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Optimisation of feed margins
Swings in aquafeed demand in 2020
Krill meal in juvenile olive flounder
Monogenean infections in striped catfish

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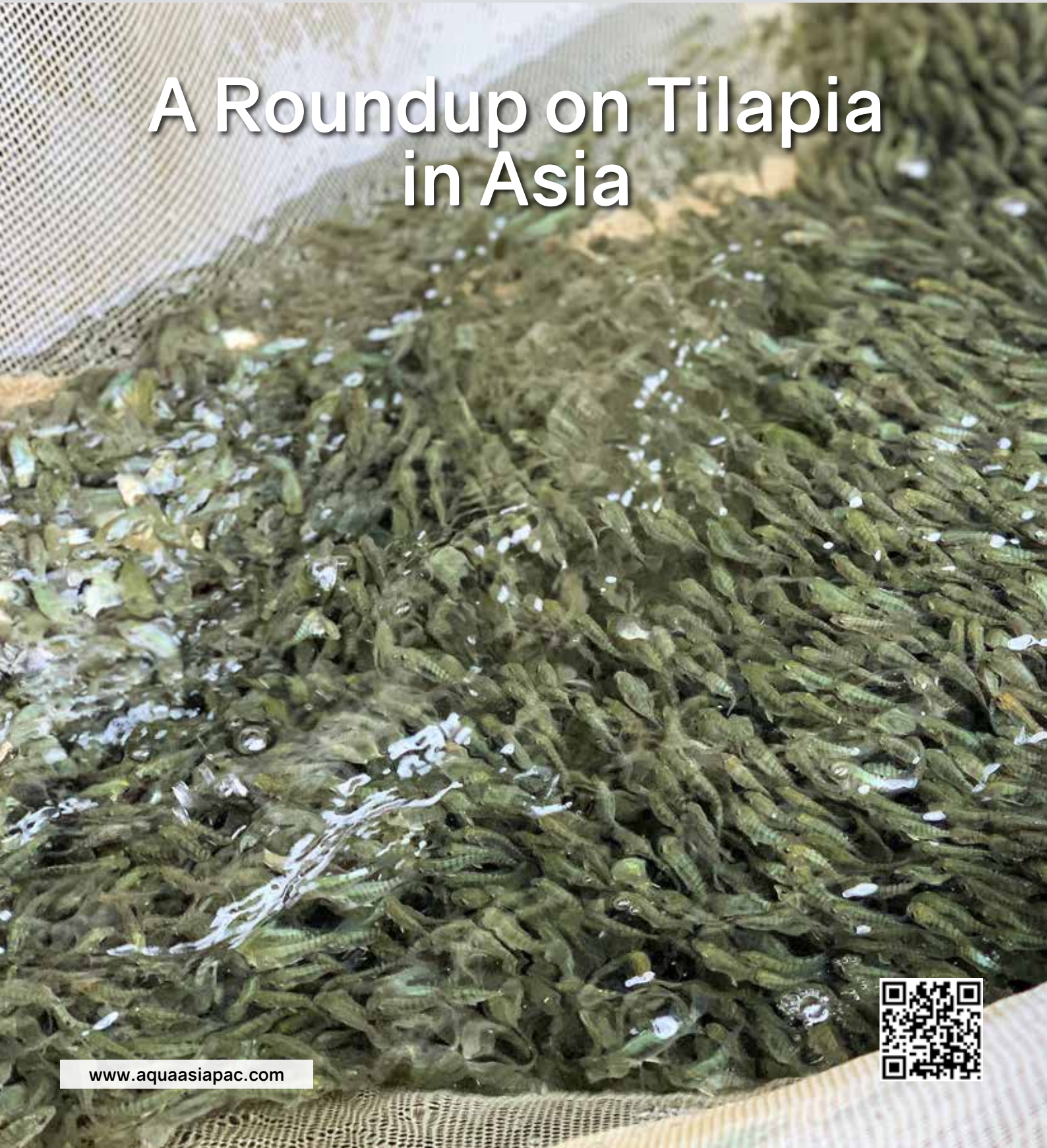
A Roundup on Tilapia in Asia



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Zuridah Merican

Demand led production – not all markets are created equal

The adage 'No one size fits all' holds true for aquaculture markets. From seminars and webinars, various countries have touted when they will achieve the one million tonne production number for shrimp. While being brave, it could be a foolish and totally wrong benchmark. Asian shrimp producers seem so keen on being production driven that they forget who is going buy their shrimp, let alone why the market should buy Asian shrimp over other shrimp, seafood and protein sources.

If the Covid-19 pandemic in 2020 has taught our industry anything, it is that we should focus on demand led production. With lockdowns, the global economy has suffered, and many countries are now looking to increase aquaculture exports to drive the economy. Consequently, the markets should be analysed as well.

Prior to the pandemic, the US shrimp market relied heavily on the food service sector but with restrictions on dining-out, the share of the retail sector increased as many households started cooking seafood at home. In January 2021, Bloomberg reported that seafood consumption at home increased by 25%. However, the retail sector and food service seek different products. While dining out offers the more impressive HOSO shrimp, households buying from the retail sector look for the 3Rs; ready to cook, ready to heat and ready to eat shrimp which comprise peel deveined, cooked and marinated products.

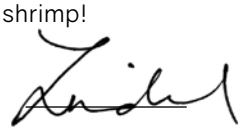
In the EU, the northern member states prefer peel deveined shrimp while the southern states look for whole shrimp, which are generally defrosted and cooked commercially daily. Willem van der Pijl asked a pertinent question in his recent Shrimp Blog – 'Although 2020 was not a bad year for *Peneaus* shrimp imports in the EU, Asia fared badly. Does Asian shrimp have a future in the EU market?' Willem will give his views in the session - Understanding Markets and Consumers at The Aquaculture Roundtable Series (TARS 2021) on August 18. With increased Covid-19 inspections (for the packaging, not the food item) for imported seafood into China, Rabobank reported a 50% and 25% fall in imported seafood for 4Q 2020 and 1Q 2021, respectively. China, a large importer of live black tiger shrimp has also seen reduced volumes of this product form.

Can the marine fish sector learn from the Norwegian salmon industry which developed a new market for its product in the 1980s? This is a journey of culinary history. The Japanese love their sushi and sashimi but it was mainly tuna and seabream from capture fisheries. Norway had to find markets for the increasing production of salmon. So back in 1986, the then Norwegian fisheries minister introduced salmon for sushi in Japan and today, the salmon sushi is the biggest global food trend. Imagine Norwegian salmon and Japanese sushi, said Asbjørn Warvik Rørtveit, Norwegian Seafood Council (NSC), Thailand, at the recent "Salmon e-dialogue 2021" organised by Infofish. "The acceptance was due to the red flesh colour and of course the link between sustainability and Norway."

The tilapia and pangasius, our two leading freshwater commodities, have thrived on export markets in the US and EU, respectively, but supply chain disruptions which emanated from the pandemic have increased shipping cost from Asia. Cold chain transport costs have increased more than 4 times from Vietnam to the US. Perhaps it is time to develop a local market in-country.

Demand led production also includes listening to consumer wishes which is often influenced by NGOs and large supermarket chains. Consumer demands have not changed over the last 2 years, but they have been re-enforced. There is an overall demand for sustainability and perhaps made more urgent by Netflix' Seaspiracy documentary. In addition, there are specific demands for each species. In shrimp, animal welfare groups have been asking to avoid eye-stalk ablation during broodstock maturation. Retail buyers in UK and EU supermarket chains have avoided tilapia due to hormonal treatments in producing all male fish for better growth. In marine fish species, aquaculture certification bodies are looking for zero-use of trash fish in feeding.

Whichever species, each producing country must look at its strengths and weaknesses and then target products to match the segment that provides the best opportunity because not all markets are created equal. Otherwise, we will suffer the lowest price for our million tonnes of shrimp!



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Global and Vietnamese marine ingredients supply chain

Key takeaways from a webinar on the global fishmeal and fish oil industry and Vietnam's role as consumer and producer.

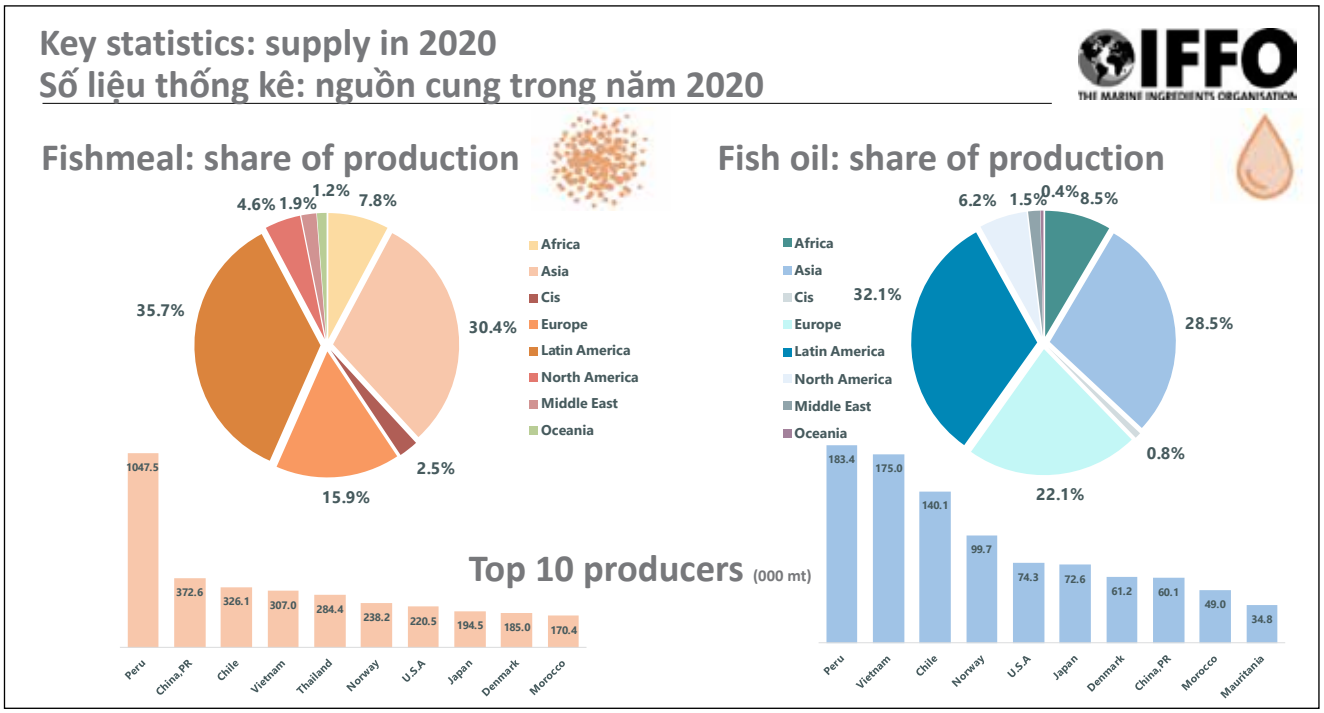
Speakers at the webinar included Nguyen Thi Thanh Binh, Viet Nam Country Coordinator, GSA, Vietnam who presented on Best Aquaculture Practices (BAP) and Best Seafood Practices (BSP) certification programs.

The webinar on July 14, conducted in English and Vietnamese, addressed global market dynamics of the marine ingredient industry. As a leading aquaculture and aquafeed producer, Vietnam is an important player in this industry, not only in terms of consumption but also as a producer of fishmeal and fish oil. IFFO - The Marine Ingredients Organisation represents the marine ingredient and other related industries, involved with the trading of marine products such as fishmeal and fish oil.

In his keynote address, Tran Dinh Luan, Director General of the Directorate of Fisheries at the Ministry of Agriculture and Rural Development, Vietnam, detailed some proposals on the 10-year plan to develop the marine aquaculture sector. The target is to industrialise marine cage farming in open waters and increase marine fish production, since the supply from capture fisheries is declining. Vietnam wants to be a leader in marine fish production in ASEAN. Currently, the main farmed species are grouper, cobia, red snapper, tuna, milkfish and lobster. The lobster is exported mainly to China and seabass to global markets.

With over 60 years of representing the marine ingredient industry, IFFO's members from 50 countries, account for 55% of global production and 75% of the fishmeal and fish oil traded worldwide. IFFO supports its members with a wide range of benefits; one of IFFO's focus is to further the responsible supply and production of marine ingredients. Demand for marine ingredients remains high and to ensure the industry's future, a chain of industry standards now offer full traceability from the fishery to the consumer.

Petter M. Johannessen, Director General, IFFO said, "The industry's value chain and chain of custody allow



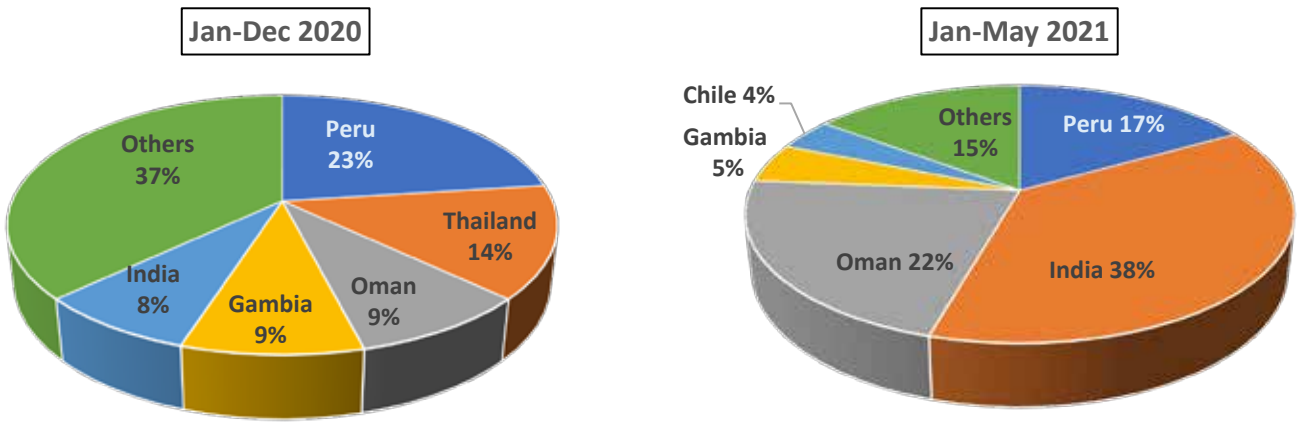


Figure 1. Vietnam's imports of fishmeal in Jan-Dec 2020 and for Jan-May 2021. Ranking of the top 5 supplier countries changed in the first 5 months of 2021. Source: Nguyen Nam Hai, Kanematsu, Vietnam

producers of marine ingredients and their customers to demonstrate robust traceability at every stage. IFFO is working with our members and partners to strengthen the global standing of the industry, while supporting responsible sourcing worldwide. Each stage of the chain is covered by relevant checks and certifications, to put in place recognition procedures among each other to ensure smooth collaboration and flow of the products." In 2020, some 51% of the world's marine ingredients are responsibly produced.

An overview of the latest trends

Dr Enrico Bachis, Market Research Director, IFFO said that with 81 countries across the world producing fishmeal, 73 exporting and 89 importing, this is a truly international market. The fish oil industry shares the same features, with 70 countries producing fish oil, 80 countries exporting and 98 importing. Global fishmeal production is led by Latin America at 35.7%, mainly Peru and Chile, followed by Asia (China, Vietnam, Thailand and Japan) at 30.4%. World fish oil production is led by Latin America at 32.1%, followed by Asia at 28.5%. "Europe and USA play a slightly bigger role in fish oil production compared to global fishmeal production. Yield, which depends on how much fat can be extracted from the species, is a key factor to explain the difference," said Bachis.

Asia is the leading importer of fishmeal at 66.4%, led by China at 1.4 million tonnes. Europe imports 21.1% of the global supply. Europe is the largest importer of fish oil at almost 54% followed by Asia (19.6%) and Latin America (9.9%). Today, most of the fishmeal and fish oil are consumed by the aquaculture sector at 78% and 68.4%, respectively.

"This difference in fish oil consumption between Europe and Asia, can be explained by the inclusion rates of fish oil in the diet of farmed fish. In Europe and Latin America (mainly Chile), it is for the salmonids. In Asia, the inclusion rate of fish oil in aquafeeds is lower. Turkey imports 76,000 tonnes for seabass and seabream feed production," said Bachis.

Global production in 2020 was almost 5 million tonnes of fishmeal and 1.2 million tonnes of fish oil. Overall, fishmeal supply improved by more than 100,000 tonnes compared to 2019 while for fish oil, the additional amount was 30,000 tonnes. "Based on our assumption, a stable output is expected for 2021 at the same level for fishmeal and for fish oil, 1.3 million tonnes." Bachis underlined that agri-commodities are natural ingredients whose availability depends on climate. This explains price volatility: while price of fishmeal has been stable over the last 12 months, other commodities such as corn and soya meal have been less stable. Prices of corn and soybean meal rose 200% and 20%, respectively, since June 2020, and fish oil prices went down 20%, while soy oil and palm oil rose 140% and 80%, respectively.

On quality parameters of fishmeal, Dr Brett Glencross, IFFO's Technical Director since June 2021 said, "The main driver behind some of the variability comes from the species used in fishmeal production. There is an increasing harmony over the last two decades in particular to get more consistent production quality across fish meals and this is largely driven by the market and their expectations. Within the individual regions in fishmeal production, such as in Scandinavian countries or Peru, we see that there is also a dichotomy of products focusing on different niche markets and applications."

Overview on fishmeal and fish oil supply and demand in Vietnam

Nguyen Nam Hai, Sub-manager, Kanematsu, Vietnam showed some trends in supply and demand during 2020 and in the five months of 2021. He also highlighted the outlook for 2022. In 2020, Vietnam imported 200,000 tonnes of fishmeal, making it one of the largest importers in Asia. In the first 5 months of 2021, origins of imports changed (Figure 1) with more from India and Oman.

In 2020, local production in Vietnam was 300,000 tonnes and it exported 150,000 tonnes of fishmeal, mainly to China (Figure 2). "The reason China keeps importing pangasius fishmeal is because of the low total volatile nitrogen (TVN) indicating freshness, short transit time, stable supply, sustainability and traceability," said Nam Hai.

However, he forecasted that imports may drop to 150,000 tonnes in 2021 and to 160,000 tonnes in 2022. By contrast, exports will increase to 180,000 tonnes in 2021 (from 301,000 tonnes of local production), and 190,000 tonnes in 2022 (from 298,000 tonnes of local production).

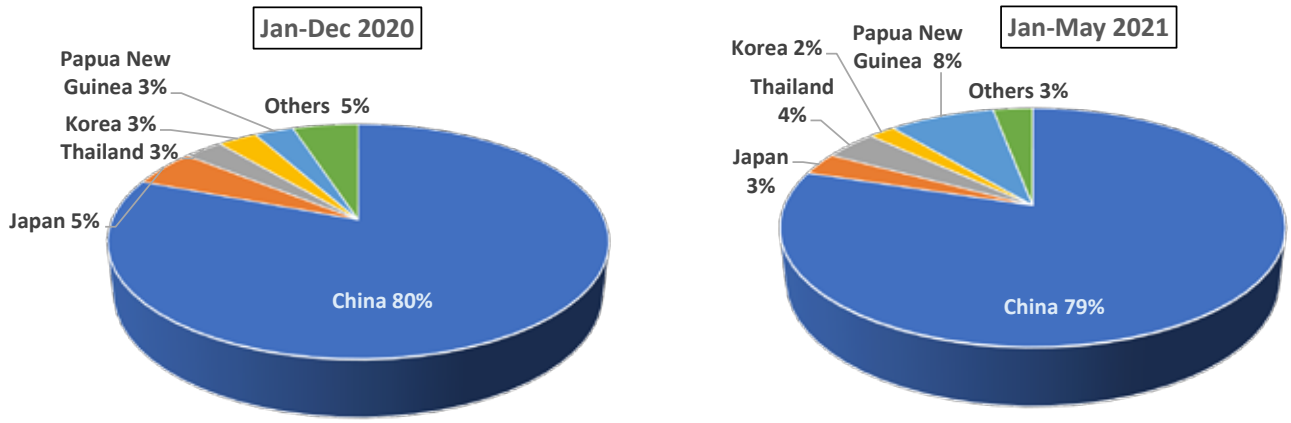


Figure 2. Vietnam's exports of fishmeal in Jan-Dec 2020 and for Jan-May 2021. China remained number 1 among the top 5 export markets in the first 5 months of 2021.Source: Nguyen Nam Hai, Kanematsu, Vietnam

In 2020, Vietnam imported 17,000 tonnes of fish oil, comprising 55%-65% of Chilean and Norwegian salmon fish oils. The reason why customers prefer this supply source is because they can get good quality MarinTrust approved fish oil at a competitive price and stable supply. "If customers choose fish oil with higher total omega-3s, then Japanese, Oman, Pakistani and Thailand sardine fish oils could be considered, which currently only contribute 20%-25% of total import volume."

In 2020, Vietnam produced 169,000 tonnes of fish oil, mainly pangasius oil, and exported 83,000 tonnes of fish oil. The largest export market is Singapore, for its biofuel production. Nam Hai forecasted that import volumes will remain at 17,000 tonnes in 2021 and rise to 18,000 tonnes in 2022. Exports will be 84,000 tonnes in 2021 (from 175,000 tonnes of local production), and in 2022 (from 177,000 tonnes of local production).

Regarding fishmeal and fish oil import regulations in Vietnam, Nam Hai said that the new parameters listed include arsenic, cadmium, lead, mercury and ethoxyquin for fishmeal, and arsenic, ethoxyquin and free of *E. coli* and *Salmonella* for fish oil.

Fishmeal production in Vietnam

Vietnam produces fishmeal with crude protein (CP) levels from 60% to 65% and at the right season, the CP level can go up to 67%," said Vinh Binh Hau, Tongwei Vietnam. There are two production areas: south and north-central regions. Aquafeed companies in the south use 70-80% of fishmeal production from the south and will use 20-30% of the production from the north-central regions when prices are conducive. Production in the north is usually used by livestock feed producers and the rest exported to China.

Production of pangasius fishmeal with 60% CP is in the Mekong Delta. The raw material is fresh as the fishmeal plant is near to pangasius processing plants. The proximity to China means that within a month, the fishmeal is used in aquafeed production in China. A comparison of Vietnam's fishmeal specifications with that of fishmeal from several other sources, showed that the amino acid level is comparable to fishmeal from Thailand and Mauritania. In terms of pricing, Vietnamese fishmeal is 6% cheaper than domestic fishmeal in China.

Fishmeal in feed production in Vietnam

Skretting South-Asia has a feedmill in Long Anh and another one under construction with 100,000 tonnes per year capacity in the same location. Skretting Vietnam produces starter, grower and functional feeds for several fish and shrimp species. Michael Leger, Technical Manager and Yosuke Sakurai, Procurement and Purchasing Manager/Lead Buyer Marine Ingredients Asia, described some strategies on fishmeal and fish oil sourcing for the company's aquafeed production. Developing sustainable solutions to address a limited supply of ingredients is part of Skretting's mission of "feeding the future".

Skretting has set to achieve its sustainability goals by 2025 and therefore, responsible sourcing is important. It is the role of the Global Procurement Network to create maximum value by frequent and close collaboration. Sakurai expects the supply to be stable with more ingredients certified but the concern is illegal fisheries and human rights issues. He expects demand to increase for omega-3 oils and the demand for marine ingredients to grow faster than output, putting pressure on prices. Sourcing responsibly is challenging.

Leger said that the quality of fishmeal is a challenge since there is a large variation, depending on the season and producer. Quality assessments of fishmeal include using NIR as well as conducting *in vivo* protein digestibility experiments for the various aquaculture species. By improving the knowledge on the nutritional requirements and understanding better the quality and the digestibility of the ingredients, the company can deliver performing diets while optimising the use of fishmeal and oils.

Access to China market

Xiaowen Ling, Technical Specialist at IFFO, China gave an overview of China's import regulations; she summarised government regulations and standards related to imports and explained the conditions for exporting fishmeal/fish oil to China. In the past 10 years, IFFO China has been offering licensing application assistance services to cover new license application, license renewal and license alteration, to IFFO producer members. The success rate is 100%, with 289 licenses granted by MOARA to the clients from 15 countries. The market share in license application service accounts for almost 30%. From 2021, IFFO has opened this service to non IFFO members and Ling gave a short introduction on the MOA licensing application assistance service.

In her closing remarks, Maggie Xu, China Director, IFFO said that IFFO recognises Vietnam's key role in the global marine ingredients and aquaculture industries. "Both access and sustainability remain at the core to the long-term success of this industry," said Xu.

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How Vietnam is moving towards responsible and sustainable shrimp production

Steps include the introduction of a locally developed disease free vannamei broodstock, eco-friendly farming of the black tiger shrimp, real time water quality monitoring, functional feeds against diseases and more sustainable farming models

By Van Tan

Along with its fast growth, attention is on the sustainability of Vietnam's shrimp farming industry.

Le Dang Quang, General Director of Minh Phu Group said that he is promoting the rice-shrimp co-farming model. He believes this model is environmentally friendly and economically stable for all stakeholders.

Amidst the worldwide COVID-19 pandemic, industry players want to showcase Vietnam as a leader in sustainable shrimp production. The latest industry developments were exhibited at the Vietshrimp International Fair, the largest shrimp show in Vietnam, held in Can Tho City, in the Mekong Delta, on April 14-16. The exhibition attracted 200 exhibitors and more than 10,000 visitors, compared to 150 exhibitors and 8,000 visitors in 2018.

Evident at Vietshrimp was an eagerness of the industry to move forward and meet global demands for a responsible and sustainable shrimp aquaculture sector in Vietnam. At the trade show, some exhibitors displayed modern technologies in shrimp farming – from digitalisation, nutrition to post larvae production. There were three conferences focused on the theme of "sustainable destination" that discussed solutions to improve the sustainability of shrimp farming.

Tran Đinh Luan, Director General at the Directorate of Fisheries, said that shrimp farming methods should go hand-in-hand with protecting the environment and providing product traceability. Along with the fast-paced growth of the industry, comes problems of untreated waste discharged into the environment. Non-compliance with regulations is a major concern.

"Drugs and chemicals of unknown origin have major consequences for the environment. For the long-term development of the industry, these issues should be addressed and be well-managed," said Luan.

More eco-friendly farms

There is a view that earthen shrimp ponds are no longer suitable because of poor bottom soil as well as polluted environmental conditions. Meanwhile, the super intensive model requires high investments, which are not financially viable for small-scale farmers. According to Le Dang Quang, General Director of Minh Phu Group, switching to black tiger shrimp farming and rice-shrimp farming models are both environmentally friendly and economically beneficial for all types of investors.

The model Quang mentioned is farming with a sparse density of 10-12 post larvae (PL)/m^2 to suit the carrying capacity of the environment. The model will be implemented in the form of one shrimp crop and two rotational rice crops to create a carbon balance and make sure the land is not over-exploited. The products of this model are organic black tiger shrimp and rice; there are no chemicals nor antibiotics involved in the entire production cycle.

"This model produces an average yield of about 380-500kg of shrimp/ha," said Quang. Minh Phu is developing both extensive (eco-friendly) models to produce organic shrimp and intensive models to produce regular shrimp. "This recirculating organic green smart shrimp value chain and carbon balance will be developed simultaneously with intensive models to ensure that the volume of shrimp supply remains high."

Currently, Minh Phu has established a network of shrimp producers and suppliers across the Mekong Delta with a variety of shrimp farming models. The company has built 100,000ha of intensive farms, 25,000ha of organic shrimp farms in mangrove areas and more than 10,000ha of rice-shrimp farms.

Quang stressed that Vietnam needs to continue domesticating the black tiger shrimp to create broodstock with good disease resistance and adaptable for farming in the natural conditions in the Mekong Delta. In addition, he also wished to develop a strong linkage between input suppliers, shrimp farmers and processors to form a sustainable model for the benefit of all.

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Viet Uc's VUS 21 Leader is the new generation of vannamei shrimp broodstock with 10% improved growth rate, higher survival rate and higher disease resistance.

Sustainable farming model

Viet Uc Group is Vietnam's leading post larvae producer and has introduced a sustainable farming model that minimises water exchange and reduces water discharge to the environment.

"The model applies biofloc technology and a multi-phase farming model. With this combination, water exchange is minimal in the entire farming cycle," said Vu Duc Tri, Viet Uc's Director of Enterprise Management. In Viet Uc's model, biofloc technology can be applied in open farms, which requires less investments compared to indoor farms. The model also includes the latest technology in water control, automatic feeding and oxygen generation.

"With these new technologies, we can control environmental parameters automatically and efficiently; in traditional farming models, these parameters are difficult to control. These technologies help shrimp farming become more professional, reduce labour and avoid human error," explained Vu.

High quality post larvae

Post larvae quality is of increased concern in Vietnam's shrimp industry, given that the country is heavily dependent on imported broodstock. This is a big risk for the industry as a whole. Through an exclusive cooperation with Australia's CSIRO since 2010, Viet Uc has been working on a breeding program for shrimp broodstock. With the approval of the Ministry of Agriculture and Rural Development (MARD), it worked on breeding the vannamei shrimp. At the show, Viet Uc launched VUS Leader 21 broodstock to produce high quality post larvae. This puts Vietnam in the league of countries with vannamei shrimp breeding programs – USA, Thailand, Indonesia and China.

Tri explained. "This broodstock is the result of using the most advanced genetic tools which allow for genome sequencing on a large scale. Traits include fast growth, strong disease resistance and adaptability to local farming conditions. Viet Uc has also worked on post larvae nutrition, developing a quality diet of fresh algae and Artemia. The feeding regime is twice the amount given to previous generations of post larvae. The aim is to produce post larvae with outstanding health.

"VUS Leader 21 has significantly improved genetic traits, resulting in 10% improved growth rate, higher survival rate and higher disease resistance. With these advantages, we believe the new shrimp post larvae will help farmers achieve better yields," he added.

Vu Duc Tri, Viet Uc's Director of Enterprise Management, said Vietnam's shrimp industry has made significant growth in terms of intensification and technology application in the last three years.

Digitalisation

The Vietnamese shrimp industry is focusing on increasing areas for intensive and super-intensive shrimp farming for higher productivity. The management of these farming models requires the support of machine learning tools which are also the drivers for high technology investments in shrimp farming.

At Vietshrimp, AquaEasy, a subsidiary of the Bosch Group, introduced solutions based on the internet of things, combining sensor systems, software, data analysis systems, and artificial intelligence to enhance farm management. "According to World Wildlife Fund, about 3 billion people around the world will rely on seafood as their primary source of protein. Aquaculture will be an important part of the global food supply chain. AquaEasy's mission is to make aquaculture work easier, smarter and more sustainable," said Product Manager Aries Dwiputera.

Smart farming model

Since 2019, the R&D team at Sheng Long Bio-Tech International has been working on optimising culture technology at its three research bases in Ninh Thuan, Tien Giang and Soc Trang. Water treatment is the backbone of Thang Long Smart System (TLSS), introduced at VietShrimp.

In this smart farming model, Nguyen Khac Hai, Technical Manager, explained that the water treatment process is divided into four steps.

- The first step is sedimentation, removing all impurities. Fish, molluscs and bivalves are removed from the water source.
- Step two is the first level of antibacterial treatment and further sedimentation, using potassium permanganate at 2-4ppm.
- Step three is the second sterilisation process, using chlorine at 10-15ppm.
- Lastly, there is further sedimentation and at this stage, the water is thoroughly disinfected and safe for shrimp farming.

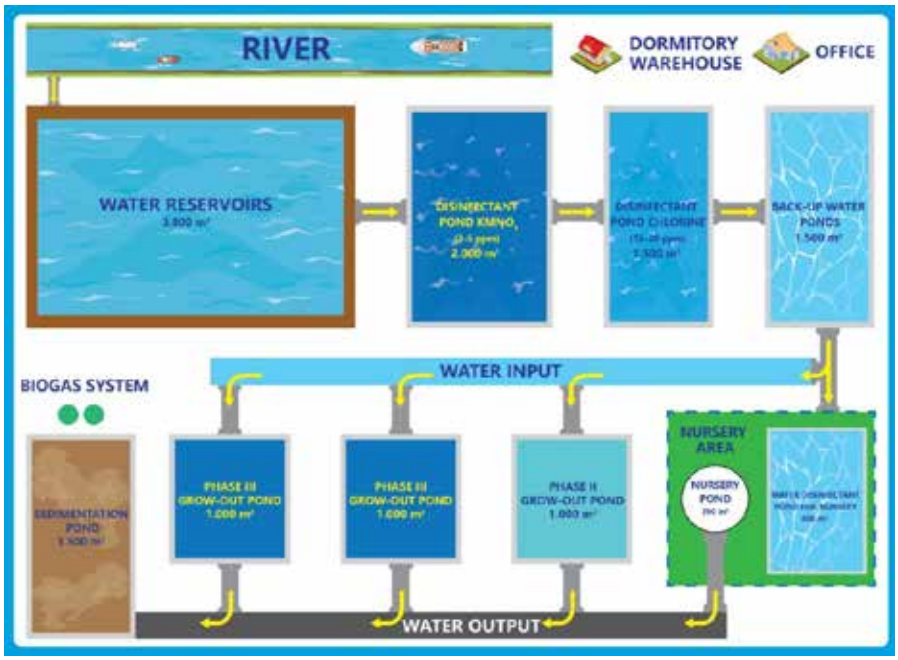

Figure 1. Sheng Long's TLSS Farming Method and System. The model focuses on pond design and production planning, a 4-step water treatment system, 3-phase farming with fast-growing post larvae and better animal health with functional feeds.

In Shenglong's smart farming model, shrimp culture area accounts for 15-20% of the total farming area.

Despite Covid-19, VietShrimp 2021 attracted 200 exhibitors and more than 10,000 visitors

In this model, the area for water treatment accounts for more than 80% of the total farming area. Therefore only 15-20% is used for culture ponds. With regards to the farming process, Hai explained that there should be a nursery stage and 2 stages of grow-out farming. At the 25-day nursery stage, stocking is 1,200-2,500PL/m^2 and at the grow-out stages, stocking density is at 200-500PL/m^2. The entire farming process should be conducted in lined ponds.

"The model is smart because it can be applied to a wide range of farm sizes starting from 1.5ha/pond and requires low initial investments," added Hai. "In 2020, Shenglong introduced this model to its customers in the Mekong Delta and received good feedback with a success rate of 83%. We are expecting to introduce this model to more farmers in this area this year."

Functional feed

As the global shrimp industry continues to face increasing risks of diseases, Grobest has introduced its functional feed to improve shrimp health. Emma Li, Deputy Head of Formula said that the additives supplemented in the feed are divided into five main groups: fermentation products, organic acids, activated peptides, free amino acids and trace elements.

Li said that it is the combination of these groups of additives which helps improve the health of shrimp hepatopancreas and the digestive system, inhibits bacterial growth, and reduces the risk of white faeces disease.

This is Grobest's proprietary formula, developed by its R&D team and manufactured in its factory in Taiwan. It is distributed all over the world. The research centre has more than 40 years of experience in understanding shrimp diseases and research on creating functional additives that support the physiological metabolism and nutritional needs of shrimp.

"Grobest's Super Shield is a functional shrimp feed and has the highest amount of feed additives among its peers," added Li.

Van Tan is a contributing writer based in Ho Chi Minh City, Vietnam

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Artemia harvest made easy

A call to move away from double sieving

Fish and shrimp hatcheries around the globe rely on Artemia nauplii as the preferred live feed for larval stages of fish and shrimp in order to obtain a consistent and predictable production. Artemia triggers the feeding behaviour of fish and shrimp larvae, has the appropriate size and is highly nutritious.

Convention, but not convenient

During the hatching process, Artemia embryos inside the cysts develop into free-swimming live nauplii that can be found in the hatching tank together with the rigid shells and the unhatched cysts. These unhatched cysts and remaining shells are inedible and must be separated from the nauplii before they can be used as feed. The cyst removal is a challenge even to modern aquaculture since the current methods are not always efficient and sustainable.

Commonly, Artemia nauplii are separated from the cysts and shells by using the double-sieving method (Figure 1). Double sieving is conceptually easy, requiring only two superimposed, fine-meshed nets that function as two-layered filter to separate the cysts from the Artemia nauplii, forcing the nauplii to pass through the mesh. This filtration process is time consuming and laborious, and it determines the final quality of the live feed.

Additionally, the efficiency of the double-sieving method is influenced by several factors:

- Cysts with a smaller size than the mesh will pass through the sieve, polluting the live nauplii suspension with indigestible material.
- Double sieving can only be done when the live nauplii are still small (first larval stage, instar I), which restricts the method to an optimal harvesting time and puts the nauplii at high risk of being damaged during the separation process. Damaged and dead nauplii are a less attractive feed and leak nutrients to the medium. Together with the presence of unhatched cysts and shells, these nutrients can induce suboptimal conditions in the larval tanks, favouring unwanted bacterial development in the larval tanks and increasing biosecurity risks in the hatchery.
- Due to clogging of the sieve by double sieving, the hatchery operator cannot recover all nauplii and only a fraction of the Artemia biomass can be recovered, resulting in direct economic losses in the hatchery and increased production costs.

All of these factors contribute to the fact that the double sieve is an inefficient and labour-intensive method, less suited for economic upscaling.

A more efficient method

INVE Aquaculture has developed the SEP-*Art* technology that allows the harvest of more and better quality Artemia nauplii with minimal labour input. This technology addresses the shortcomings of double-sieving, particularly the suboptimal recovery of biomass and the quality loss of the live feed. SEP-*Art* uses magnetism to separate Artemia nauplii from their cysts (Figure 1):

As opposed to double sieving, SEP-*Art* does not employ meshed nets, entirely removing the chance of physical damage to the nauplii. On top, all the nauplii present in the hatching tank can be efficiently recovered. The result is a suspension of very attractive, undamaged, and highly active nauplii ready to be fed to the shrimp/fish larvae.

More and better quality Artemia nauplii are harvested in less time and with less effort. This increases the efficiency of the process and the quality of Artemia, allowing the upscale of nauplii production to support the sustainable growth of the aquaculture sector.

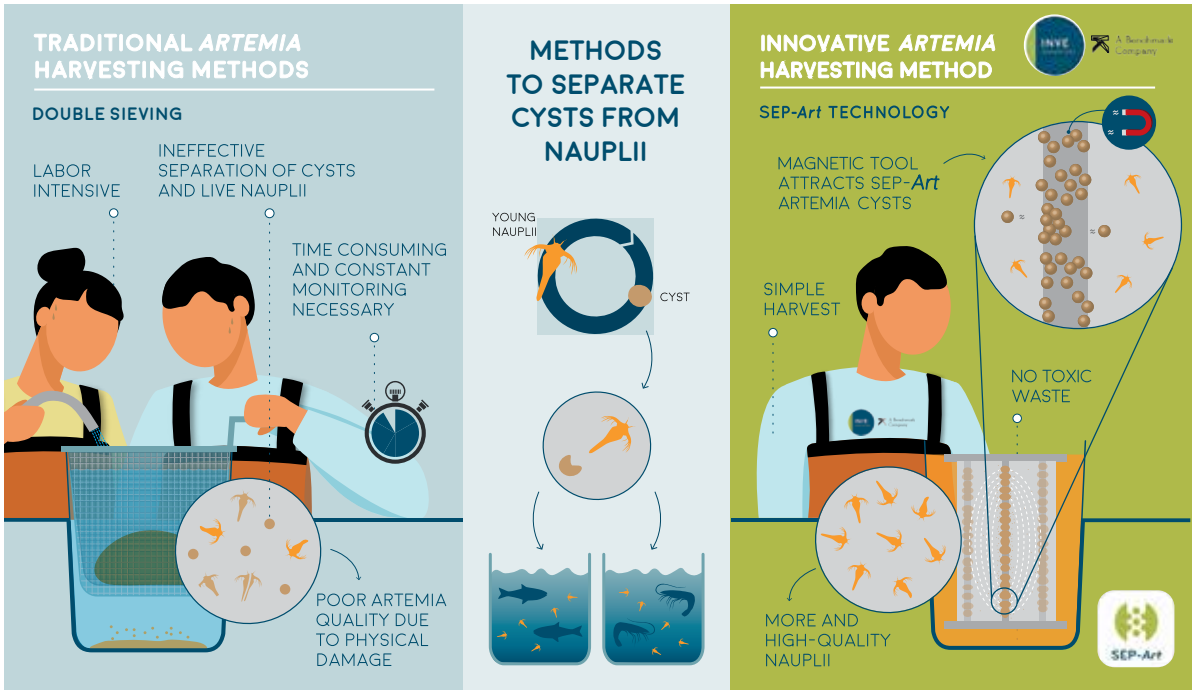

Figure 1. Right: The SEP-*Art* technology allows the harvest of more and better quality Artemia nauplii with minimal labour input. Left: The traditional double sieving filtration process is time consuming and laborious.


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Krill is king: How a tiny crustacean can lead to big savings

Krill meal supplementation in fish meal challenged diets fed to juvenile olive flounder resulted in savings per kg of fish produced.

By Tibiabin Benitez-Santana

For decades, the fish and shrimp aquaculture sector relied on fish meal and fish oil to nutritionally upgrade feed formulas to maximise growth and efficiency. However, the use of fish derived products is becoming highly scrutinised due to sustainability concerns, which have driven to the development of low- to no-fish meal aquafeeds. This paradigm shift left the industry asking the million-dollar question: how to ensure higher sustainability at equal nutritional quality and feed cost? What does the feed of the future look like – and is it affordable?

A 'small' solution to a big challenge

Replacing fish meal is the greatest challenge for the aquaculture production of carnivorous fish. How do we reduce or completely remove fish meal from diets of fish species without running into nutritional imbalances or ramping up feeding costs? The answer to this huge problem lies with a tiny crustacean.

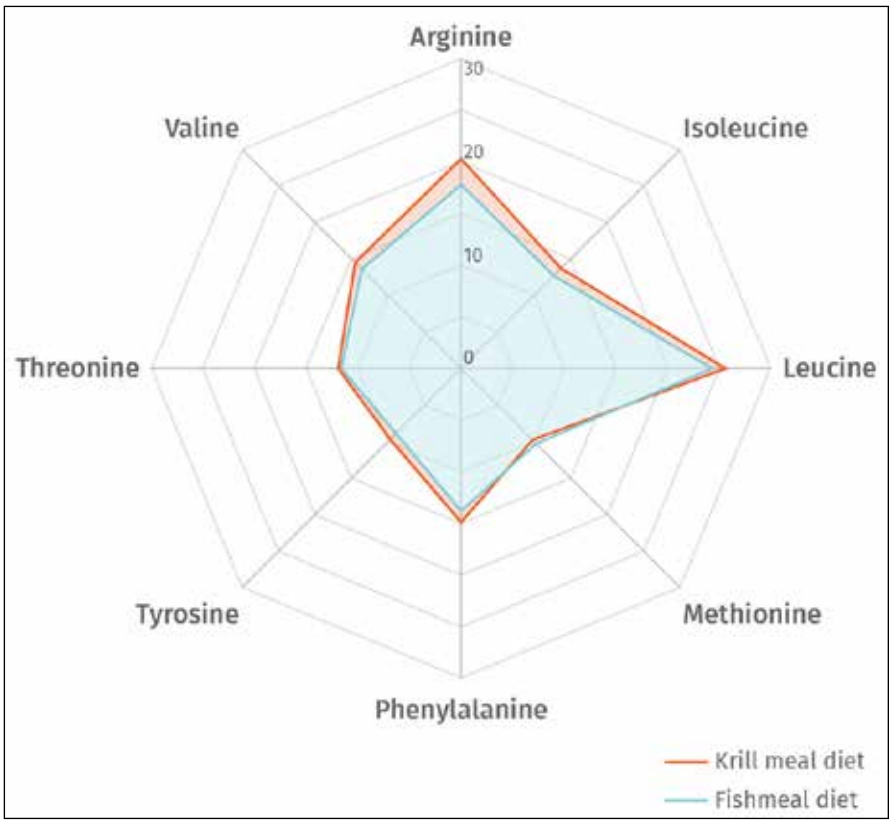

Figure 1. Comparative plot for essential amino acid profile (as g/100g diet) of krill meal (inclusion at 11%) and 3% fish meal diets (Moreno-Arias et al., 2018; Nunes et al., 2011)

Produced from Antarctic krill (*Euphausia superba*), krill meal has a rich protein and amino acid nutritional profile, on par with that of fish. It includes high levels of long-chain polyunsaturated fatty acids, such as eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), feed attractants and astaxanthin, which stimulate fish feeding behaviour (Tharaka et al., 2020). Krill meal is, therefore, a powerful supplement to low fish meal diets. In addition, krill meal supplementation stabilises feed costs. This has been validated in recent studies addressing zootechnical performance and cost-benefit of krill meal supplementation in diets provided to the carnivorous fish species European seabass (*Dicentrarchus labrax*) and olive flounder (*Paralichthys olivaceus*) (Khosravi et al., 2018).

Bringing krill meal to the (aqua) table

Aside from enhancing fish growth and performance, krill meal supplementation has several proven benefits for aquaculture as it also promotes hepatic health (Torrecillas et al., 2021). The amino acid composition of krill protein is very similar to that of fish meal (Figure 1; Moreno-Arias et al., 2018; Nunes et al., 2011). This generally results in increased feed intake, as reported in different studies documenting a stimulatory effect of different krill products on the appetite of several fish species (Choi et al., 2020).

Made from Antarctic krill, QRILL Aqua (AkerBiomarine, Norway), is known as a feeding stimulant potentiating feed uptake and growth. It also improves fish health and stress tolerance. This product was recently tested in both European seabass and olive flounder, with remarkable results towards improving biological performance, while also enhancing the feed cost-benefit ratios. Fish meal based diets were compared with low fish meal diets supplemented with different amounts of krill meal (5%, 7.5%, and 10% for European seabass; 3%, 6%, 9%, and 12% for olive flounder).

After 12 weeks, growth performance results revealed that a krill-supplemented (low fish meal) feed outperformed high fish meal feed (Figure 2). For European seabass, fish growth improved by 22%, with the final body weight increasing from 54g to 65.6g. Olive flounder' average final body weight was also higher in fish fed krill meal supplemented diets.

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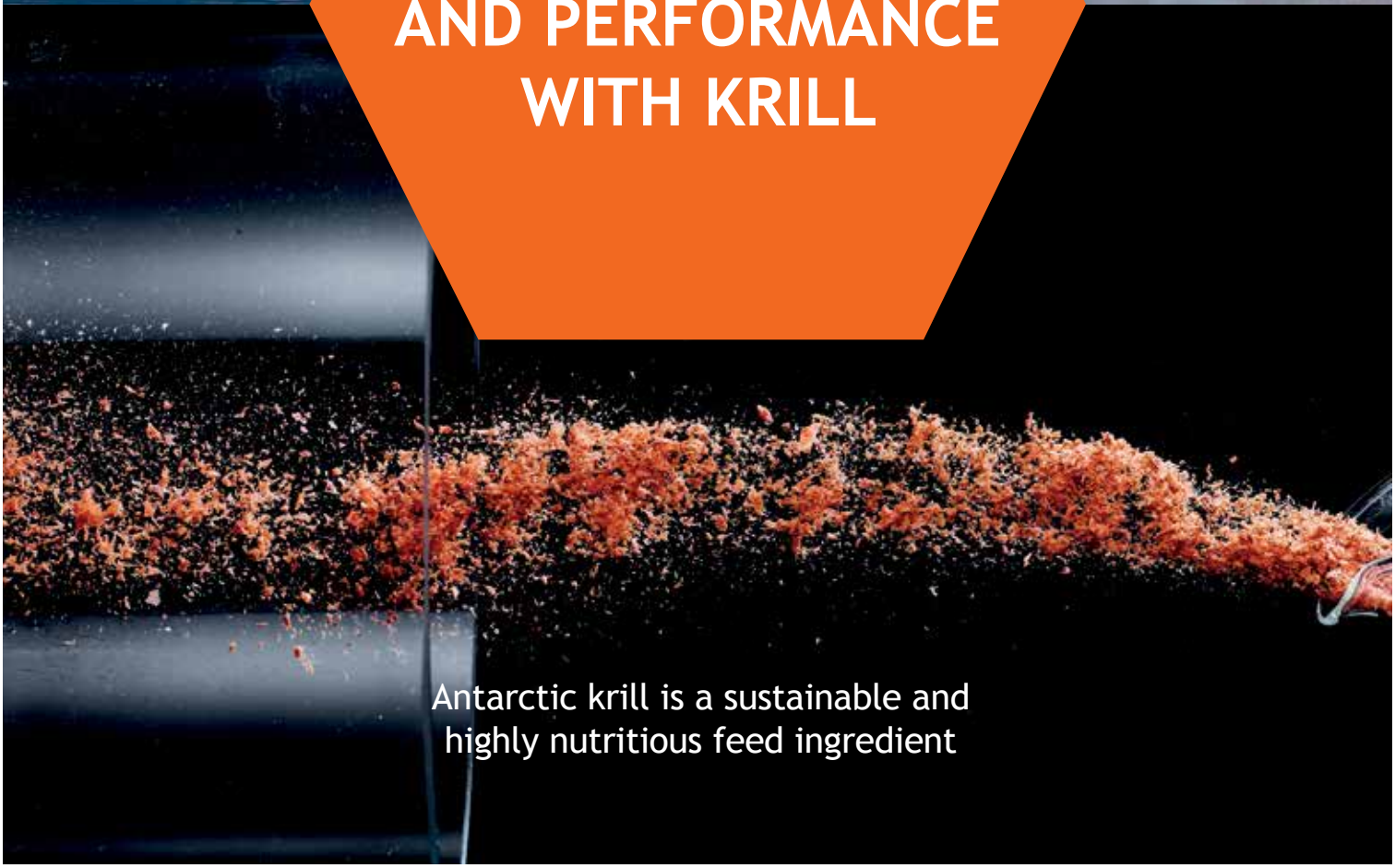

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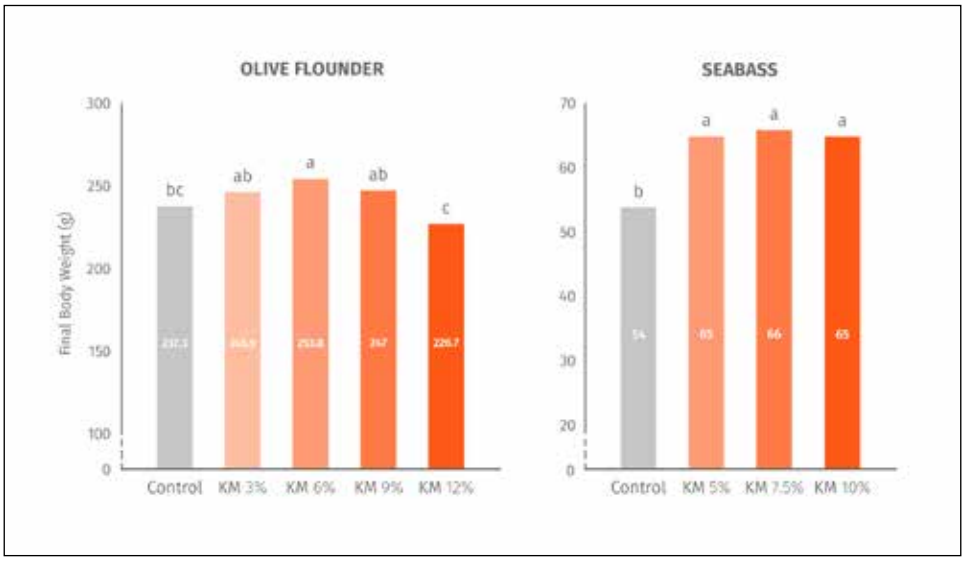

Figure 2. Final body weight for European seabass (*Dicentrarchus labrax*) and olive flounder (Paralichthys olivaceus) fed different feed formulations. Olive flounder: inclusion levels of fish meal were 56% in control group, 28% in krill meal (KM) groups (KM3%, KM6%, KM9% and KM12%). Seabass: inclusion levels of fish meal were 15% control group and KM groups (KM5%, KM7.5%, and KM10%).

Figure 3. Feed conversion ratios (FCR) for olive flounder (*Paralichthys olivaceus*) and European seabass (*Dicentrarchus labrax*) fed different feed formulations. Olive flounder: inclusion levels of fish meal were, control, 56% and 28% in krill meal (KM) groups (KM3%, KM6%, KM9% and KM12%). Seabass: inclusion levels of fish meal were, control 15% and KM groups (KM5%, KM7.5%, and KM10%).

The trials also illustrated the benefits of using krill meal supplemented diets in optimising feed conversion ratio (FCR) regardless of the supplementation level, for both olive flounder and European seabass. Lower FCRs were recorded for both fish species in the krill meal supplemented dietary treatments (Figure 3). Feed intake of olive flounder also increased with QRILL Aqua supplementation in a low fish meal diet. A significant increase from 284g to 294g in feed intake per fish was found between a high fish meal diet and a low fish meal diet supplemented with 3% of krill meal.

When comparing the different krill meal supplementation rates, results showed that the optimal supplementation level was 6.6%. For olive flounder, this level of supplementation also showed positive impacts in feed digestibility, intestinal development and function, and innate immunity. Results further suggested an important role of krill meal in improving disease resistance after being challenged with the pathogen *Edwardsiella tarda* – a deadly bacterial pathogen prevalent in flounder farms in South Korea. The cumulative mortality after a 25 day-challenge was lower in fish fed krill meal supplemented diets (50% survival rate in the 9% krill meal dietary treatment) than in the low fish meal diet control group (10% survival rate).

"The benefits of supplementation with krill meal go beyond improving biological performance. From an economic perspective, the potential financial improvement of krill meal supplements is equally, if not more, relevant to farmers."

The cost benefit of krill meal

The benefits of supplementation with krill meal go beyond improving biological performance. From an economic perspective, the potential financial improvement of krill meal supplements is equally, if not more, relevant to farmers. However, krill meal supplementation in low fish meal diets improved the ratio between feed cost and amount of fish produced, for both the olive flounder and European seabass. This is supported by the previously highlighted results: fish fed krill meal supplemented diets improved growth and FCR, thus leading to a reduction in the feed cost per fish.

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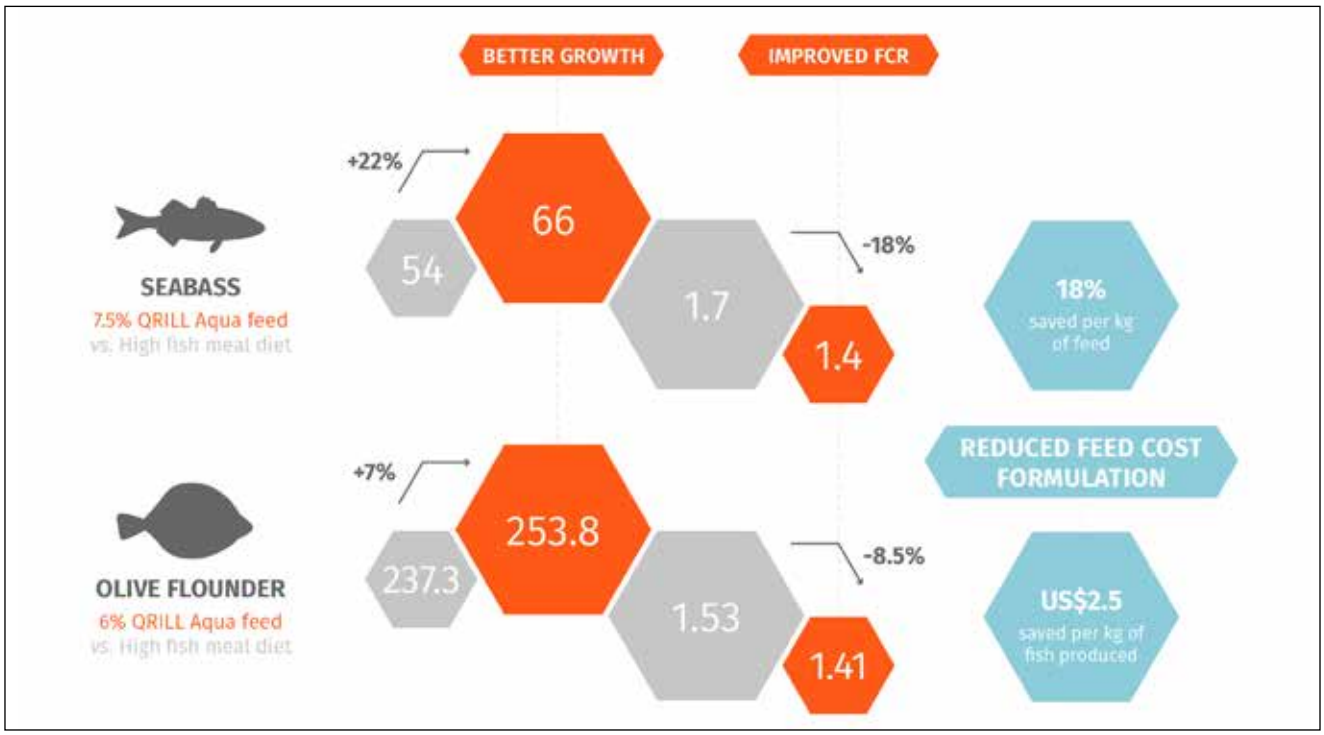

Figure 4. Impact of krill meal vs high fish meal feed on zootechnical performance and cost-benefit ratio on olive flounder (*Paralichthys olivaceus*) and European seabass (*Dicentrarchus labrax*) populations (Tharaka et al., 2020).

For European seabass, feed costs savings were up to 14% or 18% on a 5% or 7.5% krill meal diet, respectively, compared to a control diet (0% krill meal and LT70, Norvik 70). Such savings are driven by a faster growth and a reduced number of days to produce similar size fish. For olive flounder juveniles the krill meal supplementation resulted in feed cost savings by USD2.5 per kg of fish produced. Fillet yield of olive flounder also increased from 47.2g to 49.2g when comparing a high fish meal diet with a krill meal supplemented low fish meal diet. Other indirect cost-benefits associated with krill meal supplementation are higher disease resistance and, consequently, higher survival (Tharaka et al., 2020). To sum up, krill meal benefits health and biological performance parameters; it initiates a positive feedback loop also improving product quality and quantity at reduced costs (Figure 4).

Krill meal: better performance with lower feed formulation cost

The advantages of utilising QRILL Aqua on low fish meal aquafeeds are clearly manifold. Krill meal stimulates biological performance, particularly growth, feed intake, FCR, digestibility and immunity. Enhanced fish growth also improves the cost-benefit ratio. Krill meal embodies an ideal solution for the sustainability problem that high fish meal and fish oil diets represent. Supplementation with krill meal is expanding to be the top choice in the production of nutritionally balanced feeds. Krill meal in feed formulations will undoubtedly deliver upon promises of improved performance, sustainability, and cost-efficiency of a futuristic aquaculture sector.

References

Choi, J., Lee, K. W., Han, G. S., Byun, S. G., Lim, H. J., & Kim, H. S. (2020). Dietary inclusion effect of krill meal and various fishmeal sources on growth performance, feed utilization, and plasma chemistry of grower walleye pollock (*Gadus chalcogrammus*, Pallas 1811). Aquaculture Reports, 17, 100331. https://doi.org/10.1016/j.aqrep.2020.100331

Khosravi, S., Bui, H. T. D., Herault, M., Fournier, V., Kim, K. D., Lee, B. J., Kim, K. W., & Lee, K. J. (2018). Supplementation of protein hydrolysates to a low- diet improves growth and health status of juvenile Olive Flounder, *Paralichthys olivaceus*. Journal of the World Aquaculture Society, 49(5), 897–911. https://doi.org/10.1111/jwas.12436

Moreno-Arias, A., López-Elías, J. A., Martínez-Córdova, L. R., Ramírez-Suárez, J. C., Carvallo-Ruiiz, M. G., García-Sánchez, G., Lugo-Sánches, M. E., & Miranda-Baeza, A. (2018). Effect of replacement with a vegetable protein mixture on the amino acid and fatty acid profiles of diets, biofloc and shrimp cultured in BFT system. Aquaculture 483, 53-62. doi:10.1016/j.aquaculture.2017.10.011

Nunes, A. J. P., Sá, M. V. C., & Sabry-Neto, H. (2011). Growth performance of the white shrimp, *Litopenaeus vannamei*, fed on practical diets with increasing levels of the Antarctic krill meal, *Euphausia superba*, reared in clear- versus green-water culture tanks. Aquac. Nutr. 17. doi:10.1111/j.1365-2095.2010.00791.x

Tharaka, K., Benitez-Santana, T., Gunathilaka, B. E., Kim, M. G., Lee, C., Shin, J., & Lee, K. J. (2020). Evaluation of Antarctic krill (*Euphausia superba*) meal supplementation in diets for olive flounder (*Paralichthys olivaceus*). Aquaculture Research, 51(6), 2291–2302. https://doi.org/10.1111/are.14573

Torrecillas, Silvia, Benitez-Santana, Tibiabin, Montero, Daniel, Izquierdo, M. (2021). Replacement of by antarctic krill meal in diets of European Sea Bass *Dicentrarchus labrax*: effects on growth performance, feed utilization and liver metabolism. World Aquaculture Society Meeting.

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Sustainable aquaculture with a new generation of shrimp feed

Sustainability in shrimp farming takes a step forward with a new functional feed to control pathogens and enhance immunity and gut health.

By Cuong Huynh Tran, Vu Hoang Nguyen and Van Thi Thai Nguyen

Diseases are one of the main bottlenecks in aquaculture development. A vast majority of farmers are regularly hit by severe disease outbreaks and are attempting to implement actions to control the occurrence and severity of these events. The lice *Argulus foliaceus* is thought to cause more than USD6.5 billion losses annually in freshwater fish, while *Streptococcus agalactiae* causes more than USD700 million of damages worldwide. One of the biggest threats to shrimp production is early mortality syndrome (EMS) or otherwise known as acute hepatopancreatic necrosis disease (AHPND), with damages estimated at USD20 billion globally (Shinn et al., 2018).

In an industry that requires full traceability and only allows the judicious use of permitted antibiotics, farmers are investing at different stages of the farming cycle to mitigate occurrences and the severity of these outbreaks. As the development of vaccines in aquaculture is currently limited, one of the main ways to control diseases is by implementing biosecurity measures and improving pond bioremediation.

On the other hand, farmers are increasingly looking at and investing in dietary approaches to make their animals stronger and resist any potential pathogens. Interest is in enhancing feed digestibility, boosting the immune system and controlling gut microbiota. This has led to the development of a new era of functional feeds. Depending on their formulation, functional feeds, through the incorporation of specialty ingredients that promote growth, health and survival, can induce physiological benefits beyond conventional feeds which focus only on providing sufficient nutrients for growth of the animal. At ADM, our functional feeds mainly focus on health-promoting solutions for the animal because this is the vital challenge faced by farmers.

As a global group involved in all stages of fish and shrimp farming, ADM has the responsibility to research into solutions for the sustainable development of the aquaculture industry. Using a variety of internal solutions, ADM has developed 'Life Defense', a functional feed concept designed to support the health of farmed fish and shrimp. The formulation is built around three multi-layers of solutions, namely, to safeguard the external protection (skin, shell, mucus, gill) of the animal; control the pathogenic load; and enhance the animal's health status, by boosting the immune function and improving gut microflora.

The company has applied this concept to shrimp using its extensive R&D network under Asian farming conditions. The result of more than three years of R&D is a functional feed for the vannamei shrimp (Vanalis Pro) with a 3-in-1 solution. By improving the natural defense mechanisms of the shrimp, the farmer will benefit with an increase in farm revenue. Besides a strong growth potential of shrimp offered by this feed, this synergistic combination of additives promotes gut health, strengthens the immune system and controls pathogens in shrimp.

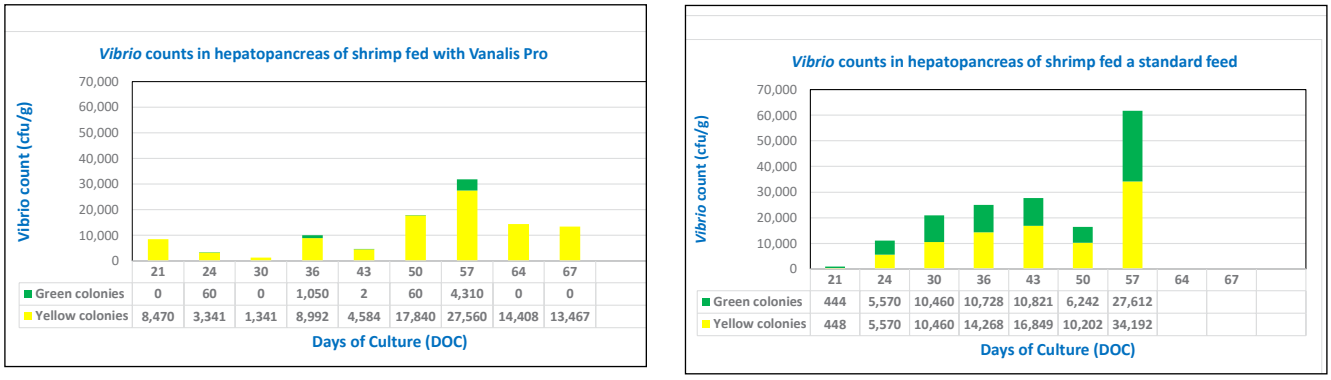

Figure 1. A reduction of pathogenic green *Vibrio* colonies was observed in the hepatopancreas of shrimp fed Vanalis Pro (left) compared to a standard shrimp feed (right).

Strengthening gut health

The digestive tract is one of the first and most important entry points in shrimp for pathogens. This functional shrimp feed has probiotics incorporated using a specific production technology to improve microflora and gut health. The selected *Bacillus* strains offer a high level of enzymatic production and secretion of antimicrobial compounds. This leads to improved nutrient absorption and dramatically reduces the risk of infection in the hepatopancreas by *Vibrio* spp.

Control of pathogens

In addition to the probiotics, this functional feed contains a blend of premium feed additives selected to control gut pathogens. These supplements have the capacity to penetrate the pathogenic bacteria and release toxic compounds that will eventually inhibit the bacteria.

Enhancing immunity

Specific functional ingredients promote the immune pathways to help shrimp fight actively against pathogens. The added probiotics and resulting improvements in the gut microflora will also have a significant impact on the host immunity.

This functional feed Vanalis Pro contains a specific blend of feed probiotics and additives. The *Bacillus* probiotic is fermented and manufactured by ADM in the US to ensure quality and traceability. The feed is tailored specifically for shrimp rearing conditions in Asia. The production technology used to produce the feed probiotics ensures a high degree of homogeneity, dosage accuracy and CFU count as compared to when the farmer mixes feed probiotics as top dressing at the farm. The production process significantly reduces the probiotic loss into the rearing water while also guaranteeing an optimal retention of the probiotics over a 6-month period in tropical conditions. Besides the R&D trials, the efficacy of this feed was validated under actual farming conditions. With shrimp often challenged with high levels of *Vibrio* spp. farmers in Vietnam have tried this innovative feed and observed a reduction in pathogenic green *Vibrio* colonies in shrimp hepatopancreas (Figure 1).

Besides a reduction in mortality, farmers also noticed better growth performance. Shrimp were able to perform better under challenging conditions while using this functional feed compared to a standard feed (Figure 2).

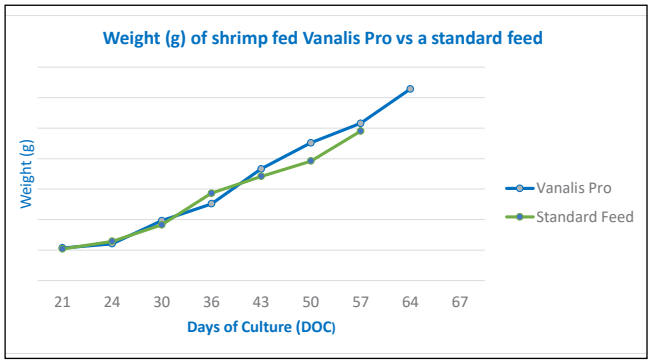

Figure 2. Under farming conditions, shrimp fed Vanalis Pro showed better growth performance as compared to shrimp fed a standard feed.

This feed functions as a solution to strengthen gut health, control pathogens and optimise shrimp growth. The full range of shrimp feeds, starting from crumble to pellet structure, through nursery until the finisher stage is available. With a successful launch of the first functional feed, ADM is leading new pathways to a sustainable development of the shrimp industry. New functional feeds will soon be added to the 'Life Defense' product portfolio of ADM to broaden the range of species and applications.

Reference

Shinn, A.P., Pratoomyot, J., Metselaar, M and Gomes, G.B. 2018. Diseases in Aquaculture-Counting the Costs of the Top 100. World Nutrition Forum. S.C.O.P.E. Scientific Challenges and Opportunities in the Protein Economy. pp 227-262.

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Marine fish farming in Japan

Private and public alliances can help reduce the use of fishmeal and fish oil in feeds and mineral waste from feeds, as well as create awareness on antimicrobial resistance in fish farming

By Renato E Kitagima

Fish farming in Japan covers multiple freshwater, euryhaline and saltwater species due to diverse local demand for traditional Japanese cuisine. Many companies see opportunities in farming high-value species, rare species or promoting a specific characteristic of the product, including differentiated taste, special feed, clear brand concept or even fish size. Since Japan is an archipelago, food habits are strongly linked to ocean resources and consumption of a wide range of seafood is part of the general population's regular basic diet.

Globally, Japanese food is considered very healthy, and it is possible to find Japanese restaurants all over the world. In 2013, UNESCO nominated the traditional Japanese food "Washoku" as an "Intangible Cultural Heritage". Appearance is crucial to Japanese cuisine, requiring a diverse variety of fish meat colours, textures, scents and flavours. Flesh quality is the main parameter when evaluating the value of the fish. Not only freshness or nutritional value but also smell, marbled meat appearance, correct processing and proper blood removal are important factors when selecting seafood in the market. On the other hand, it is possible for the main farmed species to see a commoditisation of prices because there is a certain standardisation on large-scale fish harvesting and processing.

According to the Japanese Ministry of Agriculture, Forestry and Fisheries (MAFF 2018), the total production of farmed fish in Japan is 280,000 tonnes annually (Figure 1). Of this, 73% is produced in the southwest of Japan (Shikoku and Kyushu regions), where higher water temperatures during spring, summer and autumn allow maximum fish growth. The north of Japan has lower water temperatures on average. However, many areas are not suitable for cold-water species like salmon due to the water temperature reaching over 20°C during high summer and the huge quantity of ocean ice blocks coming from the north during winter.

Most of the production is based in net pens located close to the coast, mainly in bays. The main marine species (yellowtail, seabream and bluefin tuna) are usually farmed in net pens of 8–30m depth and up to 80m in width. The size and depth depend on the farming area and species. Smaller cages are usually used for tiger pufferfish or amberjack due to the need to regularly handle the fish for parasite management. Larger net pens are used in tuna farming, which has large harvests (30–100kg). There are many types of pen structures, including ones made from polyethylene, submersible net pens in areas that experience typhoons, and free-form net pens made from floats, ropes and net. However, the majority of net pens consist of a metal frame with revested styrofoam floats. Polymer-based nets are regularly used, while some farms use metal nets.

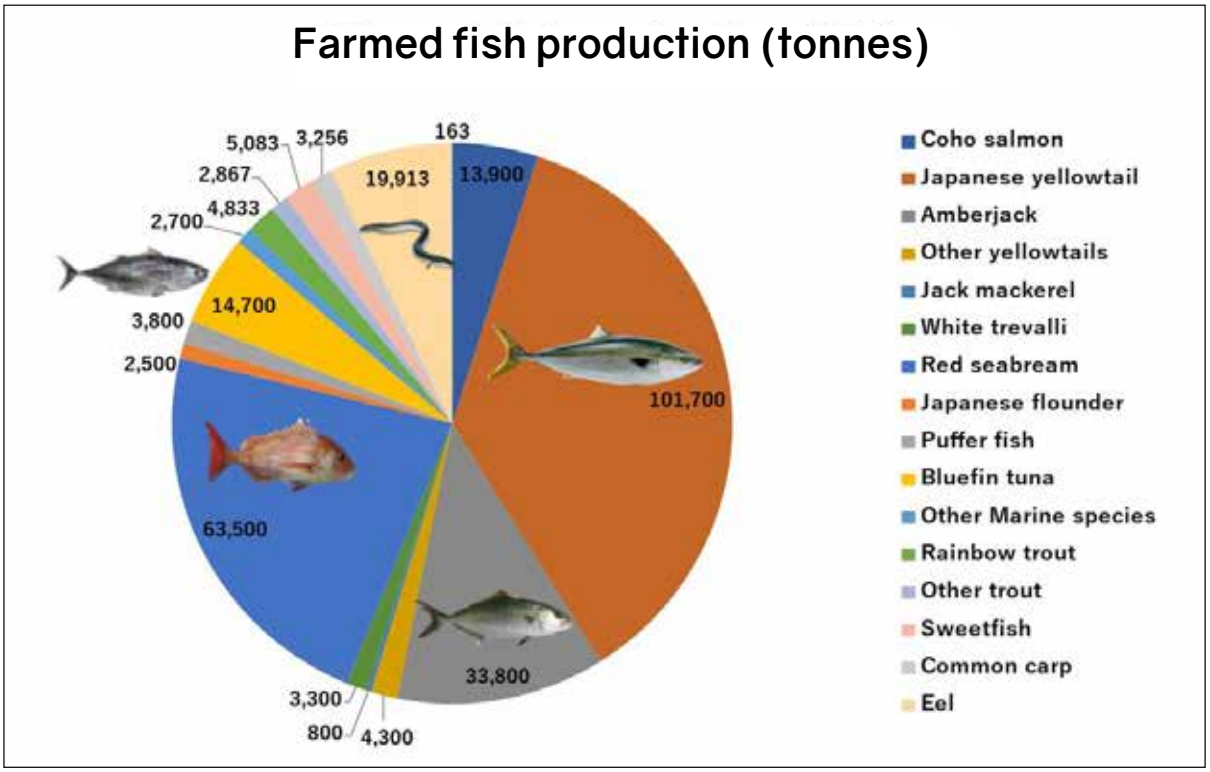

Figure 1. Fish species production in Japan according to the Japanese Ministry of Agriculture, Forestry and Fisheries. Some 73% is produced in the southwest of Japan (Shikoku and Kyushu regions) where water temperatures are higher during spring, summer and autumn for maximum fish growth.

Figure 2. Traditional Japanese fish net pens and tanks. (A) Flow-through round tanks for Japanese flounder; (B) commonly used net pen with metal frame and polymer net; (C) polyethylene round cages; (D) large-size net-float type pens; (E) submerged type net cage lifted at the time of feeding; and (F) cage distribution in a bay of Kagoshima prefecture.

Recirculation Aquaculture Systems (RAS) are used for shrimp and salmonid species, but at present, most are small-scale. Local and foreign investment groups have announced several thousand tonnes of salmonids in RAS for the near future, but it is necessary to wait and see if those projects become a reality.

Marine fish farming started in Japan in 1928. Noami Wasaburou was the first to report and succeed in keeping and raising yellowtail in ponds. Commercial net-pen aquaculture in Japan began in 1955, with small cages of yellowtail mixed with other species. At that time, commercial feeds were not available and low-value fish species were used as feed. Today, commercial compound feeds are diverse and offered in a variety of technologies to fish farmers, from traditional dry pressed pellets, passing through to extruded pellets and reaching "sausage" shaped moist feed for big size fish like tuna.

Sustainable feeds

Although some farms still use old practices, most use commercial feeds due to their stable supply, higher biosecurity and adaptability to sustainable novel formulations. There is a governmental effort to increase the sustainability of feeds. Public universities such as Tokyo University of Marine Science and Technology, Kochi University and Kagoshima University have been using plant protein and plant oils, among other alternative ingredients, in fishmeal replacement research. Other public institutions and private universities, such as Kinki University, also contribute to this area. Moreover, local retailers have started to purchase fish with Aquaculture Stewardship Council certification (ASC) and other sustainability-related certifications, but the awareness of certifications is generally low since the local population considers locally farmed fish safe to consume.

Disease management

A constant problem affecting the farms is the presence of disease and parasites. For many well-known diseases like iridovirus, streptococcus and vibrio, commercial vaccines are available in multiple forms. Similarly, for most of the main parasites, like skin fluke (*Benedenia seriolae*), there are effective treatments that do not harm the environment (Figure 3). However, farmers look for alternatives to reduce the number of treatments necessary and the high operational cost.

Figure 3. Common diseases, parasites and treatments. (A) *Microsporidium seriolae* cysts mass in muscle of yellowtail fingerlings; (B) skin fluke (*Benedenia seriolae*) causing irritation in yellowtail skin, injury caused by fish trying to remove the parasite on tank wall; (C) vaccination of yellowtail fingerlings; (D) *Acanthocephalan* parasite attached to seabream intestine; (E) fish affected by *Edwardsiella tarda*; (F) treatment of fish by inserting sheet-tank and active component inside the net-cage.

"New sustainability certifications and awareness on antimicrobial resistance (AMR) require its reduction by using regulated treatments and adopting preventative farm management"

Prefectures of areas with high production volume have fishery research centres where farmers can send fish with signs of disease for early identification of any possible outbreak. However, "non-regular diseases" (outbreak once in several seasons) and new strains of bacteria still affect the farms. Since most farms are in the Pacific Ocean, rich in nutrients and life, the year-by-year variation in farm environment conditions can be very high considering the biodiversity brought by the Black Current.

There are diseases which affect fish with constant low mortality rates, like *Edwarsiella tarda* in red seabream farming that cannot be eliminated with antibiotics. Control needs to come from improved farm management and preventive measures. New sustainability certifications and awareness on antimicrobial resistance (AMR) require its reduction by using regulated treatments and adopting preventative farm management. This includes better practices and utilisation of additives that can improve the immune system, osmoregulation, digestion of plant ingredients and gut microbial community.

Moreover, the shift from wild catch fingerlings to hatchery produced fingerlings with better genetics is key to reducing diseases and improving performance with sustainable diets. Seabream production is based on hatchery produced fingerlings, but in yellowtail production, more than 90% wild catch fingerlings are used due to their abundance during spring. There is a great effort to increase the production of bluefin tuna in hatcheries. Some companies have already developed the technology and are commercially farming closed-cycle tuna.

On-farm support

Farm support is vital in an open environment production system, especially in net-cage production, where huge water temperature variations, dissolved oxygen and threats brought by currents like red tides and parasites should be monitored constantly. Alltech Japan keeps in close contact with farms conducting trials and discusses the dynamic of challenges during the year. Following up with visual documentation is very important for a better understanding of results by the farmer (Figure 4). This is especially true when the farmer is not aware of potential problems. Although many farms raise the same species, farm characteristics, location and feed utilisation make each farm, and its challenges, unique. Our technical team makes detailed profiles of farmers and can pick from a vast solutions portfolio to find each farm's best possible fit.

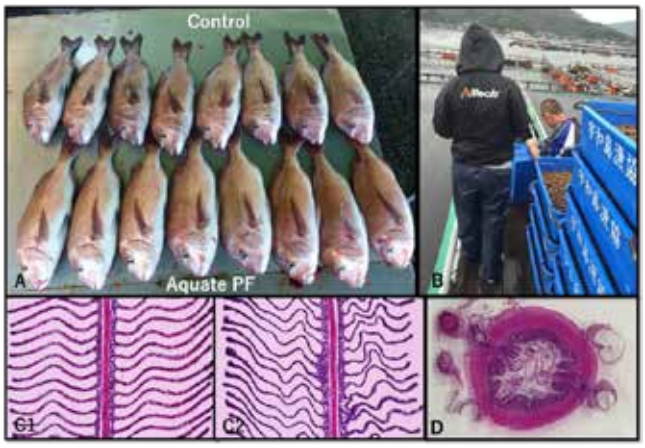

Figure 4. On-farm support. (A) Follow-up and trial sampling at farm - Aquate PF to improve colour and fin integrity due to increased antioxidant status of red seabream; (B) Farm visit, checking fish colour, condition and feed intake with farmer; (C1) Monitoring gill filament condition, normal gill; (C2) Gill affected by stress factors presenting inflammation signs; (D) Monitoring the fish intestine by histology showed parasite piercing the intestine wall.

Alltech also works in a research alliance with Kochi University to help contribute to the development of more sustainable feeds, aligning with company policy and its commitment to the UN Sustainable Development Goals to reduce the use of fishmeal and fish oil and industry waste (Figure 5). Recently, a specific trace mineral pack for marine fish was developed to help drastically reduce mineral waste from feed. Since net-cage systems discharge faeces directly into the environment, more highly digestible feeds will reduce this impact. This will also lead to a reduced risk of extra feeding while red tides bloom, common in spring and autumn.

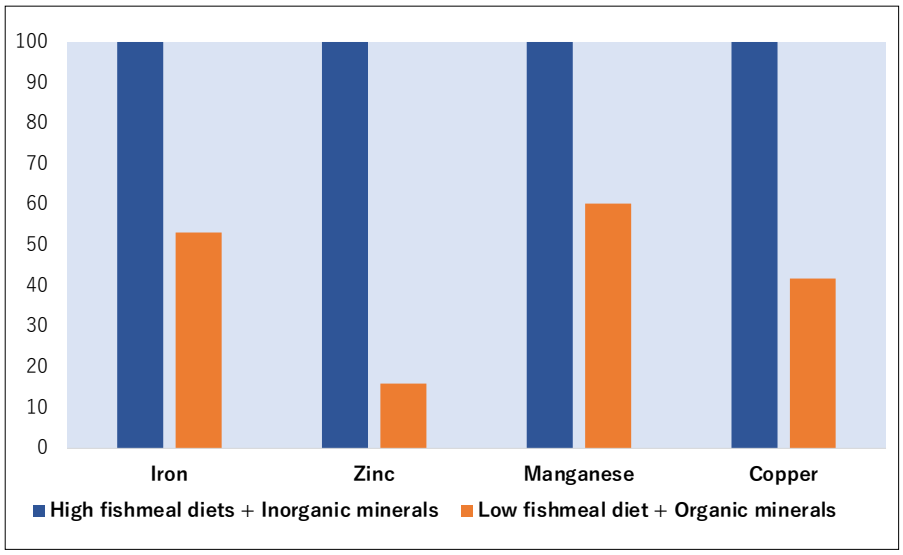

Figure 5. Mineral waste (%) of traditional feeds with high fishmeal inclusion and inorganic minerals against novel low-fishmeal diets with highly digestible organic mineral (Bioplex). Results from Kochi University-Alltech research alliance.

Although aquaculture in Japan is based on high-value species, it faces the same sustainability and disease challenges as other Asian countries. But the industry is evolving, moving toward sustainable practices due to govermental guidelines on feed and CO_2 emissions. Japan has an inverted population pyramid, where local consumption tends to decrease and local farming follows suit. However, since Japan is a big importer of seafood, the possible replacement of imported products with locally produced land-based aquaculture products could revert this trend. But for the moment, let us enjoy our Japanese food while talking about the future.

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A changing landscape for aquafeed production in Asia

Swings in aquafeed demand in 2020 and the first half of 2021 as farmers manage the pandemic in 2020 in various ways

By Zuridah Merican

As they were hit with drastic drops in prices in 2020, to survive, aqua farmers in many parts of Asia changed culture practices to match circumstances and market demand. In general, it was dire straits for fish farmers with rock bottom prices for some freshwater fish and others on the verge of production costs as consumers' purchasing power went down. In Cadiz, Philippines, milkfish farmers lamented that when fish prices went down to USD1.30/kg, they still needed large capital for feeds. A strategy was to shift to species in demand locally. In Taiwan and Malaysia, farmers changed from the culture of high value groupers to threadfin and snappers, respectively. It was common for farmers to keep fish, shrimp and crabs in ponds as there were no buyers. Steps taken included ad hoc reduction of feeding and harvesting only when there was an order. With extremely uncertain demand for their fish, farmers also reduced stocking density and skipped cycles. This situation continued into the first half of 2021.

However, for Asia's aquafeed producers, they not only had to accept these conditions which affected feed sales but at the same time, they had to find ways to support farmers by extending credit and help to market fish/shrimp. In Thailand, feedmillers found it difficult to lower feed prices to help farmers suffering from low ex-farm prices of tilapia. Fortunately, the possibility to export frozen tilapia to China via Laos helped farmers to increase volumes in 2021. With rising raw material costs of feeds, one business strategy is to implement a strict credit policy to maintain cash flow, which will impact feed sales in the short term but liquidity in the long term.

Since September 2020, feedmillers encountered another dilemma - the rising costs of feed raw materials. The impact of this and higher freight costs on the industry and subsequently on selling prices of shrimp and fish feeds is covered in an article in issue May/June 2021 (pages 28-34). The situation remains ominous as corn prices continue to rise - in June at 40% above the price in 2020 and are expected to stay high in 2021. Since March, prices of wheat and soybean meal dropped 2.5% and 7.1%, respectively (Nutrispices, June 2021). This follow-up article discusses some country specific developments, mainly in China, India, Vietnam and Indonesia, as well as some common issues.

China

In China, while e-commerce helped in marketing fish, emphasis was given to the production for local markets. USSEC's Zhou Enhua, Aquaculture Technical Manager, said, "We helped farmers to improve fish survival rate and reduce feed conversion ratio (FCR), as well as to encourage them to culture some high value fish such as snakehead and largemouth bass, instead of tilapia." In the marine fish segment, the industry saw a decline in the production of high value species such as the flounder and turbot since there was a lower demand from restaurants. The farming of the yellow croaker was less affected since almost 98% of the production was for the domestic market; there was lower production of the Japanese seabass which was mainly exported to Korea and Japan as a low-priced fish for institutional markets.

"The official figure for aquafeed production in China in 2020 was 21 million tonnes, which was a drop of 1.2% compared to 2019," said Houguo Xu, Yellow Sea Fisheries Research Institute at a Network for the Development of Agricultural Cooperatives in Asia and the Pacific (NEDAC) webinar in May 2021. Xu attributed the drop in feed demand to lower aquaculture production due to poor weather conditions and the COVID-19 pandemic.

"However, if we include farm made feeds and even the feeds produced by small companies which are not in the government list for data collection, the amount is 38 million tonnes," said Zhou. The volume of commercially produced marine fish feeds in 2020 was estimated at 1.5-2 million tonnes. While pompano, seabass and shrimp are 100% fed pelleted feeds, the large yellow croaker and seabream are fed a combination of trash fish and pelleted feeds. For the

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yellow croaker, 250,000 tonnes of pelleted feeds and an equal amount of trash fish are used. Puffer fish and eels are fed powder feeds. Recently, fermented feed is popular. The Chinese government is considering imposing a regulation to ban the direct use of trash fish.

Using a FCR of 1.5, total marine fish production could have declined to 1 million tonnes, a drastic 37% decline, when compared to the official data which showed that total marine fish production was 1.6 million tonnes in 2019. According to Xu, fish feeds can be divided into 83% pelleted and 17% extruded feeds, with the latter gaining popularity.

The volume of shrimp feeds (for culture in marine and freshwater ponds) was estimated at 1.2 million tonnes and less than 10% are extruded. "Shrimp feed is diverse in terms of price, quality and fishmeal content, depending on the culture model. Many feeds are developed for polyculture with fish," said Xu. In 2021, as shrimp imports could be affected by retention at ports because of compulsory tracking of the coronavirus in seafood, the industry expects increases in the local supply with the farming of black tiger shrimp in enclosed farms in South China and similarly for the vannamei shrimp in the north.

Improving environmental sustainability

Over the last few years, imposing regulations to minimise the environmental effects of cage culture has led to a reduction of cages in lakes. Zhou said that USSEC is promoting recirculation aquaculture systems (RAS) technology. "To replace cage culture in open waters, we want to promote IPRS (in pond raceway system) floating operations, such as in lakes which allows us to collect fish waste. This is part of the sustainable aquaculture package with new aqua technologies (IPRS and RAS) and SSAP (soy sustainability assurance protocol) feed."

Xu also mentioned some recent changes in China's aquafeed sector, such as the reduction of aquafeed companies, from 10,000 in 2010 to the current 3,000, producing an average of 5,500 tonnes per year (tpy). With strict environmental regulations, starting a new aquafeed company is no longer easy. Aquafeed production in China which increased during 2011 to 2018 began to decline from 2018 to 2020. "Some small feedmillers have competitive advantages in some specific areas and with some species, or some specific farming models. They are more flexible at marketing and feed specialisation."

In China, many of the leading players are public listed. Today, the seven top companies have a total market share of 38% compared to five companies with 30.3% in 2014. The number one aquafeed company Haid, produced 3.5 million tonnes in 2019 and had a 14% market share. Tongwei had 10% market share followed by 5% each for New Hope and Evergeen, and Da Bei Nong, Yuehai and CP had 2% each. The top companies have feed mills abroad such as in Vietnam, Indonesia, Malaysia and India.

"We helped farmers to improve fish survival rate and reduce feed conversion ratios (FCR), as well as to encourage them to culture some high value fish such as snakehead, largemouth bass, instead of tilapia."

- Zhou Enhua

India

The estimate for 2020 was less than 650,000 tonnes of shrimp which led to lower shrimp feed demand at 1-1.19 million tonnes, in contrast to 1.3 million tonnes of feeds for a shrimp production of 800,000 tonnes in 2019.. The pandemic disrupted broodstock supply due to the imposition of lockdowns; other adverse impacts include poor post larvae quality, diseases (mainly white faeces disease-WFD, and *Enterocytozoon hepatopenaei*-EHP), lower survival rates and farmers reducing stocking density from crop failures or opting for one crop and large sized shrimp. The second crop was affected by rains and changing weather conditions triggering white spot syndrome virus-WSSV outbreaks. The overall effect was cash flow problems along the supply chain to the feed miller, starting with shrimp buyers not paying farmers pending payments from processing plants.

"Although shrimp hatchery operators were better prepared in 2021, unseasonal rain affected pond preparations and therefore delayed stocking," said a feedmiller who expected stocking only in March for most regions. Nevertheless, with fast growing (10g in 45 days) and better quality post larvae, industry is expecting a 20-25% increase in production in 2021. Adding to production is a shift by freshwater fish farmers in Andhra Pradesh to culture vannamei shrimp at low density (20-40 PL/m^2 or only 20 PL/m^2 in winter). However, cyclone Yaas which affected West Bengal and Odisha in May is expected to bring down the 2021 production by 12,000 tonnes (thefishsite.com).

The worry is markets and prices - whether exporters to the Chinese market can meet requirements on inspections during this pandemic and survive the drop in ex-farm prices which recently fell to below the costs of production. Prices for large shrimp (30-33g) remained stable. In Andhra Pradesh, the government has fixed a ceiling price of INR200/kg (USD2.68/kg), giving farmers a small margin over their cost of production of INR180/kg (USD 2.41/kg) for size 100/kg.

Moving the freshwater fish feed segment

Out of the 1 million tonnes of fish feeds in 2020, industry estimated a feed ratio of 6.5:3.5 (rohu:pangasius). "Rohu feeds are mainly pelleted feeds while most pangasius feeds are floating pellets. Feedmillers encourage farmers using farm made feeds to slowly change to either pelleted or extruded feeds. However, in 2020, with difficulties in selling live fish, there has been a setback. Today, it is selling low cost feeds," said Ajay Baskar, Nutritionist at IFB Agro Industries. "In 2021, rohu feed prices increased to INR32/kg for pelleted and INR40/kg for extruded feeds. I would expect that prices will continue to rise with increases in feed ingredient prices ".

Dr Narashimha Rao, Managing Partner at Uno Feeds said, "In 2020 up to December, we saw small drops in fish prices, as farmers were hoping for better prices and refrained from harvesting. In fact, prices for pangasius in Andhra Pradesh were better than before the pandemic due to low supply. However, since early 2021, as more and more farmers started harvesting when they could not delay harvesting any longer, fish prices began to decline, and the outlook does not look good even in the coming months."

Rao is expecting better production volumes of snakehead fish. In 2020, only 1,500 tonnes were produced but he sees volumes to double in 2021. "Live fish has a 10%-20% premium but we have to watch how much volumes would be absorbed as production grows. The only constraint is how much the market can absorb and this pandemic is not helping. Tilapia is an ideal species for live transport and we are hoping to reposition tilapia as a good fish for consumers."

Vietnam

Despite the pandemic, industry players in Vietnam have been upbeat on demand for shrimp feed as farming continues unabated. Shrimp feed production was estimated at 900,000 tonnes with 70-80% comprising feeds for the vannamei shrimp. Dr Loc Tran, ShrimpVet Laboratory, Vietnam said the success was due to various culture strategies which depended largely on salinity; 30-50 PL/m^2 at low salinity and 50-100 PL/m^2 at medium salinity. Then, there is a multiphase model with stocking at 2,500 PL/m^2 at the first nursery stage, stocking 1g shrimp at 300-500/m^2 and then focusing on carrying capacity of 3-4kg/m^3 depending on salinity and dissolved oxygen and stocking at 60-70 pcs/m^2 to obtain final harvest of 50g shrimp. The progress can be attributed to efforts of Minh Phu, the largest shrimp producer in Vietnam as well as several feedmillers, in developing farming models such as the ones displayed at VietShrimp 2021 recently. These developments were reported in issue May/June 2021 (page 59) and in this issue (pages 8-11).

"Shrimp feed demand in Vietnam which increased slightly by 8-10%, was mainly due to the optimisation of farming models. Many have installed liners in ponds, increased the capacity of reservoirs and disinfected the water before pumping into ponds. We also think that when stocking density increased to 300-400 pcs/m^2, it effectively increased the yield and survival rate, and of course, shrimp feed consumption," said Jeff Jie-Cheng Chuang, General Manager, Sheng Long Bio-Tech International.

Optimistic on pangasius

Demand for fish feed dropped by 10-15% due to the low ex-farm fish prices which were below production cost, particularly for the pangasius. Chuang said that exports of the pangasius and snakehead fish to China were blocked which led farmers to either reduce stocking, lower the feeding rate or even abandon the crop. To make matters worse, feedmillers were forced to raise feed prices by 15-19% with rising costs of soybean meal and corn. In 2020, industry had estimated a lower volume of pangasius feeds at only 1.6 million tonnes.

At the end of May 2021, the export value of the pangasius increased by 14.7%, compared to the same period in 2020. The Vietnam Association of Seafood Exporters and Producers (VASEP) is upbeat and expects a 5% growth in 2021. However, China recently moved to tighten control over imported frozen seafood shipments, including pangasius fillets, which require certificates for food testing, quarantine, disinfection, origin and traceability, along with a negative coronavirus test, before entering the market. In April, the ex-farm fish price rose to VND21,000 - 22,000 (USD0.91- USD 0.96)/kg, an increase of about VND2,000 (USD0.087)/kg versus VND21,000/kg in May 2020.

For the tilapia and snakehead, feed production in 2020 was estimated at 300,000 and 250,000 tonnes, respectively. Exports of tilapia fillet is a governmental initiative and by 2030, the Ministry of Agriculture and Rural Development (MARD) expects a production of 400,000 tonnes with half the volume for export. Tilapia, mainly the red tilapia is popular in domestic markets.

Indonesia

The demand for shrimp feeds rose 8% to 383,800 tonnes on the back of higher shrimp exports at 15% higher than in 2019 (207,703 versus 239,000 tonnes in 2020), according to data from Indonesia's Directorate General of Marketing. In 2021, the feed industry is optimistic that demand will continue to increase.

The Indonesia Feed Industry Association or GPMT reported a total aquafeed production of 1.6 million tonnes in 2020, This was 8.4% lower than that reported for 2019. The total feeds for freshwater fish was 1.2 million tonnes, led by tilapia (230,000 tonnes), catfish (280,000 tonnes), carps (250,000 tonnes) and pangasius 195,000 tonnes. Feeds for the milkfish totalled 180,000 tonnes. With challenging marketing issues for live marine fish, in particular, the high value groupers, feedmillers are disappointed with the small volume of marine feeds (31,400 tonnes) utilised. Haris Muhtadi, Chairman, Aquafeed Division, Indonesia Feedmills Association and Associate Director, PT CJ Feed and Livestock Indonesia, and Dr Erwin Suwendi, Head of Nutrition and Feed Technology, Japfa Comfeed's PT Suri Tani Pemuka (STP) noted that their most significant challenge in 2020 was the decreasing demand for feed and the lower purchasing power of farmers.

Push for cheap freshwater fish feeds

This is a common mandate by governments in Asia, particularly for low value freshwater fish usually farmed by small scale farmers. Indonesia's Ministry of Marine Affairs and Fisheries (MMAF) has been supporting the production of cheap farm made feeds, using local raw materials as much as possible. Under this Gerpari program (Indonesia Aquafeeds Independence Movement), MMAF has been providing 200kg/hour pelleting machines, disk mills and raw materials (fishmeal, soybean meal, rice bran, tapioca, vitamin mix etc.) mainly to freshwater farmers (carps, *Clarias* and pangasius catfish, tilapia and milkfish). During the Indonesia conference on Aquafeeds (ICA 2020,) Dr Mimid Hamid, Director Aquafeeds at the Directorate General of Aquaculture said that such farm made feeds totalled 34,000 tonnes in 2020. Farm made feeds with 22-25% crude protein (CP) cost IDR5,000 versus IDR7,500 for commercial feeds. The FCR of farm made feeds was 1.7 versus 1.3 for commercial feeds.

Local fishmeal

MMAF is also looking at reducing dependence on imported raw materials, particularly in shrimp feeds where almost 80% of raw materials are imported. Mimid said that local fishmeal supply is 62,238 tpy which is 45% of 140,000 tpy required for aquafeed production. Data up to August 2020 showed that 71,292 tonnes of fishmeal and 160,805 tonnes of soybean meal were imported. In the short term, MMAF is targeting locally produced high quality fishmeal for use in shrimp feed production. In the long term, Indonesia aims to be an exporter of fishmeal.

Both Thailand and Vietnam have several Marin Trust certified producers. Thailand's fishmeal production of up to 65% CP was estimated at 320,000 tonnes in 2020 (USDA, 2020). Imports of both high and low quality fishmeal are taxed (15%), except for imports from countries with free trade agreements (FTA). Certified fishmeal has a 4-6% price premium. China's fishmeal production declined in 2020 because of a May-September moratorium on fishing. However, China has implemented tariff exemption for fishmeal imported from the US, where the Gulf menhaden sector is playing an increasing role in supplying the world with high quality fishmeal (Globefish, 2021).

Functional shrimp feeds

As shrimp production is challenged by WFD, EHP, acute hepatopancreatic necrosis disease (AHPND) and WSSV, there are shrimp feeds designed to combat disease via stimulation of immunity and enhancement in disease resistance. During the SAP (Society of Aquaculture Professionals) virtual seminar on "Overcoming the hardships in shrimp farming: lessons from India and elsewhere" in January 2021, panellists noted that there is no clear definition on what constitutes functional feeds. It was agreed that functional feeds must have better nutrition and minerals, better palatability and digestibility in addition to a particular health component to combat a particular disease.

The demand for functional or booster feeds for the nursery stage of culture is increasing. It is easier for farmers to accept the small increase in feed cost per biomass. Doubts persist on the cost efficiency of functional feeds for grow-out stages. A higher level of transparency and explanation on the mode of action of the feed as well as changes to farm management protocols are needed to overcome such doubts on functional feeds. "In this way, the farmer will not top dress with the same components and save costs," said Loc.

Price premiums for functional feeds range from 20-30%. At grow-out stages, farmers may use functional feeds together with regular feeds at various ratios, ranging from 10% to as high as 50%, or at worst, irregularly at 1-2 times/week depending on their financial situation. Many farmers would like to use functional feeds but there is an uncertainty on the final ex-farm prices and final cost of production.

Taiwan based Grobest has been marketing its functional feeds for the farming of vannamei and monodon shrimp to farms in China and Southeast Asia, since 2017 and 2018 in Malaysia and Indonesia, respectively. Other players are Growel Feeds in India and Sheng Long Bio-Tech in Vietnam. Several Indonesian feedmillers have functional feeds, including PT CJ Feed and Livestock Indonesia, which introduced its functional feeds in September 2020, PT Suri Tani Pemuka (STP) and PT Cargill. In Vietnam, ADM recently announced a functional feed with an immunostimulant specially tailored for shrimp rearing conditions in Asia (see pages 21-22).

"Some conditions in the new regulation may be seen as restricting flexibility with respect to innovation for new species."
- Narashimha Rao

Recent regulations

Vietnam has a new regulation on maximum allowable levels (MLs) of undesirable substances (including heavy metals) in animal feed and aqua feed ingredients. "This will restrict ingredients such as squid liver paste from being added into shrimp feed," said Dong Qiufen, Guangdong Nutriera Group, China. In Thailand, to prevent the entry of African swine fever into the country, the Department of Livestock has changed the regulations, making it difficult to import products from swine, such as meat and bone meal and blood meal.

In India, two new regulations affect the aquafeed industry. The Andhra Pradesh state government will regulate fish and shrimp production. Another regulation will bring all aquafeed production under the food safety regulations of India. Dr Arul Victor Suresh, Managing Director, United Research (Singapore) Pte Ltd, said, "Both will have wide ranging ramifications on the aquafeed business in terms of compliance and complexities." Rao added, "Some conditions in the new regulation may be seen as restricting flexibility with respect to innovation for new species. There is also an increase in tax rates for feed imports to 10%".

Updates on recent business activities

BioMar Tongwei (Wuxi) Biotech Co. Ltd became **China's** first feed mill with the Global Aquaculture Alliance's Best Aquaculture Practices (BAP) certification for trout and turbot. Marubeni Nisshin Feed Co., Ltd, announced the start of an aquafeed manufacturing and sales business in China. Marc Campet, ADM's Aquaculture Business Development Director said that the company is investing in manufacturing in China and will tailor its probiotic coated shrimp feed for the Chinese market (Feed Navigator.com). Tongwei and Tianbang will be forming a strategic alliance in July 2021, with the latter transferring all aquafeed assets to Tongwei.

In **Vietnam**, BioMar and Viet-Uc signed an agreement in March 2021, for the former to acquire the majority of the latter's feed business. By the end of 2021, global pangasius leader, Vinh Hoan's new aquafeed factory with a 350,000 tpy production capacity in Dong Thap, will start operations. In November 2020, Sheng Long Bio-Tech International had a ground breaking ceremony for the construction of a new 150,000 tpy factory with three fish feed production lines in Hoa Phu Industrial Park, Vinh Long province. Production is scheduled for September 2021.

In **Indonesia**, industry players reported more imports of shrimp feeds from regional producers. China's Haid set up its first feed mill in East Jawa. In 2020, STP built a new R&D centre in Banyuwangi for freshwater and marine fish culture to produce fry and fingerlings. It also has a JV with Hendrix Genetics (PT Kona Bay Indonesia) for a broodstock multiplication centre. The long-term aim is to be a total solution aquaculture company in Asia and in line with Indonesia's vision to grow its domestic shrimp production.

PT Cargill Aqua Nutrition began production of its first shrimp feed at the plant in Serang, Banten. In 2021, it began to produce the starter feed at the same plant. By the end of 2021, PT CJ Feeds and Livestock will have a new plant with two lines of extruded fish feeds in Banten and a research farm for shrimp R&D. Future plans include a shrimp hatchery.

In November 2020, Thang Long Group (as Sheng Long Bio-Tech International is known in Vietnam) held the ground breaking ceremony for the construction of an aquafeed factory in Hoa Phu Industrial Park, Vinh Long Province. The group is planning for 1 million tonnes production by 2026 with additions of new feedmills in northern Vietnam and Malaysia.

Improvement in growth and health performance of juvenile striped catfish with the supplementation of functional protein hydrolysates

This adds to the evidence of robustness obtained with dietary supplementation of such ingredients previously demonstrated with marine shrimp and fish.

By Fabio Soller, Paul Seguin, Mikael Herault, Vincent Fournier, Nguyen Van Trieu and Tran Thi Tuyet Hoa

The latest aquaculture production statistics published for 2018 (FAO, 2020) showed that the global supply of the striped catfish (*Pangasianodon hypophthalmus*) was around 2.3 million tonnes. Vietnam is the largest supplier of this fish with a projected harvest of 1.56 million tonnes in 2021 (Ha, 2021). Since 2020, the impact of COVID-19 weakened the demand of this fish from its largest markets, US, Europe and China – keeping the per kg farm gate prices heavily depressed, ranging from VND17,500 (USD0.76) to VND19,000 (USD0.82). This reduction in demand had producers reportedly losing around VND3,500 (USD0.15) to VND5,000 (USD0.22) per kg of fish (FAO, 2021).

Throughout the striped catfish production cycle, the nursery phase in earthen ponds, where day-old larvae are reared to 30g animals, is the most difficult and crucial phase for farmers, with mortality rates surpassing 90% from pathogenic infections brought in from the hatchery, from starvation due to overstocking, and from poor feed quality and feed management (Alban Caratis, pers. comm., April 2, 2021).

Functional hydrolysates from Diana Aqua's ACTIPAL range are designed to enhance feed palatability, feed efficiency and the overall health status of animals through bioactive peptides. The synergic effect of water soluble free amino acids, short peptide chains, bioactive peptides, and acidifiers brings out the optimal flavour of the feed, stimulating the taste buds and modulating metabolic pathways of the aquatic animals. This stimulation triggers a series of physiological and endocrinal responses, preparing the digestive system to properly digest the feed, modulate the microbiota in the gut, and enhance the immune system.

Diana Aqua's tuna and poultry hydrolysates are manufactured from fresh by-products (chilled viscera), from carefully selected processing plants and are well-characterised functional ingredients. The raw materials are inspected for freshness, temperature and any bad odour on arrival before production. The viscera are processed according to the state-of-the-art hydrolysis process developed by Diana Aqua. Specially designed processing equipment are utilised to reach the highest yield of bioactive peptides and a standardised final product. In the same way, our hydrolysis process is the result of many years of research leading to the highest performing peptide profiles, combining the precise levels and balance of free amino acids, di and tri-peptides and bioactive peptides of higher molecular weights, acidifiers, and antioxidants (Seguin and Martineau, 2019).

The benefits have been researched, tested, and proven in many species, such as, the Asian seabass *Lates calcarifer*, red seabream *Pagrus major*, European seabass *Dicentrarchus labrax* juvenile and larvae (Gisbert et al., 2018; Leduc et al., 2018a; Leduc et al., 2018b), Atlantic salmon *Salmo salar* (Seguin et al., 2020), Nile tilapia *Oreochromis niloticus*, and Pacific white shrimp *Penaeus vannamei* (Seguin et al., 2018; Soller et al., 2019; Herault et al., 2020).

In this article, we will relate the results of the latest nutrition research trial, followed by health marker analysis, and disease challenge, conducted at Can Tho University, Vietnam, in juvenile striped catfish to evaluate the benefits of functional hydrolysates to this valuable industry.

Experimental setup

Starting in August 2020, a 45-day nutrition research trial was conducted in 2m^3 concrete tanks with 1.36 ± 0.09g juvenile catfish stocked at 300 fish/m^3, with four replicates per treatment. The nutrition trial was followed by blood sampling for health marker analysis and a 14-day disease challenge – 12 fish/replicate – with *Edwardsiella ictaluri* injected intraperitoneally at a concentration of 1.2x10^3 CFU/mL. *E. ictaluri* is responsible for one of the most common diseases in this species, known as bacillary necrosis of pangasius (BNP).

Juvenile striped catfish were fed four times daily with a 40% crude protein experimental diet for 2 weeks, then three times daily with a 35% crude protein experimental diet for the remaining of the trial. The test diets were prepared with a commercial feed (control diet) top coated with 2% of ACTIPAL liquid functional hydrolysates, which were manufactured from tuna or poultry co-products as described in Table 1.

Treatments	Test ingredients
Cf (Commercial feed) – Control diet	
CfTH	2% tuna hydrolysate – ActiTuna
CfPH	2% poultry hydrolysate – ActiPoultry
CfTHL	2% tuna hydrolysate L – ActiTuna L

Table 1. Dietary treatments assessed in trial, with test ingredients inclusion levels and products commercial names.

The test diets were manually top coated using a spray gun with 1.2mm nozzle inside a revolving cement mixer. The full amount of the products was sprayed for a minimum of 60 seconds and the mixing was done for 5 minutes. All three products used to prepare the test diets had slight variances in composition, due to the raw material origin and manufacturing process (Figure 1). These distinctions provide each of the products with exclusive physical and biological characteristics.

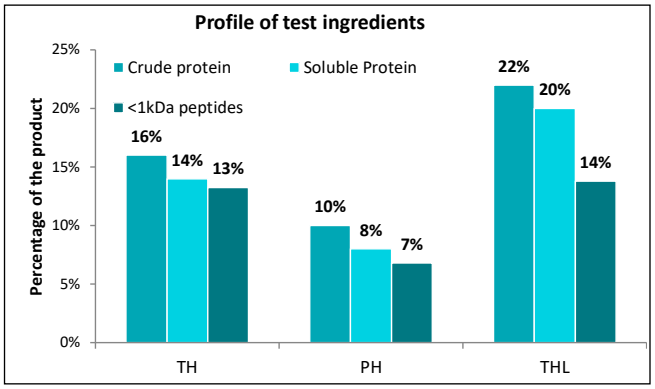

Figure 1. Composition of the liquid functional hydrolysates tested during the research trial. Graph displays amounts of crude protein, soluble protein, and peptides smaller than 1k Dalton, as percentage of the product. TH = Tuna Hydrolysate, PH = Poultry Hydrolysate, THL = Tuna Hydrolysate L.

Better growth and eFCR

The survival rates seen during this nutrition trial were excellent, with the lowest at 98.5% seen in the control treatment. This validates the fundamental concept that stocking the correct number of animals and following closely water quality and feed management are crucial for any aquaculture enterprise.

The striped catfish had very good growth results, with economical feed conversion ratios (eFCR) between 0.53 and 0.66 (Figure 2), which were well above expectations. Catfish fed the commercial feed supplemented with 2% of

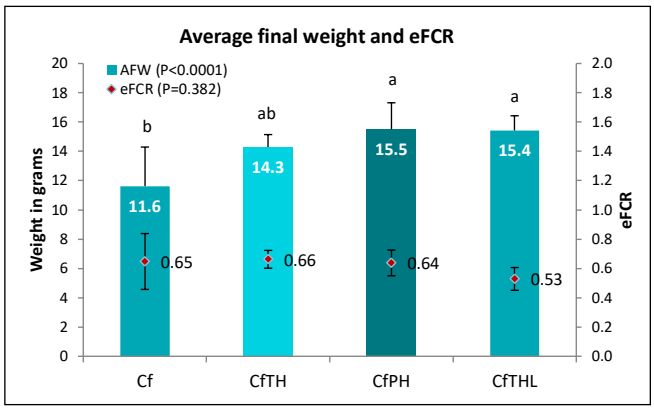

Figure 2. Average final weight and economical feed conversion ratio (eFCR) at the end of the growth research trial. Cf = Commercial feed (control diet), CfTH = Control feed with 2% Tuna Hydrolysate, CfPH = Control feed with 2% Poultry Hydrolysate, CfTHL = Control feed with 2% Tuna Hydrolysate L. Letters indicate statistical differences among treatments ($P<0.05$).

any of the hydrolysates presented 23 to 34% higher growth than the non-supplemented commercial feed, with groups CfPH and CfTHL providing statistically significantly higher growth performance than the regular commercial feed. These good performances were the results of a better feed intake resulting from the application of protein hydrolysate by top-coating which stimulated fish feeding behaviour, combined with better feed digestibility linked to the highly bioavailable peptides and acidifiers supplied by 2% of functional hydrolysates. In the nursing stage, survival rate of striped catfish larvae is dependent on food (Phan et al., 2009) and feeding frequency (Slembrouck et al., 2009).

Improved immune system

A similar trend was seen on the health of the animals. The total erythrocyte and leukocyte counts, red and white blood cell counts, along with the lysozyme activity, were strongly stimulated by all the functional hydrolysates (Figures 3-5) strengthening the immune system of the striped catfish in the research trial.

From the analyses of these immune system indicators, the CfPH group displayed the strongest immune system modulation, followed closely by CfTH and CfTHL groups. Moreover, this immune system strengthening was directly correlated with the survival rate of the catfish during the disease challenge (Figure 6). Again, CfPH, CfTH and CfTHL outperformed the group fed the commercial feed.

These growth and health results confirmed the good performance already documented by Diana Aqua in many different aquaculture species (from marine fish to shrimp), fed either commercial diets or optimised diets (low fishmeal) supplemented with functional hydrolysates of different origins. These are evidence of the effectiveness of dietary supplementation with such ingredients. It is worth noting that the performance of functional hydrolysates is closely related to their peptide profile, which is a consequence of the type of raw materials used and the hydrolysis process. Peptide profiles of functional hydrolysates will drive their final performance and hydrolysis process standardisation will be essential to guarantee product performance consistency from batch to batch.

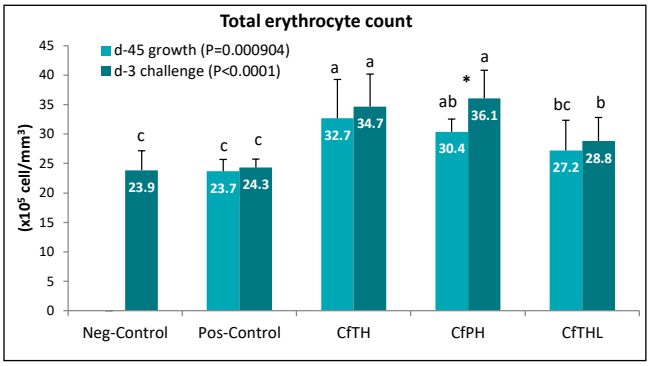

Figure 3. Total erythrocyte count at end of growth trial (d-45 growth) and 3 days into the disease challenge (d-3 challenge). Letters indicate statistical differences among treatments and the asterisk indicates difference in treatment between sample times ($P<0.05$).

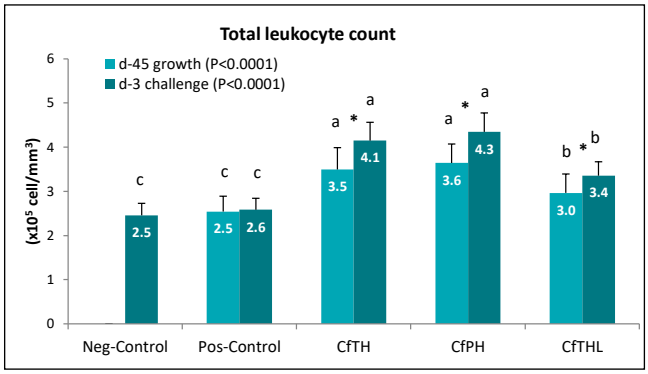

Figure 4. Total leukocyte count at end of growth trial (d-45 growth) and 3 days into the disease challenge (d-3 challenge). Letters indicate statistical differences among treatments and the asterisks indicate difference in treatment between sample times ($P<0.05$).

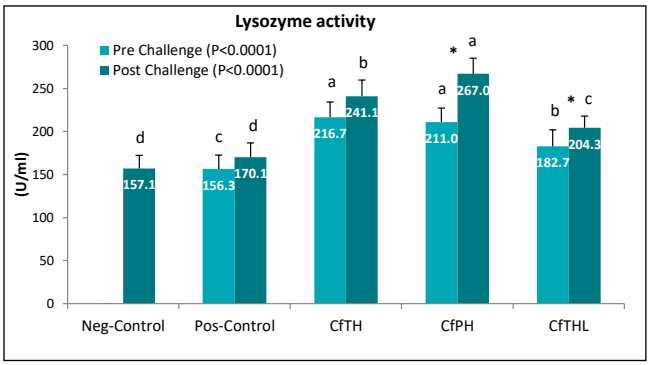

Figure 5. Blood plasma lysozyme activity, before and after disease challenge. Letters indicate statistical differences among treatments and the asterisks indicate difference in treatment between sample times ($P<0.05$).

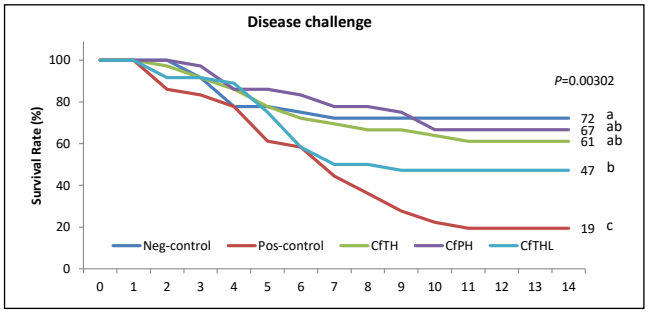

Figure 6. Survival rate (%) of fish after growth trial, during 14-days disease challenge with *Edwardsiela ictaluri*. Letters indicate statistical difference among treatments ($P<0.05$).

Conclusions

Functional hydrolysates provide more than just flavour to aquafeeds; they also stimulate the physiology of the animals by increasing feed intake, feed digestibility, and boosting the immune system, as seen from this research trial. The combination of bioactive molecules, acidification and the feed formulation itself, act synergistically to provide the animals all the nutrients and health support needed to optimally perform during production.

The results showed that the three different ACTIPAL functional hydrolysates tested (having tuna or poultry as raw material and with different levels of soluble protein and small peptides), gave positive benefits to all the parameters measured for growth, survival and health in the striped catfish during the nursery phase. These results showed that the amount of protein in the functional hydrolysate was not responsible for the animals' improved performance; instead, the improvement in performance is a function of the animal's own physiology and how it synergizes with the bioactive molecules coming from the functional hydrolysates.

Furthermore, from the disease challenge results with a common pathogen, it is evident that the functional hydrolysates brought advantages to this large industry when added in small amounts to aquafeed. The return on investment can be seen at fish harvest, not only for the producer but also for the environment.

The functional hydrolysates produced by Diana Aqua are unique products that cannot be replaced by other products such as fish soluble or fish silage. Dietary supplementation with such functional ingredients will help to offset deviations in raw material quality and will improve and standardise feed quality, feed and fish performance from batch to batch.

In summary, by using these functional hydrolysates, during the nursery stage the farmer can get 23 to 34% better growth, up to 22% better eFCR, and 60 to 74% better survival by only investing a few USD/kg of feed. These benefits will also allow the farmer to cut costs by purchasing fewer fingerlings, and to reduce feed wastes and chemical treatments. All these savings will promptly return the investment back to the farmers' pockets.

References

FAO. (2020). The State of World Fisheries and Aquaculture 2020. FAO. https://doi.org/10.4060/ca9229en

FAO. (2021). Pangasius prices plunge as pandemic impact lingers on. GLOBEFISH - Information and Analysis on World Fish Trade. http://www.fao.org/in-action/globefish/market-reports/resource-detail/en/c/1263847/

Gisbert, E., Fournier, V., Solovyev, M., Skalli, A., & Andree, K. B. (2018). Diets containing shrimp protein hydrolysates provided protection to European sea bass (*Dicentrarchus labrax*) affected by a *Vibrio pelagius* natural infection outbreak. Aquaculture, 495(May), 136–143. https://doi.org/10.1016/j.aquaculture.2018.04.051

Ha, T. (2021). Pangasius prices in the Mekong Delta recovered since the fourth quarter of 2020. Vietnam Association of Seafood Exporters and Producers. http://seafood.vasep.com.vn/key-seafood-sectors/pangasius/news/pangasius-prices-in-the-mekong-delta-recovered-since-the-fourth-quarter-of-2020-21030.html

Herault, M., Gunathilaka, B. E., & Lee, K.-J. (2020). Functional hydrolysates increase shrimp feed consistency, sustainability and performance. AQUA Culture Asia Pacific, July/August, 41–45.

Leduc, A., Hervy, M., Rangama, J., Delépée, R., Fournier, V., & Henry, J. (2018). Shrimp by-product hydrolysate induces intestinal myotropic activity in European seabass (*Dicentrarchus labrax*). Aquaculture, 497(August), 380–388. https://doi.org/10.1016/j.aquaculture.2018.08.009

Leduc, A., Zatylny-Gaudin, C., Robert, M., Corre, E., Le Corguille, G., Castel, H., Lefevre-Scelles, A., Fournier, V., Gisbert, E., Andree, K. B., & Henry, J. (2018). Dietary aquaculture by-product hydrolysates : impact on the transcriptomic response of the intestinal mucosa of European seabass (*Dicentrarchus labrax*) fed low fish meal diets. BMC Genomics, 19(396), 1–20. https://doi.org/10.1186/s12864-018-4780-0

Phan, L.T., Bui, T.M., Nguyen, T.T.T., Gooley, G.J., Ingram, B.A., Nguyen, H.V., Nguyen, P.V., De Silva, S.S., 2009. Current status of farming practices of striped catfish, *Pangasianodon hypophthalmus* in the Mekong Delta, Vietnam. Aquaculture 296, 227–236.

Slembrouck, J., Baras, E., Subagja, J., Hung, L.T., Legendre, M., 2009. Survival, growth and food conversion of cultured larvae of *Pangasianodon hypophthalmus*, depending on feeding level, prey density and fish density. Aquaculture 294 (1–2), 52–59

Seguin, P., Fournier, V., Herault, M., & Soller, F. (2020). A new generation of feed palatability enhancers designed for carnivorous fish species. AQUA Culture Asia Pacific, November/December, 50–53.

Seguin, P., Herault, M., Lee, K., & Utairungsee, T. (2018). Functional hydrolysates: sustainable ingredients to support development of the next generation of aquafeeds. AQUA Culture Asia Pacific, January/February, 32–35.

Seguin, P., & Martineau, C. (2019). Alternative ingredients to satisfy farmers' perceptions towards feed quality and performance. AQUA Culture Asia Pacific Magazine, September-October, 42–45.

Soller, F., Herault, M., & Fournier, V. (2019). A focus on shrimp hydrolysate. AQUA Culture Asia Pacific, January-February, 25–28.






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Treating monogenean infections in striped catfish

A suitable dose and regime of a praziquantel suspension can improve survival rate of pangasius and reduce infestations caused by monogeneans.

By Phuong Do, Phuoc Nguyen, Dung Tu, Philippe Mahl and Hoang Phan

Production of freshwater species, such as catfish, has increased dramatically in recent years and has contributed to the economic growth of many countries. Vietnam is the world's largest producer of the striped catfish (*Pangasianodon hypophthalmus*) with approximately 1.58 million tonnes of fish exported for a value of about USD 2 billion in 2019 (VASEP, 2020). In order to increase production and to be profitable, intensive farming of striped catfish has been gaining in importance; however, this comes this comes with a risk of increased diseases caused by pathogens like bacteria, parasites and fungi.

Monogeneans (such as *Dactylogyrus* sp. and *Gyrodactylus* sp.) are larviparous or oviparous ectoparasites with a direct life cycle and are commonly found on catfish skins and gill arches. They can easily be transferred from host to host in aquatic environments. Monogeneans can cause suffocation leading to death of their hosts and may induce high levels of mortality (>80%) in fish with high parasite burdens (Thoney and Hargis, 1991). In aquaculture systems, high accumulation of monogenean parasites can also cause tissue damage on fish which then leads to secondary microbial infections (Zhang et al., 2013).

Since 1986, formalin has been approved by the US Food and Drug Administration (FDA) for use in aquaculture for the treatment of finfish against external parasitic infections (Howe et al., 1995). However, it still carries some issues of practical concern (Reed et al., 2012). Alternatively, praziquantel is one of the most common agents used for anti-flatworm activity, as it has been successfully used to treat infestations of several species of monogeneans on various fishes (Barber, 2003; Partridge et al., 2014; Sharp et al., 2004; Kim and Park, 1998). In addition, a very low level of toxicity of praziquantel has been shown on fish (Björklund and Bylund, 1987; Dhakal et al., 2015). Therefore, the aim of this study is to assess the ability (in terms of dose and duration of protection) of formalin and praziquantel (in a suspension of PraziSol, manufactured by Virbac Vietnam) for treating monogenean infections on striped catfish.

Materials and methods

Two batches of striped catfish (*P. hypophthalmus*) naturally infected by parasites were used for this study, which consisted of two parts - one at the wet laboratory at the College of Aquaculture and Fisheries, Can Tho University, Vietnam and the other at the Laboratory of Fish Pathology, Hue University of Agriculture and Forestry, Vietnam. Both used fish of ~6g (±0.5) obtained from the Mekong Delta and ~10g (±0.3) obtained from the Provincial Breeding Centre, Cu Chanh commune, Thua Thien Hue province. Fish were acclimated for 2 weeks and the presence of monogeneans on gills was confirmed by examining 20 fish randomly before starting the experiments. The study was conducted when the infestation rate on catfish reached 100% and the infestation intensity reached 5-10 parasites per gill.

Treatments and experimental set-up

Seven treatments in total were performed in this study - the first part with four treatments and the second part with three treatments. The experimental design is described in Figure 1. All treatments were continuously aerated and water parameters were examined during the study to avoid accumulation of toxic substances (resolved by water exchange of a maximum of 30%).

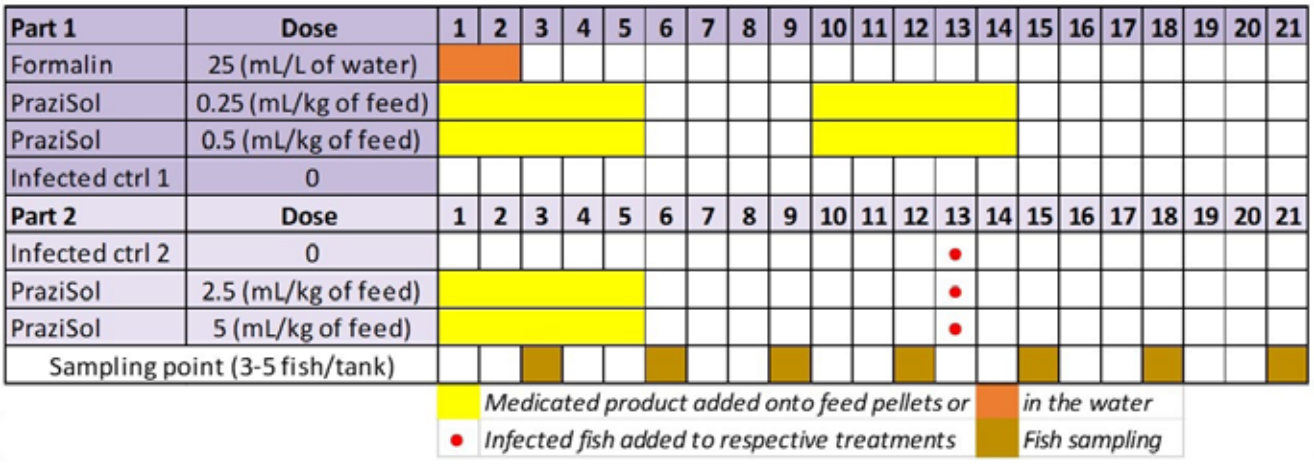

Figure 1. Summary of experimental design of the study on striped catfish infected by monogeneans.

In the first part, 80 fish were placed into each tank of 250L capacity (with 200L of freshwater). Four treatments were performed, i.e. infected control 1, formalin (a formaldehyde solution; applied at 25mL/L of water for experimental days 1-2 via immersion), and treatments with the praziquantel suspension, containing either 0.25 or 0.5 mL/kg of feed. Fish in these praziquantel treatments were fed this feed over days 1-5, then repeatedly on days 10-14. Normal feed was used in the control and formalin treatments. Each treatment was replicated three times. During part one of the study, three fish/tank were sampled for rate and intensity of parasitic infestation every 3 days, starting from day 3 to day 21.

In the second part, three treatments, i.e. infected control 2, treatments with the praziquantel suspension applied at either 2.5 or 5mL/kg of feed (for days 1-5) were carried out. Fifty fish were placed into each 250L plastic tank (with 200L of freshwater) with each treatment replicated three times. A commercial feed was used for the rest of the study duration. On day 13 of this study, five infected fish were added to each tank of these three treatments, and they were marked by fin-clipping. Samplings of 5 fish/tank were done at the same interval of 3 days for parasitic inspections as in the first part of the study.

For the medicated feed used in the study, the various concentrations of the praziquantel suspension added to commercial pellets were 0.25, 0.5, 2.5 and 5mL/kg of feed, respectively. The different concentrations of the product were prepared/diluted in sterile water (up to 20mL/kg of feed), then each solution was homogenously sprayed onto feeds. Final top coating was done with squid oil at a 2% ratio and feed pellets were then thoroughly mixed until dry and kept in a cool place for use during the study. Feeding was done twice a day for all treatments, and total feed intake was recorded for each treatment.

Mortality, parasitic inspection and data analysis

At all sampling points, i.e. days 3, 6, 9, 12, 15, 18 and 21, ectoparasites were detected in fish samples of skin mucus and gills; their prevalence (the total number of infected cases in the sampling population) and intensity (the number of infectious parasites in a sample) were determined. Dead fish were quickly removed from the experimental units twice a day. At the end of the study duration, the number of fish remaining in each treatment was recorded for statistical analysis.

Data were collected for one-way analysis of variance (ANOVA) and Tukey's post-hoc test to identify differences among treatments. All analyses were performed using Minitab version 18.

Water quality parameters

During the experiments, the water quality parameters were maintained at optimal ranges for the growth of striped catfish. Water temperature was in the range of 29.8-29.9°C, pH of water varied from 7.5 to 7.7, and dissolved oxygen varied in the range of 4.7-4.9mg/L. Ammonia and nitrite contents were maintained low during the study, at ~1.5 and ~0.82mg/L, respectively.

Feed intake and fish mortality

Results of mortality rate and feed intake in all treatments of the study are presented in Table 1, and examples of clinical signs of infected fish are shown in Figure 2. Microscopic observations of monogeneans on gill arch samples are shown in Figure 3. There were significant differences in the mortality between treated groups and the controls ($p<0.05$). The formalin immersion treatment brought about a negative impact on fish survival (i.e. high mortality rates) and feed intake, which may be a result of toxicity of formalin on fish growth and physiology (Song and Kou, 1981).

During part one, repeated application of the praziquantel suspension at 0.5mL/kg of feed showed a better survival rate of catfish with parasitic infection. For part two, both treated groups at 2.5mL and 5mL of PraziSol per kg of feed showed the best survival rate (~95%) by the end of the experimental duration. Overall, there were no indications that praziquantel affect feeding behaviour and feed intake of striped catfish during the study.

Treatment	Mortality (%)	Average feed intake (g)
Formalin 25mL	29.52 ± 2.2[a]	175.0 ± 33.8
PraziSol 0.25mL	37.14 ± 7.6[a]	197.6 ± 85.4
PraziSol 0.5mL	12.38 ± 1.6[b]	222.0 ± 36.7
Infected ctrl 1	31.43 ± 2.9[a]	194.2 ± 34.6
Infected ctrl 2	28.00 ± 4.0[a]	345.3 ± 12.3
PraziSol 2.5mL	5.45 ± 1.8[b]	456.5 ± 3.2
PraziSol 5mL	4.85 ± 1.8[b]	457.7 ± 8.5

Values with different superscript characters in the same column are statistically different ($P<0.05$).

Table 1. Fish mortality and feed intake of different treatments"

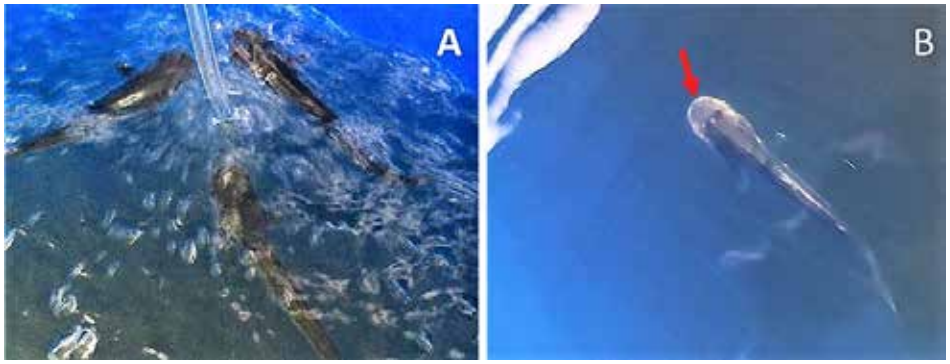

Figure 2. Clinical signs of striped catfish infected by parasites, e.g. (A) fish gathering near the aeration system, and (B) plenty of mucus appearing on skin and gills of infected fish.

Parasitic prevalence and intensity on fish during the study

Results on the prevalence of monogenean infections and intensity during the study duration are presented in Table 2 and Table 3, respectively. The intensity was calculated based on means of triplicates of each treatment. The initial infection was with 7.6 ± 0.0 pc/gill arch (parasites per gill arch) at a 100% rate for the part one study, while it was with 10.4 ± 1.7 pc/gill arch at a 100% rate for the part two study.

For both parts of the study, the results show that parasitic infection on fish decreased from day 3 to day 6, which indicated a good effect of PraziSol supplemented in feed, compared to unchanged or increased parasitic prevalence/intensity in the controls. The higher dose of the praziquantel suspension (i.e. 5mL/kg of feed) introduced a significantly better efficacy in treating monogeneans in terms of both prevalence and intensity, and the efficacy could last until the end of the experiment (even with a possible co-habitation infection introduced on day 13).

Prevalence of 100% at day 0	Experimental days						
Treatment	Day 3	Day 6	Day 9	Day 12	Day 15	Day 18	Day 21
Formalin 25	100 ± 0.0	88.9 ± 19.2^{a}	100 ± 0.0^{a}	55.6 ± 50.9^{a}	33.3 ± 33.3^{a}	88.9 ± 19.2^{a}	33.3 ± 33.3^{b}
PraziSol 0.25	100 ± 0.0	66.7 ± 0.0^{b}	100 ± 0.0^{a}	100 ± 0.0^{a}	77.8 ± 33.3^{a}	66.7 ± 33.3^{a}	100 ± 0.0^{a}
PraziSol 0.5	100 ± 0.0	66.7 ± 0.0^{b}	88.9 ± 19.2^{a}	88.9 ± 19.2^{a}	88.9 ± 19.2^{a}	88.9 ± 19.2^{a}	66.7 ± 33.3^{ab}
Infected ctrl 1	100 ± 0.0	100 ± 0.0^{a}	100 ± 0.0^{a}	88.9 ± 19.2^{a}	77.8 ± 38.5^{a}	77.8 ± 38.5^{a}	77.8 ± 38.5^{ab}
Infected ctrl 2	100 ± 0.0	100 ± 0.0^{a}	100 ± 0.0^{a}	100 ± 0.0^{a}	100 ± 0.0^{a}	100 ± 0.0^{a}	100 ± 0.0^{a}
PraziSol 2.5	100 ± 0.0	80 ± 0.0a^{b}	100 ± 0.0^{a}	100 ± 0.0^{a}	100 ± 0.0^{a}	100 ± 0.0^{a}	100 ± 0.0^{a}
PraziSol 5	100 ± 0.0	60 ± 0.0^{b}	60 ± 0.0^{b}	60 ± 0.0^{a}	80 ± 0.0^{a}	80 ± 0.0^{a}	100 ± 0.0^{a}

Values with different superscript characters in the same column are statistically different (P<0.05).

Table 2. Prevalence of monogenean-infected fish sampled from all treatments during the study.

Intensity at day 0: 7.6-10.4 pc/gill arch	Experimental days						
Treatment	Day 3	Day 6	Day 9	Day 12	Day 15	Day 18	Day 21
Formalin 25	3.9 ± 0.8^{a}	5.2 ± 3.4^{b}	8.9 ± 7.3^{b}	1.3 ± 1.3^{d}	1.2 ± 1.6^{c}	5.6 ± 1.6^{b}	1.7 ± 2.6^{c}
PraziSol 0.25	10.3 ± 7.6^{a}	9.6 ± 7.2^{b}	4.4 ± 2.4^{b}	9.6 ± 2.3^{bc}	12.2 ± 5.4^{b}	9.8 ± 8.9^{b}	15.8 ± 4.4^{b}
PraziSol 0.5	6.2 ± 3.2^{a}	2.6 ± 1.4^{b}	2.2 ± 0.4^{b}	6.3 ± 4.3^{bcd}	4.2 ± 3.0^{c}	14.1 ± 8.1^{b}	5.3 ± 4.5^{bc}
Infected ctrl 1	15.0 ± 9.2^{a}	31.2 ± 14.3^{a}	10.2 ± 7.6^{b}	12.3 ± 4.8^{b}	4.0 ± 2.1^{c}	9.6 ± 8.4^{b}	11.3 ± 8.6^{bc}
Infected ctrl 2	14.6 ± 2.2^{a}	19.4 ± 4.6^{ab}	27.6 ± 5.4^{a}	36.6 ± 4.4^{a}	50.4 ± 5.2^{a}	96.0 ± 7.1^{a}	112.0 ± 8.7^{a}
PraziSol 2.5	8.6 ± 0.6^{a}	3.8 ± 2.3^{b}	4.7 ± 0.6^{b}	4.8 ± 0.5^{cd}	5.2 ± 0.8^{bc}	5.8 ± 0.8^{b}	7.0 ± 1.0^{bc}
PraziSol 5	5.2 ± 0.8^{a}	2.0 ±.9^{b}	2.0 ± 1.9^{b}	2.0 ± 1.9^{d}	3.6 ± 2.2^{c}	2.8 ± 1.6^{b}	3.8 ± 0.8^{c}

Values with different superscript characters in the same column are statistically different (P<0.05).

Table 3. Intensity of monogeneans on gill arches of infected fish sampled from all treatments during the study. The numbers 7.6 ± 0.0 and 10.4 ± 1.7 pc/gill arch were initially recorded for parasitic infection rate for the part one and part two studies, respectively.

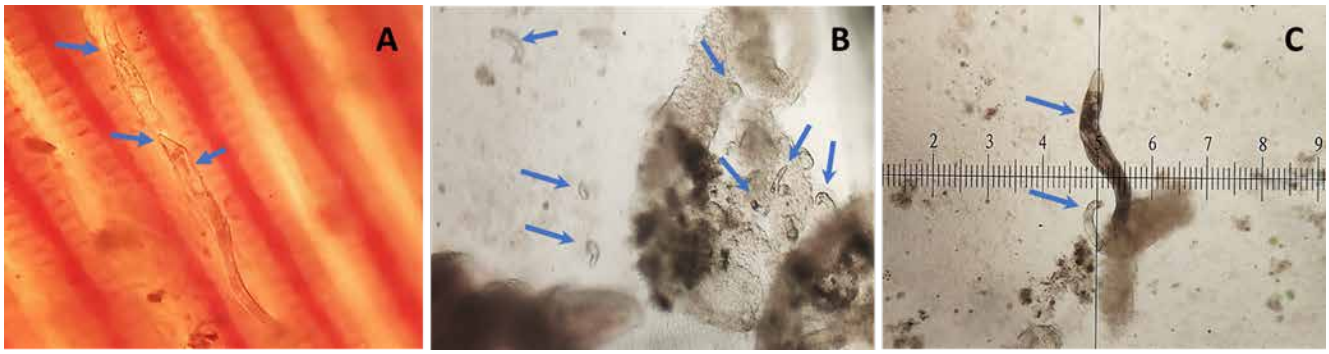

Figure 3. Microscopic sections of (A) *Dactylogyrus* sp. infecting striped catfish gill arches (arrow), (B) Monogeneans at larval stage, and (C) different stages of monogenean in a scope of view.

With regards to parasitic prevalence, significant differences among treatments were recorded on days 6, 9 and 21 ($p<0.05$), whereas there were insignificant variations on other sampling days 3, 12, 15 and 18. The formalin treatment did not show significant efficacy on parasitic prevalence in comparison with infected control 1.

After the first PraziSol application over days 1-5, parasitic prevalence of various treatments was reduced significantly, and the treatment at dose of 5mL/kg of feed remained significant, and parasitic prevalence decreased until day 9. With some water exchanges done after day 9 due to water getting dirty, the part one study had some variations in parasitic prevalence percentages, but the variations were insignificant ($P>0.05$). During and after the second PraziSol application (days 10-14) at lower doses, there were insignificant reductions of parasites on fish.

For parasitic intensity, there were significant differences among the treatments throughout the sampling days (except day 3). For the treated groups of the part one study, even with some water exchanges and second round of treatment application during the later phase of the experiment, limited efficacies were obtained in comparison with control 1. There was also little efficacy of formalin after its immersion duration (sampling on day 3). Whereas, for the treated groups of the part two study, significant differences were obtained at all sampling days following the 5-day product application of higher doses of PraziSol (2.5 and 5mL/kg of feed) compared to the infected control 2. The data of these higher dose groups also showed a lasting effect until the end of the test, when the second infection on day 13 showed an increase in the parasitic intensity at the same magnitude as the control.

For immersion treatment, dilute formalin preparations are recommended for monogeneans such as *Cleidodiscus*, *Dactylogyrus* and *Gyrodactylus* (FDA, 2016). However, formalin cannot be added to certain aquaculture systems due to its damaging effects on biofilters which indirectly result in increased harmful ammonia levels in the water (Keck and Blanc, 2002). There are reports that indirect reduction of dissolved oxygen in water due to formalin application impacted algicidal and bactericidal activities (Neely, 1963). In addition, immersion practices should be challenging in continuous water exchange areas and large ponds with intensive fish density. In a variety of situations, formalin may add stress and/or toxicity to fish which may seriously damage their gills, eyes and skin. Water temperature should be a concern as using formalin in tropical regions (warmer temperature) has been shown to produce greater toxic effects on fish (Piper and Smith, 1973). Therefore, a safer solution e.g. oral application with praziquantel can be a powerful alternative.

Conclusion

Infections with monogeneans clearly impact fish growth and health, which can lead to high mortality without treatment. A conventional way of using formalin immersion might introduce stress and/or toxicity to aquaculture systems, which could lead to lower feed intake, fish mortality and possible ecosystem changes. In this study, we concluded that dietary addition of praziquantel suspension is efficient and safe. The best result was obtained at a dose of 5mL of PraziSol per kg of feed for 5 days on experimental fish. The supplementation of PraziSol significantly reduced parasitic prevalence and intensity of monogeneans on striped catfish. There has been an indication that this product should be used with a periodical application for prevention and a longer application duration and/or a higher dose for treatment of disease outbreaks caused by monogeneans.

References available on request

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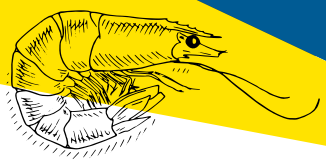

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Optimisation of feed margins

As COVID-19 presents a real crisis for the aquaculture industry, it could also induce improvements in shrimp farming

By Hervé Lucien-Brun

A major impact of the COVID-19 pandemic on shrimp aquaculture has been the reduction of its main markets. Examples include confinement of people in their homes and closure of restaurants, especially in China and Europe, as well as the postponement of the Olympic Games in Japan, which caused a sudden stop of imports in this country.

This pandemic has caused a sharp decline in demand and a fall in market prices. In China, there was an increase in imports at the end of 2019, resulting more from speculation of Chinese importers counting on a short crisis and wishing to take advantage of lower prices. However, imports then collapsed as domestic demand failed to recover and prices continued to fall. While this led to serious financial problems for many Chinese importers, two attempts to resume imports, in May 2020 and October 2020, were quickly thwarted due to suspicions of contaminating viruses in frozen seafood. Today, Chinese consumption of imported seafood products is still resuming very cautiously due to consumer suspicion regarding the risk of contamination by COVID-19 virus in imported products. This also contributes to the fall in prices of imported frozen shrimp (Figure 1).

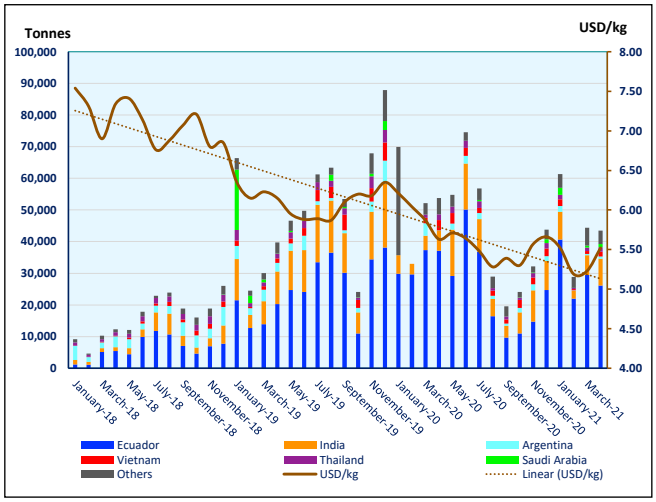


Figure 1. Declining prices since January 2018 for frozen tropical shrimp imported into China. Source: Chinese customs (HS code 030617). Direct imports only, excl cold-water.

Transportation too was a key factor impacted by the pandemic. A lack of labour due to containment measures caused an accumulation of full containers waiting to be unloaded in Chinese ports. Transport within China was also impacted, especially transport from ports to different markets, significantly increasing the cost of domestic transport. Both resulted in a lack of available containers for shipping companies, which has also contributed to the increase in transport costs.

Market reduction was not observed in the USA, where no widespread lockdown was imposed by federal authorities as was the case in China, Europe and India. However, a significant drop in prices occurred in the North American market. (Figure 2).

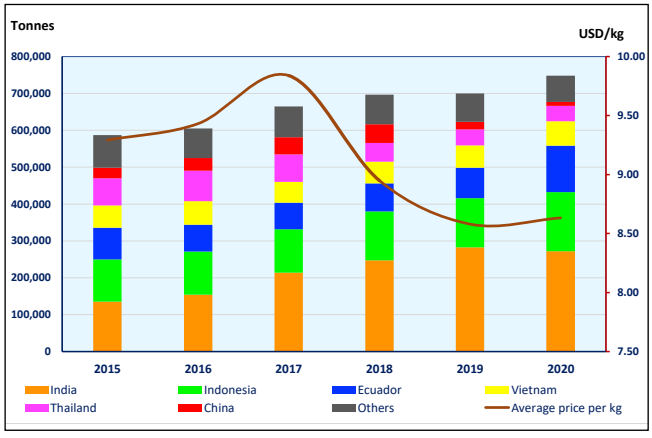


Figure 2. Evolution of shrimp imports into US markets and average prices since 2015. Source: https://www.st.nmfs.noaa.gov/.

The supply factor

In countries such as India, farmed shrimp production was affected by government-imposed strict containment of populations, which brought about labour shortages and increased transportation costs for farms. The Indonesian archipelago also suffered from an inter-island transport disruption that caused a delay in stocking shrimp early in the year.

In some Asian countries, the significant decrease in air traffic following the global health crisis has been an important choke point for the importation of specific pathogen free (SPF) broodstock, mostly from the USA (Hawaii or Florida). In these countries, such as India, national regulations require certified hatcheries to work only with broodstock from suppliers registered with the Coastal Aquaculture Authority. The hatcheries in these countries could not ensure sufficient production of post larvae to stock ponds according to schedule. This situation has caused a significant decrease in production.

The production of Latin American countries did not decline despite being seriously affected by the COVID-19 pandemic, namely the fall in prices or the labour shortage in the packaging plants during the first quarter of 2020. On the contrary, exported production in 2020 increased by about 6.7% compared to 2019. Nevertheless, the fall in prices has put many farms in great economic difficulty (Figure 3).

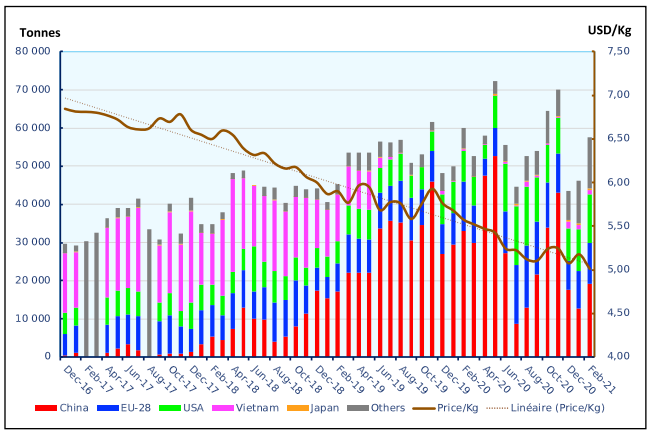


Figure 3. Ecuadorian exports of frozen shrimp and evolution of export price per kg. *Source: Banco Central del Ecuador.*

On the other hand, the rapid recovery of the Chinese economy and therefore the massive increase in demand for raw materials for animal feed has caused an exponential increase in prices of several raw materials, such as soy or corn. This increased feed prices for farmers, which amplified the economic problems they were experiencing as a result of falling market prices for farmed shrimp.

How to optimise the economic situation of aquaculture producers?

Aquaculture is a relatively young industry and a number of improvements are needed to move it forward. In the last 20 years, it was much simpler to secure good profits in aquaculture than in land-based animal farming. Today, the situation of aquaculture farmers is increasingly similar to the latter. Consequently, it is essential to optimise working methods. For this, several ways are possible in three areas, mainly: domestication of new species to diversify aquaculture products, diversification of markets to improve the average selling price, and above all, better control of farming costs, namely feed and energy.

Domestication and genetics

A continuity in species domestication is essential because of more pathologies appearing. To date, we see considerable progress in terms of growth and even tolerance to certain diseases, implemented through a number of genetic selection programs. The implementation of such programs must be generalised to avoid weakening the strains from too much inbreeding. The almost exclusive generalisation of *Penaeus vannamei* with a standardisation of the offer is penalising markets.

Domestication and selection of other species such as *P. monodon*, *P. indicus*, *P. merguiensis*, *P. stylirostris*, and even *P. semisulcatus* should be encouraged. From 1975-1985, centres such as Texas A&M and the Pacific Oceanological Center in Tahiti had encouraging results. However, a desire for development and especially for rapid profitability had pushed breeders to concentrate on *P. monodon* and *P. vannamei*. Then, at the end of the 1990s, WSSV outbreaks in Asia encouraged the use of domesticated and SPF strains of *P. vannamei* broodstock and to avoid wild broodstock of *P. monodon* often laden with diseases. We are encouraged by the work of AQUACOP in Tahiti (Michel, et al., 2013), MOANA in Hawaii and more recently UNIMA in Madagascar which showed that the domestication of *P. monodon* was possible as well as that of other species. Today, some farmers from Asia are seriously considering farming *P. monodon* to diversify their production.

It would probably be desirable to broaden the range of products by offering several species, especially in Asia where they are indigenous. This requires R&D to domesticate and select strains. This can be carried out by large groups and producers' associations with the support of researchers or government agencies. However, it will be several years before we can obtain sustainable results.

Market and prices

The widespread availability of *P. vannamei* in global market makes it a commodity. However, there are many highly profitable niche market products; as long as the quality of products corresponds to the required standards, demand will be good. Better knowledge of these markets would open access to them, but such markets are limited in terms of volume, although they command very good prices and interesting margins. If we want these niche markets to remain profitable, it is imperative not to saturate them and bring down prices. Therefore, it is necessary to know these markets well, including the volume they can absorb knowing that any oversupply will only result in lower prices. These markets must remain in demand. In fact, price control is not only difficult but impossible to put in place because of the worldwide supply of *P. vannamei*, compared to the demand which increases slowly.

Farming techniques and feeding

Today, there are multiple methods of shrimp farming, from the most extensive system such as in Bangladesh to the hyper-intensive system using biofloc in Korea or Europe. In between, we have semi-intensive systems in Ecuador and intensive ones in many Asian countries.

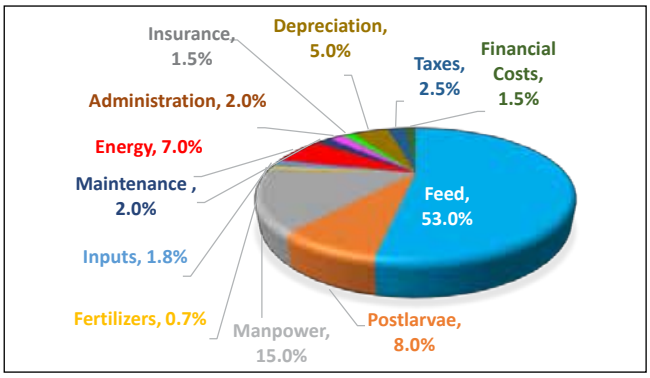


Figure 4. Breakdown of production cost in semi-intensive shrimp farm in Ecuador.

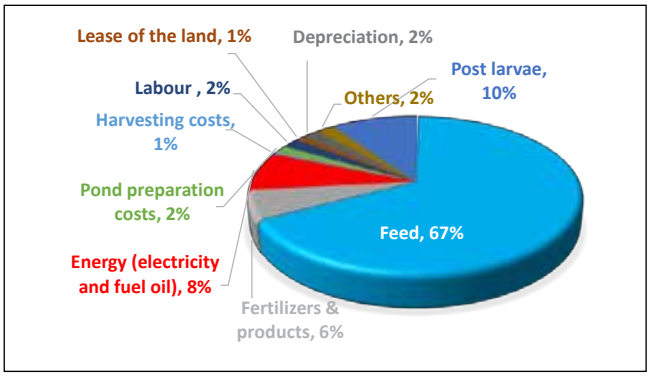


Figure 5. Breakdown of production cost in a intensive shrimp farm in Vietnam.

There are advantages and disadvantages with each of these farming methods. All of them, except for the extensive systems, require feed and energy. These two inputs represent between 60% and 75% of the production cost depending on the country and the farming method. (Figure 4 and Figure 5). Feed and energy inputs have a strong impact on the valuation of the end product - because consumers are becoming more and more sensitive to the adverse impacts of aquaculture on the environment.

Feed

Protein is the most critical ingredient in shrimp diets, both in terms of production cost and animal growth. The salinity of the culture water, age and physiological condition of shrimp influence to varying degrees, the use of dietary protein for growth or as an energy source.

Shrimp farmers use increasingly high protein feeds. A certain increase in protein content can be justified by the faster growth rates of the selected genetic strains farmed. It is obvious that the faster an animal grows, the more protein it needs. It should be noted that proteins are the most expensive nutrients in the composition of the feed: between 42 and 45% of the cost of the formulation.

Nutritionists often consider the protein content when evaluating feeds, both in terms of quality and price. However, the crude protein content is not the most important criterion. The persistent use of the concept of dietary crude protein by most nutritionists, feed manufacturers and aquaculturists is understandable as it is a simple and practical parameter, but it is also perplexing to some extent. The digestible protein content and the amino acid profile are of greater importance. Non-digestible proteins are not used by the animals and only pass through the digestive tract. They cause unnecessary additional costs and contaminate the pond water (Figure 6).

On the other hand, the method for calculating the crude protein content is most often based on the nitrogen (N) concentration, at 16%N. However, this is only an approximate method because the nitrogen contained in feed includes not only proteins and amino acids, but also other compounds such as nucleic acids, amines, urea, ammonia, nitrates, nitrites, phospholipids, and nitrogenous glycosides. It is estimated that N-containing compounds other than amino acids may account for as much as 10-20% of the crude protein content of feed ingredients.

Proteins are made up of chains of 22 amino acids linked by peptide bonds. Apart from a few very specific exceptions (McLean, et al. 1999), only free amino acids and some small

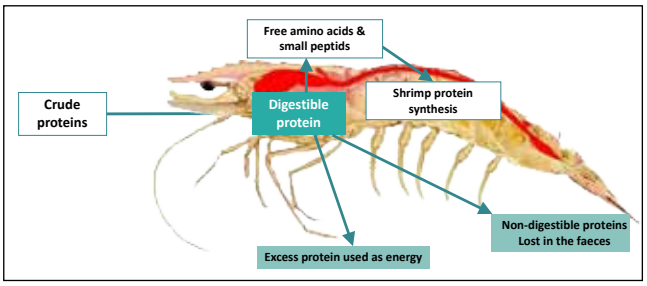


Figure 6. The protein ingestion in shrimp.

peptides are absorbed from the intestinal mucosa. The large peptides are excreted and form the non-digestible proteins. In general, animal proteins are composed of shorter protein chains than plant proteins and are therefore often more digestible for shrimp.

Peptic bonds can be broken by proteolysis with enzymes called peptidases or proteases. Proteases are specific and preferentially cleave the peptide chain at precise positions between specific amino acids. In some cases, this specificity is weak, but in others, it can be very selective. Thus, each species naturally has a pool of specific proteases that has been established during its evolution according to the natural food available in its natural environment.

Due to the decreasing availability of quality protein sources, and in the face of rising prices and pressure to reduce the cost of feed, nutritionists are forced to resort to alternative protein ingredients, often from plant sources. Some alternative sources are often poorly standardised and vary considerably in their nutritional profile as well as contain certain anti-nutritional factors that make it difficult to increase their use in aquaculture. It is also obvious that marine organisms are not equipped with all the proteases necessary to digest terrestrial plant proteins.

Among several solutions, the use of exogenous proteases incorporated in the feed can contribute effectively by improving protein digestibility.

Protease in fish

Lee et al. (2020) demonstrated the efficacy of a protease Jefo Pro Solution in enhancing nutrient digestibility of feed ingredients in rainbow trout (*Oncorhynchus mykiss*). Duplicate groups of fish were fed diets containing 30% of test ingredient and 70% reference diet. The reference diet was prepared with practical ingredients (fishmeal and sardine) and 0.1% indigestible inert marker (yttrium oxide). Eight ingredients were selected and their digestibility was measured with and without the supplementation of this protease. The experimental diets were fed to two replicate tanks of fish.

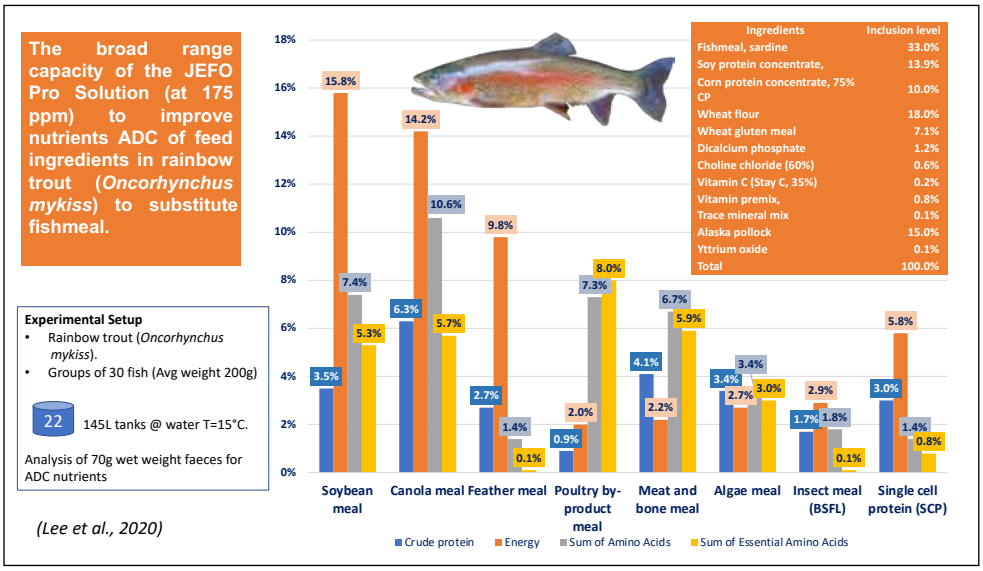


Figure 7. Apparent digestibility of protein, amino acids and gross energy in rainbow trout fed various feed ingredients with or without JEFO Pro Solution.

On day 5, fish in each tank were lightly anaesthetised and fish were stripped to collect faeces (approximately 70g of wet faeces). Diet and faeces were pooled by tank and analysed for proximate composition, energy, amino acids and minerals, including yttrium oxide. The digestibility of the test diets containing the test ingredients was compared to the reference diet and digestibility of nutrients in the test ingredients was calculated according to standard methods (Bureau, et al., 1999). Analysis of the results is shown in Figure 7, demonstrating a broad range capacity of the Jefo Pro Solution to improve the nutrient apparent digestibility coefficient (ADC) of the raw material used in these diets to substitute fishmeal.

Protease in shrimp

In Ecuador, experiments showed that the use of protease in the shrimp could also allow the reduction of the crude protein content of the feed without any negative impact on the growth performance.

The first experiment (Roman et al., 2015) was done using 12 ponds of 400m^2 each stocked with 10 PL14~17/m^2. Four different extruded experimental feeds (Table 1) were used in three ponds each over 110 days. Results showed growth advantages for the feed with Jefo Pro Solution included, even at the lowest crude protein level. Its inclusion allows the farmer to significantly improve his margin, even with a lower protein feeds and a higher vegetable protein inclusion rate (Figure 8).

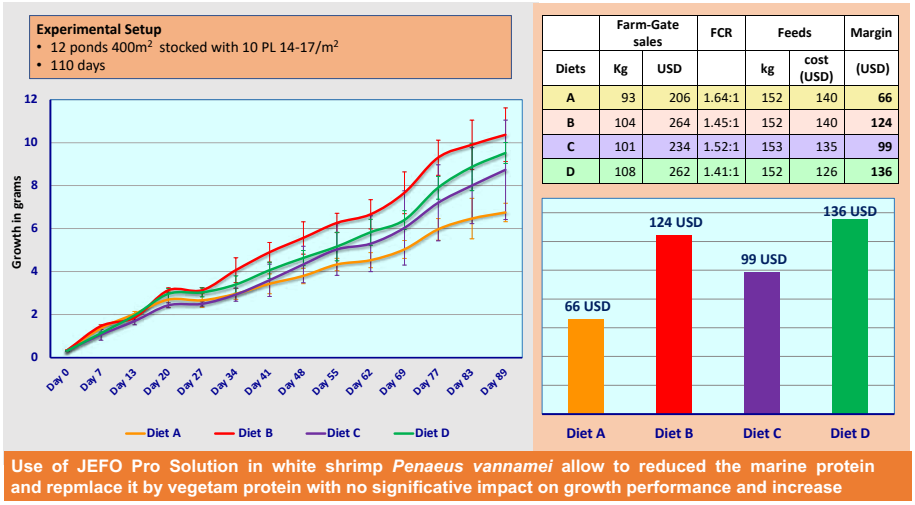
The second experiment (Missale et al., 2017) was conducted in 4.2ha ponds over 140 days with an initial stocking of 10 PL12/m^2. Shrimp in two ponds were fed a 35% crude protein commercial feed, and shrimp in the other two ponds were fed with a 28% crude protein commercial feed with an inclusion of 175ppm of Jefo Pro Solution. Both feeds were produced by the same Ecuadorian feed miller, and the experiment was repeated twice. Shrimp growth did not show a significant difference between both diets, but with the 28% crude protein feed plus the protease Jefo Pro Solution, the margin was higher by almost 62% as compared with the group fed the 35% crude protein feed (Figure 9).

These trials demonstrate that the inclusion of protease in the feed formulation can improve digestibility and efficiency of the protein. This also permits the use of more plant protein as well as cheaper but less digestible ingredients. Nevertheless, the feed formulator must ensure that all essential amino acids needed are present in the feed. It must be clear that if the amino acids are unbalanced in the feed, shrimp growth will be affected as an animal does not have a requirement for protein but rather the amino acids that constitute it.

Ingredients	A	B	C	D
Fish meal	27.7%	27.7%	22.7%	20.8%
Soybean meal 46% CP	25.9%	25.9%	32.9%	19.4%
Wheat	24.8%	24.8%	22.1%	34.8%
Rice powder	17.1%	17.1%	17.1%	20.5%
Fish oil	2.5%	2.5%	3.0%	2.5%
Cellulose	1.0%	1.0%	1.0%	1.0%
Binder	0.5%	0.5%	0.5%	0.5%
Shrimp premix	0.2%	0.2%	0.2%	0.2%
Antifungal	0.1%	0.1%	0.1%	0.1%
Lysin	0.0%	0.0%	0.2%	0.0%
Methionine 99%	0.1%	0.1%	0.1%	0.1%
Antioxidant	0.0%	0.0%	0.0%	0.0%
CR_2O_3	0.3%	0.3%	0.3%	0.3%
JEFO Pro Solution	0.0000%	0.0175%	0.0175%	0.0175%
Crude protein	**35.5%**	**35.5%**	**35.5%**	**29.4%**
Price/tonne (USD)	919.44	922.71	886.16	830.13

Table 1. Experimental feed composition (%).

Additionally, amino acid requirements vary depending on whether the amino acid in question can be synthesised by the animal (EAA or essential amino acids). Since the respective quantities of amino acids present in a particular protein vary depending on the animal or plant source, it is therefore often necessary to combine protein sources or to supplement the diet with the missing amino acids. EAAs of crustaceans are well-known and include arginine, histidine, isoleucine, leucine, lysine, and methionine, which are all required for optimal growth and survival of shrimp, as well as phenylalanine, threonine, tryptophan and valine. Tyrosine and cystine should be considered as semi-essential or reserve amino acids.



Diets	Farm-Gate sales Kg	Farm-Gate sales USD	FCR	Feeds kg	Feeds cost (USD)	Margin (USD)
A	93	206	1.64:1	152	140	66
B	104	264	1.45:1	152	140	124
C	101	234	1.52:1	153	135	99
D	108	262	1.41:1	152	126	136

Use of JEFO Pro Solution in white shrimp *Penaeus vannamei* allow to reduced the marine protein and repmlace it by vegetam protein with no significative impact on growth performance and increase

Figure 8. Dietary protease improves growth and economic performance of Pacific white shrimp in Ecuadorian farm conditions. Source: Roman et al. 2015.

While a deficiency in one of these essential amino acids slows or stops the growth of the animal by interrupting the production of proteins, a deficiency of a single amino acid could lead to decreased feed intake (Kaushik and Seiliez, 2010) with all the consequences on the growth and health of fish or shrimp.

The intake of amino acids over the amount required for protein development, maintenance requirements and inevitable catabolism will result in further catabolism of these amino acids. However, a diet with an amino acid profile that is deficient in one or more amino acids relative to dietary requirements will limit protein development, limit retention of other amino acids, and force their deamination in catabolism.

The degradation of amino acids takes place in two steps:

- The first is deamination with the removal of the amino group, which is either converted to ammonia or transferred to become the amino group of a glutamic acid molecule. Shrimp and fish excrete this ammonia through their gills.
- The second step is the conversion of carbon skeletons to an intermediate in the citric acid cycle, which releases energy that can be used by the animal or converted to fatty acids and/or glycogen for later use.

Therefore, we can say that excess amino acids produce an expensive energy supply compared to a formulation richer in energy and contribute to the pollution of the rearing environment by increasing the nitrogen excretion of shrimp. Excessive amino acids could thus be considered as a useless expense and a source of pollution, which is becoming more and more a concern in aquaculture.

Improving N digestibility and reducing N excretion

Consumers are increasingly sensitive to the environmental impact of aquaculture operations when making their purchases. It is also considered when acquiring certifications such as Aquaculture Stewardship Council (ASC) certification and Best Aquaculture Practices (BAP). But also, above all, this is a way to maintain the quality of the environment in and around a farm. Acquiring certification is crucial to ensure a sustainable production and a profitable activity in the long term for the farmer.

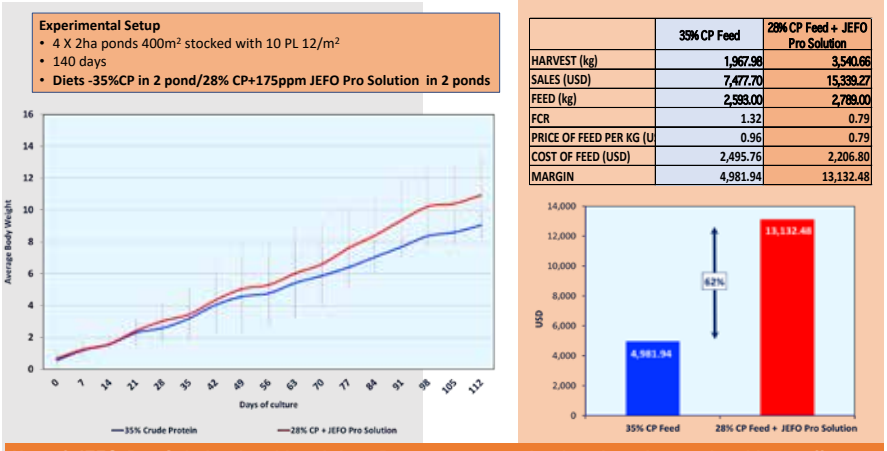
Feed efficiency and its impact on the environment can be measured by several parameters such as:

- Protein Efficiency Ratio (PER) which is body weight gain/protein intake.
- Protein Retention Efficiency (PRE) is the measure of net protein loss in the aquaculture system.
- Feed Fish Equivalency Ratio (FFER) is the kg of wild fish used per kg of farmed fish produced (iffo.com).
- Effluent contaminant load by measuring the nitrogen effluent load/tonne of shrimp produced over 12 months.

These parameters permit an objective measure of the impact of shrimp farming on the environment. As an example, the ASC Shrimp Standard requires:

- a FFER lower or equal to 1.35:1 for *P. vannamei* considering a FCR of 1.5:1 with a fishmeal inclusion rate of 20% and for *P. monodon*, a FFER of 1.9:1: with 23.4% fishmeal and a FCR of 1.8:1 (ASC 2019).
- Less than 25.2kg of nitrogen per tonne of *P. vannamei* and/or less than 32.4kg of N per tonne of *P. monodon* (ASC 2019).

By taking up the two experiments outlined in Figure 10 and Figure 12, it shows that in both experiments, the positive impact on the significant reduction of the FFER with an improvement of the FCR and the PRE induced by the inclusion of the JEFO Pro Solution.



	35% CP Feed	28% CP Feed + JEFO Pro Solution
HARVEST (kg)	1,967.98	3,540.66
SALES (USD)	7,477.70	15,339.27
FEED (kg)	2,593.00	2,789.00
FCR	1.32	0.79
PRICE OF FEED PER KG (U	0.96	0.79
COST OF FEED (USD)	2,495.76	2,206.80
MARGIN	4,981.94	13,132.48

Use of JEFO Pro Solution in white shrimp *Penaeus vannamei* reduced crude protein with no effects on growth performance and increase margins

Figure 9. Dietary protease improves production performance of commercially farmed pacific white shrimp *Penaeus vannamei*. Source: Missale et al., 2017.

Figure 11 and Figure 13 also show a significant reduction of the nitrogen effluent loads for both experiments. In both cases, all these positive results were obtained with a significant reduction of the feed cost and an increase of the net margin on feed. The use of a protease in the feed will reduce the impact on the environment in two different ways:

- Improving the digestibility of the proteins in feed, which increases the proportion of digestible proteins.
- Reducing the concentration of total protein, which will lead to a better PER and/or PRE.

Conclusion

The recent dramatic situation induced by the COVID-19 pandemic: the fall in market demands and the increase in production costs has highlighted the fragility of the situation of aquaculturists - mainly due to dependence on on a few international markets for products, poorly diversified protein inputs used for the formulation of aquaculture feed (soybean fishmeal) and their prices. Since feed is the main production cost for the fish farmer, it is necessary to consider optimising the use of proteins: by increasing their digestibility and diversifying the sources.

The incorporation of a protease in the feed formulation makes it possible to seriously improve digestibility and thus, increase the proportion of vegetable proteins while maintaining good digestibility and a correct amino acid profile. In addition, the incorporation of an effective protease in the formulation makes it possible to significantly increase the percentage of digestible proteins, and therefore it is possible to reduce the crude protein content without affecting zootechnical results.

In this article, the use of a protease, such as JEFO Pro Solution, in the diet reduces the impact on the environment in several ways:

- By reducing the level of crude protein in food and thus limiting environmental pollution resulting from the dispersion of non-digestible proteins.
- By making it possible to reduce the quantity of marine meal used in feedstuffs, and thus reduce the need to use wild fish.
- Reducing the impact on the environment is important above all from an ecological point of view, but also to ensure the sustainability of farms and meet growing consumer demand.

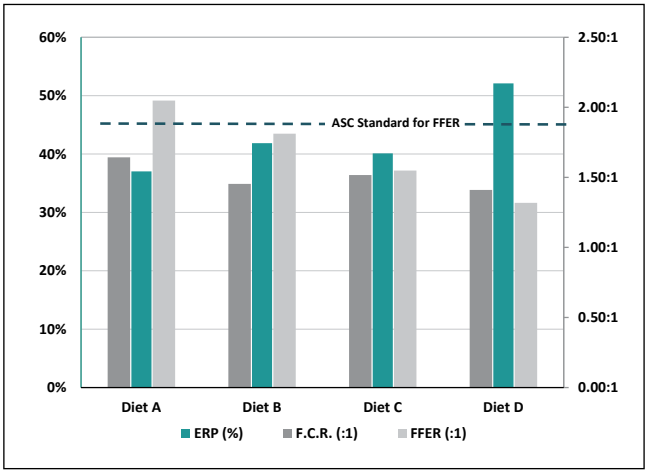


Figure 10. Efficient use of fishmeal in shrimp feed in experiment 1.

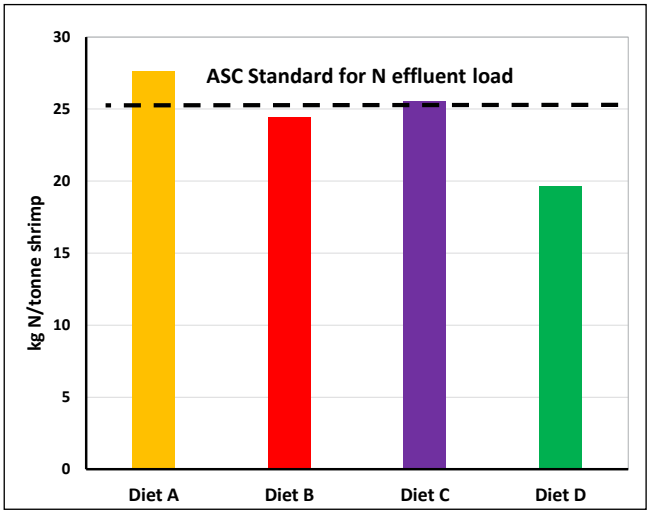


Figure 11. Impact on the nitrogen effluent load of the 4 experimental feeds - experiment 1.

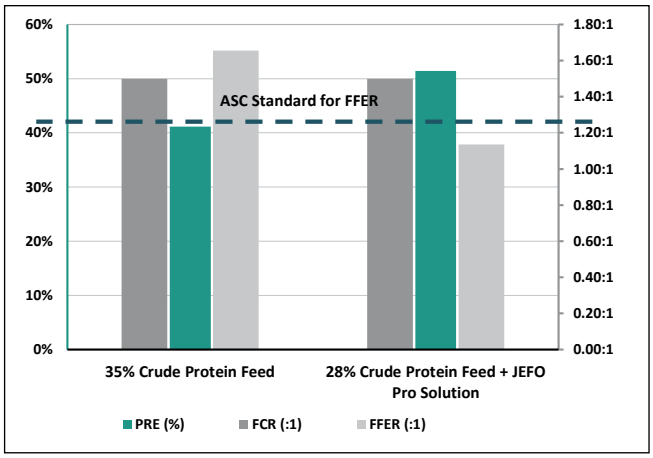


Figure 12. Impact of the crude protein level and the inclusion of JEFO Pro Solution on the efficiency of the use of fishmeal in shrimp feed.

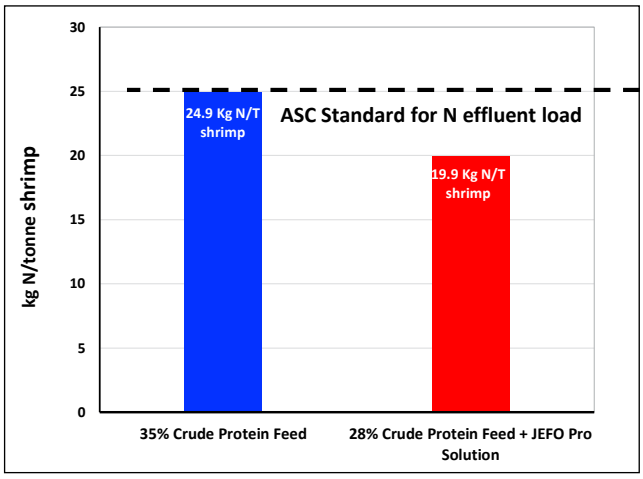


Figure 13. Impact on the nitrogen effluent load of the crude protein rate and the inclusion of the JEFO Pro Solution - Experiment 2.

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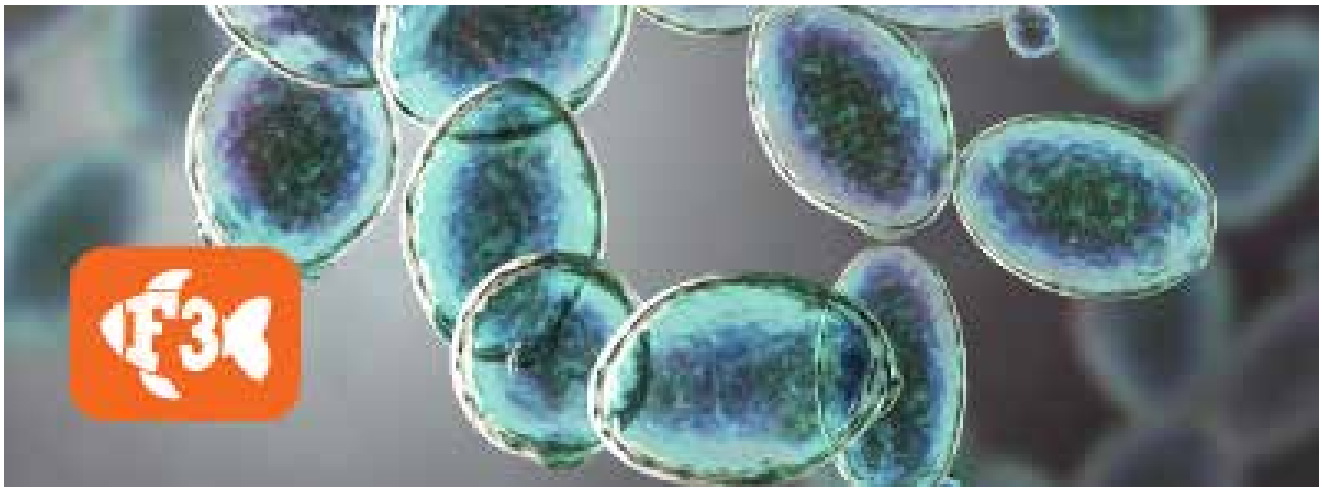
Innovators in the single cell and novel protein space and replacements for fish oils



Over 2021, the Future of Fish Feed (F3) group has put together a series of webinars to provide information to industry on options in the drive for sustainable aquafeed production. In a third webinar in April, Dr Kevin Fitzsimmons, Chair and Judge of the F3 Challenge and Professor and Director of International Initiatives at the University of Arizona, USA, led a group of top innovators in the single cell and novel protein space. They discussed their technology, products and applications in aquafeeds.

Fitzsimmons said, "We believe that single cell proteins (SCP) are taking the aquafeed industry by storm and it will be interesting to see how things develop in the coming years with a lot of innovative tools, converting pre-existing waste streams and byproducts into feedstock."

KnipBio's CEO and Co-founder Larry Feinberg said that there is a fast, dynamic, powerful opportunity around its microbial conversion protein technology. The company has run 40 trials to date with its functional single protein KnipBio Meal (KBM), a straightforward fishmeal replacement that mirrors the protein and amino acid content of conventional fishmeal. A recently completed study on juvenile Asian seabass or barramundi showed all diets containing KBM had statistically higher growth performance compared to the control diets. In post larvae shrimp, a higher protein efficiency ratio was seen in KBM diets. There was resistance to early mortality syndrome (EMS) compared to control (commercial) diets. "Immuno-nutritional benefits of KBM were beyond that of just amino acid profile," said Feinberg. KBM is currently waiting for FDA approval as GRAS -generally recognised as safe.

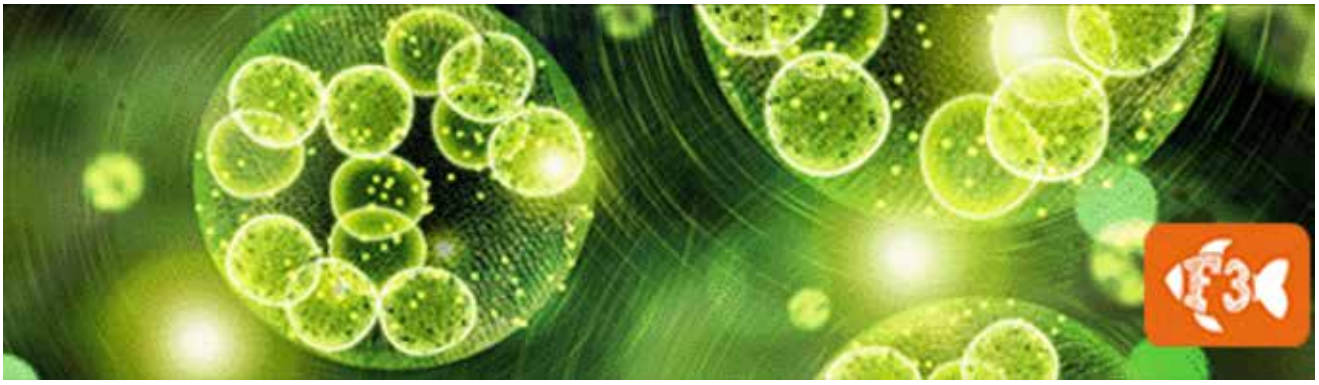
There are two global issues today: there is too little protein to meet global demand and the second issue is that there is too much carbon released into the atmosphere. "**NovoNutrients** is solving the former by producing an alternative protein source from carbon dioxide (CO_2) originating from industrial processes, thus mitigating the latter issue," said David Tze, CEO. NovoNutrients pairs CO_2 with hydrogen and gases, giving an aqueous media for fermentation to produce its SCP. "We have received regulatory approval in Japan for the product to be used in animal nutrition and aquaculture. This product, Super Prime Protein with 73% protein on dry basis, is highly digestible at 95% and is highly palatable. It also contains vitamin B, carotenoids and fatty acids. In rainbow trout, feed substituted with 55% of this protein gave comparable growth as that of a control diet."

The pilot system will be scaled up to produce 1 tonne/month in 2021. Tze described the model for NovoNutrients from project financing to offtake agreements. It has its first technology licensee and feed customer. The initial commercialisation will be in Japan in 2023, and eventually move to larger projects in the US and globally. By 2030, it should be upcycling CO_2 at 4-5 million tonnes/year.

Scaling is the next step for the SCP business and **Calysta** is achieving this with partner Adisseo in a joint venture to build a 20,000 tonnes plant in Chongqing, China with production in 2022 and sales throughout Asia for its sustainable protein FeedKind®. Allan LeBlanc, Vice President said that this guarantees entry into the largest feed market in the world. "When it comes to sustainability, SCP, especially gas-based proteins like FeedKind, stands out as they do not use agricultural inputs. There is a lower greenhouse gas (GHG) profile as our protein uses 90% less water than equivalent soy protein.

Le Blanc added that with 71% of protein comprising 60% amino acids, FeedKind fits well into a formulation where there is little space for fibre and ash for an effective or quality pellet. A recent study with Kinda University in Japan on the Japanese yellowtail *Seriola* spp has been encouraging as the fish has been resistant to replacement of marine protein with plant proteins. Strong enteritis from high plant protein diets have been reported. Commercial feeds for the yellow tail contain 35-55% fishmeal. There is also a challenge around palatability. "We found that FeedKind at up to 17-20% of total feed gave good feed efficiency, growth and the same animal health as with marine feed ingredients. Therefore, this is a great template for us to work with species in Asia with less well-defined nutritional requirements."

Hong Kong based **ICell Sustainable Nutrition** commercialises its technology in the China market from



three plants in Tiantai, Shandong and Zhoushan. It recycles clean water stream and feeds the leftover organics to microbial biomass resulting in a SCP feed ingredient for shrimp, trout, salmon and other species.

Producing SCP is capital intensive. "Therefore, we have taken a new approach by integrating ICell with aquaculture. We create a business model, which involves simultaneously solving food wastewater issues for a food company and producing SCP. The newly cleaned water is then used for aquaculture. In 3 years, we plan to have many SCP sites operating in China, and then in North America and Europe," said Mark Rottmann, CEO. "The ingredient is carbon negative, as without this ICell process, these waste products will decompose releasing methane. A typical ICell site of 1 acre (0.4ha) can produce 500 tonnes of SCP versus 350 acres (141ha) for the same amount of soybeans and it can produce this protein with less than half of the energy required for other protein ingredients."

Unibio uses a microbial fermentation technology to convert natural gas or methane, to produce a nutritious biomass. The product Uniprotein has been approved in the European Union for animal and fish feed and is certified organic by farmers and growers in the UK. It has 70% protein and 10% fat. Studies with juvenile salmon, rainbow trout and tilapia have shown that Uniprotein can replace fishmeal without any negative effects on performance. In tilapia, 100% of fishmeal which was 25% of the protein, was replaced.

Paul de Pauw, Business Development Director – Feed said that the first industrial fermenter was set up in Russia, with an initial capacity of 6,000 tonnes. This has a modular concept and production can be expanded in the coming years. In 3 years, it plans for more plants across the globe and producing more than 100,000 tonnes/annum. GRAS is pending in the US. Technology development will continue at the demonstration plant in Denmark.

The Scoular Company has a barley protein concentrate (BPC) called Emerge™ as a substitute and complementary product to fishmeal. The patented production process converts the non-GMO (genetically modified organism) barley to a protein concentrate. Production of 3,600 tonnes of this BPC is expected in 2021. Michael Cici, Global Pathfinder said that in the Coho salmon, replacement of fishmeal with BPC at 20% and 30% did not evoke any palatability issues and FCR improved. A two- year study on 375,000 freshwater trout in alternating raceways in the US, where BPC was included at 30%, showed no difference in terms of growth rate, final weight, FCR and flesh colour and taste compared to a dense fishmeal diet in the control.

The leading US agri-tech company, **Green Plains** has an innovative ultra-high protein corn concentrate for aquafeeds. Dr Peter Williams, Senior Nutritionist explained the process using Fluid Quip Technologies patented maximised stillage co-products (MSC™) system. The product is already classified in the Association of American Feed Control Officials (AAFCO) handbook under distillery products and is regulatory compliant in the international market. This product also contains beta glucans and mannans.

This ultra-high protein can replace fishmeal and soy isolates in aquaculture. "We have carried out trials, both in academic and commercial facilities as well as trials with carp, tilapia, trout, shrimp and Atlantic salmon. Without exception based on commercial formulations, we have either achieved the performance of the commercial formulation or better. Our current focus is using this protein in aquaculture," said Williams.

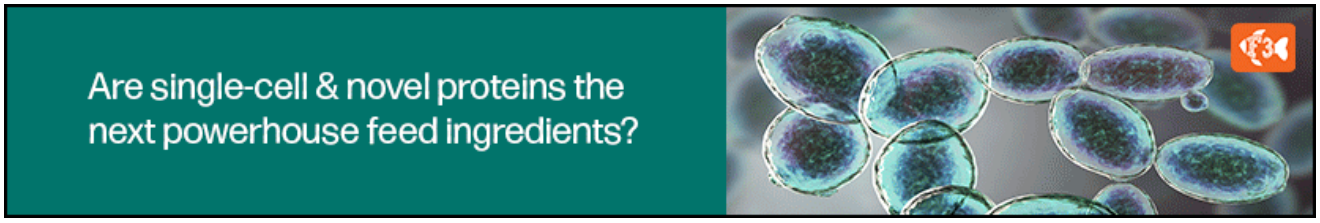
Green Plains is producing 500,000 tonnes of this protein from six plants and will increase to 1,000,000 tonnes by the end of 2023. "The challenge is to roll out the technology globally. In Europe, it will be a non-GMO alternative protein. In partnership with Novozymes, the target, by using enzyme technology, is to increase protein to greater than 60% and improve product characteristics by changing the composition of the yeast. There is an ongoing target to remove all antinutritional factors. Finally direct CO_2 sequestration from the plants will give us a carbon neutral product," said Williams.

The message by the group was that with all these technologies, reaching commercial volumes and resilience in the supply chain are key attributes. After regulatory compliance, it is getting the attention of feedmillers and reaching volumes and scale that the industry needs. Commercial adoption is a shared issue and a unified voice to address adoption issues could be the way forward.

Progress in the use of algae and seed oils in aquafeeds

In May, Fitzsimmons led four key players from the omega-3 oil segment with cutting edge innovations in their respective domains. The global fish oil supply is currently at around 1,000,000 tonnes/year and for sustainable production, aquaculture needs new sources of oils for fish oil replacement. The result of research and product development by the omega-3 oil producing companies highlight some of the most promising ingredients.

The aim of the F3 Fish Oil Challenge which ran in 2019 was to accelerate innovation in alternatives to fish oil without the use of marine animal ingredients, and these alternatives must be able to be scaled up for their widespread use in aquaculture operations. Dr Karim Kumaly, CEO of



Veramaris, winner of this challenge said, "Since winning the F3 challenge, we have come a long way. The algal oil is used to grow shrimp, trout, steelhead trout, yellowtail seabream and seabass. We have launched an omega-3 feed for shrimp using entirely algal oil, with zero fishmeal and fish oil, and this feed is available in the US markets. We tripled production in 2020, with the volume equating to 8 billion forage fish."

In 2021, Veramaris will be partnering Ecuadorian shrimp integrator Empagran in the F3 carnivore edition on shrimp feed. The goal of Veramaris is to expand the world supply of DHA (docosahexaenoic acid) and EPA (eicosapentaenoic acid) for aquaculture and beyond. It is the first producer of marine algal oil which is rich in both EPA and DHA to receive MSC certification and add 45% to the global supply of MSC certified EPA and DHA. In aquafeeds, the algal oil reduces forage fish dependency ratio (FFDR) to below 1 in farmed fish and shrimp.

The industry target is to have oil sources, equal or lower in price to fish oil. On the contrary, Kumaly said the algal oil DHA and EPA is 2.5X more concentrated than Peruvian fish oil and allows any smart feed formulator to reap the benefits of the product, leaving space for other ingredients.

The goal of **Global Algae Innovations** is to create 1,000,000 acres (404,685.6ha) of algae by 2030. Founder and CEO, Dr David Hazlebeck, believes that an algae revolution will change the aquaculture paradigm. The company founded in 2013 wants to harness the productivity of algae to provide food and fuel for the world; produce algae meal with 70% protein for food and feed markets; and fractionate oil into three main products: omega-3s for feeds, unsaturated oils for the consumer market and saturated oil for jet fuel.

Hasselbeck showed how radical innovations can reduce the cost of algae production along with the process of scaling up this technology stream. "This is from the current 8-acre (3.23ha) farm, to 160 acres (64.7ha) farm and then to the commercial scale of 5,000 acres (2023.4ha) farm which will reduce costs from USD20/kg to a commodity level at USD1-2/kg. The current stage is in the design phase for a 160-acre farm." The development is from the R&D farm in Hawaii and then build and operate worldwide - from Peru, Australia, Indonesia, Malaysia etc. The level of productivity of algae is unprecedented - a 40X increase as compared to soybean yield of 3X in 60 years. It addresses the root cause of deforestation.

Nuseed started in Australia in 2006 and has come a long way with Aquaterra®omega-3 for aquafeeds. The product is now available in markets in Australia, North and South America and Europe. It has two innovation centres in California and Victoria, Australia. In collaboration with Australia's CSIRO and Grains Research and Development Corporation (GRDC), Nuseed developed omega-3 canola to supply DHA for aquaculture, raising the total omega-3s in conventional canola from 9% to a total of 34% total omega-3s in Aquaterra. DHA from one ha equals production from 10,000kg of wild fish.

Pablo Berner, Aquaculture Lead said, "In 2018-2019, we conducted commercial trials where Aquaterra performed beyond expectations: better eFCR, decreased mortality by 2%, favourable ω6: ω3 ratios, and excellent fillet quality and colour." Aquaterra replaced fish oil in salmon feeds at 60%, 50% and 30% in three separate trials. Consistently, the product improved survival and increased total omega-3s by 2%. In terms of sustainability indexes, FFDRo (forage fish dependency ratio for oil) was reduced by up to 61% and FIFO (Fish-in Fish-out) by up to 27%. It is scaled for growth in tandem with that of aquaculture."

Available as powder and liquid, **Corbion's** AlgaPrime™ DHA is now produced at capacity and is poised to expand in the future. Ruud Peerbooms, President, Algae Ingredients, said that with this pandemic, questions on the sustainability of the food chain have been asked."But, there is no doubt that this product will see further market expansion. Human health has shown to be improved by increased seafood consumption and the active ingredient is omega-3s. This aligns with Corbion, which has, a sustainable source of long chain omega-3s.

"By growing algae omega-3 via fermentation of sugar, we remove the fish in the food chain but still deliver the omega-3s to the consumers. Market adoption of AlgaPrime DHA in aquaculture is led by salmon feeds with 30% inclusion rate but the shrimp feed segment is fast catching up," said Ruud. Diana Visser Director of Sustainability said that the life cycle assessment (LCA) in 2020, covering the full supply chain showed lower carbon footprint compared with traditional sources of fish oil. This is attributed to three factors: use of renewable energy powered from a sugar cane mill, high yield feed stock with sugar cane for the fermentation process, and efficient land use.

Kumaly also added that to create the market, Veramaris collaborated with actors along the value chain, by talking to farmers, feedmillers, processors, distributors, retailers and consumers. "The retail sector leaders engaged with supply chains to demonstrate their sustainability credentials. In the salmon it allows the farmer to reverse the decline of omega-3s in fillet."

Iridovirus in Ghana: A case of partnerships across the globe

A new approach of immunotherapy linked with upregulation of anti-stress heat shock protein and other biological pathways for tilapia.

By Alain Michel

With travel restrictions during this pandemic, it is the internet that is helping to settle disease challenges. It has been matching scientific knowledge and fielding answers. This is a story of how the internet can be used to help another 6652km away to use upregulation of anti-stress heat shock protein to arrest the emergence of an iridovirus in tilapia.

Preamble

It is clear that the control of pathogens is key to developing a sustainable aquaculture project at a commercial scale and this is particularly true in tropical conditions where high ambient temperatures are accelerating triggers for diseases.

Aquatic organisms, from invertebrates to vertebrates, live in a world full of viruses and bacteria. To survive in such environments, they are equipped with defence mechanisms in their immune system. But this is a learning machine which has to be taught.

Fish have an innate immune system, which is the first line of defence. It is mostly a cell system able to react quickly as soon as some cellular receptors are flashing to indicate stressful conditions. But they also have a memory system, an ability to remember the first encounter with a pathogen and to immediately develop a counterattack.

"There is no doubt that pathogens will always be there in the field. The reality is that it is a necessity to learn to live with them."

One pathogen, one disease?

The idea of one pathogen one disease cannot explain what is being observed at the field level, and the pathobiome concept, which is the pathogens in their environment including the other pathogens, is more relevant. And recently, some genomic research have demonstrated well the direct impact of some viruses on outbreaks of opportunistic bacteria resulting in high mortality.

Furthermore, we are always densifying the populations in a limited space, providing the pathogens a nice playground. It should be understood that there is always a strong host-pathogen relationship, with both continually co-evolving. It is an illusion to think we can eradicate them when they are, in fact, a permanent component of the ecosystems.

Live with pathogens

There is no doubt that pathogens will always be there in the field. The reality is that it is a necessity to learn to live with them.

In this article, I focus on a recent case study highlighting the efficiency of heat shock treatment to enhance the immune system of the hosts and to control the mortalities. This is with the tilapia in Ghana where there was an emergence of an iridovirus around the end of 2018 and early 2019.

Emergence of an iridovirus in Ghana: an internet story

In early 2020, a biologist A, in charge of a tilapia farm in Ghana called his friend B running a tilapia farm in Sumatra. A recounted to B of a sudden and huge mortality in the cages of the farm he was working at. During the discussion, B suggested that A call another marine biologist C (me) in Paris who has worked for many years to mitigate outbreaks of viruses and bacteria in a barramundi farm in Indonesia.

Following this advice, some hours later A was describing to C the clinical signs he observed in his tilapia. A suspicion of an iridovirus was the outcome, and some days later, it was confirmed by PCR analysis on some samples from Lake Volta. C then advised A of the approach he had developed with the production of barramundi or Asian seabass (*Lates calcarifer*) juveniles over 10 years. Back then, C faced different kinds of pathogen outbreaks, including an iridovirus type infectious spleen and kidney necrosis virus (ISKNV).

C described that he used a non lethal short duration heat shock repeated every day until the mortality was under control. He also suggested that A start preliminary trials on some hundreds of juveniles and fry coming from cages or from the hapa nursery where they were also observing high mortality rate 2-3 weeks after the sex reversal procedure.

History of pathogens in tilapia in Ghana

In mid-2018, a scientific survey funded by the World Bank investigated the health status of the tilapia farms on Lake Volta, mainly in search of a newly emerging virus. At that time, the tilapia lake virus (TILV) was already suspected to be the cause of regular and significant mortalities. However, the study concluded that:

- TILV virus was not detected.
- Farms are accustomed to these mortalities and no severe impact of social and economic consequences was observed on the local community.
- Various bacteria were detected with a predominance of *Streptococcus agalactiae*.
- Biosecurity measures were very poor and hatcheries, being at the top of the production pyramid, have a high potential to spread infectious diseases to all farms.

Diseased fish were observed away from the school with erratic swimming: on one side, in circles, lethargic, with no equilibrium, upside down, etc. Externally, the fish displayed a range of clinical signs, including skin nodules, loss of eyes, opaque eyes, loss of scales, exophthalmia, anorexia, decolouration or darkened skin, excess mucous, skin haemorrhages and distended abdomen.

In mid-2018, the prevalent idea was that the "Devastating spread of new infectious agents within Lake Volta, if introduced, must be regarded as highly likely." This was a premonitory forecast as by late 2018 and early 2019, there was a huge outbreak resulting in high mortality in all the farms.

In late 2018, a second scientific survey was organised by a team of UK-based scientists working for a biological company.

An excerpt from the report dated June 2018, states;
"In late 2018, unusual patterns of very high mortality (>50% production) were reported in intensive tilapia cage culture systems across Lake Volta in Ghana. PCR confirmation and DNA sequencing identified the virions in the tissues of the diseased fish as infectious spleen and kidney necrosis virus (ISKNV). It was clear that this virus was the cause of disease and likely had a primary role in the mortality events. In 2018, ongoing mortalities were in fish bigger than 20g but in 2019, mortalities spread to the hatcheries where the water source was coming from the lake."

Vaccination against Streptococcus

The only prevention effort conducted at that time on some farms was to vaccinate the tilapia of around 20g against the *Streptococcus* bacteria, which was killing large fish in cages. It was done by a French vaccine company developing an autogenous vaccine. However, it was opportune that C had worked together with this vaccine company previously and therefore, together they again decided to join efforts to find a solution to the crisis in Lake Volta.

Farm action

Back at A's farm, C guided A on how to implement, at a small-scale level, heated water applied to the tilapia fry at size 0.2-0.3g. Subsequently, after a positive result using a crude system to heat the water, the farm management decided to react rapidly and to set up a treatment unit on the shores of the lake to handle as many fry as possible each week. Four circular tanks of 25m^3 and reservoirs were built to stock water heated with gas burners at 55^{o}C. The whole system was operational by May; a rapid reaction of the team in a critical period.

Treatment in tanks

The team at the treatment unit received fry from the hatcheries and was able to carry out the heat shock according to the protocol provided by C and adapted to local conditions by the vaccine company's local veterinarian and the biologists in charge of the farm working together efficiently with strong support from the management.

As advised by C, the treatment was conducted on fry already showing clinical signs. A demonstration was done to show that treating non-affected fish will not result in a single preventive effect on the propagation of the virus.

Basically, several hundred thousand fry were transported from the hatcheries to the treatment unit and placed into a tank. Water flow was stopped and the water level was lowered to have enough room to raise the temperature to the level targeted to upregulate the heat shock proteins (39^{o}C), which was done in a short period of time by injecting hot water from the reservoirs. Then the temperature was maintained at a stable at 39^{o}C over 30 minutes, before allowing the water to return to normal temperature.

The result of these first trials was quite convincing in terms of mortality reduction and progressively, the treatment was fine-tuned to maximise survival. The most interesting finding was that the first treated juveniles sent to the pre-growing cages did not redevelop iridovirus clinical signs. They could suffer from *Flexibacter columnaris* attacks which were progressively controlled by peroxide baths and the use of the licensed antibiotic Aquaflor.

Over some months, the team gained experience and knowledge on the spread and outbreak of iridovirus and in early September, they were again in a position to begin vaccination against *Streptococcus*, 800,000 juveniles (20-30g size) per week. The survival rates after the heat treatment were between 60 and 90%. By March 2020, all the cages were fully stocked and the production had resumed. At this time too, the market was disrupted by the world crisis due to the coronavirus pandemic.

Preliminary trials done on a barge with juveniles transferred from cages to tanks, with hot water from large pans heated by gas.

A treatment unit set on the shores of the lake to handle as many fry as possible. Top: one of the four circular tanks for treatment. Bottom: reservoirs of hot water delivered by gravity to the treatment tanks.

Underlying science

Thanks to the quick reaction of the farm management and the systematic use of non-lethal heat shock, the production which was almost totally destroyed in early 2019 is again on its way after a year. It was a pure field and pragmatic approach adapting a non-lethal heat shock technique developed from 2000 to 2015 in an Indonesian farm on a marine species, the Asian sea bass to the freshwater tilapia.

The underlying science is the boosting of the innate immune system by the heat shock giving the fish the time and strength to build their own lines of defence at the right level to stop the mortality and teach their adaptive system. The genes in action are the ones coding for the chaperones anti stress proteins with a direct effect on the immune system.

By the end of 2020, the non-lethal heat shock treatment had diffused to other farms allowing them to resume production. Some different heat shock protocols aimed at containing the virus until vaccination have not been successful with no positive effect of the experimental iridovirus vaccines.

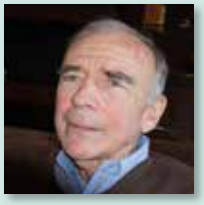
In conclusion, it should be acknowledged that, once in the Lake Volta, the iridovirus will be there forever. It cannot be eradicated and the only choice is to live with it.

In this context, the best approach is to control the first infection at the right moment in the nursery system and to apply the heat shock treatment when first clinical signs appear. Another possibility in the future, will be to send the juveniles directly to the cages and to treat them using a tarpaulin and a barge with a boiler and a heat exchanger when mortality is starting.

Thus, the loop is closed: the virus itself is participating in its own control in favour of the farmers.

Acknowledgement

Many thanks to the different field actors of this heat shock story. It was an international cooperation between, Eric Vigne and Adrian Astier in France, Oliver Arribas in Spain and Alfonso Arango in Colombia, in support of the whole team of the farm.



Alain Michel is currently a permanent consultant for a new barramundi farm in Sri Lanka. From 1998 until 2014, Alain was scientific adviser to Fega Maricultura, a barramundi farm in Indonesia. Currently, his main interest at the field level is the boosting of the innate immune system to have better control of aquaculture pathogens. Email: alainhenri@aol.com

The Asian tilapia during the pandemic years

A recovery after the initial setback for China's tilapia but low demand persists in certain countries.

At GOAL 2020, Gorjan Nikolik, Rabobank Research, reporting results from the global aquaculture production survey and forecast, said that in 2019, China's tilapia production was 1.8 million tonnes and in 2020, the expected production was 1.75 million tonnes. An industry source in China gave a projection of 1.7 million tonnes in 2020 and added that in 2021, less tilapia is expected with the extreme cold weather.

The other large producer in Asia, Indonesia did not see any production decline in these two years, at 900,000 tonnes/year, according to the GOAL survey. However, the Directorate of Aquaculture, Ministry of Marine Affairs and Fisheries, Indonesia (MMAF) gave a production at 1.47 million tonnes in 2019 and a reduction to 1,235,514 tonnes in 2020. Bangladesh showed an astonishing CAGR of 38% over the years 2010-2018, and in 2019 produced 360,000 tonnes and this increased to 370,000 tonnes in 2020. While the CAGR (2010-2018) of the other major tilapia producers in Southeast Asia (Philippines and Thailand) was in the range of 0.9 to 2.1%, Vietnam had a CAGR of 10.0% (GOAL, 2020). Vietnam's growth is supported by its government's efforts to raise production and create another whitefish export commodity.

With regards to global tilapia production in 2020, the GOAL 2020 survey estimated 6.05 million tonnes - 0.8% higher than in 2019. Globefish (FAO, 2021) said its estimate of 6.93 million tonnes was approximately on par with the production in 2019 and a break from the sector's long-term growth rate of 5-6%/year. The total drop in Asian output was around 1.3% to 4.55 million tonnes.

It added that meanwhile, production in the Middle East, Africa and Latin America, increased marginally in 2020. Today, African production is mainly in Egypt at 1 million tonnes for 2020, but production is expanding in Sub Saharan regions where tilapia is currently the most farmed fish at 125,000-150,000 tonnes annually. Van der Pijl (2020) said this region is the new frontier for farmed tilapia, primarily for domestic consumption. Expansion is now driven by commercial as well as by small- and medium-sized cage farms. Brazil's production was expected to increase to 500,000 tonnes in 2020 (GOAL 2020). A UCN (2019) report said that Brazil is poised to challenge China in the US frozen tilapia market with the diversification of large poultry players with state- of-the-art processing technology and partnering with a genetics group.

The tilapia market during the pandemic in 2020

The tilapia sector had a temporary slowdown in 2020, according to the report in the first issue of Globefish highlights (FAO, 2021), with statistics up to September 2020. It added that the tilapia market survived the Covid-19 pandemic with relatively little damage in comparison to many other species, due to its strong presence at retail and China's recovery. In China, the largest producer and exporter of tilapia, harvests dropped to around 3% in 2020 from 2019. This decline was due to a slowdown in farming and processing activities on top of a sharp reduction in domestic demand as the Covid-19 crisis developed in early 2020. Slight declines have also been observed in the other large Asian producers, including Indonesia and the Philippines.

In his run through of regional effects of the pandemic on tilapia consumption and trade, Fitzsimmons (2020) said that way before the pandemic months, Chinese exports to the US, its largest market for frozen products, were down 30-40% due to the imposition of the 10% (later increased to 25%) import tariffs since September 2018. The drop in demand fed back to the even lower prices for Chinese exporters and processors. When the tariffs were removed in March 2020, although sales increased, these were still lower than the 2017 level.

Interestingly, the cancellation of a major seafood show had far reaching effects on trade in tilapia. A report in chinadialogue.net (Zhang, 2020) quoted Chen Sheng, Maoming Evergreen Aquatic Product Co Ltd, saying that usually around 200 companies promoted their products at the annual seafood show in Brussels, resulting in almost 40-50% of their orders. He added that in March 2020, customers delayed more than 40% of orders. The shut-down of export markets affected tilapia; according to Dr Cui He, China Aquatic Products Processing & Marketing Association (CAPPMA) almost half of its production is exported. The US buys one third of China's tilapia. The delay in orders filtered down to the farmers who were not able to harvest and restock ponds; there are two cycles/year for South China producers like in Hainan.

Han Han, China Blue Sustainability Institute, noted that a survey by Hainan Tilapia Sustainability Alliance found that 10% of farmers could not clear their ponds and restock for a new cycle. In general, China's tilapia producers are looking to expand domestically while also looking at international sales. In Guangdong, China's major tilapia production hub, the farm gate price for size 500g to 800g fish was CNY9.34/kg or USD1.42/kg in week 13 of 2021. This was a three-year high.

Tilapia, because of its short cycle of 6-8 months, farmers can start and stop production, making supplies unpredictable and prices elastic. In the Philippines, where the annual consumption of tilapia is 5kg/capita, Covid-19 did reduce sales and 20% decline in farm gate prices. Retail prices for 5-6 pcs/kg tilapia fluctuated between PHP95-130/kg (USD1.9-2.6/kg) in January 2020 to PHP70-120/kg (USD1.4-2.4/kg) in January 2021 (BFAR, 2021). In Sumatra, Indonesia, in September 2020, tilapia prices at IDR19,000/kg (USD1.3/kg) went down almost 16% to IDR16,000/kg (USD1.10/kg), creating losses for farmers. With already thin margins in tilapia production, a 10.53% decrease in prices will result in losses for farmers in Sumatra (Wahidin et al., 2020). The reason for the losses was due to excess supply and low demand.

Tilapia in the US

Tilapia is the fifth most consumed fish in the US in 2019, according to the National Fisheries Institute (NFI) at 0.98lbs/capita (0.45kg/capita). There was more home cooking at the expense of food service, as the pandemic developed. Globefish said that as a cheaper alternative to many competing seafood options and a product that is already well-established at retail, tilapia was well-positioned to capitalise on the shift in consumer purchasing in the US, the largest market for imported tilapia. Consumption remained relatively steady despite a temporary drop in imports from China, with plentiful frozen inventories. US imports of frozen whole tilapia rose to 18,500 tonnes and that of tilapia fillet 82,800 tonnes, for the January-September 2020 period. US tilapia imports increased year-on-year in the first nine months of 2020 compared with 2019, to 141,000 tonnes (+18%), valued at USD460 million (+6%).

The outlook by Globefish is that the global tilapia sector is set to resume growth in 2021, increasing output by some 5%. Globally, Fitzsimmons (2020) sees that farmed tilapia production may see a year-on-year decrease for the first time. Farms in many countries have held fish in ponds/cages, processors have plenty of inventory in cold storage, and farmers have cut back on stocking fingerlings. Domestic markets have been hurt in almost all the tilapia producing countries outside of Africa. He also expects the retail markets to continue to be a bright spot while tilapia producers hope that the retail sales will continue after food service makes a comeback.

References

BFAR, 2021. https://www.bfar.da.gov.ph/files/img/photos/2021-1-1stWEEK(Retail)January3-9.pdf

FAO, 2021. Globefish Highlights. A Quarterly Update on World Seafood Markets, 1st Issue 2021. http://www.fao.org/in-action/globefish/publications/details-publication/en/c/1297260/

Fitzsimmons, K. 2020. Fishsite.com. https://thefishsite.com/articles/the-global-status-of-tilapia-production-and-marketing-under-covid-19-conditions

Nikolik, G. 2020. Fin Fish: presented by the Global Aquaculture Alliance and Rabobank, GOAL 2020, October 6-8, 2020.

UCN, 2019. Brazil poised to emerge as surprise competitor to China in US frozen tilapia market. https://www.undercurrentnews.com/2019/09/30/brazil-poised-to-emerge-as-surprise-competitor-to-china-in-us-frozen-tilapia-market/

Van der Pijl, W., 2021. https://mailchi.mp/027508c10d91/introducing-aqua-insights-and-tilapia-in-sub-saharan-africa

Wahidin, L.O., Rudiansyah, Neksidin, Sri Murtini, 2020. Dampak Covid-19 terhadap ekonomi perikanan budidaya di Kota Lubuklinggau, Sumatera Selatan (Covid-19 on the aquaculture economy in Lubuklinggau City, South Sumatra). Jurnal Perikanan Darat dan Pesisir (JPDP). Vol 1, No. 1 Oktober 2020.

Zhang Chun (2020). Coronavirus hits sustainable aquaculture. https://chinadialogueocean.net/13453-coronavirus-hits-sustainable-aquaculture/

Tilapia in Vietnam

Driving growth with local production of fingerlings

Fingerlings at the Sheng Long hatchery in Soc Trang province; 40 days old (2000-2500 fingerlings/kg)

The national target in Vietnam is to reach 400,000 tonnes of tilapia by 2030. The plan by the Ministry of Agriculture and Rural Development (MARD) is for 45-50% of production to be exported in product forms such as tilapia fillets and value added products. There is a relatively large domestic market where the preference is live or chilled fish of 600g to 1kg, the latter size for hot pot meals.

To succeed, the plan calls for support activities: production of enough fingerlings and control of diseases such as *Streptococcus* which is prevalent at water temperatures above 30°C. MARD's target is to reach 40,000ha of farming area and 1.8 million m^3 of cage culture in rivers and large reservoirs by 2030.

In 2019, the Vietnam Directorate of Fisheries said that the country had 16,000ha of farming area and produces 125,000 tonnes. In 2020, this area was expected to increase to 21,000ha and 150,000 tonnes. In 2020, Vietnam exported frozen whole fish, skin-on fillet and skin-less fillet to more than 60 countries.

In north Vietnam, Van Tien Nguyen (2020) reported that trials with farmers on intensive culture of Nile tilapia (*Oreochromis niloticus*) in monoculture in ponds showed that tilapia could reach an average weight of 500g after 6 months, with productivity up to 20 tonnes/ha/cycle. The net income per ha of pond was VND60,000,000 (about USD4,000). Floating extruded feed with 26-28% protein was used for fish smaller than 300g and feed with 18% protein when fish were larger than 300g. The culture season for tilapia is 7-8 months from April to the middle of November.

Broodstock and fingerlings

Tilapia farming largely depends on imported 21-day old tilapia fry from Taiwan and China. Although more expensive than locally produced fingerlings, there is a demand as these grow much faster. There is a market for fingerling production in Vietnam. In 2021, Genomar Genetics announced its expansion into Asia with its subsidiary in Vietnam. In phase I, the company plans to produce 50 million fingerlings/year. The first hatchery is in Tay Ninh province and a second hatchery in Northern Vietnam will be in operation by Q1, 2022.

Sheng Long Bio-Tech International, a leading aquafeed producer in Vietnam has fulfilled its plans to spearhead tilapia farming in Vietnam. In 2016, it began to import broodstock genetically selected for fast growth and high fillet ratio from its parent company in China. The first trait is to satisfy farmers and the second, importers. The fast-growing fingerlings can reach 600g in 4 months and 1 kg by 6 months in brackish water ponds at <8ppt salinity. In 2018, it expanded its hatchery in Soc Trang to supply 200 million fingerlings/year of both black and red tilapia. Sheng Long sees a strong export potential for Vietnam's tilapia.

The company has not only invested in quality fingerling production and feed but is closing the loop with farmers with a farming model suitable for the environment, technology transfer and a product offtake contract for processing. In Long Phu district, Soc Trang province, farmer Vo Thanh Van harvested 235 tonnes of tilapia from eight ponds of average sizes of 4,000m^2/pond in 2019. In his first farming period, the average ex-farm price was VND27,000/kg (USD1.17/kg) with a profit of VND1.5 billion (USD65,186).

Reference

Nguyen, Van. (2020). Intensive culture of Nile tilapia, *Oreochromis niloticus* in North Vietnam. 10.1079/AC.79343.20203483523.

Some updates on the tilapia lake virus

With no therapy in sight and pending resilient tilapia breeds, biosecurity is crucial. Key to controlling the disease during early production is rigorous screening of broodstock for TiLV.

In the last few years, the tilapia lake virus (TiLV) has been making the news, leading to several research groups addressing the challenges posed by the disease. The resilient tilapia, where Asia is a leading producer, is farmed in almost every corner of Asia and with new regions such as India, Myanmar and Cambodia interested in commercial production, there is concern on the spread of TiLV with the transboundary transfers of broodstock and fry. Losses from TiLV on an industry level, is not available but Dr Andy Shinn, INVE Aquaculture showed a loss of USD26,000 over a two-month period in a large cage farm in Malaysia (Shinn, 2018).

Surachetpong et al. (2020) published a comprehensive review in the Journal of Fish Diseases, titled, *Tilapia lake virus: The story so far*. TiLV was discovered in 2014 and currently, it has been reported in 16 countries, and this number is continuing to rise due to improved diagnostic assays and surveillance activities around the world.

The authors summarised the up-to-date knowledge of TiLV with regards to TiLV host species, the clinical signs of a TiLV infection, the affected tissues, pathogenesis and potential disease risk factors among others. They also described the virus itself: its morphology, genetic make-up and transmission pathways. They highlighted a recent study which mentioned that the genetic traits of the Genetically Improved Farmed Tilapia (GIFT) strain of Nile tilapia (*O. niloticus*) was resistant to TiLV which should benefit the selective breeding program to produce a TiLV-resistant line (Barría et al., 2020).

Species transmission

There is a concern on transmission across species and in Malaysia, Azila et al. (2021) described the results of sampling for the occurrence of TiLV in freshwater fish, aside from both red and black tilapia. TiLV was detected in tinfoil barb (*Barbonymus schwanenfeldii*) in some of the government hatcheries and in almost all the states in Malaysia where tilapia is cultured. The mean percentage detection of TiLV by RT-PCR at all these places was estimated between 10 to 50%. Susceptible species in Malaysia were confirmed as hybrid tilapia including the genetically selected DOFia Red (a strain developed by the Department of Fisheries, Malaysia), GIFT tilapia, wild black tilapia and wild tinfoil barb. Aich et al. (2021) quoted several studies which showed that upon co-habitation with tilapia in the culture pond, fish such as the catla, rohu, mrigal and milkfish as well as the mullet did not show any mortality during the TiLV outbreak.

Threat of co infections

At the virtual Aqu@Event by Adisseo, while discussing co-infections, the reality of disease in aquaculture, in March 2021, Dr Win Surachetpong, Kasetsart University, Thailand, described an example of co-infections in the one-month mortality syndrome or TOMMS (which was later identified as TiLV, Surachetpong et al., 2017) in Thailand. Data from June-December 2015 showed that in a sample of 600,000 fingerlings, there were multiple causes of mortalities: *Aeromonas* (52%), *Flavobacterium* (19%), Streptococcosis (2%), transportation stress (17%) and other parasitic infections (10%) like *Trichodina*, *Gyrodactylus* and *Dactylogyrus* implying that there are always more than one pathogen causing mortality.

During the production of tilapia, there are several infections like *Flavobacterium* during the earlier phase of the life history and towards 1kg fish, Streptococcosis. Surachetpong noticed the presence of ectoparasites and bacteria (*Aeromonas, Flavobacterium*) together with viral infections in 32 cases of TiLV outbreaks. Co-infections of *Flavobacterium* and TiLV, and *Aeromonas* and TiLV were dominant resulting in high mortalities. He said, "Bacteria and TiLV are frequently found in moribund fish. In a comparison between single infections of TiLV with *Aeromonas* and Streptococcosis, Nicholson et al. (2020) noted that the percentage was 39% for the single infections and 31% for the concurrent infections. The latter with higher cumulative mortality."

Amal et al. (2018) reported a case of natural co-infection of TiLV and *Aeromonas veronii* in a Malaysian red hybrid tilapia (*Oreochromis niloticus* × *O. mossambicus*) farm in 2017, with mass mortality among cultured red hybrid tilapia juveniles, approximately 45 days after introduction into earthen ponds. Phylogenetic tree revealed that Malaysian's TiLV strain was more closely related to the virus isolated in Israel than in Egypt or Thailand, while Malaysian's *A. veronii* strain 5L was closely related with strains from China. Basri et al. (2020) reported on a TiLV outbreak in red hybrid tilapia in a farm in Malaysia, in January 2020. TiLV, *Aeromonas hydrophila* and *Streptococcus agalactiae* were identified in the affected fish. The TiLV strain was closely related to the previously reported Malaysian strain that was isolated in 2019. On the other hand, *A. hydrophila* and *S. agalactiae* were closer to Algerian and Brazilian strains, respectively.

Mitigation efforts

In the absence of vaccines, Aich et al. (2021) indicated that implementations of strict good management practices, including quarantine protocols, are the only available option to combat the spread of the disease. To reduce the occurrence and severity of the virus, biosecurity and the use of disinfectants are crucial. Surachetpong and Gerharz (2021) reported how virucidal inactivation at 28°C occurred within 10 minutes of exposure to 50ppm concentration of an aquatic disinfectant Virkon. Waiyamitra et al. (2020) showed that in a TiLV challenge trial, the dietary supplementation of *Bacillus* spp probiotics reduce the viral load and expression of immune-related genes in hybrid red tilapia. There was also lower cumulative mortality in treatment groups. They concluded that probiotics may be beneficial and strengthen tilapia immunity and resistance against TiLV infections.

According to Ariav and Wajsbrot (2020), TiLV can be transmitted vertically, and therefore the establishment of a specific pathogen-free (SPF) broodstock is essential to avoid the spread of the disease. Meanwhile, key to controlling the disease during early production is rigorous screening of broodstock for this disease, which will ensure TiLV-free fingerlings. All live tilapia shipments (including eggs) must be highly regulated and monitored for the possible presence of TiLV.

References available on request

DNA region linked to disease resistance in tilapia

Scientists have analysed the genome of almost 1,000 fish from a pond that had experienced an outbreak of tilapia lake virus (TiLV). Image credit: Mahirah Mahmuddin, WorldFish

A study led by the Roslin Institute and WorldFish has found that a specific region in the genome of Nile tilapia – a key aquaculture species that is worth nearly USD10 billion globally – has a major effect on mortality levels during an outbreak of TiLV. The study, published in the journal Heredity, was funded by the CGIAR Research Program on Fish Agri-Food Systems (FISH) and the Biotechnology and Biological Sciences Research Council, part of UK Research and Innovation.

Fish with specific genetic variants in this region were substantially less likely to die in an outbreak of the virus than fish without these variants. Survival rates improved by approximately one-third, scientists observed.

By selecting parent fish for breeding based on these variants, tilapia strains with innate resistance can be developed. This will reduce the number of outbreaks and mortality rate of TiLV, which is one of the biggest threats to tilapia aquaculture, with mortalities up to 90% and for which vaccines are not yet available.

Improved survival

Scientists analysed the genome of almost 1,000 fish from a pond that had experienced an outbreak of TiLV. They compared the genomes of fish that survived the outbreak with fish that did not. This enabled scientists to find the region in the genome containing variants associated with survival. The average survival rate of tilapia with the favourable variants was 32% higher than that of fish with none of the variants.

"Tilapia lake virus can cause mass mortality to farmed Nile tilapia, which has major negative impacts for farmers and food security in many countries. Our results provide a clear route to selecting fish with improved genetic resistance to TiLV, with major potential to help tackle this devastating virus," said Professor Ross Houston, Personal Chair of Aquaculture Genetics, Roslin Institute.

"Breeders will be able to select the best candidates for resistance to TiLV by marker assisted selection, generating new strains of Nile tilapia with enhanced resistance. Interestingly, we also showed that this selection will not have any negative impact on the fish harvest weight," said Dr Agustin Barria, Roslin Institute.

"This information will be invaluable in creating resilient tilapia breeds that can help maintain production of fish in the face of increasing disease risks that threaten food security in many parts of the world. WorldFish plans to incorporate TiLV resistance in the new strains of GIFT we are developing," said Professor John Benzie, WorldFish.

Insights from agri-food experts and sustainable aquaculture

Over 4 days, from June 21-24, the Alltech ONE Ideas Conference was held virtually to unite thought-leaders and changemakers for an exploration of the power of science, sustainability and storytelling. Now in its 37th year, Alltech's flagship event continues to be an invaluable industry resource, with innovative ideas, inspiration and motivation from world-class speakers. Alltech announced that 10,000 attendees from 101 countries had access to a virtual platform to listen to 90 speakers.

"We are on the brink of a new beginning, and I do not believe that is just a new beginning for Alltech. I think it is a new beginning and a new golden era for agri-food, and it is led by what we believe is a bold vision," said Dr Mark Lyons, President and CEO of Alltech, in his opening remarks. "We want to deliver smarter, more sustainable solutions for our customers and for all of agri-food."

One of the keynote speakers, Anna Rosling Rönnlund, now Vice President and Head of design and user experience at Gapminder and co-author of "Factfulness," designed the user interface of the famous animated bubble-chart tool Trendalyzer, which helps people better understand global development trends, said, "A lot of things are actually improving, but we are very bad at seeing these slow trends on a global level. We need to have a fact-based worldview, and we need to remember that we need to keep upgrading our worldview, because the world changes, and so has our facts about it."

Change is happening

"To confront the myriad of challenges we face today, we need to have a legacy mindset," said Lyons, as he looked at the past for perspective and for learning. "Agriculture was growing. Scientific breakthroughs were leading the way to a more efficient food system and created the opportunity for the rise of brands and businesses that, today, we call the food industry."

Lyons looked at 18 innovations being dreamed of and implemented around the world. Among them, an antibiotic alternative capable of treating resistant bacterial infections. Scientists at Durham University have improved the current standard alternative to antibiotics (called peptoids) by altering their chemical structure to enhance their delivery into cells and their effectiveness against bacterial infections and methane from animal waste can be used to grow single-cell protein for food for animals. He also included, using activating enzymes as biological catalysts. Lyons said that enzymes can help us in many areas, such as improving digestion and feed utilisation, beneficially modifying microbiomes in animals and soils, altering fermentation patterns to break down waste and mitigating environmental toxins.

"I believe the agriculture industry will create climate-neutral food. We will continue to be one of those core industries that can sequester carbon, and we will be a big part of the answer to climate change.

"It is the industry that I am most excited about, and it is a great honour to be working in this industry," Lyons shared. "We can nourish the world while cooling its climate. We can leave not a footprint but a legacy. What an extraordinary opportunity as we all gather, working together for a Planet of Plenty™."

- Dr Mark Lyons, President and CEO of Alltech

Sustainability and aquaculture

In the aquaculture segment with presentations on demand, Alltech's Aquaculture Lead and CEO Alltech Coppens, Ronald Faber explored aquaculture's sustainability agenda with four speakers. There is a push for more environmentally friendly food production solutions which is an exciting opportunity for the aqua industry. On the question "Can sustainability remains aquaculture's unfair advantage",

Karin van de Braak, Aquaculture Health Specialist, Sustainable Aquaculture Solutions (SAS) and Esther Luiten, Commercial Director, Aquaculture Stewardship Council (ASC), in their joint presentation said, "Yes, it can maintain its advantage but aquaculture must move from more to better. It needs to do in a different way, shift from eco-efficiency to eco-effectiveness." They added that the industry is running out of resources and therefore there should be a synergy between being ecological and economical. Aquaculture sees that the right move is to reduce carbon footprint, but they say this is not enough. "It is not only to minimise footprint by increasing efficiency but also to optimise the positive ones. It is important to see things are connected in a complex system to be effective." They added that industry has been focussing on disease per se but less on efficiency. There are also environmental and social costs of diseases.

Bjarne Hald Olsen, COO and Business and Development Manager, Billund Aquaculture, argued the case for land-based farming to meet the growing needs of the aquaculture industry, especially using recirculating aquaculture systems (RAS). Denmark based Billund Aquaculture is a pioneer in the development of RAS worldwide and is present in 20 countries.

In comparing the water consumption required in producing per kg of fish, energy use and carbon footprint with meat production, there is no doubt that aquaculture uses less. Olsen listed the advantages of RAS; minimum water usage, optimal temperature control, stable and predictable production, disease control, 100% control on fish escapes and faecal waste can be captured and converted into fertiliser. There is the climate and environmental control. RAS fulfils 12 out of 17 of UN's Sustainable Development Goals (SDGs). Olsen added that today, consumers are very concerned on the environmental impact of aquaculture while in open sea cages, the salmon faces effects of climate changes, higher water temperatures, algae blooms in addition to parasite infestations.

Ben Lamberigts, Manager of Quality, Research and Nutrition at Alltech Coppens, offered his insights on nutrition for a sustainable future through the four pillars of fish nutrition: palatability, performance, pollution and planet. "It is a challenge that we have to solve before we can grow the aquaculture industry," said Lamberigts. "But the industry is working on this, and we are doing a very good job. In fact, we have already lowered the fish in fish out (FIFO) factor since the 1990s. Still, we need more fishmeal alternatives." While the global aquaculture production has achieved a 0.27 FIFO, Alltech Coppens even lowered the FIFO to 0.10, which means only 100g of wild-caught fish is needed to produce 1 kg of farmed fish.

Lamberigts emphasised, "No fish has a requirement for fishmeal or even a requirement for a specific raw material. They require essential nutrients, such as digestible protein, fat for energy, vitamins and minerals." Alltech Coppens, has defined alternatives to fishmeal with these requirements; split them up into single metrics, to compare between each other and to fishmeal. This has been done in human food items with the nutrition score on food packaging. Nutritional scoring, as well as sustainability scoring, helps consumers compare between products and make the right decision. (Source: Tien Le@Alltech.com).

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Aquaculture and alternative seafood pre-accelerator in Singapore

HATCH, the aquaculture tech venture capital company is known for its global accelerator programme investing in companies focused on sustainability improvements in the aquaculture value chain. The first instalment of the new programme called 'Hatch Innovation Studio' took place in Singapore from May 4 to June 11, 2021. The Innovation Studio SG 2021 focused on developing aquaculture and alternative seafood projects. It is supported by Startup SG, Enterprise Singapore.

Wayne Murphy, Co-Founder and Partner at Hatch, said, "Seafood consumption drives the growth of the aquaculture and alternative seafood in the region. With the rising populations, existing opportunities in the region will only grow further. We are looking for the best ideas to develop and scale into viable businesses to address the challenges in Asia."

Hatch has been working closely with Enterprise Singapore to drive innovation since 2019. It is committed to supporting more talent from Singapore and the surrounding region to create a local pipeline of aquaculture and alternative seafood startups. In 2021, there are 11 companies, ranging from early-stage pre-commercial projects to companies that have raised seed funding. The studio is a part-time programme to help them develop their businesses and network with industry experts. The teams showcased their technologies to industry stakeholders and investors to explore potential collaborations at the Aquatech Pitch Day in June. A summary of the participating team is given below:

Singapore based **The Agrata** group uses recirculating aquaculture system (RAS) for a hatchery based, vertically integrated *Scylla serrata* (mud crab) production. The partner farming operations are on Riau Islands, Indonesia. Agrata, has secured funding in November 2020 and will commence operations in August 2021 and produce the first batch in January 2022.

Vietnam based **TEPBAC** has a platform of software and hardware IoT solutions for a more profitable and transparent shrimp farming. These include real-time monitoring of several parameters, such as pH, temperatures, salinity and oxygen. The next focus is pangasius farming.

Singapore based **Universal Aquaculture** (UniAqua) has an indoor high-density shrimp farm using proprietary Hybrid Biological Recirculation System (HBRS)-an energy saving water treatment system, developed from 6 years of research. Their inaugural 1,400m^2 farm is expected to produce a tonne of vannamei shrimp per week. The target is to have farms close to markets, within Singapore and overseas, with partners.

Singapore based **Protenga** has scaled to commercial production in Johor, Malaysia with its data driven technology for insect meal production. In 2020, it raised USD1.6 million from a seed investment round. It has an insect-based shrimp additive product (ShrimProX). The market is feeds for petfood, livestock, marine shrimp and freshwater prawn.

Impacfat has cultured meat technology to produce cell-based fat (adipocytes) efficiently and sustainably from edible fish species to complement existing plant-based meat or muscle-dominant cultured meat to improve its taste, texture, appearance and nutritional value.

Australia and Philippines based **COAST 4C** have a social enterprise focusing on seaweed production and includes a fishing net buy-back scheme. The mission is to build vibrant and resilient blue economies in marginalised coastal areas that benefit the 4Cs: Communities, Conservation, Commerce and Climate. Over the next 24 months, it will be seeking seed funding.

Singapore's **Aquaculture Innovation Centre** or AIC is working on a vaccine to combat iridovirus in fish; a multivalent oral vaccine using algae as the carrier for top coating on feed for less than 3g fish. The initial target will be local farms, followed by farms in China and Southeast Asia. Funding is required initially for the pilot plant and commercial validation.

Indonesia based **Minapoli**, a startup for information and business in fisheries and aquaculture wishes to integrate all segments in Indonesia's fisheries and aquaculture to contribute to its development. It is the first marketplace for aquaculture. The coverage in Indonesia is over 47 cities in 18 provinces. A target is to expand into the Asia Pacific region.

Singapore based **Luminis Water Technologies** provides proprietary water sampling and analysis equipment, molecular diagnostics, rapid in-the-field pathogen ID, and advanced AI microbiome analytics. The business model is subscription-based and consulting/analytical project services.

RAS Aquaculture is a farm technology company with production systems, hardware, software to scale up sustainable and efficient indoor aquaculture of crustaceans and fish using a combination of closed loop recirculating systems and biofloc. The business model is subscription-based and consulting/analytical project services. It expects to scale up by 2023 with seed funding.

Through biotechnology, **TeOra** designs proprietary peptides for immunostimulation and disease prevention. These can target multiple diseases and can be done 10 times faster and 100 times cheaper than traditional methods. The startup is initially targeting white spot syndrome virus (WSSV) prevention in shrimp. Seed funding required is USD1 million to upscale. It also needs strategic partnerships to conduct commercial trials.

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www.taiwanfishery.com

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Thailand's First Sustainability-Linked Bond

Thai Union Group PCL. The world's leading seafood processor, has successfully priced a THB 5 billion seven-year senior, unsecured Sustainability Linked Bond (SLB) for institutional investors. This is the first SLB launched in Thailand and follows the launch of Thai Union's inaugural Sustainability Linked Loan (SLL) in February 2021, further demonstrating the company's ongoing commitment to its ESG principles. It is another significant step forward for Blue Finance—financing for projects benefiting oceans—and the seafood industry as a whole.

Thai Union's SLB is not only the first in Thailand but also the first globally to introduce step-up and/or step-down facilities related to the achievement of Sustainability Performance Targets (SPTs). These targets include remaining in the Dow Jones Sustainability Index (DJSI) Emerging Markets and ranking in the top 10 companies for the DJSI Food Products Industry Index; reducing Thai Union's Scope 1 and Scope 2 carbon emissions from manufacturing operations by 4% annually (carbon intensity); and increasing the monitoring and surveillance of Thai Union's wild-caught tuna supply chains, whether electronically and/or through the use of human observers at sea. Investors in the bond will be entitled to a lower or higher coupon should the company achieve or fail to achieve these SPTs in 2023 and 2026. The company's Sustainability Linked Financing Framework is externally verified by Sustainalytics to ensure alignment with international best practices and standards. www.thaiunion.com

"Sustainability is central to our operations and business philosophy and we have committed to a policy of healthy living, healthy oceans. This type of Blue Financing represents another way we can now work with our partners in the financial community on products that help ensure we continue to preserve the oceans that are vital not only to our business, but also the planet while providing healthy and nutritious products that health-conscious consumers globally are demanding," said Thiraphong Chansiri, President and CEO of Thai Union.

New logo and new brand identity

Akiolis has announced several changes in 2021, in line with the work to date, both its raison d'être and strategy. These changes translate into the affirmation of its role as a "Révélateur de valeur" (Value Developer), within a chain that starts with the sourcing of animal materials and continues with the production of the fats and proteins used in formulations. "We are investing heavily in the quality of our products and services. Now, we want to go even further and prove every day that we are "Révélateurs de valeur", said Sophie Grégoire, Communication Manager. "More than never, the attention focuses on quality of end products and listening to the needs of customers and customers' clients."

AKIOLIS
Révélateur de valeur

Akiolis has changed its logo. "Our new logo reflects this ambition and our commitment. The business is at the heart of sustainable development and the circular economy. This approach is first and foremost for our customers, but it is also for ensuring a better everyday life and a better planet. We are aiming to transform the end of a life cycle into the beginning of a new life, even more valuable," said Grégoire.

Akiolis specialises in rendering activities and the transformation of animal by-products into high-value proteins and fats. Through partnerships it has access to a vast array of animal materials and through industrial processes valorises these for pet food and animal nutrition, aquafeed and others. It has created 7 new brands for its ingredients. These brands replace the old brands Prossential and Soleval.

The company said that this is another sign of the importance placed on the image and consistency of their products. Each brand carries specific promises that meet the current or future needs of users in each market.

"We are fortunate to be the subsidiary of a group (Tessenderlo Group) that has a real industrial vision in the long term. Investing in the future does not scare us!" - Gilles Cogny, Akiolis Executive Vice President.

For aquaculture, the products are under the brand Hydrofaks by Akiolis. To meet performance challenges for aquatic species, this brand, which features the Akiolis guarantee, gathers the ingredients of current ranges, the latest innovations under development, and the associated services. www.akiolis.com

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TIFSS 2021 Reschedule to December 2-4

Due to the ongoing COVID-19 situation and the Level 3 epidemic alert locally in Taiwan, in consideration of the health and safety of all visitors and exhibitors and in consultation with relevant stakeholders, the Taiwan Int'l Fisheries and Seafood Show 2021 (TIFSS 2021), originally scheduled to be held from September 2 to 4 this year, has been moved to **December 2-4** at Taipei Nangang Exhibition Center, Hall 2. The virtual exhibition, the TIFSS online 2021, will be simultaneously rescheduled to **December 2-31** for global exhibitors who might be unable to take a business trip to Taiwan under the epidemic.

TIFSS is Taiwan's first tailored exhibition for fisheries industry. This year, four major themes will be presented in the exhibition, including "Ocean Fishery & Fishing Equipment", "Smart Aquaculture & Fish Seeding Technology", "Seafood & Value-added Process", and "Fishing Tackle & Water Equipment"; meanwhile, TIFSS online 2021, will have online services including virtual booth display, meeting scheduling and messaging, to welcome overseas exhibitors and visitors to explore business opportunities. The TIFSS virtual show and hybrid (online plus offline) booth are still available for international exhibitors to join.

Email: taiwanfishery@taitra.org.tw or sonya_chaw@myexhibition.com.tw

Web: https://www.taiwanfishery.com

Updates on EAS and WAS events

AQUACULTURE EUROPE 2021 in Madeira, Portugal, ***October 4-7*** is an In-Person event! The full conference program grid is now online. The deadline for submitting abstracts for E-poster presentation remains as **August 28**. The Covid-19 restriction are updated weekly. Organisers ask participants to continue submitting abstracts and reserving booths (mario@marevent.com) Web:www.aquaeas.org

WORLD AQUACULTURE 2021 Merida, Mexico ***November 8-12, 2021***. The international event organised by the World Aquaculture Society is combining the Latin American & Caribbean Aquaculture 2021 event with the international WAS event. It is now time to submit abstract. Booth booking (mario@marevent.com). Web: www.was.org Email:info@marevent.com

WORLD AQUACULTURE 2020 Singapore ***December 5-8***, 2021. There is still time to submit abstracts and to book a booth in the exhibition. Email: info@marevent.com

AQUACULTURE AFRICA 2021 Alexandria, Egypt ***December 11-14***. AFRAQ21 is an In-Person meeting in Alexandria after approval of the Ministry. Submission of abstracts and full papers has now been extended to ***30 Septembe***r. Organisers urge participants to get vaccinated. Registration is open. Complete the online registration form at www.was.org. Book a booth (Email: mario@marevent.com).

Email: worldaqua@was.org or africanchapter@was.org

2021

August 11-14
Aquaculture America 2021
San Antonio, Texas
www.was.org

August 18-20
TARS 2021:
Shrimp Aquaculture
VIRTUAL
www.tarsaquaculture.com

August 23-27
Annual Practical Short Course on Aquaculture Feed Extrusion, Nutrition and Feed Management
ONLINE
http://tx.ag/extrusion

September 14-16
SPACE 2021
www.space.fr

October 4-7
Aquaculture Europe (AE2021)
Madeira, Portugal
www.aquaeas.org

October 13-15
Aquaculture Vietnam
Can Tho City
www.aquafisheriesexpo.com/vietnam

November 8-12
World Aquaculture 2021
Merida, Mexico
www.was.org

November 24-26
Aquatica Asia
Tangerang, Indonesia
https://aquaticaasia.com

December 5-8
World Aquaculture 2020
Singapore
www.was.org

December 11-14
African Aquaculture 2021
Alexandria, Egypt
www.was.org

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18 - 20 August 2021 • 2.00pm to 6.30pm SGT (GMT+8) VIRTUAL EDITION

TARS 2021 The Aquaculture Roundtable Series®

SHRIMP MARKETS • MARGINS • PRODUCTIVITY

The Aquaculture Roundtable Series (TARS) 2021 will be from **August 18-20** and focus on **Shrimp: Markets • Margins • Productivity**. The three-day meeting from SGT 2pm to 6.30pm (GMT+8) will address key issues impacting Asia's farmed shrimp industry today and explore opportunities for the future. The pandemic has brought new market challenges, namely a shift in demand, a shift in supply, disruptions along the supply chain and changes in market preferences. Diseases continue to impact productivity. Decreasing survival rates have led to higher cost of production and lower margins. A higher supply from Asia and Latin America have brought down prices and are squeezing margins.

"During these challenging two years, we see how shrimp markets and consumer perceptions are influencing industry trends in Asia. While we seek ways to improve production efficiency, it is important to draw the industry's attention to sustainability demands to build consumer confidence in Asian shrimp. At the same time, farmers must move to adopt innovations and big data analyses to build a predictable and consistent industry," says Dr Zuridah Merican, conference chair and editor of Aqua Culture Asia Pacific magazine.

TARS 2021 will bring industry stakeholders together to address these critical issues and seek solutions with market-led production while using innovative technologies to increase production efficiency. Discussions will focus on building consumer confidence in farmed shrimp from Asia and convince markets on its sustainability agenda.

The TARS 2021 program includes 7 plenary and Q&A panel sessions with invited industry leaders. Not to be missed is the Hard Talk with 3 business leaders in their respective fields (shrimp feed production, farming and functional additive supplier) who will offer their perspectives on *"Why is there a trust deficit among Asian farmers on functional feeds?"*

The virtual platform will feature live streaming of the full conference sessions; on demand content; live Q&A sessions and chats; sponsors' hall; and networking and matchmaking opportunities.

"Although TARS 2021 will be a virtual edition, attendees can expect the same quality and output as previous in-person events, including networking opportunities," Merican reiterates.

PROGRAM DETAILS

are available at https://tarsaquaculture.com/program/

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More on TARS 2021 at www.tarsaquaculture.com/Email: conference@tarsaquaculture.com

State of the Industry – Understanding Markets and Consumers

In these pandemic years, there has been a demand shift and supply shift. We look at changing consumer preferences in the EU, China and US. What is the market outlook and trends in 2022? We follow with a Q&A panel session moderated by Ronnie Tan with ChingLing Tanco, Philippines and S Santhana Krishnan, India to explore how can Asian producers better position products in these markets.

- An EU Market Perspective of Asian Shrimp Production-Willem van der Pijl, Shrimp Insights, The Netherlands
- Some Perspectives on China's Changing Shrimp Demand-Lee Ho, Zhanjiang Gangyang Aquatic Co Ltd, PR China
- U.S. Shrimp Market: Outlook and Trends -Angel Rubio, Urner Barry USA.

Willem van der Pijl

Lee Ho

Angel Rubio

ChingLing Tanco

Ronnie Tan

S Santhana Krishnan

SWOT Analysis on the Asian Model

How sustainable is the Asian intensive model compared to LATAM's extensive model? How can Asia augment its weaknesses and build on its strengths to meet market demand? Is bringing back black tiger shrimp farming a blunder? Moderated by Patrick Sorgeloos, Belgium and joined by Tung Hoang, Australia and Darryl E. Jory, USA.

- Cultured Shrimp in 2030: Low Density Models of the Americas or the More Intensive Models of Asia-Robins McIntosh, Charoen Pokphand Foods, Thailand
- Bringing Back Black Tiger – Better or Blunder-Manoj M Sharma, Mayank Aquaculture, India

Robins McIntosh

Manoj Sharma

Patrick Sorgeloos

Tung Hoang

Darryl E. Jory

Sustainability – Building Consumer Confidence

Consumers are demanding that producers work with sustainability in mind. While the Seaspiracy documentary demonstrated the vulnerability of aquaculture in general, we need to build consumer confidence in Asian shrimp. Moderator Ronnie Tan and industry players, Han Han, PR China and Haris Muhtadi will discuss current challenges.

- Emerging Sustainability Themes in Aquaculture-Marcela Salazar, Benchmark Genetics, Colombia
- Marine Microalgae Omega-3s Enable Sustainable Growth of the Shrimp Industry-Fuci Guo, Corbion Algae Ingredients, Malaysia
- Adding Value to Side-Stream Products: A Concrete Case for Sustainable Shrimp-Vincent Fournier, Diana-Aqua, France

Marcela Salazar

Fuci Guo

Vincent Fournier

Han Han

Haris Muhtadi

Margin Optimisation

Safeguarding margins and costs of production is a perpetual challenge, more so with lower offer prices in recent years. Romi Novriadi, Indonesia will moderate the Q&A panel with industry players Soraphat Panakorn, Thailand and Sreeram Raavi, India.

- Getting It Right: Microbial Management in Shrimp Hatchery and Ponds-Benedict Standen, Biomin GmbH, Austria
- Optimisation of Feed Margins: Extracting Value out of Feed Proteins-Hervé Lucien-Brun, Jefo Nutrition, Canada
- The Potential for Technology, Modelling, Data Analyses and Artificial Intelligence to Improve Productivity and Sustainability of Aquaculture in Asia-Dominique P Bureau, University of Guelph, Canada

Benedict Standen

Hervé Lucien-Brun

Dominique P Bureau

Romi Novriadi

Soraphat Panakorn

Sreeram Raavi

Managing Productivity – Survival Rates and Disease Control

Lower survival rates have increased costs of production from diseases such as EMS/AHPND, WFD, EHP and muscle necrosis. There are also newer possibilities with digitalising and real-time monitoring to learn to manage disease trigger points. Olivier Decamp, Thailand will moderate the session, with Ravikumar Bangarusamy, India and Kallaya Sritunyalucksana-Dangtip, Thailand.

- Science in Shrimp Farming and Recent Innovations in Production in Vietnam - Loc Huu Tran, ShrimpVet Lab, Minh Phu AquaMekong, Vietnam
- Precision Nutrition and Health Solutions for Higher Productivity - Daranee Seguin, DSM Nutritional Products, Thailand
- Opportunities in Real-Time Monitoring and Digital Farming Tools – What are the Key Elements in Health Management for Farmers and the Industry? - Ralf Onken, Fai Farms, Norway

Loc Huu Tran

Daranee Seguin

Ralf Onken

Olivier Decamp

Kallaya Sritunyalucksana-Dangtip

Ravikumar Bangarusamy

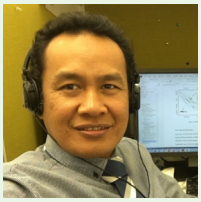
Weak Links in the Supply Chain

In this multidisciplinary shrimp farming industry, how can industry augment the weak links to achieve margin optimisation and higher productivity? Here, three areas of weak links are covered by speakers. Moderator Ravi Kumar Yellanki, India will lead the conversation, joined by Dylan Howell, Singapore and Christopher Co, Philippines.

- Bridging the Gap: Genetic and Hatchery Considerations for a Maturing Shrimp Industry - Steve M Arce, Hendrix Genetics/Kona Bay, USA
- Functional Feed Additives in Shrimp Farming to Reduce the Impact from Diseases: Are They Really Worth it? - Martin Guerin, Adisseo Asia Pacific Pte Ltd, Singapore
- Challenges and Opportunities in Reducing Greenhouse Gas Emissions from Indonesia's Shrimp Aquaculture, Ilman Muhammad, Yayasan Konservasi Alam Nusantara, Indonesia

Steve Arce

Martin Guerin



Ilman Muhammad

Ravi Kumar Yellanki

Dylan Howell

Christopher Co

Future Growth Needs Investments and Big Data

Financing continues to be a bottleneck. How can the industry attract investments and reduce risks? Investors look for credibility, predictability and risk mitigation. Integrating big data along the supply chain is a foundation for predictability. Moderator Anton Immink, with Jeremy Ong, Singapore will lead discussions on how to improve investor confidence in shrimp aquaculture in Asia.

- Unlocking Investment: Consistency, Record Keeping, and Risk Mitigation-Alexander Farthing, Alune Aquaculture, Singapore
- Production Predictability with AI and Big Data in Asia's Shrimp Farms - Chelsea Andrews, XpertSea, Canada
- How can Real Time Monitoring, Automation and Industrial Revolution 4.0 Improve Shrimp Aquaculture?-Aryo Wiryawan, JALA Tech, Indonesia

Alexander Farthing

Chelsea Andrews

Aryo Wiryawan

Anton Immink

Jeremy Ong

HARD TALK with Business Leaders

Moderator Ronnie Tan will pose hard-hitting questions on "Why is there a trust deficit among Asian farmers on functional feeds?" to three business leaders in their respective fields, i.e. shrimp feed production, farming and functional additive supplier.

Panellists for Hard Talk

Samson Li
CEO, Grobest,
Hong Kong SAR

Guntur Mallarangeng,
CEO, Dewi Laut
Aquaculture, Indonesia

Dr Peter Cotteau,
Business Unit Director,
Adisseo, Belgium

The forte of TARS, the **Interactive Breakout Roundtable** sessions will continue in virtual rooms. With the focus on ***"Building Alliances to Improve the Supply Chain and Traceability,"*** stakeholders will explore ways to build alliances, collaborate and integrate with each other. Participants will join a virtual room of one of these groups.

Group 1:
Feedmillers & Farmers

Group 2:
Genetics, Hatchery, and Farmers

Group 3:
Processing, Marketing, and Farmers

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