RF), XGBoost Regression (XGB), and Stacking Regression (Stack). Table 1 provides a comprehensive overview of the model performance results for parameters such as Ammonium (NH4), Dissolved Oxygen (DO), Nitrate (NO3), Nitrite (NO2), Oxygen Saturation (OS), pH, Salinity (Sal), Total Nitrogen (TN), Total Phosphorus (TP), and Water Temperature (WT).

Table 1. Model performance result

■		NH4	DO	NO3	NO2	OS	pH	Sal	TN	TP	WT
SVR	R^2	-7.709	0.619	0.179	-0.071	0.207	0.232	0.751	0.261	-7.015	0.906
	MAPE	4491.9	13.15	822.79	1568.6	8.75	2.69	16.91	58.47	536.66	5.78
RF	R^2	0.588	0.855	0.162	**0.251**	0.738	0.664	0.955	0.506	0.026	0.987
	MAPE	234.12	6.61	286.49	**268.31**	4.73	1.64	5.41	34.58	71.71	2.17
XGB	R^2	**0.788**	**0.873**	**0.590**	0.090	0.705	**0.690**	0.953	**0.511**	**0.435**	0.989
	MAPE	**86.07**	**6.24**	**146.74**	391.73	4.58	**1.54**	5.15	**29.81**	**50.11**	**1.66**
Stack	R^2	0.696	0.871	0.455	0.242	**0.747**	0.690	**0.958**	0.509	0.348	**0.990**
	MAPE	213.63	6.25	229.18	314.68	**4.48**	1.56	**5.04**	31.58	60.83	1.79

XGBoost consistently emerged as the superior model across six water parameters, demonstrating robust predictive accuracy for NH4, DO, OS, Sal, and WT. Despite these successes, challenges were observed, notably in achieving optimal performance for parameters such as NO2 and TP. This research underscores the potential of integrating satellite data and machine learning for effective effluent monitoring via water quality prediction in aquaculture, contributing valuable insights for sustainable shrimp farming practices.

INFECTION OF *Cryptocarion irritans* PARASITE ON SEABASS (*Lates calcarifer*) BROODSTOCKS IN MARICULTURE CENTRE BATAM : OUTBREAK AND CONTROLLING

Endang Wijayanti*, Uray Hendri Istrada, Sri Agustatik, Ikhsan Kamil, Ade Harwono

Mariculture Centre Batam,
Barelang Street, 3rd Bridge
Setoko Island, Batam City
Riau Islands Province, Indonesia
Email : ndngwijayanti@gmail.com

Broodstock is the most important stage in aquaculture. One of the obstacles in broodstock maintenance is disease. Some pathogens can cause death quickly and in large quantities. *Cryptocarion irritans* is a parasite that often infects Seabass (*Lates calcarifer*) broodstock, especially those kept in tanks. Every year, this parasite infection always occurs and caused mass mortality of Seabass broodstocks in the Mariculture Centre Batam. This confirmed by laboratory data, which shows that apart from the broodstock, the high pathogenicity of this parasite also causes mortality in other fish seeds such as pompano with a mortality rate 80 - 100%. The last case in May 2023 was 15 Seabass broodstocks weighing 2-5 kg kept in one tank, positive for *Cryptocarion irritans* infection. A total of 12 fishes died with clinical signs of a smooth body, no wounds or nodules on the body surface, pale gills with excessive mucus production. The results of microscopic observations showed that the parasite was round in shape and surrounded by cilia with an average diameter of 231.8 µm, actively moving with high intensity and was identified as *Cryptocarion irritans* in the trophon phase. A more severe outbreak occurred in September 2022, as many as 15 broodstocks in one tank wasdeath. The treatment was done for infected broodstocks were carried out by dipped in formalin at dose 150 – 200 ppm, moving the broodstocks to a new tank. But deaths still occured. The next control step was to move the broodstocks to floating net cages in the sea and significantly reduced mortality. Apart from that, preventive efforts are also carried out by regularly monitoring the condition of the fish by swabbing mucus and observing in the laboratory.

DIETARY ORGANIC ZINC POSITIVELY AFFECTS GROWTH, ANTIOXIDANT CAPACITY AND LIPID STORAGE IN JUVENILE LARGEMOUTH BASS *Micropterus salmoides*

Yufan Zhang*, Xuanshu He, Anqi Chen, Zhihong Liao, Gang Lin, and Jin Niu

Beijing Alltech Biological Products Co., Ltd.
Beijing, PR China

Zinc is a trace element which participates in various fundamental biochemical processes in vertebrates. Zinc deficiency in animals results in oxidative damage by oxygen free radicals. Thus, appropriate zinc absorption is essential for maintaining normal growth and development in animals. Largemouth bass, an important carnivorous economic fish, is extensively reared in southern China because of its high nutritional value and promising economic benefits. In the present study, we explored the regulatory effects of zinc treatment in modulating growth, antioxidant capacity and lipid storage, as well as comparing the difference of such effects in fish fed with organic or inorganic zinc.

Sul120 and Bio120 groups showed significantly higher weight gain and specific growth rate than Con group (Table 2), with Bio60 group obtaining the lowest viscerosomatic index and hepatosomatic index (Table 3). Up-regulation of hepatic SOD, GSH-PX and CAT activities and decline of MDA contents indicated augmented antioxidant capacities by organic zinc (Table 4). The alterations in whole body and liver crude lipid contents illustrated the regulatory effect of zinc on lipid storage (Table 5).

These findings demonstrated the capabilities of zinc in potentiating growth and morphological performance, antioxidant capacity as well as regulating lipid storage in *M. salmoides*. Organic zinc exhibited higher efficiency than inorganic.

TABLE 1. Ingredients and proximate composition of experiment diets (g 100g^{-1} diet)

	Con	Sul60	Sul120	Bio30	Bio60	Bio90	Bio120
Wheat flour	12.3	12.2736	12.2472	12.2798	12.2596	12.2404	12.2202
White fish meal	40	40	40	40	40	40	40
Soybean meal	16	16	16	16	16	16	16
Fish oil	6	6	6	6	6	6	6
Bioplex-Zn(15%)	0	0	0	0.02	0.04	0.06	0.08
ZnSO4·7H2O	0	0.0264	0.0528	0	0	0	0
Other	25.7	25.7	25.7	25.7	25.7	25.7	25.7
Zinc (mg kg^{-1}diet)	57	116	176	95	114	147	178

TABLE 2. The effects of different sources and doses of zinc supplementation on growth performance of *Micropterus salmoides*. Results are presented as "mean ± SEM" (n = 3), and mean values on the same row with different letters indicate significant differences ($P < 0.05$)

Groups	Final weight (g)	Weight gain (%)	Specific growth rate (%day^{-1})	Feed conversion rate
Con	35.49±0.74^{a}	297.73±8.80^{a}	2.60±0.04^{a}	1.25±0.08^{ab}
Sul60	40.61±0.19^{ab}	354.93±2.61^{ab}	2.86±0.01^{ab}	1.35±0.15^{b}
Sul120	41.82±1.14^{b}	367.85±12.70^{b}	2.91±0.05^{b}	1.10±0.08^{ab}
Bio30	40.52±0.28^{ab}	353.57±2.98^{ab}	2.85±0.01^{ab}	1.12±0.04^{ab}
Bio60	39.10±0.25^{ab}	338.01±2.04^{ab}	2.79±0.01^{ab}	1.09±0.04^{ab}
Bio90	40.03±2.82^{ab}	349.62±30.80^{ab}	2.83±0.13^{ab}	1.06±0.06^{a}
Bio120	42.19±3.67^{b}	374.82±41.51^{b}	2.92±0.17^{b}	1.06±0.05^{a}

TABLE 3. The effects of different sources and doses of zinc supplementation on morphological indices of *Micropterus salmoides*.Results are presented as "mean ± SEM" (n = 3), and mean values on the same row with different letters indicate significant differences ($P < 0.05$)

Groups	Condition factor(g cm^{-3})	Viscerosomatic index(%)	Hepatosomatic index(%)	Intraperitoneal fat ratio(%)
Con	1.96±0.05	7.85±0.40^{bc}	2.63±0.32^{ab}	0.74±0.18
Sul60	1.98±0.02	7.85±0.18^{bc}	2.58±0.17^{ab}	0.87±0.03
Sul120	2.06±0.03	8.14±0.26^{c}	3.06±0.27^{ab}	0.85±0.12
Bio30	1.92±0.05	7.37±0.27^{ab}	2.72±0.23^{ab}	0.79±0.08
Bio60	1.96±0.04	6.91±0.17^{a}	2.35±0.02^{a}	0.71±0.07
Bio90	1.96±0.07	7.73±0.08^{bc}	2.81±0.11^{ab}	0.79±0.08
Bio120	1.96±0.05	8.22±0.11^{c}	3.19±0.33^{b}	0.90±0.07

TABLE 4. The effects of different sources and doses of zinc supplementation on hepatic anti-oxidant capacities of *Micropterus salmoides*. Results are presented as "mean ± SEM" (n = 3), and mean values on the same line with different letters indicate significant differences ($P < 0.05$)

	Con	Sul60	Sul120	Bio30	Bio60	Bio90	Bio120
T-SOD(Umgprot^{-1})	443.16±35.71^{a}	512.31±24.29^{ab}	463.66±3.86^{a}	473.66±3.96^{a}	564.40±39.78^{b}	460.94±14.44^{a}	451.24±9.51^{a}
Cu-Zn SOD(Umgprot^{-1})	275.92±8.00	297.30±16.25	283.60±22.97	293.65±11.72	324.02±9.17	280.60±18.59	280.10±8.24
GSH-PX(Umgprot^{-1})	18.87±1.24^{a}	26.39±1.84^{bc}	21.18±1.06^{ab}	25.60±2.39^{bc}	28.90±2.07^{c}	24.54±2.84^{abc}	23.83±1.03^{abc}
CAT(Umgprot^{-1})	6.87±0.45^{abc}	6.36±0.76^{ab}	6.26±0.80^{a}	9.51±0.43^{d}	9.12±1.26^{cd}	8.81±0.06^{bcd}	5.77±0.60^{a}
MDA(nmol mgprot^{-1})	0.80±0.10^{b}	0.65±0.05^{ab}	0.74±0.12^{ab}	0.67±0.06^{ab}	0.64±0.04^{ab}	0.44±0.06^{a}	0.67±0.21^{ab}
T-AOC(mmolgprot^{-1})	0.12±0.01^{a}	0.15±0.01^{ab}	0.14±0.01^{ab}	0.16±0.01^{b}	0.17±0.01^{b}	0.14±0.00^{ab}	0.14±0.02^{ab}

TABLE 5. The effects of different sources and doses of zinc supplementation on whole body and liver proximate composition of *Micropterus salmoides*. Results are presented as "mean ± SEM" (n = 3), and mean values on the same line with different letters indicate significant differences ($P < 0.05$)

	Con	Sul60	Sul120	Bio30	Bio60	Bio90	Bio120
Whole body							
Moisture (%)	72.18±0.55	72.24±0.65	72.55±0.41	72.20±0.32	72.79±0.53	72.44±0.47	72.81±0.55
Crude protein(% dry weight)	59.05±0.89^{a}	59.74±0.52^{ab}	61.06±0.26^{ab}	60.89±0.49^{ab}	61.99±0.40^{b}	60.25±1.27^{ab}	60.57±0.27^{ab}
Crude lipid(% dry weight)	24.42±0.75^{c}	24.12±0.80^{bc}	21.61±0.66^{a}	23.45±1.44^{abc}	22.08±0.51^{ab}	24.16±0.21^{bc}	24.15±0.07^{bc}
Liver							
Moisture (%)	68.92±1.28	69.41±1.53	68.64±1.60	69.35±0.54	68.61±0.38	68.55±0.98	68.98±1.25
Crude lipid(% dry weight)	5.42±0.61^{ab}	4.18±0.81^{ab}	5.15±0.62^{ab}	4.51±0.29^{ab}	3.98±0.35^{a}	4.98±0.67^{ab}	5.98±0.46^{b}

EVALUATION OF LARGEMOUTH BASS *Micropterus salmoide* FED SELENIUM YEAST DIETS: GROWTH, HISTOPATHOLOGY, ANTIOXIDANT ABILITY, AND APOPTOSIS

Junru Hu*, Zhixiong Xu, Yufan Zhang, Lirong Bai

Guangdong Academy of Agricultural Sciences
Guangzhou 510640
China
hujunru1025@163.com (Junru Hu)

Selenium is an essential mineral for animals and crucial for animal metabolism, impacting growth, reproduction, antioxidant capacity, immunity, and muscle nutrition. Therefore, adequate dietary selenium is vital in animal production. Organic selenium, particularly selenium yeast offers higher utilization, stable structure, and lower toxicity than inorganic selenium. The largemouth bass (*Micropterus salmoide*), a carnivorous fish native to California,is extensively farmed in China for its rapid growth, appealing appearance, adaptability, short breeding cycle, spineless meat, and high nutritional value. This study aims to investigate the effects of selenium yeast on the hemocytes antioxidant capacity and apoptosis, as well as the morphological histology in largemouth bass.

The feeding experiments were conducted in an indoor recirculating water system (naturallight cycle). The five iso-nitrogen and iso- lipid feeds were supplemented with seleniumyeast levels of 0, 0.5, 1.0, 1.5 and 2.0 mg/kg,respectively. Largemouth bass (initial body weight: 11.48 ± 0.43 g) were randomly and equally distributed among 15 tanks, with 35 fish in each tank. The feeding experiment was conducted for 67 days with dailyapparent satiation feedings at 9:00 and 16:00.During the feeding period, dissolved oxygenconcentration was between 6.00-7.88 mg/L, pH level was 7.7-7.9, water temperature range was 25.5-31.5 °C, nitrite content was lower than 0.002 mg/L, and ammonia nitrogen content was not higher than 0.1 mg/L.

After 67 days, based on the growth, liver histology, and serum antioxidant performance of largemouth bass, the additionof selenium yeast should not exceed 1.5 mg/kg. However, supplementation with 1.5 mg/kg of selenium yeast can improve the antioxidant capacity of hematocyte and inhibit the apoptosis. However, the addition of selenium yeast should not exceed 1.5 mg/kg.

Table 3
Growth performance of *Micropterus salmoides*.

Index	Addition level of selenium yeast (mg/kg)				
	0	0.5	1.0	1.5	2.0
IBW (g)	11.41 ± 0.46	11.87 ± 0.56	11.42 ± 0.53	11.19 ± 0.18	11.52 ± 0.43
FBW (g)	88.47 ± 0.80^{a}	83.76 ± 0.92^{ab}	82.38 ± 1.52^{ab}	77.77 ± 1.98^{b}	79.12 ± 3.05^{b}
SR (%)	94.31 ± 1.53^{b}	96.94 ± 1.75^{ab}	98.15 ± 1.85^{ab}	99.05 ± 1.65^{a}	97.68 ± 0.06^{ab}
WGR (%)	683.91 ± 9.49^{a}	642.21 ± 10.10^{ab}	629.70 ± 15.24^{ab}	586.59 ± 17.74^{b}	600.68 ± 25.40^{b}
SGR (%/d)	3.07 ± 0.02^{a}	2.99 ± 0.02^{ab}	2.97 ± 0.03^{ab}	2.88 ± 0.04^{b}	2.90 ± 0.05^{b}
FCR	0.87 ± 0.01	0.91 ± 0.03	0.93 ± 0.03	0.89 ± 0.01	0.94 ± 0.04
CF (g/cm^{3})	2.50 ± 0.11^{a}	2.42 ± 0.11^{ab}	2.18 ± 0.05^{c}	2.35 ± 0.05^{b}	2.22 ± 0.06^{c}
HSI (%)	2.69 ± 0.31^{ab}	2.13 ± 0.17^{b}	2.68 ± 0.16^{ab}	3.18 ± 0.43^{a}	3.53 ± 0.61^{a}
ISI (%)	0.47 ± 0.06	0.43 ± 0.05	0.36 ± 0.03	0.44 ± 0.07	0.52 ± 0.19
IPF (%)	2.67 ± 0.29^{ab}	3.17 ± 0.34^{ab}	3.40 ± 0.20^{a}	2.28 ± 0.51^{b}	2.91 ± 0.44^{ab}
VSI (%)	9.69 ± 0.27^{b}	10.17 ± 0.75^{ab}	11.05 ± 0.33^{ab}	10.25 ± 0.22^{ab}	11.18 ± 0.24^{a}

Table 5
Antioxidant capacity of *Micropterus salmoides*.

Index	Addition level of selenium yeast (mg/kg)				
	0	0.5	1.0	1.5	2.0
GSH-Px (U/mL)	3.61 ± 0.30^{b}	3.88 ± 0.38^{b}	4.62 ± 0.42^{a}	4.06 ± 0.13^{ab}	4.36 ± 1.25^{ab}
SOD (U/mL)	29.00 ± 2.65^{b}	27.61 ± 6.68^{b}	39.02 ± 9.36^{a}	28.99 ± 0.64^{b}	29.17 ± 8.36^{b}
T-AOC (U/mL)	3.45 ± 0.35	4.28 ± 0.16	3.76 ± 0.56	3.67 ± 0.29	3.82 ± 0.12
O_2^- (U/L)	456.90 ± 25.87	378.45 ± 40.52	460.34 ± 25.00	417.24 ± 24.77	415.52 ± 31.04
NO (μmol/L)	361.50 ± 60.35	378.17 ± 9.20	401.53 ± 52.17	331.80 ± 12.46	358.05 ± 5.18

TRANSCRIPTOME SIGNATURE OF JUVENILE *Litopenaeus vannamei* CULTURED UNDER DIFFERENT SALINITY LEVELS IN RESPONSE TO *Vibrio harveyi* INFECTION

Li Lian Wong *, Zulaikha Mat Deris, Dinh Thinh Do, Shumpei Iehata, Mhd Ikhwanuddin, Md Asaduzzaman, Cher Chien Lau, Yantao Liang, Min Wang, Yeong Yik Sung, Chao Li

Institute of Climate Adaptation and Marine Biotechnology (ICAMB)
Universiti Malaysia Terengganu
21030 Kuala Nerus
Terengganu, Malaysia
lilian@umt.edu.my

Although the widely cultured *Litopenaeus vannamei* is highly tolerant to varying salinity levels, the rapid fluctuation of abiotic and biotic factors due to climatic changes may become stressors to the shrimp's physiology, resulting in impaired immunity and increased disease susceptibility. This study aimed to investigate the combined effects of both factors towards *L. vannamei* at transcriptomic level. *L. vannamei* were cultured at three different salinity levels (5ppt, 20ppt and 30ppt) for 60 days and were challenged with *Vibrio harveyi*. RNA-seq analysis was conducted on the hepatopancreas to assess the differential expressed genes (DEGs) in both control and *V. harveyi* infected groups. Our results revealed 5,725 DEGs was observed in shrimp reared at 5ppt, 3,643 DEGs at 20ppt and 1,560 DEGs at 30ppt. Most DEGs were identified to be associated with osmoregulation and transport activities, immune and stress regulation, nutrient metabolism, growth, chitin binding, gonadal development, and metal ion binding and toxicity. We identified that shrimp cultured at intermediate salinity of 20 ppt exhibits the greatest immunity level after infection by *V. harveyi*, given that low salinity (5ppt) may augment the free ion metal toxicity, resulting in higher disease susceptibility. Both *V. harveyi* and salinity stress function together or separately to activate a wide range of immune and stress regulatory genes, which could be potential candidate markers for future RNAi and knockdown research in developing efficient prophylactic management strategies for *L. vannamei*.

DOMESTICATION OF SNAKEHEAD FISH, *Channa Striata Blkr*, AS AN OPTIMIZATION EFFORT AT THE TATELU FRESHWATER AQUACULTURE CENTER

Francis Wowor[1]), Ezra Wowor[2])*, dan Verry Pandey[3])

1) Funsional Pengawas Perikanan Ikan Muda di BPBAT Tatelu
2) Pembudidaya Ikan Gabus Binaan dari BPBAT Tatelu
3) Funsional Umum;Penyusun Bahan Informasi dan Publikasi di BPBAT Tatelu
email: eframanwowor@gmail.com

The domestication of snakehead fish is carried out as an effort to ensure that snakehead fish that are produced and sold or extracted for their albumin come from catching them in the wild, and there is great concern about their sustainability. Continuous fishing of snakehead fish in the wild results in a decline in its natural population. Apart from that, snakehead fish will become rare because the stock is decreasing, so meeting the need for consumption will not only depend on catching.

This activity was carried out at the Tatelu Freshwater Aquaculture Fisheries Center (BPBAT) Tatelu from January 2023 to December 2024. Snakehead fish caught from fish cultivator land ponds assisted by BPBAT Tatelu came from North Minahasa Regency (4 pairs) and Southeast Minahasa Regency (4 pairs) North Sulawesi Province were selected with relatively the same weight and size and then kept in a concrete pond. A total of 8 pairs were placed in 4 experimental concrete pools measuring 3X5X1.5 meters with water hyacinth plants as cover for the top of the water pool and as a place for laying snakehead fish eggs. Feeding is given at 5% of body weight/day, there are two types of feed given, namely commercial 30% protein feed which is given 2 times/every 2 days and freshwater mussels/kijing from the earthen pond at BPBAT Tatelu which is given at night day and silk worms cultivated at BPBAT Tatelu which are given in the morning. with a frequency of administration once/every 3 days. This activity uses observation, interview and documentation methods, the parameters observed include fecundity, egg fertilization hatching rate, specific growth rate and survival rate. The results of the activity showed that it produced a fecundity of 20,000 eggs, a fertilization rate of 96%, a hatching rate of 95%, a specific growth rate of 15% and a survival rate of 95%. In this activity, we succeeded in taming wild fish into cultivated fish so that they can provide added value to fish farmers because they are no longer dependent on natural stocks, which are increasingly limited in number.

CHARACTERISTICS OF TILAPIA FISH ON THE NORTH COAST OF JAVA

Harry Wuwungan[1], Deni Sugianto[2], Syofan[3]

[1]BLUPPB Karawang
Dusun Sukajadi Desa Pusakajaya Utara RT.01/RW.04 Kecamatan Cilebar Kabupaten Karawang
Correspondence email: satker_bluppb.karawang@kkp.go.id

Historically, the development of tilapia fish farming began after a decline in environmental quality and an attack by shrimp farming disease, resulting in most of the pond land on the North Coast of Java becoming abandoned or idle. The euryhaline character of tilapia is an alternative for utilizing former shrimp ponds. This activity aims to hatch tilapia fish on the North Coast of Java. The parent tilapia fish used is the Sultana strain. The spawning ratio of male and female tilapia is 1:3, with a feeding percentage of 1% of the biomass. The parents will spawn after the 10th day since the parents were mixed into the spawning pond. The larvae are completely harvested on the 13th or 15th day, from the time the parents are spawned/ mixed. The resulting larvae are then reared until the seed size is 5-8 cm/ind with a stocking density of 50-75 larvae/m2. The percentage of parent tilapia fish that spawn ranges from 25.31% - 45.50% and the survival rate of tilapia fry ranges from 73.21% - 88.56%.

THE GROWTH OF GREEN SEAWEED *Chaetomorpha linum* (O.F.Müller) Kützing CULTURED IN A RANGE OF IONIC PROFILES USING INLAND SALINE WATER AND OCEAN WATER

Joel Wynhorst*, Ashiwin Vadiveloo, Navid R. Moheimani, Ravi Fotedar

School of Molecular and Life Sciences
Curtin University
Perth, Western Australia, Australia
E-mail: joel.wynhorst@postgrad.curtin.edu.au (J. Wynhorst)

Seaweed cultivation due to the demand for its products is rapidly increasing worldwide. Ocean and coastal seaweed farming practices in Australia are limited by cost, potential environmental impact, and legislation. Land-based cultivation using Inland Saline Water (ISW) presents a pathway for the use of degraded land to yield commercially viable products in Western Australia. ISW is known to have significantly different ionic ratios than ocean water (OW), specifically Na:K and Mg:Ca, and its capacity to grow across a range of ionic profiles is not yet well understood.

This study tested growth of Chlorophyta *Chaetomorpha linum* cultured in different ionic profiles created by mixture of ISW with Ocean Water, over two experiments. In the first experiment, *C. linum* was grown across a broad range of ionic profile mixtures including $OW_{100}ISW_{0}$, $OW_{66}ISW_{33}$, $OW_{33}ISW_{66}$, $OW_{0}ISW_{100}$ (subscript represents the percentage of water mix). In the second experiment, *C. linum* was grown across a more specific range of ionic profile mixtures including $OW_{33}ISW_{66,}$ $OW_{22}ISW_{77}$, $OW_{11}ISW_{88}$, $OW_{0}ISW_{100.}$ Sixteen tanks with four replicates per ionic profile, were randomly organised outdoors under direct sunlight. Water salinity was maintained at 25 ppt for the duration of experiments by adding dechlorinated freshwater. A water bath was used to stabilise the water temperature in tanks, and moderate aeration was provided to all tanks. Agilent microwave plasma atomic emission spectrometry (MP-AES), Ion Chromatography (IC) and Total Organic Carbon (TOC) were conducted on all water profiles. Seaweed growth was recorded every three days by weighing strained wet biomass on a scale.

C. linum specific growth rate (SGR) over 15 days in $OW_{0}ISW_{100}$ (2.73 ± 0.35 % day^{-1}) and $OW_{33}ISW_{66}$ (2.65 ± 0.49 day^{-1}) was significantly higher ($p < 0.05$) than in $OW_{66}ISW_{33}$ (0.94 ± 0.49 % day^{-1}) in EXP 1. No significant difference in growth was observed in EXP 2 between treatments, however, SGR of $OW_{33}ISW_{66}$, $OW_{22}ISW_{77}$ and $OW_{11}ISW_{88}$ water profiles was significantly higher on Day 15 than on Day 0. The high initial growth rate (T1 – T2) in EXP 1 followed by a plateau and overall lower growth rates in EXP 2 was likely caused by a shortage of nitrogen-based nutrients. Further experiments should investigate the growth of *C. linum* in $OW_{0}ISW_{100}$ supplemented with nutrients and with variable initial starting biomass. This study demonstrates the potential for the cultivation of *C. linum* in ISW, presenting a pathway for dryland affected salinity-affected farmers to diversify their income and utilise otherwise barren land through ISW aquaculture.

Figure 1: *C. linum* SGR over 15 days (EXP 1)

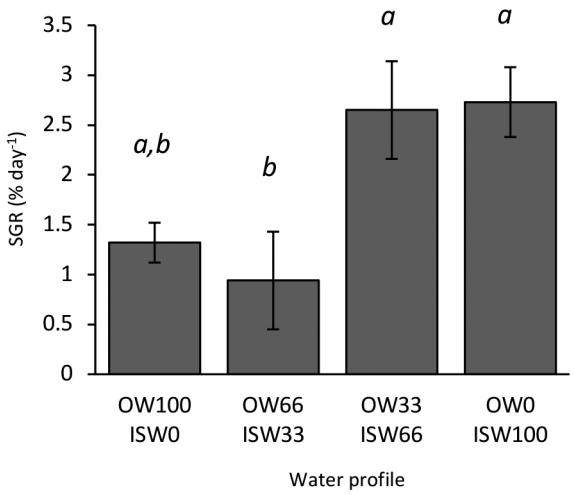
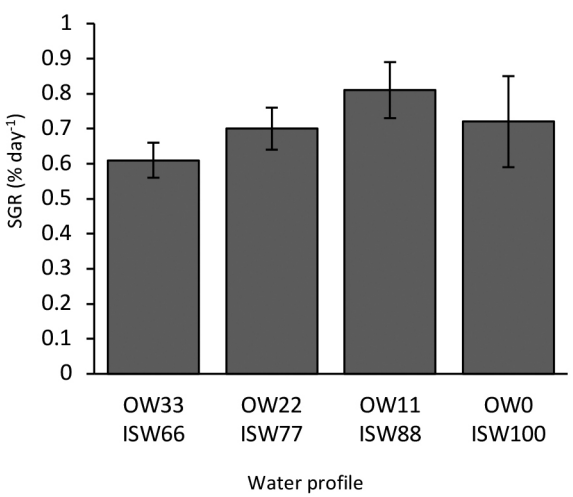


Figure 2: *C. linum* SGR over 15 days (EXP 2)



INSIGHTS INTO CLAM BEHAVIOR: A NOVEL MONITORING SYSTEM FOR CLAM CULTURE

Sheng-Xiang Xu*, Alexander Munyaev, Ing-Jer Huang, Li-Lian Liu

Department of Oceanography
National Sun Yat-sen University
Kaohsiung, Taiwan
D085620003@student.nsysu.edu.tw

The hard clam *Meretrix taiwanica* is a vital farming species in Taiwan; the frequent massive mortality damages the clam fishery and causes substantial economic loss. In commercial aquaculture, insights into animal behavior help to assess organisms' physiological conditions, such as applying behavior monitoring techniques in fish farming to reduce risk and operation costs. However, it isn't easy to achieve in clam farming due to their infaunal living habits. This study presents a novel video-based clam behavior monitoring system to alert unusual events and reduce economic losses.

Shell exposure and enduring valve closure are the primary reactions of infaunal clams under stress based on our long-term laboratory and clam farm in-situ investigations. Hence, four clam states, Siphon (S), Hidden (H), Exposed (E), and Exposed with a siphon (ES), were formulated as behavior indicators. An automatic clam behavior monitoring system was developed using an underwater camera and deep learning convolutional neural network (CNN) model; the accuracy, precision, recall, and F1-score of clam state classification in laboratory and clam farm scene trained model was 0.924, 0.838, 0.793, 0.804 and 0.930, 0.808, 0.667, 0.704, respectively. The system can individually track each clam, conduct real-time state analysis, and output the results to the website platform. Our results demonstrate the feasibility of utilizing non-invasive visual signals for the behavioral monitoring of infaunal clams.

Fig1. Example images of clam states.

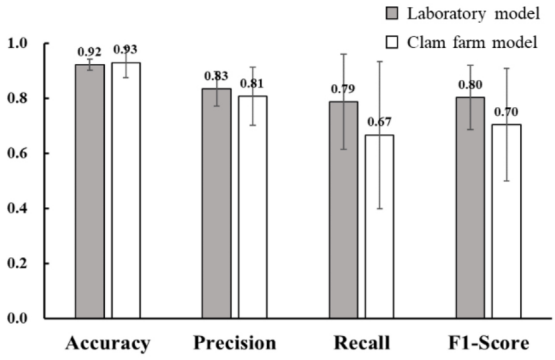
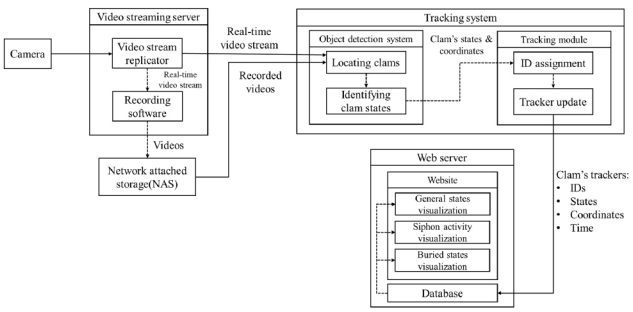


Fig2. The performances of clam states by the CNN model.

Fig3. The clam behavior monitoring system.



OTAQ AQUACULTURE – LIVE PHYTOPLANKTON ANALYSIS SYSTEM

Belinda Yaxley, Kypher Shreves

Email: byaxley@nautiluscollaboration.com

The live plankton analysis system (LPAS) is a great example of artificial intelligence technology that has been through a commercialisation pipeline successfully in the last 5 years. This talk will cover the commercialisation steps, learnings, and the application of LPAS in the field. Currently, the machine learning model is able to identify algal based taxonomic features and quantify. In the future, it is anticipated that an automated sampling system could be used as a part of the solution to allow regular sampling and counting of algal species.

The use of artificial intelligence reduces the need for skilled labour; improves data integrity and standardises algal identification. There is scope for modelling, combining data with other water quality metrics, and using fish-related data to provide more accurate operational trigger limits. Further investment into this technology may unlock opportunities for identification/monitoring of zooplankton and hydrozoan medusae.

APPROACHES TO DIFFERENTIATING AQUACULTURE PRODUCTS WITHIN THE GLOBAL MARKET FOR SEAFOOD

James A Young*

Marketing & Retail Division, Stirling Management School
University of Stirling
Scotland FK94LA
j.a.young@stir.ac.uk

Globally aquaculture products constitute the dominant share of seafood consumed and will continue to play an increasingly important role in world food supplies. Despite the global importance of fisheries and aquaculture production (214Mt in 2020, FAO, 2022) most seafood products reach their markets as an undifferentiated commodity. One significant consequence of this is the loss of potential value achievable through product differentiation. The increasing market share of aquaculture products heightens the importance of identifying how value currently foregone through non-differentiation might be recouped.

This paper draws upon a number of research projects concerned with alternative marketing strategies to differentiate seafood products in Europe and SE Asia. It appraises various ways in which products can be differentiated and reports on how buyers, both B2B and B2C, evaluate the alternatives. Market responses vary and will do so over time under changing socioeconomic circumstances. If aquaculture value chains are to succeed in proactive responses to evolving markets they must, at least, be alert to options for revenue growth.

Differentiation aims to create some combination of those Unique Selling Points (USPs) identified as important determinants of demand. USPs may enable differentiated products to attain, *inter alia*, brand identity, customer loyalty and a willingness to pay some price premium. Differentiation may be achieved using a range of different attributes whose relative importance will evolve. Potential intrinsic and extrinsic attributes including quality, size, freshness, texture, fat content, provenance, capture mode, organic status, ecolabelling, branding, packaging and others may be used to promote differentiation.

However, as the commodity-centric tendency evidences, some disincentives to differentiation also exist. Not least is cost and consequent reduction in profitability: the antithesis of differentiation. Limitations of market size; delivery costs of highly specific USPs; changing customer preferences and the need to create and maintain market research can hinder adoption. Some differentiation strategies, including new products developed, may be readily copied by follower competitors and discourage leadership in differentiation.

The paper concludes that the greater controls available in aquaculture value chains should provide more amenity to differentiation when compared with those that are capture based. Appraisal of the scope for differentiation to improve the utilization of seafood resources suggests there may be many more shades in blue transformation.

EFFECTS OF THE SIZE OF ABALONE (*Haliotis discus hannai*) SEEDS STOCKED ON THE SEA CAGE ON GROWTH

Young Dae Oh*, Mi-Jin Choi, Dian Yuni Pratiwi, Kang Won Kim, Han Kyu Lim

Smart Aqua Farm Convergence Research Center
Mokpo National University
Muan, Jeonnam 58554
oh9108@mnu.ac.kr

The study investigated the long-term growth and survival rates of Pacific abalone (*Haliotis discus hannai*) seeds stocked in sea cages. It was conducted at the abalone cage culture in Bogil-do, Wando-gun, Jeollanam-do. The experiment utilized a 2.4 m × 2.4 m cage, with *Undaria pinnatifida* and *Saccharina japonica* provided as diet. The sea cage stocking seeds were categorized into groups A (3.2 to 3.6 cm), B (2.9 to 3.2 cm), C (2.6 to 2.9 cm), and D (less than 2.6 cm) based on Shell length. Throughout the experiment, salinity and pH remained constant, while water temperature and dissolved oxygen content exhibited seasonal variations within suitable ranges for abalone rearing. After 722 days of rearing, survival rates did not substantially differ among experimental groups, except for group D, which experienced excessive early mortality upon stocking and was consequently excluded from the analysis. Seed growth rates gradually declined as the rearing period extended after initial stocking in sea cages, with no substantial differences observed between groups A, B, and C after the 722 days. In conclusion, the study indicates that the initial stocking size of abalone seeds does not substantially impact productivity during long-term rearing.

MORPHOMETRIC DIVERSITY OF PROSPECTIVE PARENT SHRIMP *Penaeus Indicus* DOMESTICATION RESULTS

Amri Yudhistira*, I Kadek Ariawan

Jepara Brackish Water Aquaculture Development Center
Jl. Cik Lanang, Rw. IV
Bulu, Kec. Jepara, Jepara Regency
Central Java 59418, Indonesia
Phone: (0291) 591125
Fax: (0291) 591724

Corresponding Author:
utamabbpbapjpr@gmail.com

Indicus shrimp is one of the pond cultivation commodities which is expected to become a favorite for Indonesian fisheries exports, however its development is currently still limited. Therefore, efforts to revive indicus shrimp cultivation can be done by encouraging the supply of quality indicus shrimp parents, one of which is through domestication efforts. This test aims to determine the progress of indicus shrimp domestication efforts at Jepara Brackish Water Aquaculture Development Center. Identification of morphometric diversity is carried out by calculating the diversity coefficient. The method used is truss morphometry. There were 15 shrimp samples tested for each male and female in G-1 and G-2. The lifespan of shrimp ranges from 6-7 months with an average total length of female shrimp 12-15 cm and male shrimp 15-18 cm. There were 19 landmarks and 42 morphometric characters measured on the shrimp body surface. Measurements are carried out digitally.

The test results showed that the diversity coefficient of G-1 and G-2 indicus shrimp was relatively low because it was in the range of 2-18%. The results indicate that indicus shrimp populations tend to be homogeneous and uniform. However, there was an increase in the average diversity coefficient from the G-1 population (5.8%) to G-2 (7.6%).

DEVELOPMENT OF CLOWNFISH CULTIVATION (*Amphiprion* sp) AT MAIN CENTER FOR MARINE AQUACULTURE (MCMA) LAMPUNG

Yuli Yulianti*, Ali Hafiz Alqodri, Rendy Fitrianto and M. Ilham

Main Center for Marine Aquaculture
Main Center For Marine Aquaculture
Marine Affairs and Fisheries Ministry
Email : bbpbl.lampung@gmail.com

Ornamental Clownfish (*Amphiprion* sp) cultivation in Lampung has been carried out since 2011 until now (MCMA and Fish farming). Lampung is one of the areas that supplies marine ornamental fish and coral reefs to exporting companies and local ornamental fish traders in Jakarta and other big cities. Assistance for Marine Ornamental Fish Seeds and Assistance for Ornamental Fish Infrastructure is one of the Main Performance Indicators of the Lampung Marine Aquaculture Center. Production and assistance for marine ornamental fish seeds (clownfish) is carried out every year, while assistance for marine ornamental fish facilities and infrastructure has been implemented in 2021 and 2023.

The types of ornamental clownfish produced at MCMA Lampung are the clown type *Amphiprion ocellaris, Amphiprion percula, Amphiprion clarky, premnas biocoelatus*, as well as the nemo hybrid types (Platinum, Picasso, snow flake, Black nemo, mid night, frost bite, lighting maroon and others). Clownfish seed production (*Amphiprion* sp) in 2022 will be 25,921 individuals. 20,000 seeds were distributed and 3,228 were sold. Mean while, in 2023, clownfish seed production will be 19,973 fish. The seeds distributed were 6,181 heads and sales were 8,220 heads.

Two packages of marine ornamental fish infrastructure assistance in 2023 were given to two Fish farming on Pahawang Island, namely “Sinar Harapan Fish Farming” and “Semoga Jaya Fish Farming”. The marine ornamental fish facilities and infrastructure assistance received by each fish farming includes 3 units of RAS system, clownfish seeds, feed, medicine and other work equipment. Clownfish seeds are raised in RAS media for approximately one month, then raised in Floating Net Cages for 1 to 2 months. From the 1500 clown fish seeds provided (size 1.5 - 2 cm), 1000 to 1200 clown fish seeds (size 3-4 cm) can be harvested ready for sale with a maintenance period of 2 - 3 months.

VIRTUAL SCREENING OF POTENTIAL THERAPEUTIC AGENT FOR STREPTOCOCCOSIS VIA LIGAND-BASED PHARMACOPHORE MODELLING

ZF Helmi Husaini*, H Nurasyikin, M Nur Nazifah, S Nurul Hidayah AH Azzmer Azzar

Kuliyyah of Science
International Islamic University Malaysia
Bandar Indera Mahkota
Kuantan, Malaysia
helmihusainizf@gmail.com

Streptococcosis is a bacterial disease prevalent among warm-water fish, posing a significant threat to the aquatic industry, particularly in tropical regions. The causative agent, *Streptococcus agalactiae*, is a gram-positive, beta-haemolytic and facultative anaerobe bacterium. The limited use of antibiotics in aquaculture due to bacterial resistance and has heightened the urgency for the discovery of new drugs. This research aims to explore natural product compounds for treating streptococcosis through ligand-based pharmacophore modelling and virtual screening.

By focusing on *S. agalactiae*, 1061 compounds with Minimum Inhibitory Concentration (MIC) values have been identified using the ChEMBL database. Subsequent filtering by selecting approved drugs and removing duplicate compounds have resulted in a total of 49 active compounds used for modelling. Clustering analysis using LigandScout unveiled 17 distinct clusters, with a notable observation of similar functional groups. Beta-lactam structures, targeting penicillin-binding proteins, were prominent, alongside fluoroquinolones affecting DNA gyrase and topoisomerase IV. Glycopyronase structures exhibited potential in targeting the cell membrane and bacterial ribosome.

The best model as in Figure 1 consists of nine features demonstrating an AUC value of 0.74 with 0.65 sensitivity and 0.73 specificity. Virtual screening was conducted using the natural product NADI database and detecting 77 compounds. The extract of the top 5 compounds in Table 1 has been recorded previously able to inhibit *Streptococcus sp* indicating the potential of these compounds to be able to work as therapeutic agents for streptococcosis. These findings contribute to ongoing efforts to combat antibiotic resistance in aquaculture, underscoring the importance of innovative drug discovery strategies by using natural product for the sustainable health of aquatic ecosystems.

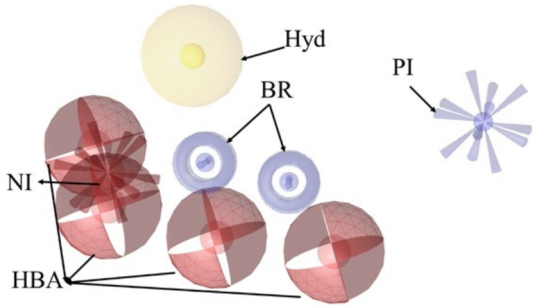


Figure 1: The best pharmacophore has been selected with a combination 9 features

Table 1: List of top 5 compounds that have been detected from virtual screening

Comp. ID	Plant source	Plant part
MSC2202	*Syzgium aromaticum*	Flower
MSC2527	*Murraya paniculata*	Leaf
MSC0605	*Oryza sativa*	Seed
MSC0783	*Harrisonia perforate*	Bark
MSC0365	*Garcinia mangostana*	Pericarp

PROGRESS TOWARD DEVELOPMENT OF MARINE ORNAMENTAL FISH *Premnas biaculeatus* AQUACULTURE IN THE LOMBOK MARINE AQUACULTURE DEVELOPMENT CENTER, WEST NUSA TENGGARA, INDONESIA

Zainuddin*
Bayu Priyambodo*
Moch. Amiri*
Arif Supriyanto*

*Lombok Marine Aquaculture Development Center of Indonesia

Ornamental fish production is one of the important sectors in the aquaculture industry. Indonesia has shown a great improvement in the trade of ornamental fish exports in the last decade, growing 69.64% per year. However, the common challenges identified can be categorized into four: production-related issues, market/economy, technology adoption, and other problems.

This study discusses the production of perspective broodstock of 'Balong' fish (*Premnas biaculeatus* The juveniles, which had been produced from the hatchery, were reared at sea in a floating cage of 1m x 1m (mesh size 1,5mm) covered by 3m x 3m x 3m net (mesh size 1cm) for security with the stocking density of each cage being 200 fish. Feeding is carried out in a controlled manner at least 2 times a day in the morning and afternoon until the fry is full using fresh feed and commercial pellet feed. Health management involves minimizing excessive feeding, replacing the dirty nets with clean ones regularly, and soaking the fish in freshwater once a month. After a 4-month day of culture, the fish reached 5 - 6 cm in total length. Then, fish were sorted, graded, and selected to discover the best shape/physical performance of the fish to be a perspective broodstock.

ECOSYSTEM SERVICES OF SEAGRASS HABITATS IN PENINSULAR MALAYSIA

Muta H. Zakaria*, Nurul N. F. Syed, Mohammad A. Che Alias, Nur Leena W.S. Wong and Japar S. Bujang

Department of Aquaculture
Faculty of Agriculture
Universiti Putra Malaysia
43400 UPM Serdang
Selangor Darul Ehsan, Malaysia
muta@upm.edu.my

Seagrasses are submerged monocotyledonous plants that play a crucial role in providing ecosystem services with direct and indirect benefits to humans. This study explores the diverse ecosystem services offered by seagrass habitats across Malaysia, encompassing monospecific and multi-species. With sixteen seagrass species identified along Malaysia's extensive 4800 km coastline, stretching from the Malay Peninsula to Sabah and Sarawak, these habitats thrive in varied environmental conditions. Seagrasses are primary producers in marine and estuarine settings and serve as essential food sources for marine organisms, including dugongs, green turtles, and fish. Additionally, seagrass meadows, such as those in Sungai Pulai estuary, Johor, and Pulau Korea, Jelutong, Penang, support diverse fish and invertebrates, contributing significantly to local fisheries. Coastal communities rely on seagrass meadows to gather gastropods, bivalves, sea cucumbers, cockles, and edible seaweeds for sustenance and economic activities. Aquaculture activities within seagrass habitats in Pengkalan Nangka, Kelantan, Tanjung Surat, Johor, and Gong Batu, Terengganu, showed the link between seagrass ecosystems and human livelihoods. On the other hand, escalating land reclamation in coastal areas, such as Port Dickson, Negeri Sembilan, Johor, and Penang, poses significant threats to seagrass habitats and their regulating services. The value of seagrass ecosystems and their preservation importance are highlighted in awareness and educational programs. This study emphasizes the importance of natural resource sustenance and conservation to support local population livelihoods dependent on the seagrass ecosystems.

CMOS ENHANCED THE MUCOSAL IMMUNE FUNCTION OF SKIN AND GILL OF GOLDFISH (*Carassius auratus linnaeus*) TO IMPROVE THE RESISTANCE TO *Ichthyophthirius multifiliis* INFECTION

Senyue Liu[1,3], Yufan Zhang[2], Gang Lin[2], Xiaoli Huang[3]

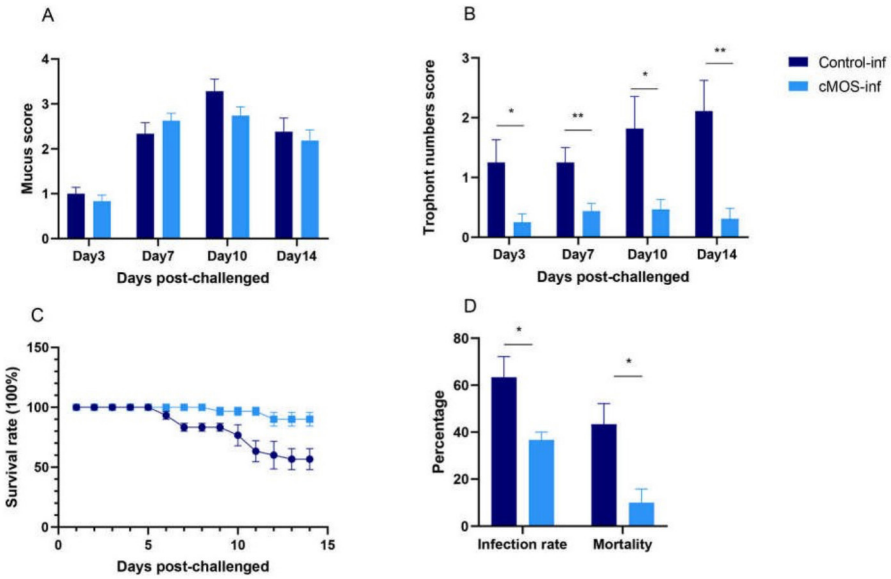
Fisheries Research Institute, Sichuan Academy of Agricultural Sciences, 611731,Chengdu, Sichuan, China
Alltech Biological Products (China) Co. Ltd, 100060, Beijing, China
Department of Aquaculture, College of Animal Science & Technology, SichuanAgricultural University, 611130, Chengdu, Sichuan, China

Methods of supporting mucosal immune barrier integrity and prevention of some pathogenic infections in aquatic species, are key areas of active study, often focusing on feed additives. Theobjectives of this study were to explore the effects of feeding cMOS (concentrated mannan oligosaccharide) on the gill and skin mucosal barriers of goldfish and evaluate health status during *Ichthyophthirius multifiliis* (Ich) infection.

After feeding the cMOS-containing diet for 60 days, H&E staining showed greater length of gill lamella and thicker dermal dense layer, while AB-PAS staining showed higher numbers ofmucin cells in cMOS fed fish. Chemical analysis showed that fish fed cMOS had greater enzyme activity of LZM and alkaline phosphatase AKP in gill and skin tissues, while qRT-PCRrevealed higher expression of Muc-2 and IL-1β, as well as lower expression of IL-10.

After Ich challenge,goldfish fed the cMOS diet had lowermortality andinfection rates, as well as fewer visible white spots on the body surfaces.Histologically, thegill and skin of these fish presented less tissue damage and fewer parasites, andhad a greater number of mucus cells. In addition, the expression of Muc-2 and IL-10 were notably higher while the expression of IL-1β was significantly lower in cMOS fed goldfish than control fed fish.

In conclusion, our experimental results suggest that cMOS fed goldfish had stronger immune barrier function of skin and gill mucous, and better survival after Ich infection.



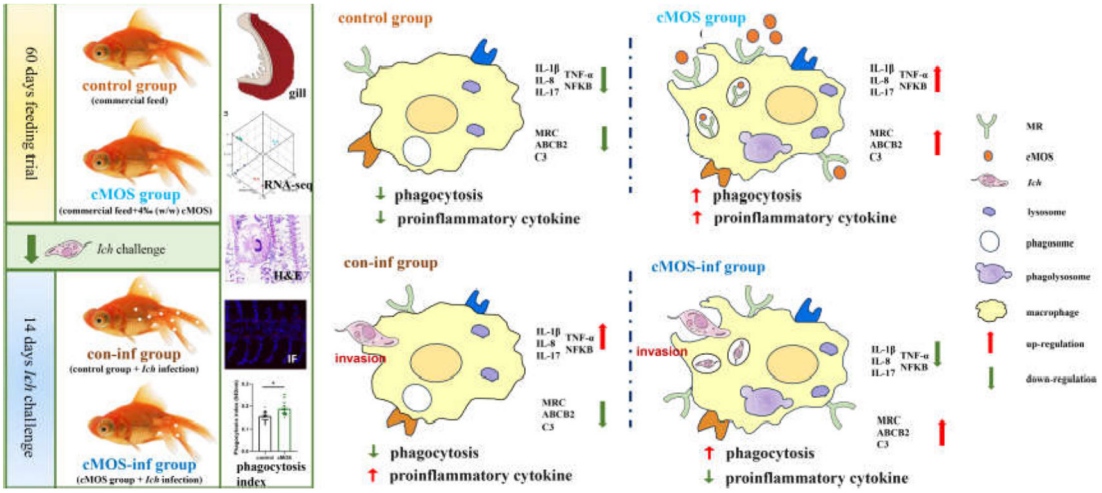
THE POTENTIAL MECHANISM OF CONCENTRATED MANNAN OLIGOSACCHARIDE PROMOTING GOLDFISH'S (*Carassius auratus linnaeus*) RESISTANCE TO *Ichthyophthirius multifiliis* INVASION

Senyue Liu[1, 3], Yufan Zhang[2], Gang Lin[2], Xiaoli Huang[3]

Fisheries Research Institute, Sichuan Academy of Agricultural Sciences, 611731, Chengdu, Sichuan, China
Alltech Biological Products (China) Co. Ltd, 100060, Beijing, China
Department of Aquaculture, College of Animal Science & Technology, Sichuan Agricultural University, 611130, Chengdu, Sichuan, China

Because of the low host specificity, *Ichthyophthirius multifiliis* (Ich) can widely cause white spot disease in aquatic animals, which is extremely difficult to treat. Prior research has demonstrated a considerable impact of cMOS on the prevention of white spot disease in goldfish, but the specific mechanism is still unknown. In this study, RNA-seq, histological analysis, immunofluorescence analysis, phagocytosis activity assay and qRT-PCR assay were used to systematically reveal the potential mechanism of cMOS in supporting the resistance of goldfish to Ich invasion.

11According to RNA-seq analysis, the gill tissue of goldfish receiving cMOS diet showed greater expression of mannosereceptor (MRC) related genes, phagocytosis-related genes, inflammatory-related genes, and higher phagocytosis activity compared with the control. After Ich challenge, RNA-seq analysis revealed that cMOS fed goldfish displayed a higher level of phagocytic response, whereas non-cMOS fed goldfish displayed a greater inflammatory reaction. Besides, after Ich infection, cMOS-fed goldfish displayed greater phagocytosis activity, a stronger MRC positive signal, higher expression of genes associated with phagocytosis (ABCB2, C3, MRC), and lower expression of genes associated with inflammation (IL-1β, IL-17, IL-8, TNF-α, NFKB). Our experimental results suggest that cMOS may support phagocytosis by binding to MRC on the macrophage cell membrane and change the non- specific immunity of goldfish by stimulating cytokine expression.



INTERTINAL MICROBIOTA DIFFERECES ASSOCIATED WITH PHYSIOLOGICAL HEALTH, MEAT QUALITY, AND REGULATING MINERAL INTERACTIONS OF *Penaeus vannamei* FED ORGANIC MANGANESE

Jinzhu Yang [a], Zhonghao Zhang [a], Gang Lin [b], Mingzhu Li [c], Yanjiao Zhang [a, d, *], Kangsen Mai [a, d]

[a]The Key Laboratory of Aquaculture Nutrition and Feed (Ministry of Agriculture), The Key Laboratory of Mariculture (Ministry of Education), Ocean University of China, Qingdao 266003, China
[b] Institute of Quality Standards and Testing Technology for Agricultural Products, Chinese Academy of Agricultural Sciences, Beijing 100081, China
[c] College of Agriculture, Ludong University, Yantai 264025, China
[d] Qingdao National Laboratory for Marine Science and Technology, Qingdao 266237, China

*Corresponding author:
E-mail: yanjiaozhang@ouc.edu.cn (Y. Zhang)

The objective of this study was to investigate the effects of organic manganese (Mn) on the health status of white shrimp (*Penaeus vannamei*) and the potential correlations between intestinal microbiota and host health, meat quality, and mineral interactions. An 8-week experiment was designed with 7 dietary treatments: C_0, no Mn supplementation; S_{20}, 20 mg/kg Mn from $MnSO_4 \cdot H_2O$ (inorganic); SO, 10 mg/kg inorganic Mn and 5 mg/kg Mn from Mn-proteinate (organic); O_{10}, O_{20}, O_{30} and O_{40}, 10, 20, 30 and 40 mg/kg organic Mn, respectively. The 840 shrimp (approximately 5.30 g) were randomly allocated into 21 tanks, with each diet group containing 3 tanks and each tank accommodating 40 shrimp. The results showed that 10 mg/kg organic Mn supplementation is optimal to replace 20 mg/kg inorganic Mn. Compared with inorganic Mn, organic Mn shaped healthier intestinal microbiota communities and enhanced the competitive advantage of shrimp for Mn uptake, which resulted in promoting nutrition metabolism (higher apparent digestibility coefficient (ADC) of crude protein ($P = 0.031$) and concentrations of glucose ($P = 0.013$), triglyceride ($P < 0.01$) and total cholesterol ($P < 0.001$)), enhancing antioxidant capacity and immune response ($P < 0.05$), improving meat quality ($P < 0.05$), and regulating iron content in whole body and muscle, zinc content in muscle and ADC of copper and zinc ($P < 0.01$). Pearson's correlations were observed between gene expression analysis of the immune response and antioxidant capacity, Crude $protein_{ADC}$, meat texture, and dietary organic Mn, between ADC of copper and zinc, muscle content of iron and zinc ($r = 0.55, 0.79, 0.93, -0.91, -0.90$, respectively, $P < 0.001$). In conclusion, organic Mn affects shrimp health status, meat quality and mineral interactions which correlate with changes of the intestinal microbiota.

ORGANIC COPPER PROMOTED COPPER ACCUMULATION AND TRANSPORT, ENHANCED LOW TEMPERATURE TOLERANCE AND TOLERANCE AND PHYSIOLOGICAL HEALTH OF WHITE SHRIMP (*Litopenaeus vannamei* Boone, 1931)

Jinzhu Yang [a], Zhonghao Zhang [a], Gang Lin [b], Mingzhu Li [c], Yanjiao Zhang [a,*], Kangsen Mai [a]

[a] The Key Laboratory of Aquaculture Nutrition and Feed (Ministry of Agriculture), The Key Laboratory of Mariculture (Ministry of Education), Ocean University of China, Qingdao 266003, China
[b] Institute of Quality Standards and Testing Technology for Agricultural Products, Chinese Academy of Agricultural Sciences, Beijing 100081, China
[c] College of Agriculture, Ludong University, Yantai 264025, China
*Corresponding author:
E-mail: yanjiaozhang@ouc.edu.cn (Y. Zhang)

This study was conducted to assess the effects of dietary copper source and level on hematological parameters, copper accumulation and transport, resistance to low temperature, antioxidant capacity and immune response of white shrimp (*Litopenaeus vannamei* Boone, 1931). Seven experimental diets with different copper sources and levels were formulated: C, no copper supplementation; S, 30 mg/kg copper in the form of $CuSO_4 \cdot 5H_2O$; SO, 15 mg/kg copper in $CuSO_4 \cdot 5H_2O$ + 7.5 mg/kg copper in Cu-proteinate; O1, O2, O3 and O4, 10, 20, 30 and 40 mg/kg copper in the form of Cu-proteinate, respectively. A total of 840 shrimp (5.30 ± 0.04 g) were randomly distributed to 21 tanks (3 tanks /diet, 40 shrimp /tank). An 8-week feeding trial was conducted. The results showed that there was no significant difference in growth performance and whole shrimp chemical compositions among all groups. Compared with inorganic copper, dietary organic copper (O2 and O3) increased total protein, albumin, and glucose content of plasma, while decreased triglyceride and total cholesterol of plasma. Copper concentration in plasma and muscle and gene expression of metallothionein and copper-transporting ATPase 2 like in hepatopancreas were higher in shrimp fed organic copper (SO, O2, O3 and O4). The lowest mortality after low temperature (10 °C) challenge test was observed in the O2 and O3 groups. Organic copper (SO, O2, O3 and O4) significantly enhanced the antioxidant capacity (in terms of higher activities of total superoxide dismutase, copper zinc superoxide dismutase, catalase, glutathione peroxidase and total antioxidant capacity, lower malondialdehyde concentration of plasma, and up-regulated gene expression of superoxide dismutase, copper zinc superoxide dismutase, catalase and glutathione peroxidase of hepatopancreas). Organic copper (SO, O2, O3 and O4) enhanced the immune response (in terms of higher number of total hemocytes, higher activities of acid phosphatase, alkaline phosphatase, phenoloxidase, hemocyanin and lysozyme in plasma, and higher gene expressions of alkaline phosphatase, lysozyme and hemocyanin in hepatopancreas). Inorganic copper (Diet S) also had positive effects on white shrimp compared with the C diet, but the SO, O2, O3 and O4 diets resulted in better results, among which the O2 diet appeared to be the best one. In conclusion, organic copper was more beneficial to shrimp health than copper sulfate.

EFFECTS OF SALINITY ON THE GROWTH OF ENIGMATIC GREEN MACROALGAE, *Caulerpa macrodisca* (BRYOPSIDALES, CHLOROPHYTA), UNDER LABORATORY CONDITIONS

Wahidatul Husna Zuldin* and Muhammad Dawood Shah

Borneo Marine Research Institute
Universiti Malaysia Sabah
Jalan UMS
88400 Kota Kinabalu, Sabah, Malaysia
wahidatul@ums.edu.my

Salinity is among the eminent environmental factors besides temperature, nutrients, and light that affect the growth and distribution of macroalgae. An experiment under laboratory conditions was conducted to determine the effect of salinity on the growth of the enigmatic green macroalgae, *Caulerpa macrodisca*. Simulating the common in situ salinity conditions around the sampling stations, five salinity ranges (17, 21, 24, 27, and 31 ppt) were tested in this experiment. The *C. macrodisca* fragments were cultured in a flask with controlled temperature and light intensity under a 12:12 photoperiod. The following growth responses were measured weekly: wet biomass (g), disc diameter (cm), stolon length (cm), and frond length (cm). In the experimental cultures, growth (increase in wet biomass, disc diameter, stolon length, and frond length) was calculated as the relative growth rate (RGR), expressed as a percentage of daily growth. The results showed that salinity had a significant effect ($p<0.05$)on the RGR of *C. macrodisca*. Maximal RGR of wet biomass (5.08 ± 0.04 % day^{-1}) was achieved at 27 ppt, while the negative growth rate was obtained at 17 ppt, with discolouration and progressive deterioration of *C. macrodisca* being observed. These results are in line with *C. macrodisca's* native habitat in the waters of Menumbok, where it is active throughout its yearly cycle near regions with an average salinity of 23 to 30 ppt. According to the study, the physiological responses derived from the results are significant in establishing a baseline for the ecology of the habitat for *C. macrodisca*. This work is important for examining potential environmental influences on the development of the mysterious Caulerpa in tropical estuaries.