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Revitalising farming of the black tiger shrimp in India. Courtesy of Dhaval Contractor, Vaishnavi Aquatech. p20

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Zuridah Merican

ESG and the future of aquaculture

Reuters reported on July 28, 2022, that Singapore's central bank issued new disclosure and reporting guidelines for retail ESG funds. This was developed by no other than Dr Darian McBain who is familiar to us as she also led Thai Union's Sustainability program called SeaChange. ESG is the acronym for Environmental, Social and Governance which covers a plethora of objectives. It has been described as an attempt to make business work better while dealing with the threat of climate change and mistreatment of workers, amongst other things. So how does ESG affect the future of aquaculture?

The simple answer is money and investment. The idea emerged in the mid-2000 that investors should evaluate companies not only on their commercial performance but also their environmental and social record, but it was hazy. Its evolution was made more concrete by UN's Sustainable Development Goals (SDGs) in 2015.

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One might argue that this is relevant to large companies listed on the stock exchange (like Thai Union or Charoen Pokphand) or startups looking for investment. There lies proverbial 'chicken or egg situation'. Compared to salmon and the EU, Asia suffers from a lack of investment in aquaculture today. Could ESG catalyse investment in the aquaculture industry? Where do we start and how do we practice ESG along the supply chain? Because it requires action along the whole supply chain, are integrated companies are better positioned to take advantage of this?

As usual, it is better to start downstream in retail and the consumer as they speak with their purchasing power. Consumers in the US and EU are becoming increasingly well versed with the UN's 17 SDGs. Large retailers focused on the SDGs as a competitive edge in the early days but with time, this will become a norm. Hypermarkets are insisting on sustainable seafood which require responsibly and sustainably farmed products from aquaculture. Processing plants and suppliers have to pass this message on upstream to farmers. The requirements can range anywhere from fair trade and worker treatment to renewable energy for low carbon products. Seafood tends to be consumed by a higher economic segment of the population who are willing to pay a premium for fair trade and climate friendly seafood and this could be the pull effect.

During the recent Global Shrimp Forum, Hugo Byrnes, Ahold Delhaize gave a wake-up call from a retailer's perspective. Among them are issues on human rights, deforestation and shrimp welfare with no eye stalk ablation. Financial institutions want to know what retailers are doing on these matters and this goes down to the suppliers. Therefore, as leading suppliers, Asian farmers have to be educated on these new requirements, when asking for premium prices in return for their effort as the supply chain has to work together.

Feed companies also play an important role for two different reasons. The first is the ingredients they buy as not all fishmeal and fish oil are bad just as not all soybean meal is good. Fishmeal from by-products is contributing to the circular economy and reducing waste while soybeans from Brazil could be treated with suspicion if it comes from areas of the recently felled Amazon Forest.

The second is that many feed companies are large and better connected to the needs and demand of the industry and act as educators to the farmers. Information and education are key as the farmers may be the weakest link in the supply chain when it comes to adopting SDGs.

In summary, the aquaculture industry should have the SDGs adopted as a code of practice which can be certified and assisted by a pull effect from the retail segment and buyers. Although the future looks hazy now, it is logical that such a development and evolution in the aquaculture industry would attract investment and confidence. The objective is worthwhile and The Economist (July 23) reports that investment managers claim that more than a third of their assets (about USD35 trillion) are monitored through one ESG lens or another.

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Marine ingredients supply chain in Thailand

The IFFO webinar on Thailand, held in July, focussed on its marine ingredients supply chain and use of marine ingredients in aquafeeds. It also covered on ways to access China's fishmeal market and global market dynamics. IFFO - The Marine Ingredients Organisation is the international trade organisation representing the marine ingredients industry, such as fishmeal, fish oil and other related industries.

Fishmeal supply and demand in Thailand

Kittipat Oerareemitr, Vice President of the Thai Fishmeal Producers Association and Director of Fishmeal Marketing Development Co., Ltd, the largest fishmeal company in Thailand with 100,000 tonnes of trading volume per year, provided some information on production trends and market dynamics. Fishmeal production in Thailand began in 1970 and the association was founded in 1981. Kittipat showed how the industry evolved and developed in a sustainable way.

Thailand has four main fishing areas with different seasons for fishing to ensure all year-round supply. The industry involves 1,000,000 workers along the supply chain from fishing vessel to 66 fishmeal plants. Post IUU (illegal, unreported and unregulated fishing), Thailand has improved on the industry traceability and sustainability systems via the MCPD (marine catch purchasing document) from fishing vessel to port of loading. In April 2015, Thailand was given the EU's IUU yellow card and since then has overhauled and modernised its fishing and fisheries sector and built a robust new legal and policy framework to ensure a more sustainable, ethical, environmentally and socially friendly industry. Between May 2015 and September 2018, the Thai government has allocated approximately €87 million to combat IUU fishing (Department of Fisheries- DOF, Thailand)

Raw materials for fishmeal production come from whole fish and non-human consumption fish, fish waste from tuna canning, freshwater fish processing plants, supermarkets and fresh markets and from surimi production. Each year around 30-40% of total fishmeal production or around 100,000 tonnes come from whole fish. Tuna canning is a large industry in Thailand and fishmeal from tuna by-products account for 20-30% or 60,000-70,000 tonnes. Waste from supermarket processing account for 15-25% and waste from freshwater and brackish aquaculture contribute 10-20% of total fishmeal. Waste from surimi production is no longer a major contributor to fishmeal production at only 1,087 tonnes in January-April 2022 as compared to 56,691 tonnes in 2016.

The association estimated the following consumption of fishmeal in 2021: 99,200 tonnes for shrimp feed production (496,000 tonnes); 27,000 tonnes for fish feeds (540,000 tonnes) and 71,683.35 tonnes for swine feeds. In 2021, the total volume of fishmeal in feeds was 197,883.35 tonnes.

In 2014, Thailand produced 478,000 tonnes of fishmeal and since then, production has been decreasing. In 2021, production was 247,770 tonnes and in 2022, the volume expected will be close to 250,000 tonnes. Premium fishmeal (65% protein) comprises around 20% of the annual fishmeal production. Today, certified fishmeal is playing a larger role because of demand from the end users.

The highest volume of fishmeal imports was in 2021 at 73,942 tonnes from Vietnam, Cambodia and Myanmar. Exports totalled 122,773 tonnes in 2021 and the estimate of exports is 120,000 tonnes for 2022; for the period January to May, almost 56,000 tonnes was exported.

In a presentation on Thailand's swine business outlook and fishmeal usage in swine feed, Nithitad Jiebna, Sales and Technical Director at Amcovet Group, said that fishmeal is a good protein source for swine. Imported fishmeal is low temperature fishmeal and hydrolysed whereas local fishmeal comprises: Premium grade with 65% protein and grade 1 with 60% and grade 2 with 55% protein. Imported hydrolysed fishmeal and premium grade fishmeal are specifically used in feeds for sow and piglet feed while 60% grade 1 fishmeal can be used for all feed types and for fattening feeds.

Responsibly sourced fishmeal

With regards to certification with Marin Trust, Kittipat said that Thailand's industry is making inroads and more than 60% of production comes from by-product recycling. MarinTrust's Impact Manager, Nicola Clark, summarised that Thailand currently has 11 MarinTrust certified marine ingredient production sites, which use by-product raw materials to produce fishmeal and fish oil. However, raw materials being sourced locally from the Gulf of Thailand

Kittipat Oerareemitr says, "Premium fishmeal (65% protein) comprises around 20% of the annual fishmeal production. Today, certified fishmeal is playing a larger role because of demand from the end users."

"The MarinTrust programme is developing a fishery assessment method to allow them to demonstrate responsible management," said Nicola Clark.

Dr Orapint Jintasataporn said "In the tilapia, some fishmeal and linolenic acid are sufficient for fatty acid biosynthesis."

Update on global supply of fishmeal and fish oil

IFFO's Market Research Director Dr Enrico Bachis discussed recent developments on global supply of fishmeal and fish oil and outlook on supply for 2022. In 2021, Latin America supplied 42% of global fishmeal but drops of 10% in fishmeal and 5% in fish oil are expected from Peru and Mexico in 2022 which foresee fewer catches. Mexico had a record season in 2021 but is not expected to repeat this in 2022. Although Panama and Chile are expected to contribute more in 2022, the volume cannot compensate the decline in volumes from Peru and Mexico. Supplies in North America will increase by more than 12% while supplies from Europe will also increase in 2022. Here fishmeal is mainly from reduction fisheries. Supplies from Morocco and Mauritania are expected to remain similar as in 2021.

More production is expected in 2022 from India and Vietnam while supplies will be lower from Thailand and China. China's production has been declining for the past 5 years. Thailand produced 248,000 tonnes of fishmeal in 2021 and 9,000 tonnes of fish oil.

Bachis added that all eyes will be on the situation in China in 3Q and which will be a deciding factor in forecasting future supplies. A conservative estimate on fishmeal supply will be a stable 5 million tonnes of fishmeal in 2022 and fish oil at around close to 1.2 million tonnes.

With regards to responsibly sourced supply of fishmeal, 49% of global marine ingredients comply with Marin Trust certification. When other certifications such as MSC are included, Bachis said that responsibly sourced supplies are well above the 50% mark. "No other feed ingredients can enjoy this level of sustainability with responsible sourcing."

Marine ingredients have contributed to aquaculture development. In fact, crustacean farming led in 2021, followed by freshwater fish, marine fish and in fourth place, the salmonids. Asia and China, due to the sheer size of their aquaculture sector, consumed more than 70% of global fishmeal supplies. Latin America consumed 11% and Europe only 9%. Salmonids consumed the bulk of fish oil at 56% in 2021.

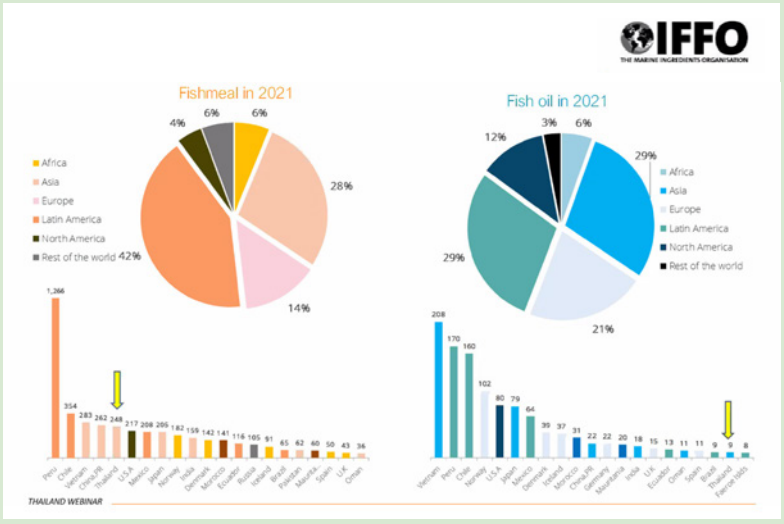

Figure 1. Supply -Geographical Breakdown. Marine ingredients are produced everywhere although Latin America, Asia and Europe are the biggest producers. Source: IFFO, Thailand Webinar, July 2022.

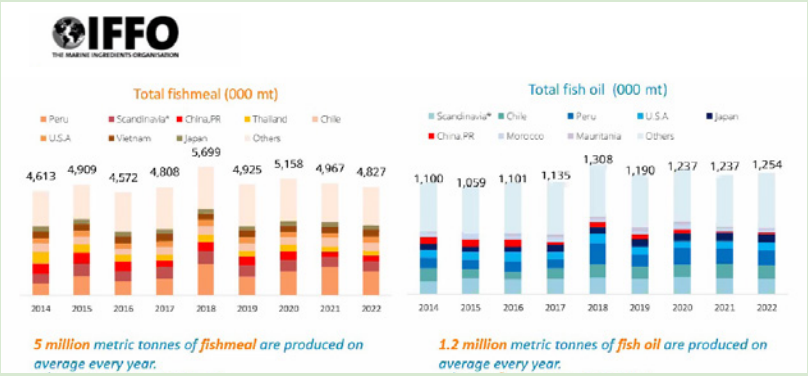

Figure 2. Supply in 2022. The projected lower production in Peru will reduce slightly the overall world supply of fishmeal in 2022. Supply of fish oil might increase due to the larger output in several regions. Scandinavia=Denmark, Iceland and Norway. Source: IFFO, Thailand Webinar, July 2022.

are not currently eligible to produce certified marine ingredients as there is not currently a mechanism in place to allow the demonstration of responsible management of such complex fisheries.

The MarinTrust programme in collaboration with Southeast Asian multispecies fisheries, including the Gulf of Thailand, are developing a fishery assessment method to allow them to demonstrate responsible management. Using the MarinTrust Improver Programme structure, which requires the establishment of a Fishery Improvement Project (FIP) and an audit of the marine ingredient production factory, Thai fishmeal producers, government representatives and other stakeholders, are working towards demonstrating responsibility of the Gulf of Thailand mixed-trawl fishery. By testing the developing multispecies fishery assessment against these fisheries, MarinTrust aims to produce an assessment process that can be incorporated into the main Standard and therefore increase accessibility to the programme.

Innovative shrimp feeds

Dr Olivier Decamp, Group Technical Director at Grobest described challenges faced by farmers. Success in shrimp farming requires the following: good quality post larvae from good genetics and screened prior to stocking and good hatchery management; quality feeds and feed management and farm management inclusive of biosecurity and microbial management. Grobest which produces functional additives in-house has incorporated combinations of additives into feeds to match the needs of each farming scenario and disease challenges such as aggregated transformed microvilli (ATM) and white faeces syndrome (WFS). To derive cost effective feed solutions, in Thailand, teams assess water quality and presence of lipid vacuoles in hepatopancreas prior to recommending a functional feed. Decamp emphasised on the importance of formulations which combines R&D in nutrition with information from the field (status of shrimp, gut health etc.). Weekly assessments of growth rate provide information on shrimp growth performance.

Importance of fish oil in aquafeeds

Dr Orapint Jintasataporn, Associate Professor at Kasetsart University in Thailand said that requirements for fish oils in white shrimp, marine fish such as the Asian seabass and freshwater fish such as tilapia and pangasius differ. While requirements for the seabass remains high as the fish grows, for the tilapia, the requirement is lower at 4% of diet for 200g fish as compared to 6% of diet for juvenile 5-10g fish. Some fishmeal and linolenic acid are sufficient for fatty acid biosynthesis. In the pangasius, the level of lipids in diets remains the same throughout the culture cycle, but the ratio for n-3: n-6 changes as the fish grows. A 1:3 ratio is required during larval development and a lower ratio is desirable to prevent fat accumulation in marketable fish.

What's more, fish oil provides cholesterol and phospholipid for all aquatic animal larvae, especially marine shrimp and fish; promotes lipid digestion, absorption and utilisation; then enhances liver function and reduces fatty liver including abdominal fat. Fish oil also contains some vitamin A and D. These substances in fish oil can enhance immunity, and bone mineralisation. Importantly, when replacing fish oil with plant oils, the focus should be on the effects of reducing these crucial components since the latter lacks omega-3 fatty acids.

IFFO's Maggie Xu who hosted the webinar noted, "Both access and sustainability remain at the core to the long-term success of this industry. IFFO recognises Thailand's key role in the global marine ingredients and aquaculture industries, and we look forward to continuing our work in this region following these fascinating discussions."

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News in brief

Two sites accepted for MarinTrust FIP

The MarinTrust Improver Programme (FIP) follows precise criteria and scoring systems in line with the FAO Code of Conduct for Responsible Fisheries, focusing on:

- stock status,
- resource management strategy,
- control and monitoring at sea and at unloading points,
- impact on protected species and the environment,
- and governance that meets the needs of the fishery and allows all industry stakeholders to participate.

In June, MarinTrust announced the first site from the Indian Oil Sardine FIP (Goa and Maharashtra) that has been accepted onto Improver Programme: Omega Fishmeal and Oil Pvt Ltd. It also announced that the first production site from the Mauritanian small pelagic fishery has been accepted onto its Improver Programme: Atyfen SARL. This follows a demonstration of compliance to the MarinTrust standard via an audit of the production site by a third-party Certification Body (CB).

The Indian Oil Sardine FIP (Goa and Maharashtra) fishery was accepted onto the Improver Programme in October 2019 as the first accepted Fishery Improvement project (FIP) in Asia under the MarinTrust Improver Programme. This FIP is currently led by Omega in collaboration with national and local stakeholders.

The Mauritanian small pelagic fishery was accepted onto the Improver Programme in October 2019 as the first accepted Fishery Improvement project (FIP) in Africa under the MarinTrust Improver Programme. This FIP is currently led by industry in collaboration with other local stakeholders.

A production site wishing to use the MarinTrust Improver Programme claim must pass a MarinTrust audit for that site. Once a production site is accepted onto the MarinTrust Improver Programme, information on the site is listed on the MarinTrust website. The site must then continue to comply with the MarinTrust audit requirements annually. The FIP they are sourcing from must also demonstrate continually improvements in line with their Fishery Action Plan (FAP).

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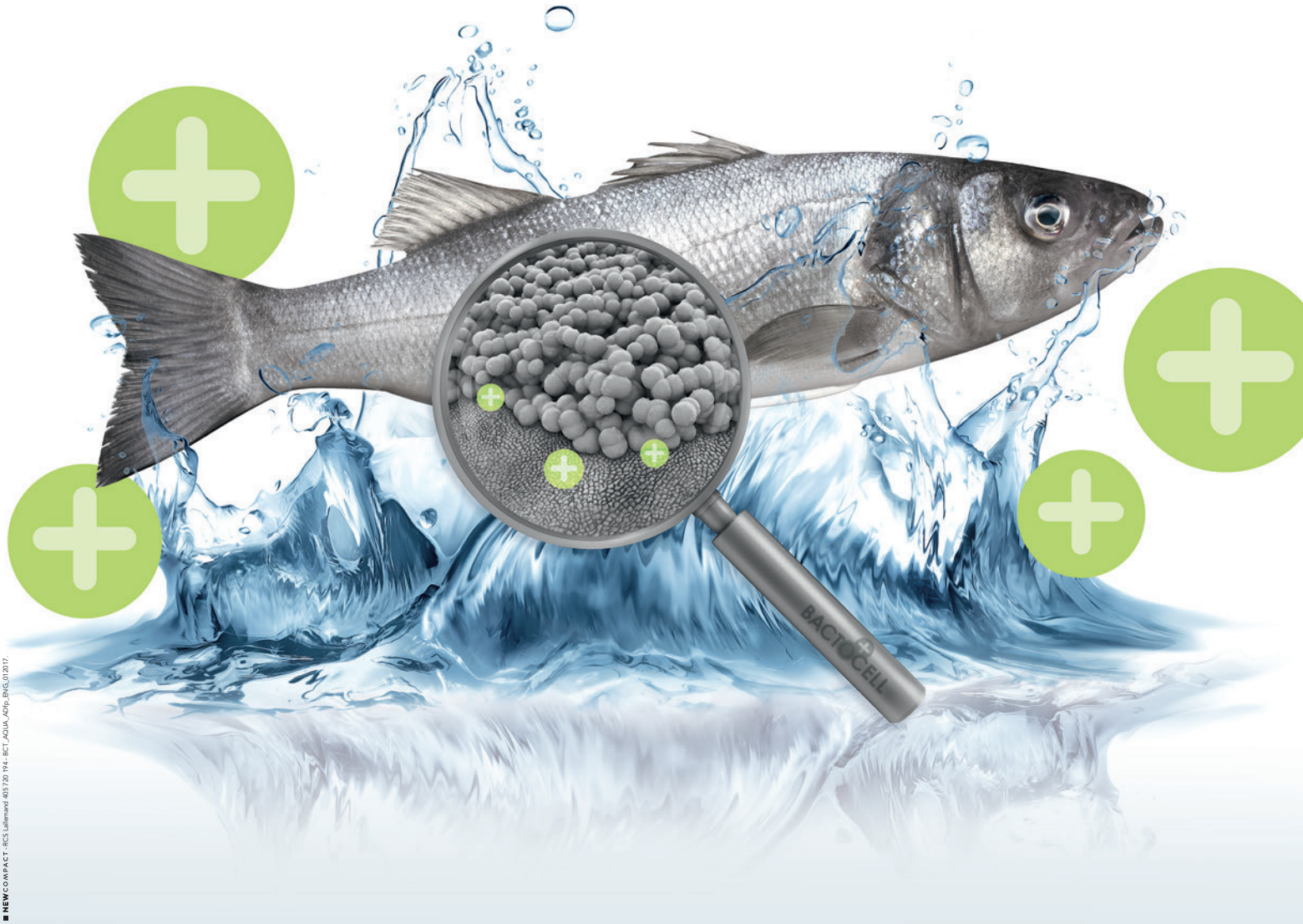

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Review of India's 2021 shrimp crop

National record production of farmed shrimp led by higher volumes in Andhra Pradesh and Odisha

The Society of Aquaculture Professionals (SAP) organised a review of the shrimp crop in 2021 in Chennai, India. The exercise involved estimating shrimp production by region, presenting and discussing challenges experienced by shrimp farmers and other stakeholders in 2021, and predicting trends for production in 2022.

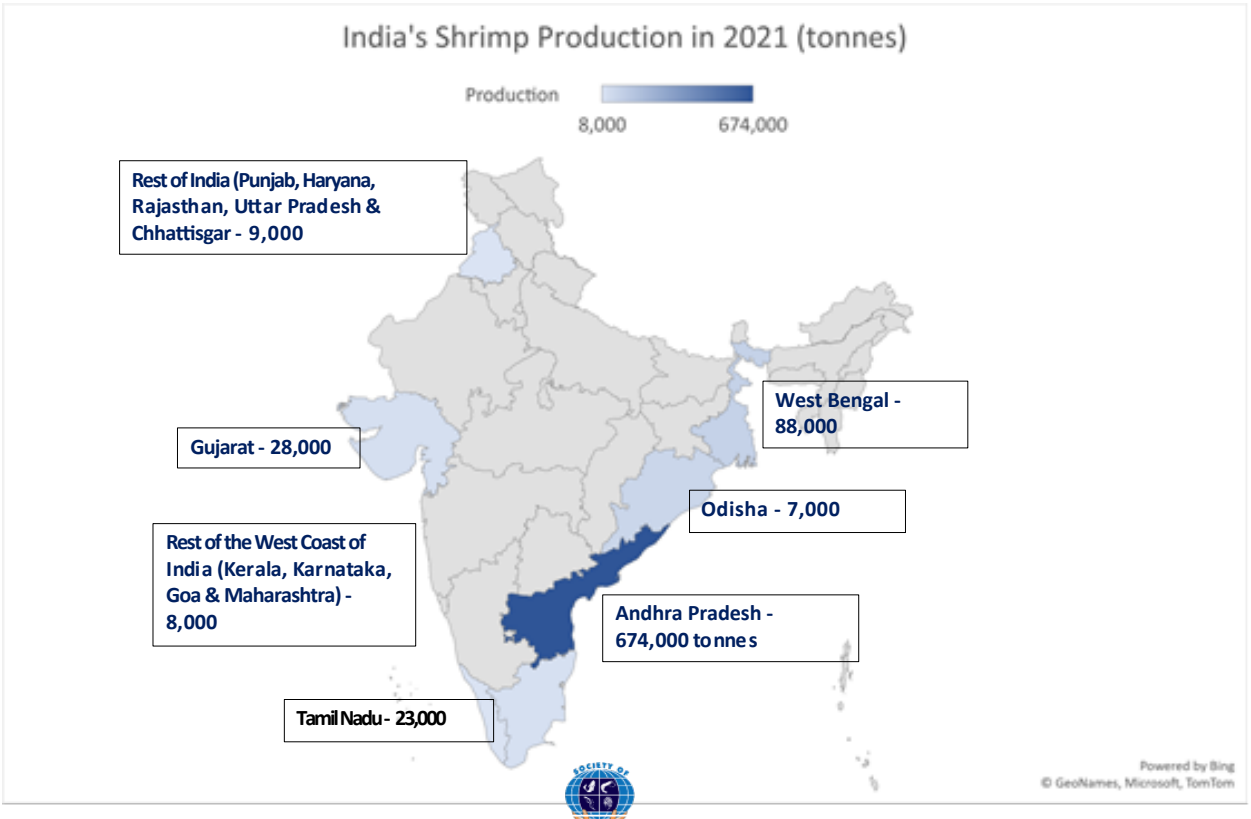
The Shrimp Crop 2021 Review was held on February 24, 2022. It was organised by S. Chandrasekar, US Soy Export Council and coordinated by Madhusudhan Reddy, SAP's Vice President (Events).

Highest production in 2021

India registered the highest ever production of farmed shrimp in 2021, estimated at 930,000 tonnes. Expansion of shrimp farming areas, increase in the number of crops and conversion of fish farms to shrimp farming contributed to the increase in production. Cyclone Yaas, floods and unseasonal rains hit shrimp production in West Bengal, Odisha and South Andhra Pradesh, resulting in lower production from these regions.

Region	Estimated production of shrimp (tonnes)
Gujarat	**28,000**
Rest of the West Coast of India (Kerala, Karnataka, Goa & Maharashtra)	**8,000**
Tamil Nadu	**23,000**
Andhra Pradesh (Total)	**674,000**
• South Andhra Pradesh (Nellore, Prakasam and Guntur districts)	114,000
• Krishna	130,000
• West Godavari	270,000
• East Godavari & Rest of North AP	160,000
Odisha	**70,000**
West Bengal	**88,000**
Rest of India (Punjab, Haryana, Rajasthan, Uttar Pradesh & Chhattisgarh)	**9,000**
Unaccounted*	**30,000**
Total	**930,000**

Table 1. Production estimates for 2021
* Other regions



Estimated farmed shrimp production in 2021 by region.
Source: Society of Aquaculture Professionals May 2022

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Andhra Pradesh remained India's leading shrimp-producing state. Three of its districts, Krishna, West Godavari and East Godavari, produced 75% of the state's production. Disease outbreaks due to white spot syndrome virus (WSSV), *Enterocytozoon hepatopenaei* (EHP) and pathogenic *Vibrio* limited shrimp production while the industry managed the second wave of COVID-19, which did not have much impact on shrimp production. The rapid increase in feed raw material prices resulted in higher feed prices and impacted farm profitability.

The introduction of specific pathogen-free (SPF) black tiger shrimp *Penaeus monodon* proved to be a successful development and created a lot of expectations among stakeholders. However, most of the segments of the farmed shrimp sector had a tough time managing their operations as profitability was reduced.

Gujarat

Gujarat, once predicted to be a sizeable shrimp-producing state, has seen its production decline due to carrying capacity challenges in the last few years. The introduction of SPF black tiger shrimp in 2021 was a welcome development for Gujarat. It enabled the farmers to produce high-value, large-size shrimp using a lower stocking density (8-15 PL/m^2). The state ended producing an estimated 28,000 tonnes of shrimp in 2021, of which 3,500 tonnes was black tiger shrimp. No major farming-related problems were reported, except for the occasional occurrence of WSSV and EHP in vannamei shrimp production.

Tamil Nadu

The state witnessed a higher success rate in farming vannamei shrimp in 2021 compared to previous years. However, the reduction in pond area used for stocking and lower stocking densities meant that production in 2021 remained the same as in previous years. Farmers in Tamil Nadu were better placed in terms of farm gate price as the price of shrimp increased after June 2021. This region's farmers saw better profits than farmers from other states.

South Andhra Pradesh

The region covered major farming areas of the Nellore district (Kota, Gudur, Nellore town and Kavali), the Prakasam district (Ongole, Chinna Ganjam, Petha Ganjam and Bheeram Gunta) and the Guntur district (Bapatla and Karlapalam). While Nellore and Prakasam districts mainly produced vannamei shrimp, Guntur district went for black tiger shrimp production in 2021. The success rate was high in farms using groundwater in the Nellore district and black tiger shrimp production in the Guntur district. The Kavali area has had consistent production of shrimp in recent years due to strict adherence to crop holidays between February and May every year. Unseasonal heavy rains and floods hit southern parts of the Nellore district and many farmers lost their crops just before harvest.

Krishna district

There was an expansion of farming areas and an increase in number of crops. The average culture period was 70 days and stocking shrimp was in ponds previously used for fish farming, especially in the second season of 2021.

The result was an increase in production by 40%. Shrimp is also produced in polyculture with fish in the district and these fish ponds are larger when compared to the shrimp ponds. Except for Machilipattinam and Nagailanka, shrimp farming is done in low salinities in the Krishna district, which is another factor in the success of shrimp farming in the district.

"Nearly 30% of the total shrimp production in India comes from West Godavari in Andhra Pradesh."

West Godavari

This district is the single largest region in terms of farming area (ha) and shrimp production. Nearly 30% of the total shrimp production in India comes from this district in Andhra Pradesh. Shrimp production expanded in 2021 and reached an estimated 270,000 tonnes. The reasons for higher production included expanding farming to newly developed areas, a reduced number of days of culture that increased the number of crops per year and the rotation of crops from fish to shrimp between July and November. Disease outbreaks were quite severe during the summer months in the district. Many farmers resorted to harvesting size 60-80 (12-16g) due to concerns about EHP and running mortality.

East Godavari and other districts in North Andhra Pradesh

The region includes Amalapuram, Kakinada, Vishakapatnam, Srikakulam and Vijayanagaram. East Godavari is India's second-largest shrimp-producing district and the estimated shrimp production in 2021 was 180,000 tonnes. Crop failure due to EHP, WSSV and slow growth affected shrimp production. The second crop was unsuccessful in East Godavari compared to other districts of Andhra Pradesh. Crop failures forced some shrimp farmers to opt for fish farming in the last quarter, but then they were hit by poor fish farm gate prices in 2021. The expansion of farming is not happening in East Godavari, unlike in West Godavari and Krishna districts. Many shrimp hatcheries are located in East Godavari, producing around 40% of India's post larvae production.

Odisha

There was a sizeable increase in shrimp production from Odisha in 2021 compared to 2020. Even though rains and floods caused by the Yaas cyclone affected certain parts, shrimp production increased in 2021. Most farms practise modern farming methods, while traditional farms produced nearly 8,000 tonnes in 2021. Expansion is happening in certain areas, and the state has a high potential for growth in shrimp farming. Odisha and West Bengal face cyclones and the increasing occurrence of storms during the shrimp farming season is a cause for concern in both states.

West Bengal

The state was expected to produce more than 100,000 tonnes in 2021, but cyclone Yaas damaged the standing crop between May and June. An estimated quantity of 20,000 tonnes of shrimp was lost due to the inundation of ponds, the outbreak of diseases immediately after rains and the destruction of infrastructure. Due to cashflow challenges, many farmers stayed away from the second crop. An estimated 88,000 tonnes of shrimp were produced in 2021 from West Bengal. The estimate includes shrimp production of around 15,000 tonnes from the traditional farming regions in and around the Sundarbans.

The introduction of specific pathogen free (SPF) black tiger shrimp has increased interest in its farming. Gujarat produced an estimated 28,000 tonnes of shrimp in 2021, of which 3,500 tonnes was black tiger shrimp. During a recent Infofish Shrimp 2022 conference, Dr Manoj Sharma, Mayank Aquaculture in Gujarat (right) said that farms reverted to black tiger shrimp particularly during the summer months. "It takes 100 days to reach 30g shrimp and another 30 days to reach 50-55g shrimp."

Rest of India

Several states in northern India have entered shrimp farming in recent years after pond culture in saline soils in the states of Haryana and Punjab showed some promise. An estimated 9,000 tonnes of shrimp were produced from these regions with Haryana contributing 4,000 tonnes. The higher cost of inputs and the lack of local processing plants are hurdles for the growth in shrimp farming in these regions.

Hatchery segment

Shrimp post larvae production reached an all-time high of 100 billion, from around 585 hatcheries, predominantly located in Andhra Pradesh and Tamil Nadu. The highest number of broodstock of around 280,000 were imported in 2021. However, no imports of broodstock in July and August cascaded to lower shrimp production and exports in the subsequent months. Breeding companies began to offer different lines –from WSSV resistant to super growth lines in 2021. Two Broodstock Multiplication Centers (BMC) became operational with an annual capacity of more than 100,000 animals.

There was a renewed interest among the farmers to take up black tiger shrimp farming as this species is not easily infected by EHP and white faeces disease, presumably due to its feeding habits. But to increase the availability of broodstock, the Government must expedite the supply of broodstock from RGCA's *Penaeus monodon* program in the Andamans as well as reconsider its ban of broodstock imports from early mortality syndrome/ acute hepatopancreatic necrosis disease (EMS/ AHPND) affected countries. It should push for Moana's broodstock multiplication centre (BMC) to start their operations immediately.

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"While this looked like a successful year for Indian shrimp farming, most stakeholders, from shrimp hatchery operators to exporters, had reduced profitability or even experienced losses due to disruptions in logistics and increased cost of operations."

Diseases

No new major diseases were reported in 2021. However, WSSV continued to cause outbreaks from time to time in different regions, and white faecal disease was reported widely. *Vibrios* may become more virulent as farms reported problems when *Vibrio* populations exceeded 10^2 CFU/mL.

Perspectives

India reached its record high farmed shrimp production in 2021 due to increased demand for frozen shrimp from the USA. While this looked like a successful year for Indian shrimp farming, most stakeholders, from shrimp hatchery operators to exporters, had reduced profitability or even experienced losses due to disruptions in logistics and increased cost of operations.

Excessive production of post larvae but reduced stocking in Gujarat, West Bengal, Odisha and South Andhra Pradesh limited the market size for the second season, thereby forcing hatcheries to sell post larvae at a low price. Feed companies had a tough time with an unexpected price increase of feed ingredients such as fishmeal and soybean meal and the increase in freight cost added to their losses. Farm gate prices were high during the last quarter and exporters paid high fees to sustain their supplies to the export market. International market prices remained constant for most months, while Indian farm gate prices were high for all sizes during the last few months of the year. In general, stakeholders expressed optimism on the country's shrimp production in 2022 but also cautioned on the steady loss of competitiveness with shrimp farming in India.

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Ablation and shrimp welfare

More attention on the practice of eyestalk ablation with consumers regarding animal welfare as part of sustainability in shrimp aquaculture

By Marcela Salazar, Bruno Decock and Oscar Hennig

A non-ablated female vannamei broodstock

Animal welfare, defined as "how well an animal is biologically, behaviourally and emotionally coping with their environment" is increasingly seen as a priority for a sustainable future. It is even recognised as beneficial to the United Nations Sustainable Development Goals (SDGs) for 2030. Discussions on the welfare of farmed aquatic animals have been absent until recent years, with animal welfare in aquaculture facing several hurdles compared to farmed terrestrial vertebrate species.

Firstly, unlike terrestrial animal production, the majority of species currently farmed in aquaculture are either wild or, until recently, domesticated. Secondly, the number of farmed species in aquaculture is at least 15 times higher than the terrestrial counterparts. In addition, there are several production systems (cages, ponds and RAS) that need to be considered for the studies on animal welfare. Thirdly, studies of sentience, pain suffering and behavioural avoidance are more challenging to perform in crustaceans than in vertebrates. Lastly, it is more difficult to empathise with a fish or crustacean than with a terrestrial vertebrate; take lamb as an example.

The evaluation of pain and sentience in decapods is complex and therefore, the main question remains: are crustaceans sentient animals? Birch et al. (2021) analysed different criteria, including the presence of pain receptors, brain regions that integrate pain responses, effect of anesthesia in the behaviour of the animal, trade-offs, self-protective tactics and learning experience, in more than 300 scientific studies, to determine the evidence of sentience in cephalopods and decapods. The research finished with the recommendation that "all cephalopod molluscs and decapod crustaceans be regarded as sentient animals for the purposes of UK animal welfare law. They should be counted as "animals" for the purposes of the Animal Welfare Act 2006 and included in the scope of any future legislation relating to animal sentience" (Birch et al., 2021). Other countries that also give legal protection to crustaceans are Australia, Austria, New Zealand and Norway.

Female shrimp eyestalk ablation

This is the removal or constriction of one or two eyestalks through cutting, cauterising or tying. The procedure started in the 1970s as a way to induce female maturation in the laboratory in *Penaeus monodon* and *Penaeus duoradum* and has been routinely used for more than 30 years to increase the predictability in nauplii production in hatcheries worldwide.

This technique promotes ovarian maturation by decreasing the production of the gonad-inhibiting hormone (GIH)/vitellogenesis-inhibiting hormone (VIH). As this hormone is secreted from the X-organ sinus gland complex located within eyestalks, removal of one or both eyestalks decrease or even abolishes its production.

".. ablation causes physiological imbalance, high energy demand, alteration of biochemical pathways and a decrease in haemocyanin and glucose levels in the hepatopancreas.."

However, nothing is perfect, and eyestalk ablation has severe adverse effects. Other hormones such as MIH (moult inhibiting hormone), MOIH (mandibular organ inhibiting hormone) and CHH (crustacean hyperglycemic hormone) are produced in the X-organ sinus gland complex as well. Therefore, ablation causes physiological imbalance, high energy demand, alteration of biochemical pathways and a decrease in haemocyanin and glucose levels in the hepatopancreas (Palacios et al., 1999a). It might even affect the immune response increasing susceptibility to vibrio infections (Zang et al., 2022) and necrotizing hepatopancreatitis or NHP (Morales-Covarrubias et al., 2005). All these effects are

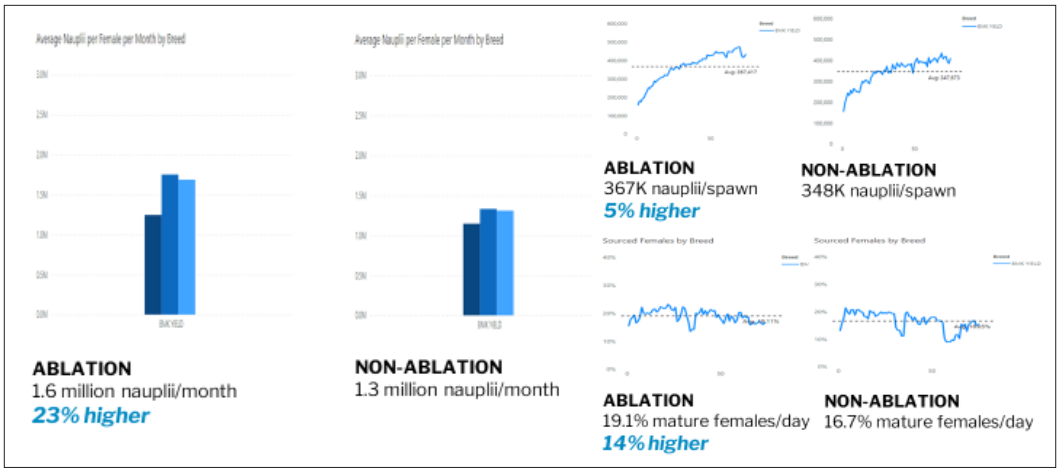

Figure 1. Maturation performance indicators in ablated and non-ablated females in a commercial laboratory.

responsible for the increase in female mortality during production, as was reported in *P. monodon* and *Penaeus vannamei* by de Meneses et al. (2019) and several other researchers.

The case against female ablation in the 21st century

In recent years, female ablation has been a frequent issue in animal welfare campaigns. Publications such as: "Can't give up prawns? We need to talk about the shocking practice of eyestalk ablation" (Gough, 2021); "Female prawns in prawn farms have their eyes cut off" (Animals Australia team, 2017), among others, cause immense damage to the image of the shrimp industry. However, despite concerns over ablation, the shrimp industry's answer is that if ablation is abolished, hatcheries would have to rely on natural breeding, which is slow and unpredictable and could lead to shortages of post larvae required to (Wright, 2016) stock ponds.

However, recent reports have suggested that new management protocols, including pre-maturation conditioning, increased stocking density and/or altered sex ratios, could lead to non-ablated breeders reaching similar productivity as ablated females (Zacarias et al., 2019).

In addition, domestication and breeding selection of early spawners can also play a vital role in the maturation performance without eyestalk ablation. Since 2017, Benchmark Genetics has abolished female ablation, both in their breeding nucleus in Colombia and its multiplication centre in Florida, USA. Five years later, production parameters are better than in previous years, with a higher number of nauplii per female, lower female mortality and better nauplii quality (Andres Suarez, Bernardo Jaramillo, pers. comm). Also, Seajoy Farms found it unexpectedly easy to abolish ablation in their hatcheries, and now, 100% of Seajoy's shrimp produced in Honduras and Nicaragua are ablation-free (Wright, 2016).

Number of nauplii

However, non-ablated production is still not as cost-efficient in terms of total nauplii produced for many hatcheries, as productive parameters for non-ablated females are 20% lower than that for their ablated counterparts. The production parameters of ablated and non-ablated females from the breeding program of Benchmark Genetics were evaluated in a commercial hatchery in Vietnam. An evaluation of females from the same origin was performed under identical conditions. As shown in Figure 1, nauplii production from ablated females was 23% higher than the non-ablated, mainly due to a higher percentage of mature females/day of the ablated females (19.1% vs 16.7% for the non-ablated animals). However, non-ablated females were able to produce 1.3 million nauplii/month, proving that non-ablation is feasible under commercial conditions.

"non-ablated production has been increasing as a practice among Asian hatcheries. This is because farmers are reporting non-empirical, better performances with post larvae from non-ablated breeders.."

Quality of nauplii

Eyestalk ablation was proven to affect nauplii and larvae quality. An article on non-ablation in the pink shrimp *Penaeus brasiliensis* showed that the quality of nauplii was higher in the progeny of non-ablated broodstock. Zacarias et al. (2021) found that post larvae from non-ablated females had significantly higher survival (70.4%) than those from ablated females (38.8%) at 96h post-challenge with VpAHPND. The study demonstrates that post larvae and juveniles from non-ablated females are more resilient to bacterial pathogens and could show higher survival rates during a disease outbreak.

Palacios et al. (1999b) found a decline in the nauplii condition index with increased days after ablation, suggesting that reproductive exhaustion of the broodstock related to the changes in metabolic pathways affects larval viability. More relevant for commercial producers is that in recent years, non-ablated production has been increasing as a practice among Asian hatcheries. This is because farmers are reporting non-empirical, better performances with post larvae from non-ablated breeders (Bruno Decock, pers. comm).

Conclusion

Female ablation was an essential tool in the early years of shrimp culture and the beginning of closed-cycle maturation. However, with the increased number of generations of animals raised in captivity and the genetic selection of early female spawners, some hatcheries and breeding programs have been able to implement non-ablation without significant issues.

Given the growing trend of the importance of animal welfare in aquaculture and the relevance of eyestalk ablation in the market and public perception, it is foreseen that consumers will only buy animals from non-ablated broodstock and producers that still use ablated females could be banned from the market. However, the abolishment of ablation can only be achieved through the cooperation of all stakeholders.

- Breeding companies should improve the maturation performance of non-ablated females and educate their clients on management protocols adapted to these animals.
- The scientific community should aim to evaluate the performance of post larvae from non-ablated females.
- Post larvae from non-ablated breeders should get a premium price to compensate for the lower efficiency, which could be achieved by increasing the demand for shrimp from non-ablated breeders. However, the consumers must also be willing to pay a premium price for that product.

Finally, the only question remaining for the hatcheries should be, "Are companies going to be the leaders in non-ablation practices, or are they going to be laggers?"

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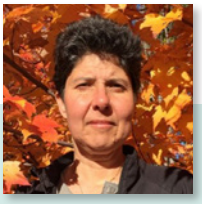

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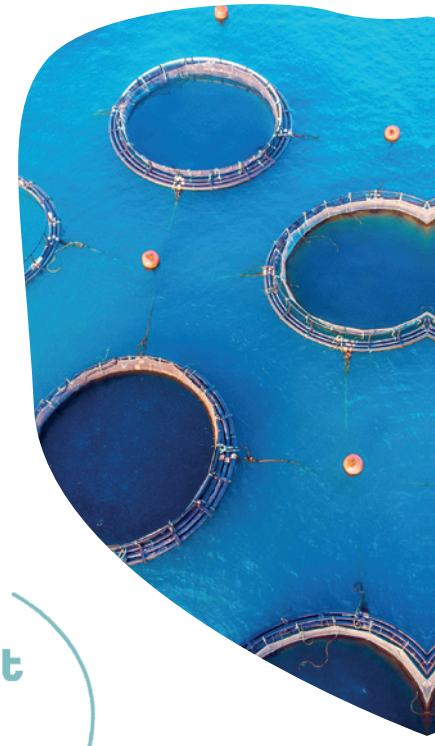

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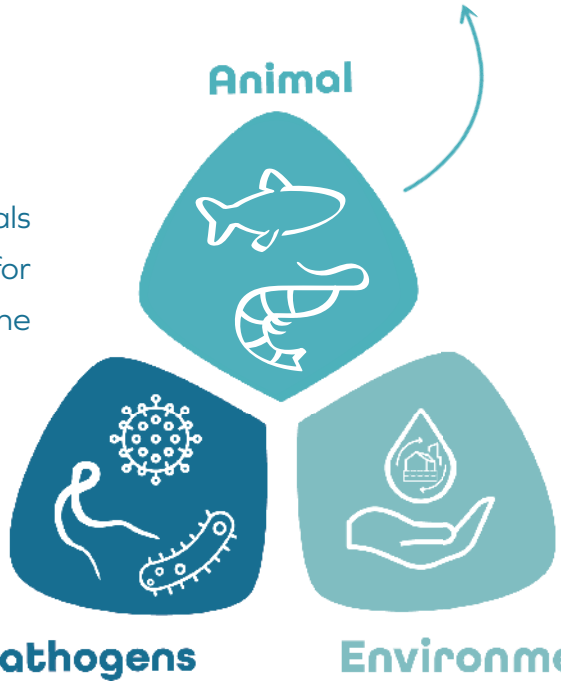

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Rise in black tiger shrimp farming

At GSF, panels reflect on production trends and markets for the increase in volumes

The inaugural Global Shrimp Forum (GSF) held recently from September 7- 8 in Utrecht, the Netherlands dedicated a half-day session on the latest in black tiger shrimp *Penaeus monodon* farming. Robins McIntosh, Executive Vice President, Charoen Pokphand Foods (CPF) Public Company, said that the rise in black tiger shrimp production in several countries, particularly in China, was due largely to the availability of CPF's domesticated specific pathogen free (SPF) broodstock. On the revitalisation of black tiger shrimp farming in India, Dhaval Contractor, Partner, Vaishnavi Aquatech, said that the increase in India has been with post larvae from imported Moana broodstock. The future post larvae will be produced at its new broodstock multiplication centre (BMC) which began operations on September 2, 2022.

Demand has been escalating in India since the company introduced SPF black tiger post larvae in 2021. Dhaval said that Vaishnavi Aquatech is one of the companies approved by the Coastal Aquaculture Authority to import SPF black tiger broodstock into India. It started with an initial supply of 300 million post larvae to farms in Andhra Pradesh and Gujarat and the company has expanded to six hatcheries in 2022. Vaishnavi Aquatech has already sold one billion post larvae in 2022. An associated company, Shree Sai Krupa Aquaculture runs several shrimp farms in Gujarat.

The resurgence in black tiger farming is not only due to the new genetics but also because black tiger shrimp tolerates *Enterocytozoon hepatopenaei* (EHP) and white faeces syndrome (WFS) better than the vannamei shrimp; in addition, in India, it is also tolerant against running mortality syndrome. Black tiger shrimp has also found its place during the hot summer months in Gujarat where high temperatures prevented the farming of vannamei shrimp. McIntosh said, "Other push factors are higher market value and that its farming requires less capex." He added that at present one disadvantage is that growth lines of new vannamei lines, exceed that of black tiger shrimp lines.

On the sidelines of the session, Dhaval emphasised that with these SPF black tiger shrimp post larvae, farmers in Gujarat now have the possibility to have a second crop as well. Furthermore, farmers in Odisha and West Bengal have indicated interest in black tiger shrimp farming. He added that ponds in South Andhra Pradesh with high salinity are suited for black tiger shrimp farming and the low salinity ponds in northern districts of Andhra Pradesh are more suitable for vannamei shrimp farming.

Dhaval Contractor, Partner, Vaishnavi Aquatech said that future post larvae will be produced at its new broodstock multiplication centre (BMC) which began operations recently.

New genetics

McIntosh said that "taming the tiger" took several generations, with initial survivals at 30% and improving to 85% for the latest stocks, which also turned in low coefficient of variations. Selective breeding of CPF's SPF black tiger shrimp began in 2014 and rose from an average daily growth (ADG) of 0.3g in 2013 to 0.50g in 2021 and survival rates increasing from 81% to 93% by 2021.

There has been progress in the Moana black tiger genetics since its first introduction to India in 2008-2009 and in 2021-2022 when compared against post larvae of wild broodstock. According to Dhaval, the Moana genetics is now the 19th generation reaching improved growth through selective breeding to 50g in 120 days. The AWG (average weekly growth) is 4g (Table 1).

Panel on market reflections.

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Growth according to post larvae source (g)			
Days of culture (DOC)	Wild broodstock	Moana broodstock (2008-2009)	Moana broodstock (2021-2022)
15-30	1.5-3.0	1.5-3.0	6.0-7.0
50-60	6.0-8.0	6.0-8.0	12.0-15.0
80-90	13.0-16.0	13.0-16.0	22.0-25.0
110-120	24.0-28.5	27.0-33.0	45.0-50.0
140-150	32.5-36.5	44.0-50.0	58.0-66.0

Table 1. Post larvae growth of Moana broodstock in India and against post larvae from wild broodstock. Source: Dhaval Contractor.

Higher production

McIntosh expects a total global production increase by 42% to 546,000 tonnes of black tiger shrimp in 2021 from 382,000 tonnes in 2019. The increase in volume is due to the domesticated stocks in China, Thailand, Vietnam, India, Malaysia, Bangladesh and Madagascar. In China, production may reach or exceed 180,000 tonnes in 2022 from the previous volume of only 100,000 tonnes in 2019. The good post larvae demand in China where CPF has 90% market share for its SPF broodstock is because of the premium prices accorded to black tiger shrimp as compared to the large size vannamei shrimp. In a panel on production, Le Van Quang, Minh Phu Seafoods CEO, said that the company expects to sell 50,000 tonnes of black tiger shrimp while the nationwide black tiger shrimp production is 20% of total farmed shrimp production which was estimated at 900,000 tonnes in 2021.

In India, Dhaval calculated production volumes based on post larvae used: 34,000 tonnes for the 2021-2022 fiscal year (April 1, 2021-March 30, 2022) and expected volumes of 70,000 tonnes for the 2022-2023 period. (April 1, 2022-March 30, 2023). These were based on post larvae from Moana and Unima (Madagascar) broodstocks.

Market reflections

Willem van der Pijl, Shrimp Insights, session moderator and GSF co-organiser, asked whether the renewed production of black tiger not only by traditional farms but also semi-intensive farms as an alternative species (such as in Gujarat) will lead to this shrimp to be in competition with large vannamei shrimp as a premium species. A panel of producers and buyers discussed current markets for the shrimp and what can be expected in the future. While the demand is for premium price large black tiger shrimp, Heiko Lenk, Lenk Frozen Foods, said that firstly, the premium price is subjective – buyers could absorb a €3/kg premium. Large black tiger is usually for the food service segment. For Mathias Ismail, R&O Seafood Gastronomy, its organic and large Madagascan black tiger shrimp is destined for the niche gastronomy market and is specific in colour and taste. "We need to remember also that massive production works against the equilibrium for a niche market," said Mathias.

Panel on production outlook for the black tiger shrimp.

Feeding the right pellet size to tilapia fingerlings

A relationship between growth performance and mouth gape determines the suitable pellet size

By Cuong Huynh Tran, Tran Minh Triet, Truong Thao, Pham Minh Anh and Marc Campet

An optimal feeding program is imperative if we want to utilise formulated feeds and to ensure that they meet the requirements of fish growth performance. The current feeding program is established based on several parameters, such as as fish weight, pellet size, feeding rate and feeding frequency. The pellet size is an important part of this guideline and has been proven to affect the feeding behaviour and response time of fish to the feed. In general, the best growth performance can be achieved with the optimal pellet size while the smaller and larger pellet sizes have resulted in a decrease in growth rate.

Currently, most feeding guidelines have been established based on farmers' experience without any proper study or observation. The purpose of this paper is to accurately propose a feeding guideline for red tilapia (*Oreochromis* sp.) fingerlings from newly hatched larvae up to 35g each, including examining the growth performance, measuring the mouth gape and determining the pellet size. At the same time, the compatibility of the reference function for estimating the mouth gape of tilapia fingerlings from a previous study was also examined.

Methodology

This experiment was conducted at the ADM Aquaculture Research and Development Centre in Ho Chi Minh City. Fish were raised in an outdoor facility in six different composite tanks (400L/tank) with a stocking density of 300 fish per tank. On the day of stocking, there was no feeding. In the following days, fish were hand-fed following the manufacturer's guidelines.

Tilapia fingerlings were then sampled to measure the growth performance and mouth gape twice a week, until they reached 35g. Six tilapia juveniles were collected from each tank, using a net scoop. Water parameters (temperature, pH, dissolved oxygen, nitrite, total ammonia) were measured, using commercial test kits (TMS).

At each sampling, body weight (WG) was measured using a sensitive electronic balance, while the total length was determined by measuring from the tip of the mouth to the end of the dorsal fin using an electronic caliper. The mouth gape (G) was determined either by measuring from the upper jaw to the lower jaw of the fish using a caliper, or by estimation based on their body weight using the linear correlation function: $Log_{10}G=0.37\times Log_{10}W+0.65$, proposed by Fessehaye et al. (2006). The mouth gape was further used for the estimation of pellet size according to the study of Azaza et al. (2010)

Water quality

Water quality parameters collected during the nursery period were not significantly different among tanks. Parameters shown in Table 1 were in an acceptable range for tilapia fingerlings (Benli and Köksal, 2005; Wang et al., 2006).

Parameters	Average	Range
Temperature at 8am (°C)	30°C	28 - 32°C
Temperature at 3pm (°C)	31°C	29 - 34°C
pH at 8am	7.6	6.8 - 8.2
pH at 3pm	7.5	7.1 - 8.0
Dissolved oxygen at 8am (mg/L)	5.6 mg/L	3.5 - 8 mg/L
Dissolved oxygen at 3pm (mg/L)	5.3 mg/L	2.5 - 8.5 mg/L
Total ammonia (mg/L)	0.5 mg/L	0.1 - 2.0 mg/L
Nitrite (mg/L)	0.1 mg/L	0.0 - 1.0 mg/L

Table 1. Water quality parameters

Growth performance

The results of growth performance indicated that the body weight and total length increased during the nursery period, as shown in Figure 1. This outcome was supported by previous tilapia research although the growth rate might vary. Growth variation can be explained by nursery conditions, as the stocking density usually ranged from 5 to 500 pieces/m^3.

Mouth gape and pellet size

The mouth gape estimation and measurement are shown in Figure 2. Tilapia juveniles from 0.5 to 12g had similar mouth gape determined by both methods. Subsequently, there were significant differences in mouth gape of fingerlings above 12g. Fessehaye's function in Nile tilapia *Oreochromis niloticus* generated greater mouth size estimation, compared to the actual mouth size measurement in red tilapia. Mouth gape calibrations of red tilapia fingerlings were used to establish a linear regression line based on body weight from 0.5 to

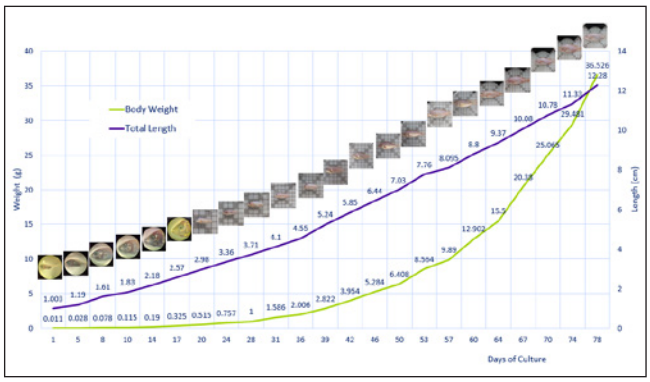

Figure 1. Development of tilapia juveniles in terms of body weight (g) and total length (cm) during the 78-day nursery phase.

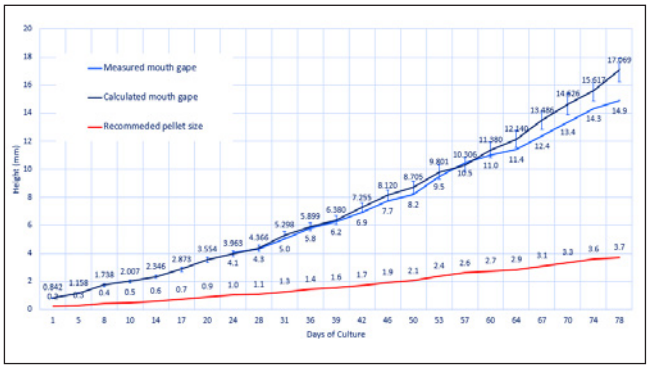

Figure 2. The relationship between mouth gape and pellet size for tilapia juveniles.

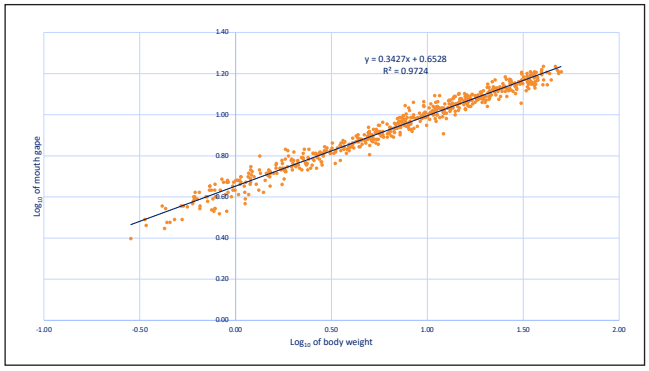

Figure 3. Linear regression between Log10 of body weight and Log10 of mouth gape.

35g: $Log_{10}G = 0.3427 \times Log_{10}W + 0.6528$ (r2 = 0.9724), as shown in Figure 3.

Recommendations

In order to achieve a high growth performance, especially at the nursery phase, it is crucial to choose the pellet size that matches the mouth gape of fingerlings. This study is an attempt to improve the current feeding program by defining the suitable pellet size for tilapia fingerlings mouth gape. In our subsequent research, we plan to conduct more in-depth studies on various cultured species, using a similar methodology.

At ADM, we have a long-term strategy to provide quality nutritional solutions that support the fish throughout their lifecycle. Our holistic approach and sophisticated production technology allow us to conduct extensive research as well as to manufacture prominent aquafeeds. We introduce the NANOLIS range that offers precise nutrition with the right particle size for fingerlings. These feeds ensure growth performance for fish to reach their full potential beyond the nursery stage.

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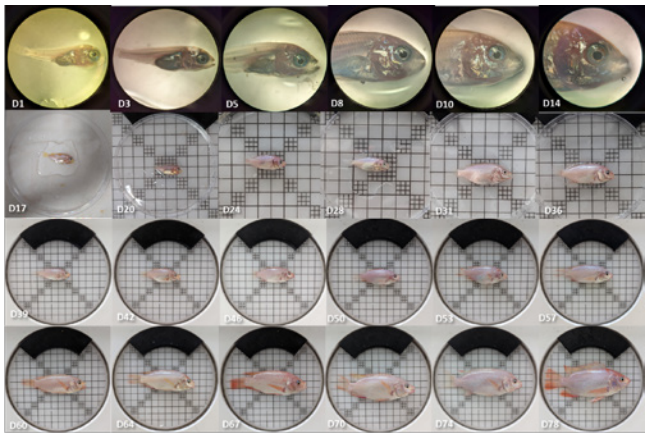

Figure 4. Overview of the developmental of red tilapia Oreochromis sp. during days of Culture (DOC 1-78)

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Efficacy of a yeast supplement in white leg shrimp after a challenge with *Vibrio parahaemolyticus*

An enzymatically treated whole yeast significantly increased survival rate of juvenile shrimp

By Ingrid Lupatsch

One of the limitations for further growth and economic viability of shrimp aquaculture is effective health and disease management. Indeed, in recent years the continuing growth and intensification of shrimp farming have brought about the emergence of several disease vectors, among them the bacterial pathogen *Vibrio parahaemolyticus*, responsible for EMS/AHPND (early mortality syndrome/acute hepatopancreatic necrosis disease). This disease is transmitted orally, and the bacteria colonise the shrimp's gastrointestinal tract producing a toxin which causes tissue damage and dysfunction of the shrimp's hepatopancreas, resulting in high mortalities.

One of the strategies of the industry is to lessen the impact of diseases through functional feeds. Among these ingredients are yeast-based products, such as whole yeast and yeast cell wall fractions. These are gaining increasing attention as promising tools to alleviate pathogen pressure. They have been shown to bind to specific bacteria before they are able to colonise the animal's gastrointestinal tract. Furthermore, yeast cell wall fractions such as β-glucans and mannan oligosaccharides can potentially enhance the innate immune response.

Livalta™Cell HY40 (Livalta, an AB Agri company, UK) is an enzymatically treated whole yeast made from non-genetically modified (non GM) *Saccharomyces cerevisiae* strains of the Brazilian bio-ethanol industry. Due to the stressful conditions of bioethanol fermentation this yeast is characterised by a comparatively thick cell wall resulting in exceptionally high levels of 1.3/1.6 β-glucans and mannan oligosaccharides (40%). With a highly available crude protein content of 37%, it combines the characteristics and benefits of both specialised yeast cell wall and yeast extract products.

The aim of our study was twofold - first to evaluate the impact of LivaltaCell HY40 on performance indices of Pacific white shrimp and second to assess its efficacy in reducing infection rates and mortality of shrimp challenged with *V. parahaemolyticus*.

Shrimp and culture conditions

The trial was carried out at the ShrimpVet Laboratory in Vietnam using specific pathogen free (SPF) *Litopenaeus vannamei*, originating from a brood stock from Shrimp Improvement Systems – Kona Bay Hawaii. The shrimp were tested for the major pathogens including *Enterocytozoon hepatopenaei* (EHP), white spot syndrome virus (WSSV), Taura syndrome virus (TSV), infectious myonecrosis virus (IMNV), and *V. parahaemolyticus* using PCR techniques. Post larvae were grown under strict biosecurity conditions until they reached 2g sizes prior to the start of the growth trial.

Tanks with a capacity of 350L were utilised for the growth trial whereas tanks with a capacity of 120L were used for the challenge period. All tanks were fitted with an activated coral filter, aerated and covered to reduce the risk of cross-contamination.

Water quality parameters including temperature, dissolved oxygen and pH were measured daily. The other parameters such as total ammonia nitrogen, nitrite nitrogen and alkalinity were checked every three days.

JMP statistical software was used to analyse results by one-way analysis of variance, followed by Tukey's HSD test to determine significant differences among treatments. Differences were considered significant when $P < 0.05$.

Growth trial

The trial was carried out under controlled water quality conditions (28°C, 20ppt salinity) using three dietary treatments with seven replicates per treatment. Shrimp of around 2g were stocked at 50 juveniles per 350L tank. The trial lasted 42 days and animals were fed manually their respective diet *ad libitum* 6-8 times per day. Feed consumption was recorded during the whole period of the trial and leftover feed quantified.

The diets were formulated to contain 38% protein and 5% lipid. LivaltaCell HY40 was added by replacing 99.5 and 98% of the basal feed mix in the feeds with 0.5% HY40 and 2% HY40 respectively (Table 1). The test diets were prepared by a cold-extrusion process: all feed ingredients were ground to fine particles (<250 microns), mixed and moisturised (30%) before being extruded through a pressurised meat grinder. The spaghetti-like strands were dried at 50°C for 12 hours to achieve a moisture content of less than 10%. The strands were then crushed to the appropriate pellet size of 2mm. The analysed diet composition is presented in Table 1.

% Ingredient	Control	0.5% HY40	2% HY40
Fish meal	11.0		
Soybean meal	26.8		
Poultry by-product meal	3.5		
Rice bran	6.0		
Corn gluten concentrate	12.0		
Wheat meal	32.5		
Fish oil	1.0		
Soy lecithin	2.0		
Vitamin and mineral premix	2.0		
Carboxymethyl cellulose	2.0		
Mono calcium phosphate	1.2		
Livalta™Cell HY40*	-	0.5	2.0
Proximate composition			
Dry matter, %	95.18	95.42	95.75
Crude protein, %	38.47	38.66	39.19
Crude lipid, %	5.29	5.55	5.70
Ash, %	7.36	7.40	7.46
* Composition 95% dry matter, 38% crude protein, 1.3% lipid, 8% ash			

Table 1. Diet formulation and analysed proximate composition.

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Challenge trial

After the completion of the growth trial, the remaining shrimp - consistent with their respective treatment group - were transferred to the 120L tanks for the subsequent challenge. Twenty shrimp were stocked in each of 24 tanks providing 4 treatments with 6 replicates each (Figure 1).

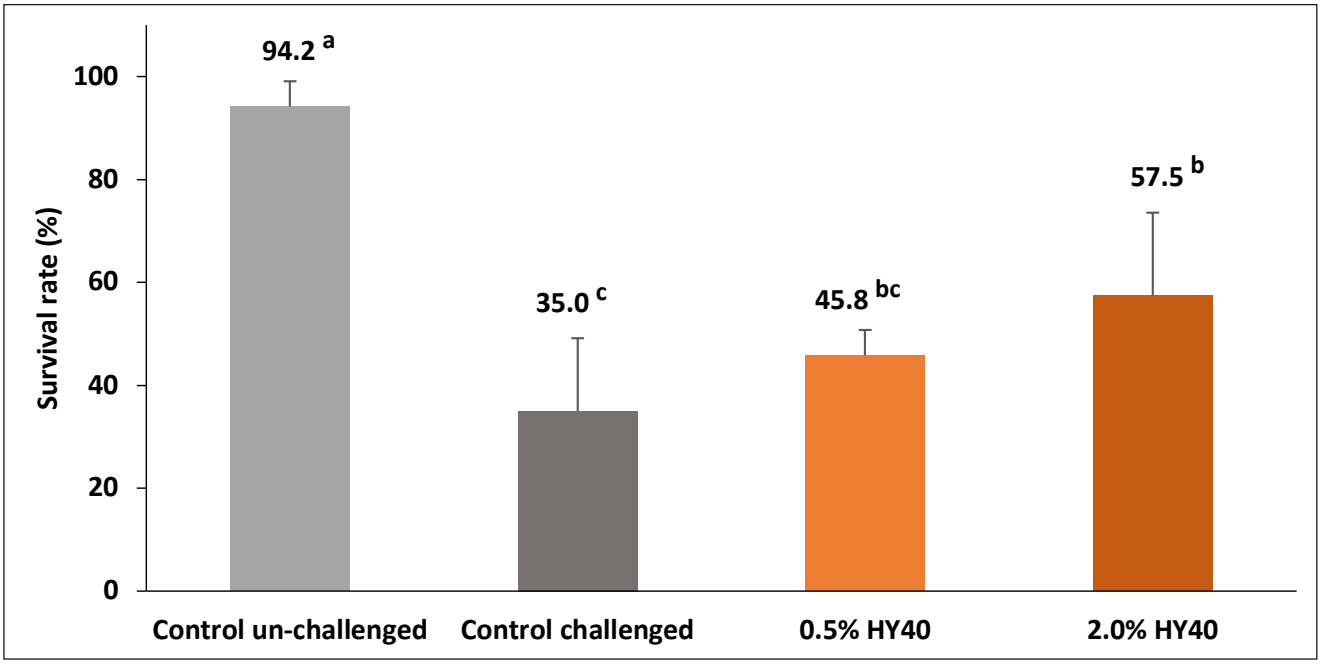
Diet	Control	Control	0.5% HY40	2% HY40
Challenge	NO	YES	YES	YES
Livalta™Cell HY40	NO	NO	YES	YES

Figure 1. Challenge trial set up.

After three days of acclimation, shrimp were subjected to an immersion challenge as follows: Tryptic soy broth +2% sodium chloride (TSB+) was inoculated with a consistently virulent strain of *V. parahaemolyticus* incubated for 24 hours. The bacterial suspension was added into tanks to achieve the bacterial density expected to kill 80 - 90% of shrimp within 10 days (7.5×10^5 CFU/mL). The un-challenged control (six tanks total) was treated with sterile TSB+ which was added directly to the tanks. Survival of shrimp was monitored for 10 days post-challenge. During the post-challenge period (10 days), the shrimp were fed *ad libitum* 4 times per day their respective diets.

Treatment	Control	0.5% HY40	2% HY40
Initial weight, g	2.07 ± 0.04	2.06 ± 0.05	2.06 ± 0.04
Final weight, g	9.43 ± 0.83^{a}	9.98 ± 0.48^{ab}	10.43 ± 0.58^{b}
Weight gain, g/shrimp/day	0.175 ± 0.02^{a}	0.189 ± 0.01^{ab}	0.199 ± 0.01^{b}
Feed intake, %/biomass/day	4.53 ± 0.21^{a}	4.39 ± 0.14^{a}	4.34 ± 0.16^{a}
Feed conversion ratio	1.15 ± 0.12^{a}	1.06 ± 0.06^{ab}	1.01 ± 0.07^{b}
Survival, %	90.7 ± 2.4^{a}	90.6 ± 4.6^{a}	89.1 ± 3.8^{a}
Values are presented as mean (n = 7) ± SD. ab Different letters in the same row indicate significant differences at P<0.05.			

Table 2. Performance parameters of white leg shrimp after 42 days of growth.



Values are presented as mean values (n = 6) ± SD. ^{ab}Different letters indicate significant differences at $P<0.05$

Figure 2. Survival (%) of white leg shrimp after 10 days following a *Vibrio parahaemolyticus* challenge.

Results and discussion

Shrimp performance, including growth and feed conversion ratio (FCR) improved with increasing inclusion levels of LivaltaCell HY40 and was found to be significantly different in shrimp fed the 2% HY40 feed compared to the control group (Table 2). There was no difference in survival among the treatments.

At day 10 post-challenge, the survival rate of shrimp fed the control diet was as low as 35%. The survival rate of both the HY40 treated groups increased with increasing inclusion levels and was found to be significantly different at 57.5% when offered the 2% HY40 diet (Figure 1).

The digestive tract is one of the first entry points for pathogens in shrimp. Thus, strategies should be developed to prevent potential disease outbreaks from the start and one of the features attributed to yeast products is the reduction in pathogen pressure.

According to published literature, yeast cell wall components which contain mannose or mannose-derived entities (such as mannan-oligosaccharides or MOS) have a high affinity for type 1-fimbriae and as a result compete with specific bacteria by providing alternative adhesion sites. It is believed that, by this functionality, yeast products can prevent many of the bacterial pathogens to attach to the gut wall. This mode of action has been demonstrated in a recent *ex vivo* study with *Escherichia coli* and *Salmonella* using pig epithelium (Livalta, internal data). In view of that we propose that the positive results in this challenge trial with *V. parahaemolyticus* can be explained by a similar mode of action.

Conclusions

In these trials, we showed that a dietary inclusion of Livalta™Cell HY40 gradually improved weight gain and FCR in shrimp, showing significant differences compared to the control when fed the 2.0% HY40 diet. In the challenge test, survival of shrimp fed diets supplemented with this enzymatically treated whole yeast product improved following infection with *V. parahaemolyticus* with a significant boost at the 2% inclusion level.

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A forward-looking development in Vietnam's shrimp feed market

BioMar is acting on its dynamic investment in Vietnam's shrimp feed market, says François Loubere

It was a combination of opportunity and synergy that led BioMar into partnership with Viet-Uc. BioMar, already a significant shrimp feed producer in Latin America, has ambitions to increase its global footprint, particularly in high end shrimp feed. Vietnam, one of the world's leading shrimp producing countries which performed well during the past decade, even during the Covid pandemic years, beckoned with bright growth potential to BioMar. With a sharing of knowhow, R&D, experiences and best practices, particularly from existing feed businesses in Latin America and from Viet-Uc's vast shrimp hatchery and farming operations, the synergistic implications would be notable.

In March 2021, BioMar bought over majority ownership of Viet-Uc's feed business. Its investment in Viet-Uc opened a milestone market base in Vietnam, seen also as an important link to building strong relationships with other shrimp feed consuming nations within the region.

Now, one year on, via email Aqua Culture Asia Pacific interviews **François Loubere**, the man heading the operations in Asia. As VP Asia, Loubere's focus is to set the strategic direction for the region, support the integration of businesses in Vietnam and China and accelerate knowledge exchange in terms of product development and R&D to further develop the business units.

With more than 30 years of experience within BioMar and the aquaculture industry, Loubere has been a key contributor to building up the business units in West Mediterranean and Africa, as well as contributing to several strategic business development projects.

As VP Asia Division, François Loubere's focus is to set the strategic direction for the region and support the integration of BioMar businesses in Vietnam and China.

AAP: What are the main aspects of the partnership with Viet-Uc? What do both parties bring to the table and what do both companies expect to benefit with this partnership?

Through this acquisition, BioMar establishes a partnership with one of the leading seafood groups in Vietnam, which is active in shrimp hatcheries, fish hatcheries and shrimp farming. The ambition is to grow the market for high-end feed products focusing on sustainability, traceability, quality and performance. We believe there is an obvious synergy in terms of commercial network and determination to innovate between our two companies.

AAP: Viet-Uc's focus is especially on marine shrimp. How will your expertise in Ecuador's shrimp feed market come into play in this partnership?

A few years ago, probably no one in Asia would have considered Ecuador as a source of inspiration as it has a very extensive production system compared to Asian farming. However, in a period of just three years, Ecuador has become the largest shrimp producer in the world and the fast growth continues, so it is worthwhile observing what is done differently. Obviously, Ecuador benefits from available land which is very scarce in Asia. Land availability allows the Ecuadorian producers to work at lower densities and tackle health challenges in a different way, for example, in terms of less or no use of medicated treatments.

Moreover, what really benefits Ecuador is a fast technification of the shrimp production led by numerous large farming groups, which represent the bulk of the Ecuadorian shrimp volume. All of this, combined with more efficient diets and improved farm management in general drives production costs down, but it also enables transparency and traceability.

Ecuador is very rapidly becoming in shrimp what Norway is for salmon. We are actively involved in all parts of this development through quickly evolving feed composition, introduction of new feed production technology (as the Ecuadorian market is moving rapidly towards extruded feeds), technical support to farmers and the massive introduction of automatic feeding, where the BioMar owned Australian company AQ1 is the absolute market leader.

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BioMar

BioMar acquired a majority stake in Viet-Uc's feed business in March 2021.

AAP: Why do you target Vietnam when there are several local and international aquafeed players?
For us, this partnership opens a big door to the Vietnamese market. Vietnam is a challenging market, but there is still room for innovators like us who can bring a good range of high-performance and health feeds into the market. Vietnam is a market that we believe is ready to embrace more sustainable practices and BioMar has extensive experience and knowledge in this area. Vietnam also offers a good base to develop our activities within neighbouring countries with potential.

AAP: Are there any specific segments in Vietnam/ Asia's shrimp feed market that you will target?
Worldwide, we have a well-established position in the hatchery feed market for both shrimp and fish. We have seen great results with our LARVIVA range for shrimp in Asia and Latin America. Now that we have direct representation in Vietnam and with a major hatchery producer as partner, we expect to take an important position in the hatchery and nursery segment.

In Ecuador we have achieved market leadership in the hatchery segment in less than 3 years, helping customers to reduce their hatchery cycle from 21 to 15 days. After building our market position in Latin America during the last years, we recently introduced with great success our INICIO nursery range in India as the first of the Asian countries. We expect the nursery segment to be another key focus area in the rest of Asia with feeds produced locally in Asia and imported from Europe.

In addition to this, looking at market forecasts and trends, there is an increasing consumer focus on healthy and sustainable seafood. Hence, the company expects a growing market share for high-end feed combining feed performance and sustainability, ensuring shrimp farmers can capture value by delivering certified and tailored products towards global retail channels.

AAP: How can you bring your sustainability focus and expertise into the industry in Vietnam and the rest of Southeast Asia?
The dramatic increase in raw material prices in the last year is a strong reminder that we are close to a global food crisis. We have to utilise the raw materials in a more efficient way and to introduce new ingredients - emphasising circular and restorative - which can be used in feed production and bring benefit to the shrimp, the farmer and the industry.

Feed formulation in Asia is very traditional and will need a major upgrade in the next few years to be able to not only maintain, but to grow the total aquaculture production in a sustainable fashion. The time when a good feed was judged merely on "it smells of fish" and raw material composition judged on crude protein, should come to an end. It is not logical to focus on crude protein levels, because proteins differ in terms of digestibility and nutritional contribution. Focusing only on crude protein could lead to resource waste and risk of severely affecting the water environment in the farms and the surrounding environment.

We should aim for efficiency on the utilisation of natural resources. We have been through this process successfully with major cultured species such as salmon, trout and marine fish species, and we are well on our way in shrimp. BioMar is currently developing completely new feed concepts in a joint effort with partners across the value chain, from suppliers to some of the major retailers in Europe and the United States. It would be natural to bring these concepts to Vietnam and the rest of the region as well.

AAP: In your opinion what does the shrimp industry in Asia require and how can BioMar contribute?

To continue growing, the Asian shrimp industry will have to embrace sustainability. The availability and sustainability of the raw materials for feed are a major concern and BioMar can bring important knowledge on feed development, efficient use of scarce resources, and testing and implementation of new ingredients. We recently acquired AQ1, which is the market leader in acoustic feeding systems. Combining the development of feeding systems and feed optimised for these systems is a logical way to achieve a more efficient use of the feed and thereby reduce feed waste and contribute to increased sustainability.

Another area where we can definitely contribute is in health solutions for fish and shrimp. Over the years, we have designed a strong methodology to develop and document preventive health solutions. We are still the only aquafeed manufacturer that has managed to get a probiotic feed solution so well documented, that after passing various strict requirements, it was approved by the European Union authorities.

AAP: Vietnam wants to be strong in marine fish production. What expertise of BioMar can be transferred to Vietnam's marine fish segment?

We have a leading position in marine fish feeds in Europe and in Latin America, and we are establishing our position in China, despite the restrictions imposed by the pandemic. We have solutions for all the species present in Vietnam. However, for now we will primarily focus on the hatchery and nursery segments with imported feeds. We have already very good results with the barramundi in Vietnam and plan to expand across species as we build our organisation.

Yeast postbiotics strengthen preventive management of *S. agalactiae* and *A. hydrophila* outbreaks in tilapia farming

There is the possibility of reducing pathogen pressure in the gut, increasing the immune response of tilapia with an adapted functional nutrition strategy

By Otavio S. Castro, Nadege Richard and Alban Caratis

Disease management and prevention are critical challenges to achieve a more efficient and environmentally friendly tilapia production. Not only do disease outbreaks cause major economic losses to the industry, but also traditional management tools such as antibiotics and antiseptic chemicals are increasingly discouraged, due to sustainability, human health safety concerns and risks of antimicrobial resistance development.

This article discusses the application of Safmannan®, Phileo by Lesaffre® yeast postbiotic, as a sustainable and effective solution to mitigate and prevent disease outbreaks in tilapia by strengthening the fish immune response and increasing survival against pathogens.

The growing cost of diseases in tilapia

Bacterial, viral and parasitic diseases can disrupt tilapia production regardless of the biological stage, production system and culture intensity. Streptococcosis (caused mainly by different serotypes of *Streptococcus agalactiae* and *Streptococcus iniae*) is one of the most impacting bacterial diseases, causing mortality rates ranging from 40% to 80% and generating high economic losses that were previously estimated at USD250 million in 2008 and around 300,000 tonnes in 2019 (Amal and Zamri-Saad 2011; Roderick 2020).

Haemorrhagic bacterial septicemia (caused by *Aeromonas* spp.) is also responsible for high mortality rates in tilapia farming, especially in weakened fish under stress and suboptimal nutritional and environmental conditions. In addition, there are new challenges linked with emerging and re-emerging diseases such as tilapia lake virus (TiLV), francisellosis, infectious spleen and kidney necrosis virus (ISKNV) and complex multifactorial co-infection cases. For instance, *A. hydrophila* can be involved in co-infections with *S. agalactiae* and TiLV (Basri et al. 2020; Nicholson et al. 2020). The co-infection of these pathogenic agents increases the severity of outbreaks and leads to mass mortality events.

Yeast postbiotics, a new option in the toolbox

Postbiotics constitute a most promising choice for a safer and more environment- friendly approach to overcoming pathogenic challenges in aquaculture. Postbiotics are part of an animal's microbiome and refer to inactivated cells and their metabolites that confer health benefits to the host when ingested.

Yeast postbiotics (*Saccharomyces cerevisiae*) in particular are frequently employed to enhance immune response, promote gut health and substitute for antibiotics (Ran et al. 2015). The benefits of yeast postbiotics in enhancing the immune system and promoting gut-health are usually attributed to the structural components in the yeast cell wall, such as β-glucans and mannan oligosaccharides (Ortuño et al. 2002; Kühlwein et al. 2014; Dimitroglou et al. 2009). β-glucans stimulate the innate immune system by interacting and subsequently activating the immune cell pattern recognition receptors that fight off pathogens. Mannans can activate the nonspecific immunity and help to diminish pathogen colonisation in the gut by blocking bacterial attachment such as from *Vibrio* sp., *Aeromonas* sp., or *Salmonella*. In this way, yeast cell wall-based products are highly effective during production periods with pathogenic challenges, thus preventing and mitigating diseases throughout fish development and production cycles.

Enhancement of immunity for improved survival

Safmannan® is a primary culture yeast postbiotic which is produced by Phileo® from a selected proprietary strain of *S. cerevisiae*. It has consistent physicochemical characteristics, stable concentrations and ratio of β-glucans and mannans (Figure 1), thus offering producers predictable biological outcomes during production, as demonstrated in multiple scientific trials.

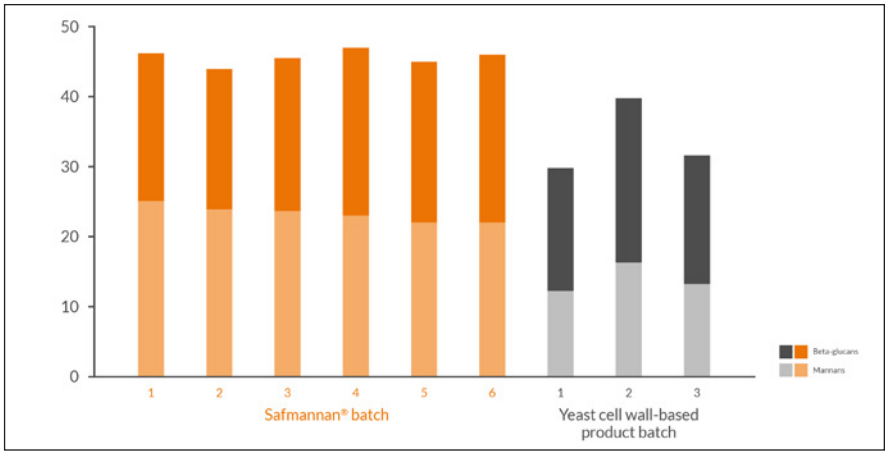

Figure 1. The consistent levels of mannans and β-glucans in Safmannan® yeast postbiotic in comparison with other commercial cell wall-based products.


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Pathogen challenge	Tilapia initial weight (g)	Dosage (kg/tonne of feed)	Feeding Period (days)	Average survival control (%)	Average survival Safmannan®	Average survival gain (%)	Trial Location
S. agalactiae	30.0	0.5 and 1.0	90	45.0	60.0 and 72.5	21.3	Thailand
S. agalactiae	1.0	0.5 and 1.0	30, 60 and 90	38.3	65.0 and 66.7	24.2	Thailand
S. agalactiae NUF 18 strain	20.0	0.5 and 1.0	51 and 21	46.55	77.7 and 79.1	30.4	Vietnam

Table 1. Effects of the yeast postbiotic Safmannan® in tilapia mortality after bacterial challenge with *S.agalactiae*.

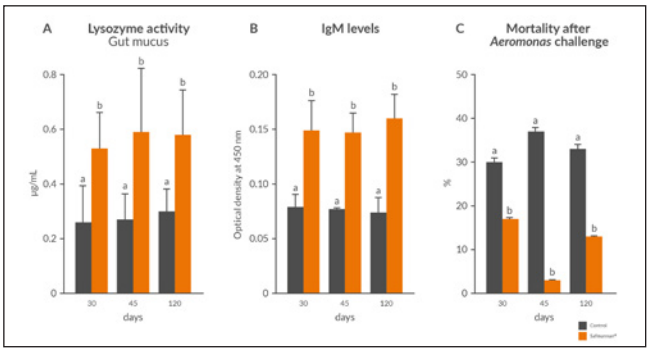

Figure 2. Strengthened immune response and survival against *Aeromonas hydrophila* after Safmannan® supplementation, evaluated by (a) lysozyme activity in the gut mucus, (b) serum IgM levels after bacterial challenge, and (c) cumulative fish mortality post bacterial challenge.

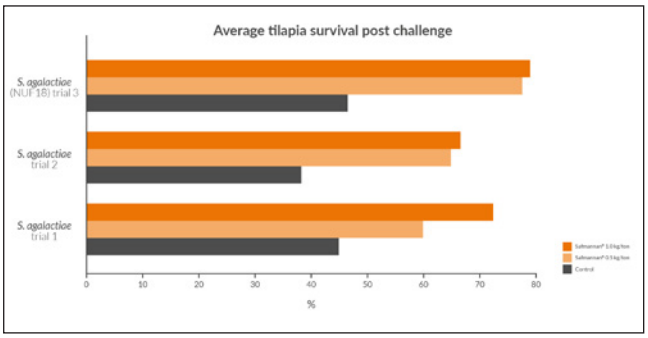

Figure 3. Effects of the yeast postbiotic Safmannan® in fish mortality after bacterial challenge with *Streptococcus agalactiae*. Average results calculated in different trials using supplementation dosages of 0.5 and 1.0kg/tonne of feed.

Yeast-based postbiotics have the ability to strengthen the immune response of tilapia and its survival when challenged with the most detrimental pathogens, such as *A. hydrophila* and *S. agalactiae*. A trial by Phileo demonstrated that supplementation of this yeast probiotic in feeds significantly improves the innate immune response of tilapia juveniles. This was highlighted by the activation of lysozyme (an antimicrobial enzyme) in the gut mucus and by the increase of the antibody levels (IgM) in the plasma. This enhancement in immunity conferred fish a higher chance of survival when challenged with *A. hydrophila* (Figure 2; internal trial data conducted at ITBOCA, Vera Cruz, Mexico).

Similar performances were also observed with *S. agalactiae* challenges, confirming the potential of Safmannan for preventing and managing chronic and recurrent bacterial diseases of tilapia (Table 1 and Figure 3; internal trial data, conducted at Chulalongkorn University, Thailand and ShrimpVet group, Vietnam).

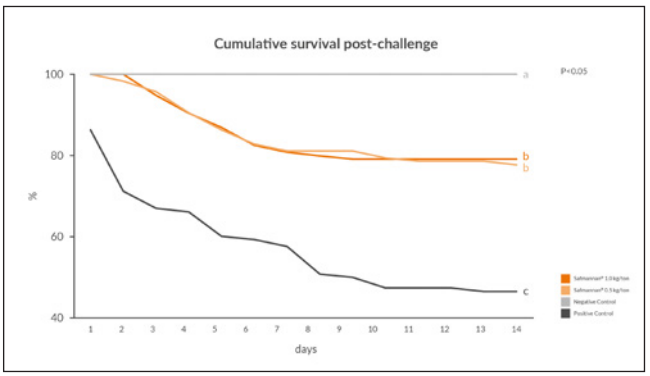

Figure 4. Effects of yeast postbiotic Safmannan® on the daily fish mortality after bacterial challenge with *Streptococcus agalactiae* using supplementation dosage of 0.5 and 1.0kg/ tonne of feed. Source: Tran, Suyawanish and Tacon, 2018.

The supplementation of this yeast postbiotic is also effective in preventing mortality peaks, especially during the first day post-challenge, significantly attenuating mortality curves (Figure 4). Bacterial counting carried out after challenge in several trials revealed reduced *S. agalactiae* count in the gut and in the liver of Safmannan supplemented fish compared to control groups. The reduced count of *S. agalactiae* in the liver was also associated with lesser liver lesions (Figure 5).

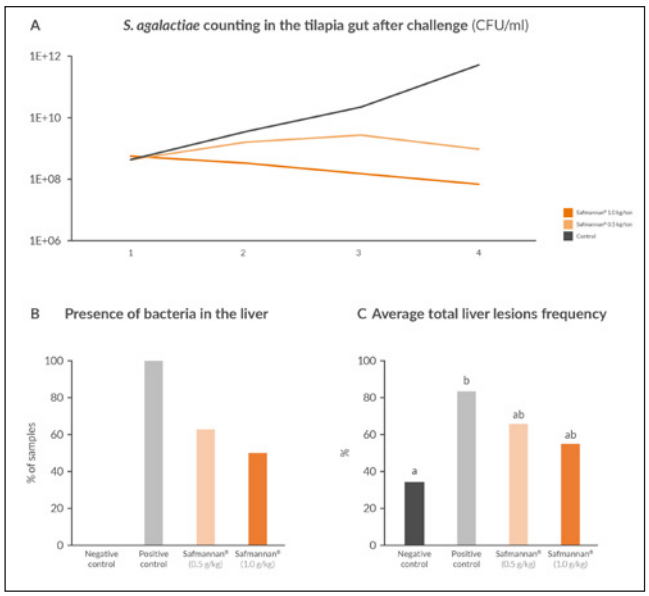

Figure 5. (a) *Streptococcus agalactiae* counts (CFU/mL) in gut of tilapia after challenge; (b) frequency of *S. agalactiae* detection in the liver; (c) average total lesions frequency in the liver of tilapia submitted to *S. agalactiae* intra-peritoneal infection challenge. Bars indicate means and different letters above bars indicate significant differences ($P < 0.01$). Source: ShrimpVet group (Phileo® by Lesaffre internal trial report).

AQUASAF TILAPIA	Fry 0.1-2g	Fingerling 2-20g	Growth I 20-150g	Growth II 150-400g	Finishing 400g -harvest
Disease prevention Standard conditions	C	C	C/P	C/P	C/P
Safmannan®	1kg/tonne	1kg/tonne	1kg/tonne	0.5-1kg/tonne	0.5-1kg/tonne
Disease prevention High density + Stress	C	C	C/P	C/P	C/P
Safmannan®	1-2kg/tonne	1-2kg/tonne	1kg/tonne	1kg/tonne	1kg/tonne
Selsaf® (selenium yeast)	80-150g/tonne	80-150g/tonne	60-120g/tonne	60-120g/tonne	60-120g/tonne
Improved Immunity	P	P	P	P	P
Safmannan*	1-3 kg/tonne	1-3 kg/tonne	1-3 kg/tonne	1-2 kg/tonne	1-2 kg/tonne
C = continuous application; P = pulsed application with minimum14 - 21 days of supplementation before challenge peak					

Table 2. Dosage recommendations of the yeast probiotics Safmannan® for disease prevention in tilapia in standard conditions and during high-risk periods.

Conclusion

The rapid development and intensification of farming systems of tilapia are accompanied by a concomitant increase of the financial losses caused by disease outbreaks. By reducing pathogen pressure in the gut and increasing the immune response, Safmannan offers producers the possibility to prevent and substantially reduce the chances of mass mortalities in the presence of pathogens and therefore limit financial losses at harvest.

Based on the results obtained in laboratory and commercial trials, we have shown how this postbiotic provides a variety of solutions depending on the origin, intensity and frequency of the pathogenic challenges encountered (Table 2).

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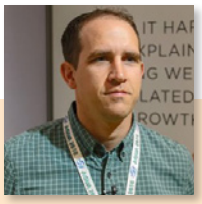

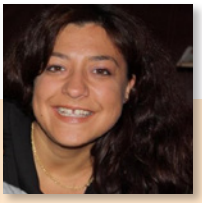

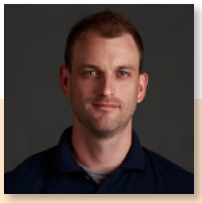

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A functional hydrolysate adds value to feeds for omnivorous fish species

Omnivorous fish species are known to be less demanding in terms of nutritional and palatability requirements and yet dietary hydrolysate supplementation greatly improved production yields and margins

By Mikael Herault, Paul Seguin and Muhammad Kabir

Tilapia (Oreochromis sp) and on the left, pabda or butter catfish (Ompok bimaculatus) are two freshwater fish species commonly farmed in Bangladesh.

Several biological benefits are associated with protein hydrolysates and they have been used in finfish larval and juvenile diets for several decades now, mainly due to their high palatability and digestibility.

Symrise Aqua Feed has been producing functional protein hydrolysates for more than 20 years and recently it has promoted the long-term use of a new generation of liquid hydrolysates formulated as palatability enhancers (PE, Extrapal range; Seguin et al., 2020 & 2021; Soller et al., 2019) in carnivorous fish species dietary formulations. In terms of dietary compositions, these species require palatable raw materials, such as fishmeal. As they are very sensitive to stressful events, which often result in reduced feeding, both farmers and feed manufacturers readily accept the benefits of using PE.

In contrast, freshwater omnivorous fish species are not perceived to require palatants *per se* and are considered as less demanding. In these species, feed acceptance becomes an issue during very specific periods, such as wintering. Challenges quoted by freshwater fish farmers are mostly related to feed costs and disease outbreaks.

Symrise Aqua Feed has developed a cost-effective solution to meet these needs by designing ActiTuna Oil which is formulated with the right balance of tuna oil and protein hydrolysate, to make top coating application easier for feed manufacturers as a one step process. The product is designed to increase feed palatability and digestibility for omnivorous fish aiming at the reduction of cost of feeds in farming.

To evaluate the performance of ActiTuna Oil in omnivorous fish species, two feeding trials were carried out with the tilapia (*Oreochromis* sp) and pabda or butter catfish (*Ompok bimaculatus*). These two fish species are commonly farmed in Bangladesh. The study took place at Sylhet Agricultural University, Bangladesh.

Trial designs

The same experimental design was used in trials for both species. A basal diet was supplemented by top-coating 0.5%, 1.0% or 2.0% of the functional hydrolysate ActiTuna Oil. The negative control was the same basal diet without any supplementation. In the tilapia trial, the basal diet consisted of a plant-based diet formulated to be closely representative as possible to a local commercial diet with 31% crude protein (CP) and 6% crude lipid (CF, Table 1). In the pabda trial, the basal diet consisted of a locally available commercial diet (36% CP, 7% CF).

Ingredients	%	USD/tonne
Soybean meal	26.32	620.00
Corn	23.58	390.00
Rapeseed	15.26	415.00
Full fat soya	13.16	1,250.00
Deoiled rice bran	10.00	283.00
Polished rice	2.63	65.00
DDGS	2.63	360.00
CGM	2.63	790.00
Poultry meal	2.63	1,023.00
Sardine fish oil	0.32	27,430.00
Vitamin and mineral premix	0.32	24,040.00
Binder	0.32	1,160.00
Soya oil	0.21	650.00
Cost of feed		737.69
DDGS =distillers dried grains with solubles CGM=corn gluten meal		

Table1. Composition of the basal diet for the tilapia trial.

There were three treatments and each treatment consisted of three replicates. Including the control, there was a total of 12 cages of 3m² for each test species. The stocking density was 100 fish/cage and initial mean weight was 5.0g for tilapia and 3.0g for pabda. Fish were fed twice a day at a fixed feeding rate. The total feed distributed over 90 days was 17g per tilapia fish and 20g per pabda fish. Water quality parameters met the requirements for each species. Means for these parameters were: temperature, 30.7±0.3°C, dissolved oxygen 5.04±0.1ppm; pH 6.95±0.07; ammonia 0.06±0.04 ppm and nitrite 0.08±0.04ppm.

A total of 12 cages, each of 3m² were used for each test species. The stocking density was 100 fish/cage and initial mean weight was 5.0g for tilapia and 3.0g for pabda

High survival and growth rates

Fish in both feeding trials showed very high survival and growth rates after 90 days. Survival rates were at least 93% for both species while specific growth rates (SGR) ranged from 3.46% to 4.15%/day for tilapia and 1.93% to 2.33%/day for pabda. The supplementation of ActiTuna Oil resulted in significant dose responses in terms of mean weights (Figure 1). Maximum weight gains were observed for the 2% supplementation group, with an increase of 86% for tilapia and 43% for pabda. Production yields calculated in terms of tonnes per hectare of rearing area increased by 97% and 52% for tilapia and pabda, respectively.

Since feed rations were fixed and remained the same throughout the trial duration, the difference in growth rates can be explained by better feed utilisation, through enhanced feed palatability reducing feed waste, and improved diet digestibility, thus increasing diet assimilation. These were illustrated by the feed conversion ratios (FCRs) and protein efficiency ratio (PER) values (Figures 2 and 3). Responses to graded supplementations of the functional hydrolysate were very highly significant for FCR improvements, with a maximum achieved reduction of 49% and 34%, observed in tilapia and pabda, respectively. These benefits can be further developed by two positive outcomes:

- A much higher PER values, (+92% and +44% for tilapia and pabda respectively) resulting in much lower nitrogen pollution in ponds and;
- A much lower budget dedicated to feed in farming production costs, as defined in USD/kg of harvested biomass. These were -47% and – 33% for tilapia and pabda, respectively.

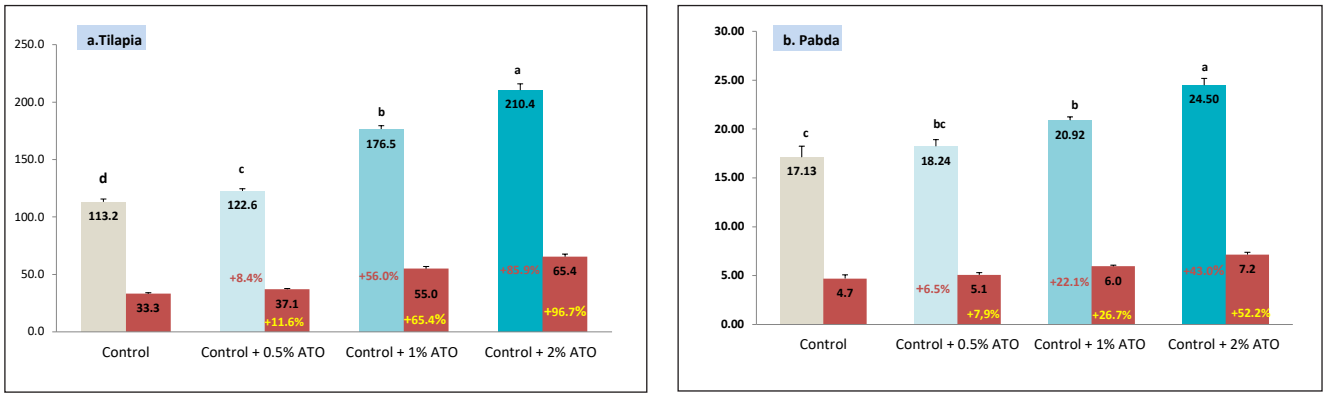

Figure 1. Final mean body weights (FMW, g) and yield in tonnes/ha for a. tilapia and b. pabda after 90 days of grow-out in trials where treatment diets were supplemented with ActiTuna Oil (ATO) at 0.5%, 1.0% and 2.0%. Different letters above the bars indicate statistically significant difference at P<0.001 for these parameters.

Some perspectives on return on investment

These functional hydrolysates from the Actipal range are designed to enhance feed palatability, feed efficiency and the overall health status of animals through their specific peptide profiles. The synergic effect of water soluble free amino acids, short peptide chains and bioactive peptides brings out the optimal flavour of the feed, stimulating fish taste buds and modulating metabolic pathways. This stimulation triggers a series of physiological and endocrinal responses, preparing the digestive system to properly digest the feed and modulate the microbiota in the gut.

In this study, fish were fed manually a fixed amount of feed daily.

Results from these trials show that there is still some room for feed cost optimisation through better feed acceptance and assimilation, even with omnivorous fish species.

The economic benefit of using ActiTuna Oil as a dietary performance enhancer was demonstrated in Figure 4. Bars showed the expected sales revenues using tilapia and pabda farm gate prices at USD1.58/kg and USD3.15/kg, respectively. While feed costs remain the same, by extrapolation of other variable and fixed costs (seeds, electricity, wages etc), revenues can be higher by 96% (tilapia) and 51% (pabda) leaving a possible margin increase by 69% for the pabda and 424% for tilapia production, assuming other variable costs are negligible compared to feed. The observed differences between the two species are explained by the fact that the tilapia feeding trial started with larger fish. Tilapia also grow much faster than pabda.

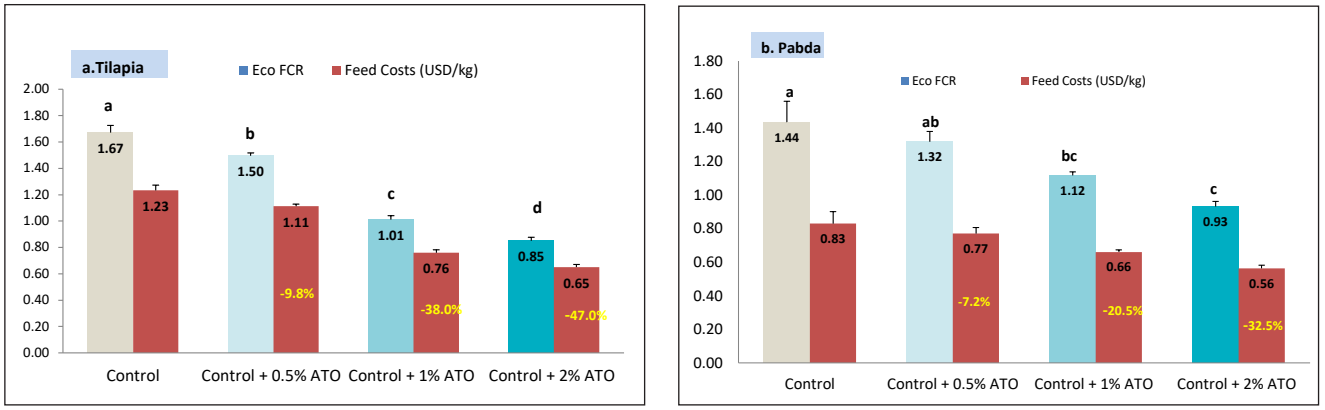

Figure 2. Economic FCR (left bars) and feed costs (right bars) in USD/kg for tilapia and pabda after 90 days of feeding diets supplemented with ActiTuna Oil (ATO) at 0.5%, 0.1% and 2%. Different letters above the bars indicate statistically significant difference at P<0.001) for these parameters.

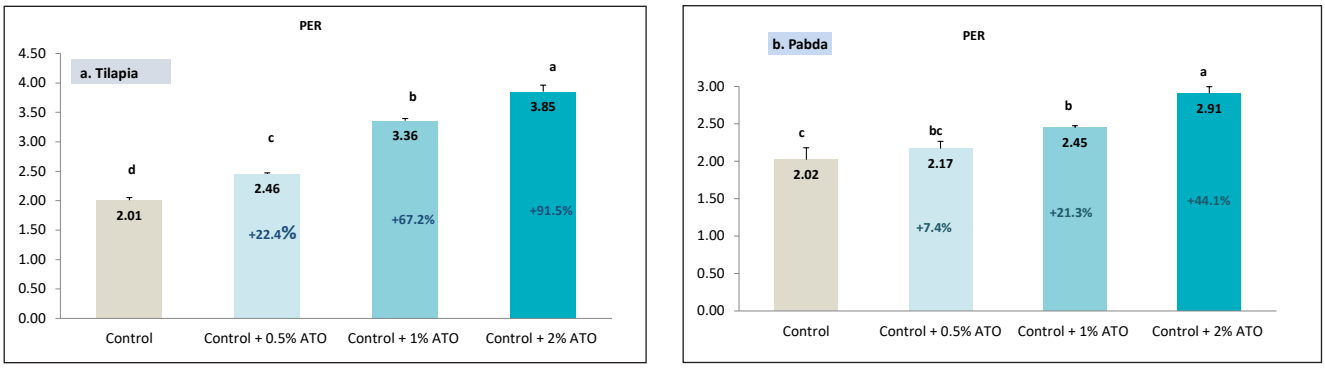

Figure 3. Protein efficiency ratio (PER) for tilapia and pabda after 90 days of feeding diets supplemented with ActiTuna Oil (ATO) at 0.5%, 0.1% and 2%. Different letters above the bars indicate statistically significant difference at P<0.01).

Returns on investment (ROIs) were calculated using revenue gains over feed investment costs. Maximum ROIs were observed for the 2% ActiTuna Oil dietary supplementation: 144% and 460% for tilapia and pabda, respectively.

Besides economic considerations, it is worth mentioning that a lower pond water pollution from lower FCR will also contribute to better fish welfare, significantly reducing the risks of disease outbreaks and production losses.

Conclusions

The two feeding trials presented in this article illustrate the positive outcomes, which one may expect from the dietary application of a functional hydrolysate -ActiTuna Oil- by top coating. What is rather uncommon is the demonstration of such production figures in omnivorous fish species, generally considered less demanding in terms of dietary composition, nutrients, and palatability. Farm gate prices of these species are also usually lower than those of marine fish species, which then give a smaller margin for sophisticated feed formulations. However, the estimated values of farm revenues, margins and feed ROIs demonstrated it is possible to generate much higher added values to feed formulas and farm productions of omnivorous fish species. The 2% dietary supplementation of the functional hydrolysate ActiTuna Oil resulted in maximum growth rates, yields, revenues and ROIs.

We have detailed the positive outcomes expected by fish farmers (higher incomes, lower water pollution and disease risks) mostly explained by a higher feed acceptance (palatability) and assimilation (digestibility), which address the industry needs of lower feed costs and disease risks, as discussed in the introduction to this article. From the feed manufacturers' perspectives, top coating application of ActiTuna Oil will bring uniqueness and differentiation to a standard formulation. Since competition among feed manufacturers is tough, giving formulators more flexibility in terms of raw material choices is a real asset in these times of scarcity and cost volatilities.

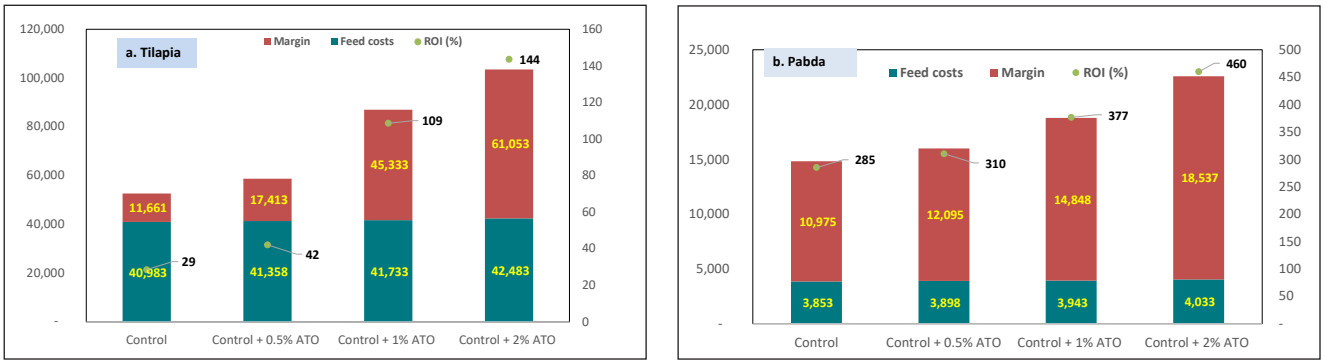

Figure 4. Tilapia and pabda feeds related economics (costs and margins, from sales in USD/ha and ROI, in %) after 90 days of feeding diets supplemented with ActiTuna Oil (ATO) at 0.5%, 0.1% and 2%. ($p<0.01$).

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A novel yeast for immune support in shrimp

An exploration of how *P. guilliermondii* in diets impacts shrimp immune physiology and performance.

By Sarah Cooper, François Jégou, Delphine Weissman and Yoav Rosen

Different types of yeasts and their extracts are used as feed ingredients in aquaculture because of their nutritional value and/or bioactive compounds. *Saccharomyces cerevisiae* is the most commonly used yeast in animal feed applications. *Pichia guilliermondii* is a novel yeast with unique morphology, structure and consequent activity that has recently shown potential in shrimp with regards to immune support.

A novel yeast with potential in shrimp feed

The differences in the morphology and physical characteristics of *P. guilliermondii* and *S. cerevisiae* have been assessed in a side-by-side study by Peisker et al. (2017). There are significant differences between them: *P. guilliermondii* yeast cell is smaller and as a result has a greater surface area to volume ratio. It is also significantly more hydrophobic compared to *S. cerevisiae*. Additionally, the distribution of glycoproteins in the yeast cell wall varies, suggesting that *P. guilliermondii* has a different cell wall structure and composition to *S. cerevisiae*. These particularities may be associated with significant differences in how the two yeast cells behave when used in aquafeeds.

A call for new shrimp management approaches

As shrimp lack an adaptive immune system, preventive therapies such as vaccines that are used in more immune-competent species cannot be used to protect shrimp against certain infectious diseases. Concomitantly, with growing concerns surrounding antimicrobial resistance, restrictions on the use of antimicrobials to support health in animals used for food are increasing, including shrimp production.

Consequently, alternative strategies are being sought to enhance shrimp health and performance in a sustainable way. Such alternative methods include farm management practices, bioremediation, genetics and nutrition including specialty additives.

Supporting immune physiology and improved performance in shrimp

The association between the use of *P. guilliermondii* in the diet of shrimp and beneficial impacts on parameters related to shrimp immune physiology and performance has been explored in a few studies.

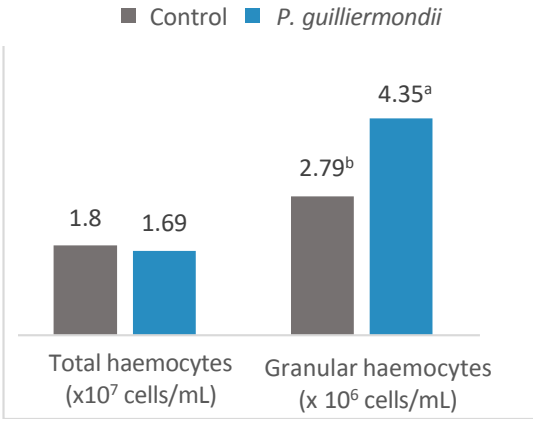

Figure 1. Number of granular haemocytes and total haemocytes in shrimp in the control and supplemented group.

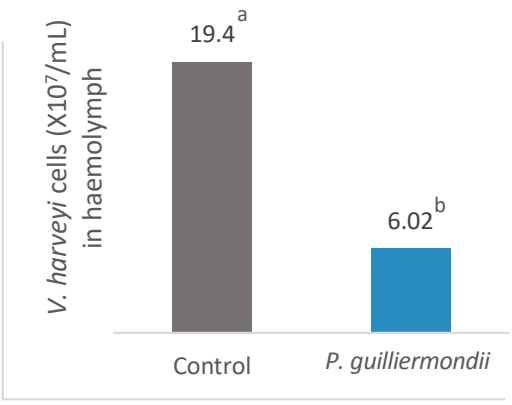

Figure 2. *V. harveyi* cells remaining in haemolymph, 3 hours following challenge.

Immune physiology

An initial study was performed in a research facility in Thailand. It evaluated changes in critical immune parameters in shrimp before and after experimental challenge with *Vibrio harveyi* when shrimp are supplemented with *P. guilliermondii*, compared to those without supplementation as shown in Figure 1.

At the end of the 28-day feeding period, shrimp from both the supplemented and control groups were sampled to measure the concentration of total and granular haemocytes. Following this, shrimp from each group were infected with *V. harveyi* and then 3 hours later the number of *V. harveyi* cells remaining in the haemolymph of each group was measured to assess the efficacy of bacterial clearance.

Whereas the level of total haemocytes remained unchanged between the two groups, the granular haemocyte count was significantly increased in the haemolymph of shrimp fed *P. guilliermondii* ($P<0.05$; Figure 1). Haemocytes are invertebrate blood (haemolymph) cells that are involved in critical shrimp immune defence processes such as coagulation and phagocytosis of invading microorganisms. Although total haemocyte count is used as an indicator of overall shrimp health status, granular haemocytes contain the primary humoral defence factors that are released during a pathogen invasion. An elevated proportion of granular haemocytes amongst total haemocytes may therefore indicate primed immune capabilities and consequently a more effective response to pathogen challenges.

The *P. guilliermondii*-fed shrimp, having a greater proportion of these granular haemocytes present, were then found to have a significantly lower number of *V. harveyi* cells remaining in their haemolymph when measured 3 hours following the challenge ($P<0.05$; Figure 2).

Improved survival when challenged

Two further studies were conducted to examine the potential impact of *P. guilliermondii* supplementation on performance during two common infectious challenges: white spot syndrome virus (WSSV) and *Vibrio parahaemolyticus*, the etiological agent of early mortality syndrome or EMS, also known as acute hepatopancreatic necrosis disease (AHPND).

Both studies took place in a wet laboratory in Peru and were similar in design, having three treatments within each study: the unchallenged control group was fed the basal diet without the supplementation of *P. guilliermondii*; the other two groups were both challenged, but only one of these groups received *P. guilliermondii* supplementation. In both studies, the groups of shrimp fed diets supplemented with *P. guilliermondii* had significantly improved survival compared to the challenged control groups: 84% greater survival in the WSSV challenge ($P<0.05$; Figure 3), and 76% greater survival in the *V. parahaemolyticus* challenge ($P<0.05$; Figure 4).

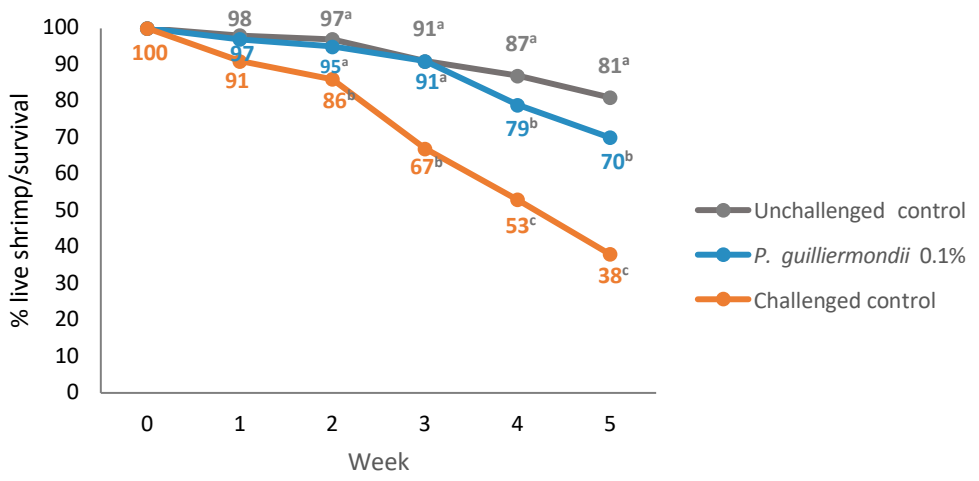

Figure 3. Survival: Percentage of live shrimp remaining in each group at weekly live shrimp counts. Two treatment groups were challenged with WSSV in this trial but only one group was fed diets supplemented with *P. guilliermondii*.

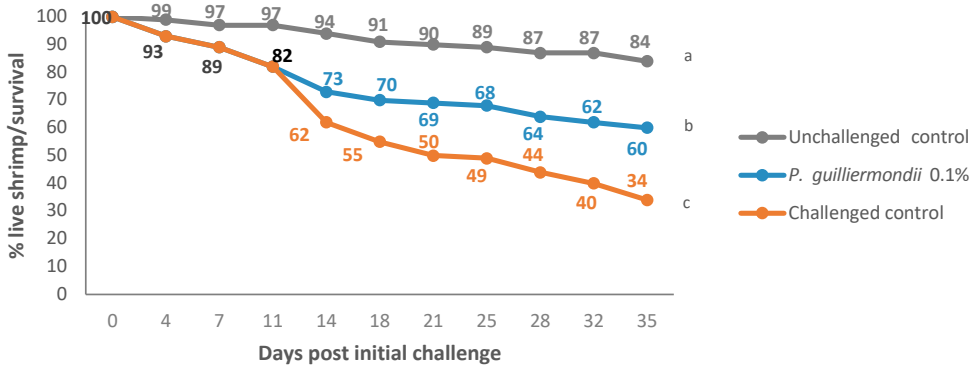

Figure 4. Survival: Percentage of live shrimp remaining in each group at live shrimp counts between day 0 and day 35 post initial challenge. Two treatment groups were challenged with *V. parahaemolyticus* in this trial but only one group was fed diets supplemented with *P. guilliermondii*.

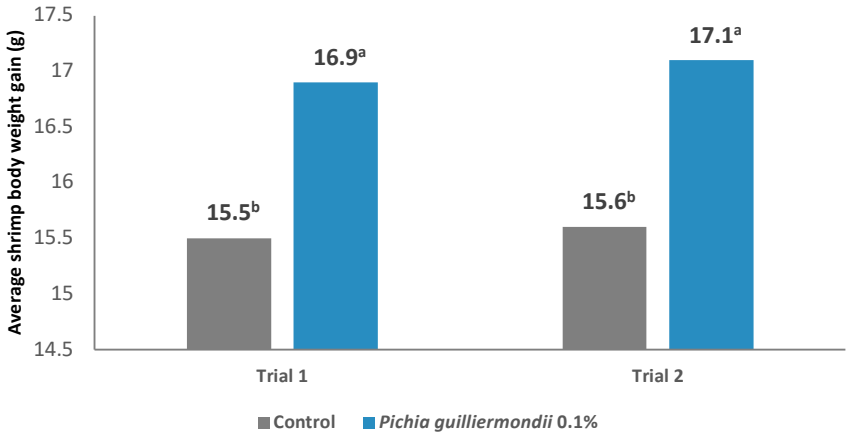

Figure 5. Average shrimp body weight gain over the study periods.

Better growth under unchallenged conditions

The performance of shrimp fed diets supplemented with *P. guilliermondii* under conditions without any specific infectious challenge was assessed in two studies in the ADM research facilities in Vietnam. During each trial, eight replicates per treatment group were fed with either a basal control diet or the basal diet plus *P. guilliermondii* supplementation at 0.1%. The average weight gain of shrimp between the start and end of the study was significantly greater, by 9% and 10% respectively ($P < 0.05$; Figure 5) for the shrimp receiving the *P. guilliermondii* supplementation compared to shrimp fed the basal control diet.

Promoting better outcomes for shrimp production

The association between the use of the novel yeast *P. guilliermondii* in shrimp diets and beneficial impacts on physiological and performance parameters has been demonstrated in several studies, across different markets and under different conditions. It may be the specific morphology and unique structure of *P. guilliermondii* that influence these extraordinary and beneficial outcomes. As such, *P. guilliermondii* may represent a cost-effective, natural means of reducing the impact of health challenges and improving performance in shrimp production.

Reference

Peisker, M., Stensrud, E., Apajalahti, J., Sifri, M. 2017. Morphological Characterization of *Pichia guilliermondii* and *Saccharomyces cerevisiae* yeast and their Effects on Adherence of Intestinal Pathogens on Piglet and Chicken Epithelium In-vitro. J Anim Res Nutr Vol No 2 Iss No 1:9 doi: 10.21767/2572-5459.100029

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Phytogenic feed additives: Garlic and cinnamon to improve health and growth performance in shrimp

Use of a phytogenic feed additive based on garlic and cinnamon benefits growth at lower inclusion, while it improves immune status and health of shrimp at higher inclusion

By Matthijs de Jong and Aurélie Montagnon

Production of white leg shrimp *(Litopenaeus vannamei)* has been increasing over the past decades and is expected to grow more in the (near) future. Shrimp farming is an exciting sector for the production of high-value end products, but it continues to face a growing number of challenges. Today, one of them is to combine improvement in productivity with the shift towards more sustainable farming, without compromising on shrimp health. Shrimp farming is under pressure to reduce its environmental impact whilst mitigating disease outbreaks. To maintain shrimp productivity and health and, at the same time cope with these challenges, the optimisation of feed is a necessity.

Phytogenic feed additives

A common nutritional strategy is the use of phytogenic feed additives (PFA). PFAs, such as garlic and cinnamon, are widely known as appetite stimulators, growth promoters and immune stimulants. Additionally, they often have anti-pathogenic, anti-bacterial and anti-parasitic properties. Garlic and cinnamon contain several bioactive molecules that can exert multiple effects on gut health. This includes an antimicrobial effect by disrupting the cellular membrane of pathogens. It can also boost host immunity, helping with anti-inflammatory and antioxidant reactions. This results in the redirection of energy to maintain or even increase animal performance during pathogenic challenges.

The mode of action behind these components can be attributed to the active compounds, which are allicin (garlic) and cinnamaldehyde (cinnamon). Both are known to be beneficial for animals. Orffa (Belgium) offers a very effective product called Excential Alliin Plus, where both garlic and cinnamon are freeze-dried and processed in a unique way to ensure optimal activity inside the animal's intestine (Figure 1).

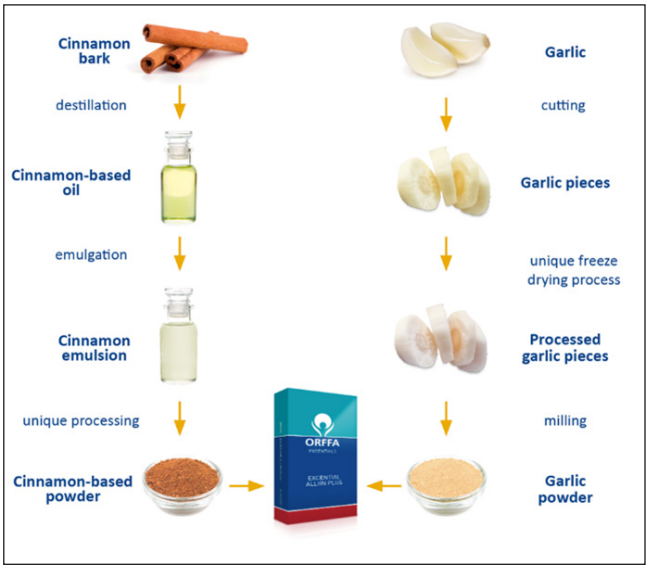


Figure 1. The unique production process of Excential Alliin Plus

The effect of garlic and cinnamon on bacteria and ectoparasites

Garlic and cinnamon usage in animal production has a long history. In livestock production, both components have been used for quite some time due to their effectiveness against parasites and opportunistic bacteria. In aquaculture, the use of garlic and cinnamon to support fish in their defense against pathogens is widely accepted. In farming of the cobia (*Rachycentron canadum*), it was observed that the inclusion of 1 kg/tonne of feed of a garlic and cinnamon product led to a significant decrease in the occurrence of sea lice on the fish by 60% (Table 1).

	Cage 1	Cage 2	Cage 3	Cage 4	Cage 5	Cage 6	Cage 7	Cage 8	Cage 9	Average Alliin Plus	Average Control
wk 4	0.5	0.7	0.3	0	0.4	0	0	2.1	0.7	0.15	0.63
wk 5	1.2	0.4	1.1	4.6	2	0	2	1.1	3.5	0.55	2.11
wk 7	5	2	0	5	0	2.4	6	1.8		1.2	3.3
wk 8	10.4	1	2	3.8	4.4	2.2	14.7	3.2	3.6	2.1	5.87
wk 9	4	0.2	1.4	0.2	1.2	0.8	6.8	0	1.2	1.1	1.94
Avg	4.2	0.9	1	2.7	1.6	1.1	5.9	1.6	2.3	1.05	2.74

Table 1. Sea lice count in cobia fish fed diets without and with 1 kg Excential Alliin Plus/tonne feed.

Additionally, in this same trial, it was observed that the size of the wounds caused by sea lice on the fish fed the garlic and cinnamon product were smaller and, in those fish, wound regeneration capacity was also increased.

Besides repelling parasites, it is known that allicin and cinnamaldehyde are both very effective against opportunistic pathogenic bacteria. Looking at an allicin *in vitro* trial, it can be observed that it is stronger against pathogenic bacteria compared to other known health stimulators or even some medicines (Figure 2). The circles seen around each product in Figure 2 show the inhibition zone against the tested opportunistic pathogenic bacteria, *Escherichia coli* and *Salmonella*. Larger inhibition zones mean a stronger anti-bacterial effect against that specific pathogen. These results indicate that the use of this PFA can lead to a decreased need of adding antibiotics in aquaculture. Similar effects are observed when cinnamaldehyde is used, pointing out the anti-pathogenic power of the product combination.

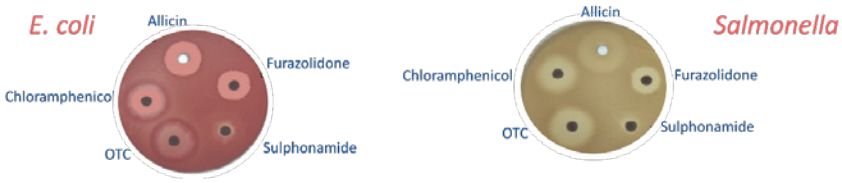


Figure2. Anti-pathogenic power of allicin compared to other anti-bacterial components.

The effect of garlic and cinnamon in shrimp

Bacterial, viral and parasitical pathogens pose serious challenges for the entire aquaculture sector. However, in shrimp, the harmful effects can be immense, since their immune system is less developed as compared to fish. Therefore, the need to derive a workable strategy to reduce the impact and increase shrimp resilience is necessary. PFAs are believed to have beneficial effects on shrimp performance and health. This was confirmed by a trial at the Kasetsart University in Bangkok, Thailand. Under the guidance of Dr Orapint Jintasataporn, Associate Professor, Faculty of Fisheries, an experiment was conducted to evaluate the efficacy of the garlic-cinnamon (GC) blend in white leg shrimp based on growth performance and immunity, in an unchallenged situation and after a bacterial challenge with *Vibrio parahaemolyticus*.

To investigate its efficacy, 300 shrimp (2.21 ± 0.06g) were divided into 15 tanks. These tanks were randomly assigned to three dietary treatments, with five replicates per treatment. The control diet was a basal commercial diet with 1,000ppm calcium carbonate added as a placebo. The treatment diets, with low (500ppm) and high (1000ppm) content of garlic-cinnamon blend, are described in Table 2. After 8 weeks of feeding, shrimp growth performance was measured, in terms of weight gain, specific growth rate (SGR), feed intake and feed conversion ratio (FCR). Additionally, after 4 weeks of feeding, the total haemocyte count, haemolymph protein and phenoloxidase activity were measured and compared among the treatments. After 8 weeks in the feeding trial, shrimp were challenged with *V. parahaemolyticus*. After 12 hours, the immune parameters were measured again together with lysozyme activity, superoxide dismutase activity and glutathione peroxidase activity.

		Basal commercial diet	Calcium carbonate	Garlic-cinnamon (GC) blend Excential Alliin Plus
Control diet		+	1000 ppm	-
Treatment diets	GC low	+	500 ppm	500 ppm
	GC high	+	-	1000 ppm

Table 2. Control and treatment diets for the trial on efficacy of the garlic-cinnamon (GC) blend.

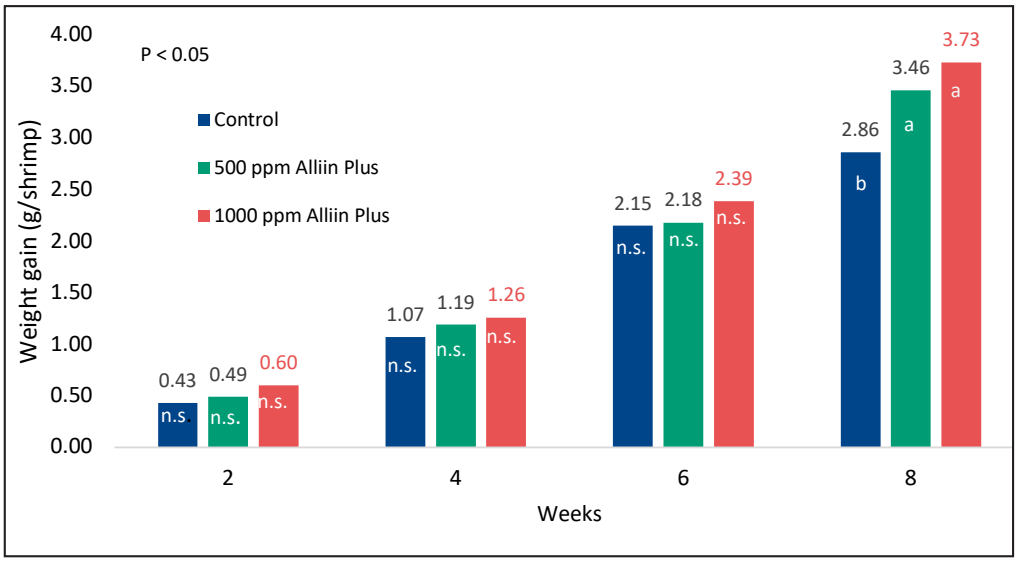


Figure 3. Weight gain of white leg shrimp fed Excential Alliin Plus at 500 or 1,000ppm.

Growth performance

Looking at the growth performance, it was observed that the PFA addition gave a significantly higher weight gain and specific growth rate regardless of the inclusion level (Figure 3). The best numerical growth was observed in treatment GC high (3.73g) compared to treatment GC low (3.46g), and both groups were significantly better than the control (2.86g). Similar results with growth performance indicators were observed. For the SGR (percentage of growth per day), it can be observed that after 8 weeks, the control group was significantly lower (1.47%/day) compared to treatments GC low (1.67 %/day) and GC high (1.78%/day).

Feed intake

Amongst treatment diets, feed intake was unaffected by the inclusion of PFA, indicating that the increased growth is the result of a more efficient feed utilisation by the shrimp fed the product. This is confirmed by the FCR in treatment GC high that was 1.18, which was significantly lower than GC low (1.27) and control (1.52), after 8 weeks of feeding.

Since the nutritional value of Excential Alliin Plus is low (it is not a protein, fat nor energy source) and the inclusion levels are negligible, the increased feed efficiency is probably linked to increased health status of the shrimp. The beneficial effect of this PFA was confirmed in this trial, where it was observed that the overall immunity status in an unchallenged situation improved, especially in GC high treatment diet (Figure 4).

Immune parameters

In particular, we observed that haemolymph protein activity, an anti-pathogenic protein, and phenoloxidase activity, a defensive enzyme, were significantly improved by the PFA addition to the feed, with 1,000ppm as optimal inclusion level (Figure 4). The improved immune status is linked to the increased growth since healthier shrimp grow better. Another interesting aspect was the difference in immune status after a challenge with *V. parahaemolyticus*. Twelve hours after the challenge, immunity parameters were analysed again (Figure 5). It can be observed that the differences in immunity status improved, and that 1,000ppm showed a strong effect especially on the phenoloxidase activity. Additionally, it was observed that shrimp fed the GC high treatment diet had a significantly higher lysozyme activity (610 unit/mL) compared to GC low (323 unit/mL) and control (227 unit/mL). Both in challenged and unchallenged situations, 1,000ppm of Excential Alliin Plus is seen to be beneficial for immune status and health of the shrimp. Accompanied by the results on shrimp growth performance, the ideal inclusion level of Excential Alliin Plus in shrimp diets is 1 kg/tonne of feed.

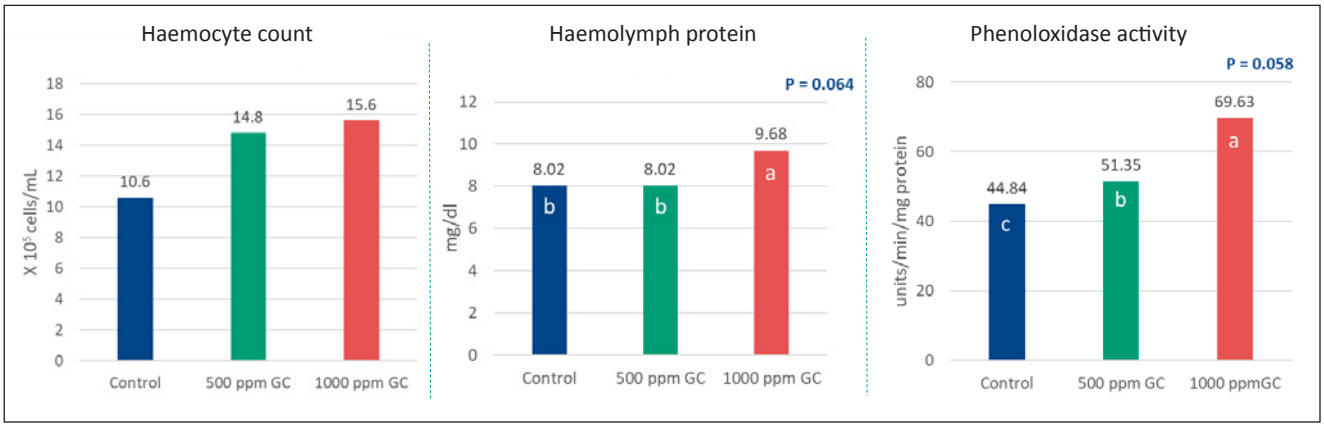


Figure 4. Immune status of shrimp fed Excential Alliin Plus at different levels.

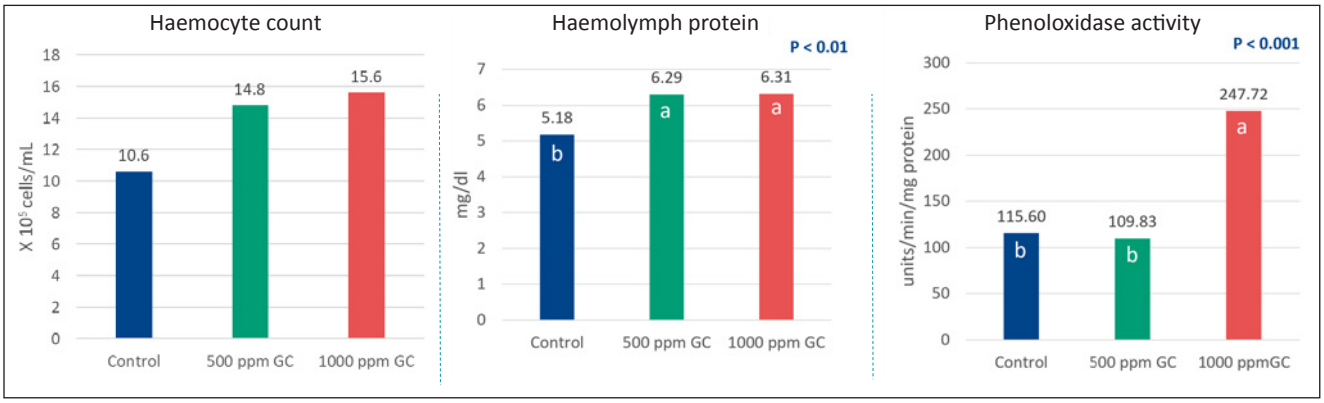
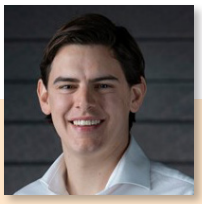


Figure 5. Immune status of shrimp fed Excential Alliin Plus at different levels after *Vibrio* challenge.

Conclusion

The use of Excential Alliin Plus in both livestock and aquaculture is already widely accepted. The experiment described in this article showed the potential of the product in shrimp, in challenged and unchallenged situations. Growth performance can be improved at an inclusion level of 500g/tonne of feed. However, higher inclusion levels have a more pronounced effect. The inclusion of 1 kg/tonne gives an even better growth performance and overall, an improved health status of shrimp. With the increasing pressure for more intensive and productive shrimp farming, the use of a phytogenic feed additive based on garlic and cinnamon might be the optimal strategy to reduce pathogenic pressure, environmental impact and antibiotic usage.



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Nucleotides: Functional ingredients in shrimp feed formulation

Supplementation of nucleotides in shrimp diets with high inclusion levels of plant-protein sources showed a positive impact on growth performance, immune response and disease resistance of Pacific white shrimp against *Vibrio harveyi*

By Romi Novriadi

In intensive shrimp farming system, a balanced diet to fulfill specific nutritional requirement of the shrimp is essential to support the rapid growth of shrimp production worldwide. However, to ensure that dietary ingredients are ingested, digested, absorbed and transported to the cells as well as to enhance the growth performance and disease resistance, the use of functional additives is increasingly very important. There is a wide range of feed additives for aquafeed, from phytogenic substances, probiotics, enzymes, antioxidants and nucleotides. All of these substances are closely connected with the state of health and growth by helping the digestive and absorptive processes and protecting the host from pathogens.

Published research indicated that nucleotide deficiency may impair liver, heart, intestine and immune functions and therefore, nucleotide administration through diet might provide adequate supply and availability to the aquatic organisms, especially during periods of high demand for various physiological and metabolic processes.

We tested the hypothesis that additional sources of nucleotide in a diet formulated with low inclusion levels of fishmeal could optimise the growth and health function of shrimp. In this study, we investigated the effects of the dietary supplementation of a nucleotide product in shrimp diets with high inclusion levels of soybean meal. Parameters studied were growth performance, protein level, immune response, and disease resistance of shrimp.

Growth trial

A total of 900 Pacific white shrimp *Litopenaeus vannamei* post larvae were obtained from PT Maju Tambak Sumur (Kalianda, Lampung, Indonesia) for the growth trial. During the acclimation period of 3 weeks, post larvae were fed with a commercial feed (Evergreen Feed, Lampung, Indonesia).

This 70-day growth trial was conducted at the PT Batam Dae Hae Seng Research Station (Batam, Indonesia). Shrimp (4.24±0.03g initial mean weight) were randomly distributed into 60 tanks, each with a volume of 98L. There were six replicates per dietary treatment. There were 10 diet treatments including the control.

Experimental diets

Crude protein content in the experimental diets ranged from 34.9 to 35.7% while the crude fat ranged from 7.0 to 7.9%. The control diet had protein from 10% fishmeal and 43% soybean meal and no nucleotides. In the treatment diets, the fishmeal was replaced with soybean meal. Shrimp were fed by hand four times daily, at 07:00, 11:00, 15:00 and 20:00h. Daily allowances of feed were adjusted based on observed feed consumption, weekly counts of the shrimp and mortality. Uneaten feed, faeces and moults were removed by siphoning the aquaria tank prior to the first feeding.

Daily feed inputs (g) were calculated as below:

Daily feed inputs (g)= Estimated FCR x Expected Growth x number of shrimp /7days

Feed inputs were pre-programmed assuming the normal growth of shrimp with an estimated feed conversion ratio of 1.5 across the growth trial.

At the end of the feeding period, all shrimp were grouped and individually weighed to calculate the final biomass, final body weight, percent weight gain, feed conversion ratio, survival and thermal unit growth coefficient. Haemolymph was withdrawn from two intermolt shrimp per tank or 10 shrimp per treatment from the pleopod base of the second abdominal segment with a sterile 1mL syringe. The lysozyme activity was measured by using a lysozyme detection kit and the results were defined by the lysis of the *Micrococcus lysodeikticus* cells.

Bacterial challenge

This was performed after the growth trial by using a suspension of *Vibrio harveyi* to reach a density of $1x10^5$ CFU/mL. Each group of treatments had six replicates and were fed the experimental diets 4 times/day. Observations on shrimp mortality were conducted daily during the 7-day challenge test to calculate cumulative mortality. The culture experiment was continued for 7 days and every day 25% of water was siphoned off and replaced to avoid deterioration of water quality. Replacement was carried out with water containing the corresponding strain concentration to maintain the bacterial concentration.

Growth performance

Nucleotide supplementation showed better growth performance, especially in the groups where fish meal was partially replaced by soybean meal. However, there were no significant differences between groups ($P>0.05$). as shown in Figure 1.

Since all diets were produced by using highly digestible ingredients and targeting similar protein and lipid level, there were no significant differences ($P>0.05$) in terms of protein level in the whole body of shrimp nor in protein retention rate.

However, the inclusion of nucleotides in general could enhance the nutrient utilisation in shrimp similar to shrimp fed with control diet. Interestingly, a reduction in fishmeal and the supplementation with nucleotides did not affect the protein deposition in shrimp.

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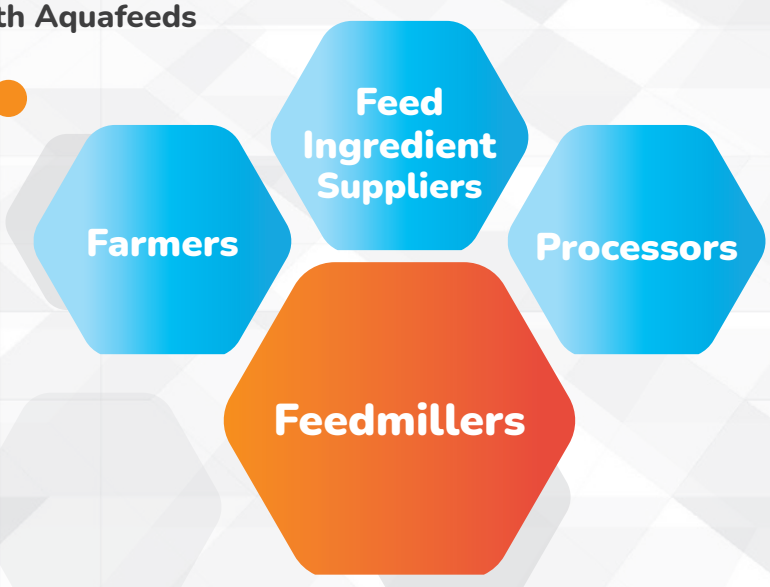

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Ingredients	Treatments Diets									
	Ctrl	1	2	3	4	5	6	7	8	9
Fishmeal	10.0	5.00	10.00	10.00	8.00	8.00	6.00	6.00	3.00	3.00
Soybean meal	43.00	50.00	45.50	45.80	44.80	44.75	47.50	47.45	51.85	51.80
Nucleoforce Aqua™	**0**	**0**	**0.05**	**0.10**	**0.05**	**0.10**	**0.05**	**0.10**	**0.05**	**0.10**
Corn gluten meal	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Menhaden fish oil	5.64	5.64	5.64	5.64	5.64	5.64	5.64	5.64	5.64	5.64
Corn Starch	6.56	4.56	3.66	3.66	6.71	6.71	6.01	6.01	4.66	4.66
Wheat products	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00
Mineral premix	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
Vitamin premix	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90
Others	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20
Proximate analysis										
Crude protein	35.72	34.91	35.84	35.81	35.42	35.77	35.48	35.77	35.39	35.24
Lysine	1.89	1.74	1.83	1.92	1.79	1.84	1.72	1.78	1.74	1.74
Methionine	0.84	0.82	0.88	0.87	0.83	0.87	0.76	0.84	0.71	0.75
Moisture	8.12	8.78	8.14	8.24	8.35	8.49	8.51	8.48	8.11	8.74
Crude fat	7.88	7.02	7.72	7.79	7.64	7.71	7.59	7.52	7.39	7.44
Crude fibre	2.89	3.55	3.14	3.22	3.37	3.41	4.42	4.39	4.83	4.66
Ash	6.11	7.35	6.56	6.78	6.43	6.29	6.33	6.53	6.47	7.01

Table 1. Composition (% as is) of diets containing two inclusion levels of nucleotide and fed to *Litopenaeus vannamei* for 70 days

Health and response to *V. harveyi* challenge

The supplementation with nucleotides allowed a significant increase (P<0.05) in total haemocyte counts (THC) and lysozyme activity, compared to the group without nucleotide supplementation in which fishmeal was partially replaced by SBM (Figure 2 and 3). A dose effect was observed for nucleotides, with 0.1% supplementation rate achieved better results than 0.05%.

In the challenge test, all nucleotide-supplemented diets gave significantly higher survival rates (P<0.05) compared to the control diet, but also compared to the group fed with a diet without nucleotide supplementation and with partial fishmeal replacement with soybean meal (diet 1).

The highest survival rates were achieved with diets with 10% and 8% inclusion levels of fishmeal, respectively, and supplemented with 0.1 % nucleotides (Figure 4).

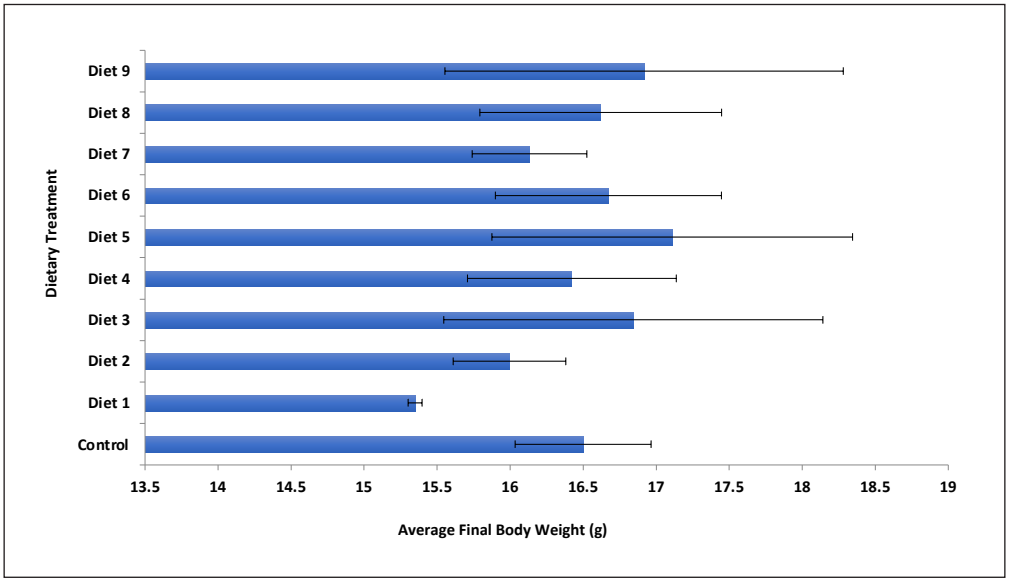

Figure 1. The average final body weight (ABW) of shrimp feed with different dietary treatments.

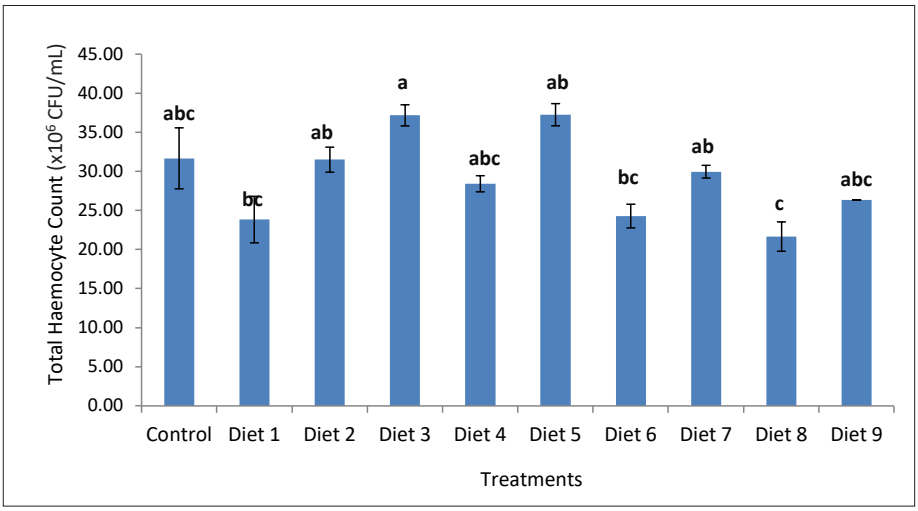

Figure 2. Total haemocyte count of Pacific white shrimp *Litopenaeus Vannamei* (10^6 cell/mL) at the end of growth trial. Values represent the mean of six replicates. Bars with different superscript letter are significantly different ($P < 0.05$) based on analysis of variance followed by Tukey's multiple comparison test.

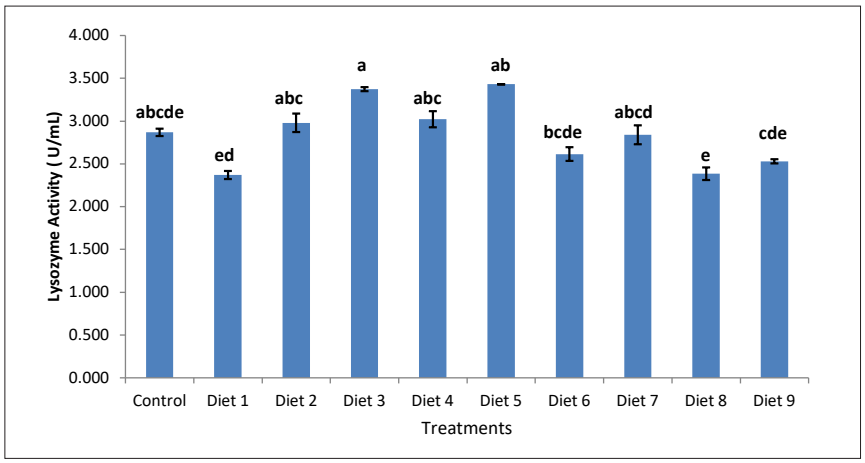

Figure 3. Lysozyme activity of Pacific white shrimp *Litopenaeus vannamei* (U/mL) at the end of growth trial. Values represent the mean of six replicates. Bars with different superscript letters are significantly different ($P < 0.05$) based on analysis of variance followed by Tukey's multiple comparison test.

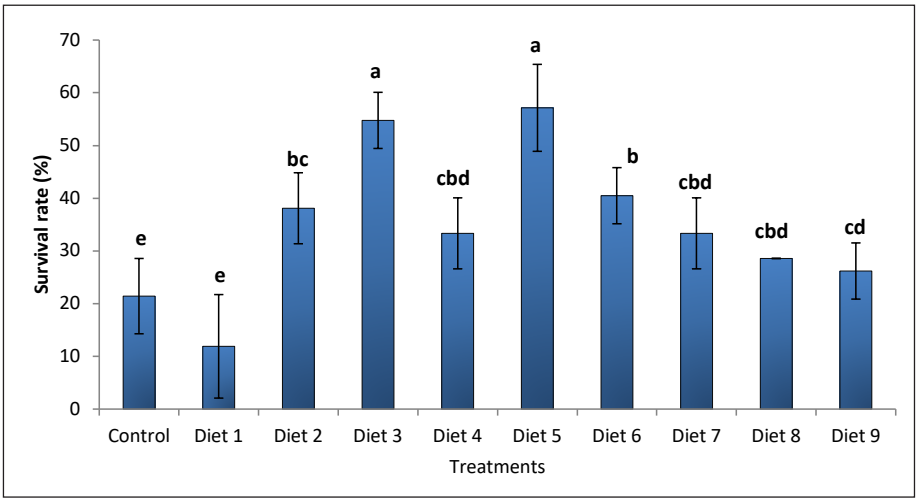

Figure 4. Survival rates (%) of *Litopenaeus vannamei* over 7 days after the challenge test with *Vibrio harveyi* (10^5 CFU/mL). Values represent the mean of six replicates.

Conclusion

Under the conditions of the present study, nucleotide supplementation showed a positive impact on performance, immune system and disease resistance against *V. harveyi* in the shrimp. Nucleotides could therefore be used as functional dietary ingredients to improve the health of shrimp. This research also provides evidence of health-related benefits of dietary nucleotides when fishmeal is reduced.

Reference

Novriadi, R., Ilham, I., Roigé, O., Segarra, S. 2021. Effects of dietary nucleotides supplementation on growth, total haemocyte count, lysozyme activity and survival upon challenge with *Vibrio harveyi* in pacific white shrimp, *Litopenaeus vannamei*. Aquaculture Reports, 21, 100840. doi:10.1016/j.aqrep.2021.100840

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Optimising efficiency and lowering aquafeed costs using the ideal protein concept

A starting point for using the ideal protein concept in aquafeed formulations

By Ewen McLean, Kelly B. Alfrey, Delbert M. Gatlin III, T. Gibson Gaylord and Frederick T. Barrows

A new analysis of the essential amino acids (EAA) of 10 major farmed fish and a shrimp species can help the industry drive down the cost of aquaculture feeds and make them more efficient. To our knowledge, this analysis is the first to examine such a wide variety of species' EAA using the same laboratory.

Ideal protein concept

The analysis of EAA was motivated by the ideal protein concept (IPC) that advocates optimising the blend of essential amino acids in feeds to precisely meet the target animal's requirements for growth and maintenance. An animal's EAA profile is considered to reflect an optimal blend for dietary EAAs. For over 50 years, swine and chicken feeds have been formulated with the IPC philosophy. The goal is a more efficient feed, in terms of cost, decreased waste and pollution, including nitrogen excretion.

Fishmeal has long been included in aquafeeds due to its favourable amino acid profile which closely resembles that of its consumers. However, with scarcity in wild-caught fish driving fishmeal prices higher, the IPC has gained momentum in aquafeed formulation over the last several years with the arrival of new and innovative protein sources, such as single-cell proteins and insect meals that offer a greatly expanded ingredient pantry for research and development. By focusing on matching animal and feed EAA profiles, feed formulators can create more efficient formulations using less expensive ingredients.

Understanding EAA requirements is critical to formulating cost-efficient feeds. Yet, of the over 230 species of aquatic animals currently being farmed, the complete EAA requirements are known for only a handful of them.

Lysine as limiting EAA

When an animal's nutritional requirements are unknown, the EAA analysis provides a good starting point to optimise that animal's feed. The IPC relies on knowing the quantitative requirements of a reference EAA. Since lysine (Lys) is one of the first limiting amino acids and its analysis is uncomplicated, it is often the first analysed. All other requirements for EAA can then be expressed as a percentage of lysine.

In our recent study published in *Aquaculture and Fisheries,* we evaluated EAA muscle profiles of the commercially important species: species such as largemouth bass (*Micropterus salmoides*), Channel catfish (*Ictalurus punctatus*), Grass carp (*Ctenopharyngodon idella*), Nile tilapia (*Oreochromis niloticus*), Red drum (*Sciaenops ocellatus*), Pompano (*Trachinotus carolinus*), Longfin yellowtail (*Seriola rivoliana*), Atlantic salmon (*Salmo salar*), Rainbow trout (*Oncorhynchus mykiss*), Yellowfin tuna (*Thunnus albacares*) and Pacific whiteleg shrimp (*Litopenaeus vannamei*), which represent nine orders.

The analyses were conducted by the same laboratory to eliminate variation due to laboratory technique so that differences in EAA could be detected across species, facilitating the efficient formulation of feed that mirrors the EAA muscle requirements.

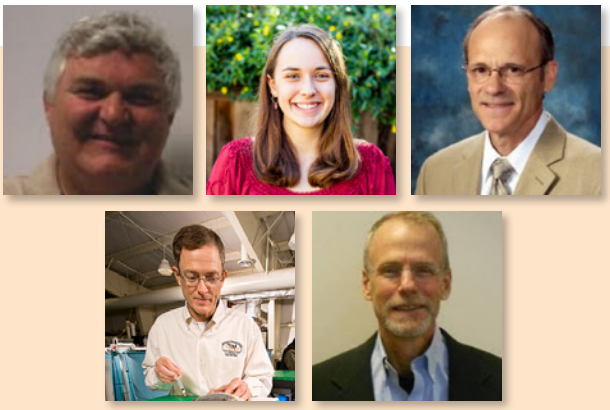
A/E ratio

In the fish group, little difference in EAA ratios (the A/E ratio) among the 10 species were detected and Lys represented the dominant muscle EAA measured, ranging between 7.06 and 9.58g/100g protein. However, distinct differences were seen between the EAA of whiteleg shrimp and fish. For the shrimp, arginine (Arg) was the principal EAA followed by Lys.

Good correlations have been found between whole-body and muscle EAA profiles. Further requirements have been estimated using the A/E ratio. The A/E ratio does not provide the quantitative requirement for EAAs but the relative balance among the ten EAAs.

Preparing feeds with this exact balance provides the means of creating low-protein feeds that return identical performance, in terms of growth rates and feed conversion ratio, when compared against an unbalanced, high-protein feed. IPC also reduces feed costs since proteins are one of the most expensive nutrients in feed, and feed is one of the most expensive variable costs in aquaculture production.

Therefore, the more efficient the feed, the more profitable and more sustainable aquaculture can become. This study offers a good starting point to better formulate aquafeeds to minimise costs and maximise efficiency.



Ewen McLean is Consultant with F3.

Kelly B. Alfrey is F3 Aquaculture Project Manager at Anthropocene Institute

Delbert M. Gatlin III is Professor at Texas A&M University System, USA

T. Gibson Gaylord is with the US Fish and Wildlife Service, Montana, USA

Frederick T. Barrows is with Aquatic Feed Technologies LLC, Florida, USA

Rapid field detection of diseases in shrimp

In partnership with the National University of Singapore, startup, Forte Biotech is ready to introduce quick lab grade and economical diagnostic tests in the field for shrimp farmers

By Lee Khoon Hwee

Figure 1. Some farmers said that diseases affect 6 out of 10 crops.

Shrimp farming is a large part of the economy in Vietnam, contributing to between 40-45% of the total seafood export value in the country. Even though shrimp farming is an extremely lucrative business for rural farmers, it is also extremely risky, with diseases being a constant menace. Due to climate change and erratic rainfall, diseases have become more rampant and hardier. According to some farmers in Vietnam, diseases can affect up to 6 out of 10 of their crops (Figure 1).

Although diseased shrimp do not pose a threat to human health when consumed, shrimp dying from disease will quickly decompose and would no longer be acceptable for human consumption. When diseases occur, usually there are no visible indicators until it is too late. Farmers could lose most of their harvest if diseases are not detected early on their farms. This poses major social, economic and environmental problems.

Current solutions

Currently, farmers commonly utilise antibiotics to combat diseases. However, this is a dangerous farming practice, and some of Forte Biotech's farming partners have said that these antibiotics are starting to lose effect and therefore farmers seek alternative solutions.

In terms of disease diagnostics, there are two leading types of tests available for farmers at the moment: Laboratory based PCR (polymerase chain reaction tests), and ART (Antigen Rapid Test) kits. While laboratory-based PCR tests are highly sensitive, the complete process can take between 24-48 hours and costs above USD20/test. It is not only expensive, but also unable to provide farmers with timely information to take action and cut their losses. Furthermore, by the time farmers receive the test results, the disease could have wiped out their crop.

ART test kits on the other hand, can provide results quickly but are not as sensitive. Farmers are only able to detect diseases in shrimp that are dead or heavily infected. As such, the current industry practice for farmers is to do a confirmatory test on their shrimp after the shrimp are dead or harvested, which does not provide them with actionable information.

The solution

Forte Biotech has developed a novel molecular diagnostic system in partnership with the National University of Singapore (NUS), under the Graduate Research Innovation Programme (GRIP). Founders, Kit Yong and Michael Nguyen, come from diverse business backgrounds and have experience volunteering and working in the rural areas in Vietnam where they have built extensive connections with the shrimp farming community and learnt about the struggles of the trade. Initially, the founders were looking into investing in the shrimp farming sector in Vietnam and realised that getting financing was hard due to the risky nature of the business. From there, they came up with the idea to minimise the risk of shrimp farming through disease testing of shrimp.

The technology was co-invented by Kit and Dr Ou Chung-Pei, who is an expert in the field of diagnostics. The patent for this technology was filed together with NUS. Forte Biotech had support from NUS in terms of funding and product development as well. Currently, there are teams in Singapore and Vietnam working on the research and development of assays and devices.

RAPID (or Robust Accurate Prawn Infection Detector) is a cheap and easy to use PCR-style diagnostic system that allows farmers to obtain laboratory grade results within an hour, on their farm. It is designed to be stable

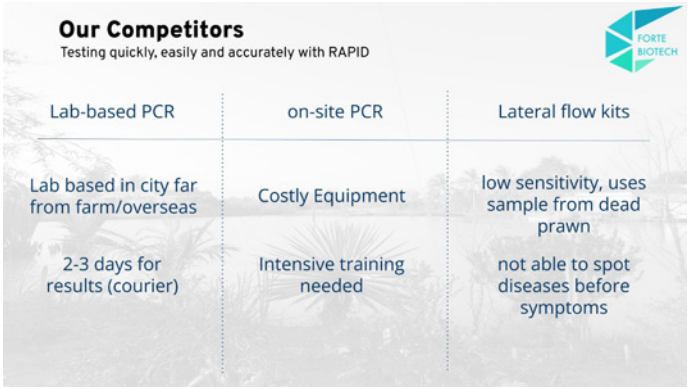


Figure 2. Pros and cons of diagnostic solutions available in the market.

Kit Yong (left) and Michael Nguyen

Figure 3. RAPID test consists of a sample processing device (red circle), and a sample extraction kit (yellow circle). The process is simple; farmers only have to run their sample through Kit 'A' (green circle) to extract the nucleic acid from the shrimp, followed by Kit 'B' which provides visuals on the presence of each disease.

Figure 4. A farmer in Can Gio District, Vietnam, performing the RAPID test on a water sample collected from a shrimp pond. WSSV was detected in the water and more frequent water changes and monitoring was recommended.

at ambient temperatures to aid transportation, and simple to allow farmers to use on site without any fancy equipment. Most importantly, the test for each disease is expected to cost not more than USD10, beating most of the PCR equivalent competition.

The idea is to allow farmers to conduct these tests more regularly on their own through eliminating the skill barrier, enabling them to detect diseases much earlier and take mitigative action to cut down on their losses.

Cutting losses

A large part of the costs incurred by farmers is the cost of shrimp feed. By helping farmers detect diseases early, Forte Biotech works to help farmers take the necessary actions to protect their gains. For example, in the case of the microsporidian *Enterocytozoon hepatopenaei* (EHP), farmers can choose to harvest their stock early to reduce feed wastage or schedule more regular water changes to flush out the pathogens, while for white spot syndrome virus (WSSV), farmers can harvest the shrimp as soon as possible to prevent the spread of the disease, which could kill up to 99% of their stock within 24 hours.

Additionally, harvesting services are divided into regular and emergency harvests. In the case of emergency harvests, usually the middlemen will take a larger portion of the profits from farmers due to the short notice given. With RAPID, farmers will be able to have an early warning of the presence of pathogens in their shrimp and water, allowing them to schedule their harvests accordingly.

In Vietnam, the Forte Biotech team has been working closely with a farming partner in Ben Tre, Mr Giau, who farms *Litopenaeus vannamei*. It is conducting an ongoing trial, with his technicians using the RAPID test kit frequently. Giau reported that diseases were detected in his farm in Ben Tre but with regular testing he managed to harvest before mass mortalities. The trial is continuing at Giau's second farm.

Yield gains

Early detection of diseases allows farmers to act earlier, mitigating the serious losses and cash flow effects of disease on the farm's operations. Forte Biotech believes that farmers will be able to earn more on an annual basis through earlier detection, and consequently also adopt better and more environmentally friendly farming practices. Ultimately, it is working to develop a predictive risk model to advise farmers if and when their crop will be affected by diseases, as well as more assays to test for a wider variety of diseases aside from WSSV, AHPND and EHP.

Progress

Currently, RAPID has just wrapped up its usability trials with two of its farming partners and is looking to officially launch the product in the later part of September 2022. Forte Biotech would be happy to recruit more farmers in and around the Southeast Asia region to participate in trials.

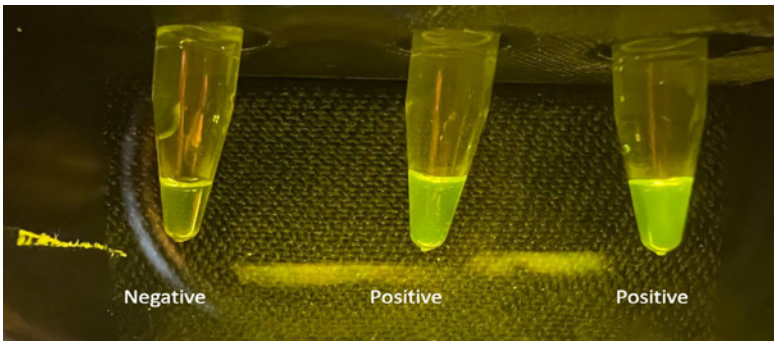


Figure 5. The results of the tests are determined based on the fluorescence level. A positive result (middle and right) would be much brighter as compared to the negative(left). Forte Biotech has developed an automatic reader to assist farmers in reading the results.

Lee Khoon Hwee is Business Development Manager at Forte Biotech. Email: khoon@fortebio.tech

Working together in Malaysia's aquaculture industry

The townhall session was moderated by Abdullah Abdul Rahim, UPM, (third right). In the photo, the panelists with MADA members, from right, Lee Low, Dindings Soya & Multifeeds; Chitra Devi, WWF; Benedict Tan, MADA President, Director of Aquaculture, Dato' Hj. Azahari Bin Hj. Othman and Noraisyah Bt Abu Bakar, Department of Fisheries; Zuridah Merican, Aqua Culture Asia Pacific and Jia Zin Khoo, STAC.

After a year-long hiatus due to the COVID 19 pandemic, the Malaysian Aquaculture Development Association or MADA organised a two-day aquaculture seminar co-located with an International Expo at the Ideal Convention Center (IDCC), Shah Alam in July. Organisers explored 12 topics, from harmful algal blooms, alternative ingredients for fish feed, fish culture, fish disease and diagnosis, to off-shore site selection for marine cage culture.

Professor Lim Po Teen from the Institute of Ocean and Earth Sciences, University of Malaya. gave an introductory lecture on the regional and global trends of harmful algal bloom (HABs) events and explained the various mechanisms involved in fish kills in both wild and cultured fishes. There is an urgency to address the issue of HABs in mariculture to ensure its sustainable development and minimise impacts to public health and food safety. "There is a need for the industry to prepare for increasing occurrences of harmful algal bloom events and consider early warning systems and effective mitigation methods," he said.

On behalf of INSEACT, a Singapore-based black soldier fly (BSF) company, Loh Jiun Yan, Assistant Professor at the Centre of Research for Advanced Aquaculture, UCSI University shared the benefits of BSF meal. Loh showed the nutritional profile in terms of proximate composition, amino acids and fatty acids. He said that in particular, BSF contained high levels of lauric acid (a broad spectrum anti-microbiological agent) and is a promising protein source for the aquafeed industry. Benefits include better immunity and faster growth. Finally, he shared results from a pilot field trial conducted by INSEACT, showing improvements in feed conversion ratio (FCR) and a significant increase in the average daily growth (ADG) of shrimp fed BSF meal.

Water Quality

Rex Chen, Fish Daddy said that today, farmers have to be more scientific in their approach to farming and need to understand pond ecology and biology of the animal and monitoring of the water quality is important. The farmer should familiarise himself with the use of oxygen probes (to maintain dissolved oxygen (DO) levels between 3-6ppm), water quality test kits to check on ammonia (NH_4^+), nitrite (NO_2^-), pH, alkalinity etc. These tests should be done daily if possible and at the same time.

Chen listed products which are highly beneficial to aquatic organisms such as effective microorganisms (EM) to control pond bottom pollution and to help control green water or pond algae. "We should also prepare hydrated lime if the pH drops as well as sodium humate or zeolite powder for use in freshwater culture systems when ammonia increases," said Chen. "Last but not least, we prepare chlorine dioxide for use to reduce bacteria or algae in the pond if the need arises."

Offshore farming

Jonathan Daniel Maxey based in Tasmania, Australia and Dr Neil Hartstein from ADS Environmental Services, Sabah, Malaysia gave a joint virtual presentation on the benefits of moving finfish production away from land-based systems to offshore environments as a more environmentally sustainable way to meet the demand for finfish products in a study they did in Sabah. One of the key components of establishing successful offshore finfish aquaculture is siting farms in areas that are environmentally suitable with designs that align with local regulations and environmental conditions.

Unfortunately, many regions around the globe lack spatially and temporally extensive robust environmental datasets describing site conditions that would inform farm placement and design during marine spatial planning exercises. Their approach to mitigating the lack of *in situ* data is to use numerical modelling to help describe those environmental conditions and coupling this with multiple criteria decision making and GIS. This approach can help data poor (or resource stretched) regions identify suitable offshore areas for industry expansion. Site selection criteria included: water depth, current speed, significant wave height, sensitive habitats, reported

fishing grounds, government-based exclusion zones, oil and gas concessions and navigation routes.

From this study they were able to determine the total area suitable for offshore marine finfish farms in the region. Importantly, they were able to eliminate areas unsuitable for industry expansion; This is the first marine spatial planning study specifically targeting marine finfish culture in the region that is guided by principles of environmental and economic sustainability.

RAS farming

A holistic development of indoor recirculation aquaculture systems (RAS) involves the culture system, enhanced quality and specific pathogen free (SPF) fingerlings, application of artificial intelligence (AI), nutrition, and the sustainable approach in converting waste to energy. "This approach can be applied to broodstock management, hatchery, nursery and grow-out," said Jia Zin Khoo, Sepang Today Aquaculture Centre (STAC). There are some concerns to which Khoo suggested some solutions:

- Unstable supply of quality grouper eggs (specific pathogen free or SPF is recommended). Therefore, it is important to obtain a supplier with in-house treatment.
- Low fingerling survival rate and susceptibility to disease carriers. RAS grow-out farmers need the right protocol on quarantine to ensure fingerlings are not disease carriers. The solution is enhanced quarantine fingerlings (EQF).
- Incomplete/improper design of indoor RAS farming systems. This requires an on-going in-house R&D on RAS performance and efficiency.
- Wastage of energy due to poorly designed RAS. There should be on-going tuning of the system and simulated calculation for different stages of growth as well as data analysis from experimental tests.
- Production costs are rather high compared with conventional farming methods. The options to increase competitiveness are in marketing: target niche market with premium prices and fine-tuning RAS to reduce production costs.
- High quality nutrition as compared to conventional farming. What is required are feeds with high digestible protein and good FCRs.

Liaw Boon Lai (left) with Erin Tan, MADA Secretary.

Giant freshwater prawn and jade perch farming

Liaw Boon Lai has 20 years' experience in farming the Malaysian giant freshwater prawn *Macrobrachium rosenbergii*. The main constraint in farming this prawn is the uneven growth during harvest as there are seven morphotypes within the same batch of culture namely blue claw male, orange claw male, small claw male, berried female, spawn female, virgin female and juveniles. Hence, grading and selection must be done during harvest. Liaw shared that the prawn grows well in water with pH 6.5 – 8, DO >4ppm, and alkalinity >60ppm.

Professor Khoo Eng Wah, a Malaysian aquaculture industry icon, shared his experiences in the farming of the jade perch (*Scortum barcoo*) which was introduced from Australia and is known for its high omega-3 content. Jade perch is an omnivorous fish and has a FCR of 1.2 to 1.4. The fish grows well at 28-33°C, pH 6.5 to 7.5, DO>4ppm, and alkalinity of >60ppm. It can be fed 1.5 to 2% of its body weight with commercial pellets of 34 to 42% crude protein. Farming of jade perch can be in indoor RAS (stocking 30-50kg/m^2) or earthen ponds (5-10kg/m^2). Khoo said that protozoa and fungus are common diseases in jade perch farming and bath treatments include those with formalin, hydrogen peroxide, acriflavine and salt.

Khoo Eng Wah (left) with Benedict Tan, MADA President.

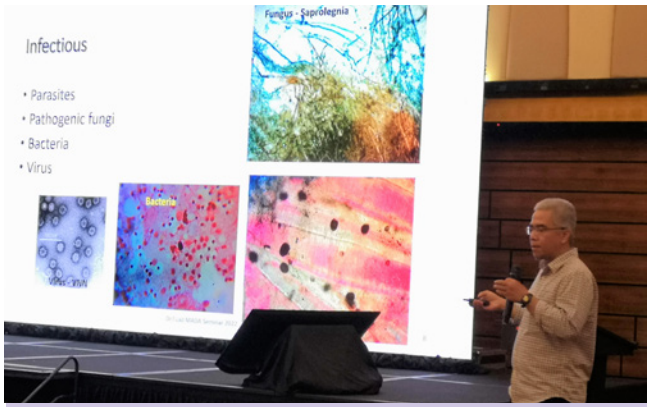
Private public interactions

The theme of the seminar was "Working together towards achieving aquaculture targets of the National Agrofood Policy (DAN 2.0) by 2030". The second day was dedicated to speakers from local universities and the Department of Fisheries (DOF) Malaysia, presenting on research outputs, biosecurity and on the MyGAP certification. A townhall session had the Director of Aquaculture, DOF and team, academicians and industry players discussing some constraints in the aquaculture industry in Malaysia, including support on disease management and selection of target species.

Disease management

Dr Fuad Matori from University Putra Malaysia said that as disease is a major limiting factor in aquaculture, diligent anticipation and readiness against any disease risk and outbreak will ensure the overall success of the operation. He stressed on the importance of finding the causative agent of the problem for easy decision making, prevent future outbreaks and allow the right treatment to be undertaken. "It is very important for the farmer to constantly observe his animals and we must rely on behavioural changes to determine if the animals are well or sick," said Fuad, adding that when sending samples to the laboratory it is important to send sick but live (or very recently dead) animals so that the health expert can diagnose the pathogen. "Ideally the farmer should send 3-5pcs mid-large size animals, and >5 small live fingerlings. Dead fishes offer little value as autolysis and decomposition occur very quickly in fish rendering the sample not suitable for histopathology," said Fuad. He recommends that every farm should have a basic light microscope for fast diagnosis.

Kevin See, Three Ocean Fish Pond & Trading with Pangasius nasutus, locally known as patin buah, an emerging farmed fish in Malaysia.



Dr Fuad Matori, University Putra Malaysia presented on managing diseases in Malaysia.

Haziq Aiman from 3 Little Fish Sdn Bhd discussed a novel method to control and eradicate the marine leech (*Zeylanicobdella arugamensis*) in farmed marine grouper. He conducted a commercial trial to test out the Break and Protect 2 (BP2) device to attract and break the life cycle of marine leeches. BP2 has won numerous awards such as the Commonwealth Sustainable Award in 2021 for being an ecologically friendly and sustainable alternative to the traditional methods for marine leech control. BP2 is a device with a substrate to attract adult leeches to stick to it and lay their cocoons on its surface.

In a study, at one site at Pulau Jerejak, Penang, three sets of BP2 managed to remove a total of 1,578 leeches and 52,330 cocoons over a period of 16 days. However, since there are many more leeches in the surrounding environment, it is important to continue to apply the BP2 device until the leech infestation has reduced significantly. One BP2 device can cover an area approximately 336m^2. After two applications of the BP2, a 17% reduction in prevalence was observed and mean intensity went from 144 leeches/fish to 9 leeches/fish.

Zahura binti Mohamed Ismail who heads the Veterinary Medicines Section, National Pharmaceutical Regulatory Agency (NPRA) explained the regulatory control of veterinary drugs for Malaysian aquaculture and elucidated veterinary product categories that need to be registered with NPRA.

Replacing Artemia

In recent years, the price of imported *Artemia* sp, traditionally used as the primary live feed in aquaculture, has risen considerably because of strong demand and finite wild supplies. Hanan Mohd Yusof from the Freshwater Research Institute (FRI), Glami Lemi, DOF, said that *Moina* sp. is the best alternative food source to Artemia sp., especially for freshwater and ornamental fish larvae. However, wild *Moina* sp. is frequently taken from unsanitary environments, such as sewage ponds or local drainage systems. Furthermore, the supply of the wild source is variable according to weather conditions.

FRI Glami Lemi has developed an intensive, hygienic, and sustainable *Moina* sp. culture technique for the industry's consistent supply requirements.

Good Aquaculture Practices

Siti Hasshura binti Hashim from the Selangor Biosecurity Centre, DOF, announced that the MyGAP certification requirements for all aquaculture farms/importers and exporters has been delayed till June 30, 2023. From July 1, 2023, all farmers/exporters/importers of aquaculture products are mandated to have MyGAP and this includes the ornamental fish industry. A facility without MyGAP will no longer be allowed to export and import aquaculture products. The aquaculture MyGAP covers pond culture, cage culture, tank culture, hatcheries, seaweed culture and ornamental fish culture. Requirements for MyGAP include information on: site selection; farm construction and infrastructure; farm facilities, biosecurity measures, animal control, fry and broodstock selection, water quality management, water source and discharge treatment, types of feed, disease issues, labour issues, record keeping and traceability, and post-harvest SOPs etc. (This report was contributed by MADA).

At the co-located trade show, CPR Feed Sdn Bhd demonstrated its portable fish tank.

Professor Lim Po Teen presented on regional and global trends of harmful algal blooms and explained the various mechanisms involved in fish kills in both wild and cultured fishes.

Aquafeeds: A New Equilibrium

Along the value chain, feed companies are a major force, which causes a push effect to drive the industry. But this year, the rise in the costs of feed ingredients, high freight costs, supply chain disruptions and push for use of more sustainable feed ingredients are major challenges facing the global aquafeed industry. For the feed industry in Asia, it is a question of raising prices, reformulating or compromising on quality. All of these is set within the increasing demand for sustainable feeds, contributing to higher costs. Where do feed companies go from here? There is a need to future proof the industry for the next decade.

Aquaculture Roundtable Series® (TARS) 2022, seeks to help the feed industry and other stakeholders navigate these challenges by looking into a new equilibrium with feed costs and feed efficiency. TARS is the ideal platform for networking and dialogue among Asia's key players in the shrimp, freshwater and marine fish aquaculture sectors, including CEOs, feedmillers, farmers and integrators, processors, nutritionists, formulators, feed ingredient, additive and equipment suppliers, industry leaders, marketers, institutional researchers, academics, government and non-government organisations, and other stakeholders in the aquaculture supply chain.

TARS 2022 will be an in-person event and will be held on 6-7 October 2022, Sheraton Hotel and Towers, Ho Chi Minh City, Vietnam.

Interactive Breakout Roundtable Sessions & Panel Discussions

One of Asia's biggest weaknesses is the fragmented nature of our value chain. We do not act as a whole, and individual segments are weaker on their own. Despite the lack of non-integration, we have to build alliances to act in a *de facto* integrated manner. The objective of this breakout session is to have the feedmillers act as major force to create these alliances.

The 1.5-hour interactive session will involve group participation of all attendees to discuss "Working along the value chain to improve efficiency, traceability and sustainability".

There will be three groups and suggested areas of discussion for each group are given below:

Group 1: Feedmillers & Farmers

- Cost of feed/kg of produce vs feed price
- Feed density vs stocking density
- Requirements for early-stage nutrition
- Important criteria for feed other than price
- Feeding efficiency and autofeeders
- Traceability, transparency & criteria for sustainable feeds

Group 2: Feedmillers & Processors

- Cost of feed/kg fillet vs feed price
- Feeds and fillet quality/shrimp colour & taste
- Acceptance of novel ingredients
- Premium pricing & branding
- Conveying retailer demands
- Traceability, transparency & criteria for sustainability

Group 3: Feedmillers & Feed Ingredient Suppliers (FIS)

- Acceptance of novel ingredients
- Functional feeds for shrimp/fish health
- Transparency in formulation
- Top dressing versus factory made feeds
- Improving early-stage nutrition
- Traceability, transparency & criteria for sustainability

Hard Talk

A feedmiller, farmer/integrator and buyer deliberate on "How to create the pull and push for industry's adoption of novel ingredients".

Henrik Aarestrup
Vice President LATAM, Shrimp & Hatchery, BioMar Group, Denmark

Josh N Goldman
Founder & CEO
Australis Aquaculture

Tony Dang Quoc Tuan
Owner, Tony Tuan Farm,
Vietnam

Christopher Tan
Director, Mida Trade Ventures Pte Ltd, Singapore

Industry Dialogue on Risk Mitigation and Investments

How can aquafeed millers "de-risk" themselves? What are the lessons from salmon and/or other animal feed production sectors? What specific areas attract investments? What are the perceptions of investing in Asia? Is integration the way to go? Below are some panellists and more to come.

Carlos Diaz
CEO, BioMar Group

Aaron McNevin
GlobalNetwork Lead,Aqua
World Wildlife Fund
USA

Benedict Tan
Programme Manager
Hatch Blue,
Singapore

Moderator: Ronnie Tan
Regional Aquaculture Consultant, US Grains Council
Malaysia

Below is a listing of speakers in the plenary session. More information on the program program is available at www.tarsaquaculture.com

State of Global Industry & Growth in Vietnam

A deep dive into the current business developments, key technologies and scientific advances propelling the aquafeed industry in Asia. Also, how Vietnam's feed companies are fuelling shrimp and fish production.

Karla Canavan
Commodity Trade and Finance, WWF-USA

Current Events and Volatility in Aquafeed Ingredients: The Journey to Sustainable Commodities

Piet Verstraete
4SEA Consulting Ltd, Thailand

Status of Asia's Aquafeed Industry: Dealing with The Challenges and Striving Towards Greater Sustainability

Matthew Clark
Director FeedGuys Resources Pte Ltd, Singapore

Formulation Techniques for Capturing Genetic Potential of Aqua Species and Optimising Digestible Amino Acid Content

Olivier Decamp
Group Technical Marketing Product Director, Thailand

Challenges in Shrimp Production in Vietnam: Role of Aquafeed Players

Nguyen Van Khanh
Head of Technical Service and Sales, Grobest, Vietnam

Improving Feed Efficiency and Functional Feeds – More with Less

Review on the state of precision nutrition, recent advances in fish and shrimp nutrition, nutritional bottlenecks and health interventions with functional feeds.

Thomas Wilson
Aquaculture Consultant
DSM Nutritional Products Asia Pacific
Thailand

Precision Farming and Precision Nutrition: Improving Aquaculture's Efficiency

Frederic Jozwiak
Product Manager – Health Solutions, INVE Aquaculture
Belgium

Improving Efficiency through a Holistic Genetic X Nutritional Approach at Hatchery and Farm Level

Bundit Yuangsoi
Lecturer
Department of Fisheries, Faculty of Agriculture
Khon Kaen University
Thailand

Palatability Enhancers: Essential Nutrient for Aquafeeds

Ruth Garcia Gomez
Business Development Manager
Aquaculture Farm Care & Health ISC/APAC Adisseo
Spain

What are the cost implications of using functional additives for farmers and what will the incentives be for feed millers to change?

Wee Kok Leong
Regional Technical Director Aquaculture for APAC
Diamond V
Thailand

Postbiotic from Yeast Fermentation Mitigates Stress in Tilapia

Adoption of Novel Feed Ingredients/Additives

What are the criteria to replace traditional marine ingredients and how do we achieve the same performance at the same costs?

Loc Tran
Senior Advisor for Minh Phu, AquaMekong/Founder and Director of ShrimpVet Laboratory, Vietnam

Cost and Performance Challenges in Evaluating Fish-Free Feeds, Novel Ingredients and Additives

Romi Novriadi
Lecturer, Jakarta Technical University of Fisheries, Indonesia

Production and Economic Sustainability in Indonesia's Aquafeed Industry

Benny Shapira
Global R&D Manager, Phibro Animal Health Corporation, Israel

The Solution for Stress Mitigation – A Technical and Innovation Perspective

Nguyen Duy Hoa
Global Technical Director, Empyreal Products, Cargill Inc., Vietnam

Fishmeal Alternatives and Formulation Approaches

Smart Feed Management

The goal is to look for synergies between feed solutions, animal performance and environment.

Regis F. Bador
Senior Aquaculture Expert
New Caledonia

Global Trends in Smart Feed Management

Masahiko Yamada
Co-founder & Managing Director of UMITRON, Singapore

AI and Satellite Technology in Feed Management for Sustainable Aquaculture

Ravikumar Bangarusamy
Assistant Vice President – Sales & Technical of Growel Feeds Pvt Ltd, India

Smart Feed Management and Use of IoT in Aquaculture

Future Proofing and Sustainability Issues with Aquafeeds

Can feedmillers in Asia learn from experiences and from counterparts elsewhere to minimise CO_2 emissions from the feed production process?

Brett D. Glencross
Technical Director
IFFO The Marine Ingredients Organisation
UK

Future Directions for Marine Ingredients

Danny Miller
Sustainability and ESG Lead Specialist, Aquaculture
World Wildlife Fund
USA

Perspectives on ESG and its Role in Aquafeed Production

About TARS

The Aquaculture Roundtable Series® (TARS) initiated in 2011 is a stakeholder-driven effort to facilitate the sharing and exchange of information and experiences for a common goal, to equip the industry with the next phase of growth. It is a platform for all – public, private sector, academia, government and non-government organizations to share new knowledge, deliberate on critical issues, and identify strategies for improvement – to ensure a sustainable aquaculture industry for the next generation. TARS is designed as a series of roundtable sessions to focus on specific sectors of the industry.

In the past ten years, TARS covered the following sectors: Aquafeeds in 2011, 2015 & 2019; Shrimp Aquaculture in 201 2, 2014, 2016, 2018 & 2021; and Finfish Aquaculture in 2013 & 2017.

TARS 2022 is supported by the Ministry of Agriculture and Rural Development, Vietnam (MARD) and the following industry sponsors.

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Ministry of Agriculture and Rural Development, Vietnam

Organisers:

AQUACULTURE Asia Pacific

corporatemedia The Total Communications Company

INVE AQUACULTURE

Benchmark Genetics

DSM BRIGHT SCIENCE. BRIGHTER LIVING.

BASF We create chemistry

Diamond V The Trusted Experts in Nutrition & Health

BioMar

Phibro ANIMAL HEALTH CORPORATION

ADISSEO A Bluestar Company

GROBEST

symrise

Cargill

Jefo

Regulatory partnership with the US on Ecuadorian shrimp

In August, Ecuador's National Chamber of Aquaculture (CNA) reported that its Vice Ministry of Aquaculture and Fisheries of the Ministry of Production, Foreign Trade, Investments and Fisheries (MPCEIP) and the US Food and Drug Administration (FDA) signed a confidentiality agreement as the first phase of an important strategic alliance with one of the main markets for Ecuadorian shrimp.

"The purpose of this agreement is to achieve a regulatory association in health matters, so that the Ecuadorian authorities, as well as the United States, can collaborate more closely and be able to offer the necessary guarantees and controls for the entry of fishery and aquaculture products into that market. This will offer official guarantees in such a way to facilitate access to that country," said José Antonio Camposano, CNA's Executive President.

"The regulatory agreement signed by the FDA and the Undersecretary for Quality and Safety is the great beginning of a collaboration process between our health authority and that of one of our most important markets. This will allow us to offer official guarantees for shrimp exports to the United States, facilitating the processes for entering this country. Personally, it is something that I have been promoting since 2010, when the draft of the United States Food Modernization Act was being discussed," said Yahira Piedrahita, CNA's Executive Director.

Within the framework of the event, FDA delegates will visit the work areas specifically those related to the aquaculture sector, such as: hatcheries, farms, processing plants, feed factories and distributors, and laboratories. They will also hold meetings with representatives of the country's production and export sectors.

In the first seven months of 2022, Ecuador exported 614,361 tonnes of shrimp and the US is a large market for Ecuadorian shrimp, importing almost 118,100 tonnes, according to CNA data.

In Guayaquil, Andrés Arens, Deputy Minister of Aquaculture and Fisheries and Mark Abdoo, Associate Commissioner for FDA Global Policy and Strategy signed the agreement.

Appointment

Senior shrimp executive to lead its Ecuador shrimp breeding activities

Hendrix Genetics has appointed **Lorenzo Juarez** as General Manager per September 1 to lead its shrimp breeding activities in Ecuador. Lorenzo brings a vast experience and track record in the global industry to Hendrix Genetics Ecuador and held senior positions in shrimp breeding in Mexico, Honduras, and the USA (Florida and Texas), combined with considerable shrimp industry experience in Thailand and Indonesia.

Dave Danson, Director of Shrimp and Operations of Hendrix Genetics said, "We are delighted to have Lorenzo on board to take Hendrix Genetics Ecuador to the next stage. In the last three years, we have built towards setting up a biosecure closed breeding cycle and are now at the eve of introducing our new product to the Ecuadorian market. As such, timing of Lorenzo joining us could not have been any better"

Lorenzo Juarez, General Manager of Hendrix Genetics Ecuador added, "Coming from a long history in the industry, I have seen and lived the challenges that farmers, hatcheries and breeding houses are dealing with to keep up with the fast pace at which the shrimp industry operates and develops. Ecuador has taken a leading position in the global production and trade of high-quality shrimp and I am excited to join Hendrix Genetics and partner up with our clients to bring juveniles of the highest quality and performance to farmers"

Hendrix Genetics Ecuador was established in 2019 as a joint venture between Hendrix Genetics, Skretting and Ecuacultivos. In 2022, the company completed the build of its Nucleus Breeding Centre (NBC) and transitioned to having a full biosecure closed breeding cycle. Hendrix Genetics has partnered with selected clients to conduct field trials of the new breeding line and will start supplying the new exclusive product to clients in limited quantities, while supplies last, later this year. www.hendrix-genetics.com

World Aquaculture Singapore 2022

Singapore EXPO Convention and Exhibition Centre & Max Atria, Singapore November 29 – December 2, 2022

The Steering committee of World Aquaculture Singapore 2022 and World Aquaculture Society (WAS) will hold the World Aquaculture Singapore 2022 at the Singapore EXPO Convention and Exhibition Centre and Max Atria on November 29 - December 2, 2022.

In a press release, organisers said that the event is expected to welcome over a 1,000 participants from the Asian Pacific region and around the world. "We encourage guests and customers who have already registered for the exhibition to invite their team members and, customers to attend the conference and exhibition with no limit on the number of live participants."

WA Singapore 2022 will be taking place as a large-scale in-person global conference and exhibition to be hosted in the Asian Pacific after a two-year gap with the relevant COVID-19 safety measures are in place.

On the first day of event, during the plenary session on Wednesday November 30, Dr Matthias Halwart from the Food and Agriculture Organization of the United Nations (FAO) will present an overview of aquaculture roles in food security. Following that, Ms Grace Fu, Singapore's Minister for Sustainability and the Environment who is the keynote speaker, will open the conference and trade show. They will be addressing the theme of WA Singapore 2022, which is the Next Generation Aquaculture: Innovation and Sustainability will Feed the World.

Deadlines:
The deadline for submission of abstracts, originally scheduled for September 1, 2022, has been extended to **October 1, 2022!**

An exciting program will be offered at WA Singapore 2022 for participants to learn more about Singapore's aquaculture. Key highlights include the Singapore Pavilion showcasing its aquaculture industry's innovation and advancement which encompasses major local aquaculture farms, Institutes of Higher Learning, startups and the Marine Aquaculture Centre (Singapore Food Agency's aquaculture R&D facility).

Participants are also able to gain invaluable first-hand experience through participating in farm tours, to visit various local farms and research centres in Singapore. Participants may also register for the pre and post tours which can be found on the website. Seats offered are limited.

Advice on Covid-19 and travel to Singapore

To enter Singapore, participants may check the ICA SafeTravel microsite for any travel related policies and COVID-19 entry requirements to ensure a smooth journey.

Singapore Airlines (SIA) is the exclusive Official Airline for our event, and they have offered the discounts off market fares for registered participants of the WA Singapore 2022. The ticket must be booked via the website to enjoy the discounted rates.

Special discounted registration rate

Those residing or living in Asian Pacific countries qualify for a special discounted registration rate for the full conference at WA Singapore 2022. To receive this special rate, you must reside in an Asian Pacific country, for students you must be a full-time college or university student and provide a copy of your student ID upon request. To register at this rate, please go to www.was.org and choose "WA Singapore 2022" on the webpage and fill in the registration form.

To date, more than 200 booths slots for the tradeshow have been booked and hundreds of papers have already been submitted. The conference will feature many world-class speakers and delegates from around the globe sharing their knowledge on the science, technology, business, and social aspects of aquaculture.

More information: www.was.org
Email: worldaqua@was.org

Strengthens QRILL™ Aqua sales team with new talent

Aker BioMarine is enhancing its QRILL™ Aqua sales organization after successfully recruiting two new talents for its Norway-based team.

The supply of sustainable and nutritious ingredients for fish feed is essential for further growth of the Norwegian salmon industry. Aker BioMarine strongly believes that QRILL Aqua can be part of the solution. Therefore, the company has decided to establish a team that will work closely with the fish farming industry to find tailor made solutions for each customer. The team will be led by **Maja Bævre-Jensen** who takes the role as Business Development Director and **Karen Kirstine Østerhus** is appointed as Business Development Manager.

"We are only at the beginning of uncovering the full potential of QRILL Aqua for salmon in Norway and our competent people are key in helping our customers and stakeholders learn more about the health benefits of Antarctic krill," says Sigve Nordrum, EVP Animal Health & Nutrition, Aker BioMarine. "Maja and Karen both possess solid aquaculture industry knowledge and a passion for exploring new and future looking solutions for the Norwegian Industry. Strengthening this team is an important part of our increasing involvement with the aqua industry in Norway."

Maja Bævre-Jensen has spent the past five years of her career working with the Norwegian Seafood Research Fund. With two decades of aquaculture experience, she has spent her career exploring new solutions for both Norwegian and global fish farming. Bævre-Jensen holds a master's degree in Aqua Medicine from the Norwegian Arctic University, with a specialisation in sea lice.

"I see Aker BioMarine as a place where everyone is encouraged to bring new ideas to life. I am a strong believer in the power and potential of QRILL Aqua as an ingredient and I am excited to explore and develop new business opportunities in order to help fish farmers reach their goals, alongside this talented team," said Bævre-Jensen.

Karen Kirstine Østerhus previously worked at STIM, where she gained experience with bacteriophages, feed and other fish health-related products. In her most recent role, she focused on fish ready to be harvested and collaborated with farmers throughout Norway. Østerhus holds a bachelor's degree in Aquaculture Management from Nord University and is halfway through a master's degree in Sustainable Aquaculture from the Norwegian University of Science and Technology (NTNU).

"I am excited for the possibility to contribute to improve fish health and the sustainability of the industry. With a lot of passion for the industry and as a self-proclaimed fish nerd, the opportunity of becoming a part of Aker BioMarine as such an innovative and forward-looking company, is a dream come true," said Østerhus.

Both Bævre-Jensen and Østerhus assumed their new roles on September 1. www.qrillaqua.com

Maja Bævre-Jensen (left) and Karen Kirstine Østerhus

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Email: worldaqua@was.org | www.was.org

Inauguration of SEAFAS in Indonesia

This is the South-East Asian Fisheries and Aquaculture Student Association (SEAFAS), the first youth association to actively include students and youths involved in fisheries and aquaculture in Southeast Asia. President Elect of World Aquaculture Society – Asian Pacific Chapter, Associate Professor Dr Krishna Salin, Asian Institute of Technology, Thailand, inaugurated the establishment of this association during the series of events in the Blue Economy Conference and Trade Exhibition 2022 which was held at the Madidihang Auditorium of the AUP Polytechnic (Politeknik Ahli Usaha Perikanan) – The Ocean Institute of Indonesia, on Monday August 22, 2022.

Dr Krishna Salin, President Elect of World Aquaculture Society – Asia Pacific Chapter confirmed Angkasa Putra as First President of the South-East Asian Fisheries and Aquaculture Student Association (SEAFAS).

The Minister of Marine Affairs and Fisheries of the Republic of Indonesia, Sakti Wahyu Trenggono, officially opened the Blue Economy conference and trade exhibition 2022.

Angkasa Putra from the AUP Polytechnic was elected as the First President of SEAFAS. Angkasa from the Indonesian Aquaculture Youth has published more than 30 articles on marine fisheries in national and international journals, proceedings of national seminars, fisheries magazine, and online media.

Angkasa Putra

Organised by the AUP, a centre of excellence for fisheries and aquaculture, Blue Economy Conference and Trade Exhibition 2022 was a hybrid event attracting around 500 participants. The aim was to share knowledge and technology to support the development of fisheries and aquaculture production in Indonesia. The conference covered aquaculture with invited speakers including Dr TB Heeru Rahayu, Director General of Aquaculture, Ministry of Marine Affairs and Fisheries (MMAF), Indonesia and Professor Rokhmin Dahuri, Chairman Indonesia Aquaculture Society. In capture fisheries, speakers included FAO's Dr Audem Lem and Dr Nicole Franz and Artati Widiarti, Director General for Marine and Fisheries Product Competitiveness, MMAF. Other sessions included education enhancement, marine and coastal management.

WELCOME NEW DATES !

Singapore - Nov.29 - Dec.2, 2022

Singapore EXPO Convention and Exhibition Centre

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For more info on the CONFERENCE: www.was.org - worldaqua@was.org
For more info on the TRADESHOW: mario@marevent.com

International Training Course on Biology and Pathology of the Penaeid Shrimp 2022, 14-25 November 2022, Thailand

The course will be held at Centex Shrimp, Faculty of Science, Mahidol University in Bangkok, Thailand. Highlights of the course include:

- Updates on major shrimp diseases including EHP, white faeces and AHPND.
- Shrimp farming systems and management.
- Shrimp molecular immunity.
- Molecular approaches for disease detection including PCR and CRISPR.
- Hands-on laboratory sessions, including pathogenic viral detection using PCR, histological preparations, EHP assays and bioinformatic analysis.
- An optional field trip to local shrimp farms in Surat Thani.

This is a paid training course. Reservations will close on 31 October. More information, contact centexcourse2022@gmail.com

2022

September 27-30
Aquaculture Europe 2022
Rimini, Italy
www.aquaeas.eu

October 3-5
GOAL 2022
Seattle, USA
www.globalseafood.org/goal/

October 6-7
TARS 2022: Aquafeeds
Ho Chi Minh City, Vietnam
www.tarsaquaculture.com

November 9-11
Aquatica Asia
Jakarta- Indonesia
https://aquaticaasia.com/

November 29-December 2
World Aquaculture Singapore 2022
www.was.org

2023

February 23 - 26
Aquaculture America 2023
New Orleans, USA
www.was.org

March 8-10
VIV Asia 2023
Bangkok, Thailand
www. vivasia.nl

April 12-14
Vietshrimp Aquaculture International Fair
Can Tho, Vietnam
https://vietshrimp.net

April 18 - 21
Latin American & Caribbean Aquaculture 2023
Panama City, Panama
www.was.org

April 21-22
RASTECH 2023
Florida, USA
www.ras-tec.com

April 25-27
Seafood Expo Global/Seafood Processing Global
Barcelona, Spain
www.seafoodexpo.com/global

May 29 – June 1
World Aquaculture 2023 Darwin, Northern Territories, Australia
www.was.org

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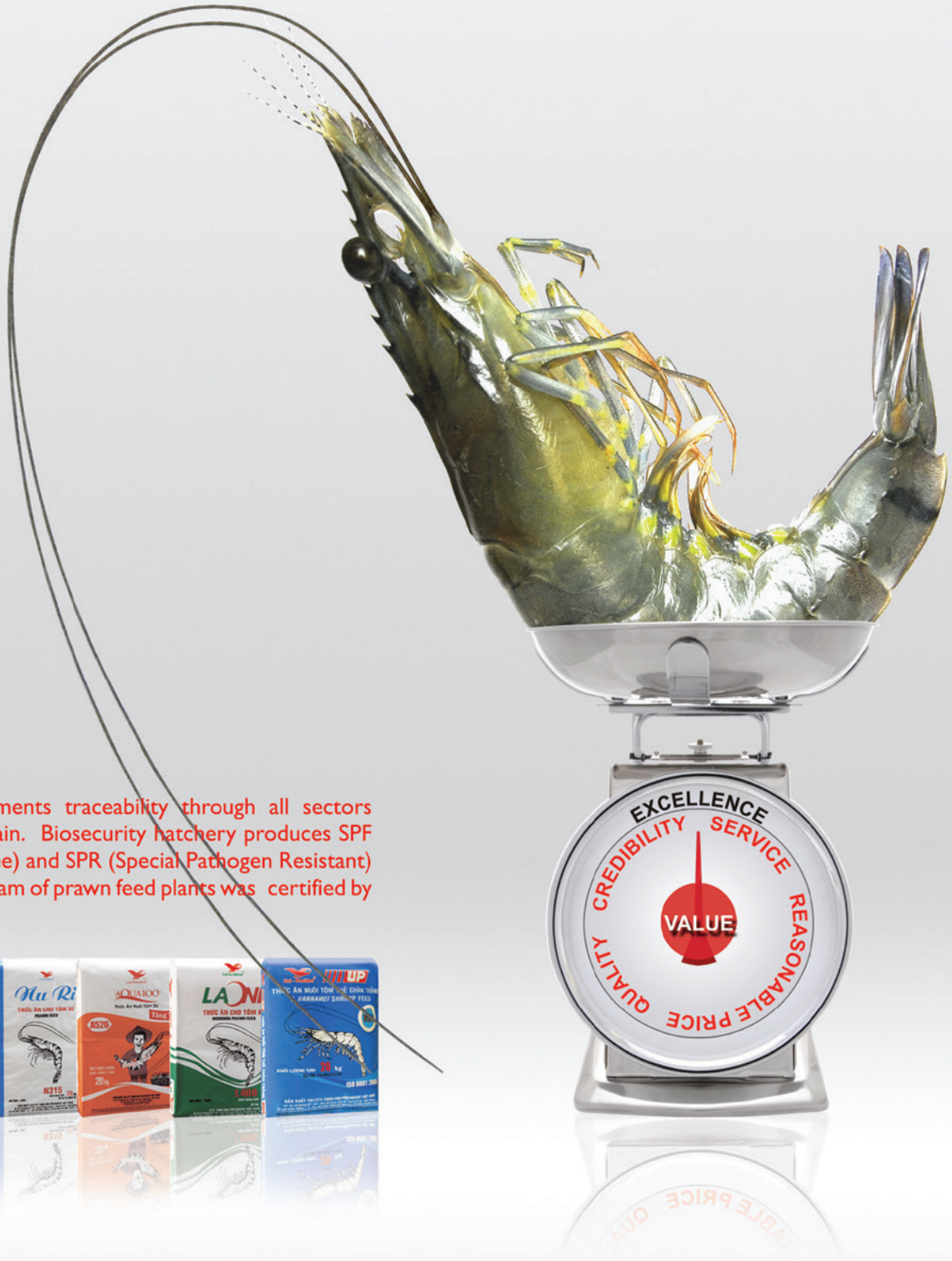

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