

# AQUA CULTURE

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COVID-19: Aquafeed Front

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Revisiting Vibriosis in Shrimp Aquaculture

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Selective Breeding of Tilapia in Thailand

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Krill Meal in Juvenile Olive Flounder

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## Aquafeeds in 2019: Pulled by market demand



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Feeding seabass at PT Bali Barramundi in north Bali, Indonesia.

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Zuridah Merican

## Shifting dynamics and supply chain uncertainties

COVID 19 has disrupted more lives and businesses than any other event in recent history. Every industry shares common factors, but each also faces particular challenges and aquaculture is no different. Unlike the oil and gas industry which is currently facing both a supply shock as well as a demand shock, the aquaculture industry faces disruptions at pinch points all along the supply chain, very much like how an accordion is played.

If we look upstream, our international shrimp genetic companies have been unable to supply broodstock to hatcheries on time and in full, especially when farmers need to stock ponds after a rather good 2019. Airlines have shutdown international flights. Countries with local broodstock suppliers have the upper hand. Has the strategy to depend on US based broodstock worked against us now? There is a possibility that hatcheries will resort to pond reared broodstock. India seems to be especially hard-hit, evidenced by prices of post larvae increasing from USD5,000 to USD6,000 per million. Andhra Pradesh, the leading shrimp farming state finally instated a ceiling price.

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Aquafeed tends to rely on marine ingredients, of which most are imported. China relies on Peruvian and Chilean fish meal which normally would require a 30+ day shipping schedule. With the pandemic, finding ships at the right place at the right time has been a challenge, disrupting the supply chain. The fish meal situation has radically changed to a bullish 2020 with higher prices, as described by Jean-François Mittaine on page 30. With supply issues in March and April, local prices of many ingredients have increased forcing some feed millers in countries like China, Vietnam and India to increase feed prices. India, which has arguably the most aggressive lockdown, suffered from the lack of workers who had to return to their home states.

For farms ready to harvest, getting fish and shrimp to the consumer is no longer business as usual. With perishable goods, time is of essence and with no brokers or local transport and delivery disruptions, many farms have had to start online sales. Although considered essential, many wholesale markets were shut down due to the impossibility with social distancing. Processing plants which were able to take the harvests, faced major challenges as well. Workers were in short supply while cold storage facilities were beginning to fill-up with no off-take. This is partly due to poor demand but the critical factor in the early stages was finding containers and shipping schedules. Guayaquil, the coordinating centre of shrimp production in Ecuador is reported to be the epicentre of Covid-19. Farm gate prices have dropped to USD3.30/kg for size 60/kg, below the cost of production and the shrimp sector is estimated to be operating at 50% of its capacity.

In the US, 70% of all seafood is sold via food service. While supermarkets and retail report higher sales, there is still a net loss of seafood sales overall. With China and some EU countries emerging from lockdown, most of the population are still hesitant to convene at restaurants

for a meal. In Asia, many seafood restaurants offer highly priced and prized live seafood and this route to market will be the biggest loser of all. This is a new world where we are likely to see the temporary demise or shrinkage of live seafood in the short to medium term. Many marine cage culture operations in Southeast Asia rely on well boats to purchase live fish for markets in Singapore and Hong Kong. The business continuity plan for this business model will be difficult to conceive. The winners are likely to be plants who can process the seafood and maintain shelf life for at least up to 12 months. Integrated enterprises will survive better under these circumstances and the goal will be to stretch the accordion as much as possible and remove any pinch points.

How will the remainder of 2020 pan out? As we are not out of the woods yet in mid Q2, it is likely that the scenario defined as the "global pandemic and recession" by McKinsey & Co will prevail.

The strength of the USD versus emerging currencies will help exports for countries like India and Indonesia. Vietnam is looking like a role model as their exit strategy from lockdown seems to be working. Vietnam's pangasius industry targeted China as the new market in 2018 but exports have fallen since February and exporters surveyed by VASEP predict a pessimistic year. Both India and Ecuador, significant exporters of shrimp to the world, have faced an extremely difficult Q2 and are predicting lower supply this year to the tune of 30%. If this is true, the supply decrease is likely to be even more than the demand drop and prices will rise in the second half of the year. With shifting dynamics, forecasting becomes more difficult and to paraphrase Darwin – it is not the strongest who will survive but those who are more adaptable.

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# COVID-19: Changing norms of seafood consumption and aquaculture

In the months of February to May, discussions among seafood and aquaculture stakeholders have focused on the impact on the supply chain during the coronavirus COVID-19 pandemic across Asia. Lower consumption was evident with disruptive distribution of seafood, mainly in the horeca market, as restaurants, cafes and hotels were not allowed to function, except for takeaways. E-commerce for fresh fish and shrimp is very usual in tier-one cities in China. In Malaysia, this suddenly became a new normal for consumers of all ages.

Robins McIntosh, Executive Vice President, Charoen Pokphand Foods Public Company, summarised the situation in shrimp farming during the few months of 2020. "Farms were actually not affected for the most part until February, March and April. The first quarter has been good, as stocking was robust in the fourth quarter of 2019. Vietnam has stayed robust with only a small fall-off in April. Thailand's shrimp farming was perhaps 5% down in Q1 too but this was because of an extension of a trend to lower production for higher value shrimp. India's shrimp farming was initially robust but stocking in late March was reduced with lower processing capacity. But there remained shrimp stocks in ponds to feed and feed plants never shut down. China's first shrimp crop failed and the second stocking was problematic with hatchery disease."

"One early impact of this pandemic was misinformation and farmers overreacting in India," said S Chandrasekar, General Manager, Grobest India Pvt Ltd, in a linked-in video. There was panic harvesting of 10-12g shrimp in Andhra Pradesh prior to the lockdown. "Logistics was the major issue—the transport of post larvae from hatcheries to farms; feeds from feed mills to farms; ice to farms and harvested shrimp to processing plants."

In Indonesia, villagers, fearing spread of the virus, stopped outsourced harvesting teams from entering farms. In the Philippines, inter island airfreight costs doubled and tripled for delivery of fresh shrimp to Manila from Bacolod and General Santos farms, respectively. Buyers also developed innovative multi-mode logistics to reduce costs as retail prices dropped. In India, hatcheries drained away unsold post larvae because of logistics issues.

## Broodstock and post larvae

The absence of commercial flights affected broodstock supplies and within countries, movements of nauplii and post larvae. "While many hatcheries took delivery of broodstock before airlines shut down in mid to late March, logistics was an issue. With Asia, we could service Asia through charter flights such as to Sri Lanka, which is of course not possible from the US," said Robins. Separately, there are already reports on the overuse of existing broodstock leading to poor post larvae quality in Indonesia, India, Thailand, Vietnam and China.

C Sugumar, Regional Director-South Asia, Kemin, in an April webinar said that up to March, 16 billion post larvae out of the annual 71 billion post larvae were produced. India's vannamei shrimp hatchery business needs 25,000 broodstock for a production of 6 billion post larvae to supply 35% of the remaining ponds which are yet to be stocked..



*In his video message to shrimp farmers, S Chandrasekar, General Manager, Grobest India Pvt Ltd assured that China is already buying shrimp leading to better farm gate prices.*

Ravi Kumar Yellanki, President of the Society of Aquaculture Professionals, told the Economic Times, India, that since March there has been no broodstock imports. Broodstock supplies are only expected in May. Even so, broodstock must undergo quarantine at the Chennai Aquaculture Quarantine Facility although industry had requested that importing hatcheries quarantine their broodstock on site. D Ramraj, President of the All India Shrimp Hatchery Association added that as post larvae distribution was disrupted, hatcheries lost almost 3.5 billion post larvae and 15,000 broodstock. The expected shortage raised post larvae prices and the Andhra Pradesh state government has set a ceiling price of INR 0.37/PL (USD4,933/million PL) but industry is of the opinion that market prices will prevail.



*In Malaysia, seabass prices dropped to only MYR 6-7/kg for 600-700g fish as borders were closed for exports to south Thailand for farmers in north Malaysia. Picture by Mohammad Noor Amal.*

## Reduced demand, low prices

"Reduced global consumption means that the losses in exports could be as high as INR4,000 crores (USD533 million) with the slowdown of exports to the EU and USA," said Ravi Kumar. Furthermore, with shrimp prices plunging, farmers are not keen to restock ponds. This may lead to a 20–30% fall in shrimp production in India. In Thailand, ex-farm prices for size 70/kg dropped to THB100/kg (USD 3.1/kg) from THB135/kg (USD4.1/kg), and farmers came together to set prices. There were no orders from US buyers but there was still a need to continue farming to keep workers in their jobs.

"In China, the immediate effect of the lockdown in February and March was disruption of market access and about 4–5 million tonnes of fish and shrimp remained unsold before April," said Dr Zhou Enhua, USSEC, Shanghai. He also expected that more fish will be sold at lower prices as farmers empty ponds for the next cycle. Dong Qiufen, Guangdong Nutriera Group noted that some farmers lost money, but others had better profits from selling some high-value species, such as yellow catfish and largemouth bass. In April, it was still mainly online marketing and home consumption.

As consumers in China emerged from the lockdown, better consumption raised fish prices. But in Malaysia and Thailand, groupers in cages and ponds remained unsold with the disruption of the live fish trade to Hong Kong and China.

In the first 3 months of 2020, Vietnam's pangasius industry saw declines in export values such as 36.4% in China, 13.2% in the US and 36.5% in EU compared to the same period in 2019. However, there is hope that exports will recover in May and finally lead to an annualised drop of 20% compared to 2019.

Domestic markets depend on large wholesale markets to distribute marine and freshwater fish, as well as shrimp to retailers and smaller wet markets. The closure of wholesale markets to prevent crowds cut off access to fresh fish. In India, there is good demand for freshwater fish but shops are allowed to open for 3–4 hours only in a day. In turn, this slows down regular harvesting.

## Price changes in shrimp markets

In April after the lockdown in China, as demand rose, Dong said that ex-farm prices on April 16 for live shrimp reached USD11.4/kg in Hebei for size 50/kg and USD10/kg in Guangdong province. High prices were due to blockages and delays in logistics for imports.

Higher prices are expected in the coming weeks. Industry in China reckoned that Thailand, Vietnam, Indonesia and India will face export problems due to lockdown and shipping difficulties.

Industry reported that vannamei shrimp prices in Malaysia and Vietnam, were holding up because of local consumption. In May, prices for size 100/kg shrimp in domestic markets in India rose to INR200–240/kg (USD2.7–3.3/kg). In addition, there was a large drop with monodon shrimp prices in Malaysia, since they are usually destined for the high-end live shrimp local and regional markets. While vannamei prices remained steady at MYR24/kg (USD5.6/kg for size 50/kg,) prices of the monodon shrimp dropped to MYR24/kg for size 30/kg.

| Farm gate price for vannamei shrimp (USD/kg) |         |          |       |           |
|--|---------|----------|-------|-----------|
| Size/kg                                      | Vietnam | Malaysia | India | Indonesia |
| 100  | 3.27    | 4.25     | 1.96  | 2.37      |
| 80   | 3.78    | 4.94     | 2.72  | 2.74      |
| 60   | 4.20    | 5.74     | 3.01  | 3.10      |
| 40   | 5.27    | 6.55     | 3.79  | 3.71      |

Source: Dong Qiufen, 5 April, 2020.

The good news out of India was that Japan has eased on sampling frequency for import inspection to help exporting countries during these challenging times. "India produced 230,000 tonnes in early 2020 and some 25,000 tonnes are in cold storage. To facilitate exports, the Andhra Pradesh government has opened up four ports," said Sugumar.

To assure farmers in India, Chandrasekar said that China is already buying shrimp leading to better farm gate prices. His advice was to stock moderately, below 50 PL/m<sup>2</sup> and target harvests of 15–20g shrimp. The expected demand from China is for smaller sizes (60–100/kg) and farmers can target larger shrimp when US resumes buying. The shortage of post larvae is expected to end in June but he reminded farmers to continue to mitigate bacterial and parasitic diseases.

Robins said, "In the future, we do not have an idea where the new equilibrium will fall with consumption in the USA, Europe, Japan and China being a black box. This may become apparent in the summer. I estimate that production will drop in summer from stocking issues."



# TARS 2020 is postponed to August 18–19, 2021

As the COVID-19 pandemic continues, organisers of TARS 2020, Aqua Culture Asia Pacific and Corporate Media Services Pte Ltd have decided to postpone The Aquaculture Roundtable Series (TARS 2020) to the following year.

The new dates for the 10th edition of TARS are **August 18–19, 2021**. The venue (InterContinental Saigon Hotel, Ho Chi Minh City, Vietnam), theme (**Shrimp: Markets • Margins • Productivity**) and program remain the same.

Organisers said, "We understand the challenges the COVID-19 pandemic presents on a global scale. With travel restrictions and social distancing measures in place, it is not conducive to hold

TARS 2020 this year. The health and safety of our attendees is our top priority.

"The new dates for TARS 2021 will provide the all-around best conditions for the shrimp aquaculture community to convene, as well as optimal business performance for all stakeholders."

TARS 2020 on Shrimp Aquaculture was originally scheduled to take place on August 19–20 2020.

More information: [www.tarsaquaculture.com](http://www.tarsaquaculture.com)  
Email: [conference@tarsaquaculture.com](mailto:conference@tarsaquaculture.com)

## The 2020 aquafeed market

In 2019, good days were seen in the Asian aquafeed market, with the expansion in the farming of fish and shrimp and with many farms learning to manage diseases and costs of production. However, in 2020 opinions vary with regards to the state of the aquafeed market and depended on how the countries in Asia have implemented lockdowns to control the COVID-19 coronavirus.

The pandemic brought uncertainties along the supply chain; complicating strategies developed to meet future aquafeed demand. Industry feels that however well-prepared they have been for adversities, the situation in 2020 is entirely unique. A common goal aside from running the business is ensuring employment.

Across Asia, aquafeed millers share some common challenges; in Thailand, Vietnam and India with social distancing rules, feed operations could continue but required working in small groups, interruptions in supply chain slowed down operations. Feed distributors working from home, did not have logistics issues with deliveries; however, payments for feeds were either slow because of poor sales or farmers took the opportunity of the pandemic to delay payments.

Jeff Jie Cheng Chuang, General Manager, Sheng Long Bio-Tech International, Vietnam commented, "Among the three countries where Sheng Long is active in, Vietnam had a better containment on the spread of the virus. Therefore, we see less impact on aquafeed sales, production and job security of staff. In the shrimp market, cancelled export orders and low prices resulted with reduced stocking of ponds. We have estimated a potential 10-20% drop in shrimp production.

"In India, where Sheng Long started aquafeed milling in 2019, it was more complicated," added Chuang. "Operations at factories stopped until we had approval to operate all our businesses - aquafeed, shrimp hatchery and aquaculture inputs - with minimal manpower. We estimate a huge shrimp shortage in the second half of 2020 in India. As suppliers of feeds, we will be affected by a possible 30-40% decline in shrimp production."

Seshu Akkina, CEO of Deepak Nexgen Feeds Pvt Ltd, India said that they faced problems in logistics: the supply of trucks, drivers and restrictions on interstate movement during this lockdown period. "There were also shrimp procurement, manpower, local community protests and infrastructure issues as farmers did forced harvests anticipating lockdowns. One such dilemma was the disruption with rice milling and supplies of deoiled rice bran (DORB) for fish feeds.

"As fish farmers delay harvesting because of the poor market situation, they still have to continue feeding their stocks, which means that they are actually increasing their costs of production and in the end may end up with losses for their crops." Seshu predicted that in 2020, if the current market situation does not improve, demand for shrimp feeds will drop by 35-40% and that for fish feed demand, by 30%.

"As prices of raw materials continue to rise, it is expected that increases in feed price will inevitably happen in 2020," said Wei Che Wen, Sales Manager, Uni President Vietnam. "We will try our best to maintain the quality and fair price and work with farmers to overcome this tough situation together."

Haris Muhtadi, Chairman at the GPMT (Indonesian Feedmills Association) said that this Covid-19 pandemic will most likely bring down fish feed demand by 28% and that for shrimp feeds by 16% as compared to 2019."

### A bad first half

"In Vietnam, food consumption is badly affected," said Nguyen Anh Tuan, Deputy Director General at Mavin Aquaculture which farms tilapia and carp and produces fish feed. "The first half of 2020 will be a tough time for the aquafeed business, but it may be able to recover from the third quarter of the year. Many small feed mills in Vietnam may close in 2020 with tough competition from big players who have an advantage of large scale production and their own farms (swine, poultry, aquaculture) that keep their production volume high and stable the whole year round."

In Bangladesh, it was estimated that aquafeed demand was 300,000 tonnes in the first 3 months of 2020. This indicates that perhaps there will be as much as a 45% drop in fish feed production because of the coronavirus as well as reduced financial capacity of the farmer.



"Vietnam had a better containment on the spread of the virus. Therefore, we see less impact on aquafeed sales, production and job security of staff."  
- Jeff Jie Cheng Chuang.



The Deepak Nexgen team with farmers during a farmers factory walkthrough. The company is one of the market leaders in shrimp and fish feed production in India. Picture credit: Deepak Nexgen.

"The way we operate during this period is a real change from the normal; we are all staying indoors, limiting visits, video conferencing, training our sales team, and optimising our internal control," said Chuang.

While there is a loss of confidence in farming, farmers will continue to farm as this is the only economic activity, they are familiar with, and they need the support of the aquafeed industry.

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Broodstock in a maturation tank. Only disease free broodstock are kept in these tanks for 1-3 months.

## Revival of the monodon shrimp with high health post larvae

The bottom line are checks for disease-free wild broodstock and a 2-week quarantine of spawners prior to introduction into maturation tanks.

There are two concurrent projects on *Penaeus monodon* or black tiger shrimp in India, both conducted by the Rajiv Gandhi Centre for Aquaculture (RGCA), the R&D arm of the Marine Products Export Development Authority (MPEDA). In 2005, well before the arrival of the Pacific white shrimp *Penaeus vannamei* in 2009, which ultimately dominates shrimp farming in India, RGCA started a domestication and breeding program of *P. monodon* at Kodiaghat and Amkunj in the Andaman and Nicobar Islands. The project is in its ninth generation to produce specific pathogen-free (SPF) monodon broodstock.

The other is a more recent maturation and hatchery facility in the Multispecies Aquaculture Complex (MAC) on Vallarpadam Island, Kochi, Kerala. The purpose is to produce disease-free monodon

post larvae. This production uses wild caught broodstock collected from all over India. The aim of the latter project is to kickstart the revival of monodon shrimp farming, the production of which is around 50,000 tonnes/annum, as compared to almost 750,000 tonnes of the vannamei shrimp in 2019.

RGCA Project Directors, Dr S. Kandan and Dr T.G. Manojkumar, who is also the Project Manager at MAC, are excited with the recent interest shown by farmers to revive the farming of the monodon shrimp. "I am very convinced that with good quality post larvae, this shrimp can make a comeback. Here we have a capacity for only 20 million post larvae (PL12-PL20), but the current bookings have already reached 24 million post larvae," said Kandan.

One of the major constraints in the development of specific pathogen-free (SPF) monodon shrimp in the Andamans has been the infectious IHGS (Idiopathic hyaline granuloma syndrome) and SMV (spawner mortality syndrome), which is apparently endemic to local populations (Luna, 2013). Recently it was found that with the progression of the generations some resistance to IHGS was noticed, according to Manojkumar.

Water treatment is an important prerequisite for this hatchery. Here seawater of 30-34ppt is drawn from the nearby creek. It passes through a micro sand filter before being channelled to a reservoir where chlorine (20ppm) is added, followed by 20 minutes of aeration. After 12 hours, the supernatant water is channelled to another reservoir for de-chlorination with sodium thiosulphate. Water flows to another reservoir for ozonation, sand and carbon filtration, before passing through a one micron cartridge filter and finally UV treatment, before being used in the hatchery.



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The quarantine area for incoming broodstock. Wild broodstock are collected from fishermen on the east and west coasts of India. The quarantine is for 14 days. Insert: Broodstock in quarantine



### Strain differences of wild broodstock

At the hatchery, Manojkumar said that they collect spawners from all over India. He noted that there are strain differences between monodon shrimp caught in the east and west coasts of India. In fact, they also saw strain differences between shrimp caught in different locations in the east coast, such as in Visakhapatnam, Paradweep



PL12 ready for packing and collection by grow-out farmers.

and Pazhayar. Similarly, differences are noted between shrimp caught in various locations in the west coast. “Dr D Lightner informed us to expect differences in shrimp from locations even 200-300km apart. Differences noticed included slower growth and also very pale colouration. We see the growth equalising with that of other families only after 120 days as well as tolerance to IHGS.”

### Disease-free-broodstock

All broodstock are quarantined and tested for 15 disease pathogens, the 7 OIE pathogens (white spot syndrome virus (WSSV), Taura syndrome virus (TSV), yellow head virus (YHV) and gill associated (GA) virus, infectious myonecrosis virus (IMNV), infectious hypodermal and haematopoietic necrosis virus (IHHNV), hepatobacter penaei (NHP-B) and acute hepatopancreatic necrosis disease (AHPND). The additional eight are *Enterocytozoon hepatopenaei* (EHP), covert mortality nodavirus (CMNV), monodon baculovirus (MBV), hepatopancreatic parvo virus (HPV), shrimp haemocyte iridescent virus (SHIV), Laem-singh virus (LSNV), spawner associated mortality virus (SMV) and rickettsia-like bacterial disease (RLB).

“Only when they are free of these diseases, do we bring them over to the hatchery for the maturation process and spawning. We then cross a female from one region with a male from another region. In 2018, we found some interesting results from these crosses. We will be revealing the results soon but I can tell you that some crosses have revealed fantastic results. A farmer said that in all of his 16 years of farming the monodon shrimp, he has not seen such fast growth, shrimp reaching 25-30 pieces/kg in 86 days. We attribute this to crossing different strains and elevating genetic vigour,” said Manojkumar.

The supply of high health post larvae to farmers began in February 18, 2019. Kandam said, “Our post larvae have a very good reputation. Farmers call them ‘Vallarpadam post larvae’. Our next target is to set up private hatcheries all over India. We have received requests from the state government of Gujarat and Andhra Pradesh. I am very convinced that if good quality post larvae are available, the monodon shrimp will make a comeback.”



A farmer packs bags of post larvae into his car for a journey of 5 hours to his farm. This way, he is assured of a cool temperature throughout the trip.

# Revisiting vibriosis in shrimp aquaculture

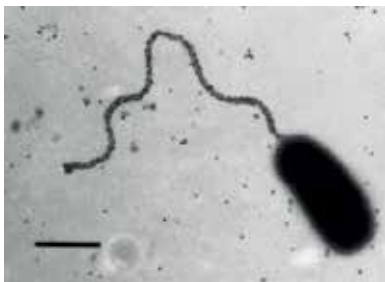
Triggers and co-infections, symptoms and prevention measures for the opportunistic and ubiquitous *Vibrio* spp.

By Anwar Hasan

**V**ibriosis is a bacterial disease caused by *Vibrio* spp. These bacteria form part of the natural microbiota of wild and cultured shrimp and the marine environments. *Vibrio* infections have become a major constraint on the production and trade in shrimp aquaculture. They are responsible for several diseases and mortalities of up to 100% and cause crop losses globally. *Vibrio*-related infections frequently occur in hatcheries, but epizootics also commonly occur in grow-out ponds.

## Pathogenic strains

*Vibrio* species such as *Vibrio harveyi* and *Vibrio parahaemolyticus* have been identified as primary pathogens in shrimp farming. Other species of *Vibrio* such as *Vibrio vulnificus*, *Vibrio anguillarum*, *Vibrio campbellii* and *Vibrio splendidus* have been associated with shrimp disease and caused massive epidemics.



**Figure 1.** Electron micrograph of a *V. parahaemolyticus* cell. Scale bar = 1µm. (Source: BIOMIN).

## Isolation

Thiosulfate-citrate-bile salts-sucrose agar (TCBS agar), is a type of selective agar culture plate that is used in microbiology laboratories to isolate *Vibrio* species. TCBS agar is highly selective for the isolation of *Vibrio* species and is easy to use in a farm laboratory. Furthermore, farmers are able to differentiate *Vibrio* species, depending on the colony colour: green and yellow. Alternatively, for *V. parahaemolyticus* enumeration, the use of chromogenic agar is also suggested.

## Shrimp diseases associated with *Vibrio* spp.

*Vibrio* can remain in the environment without causing disease, but can very easily switch from opportunistic and commensal, to pathogenic when conditions change. Thus, its ability to cause disease, or increase in virulence, is a complex process affected by many variables, including host, *Vibrio* species/strain, developmental stage, physiological conditions, environmental stress and infection method.

There are several diseases associated with *Vibrios*. *V. harveyi* is one of the most important etiologic agents of luminous disease and causes mass mortalities in penaeid larval rearing systems. *V. parahaemolyticus* is responsible for the outbreaks of early mortality syndrome (EMS) or acute hepatopancreatic necrosis disease (AHPND). In the case of white faeces disease (WFD), *Vibrio* spp. have been isolated from WFD infected animals and a challenge using *Vibrio* isolates resulted in identical WFD in field specimens (Tran, 2019).



**Figure 2.** White faeces on shrimp pond (A) and (B).

Clinical signs of *Vibrio* infections include lethargy, loss of appetite, discoloured and necrotic hepatopancreas with the presence of “clumping”, red discolouration of the body, yellowing of the gill tissue, white patches in the abdominal muscle, melanisation, granulomatous encapsulation, necrosis and inflammation of organs (lymphoid organ, gills, heart) and luminescence.

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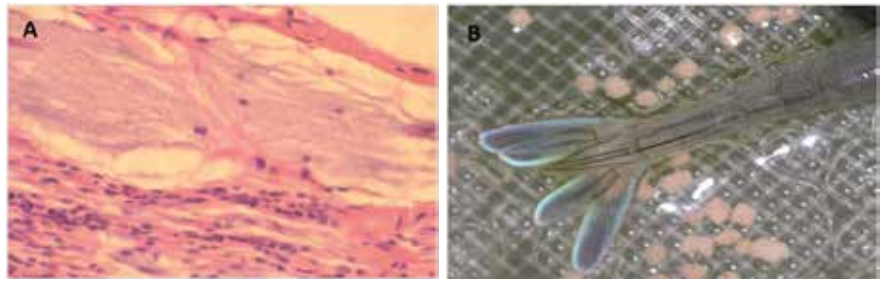
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### Triggers and co-infections

Disease outbreaks caused by *Vibrios* may occur when environmental factors trigger the rapid multiplication of bacteria (which are already present at low levels). *Vibrios* become opportunistic pathogens when natural defence mechanisms are suppressed or exposed to stressful conditions.

*Vibrio* spp. are also associated with multiple etiological agents. The rapid multiplication of *Vibrio* could be triggered by primary disease. Phuoc *et al.* (2009) reported on the rapid multiplication of *V. campbellii* in co-infection with white spot syndrome virus (WSSV, Table 1).



**Figure 3.** Necrosis on the muscular fiber caused by colonies of *V. parahaemolyticus* (A) and *L. vannamei* with greenish fluorescence on tail (B) (Courtesy Dariano Krummenauer)

| Treatments | WSSV -infected cells in organs (cells/mm <sup>2</sup> ) |                      |                        | VC (CFU/mL of haemolymph)    |
|------------|---|----------------------|------------------------|------------------------------|
|            | Gills   | Lymphoid organ       | Haematopoietic tissue  |                              |
| WSSV       | 189 ± 130 <sup>a</sup>                                  | 59 ± 72 <sup>a</sup> | 210 ± 154 <sup>a</sup> | -                            |
| VC         | -   | -                    | -                      | 231 ± 445 <sup>a</sup>       |
| WSSV + VC  | 183 ± 51 <sup>a</sup>                                   | 39 ± 18 <sup>a</sup> | 143 ± 86 <sup>a</sup>  | 83,430 ± 66,871 <sup>b</sup> |

Numbers of infected cells in the same tissue or CFU/mL with different superscripts were significantly different between the two treatments (P<0.01).

**Table 1.** Quantification of white spot syndrome virus (WSSV)-infected cells and *V. campbellii* (VC) in shrimp organs (mean±SD), collected 6 hours after *V. campbellii* injection (shrimp in dual treatment were moribund). Adapted from Phuoc *et al.*, 2009.

### Vibrio threshold in shrimp farms

There are many *Vibrio* maximum threshold standards in farms. Most of them are for *Vibrio* spp. in pond water. These are the common maximum thresholds used by shrimp farms:

- Total *Vibrio* Count (TVC): varies from 10<sup>3</sup> CFU/mL to 10<sup>4</sup> CFU/mL. Some farmers adopt the TVC of 10<sup>2</sup> CFU/mL as the maximum threshold.
- *Vibrio* colonies: 10<sup>2</sup> CFU/mL for green and 10<sup>3</sup> CFU/mL for yellow colonies.
- *Vibrio* percentage: 5% to 10% TVC of total plate count, and 10% *Vibrio* green colonies of TVC.

The threshold variation depends on farm experiences, since different farms have different environmental challenges and characteristics.

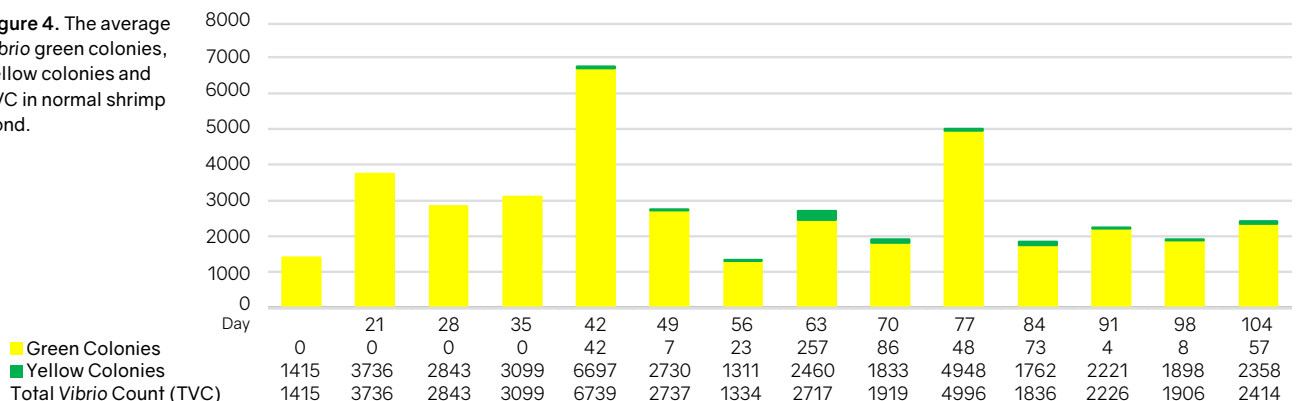
Alfiansah *et al.* (2018) reported the *Vibrio* profile in intensive shrimp ponds using zero water exchange (Table 2). *Vibrio* profiles were recorded in pond water every 10 days, from day 10 to 70. The lowest level was found in day 10 with 10<sup>2</sup> CFU/mL. The *Vibrio* concentration increased to 10<sup>3</sup> CFU/mL in day 20, 30, 40, and 50. In day 60 and 70, the *Vibrio* level was 10<sup>4</sup> CFU/mL.

In a 2019 Biomin field trial, the *Vibrio* spp. profile in pond water was recorded weekly in five ponds. Initial sampling was on day 15 (15 days after shrimp stocking) and finished at day 104 (Figure 4). In this trial, the range of total *Vibrio* count (TVC) was 1.334 x 10<sup>3</sup> CFU/mL to 6.793 x 10<sup>3</sup> CFU/mL. Green colonies were in the range of 0 CFU/mL to 2.570 x 10<sup>2</sup> CFU/mL. Compared to total plate count (TPC), the TVC ranged from 0.98% to 11.4%.

| Bacterial type | Unit          | Day  |       |       |       |       |         |        |  |
|----------------|---------------|------|-------|-------|-------|-------|---------|--------|--|
|                |               | 10   | 20    | 30    | 40    | 50    | 60      | 70     |  |
| TPPV           | LOG 10 CFU/mL | 2.13 | 3.32  | 3.98  | 3.73  | 3.72  | 5.41    | 4.36   |  |
| VC             | Colony CFU/mL | 135  | 2,089 | 9,550 | 5,370 | 5,248 | 257,040 | 22,909 |  |

**Table 2.** Profile of TPPV (total potential pathogenic *Vibrio*) in intensive pond culture (Alfiansah *et al.* 2018)

**Figure 4.** The average *Vibrio* green colonies, yellow colonies and TVC in normal shrimp pond.



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Shrimp farmers have been advised to monitor the *Vibrio* population in the shrimp gut and hepatopancreas. A study conducted by Rodriguez *et al.* (2015) can be used as a guide for the hepatopancreas. In this study, the reported *Vibrio* population in normal, initial and acute phase of AHPND in the hepatopancreas were  $5.93 \times 10^5$  CFU/g,  $1.78 \times 10^6$  CFU/g, and  $1.65 \times 10^8$  CFU/mL respectively.

In the shrimp gut, it is common to find *Vibrio* populations at  $10^6$  CFU/g. In a Biomin trial the *Vibrio* population in shrimp gut was monitored every 5 days, from day 5 to 60. The *Vibrio* populations were  $10 - 10^2$  CFU/g on day 5 to 25. In day 30 to 60, the *Vibrio* population increased to  $10^3 - 10^4$  CFU/g. Farmers were advised to use  $10^5$  CFU/g as a maximum threshold of *Vibrio* in the shrimp gut. When this increases to  $10^6$  CFU/g, the shrimp will be at risk.

### Management strategies for shrimp disease prevention and control

*Vibrios* are difficult to eradicate because they adapt well to different environmental conditions and can adopt a dormant state when facing adverse conditions. Pond management and robust gut health are important strategies to control *Vibrio*, together with frequent sampling to monitor their levels in the shrimp gut and pond ecosystem.

There are several strategies to prevent diseases caused by *Vibrios*: control the *Vibrio* population and mitigate the disease impact. Since the use of antibiotics to control these agents has led to problems of drug resistance and resulted in trade restrictions in export markets, the shrimp aquaculture industry continues to find more effective and environmentally friendly approaches in controlling *Vibrio*, such as biosecurity; disinfection, use of natural antimicrobials and probiotics.

Regarding disease mitigation, there are several strategies such as improving shrimp health or the immune system of the shrimp, a quorum quenching strategy, bind the toxin excreted by the *Vibrio*, and applying a complete biosecurity system. However, in this article we will only discuss the first strategy i.e. how to control *Vibrio* levels.

### Biosecurity and disinfection

Disinfection, filtration and sanitation are examples of biosecurity practices. Disinfectants may be used to treat incoming water

in the hatchery and grow-out phases. Chlorine, potassium permanganate, hydrogen peroxide, benzalkonium chloride, potassium monopersulfate, ozone and UV are popular disinfectants in shrimp farming. Each of these have different characteristics.

Chlorine is the most common disinfectant used in shrimp farming. The efficacy of chlorine is affected by pH, organic substance and biofilm formation. A study was conducted to evaluate the efficacy of sodium hypochlorite. In sterile seawater, at 1 and 5ppm levels, it was found that luminous bacterial (*V. harveyi*) populations were completely eliminated, from  $10^6$  CFU/mL in 30 minutes. However, in combination with an organic substance (0.1% peptone), it was demonstrated that chlorine was ineffective at inhibiting *V. harveyi* at inclusion rate less than 50ppm (Abraham *et al.*, 2002). As a reminder, there have been reported cases of rapid increases in *Vibrio* numbers after the chlorine residues have disappeared. This is to be expected as chlorine will not only lower the number of *Vibrio* competitors but also kill algae, thus increasing nutrients for *Vibrio* to propagate.

### Antimicrobials

Strategies to use antimicrobials to reduce the effects of the *Vibrio* (particularly *V. parahaemolyticus*) in the shrimp digestive system can help protect the shrimp. Certain essential oil (EO) mixtures and organic acid (OA) mixtures have been shown to be effective because of their inhibitory properties against *Vibrio* as shown in Figure 5. These compounds can be added to feed to be effective in the digestive system of the animal. The OA mixture has been demonstrated to possess an inhibitory effect on *V. parahaemolyticus* growth at doses of  $\geq 5000$  ppm and the EO mixture inhibited *V. parahaemolyticus* growth at doses of  $\geq 500$  ppm.

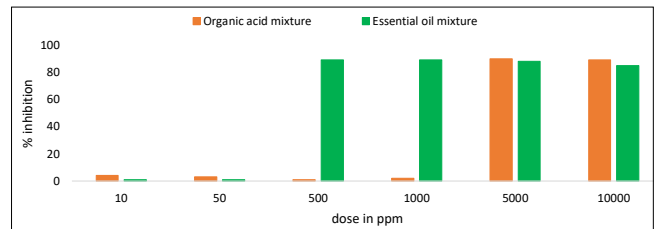


Figure 5. Growth inhibition of virulent *V. parahaemolyticus* after exposure to organic acid mixture and essential oil mixture. (Source: BIOMIN)

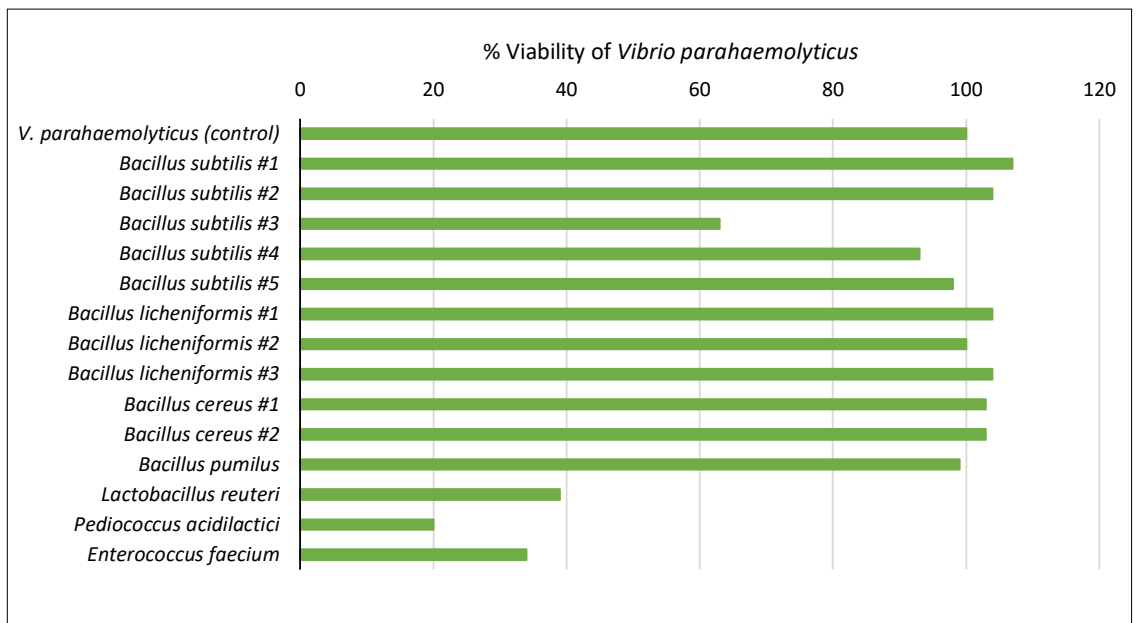


Figure 6. Varying effectiveness of probiotic bacteria against pathogenic *V. parahaemolyticus*. (Source: BIOMIN)

## Probiotics

Probiotics is another means of disease control which have been useful in aquaculture. Probiotics are administered directly in water or via feeds. The mode of action of the probiotics is to actively inhibit the colonisation of potential pathogens in the digestive tract by the production of bactericidal substances, competition for nutrients and space, and modulation of the immune system. With carefully formulated probiotics, the modes of action may be complementary and/or synergistic. For example, providing greater disease resistance by improving the immune response and pathogen exclusion.

A study was conducted to analyse probiotic species in inhibiting the growth of the pathogenic *V. parahaemolyticus*. As shown in Figure 6, the probiotic strains such as *Pediococcus acidilactici*, *Enterococcus faecium*, *Lactobacillus reuteri* and *Bacillus subtilis* #3 (proprietary Biomin probiotics) were shown to inhibit *V. parahaemolyticus*. This study shows that not every menace can be targeted with *Bacillus* bacteria.



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# Long-term selective breeding of the tilapia in Thailand

A first in Thailand, using estimated breeding value (EBV), Manit Genetics has produced over 13 generations the SuperBlack and SuperRed tilapia.

By Amorn Leungnaruemitchai, Wasana Suebsong, Danai Somjai, Kannikar Nimmual and Marissa Dee



Left, SuperBlack tilapia from generation 13 with small head and pear-shaped body, and high fillet yield. Below, SuperRed tilapia from generation 13 with good shape with high fillet yield, and distinct skin colour with less spots and greater pigmentation. Both have excellent growth rates (with proper nutrition), robust, disease resistant, high feed efficiency, good salinity tolerance when properly acclimatised, and suitable in all culture systems.



The Nile tilapia *Oreochromis niloticus* or “Pla Nil” (in Thai) was introduced to Thailand in 1965 during the reign of the late King, His Majesty King Bhumibol Adulyadej Rama IX, while the Thai Red tilapia or “Pla Nil Daeng” (in Thai) was developed by the Department of Fisheries Thailand, from the red variant *Oreochromis mossambicus*.

In Thailand, both the Nile and red tilapia are farmed since the mid-1980s and production is mainly for the domestic market. There is a larger proportion of Nile tilapia farmed as compared to the red tilapia. However, recently, there has been a rapid increase in the farming of the red tilapia, mainly due to its higher value, at 25-30%, relative to that of Nile tilapia. In terms of production systems, it is largely cage culture for the red tilapia while pond culture is common for the Nile tilapia. Tilapia farming is mainly in the northeastern, central, and northern regions of Thailand.

## Genetics as driver for growth

Globally, the tilapia is a leading aquaculture species and its production continues to grow. Some of the major factors driving growth of this fish include demand from a rising global population, rise in per capita income in emerging markets as well as increasing awareness of the fish as a healthy source of protein.

Moreover, improvements in genetic technology and selective breeding, as well as increases in government initiatives to support aquaculture, also stimulate growth in tilapia farming. Despite significant losses with disease outbreaks, tilapia production in Thailand reached 237,800 tonnes in 2017, which is 52.7% of the total aquaculture production (DOF, Thailand Statistics 2017).

However, as demand for tilapia fry and fingerling increases, some private hatcheries continue to use the same parent population which in turn have led to poor quality of stock management and seed production. This is most probably due to a lack of knowledge and an inadequate source of quality broodstock. We believe that

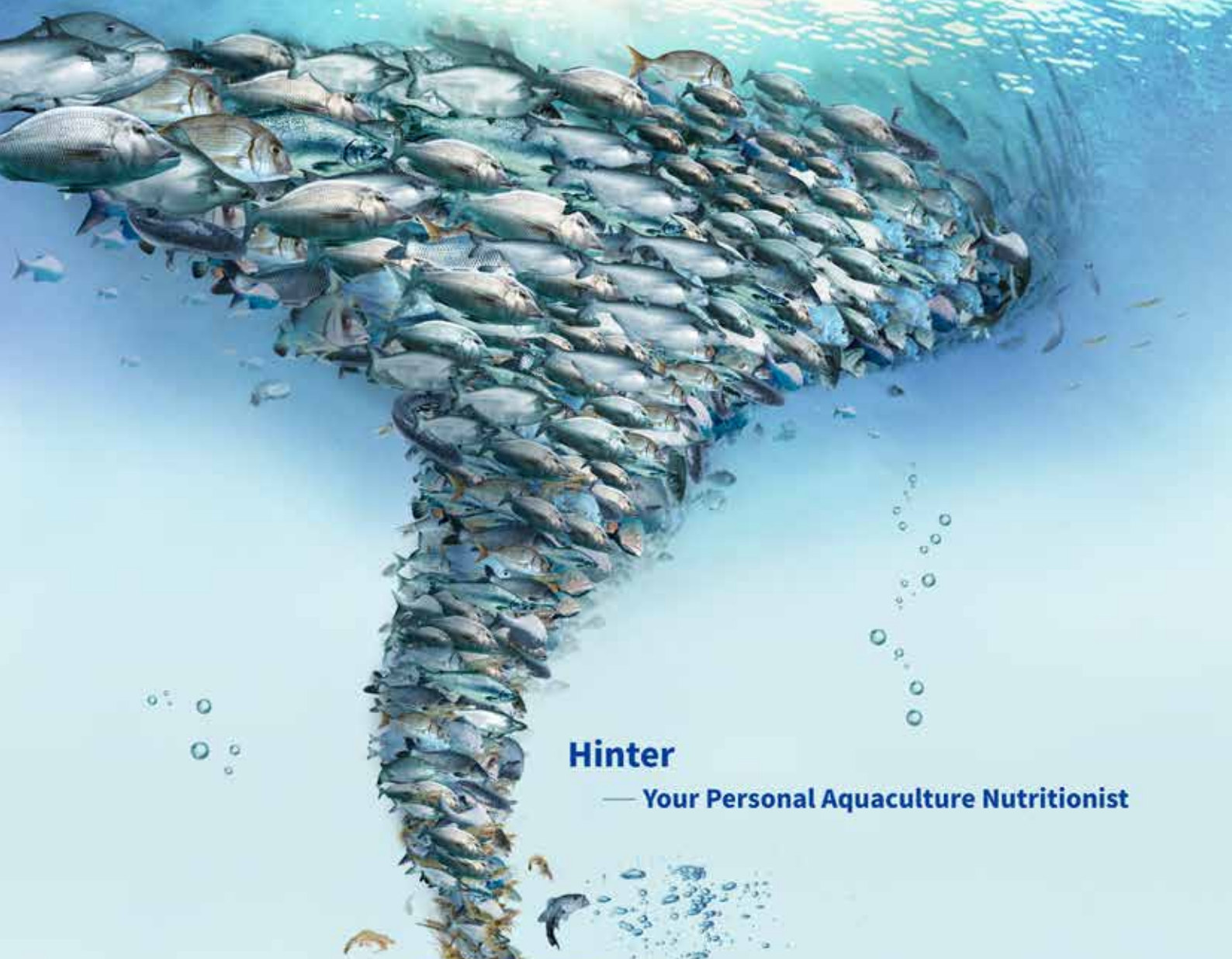
a less effective genetic breeding program, together with disease outbreaks will lead to high production costs. This constrains sustainable and quality tilapia production.

## Tilapia Genetics Centre

Manit Leungnaruemitchai started Mani Farm in Nakhon Pathom province in 1968, originally as a catfish farm. A tilapia hatchery was added in 1993, to supply tilapia fry and fingerlings across the country. This aquaculture business was then passed to his next generation, son Amorn, who went on to expand the tilapia farming and hatchery business to two locations; Khao Yoi and Ban Laem districts, Phetchaburi province. He also ventured beyond fry and fingerling supply to developing tilapia strains with commercial attributes.

In 2018, the Mani Group was formed with several businesses. Mani Genetics to focus on genetic development and supply superior quality tilapia seedstock, Mani Intertrade for product marketing nationwide and overseas, and Mani Aquaculture for shrimp and aquaculture farming.

Amorn set up the Tilapia Genetics Centre in 2007 with the collaboration of the former Akvaforsk Genetics Center (AFGC), now part of Benchmark Genetics Ltd. The aim is to spearhead the production, research, and a selective breeding program for the tilapia. This tilapia genetics centre fulfills the need for a continuous and sustainable supply of superior quality tilapia seedstock. There is now a long-term selective breeding program for the tilapia in Thailand, from which over 13 generations (from 2007 to 2018) has led to the development of the SuperBlack and SuperRed varieties of the Nile and red tilapia, respectively.



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Using indoor recirculating aquaculture systems (RAS) and biosecure nucleus breeding facilities, Manit Genetics established the first selective breeding program using estimated breeding value (EBV) in Thailand. Presently at the nucleus breeding facility, there are two selective breeding programs, one for the Nile and the other for the red tilapia.

### Selective breeding programs

The target is to improve growth performance and robustness of tilapia to suit all culture systems in Thailand: fresh water and brackish water pond and cage culture. Aside from growth performance and robustness, the breeding program for the red tilapia selects for colour traits (less black spots and higher red pigmentation). Families have been selected and ranked per generation based on their genetic performance. Within each family the best male and female broodstock were selected as breeding candidates to produce families of the succeeding generation.

### Genetic improvements

Genetic gain was measured using EBVs for each generation of selection. Relative to the base population, the cumulative gain achieved after 13 generations of selection was 91.4%, averaging 7.6% per generation in the Nile tilapia; while the cumulative gain achieved in the red tilapia after 13 generations was 93.8%, with an average of 7.8% per generation (Figure 1). Selection response for survival after 13 generations resulted in 19.5% with the average value of 1.6% per generation and 50% with the average value of 4.2% per generation for Nile and red tilapia, respectively.

In both selective breeding programs, inbreeding coefficient (F) was controlled to an average of less than 1% per generation. Across 13 generations, the heritability estimates ( $h^2$ ) were 0.24 for harvest weight and 0.04 for survival for the Nile tilapia and 0.22 for harvest weight and 0.10 for survival for the red tilapia, taking into consideration environmental effects common to full sibs ( $c^2$ ) and survival at stocking until harvest in growth test environments.

The average harvest weight of the 13th generation was 611g at 149 days of culture with 91.3% survival rate across test environments for the Nile tilapia. With the red tilapia, it was 500g at 142 days of culture with a survival rate of 85%.

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### Field results

Numerous environmental testing and commercial trials have been conducted to further evaluate growth and survival performance of Manit Genetics' SuperBlack and SuperRed tilapia strains under commercial farming in Thailand. In a commercial cage system, initially stocked with 62.5g SuperRed juveniles at a stocking density of 35 fish/m<sup>3</sup>, the result was an average weight of 994g at harvest after 104 days of culture and 92.5% survival rate. In a commercial earthen pond system stocked with 0.4g SuperBlack fry at a density of 6 fish/m<sup>2</sup>, the harvest weights ranged from 900-1,300g after 143 days of culture and 95% survival rate.

Currently, Manit Genetics is the largest and leading producer of superior quality fry nationwide. The SuperBlack and SuperRed tilapia strains are marketed to neighbouring Myanmar and Laos, as well as further afield for commercial farming in the Ukraine, Pakistan, Indonesia and Singapore.



“We believe that superior-quality strain equals profitability for the farmer. Our vision is to be globally recognised in the aquaculture industry supplying sustainable, safe and superior quality fry. This has persuaded us to continuously develop superior quality pedigree tilapia broodstock. A cost-efficient production of quality fish requires the combination of fry, genetics, quality feed, biosecurity measures and specific management protocols. We firmly believe that high-quality fish production requires optimal water quality. Working in parallel to minimise any impact on the environment is key.” -Amorn Leungnaruemitchai



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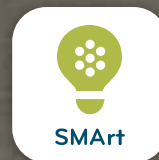
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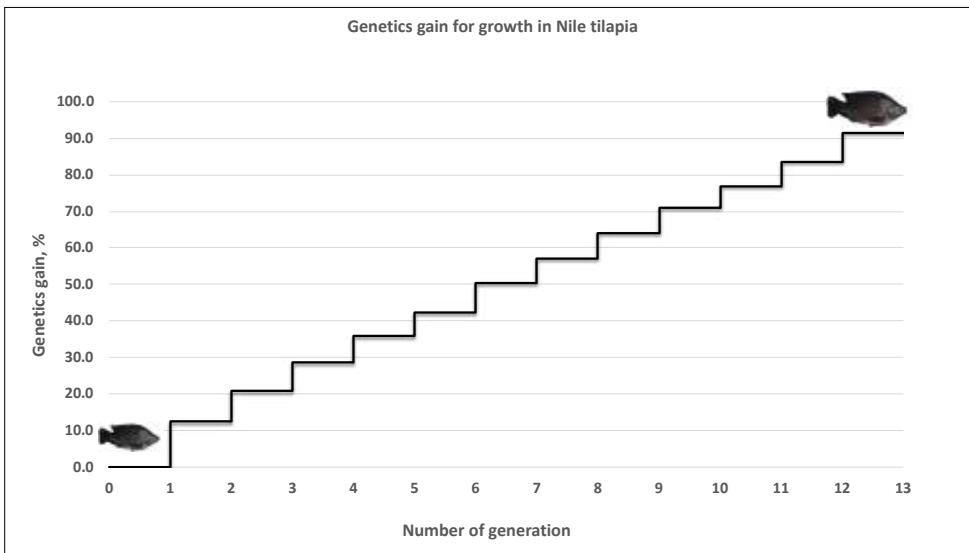
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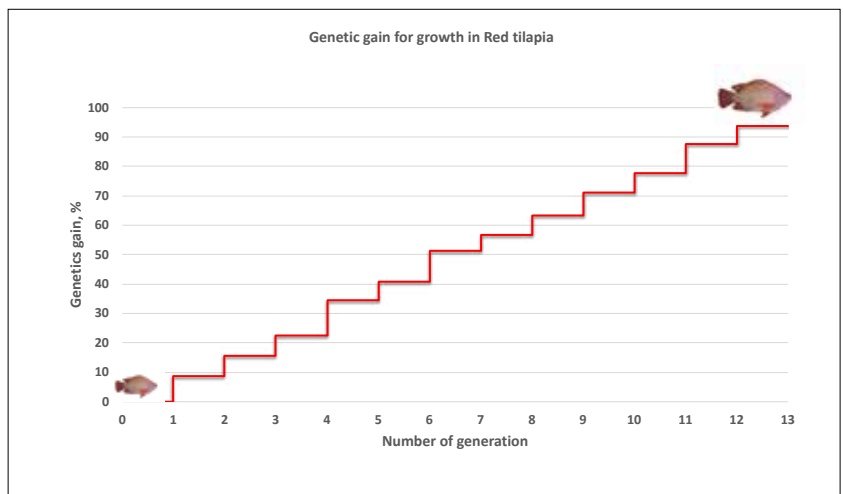
**Figure 1.** Genetic gain for growth achieved from the selective breeding programs of Nile and red tilapia at Mani Genetics over 13 generations. Relative to the base population, the cumulative gain achieved was 91.4%, averaging 7.6% per generation in Nile tilapia (right). The cumulative gain achieved in red tilapia was 93.8%, with an average of 7.8% per generation.

Mani Genetics has developed several state-of-the-art infrastructure to provide a sufficient supply of premium quality tilapia seed for farmers; strains with high survival rates, high yields and are able to grow in different environments. It has invested heavily in a responsible aquaculture system to control the many stages of farming and to produce Mani's superior tilapia. It is the only tilapia hatchery in Thailand with the Best Aquaculture Practice (BAP) certification.

**Outlook**

In the long term, the aim is have a more vigorous selective breeding program with higher accuracy and advanced selection using genomic selection. This enables the selection of animals using genomic markers which allows it to expand its research and development into complex traits – beyond a growth-survival focus.

Furthermore, genomic selection offers a wide range of opportunities for highly accurate genetic development, including the understanding and improvement of complex traits (e.g. disease resistance and fecundity). Mani Genetics could create a huge impact in the aquaculture industry by producing a highly



robust stock for tilapia farming in a sustainable way for farmers and consumers. This will help fish farmers prepare for future challenges such as climate change and increasing risks from disease outbreaks.

**Acknowledgement**

We are grateful for the valuable contributions of the former AKVAFORSK Genetics Center management and personnel in the planning, data analysis and publication of this article.



The Tilapia Genetics Center, set up in 2007, now has reservoirs, experimental ponds and nursery tanks.

# Good news for crab farmers

Simple tweaks at SEAFDEC/AQD increase higher survival rate from zoea to crablet to double crablet production

By Joesyl Marie de la Cruz

Crab farmers will be happier and the environment better, with recent improvements at the mangrove crab hatchery of the Southeast Asian Fisheries Development Center Aquaculture Department (SEAFDEC/AQD) in Iloilo, Philippines.

Crablets used in the farming of the prized mangrove crab, *Scylla serrata*, are usually collected from the wild and increasing demand has threatened their natural population with crablets becoming more difficult to find. "Overfishing has pushed the local government of areas heavily exploited for crablets such as Catanduanes, Surigao and Samar. They have implemented strict prohibitions in the collection of wild crablets," said Joana Joy Huervana, Associate Researcher at SEAFDEC/AQD and leader of the mangrove crab team.

Restrictions on wild collections in the Philippines led to the rise in demand for hatchery-bred crablets. Unfortunately, crab hatcheries suffer from very low survival rates caused by disease and cannibalism. However, Huervana recently revealed that simple tweaks in protocols at the SEAFDEC/AQD hatchery have led to a significant boost in their crablet production, with survival increasing twofold. By feeding the crabs more frequently and providing cleaner water in the tanks, Huervana reported that they were able to increase the average survival rate from zoea (newly-hatched larvae) stage to crablet, from an average of 1% in 2017 to 2% in 2019.

"This 2% might seem low to those unfamiliar with the hatchery business," said Huervana adding that crabs produce an average of 3 million larvae which translates to 60,000 crablets/spawner. She further disclosed that SEAFDEC sells crablets, as a byproduct of research, at USD 0.10/crablet but wild crablets sold by traders in the Philippines reach as much as USD0.24 to USD0.30/crablet.

The simple tweaks helped them achieve the higher survival rate from zoea to crablet, reaching as much as 10% sometime last year, which contributed to the hatchery's production of over 650,000 crablets in 2019.



Crablets produced in the mangrove crab hatchery at the Southeast Asian Fisheries Development Center Aquaculture Department (SEAFDEC/AQD) in Iloilo, Philippines where simple adjustments in feeding and water change doubled crablet production. Photo: Devcom Section, SEAFDEC/AQD



Counting crablets prior to shipping out. Photo: JD Huervana

## Increased feeding frequency, cleaner water

"Feeding frequency was increased from four to six times a day with an interval of four hours," Huervana shared, which is "based on the crabs' biomass at 100% feeding rate." This intervention worked because cannibalism among the crabs is more prominent starting in the megalopa stage (intermediate larval phase), therefore increasing the available feeds, together with providing additional shelters in the larval tanks, increased the survival.

"As for the water replacement, the interval was shortened from five to four days. Siphoning of tank bottom to remove dead larvae, microalgae and feeds is done every three days to further improve water quality. Also, monitoring of water parameters was consistently conducted," Huervana added. "These techniques were tested throughout the years and were proven effective. It could also be easily adapted by hatchery owners and other stakeholders."

Further improvements are still being done in the SEAFDEC/AQD hatchery, not only to cope with industry's demand for crablets, but also to improve the science behind the technology of mangrove crab hatchery.

"We do our share in alleviating the pressure caused by overfishing in the wild by continuously improving production techniques of our mangrove crab hatchery to share with our stakeholders."

Joesyl Marie de la Cruz is with the Development and Communication Section, SEAFDEC/AQD.  
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<http://www.seafdec.org.ph>

# New study shows positive effects of krill meal supplementation in juvenile olive flounder diets

Dr Tibiabin Benitez-Santana, Director R&D, Fish Nutrition at Aker BioMarine, discusses the recent findings from the 12-week Jeju National University study.



Researchers from Jeju National University's Department of Marine Life Sciences recently published their findings on the effects of krill meal (*Euphausia superba*) in fish meal diets fed to olive flounder (*Paralichthys olivaceus*) juveniles in South Korea. The objective of the study was to examine the response of the fish to different levels of krill meal added to a low fish meal diet (28% inclusion of fish meal). Benitez-Santana shares her insight on this experiment and its results.


## What sparked the interest to study krill meal as a supplement in olive flounder diets?

Over the past years there have been several studies on the benefits of krill meal as a part of the diets of various fish species, all with positive effects. This study looked at effects on the olive flounder, which is one of the most important fish species in South Korea. This marine fish accounts for about 50% of the total finfish production in South Korea. Most of the global aquaculture production of olive flounder occurs in the Republic of Korea, with the Korean Statistical Information Service reporting nearly 85,204 tonnes in 2019.



At Aker BioMarine since 2017, Dr Tibiabin Benitez-Santana has been applying her scientific knowledge to build an understanding of how fish nutrition can improve sustainability and productivity in the aquaculture industry. A native of the Canary Islands, Spain, she completed her PhD in aquaculture nutrition in 2011 and did post-doctoral research at both the French National Centre for Scientific Research and the French National Institute for Agricultural Research. She has also worked as a research associate at the University of Utah.



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### EVALUATION OF ANTARCTIC KRILL MEAL (*Euphausia superba*) SUPPLEMENTATION IN DIETS FOR OLIVE FLOUNDER (*Paralichthys olivaceus*)

**12 WEEK GROWTH AND HEALTH EXPERIMENT**  
Initial body weight: 62g (*Paralichthys olivaceus*)

| Test diets       |                                  |
|------------------|----------------------------------|
| Positive control | High fishmeal diet, HFMD; 56% FM |
| Negative control | Low fishmeal diet, LFMD; 28% FM  |
| Krill Meal 3*    | 28% FM + 3% krill meal (KM)      |
| Krill Meal 6*    | 28% FM + 6% KM                   |
| Krill Meal 9*    | 28% FM + 9% KM                   |
| Krill Meal 12*   | 28% FM + 12% KM                  |

\* QRILL™ AQUA



OLIVE FLOUNDER  
(*Paralichthys olivaceus*)

## How was the experiment set up?

A total of 792 olive flounder juveniles (initial body weight, 62g) were purchased from an olive flounder farm and transported to the Institute of Marine Life Sciences at Jeju University. In the study, groups of fish were fed 4 experimental diets with varying inclusion levels of krill meal (3%, 6%, 9% and 12%). The feeding trial was conducted over the course of 12 weeks. There were four replicates for each experimental diet. They also included a positive and negative control diet, i.e. a high fish meal (56%) and low fish meal (28%) diet, respectively.

## What was the result after the 12-week trial?

At the end of the 12-week feeding trial, all the fish were bulk weighed. Then, fish from each tank were randomly selected to provide samples for analysis. These results were compared to those from olive flounder fed high fish meal and low fish meal diets.

The researchers concluded that partial inclusion of krill meal improved the growth performance and feed utilisation of olive flounder, confirming the findings from an earlier research on krill meal supplementation among fish species. In addition, the groups of olive flounder fed dietary krill meal showed considerably higher survival when challenged with the bacteria *Edwardsiella tarda*, a well-known pathogen in the Asian aquaculture industry.

## Can you give more details on other effects of krill meal on the health of olive flounder?

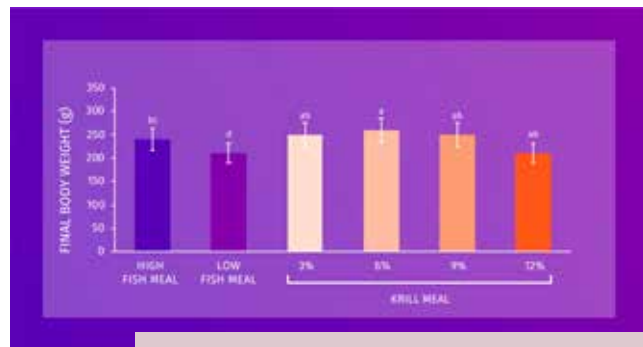
The study revealed that overall, there is a positive tendency of improved performance on growth and feed utilisation in fish fed diets supplemented with krill meal diets at 3%, 6% and 9%. These same diets show higher dry matter digestibility, while the haematocrit (%) and haemoglobin (g/dL) also increased.

The experiment also showed that the innate immunity and the condition factor of the fish improved across groups fed krill meal diets; supplemented at 3%-9%. Goblet cell counts, villi length and fillet yield of the fish improved in all krill meal diets. Final body weight and weight gain of the treatment group fed diets supplemented with 6% krill meal were significantly different from the group fed the positive control, high fish meal diet. Post challenges with *E.tarda*, survival rates were higher in the group fed diets containing krill meal diets (9%) compared to the high fish meal diet.

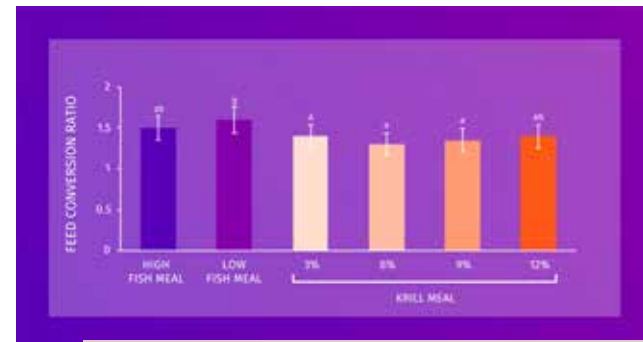
**“Based on these positive effects, the recommended level of krill inclusion for performance is at 6.6%. To challenge disease, the recommended level rises up to 9%.”**

## Based on the results of this experiment, what is the recommended supplementation levels of krill meal for the olive flounder?

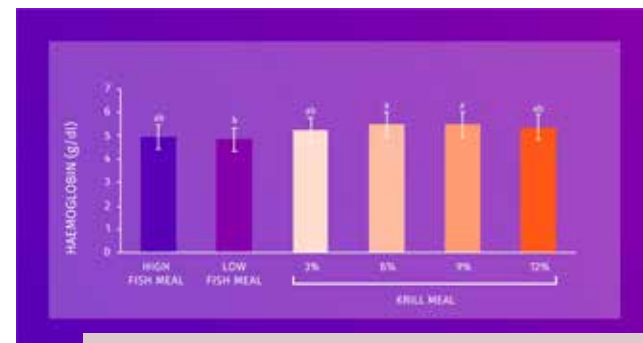
This experiment clearly showed that supplementation of krill meal in low fish meal diets increased growth, as well as improved diet digestibility, intestinal development and function and innate immunity, and also disease resistance of olive flounder. Based on these positive effects, the recommended level of krill inclusion for performance is at 6.6%. To challenge disease, the recommended level rises to 9%.



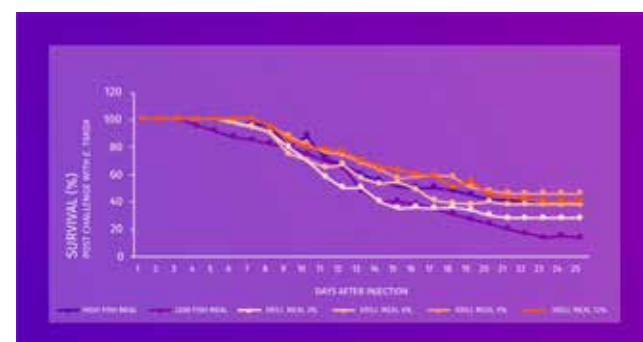
Final body weight of juvenile olive flounder fed either fish meal or 3%, 6%, 9% or 12% krill meal diets for 12 weeks.



Feed conversion ratio (FCR) of juvenile olive flounder fed either fish meal or 3%, 6%, 9% or 12% krill meal diets for 12 weeks.



Haemoglobin (g/dL) levels of juvenile olive flounder fed either fish meal or 3%, 6%, 9% or 12% krill meal diets for 12 weeks.



Survivals of juvenile olive flounder during the challenge test with *E. tarda* ( $1 \times 10^5$  CFU/mL)

# Aquafeeds in 2019: Pulled by market demand

Increased feed volumes across species and countries in combination with more investments in supporting farmers

By Zuridah Merican

As fish and shrimp production rose, so did feed volumes in most major markets; in 2019 fish feed volumes increased by as much as 30% and shrimp feed at 26%. The downside is that feed production capacity continued to increase, exceeding demand in most markets and competition remained tough. It was a push and pull effect as feed millers continued to support the farming industry in various ways to enhance success in farming: from laboratory services for diseases and water quality management, supply of quality fry and post larvae, holistic solutions to increase survival rates, feed management with digital innovations and auto feeders, to handling and processing harvests. Use of functional feeds, already common in China, had begun to spread to other countries.

## Demand and supply

In terms of feed volumes, there were increases across species and countries (Table 1) but notably, the increases have been in freshwater fish feed markets. China showed more carp feed sales, led by that for the grass carp as more farmers began to use commercial feeds (see page 31). In Bangladesh, the total demand for commercial aquafeeds increased by 36% to 1.5 million tonnes, of which 90% was fish feeds and the remaining 10% for the marine shrimp and freshwater prawn. A surge in demand in commercial

feeds for the pangasius, tilapia and Indian major carps was led by better prices for farmed fish when the supply of the preferred hilsa fish went down. Ajaya (2020) reported that fish feed production in India increased by 30% over that in 2018 (see page 33).

In Vietnam, good sales of pangasius fillet in the US and China markets helped to stabilise ex-farm prices of the pangasius to VND38,000/kg, raising production to 1.29 tonnes and total feed requirement of 2.06 million tonnes. Another estimate was at 2.5 million tonnes of pangasius feeds. Feed conversion ratios (FCR) ranged from 1.6 to 1.9. Unfortunately, prices dropped in the latter part of 2019 to VND18,500/kg. While demand for snakehead feeds rose 100% in China, there was a decline by 20% in Vietnam, the latter presumably because of lower ex-farm prices.

Indonesia's fish feed market, dominated by that for the *Clarias* catfish, tilapia and carps, showed a marginal increase (4.4%) to 1.44 million tonnes (GPMT, 2020). The demand for marine fish feeds continued to drop as farms faced marketing problems with the ban on direct sales of live fish to Hong Kong via well-boats. Total aquafeed production in Thailand was over 1 million tonnes in 2019, a marginal increase over 2018 at 0.8%. More feeds were used for the tilapia and *Clarias* catfish in 2019.

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Except for China, an increase in shrimp production (with better control on productivity and disease management, lower stocking density and higher survival rates, as well as the establishment of new farms), led to a higher demand for shrimp feeds. The highest increase in demand was in Vietnam at 26%, Thailand at 16%, Indonesia at <10% and India at 5%. However, according to industry, the large increase in Vietnam was because production in 2018 was underestimated. Most feed millers supported the industry with healthy post larvae and feed management protocols and provided complete solutions to improve survival rates along the production chain. In the Philippines, the shrimp feed market was estimated at 100,000 tonnes in 2019, of which some 50% was imported.

**Table 1.** Industry estimates on feed demand in 2019 (tonnes) in selected countries.

|             | Fish feeds | Shrimp feeds | Marine fish feeds |
|-------------|------------|--------------|-------------------|
| China       | 16,700,000 | 1,700,000    | 1,600,000         |
| Vietnam     | 4,500,000  | 1,000,000    | 60,000            |
| Bangladesh  | 1,350,000  | 72,000       | -                 |
| Indonesia   | 1,443,945  | 352,248      | 16,500            |
| India       | 1,200,000  | 1,300,000    | -                 |
| Thailand    | 580,000    | 478,000      | 32,800            |
| Philippines | 275,500    | 100,000      |                   |
| Malaysia    | 80,000     | 105,000      | 50,000            |

China- see pages 31-32 for details on production; Vietnam-vannamei: monodon feeds at ratio 6:4, 2-2.5 million tonnes of pangasius feeds; Bangladesh- monodon shrimp feeds, calculated at FCR 1.8 for 40,000 tonnes shrimp production; Indonesia-data from GPMT; fish feeds mainly for *Clarias catfish* (35%), common carp (25%) and tilapia (25%); India- excludes an estimated 60,000 tonnes of imported shrimp feeds, mainly from Vietnam; Thailand-fish feeds are mainly for the tilapia (31%) and *Clarias catfish* (21%); Philippines - data for fish feeds includes marine fish feeds; Malaysia-includes an estimated 31,000 tonnes of imported shrimp feeds and 20,000 tonnes of marine fish feeds.

### Industry trends

In Bangladesh's fish feed market, out of the 1.35 million tonnes in 2019, 70% were floating feeds for the pangasius, tilapia and Indian major carps. In mid-2019, tilapia ex-farm prices rose to USD1.5/kg, and pushed up fish production and demand for floating feeds. When ex-farm fish prices were lower, farms shifted to feeding fish with cheaper sinking pellets.



At TARS 2019 which focussed on the aquafeed industry, Dr Jarin Sawanboonchun, Thailand, Haris Muhtadi, GPMT, Indonesia, and Ravikumar Bangarusamy, Crowel Feeds, India gave overviews on the state of industry in Thailand, Indonesia and India, respectively.

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Opening of a dedicated 200,000 tpy aquafeed facility in Myaung Dagar, Myanmar by Royal De Heus Group. In the press release, Koen de Heus, CEO, said, "The usage of floating feeds, for instance, lowers water pollution which in turn supports the health of the fish and accelerate growth leading to better proceeds for local farmers."

A weak US market for tilapia affected producers in China, but 2019 production was higher at 1.76 million tonnes than in 2018 as reported by Ragnar Tveteras at GOAL 2019. In Vietnam, the government has targeted tilapia as a potential species for export, but industry commented that it is not as popular with investors as it lacks industry chain—quality fry, culture technology and processing to compete with China. Nguyen Anh Tuan, Deputy Director General at Mavin Aquaculture said that the company has developed a new type of feed, customised especially for tilapia in cage culture which is rapidly expanding in reservoirs in Vietnam.

Jeff Jie Cheng Chuang, General Manager, Sheng Long Bio-Tech International, said, "The red tilapia is popular in Vietnam and uses 300,000 tonnes of feeds. To jumpstart farming, we have imported broodstock and started supplying fry. We also bought back the harvest for processing for export to the Middle East." Sheng Long along with Uni-President Vietnam and CP Vietnam are leaders in the tilapia feed market.

A challenge in Indonesia, is to meet market demand on acceptable feed prices. At the same time, "The competitive landscape is changing with the entry of new foreign companies with lower prices and longer credit terms. We expect disruption in industry causing the oversupply of fish and shrimp feeds, when these new companies launch new products into the Indonesian market next year," said Haris Muhtadi, Chairman at the GPMT and Associate Director at PT CJ Feed and Livestock Indonesia during a presentation at TARS 2019. Despite higher production costs, feed millers have agreed not to increase prices as farms faced low shrimp prices and lower profit margins.

Fluctuations in raw material and fish meal prices were compounded in 2019 by the depreciation of local currency against the US dollar around Asia. However, the impact in India was very minimal as Indian feed millers used >95% local raw materials such as fish meal, corn and soybean meal, and deoiled rice bran (DORB). In terms of his top three challenges in 2019, Seshu Akkina, COO Deepak Nexgen Feeds prioritised fluctuations in raw material prices, fish meal availability and procurement as well as labour issues. The problem with fish meal availability was because of the 40-day strike against GST by fish meal processors. "Actually, the cost of production has increased in the last 3 years as fish meal and soybean meal prices increased continuously. In January 2020, many feed millers increased shrimp feed prices by about INR6/kg after 4 years of no price increase."

## Seabass and marine fish feeds

Uni President Vietnam has been exporting its seabass feeds to Thailand for several years now. "Thai seabass farmers growing table size and jumbo size fish prefer our feeds as they get good FCR and flesh quality. This is a testimony on the quality of the feeds," said Wei Che Wen, Sales Manager. Imported marine fish feeds from Uni President and Sheng Long in Vietnam as well as

from feed mills in Taiwan constituted a major portion of feeds used in the farming of the snappers, groupers and seabass in Malaysia. The 50,000-60,000 tpy marine fish feed market has six local feed millers, led by Star Feed Mills.

With the beginning of the diversification into seabass farming in India, Dr S Kandan at the Rajiv Gandhi Centre for Aquaculture, has made an estimation on the current feed demand based on wild catch and hatchery production of 5 million fry. "We calculated that based on a 40-45 days nursery rearing of seabass, from 1.2g to 10g, we need 2,000kg of feeds. Then for the grow out culture over 320-325 days from 10g to 1.2kg fish, we postulated a demand for 725 tonnes of feeds and rising to 1,000 tonnes by 2023. Presently, we use locally produced marine fish feeds by Growel Feeds as well as imported feeds from Skretting, Uni President Vietnam and Lucky Star for larval rearing of seabass, as well as for the pompano and cobia."

Haris also reported on the situation in Indonesia. "We changed the minimum crude protein level for milkfish and for some freshwater and brackish water fish species, from 18% to 15%. This is profitable for the feed millers and it helps farmers farming milkfish in semi-intensive and traditional systems. Previously, under the Indonesian National Standard (SNI), 15% crude protein feeds were not allowed for distribution in the Indonesian market."



Seabass feeds at PT Bali Barramundi, Indonesia

## Shrimp feeds

"The better uptake of auto feeders has helped shrimp farms with better feed management," said Ravikumar Bangarusamy, Technical General Manager, Growel Feeds at TARS 2019. The use of sensor-based auto feeders in some corporate farms has helped to reduce organic loads. Data from his R&D work comparing pelleted feeds versus extruded functional feeds in about 1,000 ponds across India for the past 3 years at various locations, at different salinities and over winter and summer, showed better survival rates by 24%, better average daily growth (ADG) by 30% and improved FCR by 21% with extruded feeds.

In Asia, there is only 5% of extruded shrimp feeds versus 95% of pelleted shrimp feeds in the market while in Latin America, all shrimp feeds are extruded. Ramesh G, Wenger India, is of the opinion that the growing use of automatic feeders and more uniform feeding favoured the use of extruded feeds over pelleted feeds which are disadvantaged by high levels of dust and breakage of pellets. With more unconventional feed ingredients, new alternative protein sources are being used and extrusion could be one of the solutions.

## Concentration

Bangladesh has around 100 aquafeed millers; almost all produce poultry feeds as well as freshwater fish and prawn and shrimp feeds. The top five feed millers (Quality Feeds, Mega/Hexa, CP Bangladesh, Nourish and Chuyya Agro) had 40% market share in 2019. On the contrary, in India's 30-feed mill (<25,000-65,000 tpy) strong industry, the top five shrimp feed millers (Avanti Feeds, CP India, Growel Feeds, Deepak Nexgen and Dewi Seafoods) had almost 76% of the market share in 2019. In the fish feed market, five fish feed millers (Indian Broiler, Deepak Nexgen, Growel Feeds, Godrej and Uno Feeds) had a 40% market share. In Indonesia's shrimp feed market, the top four market leaders (CJ, CP Prima, Japfa Comfeed and Matahari Sakti) accounted for 70% of the production and in the fish feed market, three market leaders (Sinta Prima, CP and Japfa Comfeed) produced 65% of the volume.

"In for Vietnam's shrimp feed market, there are four market leaders (CP Vietnam, Grobest, Sheng Long and Uni President) contributing almost 78% of the production. But only two feed millers (Proconco and Viet Thang) contributed equally 25% each to the pangasius feed market in 2019. Their production was at full capacity," said an industry source."

## Fish meal and alternatives

2019 was a watershed year with more certainty that many of the fish meal and fish oil replacements in Asian markets work. Dr Jarin Sawanboonchun said that current shrimp formulations contained 10-12% fish meal. Undoubtedly, vannamei shrimp requires less fish meal but for many shrimp farmers, fish meal is the gold standard and farmers insist on knowing the inclusion rates and look for dark brown pellets. With R&D, industry in Thailand is on track towards zero-fish meal diets and seek alternative protein sources and additives when feeds have low fish meal inclusion rates.

At TARS 2019, Indonesian farmer Rizky Darmawan, PT Delta Marine, said that he prefers using low fish meal feeds (finisher at 30% CP) which are fermented prior to use and fed over 24 hours with autofeeders at his vannamei shrimp farm. In his view, aside from competitive pricing, feeds should deliver his KPI of 0.3g ADG.

In China, with supply and price limitations for fish meal, feed millers have been adjusting inclusion rates. "After several years of education and performance demonstration, some farmers no longer insist on high fish meal and oil inclusions in feed," said Dong Qiufen, Guangdong Nutriera Group, China, adding that research on fish meal substitution is ongoing to help feed millers overcome the shortage of fish meal supply and cost pressure. Some alternatives, especially animal proteins have been effective in replacing 50% fish meal and their inclusion could be at 30% to 35%.

In Vietnam, farmers seek darker colour feeds as an indication of more fish meal. They link this to higher nutritional value for fast growth. Chuang said, "Our years of research showed that fish meal in feeds can be reduced, after balancing with amino acids, krill meal, insect protein, cotton meal, corn meal, soybean protein concentrate (SPC) and corn gluten meal (CGM). We continue to research on the minimum level of fish meal."

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In replacing fish meal with alternative ingredients, the objective is "same growth performance at same cost." Thailand's Thai Union Feed Mill has been conducting trials on its zero fish meal shrimp feeds with 11% FeedKind, alternative protein meal produced by Calysta. At the Seafood Expo Global in April 2019, both companies promoted shrimp fed with this feed to buyers. This is working downstream, influencing the supply chain's customers. At SeaWeb 2019, the discussion among producers of alternatives for fish meal and fish oil (Calysta, Corbion and Veramaris) and Thai Union as the feed miller, was how to communicate to consumers these innovations. These findings, as well as output from the roundtable sessions at TARS 2019 which focussed on aquafeeds, showed that fish meal and fish oil replacements in shrimp feeds are no longer a technical challenge. It is more of a marketing challenge to get the customers to start adopting feeds with alternative ingredients. As fish meal prices keep going up, the industry is pushed in this direction. (See page 30 on the update with fish meal up to May in 2020)

### Functional feeds

Functional feeds are becoming well accepted in Asia, particularly in China where industry categorises such feeds under health care, preventive, fast growth, special culture, fillet quality etc. Functional feeds with astaxanthin added are common in China, Thailand and Vietnam. A buyer's perspective is that in terms of colour, the preference for cooked shrimp is between 27-30 on the colour fan and dark coloured shrimp which can give a premium on the price at USD1/kg or more (Tanco, 2020).

The market is willing to pay for such feeds said Wei. "Our colour enhancement feeds also show excellent performance and is well accepted by our farmers. We have customers buying our feeds to increase weight to as large as wild caught monodon shrimp. Farmers can reduce losses from white faeces disease by using feed for improved digestion and nutrition."

Functional feeds for snakehead fish farming are relatively common. While Uni President markets feeds which give the fish an ability to combat stress and reduce mortality during transportation, in China and India, there are functional feeds to overcome liver disease. Farming the snakehead or murrel is beginning in India and the feed market is only at 5,000 tonnes (Chen, pers comm). Uno Feeds produces extruded 1mm to 6mm feeds with functional premixes to overcome poor liver condition.

### Expansion and acquisitions

The expansion into Asia by China's large multinationals continued to be a concern. Dr Zhang Song, Vice President at Guangdong Nutriera Group, China, explained that because of the increasing costs, from land, capex and opex to environmental issues within China, its large feed multinationals will build aquafeed mills abroad, in particular the top five aquafeed giants (Tongwei, Haid, Guangdong Evergreen, New Hope and East Hope). Four new feed mills are expected in Indonesia in 2020, contributing to 120,000 tpy of additional capacity to an existing 700,000 tpy.

Local players continued to expand capacity in Indonesia. In September 2019, Indonesia's PT Matahari Sakti started a fish feed plant in Cikupa, West Java, to be closer to farmers. This added 1,000 tpy to its production. It has an East Java fish feed plant in Gempol and shrimp feed plant in Surabaya. Shrimp feed market leader, PT CJ Feeds has added two new shrimp feed lines to the plant in Serang, Banten province.

Dr Erwin Suwendi, Manager and Head of Nutrition and Feed Technology, PT Suri Tani Pemuka (STP) said, "Japfa Comfeed's subsidiary, PT Indojaya Agrinusa has inaugurated a new aquafeed



Stakeholders in India's fish and shrimp aquaculture and aquafeed production at AquaIndia 2020, held in Kochi, India on 31 Jan -1 February. This was the last large industry gathering prior to the Covid-19 lockdown.

mill in North Sumatra with a capacity of 9,500 tonnes of floating fish feed, 2,000 tonnes of sinking fish feed and 700 tonnes of shrimp feed per month. The feed mill covers sales for the northern areas of Sumatra, where the aquaculture industry demands 30,000 tonnes of feed/month." He added that Japfa Aquaculture (STP) has been expanding several aquafeed production lines at each unit to support growth of aquaculture in Indonesia. Annual feed production capacity of STP will be around 400,000 tpy.

In Vietnam, Tuan said, "Mavin Aquaculture will invest USD30 million to start marine farming in Kien Giang province in the south of Vietnam. This large 2,000 ha project will target the grouper, barramundi and pompano with designed capacity of 30,000 tonnes/year. The project applies concepts in modern marine fish farming, such as Norway's round cage technology, France's

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feeding systems and fish harvesting technology from Australia. As we target the export market, we will focus on environmental impact and traceability to meet EU's requirements such as relating to illegal unregulated and unreported (IUU) fishing. Feeds for marine species such as cobia, grouper, pompano and barramundi are under our R&D focus and are expected to be available by 2022."

In November 2019, De Heus Group opened a dedicated 200,000 tpy aquafeed facility in Myaung Dagar, Myanmar which is close to the centre of aquaculture. The company said that this will give aqua farmers access to the affordable high-quality feeds needed to further improve the development of their farms.

In terms of acquisitions in 2019, in mid-May, Pilmico International Pte. Ltd, the agribusiness arm of Aboitiz Equity Ventures acquired Singapore-based Gold Coin Management Holdings. Gold Coin has aquafeed mills in China, Malaysia, Thailand and in Medan and Lampung in Indonesia. In July, Chicago-based ADM took over Neovia which markets the Ocialis brand of fish and shrimp feeds.

As a regional player, Chuang said, "We will continue to focus on the Vietnam shrimp feed market and enhance our competitiveness which also includes diversification of health products, establishment of optimal culture models, consolidation of our service team and eventually enter into shrimp processing. In India, our feeds have increased by an estimated 40% via our improved distribution and dealers' network."


### Outlook for 2020

Certainly, the first 5 months of 2020 has been particularly challenging for feed millers across Asia. COVID-19 pandemic and ensuing lockdowns continue to affect the supply chain, feed ingredient cost etc. One surprising effect is lower soybean meal prices, caused by African swine fever lowering feed demand. (Some experiences by industry leaders with the lockdowns and predictions on aquafeed demand in 2020 are given on page 6).

Chuang commented on concerns with the supply of imported aquafeed ingredients and raw materials. News of worker strikes and port blockades in South America prompted uncertainty on prices of fish meal and soybean meal from South America and their prices are expected to skyrocket in the short term. The supply risk is higher with other fish meal supply countries, such as India, Africa, and North America which are in the epicentre of the pandemic. "Fortunately, for the time being, raw materials such as fish meal, corn gluten meal, wheat, and miscellaneous raw materials from China, Vietnam and other countries in Southeast Asia are stable in price and supply."

### Acknowledgement

This is a review on the aquafeed industry in Asia published annually. The author would like to express her sincere gratitude to those mentioned in this article and to other industry stakeholders who have willingly provided information but have requested to remain anonymous.

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\* Fish Diseases and Management, Faculty of Veterinary Medicine, Cairo University, Egypt, 2017.

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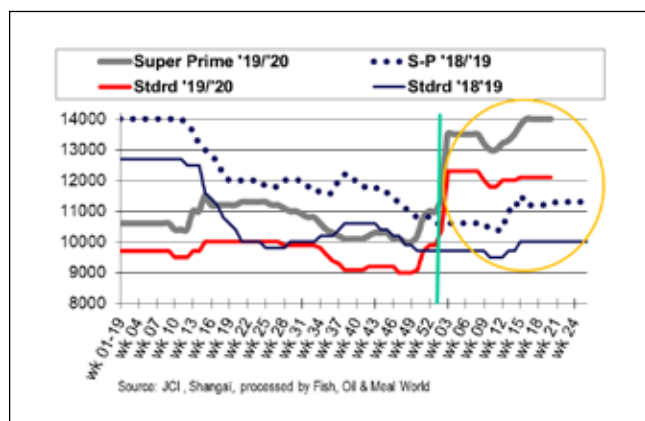
## Fish meal market update

Five months ago, the outlook for the world fish meal market was for a record second fishing season in Peru with a 2.79 million tonnes anchovy quota, the largest ever for this season, with about half being already pre-sold. At more than 187,000 tonnes, fish meal stocks in Chinese ports were 50% higher than the three-year average and imported fish meal prices in China were the lowest in many months. Large stocks and low prices on the demand side with ample future supplies gave the basis for a "bearish" 2020 fish meal market outlook with FOB Peru prices quoted at about USD1,300/tonne for the "super-prime" quality and RMB 10,000/tonne export storage in China. (Figure 1)

But as we enter the month of May 2020, the situation is just radically different. The second 2019 fishing season in Peru was stopped three weeks ahead of schedule on account of excessively large juvenile counts in the catches and only 36% of the quota was landed, corresponding to a mere 232,000 tonnes of fish meal production and less than 30,000 tonnes of fish oil. During the first trimester 2020, the outlook for the first 2020 fishing season in Peru was uncertain.

Then came the Covid-19 lockdown in Peru which practically paralysed the country since March 12. Both the start of the next fishing season and the corresponding fishing quota were unknown until the May 8 publication of a ministerial decree authorising the opening of the fishing season on May 13 with a global quota of 2.41 million tonnes, well above the general market anticipation of 2.0 million tonnes. However, at the same time very tight sanitary protocols were established raising much uncertainty as to whether such quota could be completed.

In China, fish meal stocks in ports decreased sharply as the country was coming out of its own Covid-19 lockdown. Demand from those stocks was large during April and prices rose accordingly. The current outlook for the key Peru/China fish meal market has turned



**Figure 1.** Imported fish meal prices (Standard & Super-Prime) in Shanghai (ex-port warehouse) from January 2019 to May 2020 compared with previous year (in RMB/tonne).

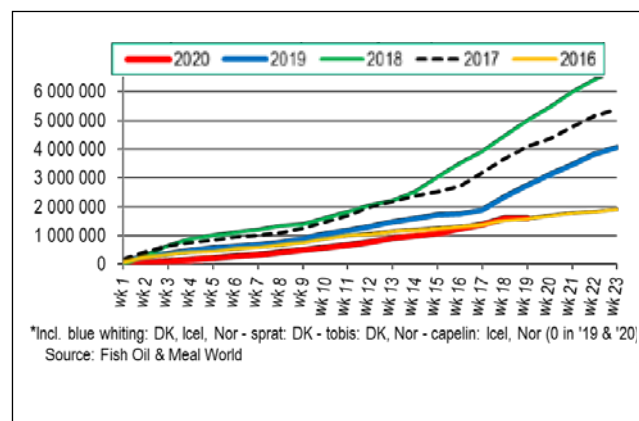


**Jean-François Mittaine** is with the Fishmeal Experts Office, Paris, France and is the Co-editor of "Fish Oil & Meal World". In November's DSM 2020 aquaculture conference, he presented on "Fish meal and fish oil - insights and projections".  
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firm with prices quoted in Peru at around USD1,700/tonne FOB but without transactions and RMB 14,000/tonne ex-port storage in China.

Fish landings in the five key fish meal producing countries have been modest to poor so far in 2020 (Figure 2). Despite a slow first quarter 2020, fishing in Chile should recover as the overall annual fishing quotas are up about 10% year on year. But it remains to be confirmed whether effective landings will be up to the quotas. In Scandinavia, despite the lack of the important capelin landings for the second year in a row, total 2020 landings are expected to be only slightly below the level of the previous year. In other producing countries, much uncertainty prevails.

**In a nutshell, the world fish meal market will likely continue to be firm as we see continuing overall supply tightness only counterbalanced by weaker demand on account of the indirect effects of Covid-19 lockdowns all over the world in the first half of 2020. However, on the other hand, it should remain much more stable than other commodity markets.**



**Figure 2.** Peru/Chile/Scandinavia\* - Cumulative landings of major species for meal & oil from January to May 2020, compared with four previous years (in tonnes of raw fish).



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# Aquafeeds in China amid a changing aquaculture landscape in 2019

In 2019, industry estimates on the total aquafeed production were between 22 and 23 million tonnes while the Alltech Feed Survey gave a production of 16,527,000 tonnes (Issue March/April 2020). "The feed demand for the carps rose in 2019, led by that for grass carp as more farmers began to use commercial feeds," said Dong Qiufen, Guangdong Nutriera Group. Production of various species of carps reached 18.2 million tonnes in 2019. In 2018, a 200% growth in demand for pangasius feeds was projected. This did not happen as low fish prices since early 2019 in Vietnam favoured imports and farming the fish in China slowed down.

Demand for snakehead fish feed doubled in 2019. The exponential rise for crayfish feeds (from 0.4 million in 2018) demonstrated the continued interest to farm this 'small lobster'. "In 2020, some expectations are small increases in the demand for feeds for the

tilapia, grass carp and marine fish but lower than in 2019 for the common carp," said Dr Zhou Enhua, US Soybean Export Council (USSEC), Shanghai.

## Environmental protection

The changing aquaculture landscape in China followed the nationwide promotions on green aquaculture and aquatic food safety. Zhou and Dong explained how regulations relating to environmental protection led to the removal of many cages from lakes and reservoirs, and how illegal offshore farming was stopped. Seafood safety supervision was further strengthened where farm inputs and final product inspections were strictly conducted. Zhou added that this favoured recirculation aquaculture systems (RAS) and the USSEC's IPRS (In Pond Raceway System).

| Freshwater fish feeds  | Million tonnes | Marine fish feeds  | Million tonnes | Crustacean feeds       | Million tonnes |
|--|----------------|--|----------------|------------------------|----------------|
| Various carps  | 9.50           | Bass and largemouth bass                                   | 1.00           | Vannamei shrimp        | 1.50           |
| Tilapia (black and red tilapia)  | 2.00           | Big yellow croaker   | 0.60           | Monodon shrimp         | 0.20           |
| Snakehead  | 0.80           | Groupers   | 0.20           | Crab                   | 0.80           |
| Pangasius  | 0.20           | Other marine fish such as pompano, snapper and marine eels | 0.60           | Crayfish               | 1.60           |
| Other freshwater fish including the channel and yellow catfish and loach | 1.00           |  |                | Giant freshwater prawn | 0.30           |

Table 1. Estimates on aquafeed production in 2019 for some leading aquatic species provided by industry in China.

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"Along the supply chain, new and high value business models have been developed quite rapidly. These included eco-branded fish, traceable certification, ready to eat or processed food, online and offline outlets and container farming. Industry emphasised this as part of the modernisation of China's aquaculture industry where small or traditional farming activities were minimised, and high value and green models will be promoted to match government regulations and consumer's preferences," said Dong.

During TARS 2019, Dr Zhang Song, Guangdong Nutriera Group noted that strong environmental actions have pushed feed mills to update feed formulation and production technology to improve management and farming models. This is also producing feeds for higher farm productivity such as feeds specific for container RAS systems. In shrimp, industry reported less outdoor shrimp farms. Culture systems producing a minimum of 5kg/m<sup>3</sup> are common.

### Tilapia and shrimp feeds

Low demand and poor prices for the tilapia in 2019 significantly affected producers. "In Hainan, it was USD2.0/kg in December as compared with USD2.42/kg in January. In Guangdong, it was USD2.28 in January and by December, prices dropped to USD2/kg. This is a major export item and with such low prices, feed millers stepped in to develop polyculture models with the vannamei shrimp and the local Chinese mud carp *Cirrhinus molitorella* to improve profit margins," said Dong. Zhou added that feed producers also helped farmers to improve productivity and to expand the domestic market.

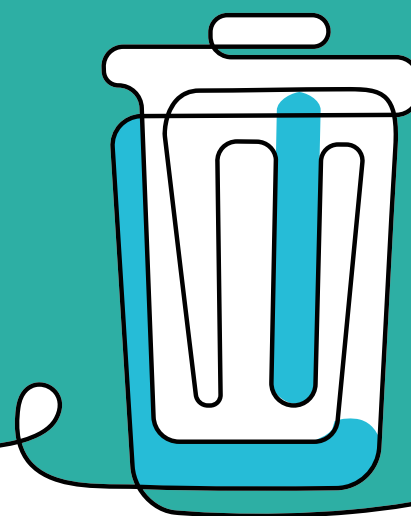
In RAS for shrimp farming, where there have been massive investments, farmers pay little attention on the costs of feeds. Their focus is on high survival and short farming cycle, as well as shrimp with colour as preferred by consumers, which meant the use of functional feeds with astaxanthin. Dong said, "In shrimp feeds, farmers believe that high fish meal and fish oil inclusions in feeds will give better growth performance but due to supply and price limitations, feed millers have been forced to adjust fish meal inclusion rates. According to some research and field results, high fish meal and fish oil diets are not necessary. Therefore, after several years of education and performance demonstrations, some farmers now do not insist on high fish meal and fish oil in feeds."

### Aquafeed outlook for 2020

"The immediate effects of the Covid-19 lockdown were labour and raw material shortages as well as shipping issues. By March, feed mill operations were normal," said Frank Zhu, Kemin Aqua Science, based in Shanghai during a webinar in April. However, prices of some feed ingredients were initially higher but with better control on logistics, supply of ingredients stabilised. Fish meal prices increased by 40%. In March, most feed producers announced price increases. They leverage with feed additives to support ingredient price changes and supply issues.

"In the short term, there will be an impact on total aquafeed use as farmers are not confident on the economy and on seafood consumption," said Dong. "In the long term, if the pandemic is well controlled, in 2-3 months, consumption will pick up and will encourage farming which will push up feed demand. Probably, some shrimp farmers may turn to fish culture. Overall, we estimate that fish feed production may only drop by 10% compared to 2019."

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# 2019: How aquaculture fuelled the best year for the aquafeed industry in India

Higher sales nationwide in 2019. Uncertainties and losses with lockdown measures are already expected to lower 2020 demand by 25-30%, says Ajaya Baskar.

It was the best year for aquafeed production in India. Its shrimp feed market saw a steady upward growth by 5.4% over that in 2018 – 1.3 million tonnes for a shrimp production of 0.8 million tonnes. Feed conversion ratio (FCR) was better too at 1.6 compared to 1.7 in 2018. The mainly freshwater fish feed market also had a good year with a production of 1.2 million tonnes, an increase of 30% over that in 2018.

## The best year for shrimp farming

In 2019, with a longer summer and mild winter, farmers had higher success rates for the whole year. The production was 750,000 tonnes of vannamei shrimp and 50,000 tonnes of monodon shrimp. The peak demand for shrimp feed shifted to April, May, June for the first summer crop and September, October, November for the second crop.

At the same time, new shrimp farming areas such as in Orissa and West Bengal created new markets for feed millers, who usually focussed on Andhra Pradesh. Notwithstanding current shifts in demand, we can produce 1 million tonnes of shrimp, increasing feed demand to 1.6 million tonnes, assuming a FCR of 1.6. This brings us closer to the 2019 installed feed production capacity of 2.8 million tonnes per year.

## Expansion in fish farming

New freshwater fish farms in northern India (West Bengal, Uttar Pradesh, Bihar and Uttarakhand) created new feed markets. Demand for commercial fish feeds is ex-farm fish price dependent. Farm-made feeds are the alternative when fish prices drop. In 2019, demand for live fish in the main market increased farm gate prices for live Indian major carps (IMC): rohu at INR150/kg and live pangasius at INR110/kg. Unfortunately, prices for chilled fish were quite poor, with rohu at INR100/kg and pangasius at INR70/kg. The potential to increase feed demand will come when more farmers shift to either pelleted or extruded feeds rather than from feeding IMCs the traditional way (fertilisation of ponds and feeding raw materials directly in feed bags containing deoiled rice bran, DORB).

## Challenges: Prices of raw materials and credits

Feed millers were challenged by perpetual price fluctuations for raw materials, depending on the season and availability. From March to June and September to November, the demand for raw materials is generally high leading to the rise in prices of most raw materials. In 2019, prices for grains and DORB increased marginally, and compared to 2018, prices for fish meal and soybean meal in 2019 were generally good too.

Then we also saw the depreciation of the INR to the US dollar; from INR68 in July to INR72 in December. Of course, the impact was not only on raw material prices but also availability, logistics and other factors. India is a major oil importer. This situation forced some fish feed millers to increase fish feed prices by INR2-3/kg in 2019. In 2020, there was an increase of INR4-5/ kg for shrimp feeds,

although with stiff competition, some feed millers had second thoughts. The increase then came in February 2020 when there was a sudden increase in the prices of some raw materials.

Most of the feed companies will give credit based on their capacity, relationship with the farmers and turnover, either directly to corporate farmers or feed dealers and distributors. Some companies are struggling to get back their investments due to various reasons.

## Outlook for 2020

The year really did not begin well. Anticipating bad news with the COVID-19 pandemic and a country-wide lockdown, farmers in Andhra Pradesh who stocked ponds in December 2019 panicked and started harvesting. The sudden lockdown imposed on 25 March obstructed logistics for raw materials, aquafeeds and finished products. Although movements were allowed 3-4 days later, there was no staff to run farms, hatcheries, feed mills and processing plants.

Selling was delayed with no buyers for the harvested shrimp. Shrimp prices fell 60% to INR120/kg for size 70/kg in early April. Fortunately, the government quickly announced a realistic INR220/kg price, ordering processing companies to buy harvested shrimp at this price. But by then, most farmers had faced huge losses. Furthermore, farmers who harvested quickly in March and incurred losses, are unlikely to restock ponds. Poor post larvae demand is expected and farms located far away from hatcheries will have difficulty obtaining post larvae.

However, farmers who stocked in February and March will harvest in May and June. But these farmers may still face problems such as feed availability and transportation. The lockdown has been extended to May 18 which means that the main farming season would have ended. My estimate is 25-30% of both shrimp production and feed business will suffer losses.

In summary, all segments in the seafood supply chain were affected in these last 4 months, in one way or another. I expect all stakeholders to be proactive and revise their business strategies and agreements.



**D. Ajaya Baskar**, PhD is an aquaculture nutritionist & feed consultant based in Bhimavaram, Andhra Pradesh since 2014. He has 15 years of experience in the aquafeed industry, mainly in India, Thailand, Bangladesh and Egypt. His focus

includes R&D in aqua nutrition, feed formulations, new product development and educating farmers on the latest technology and best aquaculture practises.

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## New generation DDGS for Southeast Asia's aquafeed markets

Targeting the expanding aquafeed market, as DDGS evolves with higher levels of consistency, higher protein and lower fat.

In the dry milling process for ethanol, the co-product, distillers dried grains with solubles (DDGS), has been available for animal feed production since 2010. Although fast expanding, the aquafeed market for this product has remained elusive, particularly in Southeast Asia. It is a nutritionally and economically attractive feed ingredient for use in various aquaculture species with an absence of antinutritional factors and with relatively high energy, digestible amino acids and phosphorus.

Aquafeed formulators and nutritionists remain averse to its use as a replacement for soybean and fish meal mainly because of its low protein and high fat levels plus a history of inconsistency in product composition. This is set to change as the US coarse grain industry is producing new and innovative products to help meet the needs and demands of global feed markets. More consistent than traditional DDGS, new generation high protein ones are entering the market.

"In 2018, the US production of DDGS totaled 37.2 million tonnes. Some 11-12 million tonnes were exported, 4 million tonnes to Southeast Asia of which 1.2 million tonnes to Vietnam. This is for the total feed market. Over the next few years, global aquafeed volume is expected to increase by 35% and presents a potential market for US grains, in particular, DDGS. This region is where growth in aquafeed production will be," said Caleb Wurth, Assistant Regional Director-SEA & Oceania, US Grains Council (USGC), during his welcome address at the Aquafeed Expo Southeast Asia 2020 in Ho Chi Minh City, Vietnam, in January.

As a market promotion board, USGC is tasked with finding new demand, building on it and keeping markets open for US corn, sorghum, barley, DDGS and ethanol. For the team in Southeast Asia, 2020 started with two-country seminars for Vietnam (Ho Chi Minh City) and Thailand (Bangkok) to encourage the use of the new generation of DDGS in aquafeeds. This is part of the council's efforts to debunk perceptions on DDGS, connect with customers

and present the latest research data on DDGS for aquaculture species. The aim was to help international buyers of US corn co-products understand the values of DDGS as they relate to aquafeeds.

"All of these activities will allow end-users to make informed decisions and increase the use of US DDGS in their aquafeed operations," said Wurth. Success in raising inclusion rates to 5% for shrimp and marine fish and 3% for freshwater fish could result in 275,000 tonnes in additional demand for US corn DDGS in a region already responsible for a third of US DDGS exports. Higher inclusion rates can increase consumption to between 500,000 and 1.25 million tonnes in the future.

### Evolution in DDGS

During the technical part of the seminar in Vietnam, Wurth presented the history of DDGS and its current position in the Asian feed industry. Back in 1964, the American Association of Feed Control Officials (AAFCO) developed the cereal-like palatable DDGS as a feed ingredient for dairy, poultry and beef feed production. With more improvements, in 2004, an entirely different DDGS was created by the expanded 201 ethanol manufacturing plants throughout the US. However, different technologies also meant products in the market with a variability range as high as 5.68%. Today, with continued refinements in processing technology, DDGS have increased protein content and decreased fat levels.

"Today, the advantage with DDGS is that producers can assure products with less variability. In general, we now have DDGS with crude protein at 27% in 2019 as compared to 25% in 2007; crude fat down to 7% in 2019 from 11% in 2007 and 12% moisture in 2019 from 10% in 2007," said Wurth adding, "With advances in processing, each company can customise products to meet the needs of the animal. Producers are also creating specialised higher



Caleb Wurth (fifth, right) with his team and DDGS producers at the Aquafeed Expo Southeast Asia 2020 in Ho Chi Minh City, Vietnam. Presenters were Ronnie Tan (sixth, right) and Dr Nguyen Lay (seventh, right). Producers were Ivan Yong (right), John Hagios, The Andersons (left), Bret Befort, Flint Hill Resources (sixth, left), and Bart Pieper and Robert Hurley Jr, Marquis Energy (fifth and seventh left). USGC representatives in Vietnam are Tran Trong Chien (second left) and Tran Trong Nghia (fourth, right).

protein products allowing formulators to assign specific values in their least cost formulations. Palatability has also been addressed.”

However, there remains some concerns on the level of xanthophyll in corn derived products and its effect on colouration. Corn has 15-25mg/kg xanthophyll and DDGS has 15-40mg/kg. Pangasius farmers raise the major issue of DDGS contributing to a yellow fillet. Wurth said the research has been done and results are ready to be presented. There is also industry’s concern on mycotoxins, with high levels concentrated in DDGS. Wurth clarified that risks of mycotoxins in new generation DDGS are exceptionally low. In the US, local corn is used for ethanol production. As poor quality corn results in poor ethanol yields, producers are very discerning on standards for their corn supplies. He also referred to the US Federal Grain Inspection Service (FGIS) programme to verify the performance of rapid tests for mycotoxins in grains.

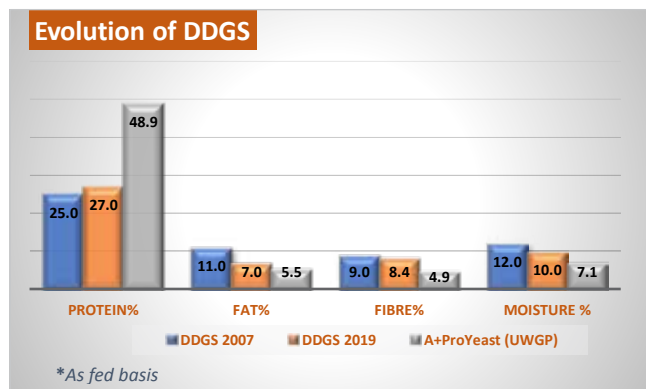


Figure 1. Evolution of DDGS since 2007 to 2019. Source: USGC

Sirirat Chatvijitkul, Thailand, discussed using DDGS in aquafeeds. DDGS can be used to produce economical diets, said Lay, in her presentation on DDGS utilisation in aquafeeds. “With the partial replacement of soybean meal and fish meal with DDGS, on per tonne basis, it is half the price of soybean meal and one tenth that of fish meal. However, compared with soybean meal and fish meal, there could be the deficiency of some essential amino acids (EAAs). For example, lysine, methionine, threonine and tryptophan may be limited, but we need to always match to the requirement of the species.”

Her message was that if DDGS is to be included at high levels, there will be a need to balance EAAs. Similarly, as 58% of the total lipids (usually 10% on dry matter basis) is linoleic acid (18:2n-6) and only 8% linolenic acid (18:3n3), in cases where the n3:n6 ratio is critical, supplementation with fish oil might be required.

## The potential aquafeed market in Southeast Asia

USGC’s regional aquaculture consultant Ronnie Tan will spearhead these efforts in the aquaculture sector in Southeast Asia, developing and targeting technical education and trade servicing programmes for aquaculture. The initial programme is focusing on Vietnam, Thailand and Indonesia, with likely expansion into Malaysia, Myanmar and the Philippines. As aquafeed demand is led by how the aquaculture sector performs, Tan showed data on the current production volumes of shrimp and tilapia in Southeast Asia while elaborating on the production challenges faced by both industries.

Asian shrimp production is hampered by diseases. Using the model of a working integrated farm in Malaysia, Tan presented the metrics and production data. He explained the practice of bio floc technology together with culture strategies of clear water, nursery technology, gas chlorination and the central drainage for sludge removal. He shared his disease experiences with acute hepatopancreatic necrosis disease (AHPND), white spot syndrome virus (WSSV) and *Enterocytozoon hepatopenaei* (EHP) with their respective causative factors and immediate actions required. Regarding the Asian tilapia model, he asked if industrialisation could produce responsible and sustainable tilapia which could be accepted by the markets in the west. He proposed cage culture in lakes and shared the example of an integrated farm in Lake Toba in Indonesia with its holistic approach of fish, feed and the environment. This model could produce fish above 1kg sizes which is ideal for filleting and production volumes of 40kg/m<sup>3</sup> of water.

## DDGS in aquafeeds

Based on their research and available information, University of Auburn, USA-trained nutritionists, Dr Nguyen Lay, Vietnam and Dr

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Sirirat outlined the strengths and concerns with DDGS in aquafeeds. Aside from the competitive pricing, the advantage with DDGS is that there are no antinutritional factors. Phosphorus is high at 0.96% compared to 0.84% in soybean meal; phytate is low at 0.27% compared to 0.39% in soybean meal and 0.89% in cottonseed meal.

DDGS may have low concentrations of several minerals such as calcium, chlorine, potassium, zinc, iron, manganese and copper but these can be supplemented with premixes. However, vitamins such as riboflavin, niacin, pantothenic acid, folic acid and choline are present at almost 3 times higher than in corn. There are also benefits from the yeast component, present at up to 10% and contributing 7.6%  $\beta$ -glucans. In the channel catfish, Lim *et al.* (2009) reported resistance to *Edwardsiella ictaluri* when 40% DDGS was added to diets but there was reportedly no effect on Nile tilapia and trout.

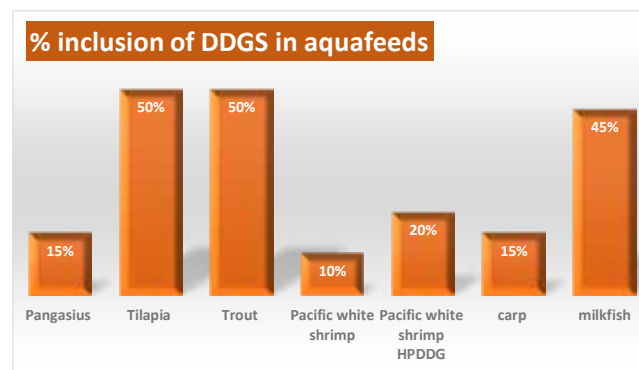
With regards to apparent digestibility, Lay said that information is limited and somehow unclear, attributing the differences to variability in ingredient and methodology. One advantage of using DDGS in diets is that the aquafeed industry can play a vital role in recycling nutrients, aside from it being a plant ingredient.

### Inclusion rates in aquafeeds

Research on inclusion levels for DDGS in some aquaculture species have been conducted since the early 1990s, such as with the channel catfish and the freshwater prawn. As it evolves, with its changing composition, comparing research findings is rather difficult. It is recommended that the new products should be re-evaluated for their efficiency (Chatvijitkul, 2016). In the pangasius, a recent research by USGC in Vietnam showed that 15% DDGS can replace soybean meal in the diet. After 118 days, weight gain reached 450.3g with an inclusion rate of 15% DDGS (27.7% crude protein, 9.8% crude fat). Addressing concerns on DDGS imparting fillet colouration from xanthophyll, the study showed no effects on fillet colour observed after 6 months to a year of culture. Xanthophyll in the diet was below the level to affect colouration.

Early studies evaluating DDGS in tilapia gave optimal inclusion rates at 29%. Subsequently, other studies concluded that including 20 to 60% DDGS gave acceptable weight gains, some diets were supplemented with lysine. In 2016, Chatvijitkul, showed that with lysine supplementation as much as 50% replacement of soybean meal in hybrid tilapia diets produced good growth performance. The most recent work by Herath *et al.*, 2016, showed that DDGS can effectively replace all of the fish meal in Nile tilapia diets at a level of 50% with supplemental L-lysine and produce the highest specific growth rates and survival. There was no effect on fillet colour and amino acid composition. This demonstrated that inclusion rates are higher in species with a greater ability to utilise fibre. Inclusion rates vary based on type of ingredients substituted and levels of other protein sources (e.g. fish meal). Supplemental essential amino acids are needed to meet requirements of aquatic species.

In the marine shrimp, Sookying and Davis (2011) showed that 10% DDGS to replace fish meal in a high soybean meal diet (58%) gave no significant differences in final weight, survival and feed conversion ratio as with a 10% fish meal diet. In the US, Jingping *et al.* (2019) used outdoor green water recirculation system tanks for trials on the marine shrimp fed diets where the HP-DDG (NexPro - Flint Hills) replaced menhaden fish meal. He showed that HP-DDG can be a protein source for the shrimp at 20% replacement but in combination with corn protein concentrate (Empyreall 75).



**Figure 2.** Some recommendations on maximum inclusion rates. Source: Lay, 2020; Chatvijitkul, 2020; USGC. (Pangasius, USGC, 2015; tilapia, with supplemental L-lysine, Herath *et al.*, 2016; trout, Overland *et al.*, 2013; Pacific white shrimp, LE-DDG, Sookying and Davis, 2011; HP DDG, Jingping *et al.*, 2019; carp and milkfish, USGC, 2007).

In commercial feed mills, a concern is the low starch which reduces pellet expansion during extrusion. The high fibre ingredient also reduces pellet durability and mechanical strength. Therefore, binding agents to achieve greater pellet durability index (PDI) in extruded fish feeds containing DDGS will be required. Although, there are significant economic advantages of using high inclusion rates of DDGS in aquaculture diets, achieving a desired PDI often limits DDGS use in feed mills. More research is needed to optimise chemical composition of aquaculture diets containing DDGS for various aquaculture species.

### New generation high protein DDGS

In the future, evolving co-products will create a higher content or quality of protein. This will be either through DDGS fractionation with the separation from fibre and protein in DDGS, DDG (distillers dried grains) or pre-fermentation of corn. The latter separates corn into components endosperm, germ and bran and allows diversification and value-added products. ICM's technology advances, such as Selective Milling Technology™ (SMT), Fiber Separation Technology™ (FST) and FST Next Gen are innovations to improve DDGs with higher levels of protein (up 53%), lower fat (as low as 3.9) and lysine levels closer to that in soybean meal and relatively higher methionine levels (Table 1).



Caleb Wurth, Assistant Regional Director-SEA & Oceania, USGC, Ronnie Tan, Regional Aquaculture Consultant for USGC and Dr Nguyen Lay, Vietnam discussed evolution of DDGS since 2010, aquaculture in Asia and inclusions of DDGS in aquafeeds, respectively.

**Table 1.** General composition of HP-DDGS and comparison with soybean meal (SBM) and conventional DDGS. Source: Chatvijitkul (2020)

| Composition (%) | HP-DDG (NRC, 2012) | Still Pro A+Pro4 | DDGS IAFFD | SBM (NRC, 2012) |
|-----------------|--------------------|------------------|------------|-----------------|
| CP              | 49.7               | 53.4             | 27.2       | 48              |
| CF              | 3.9                | 5.8              | 8.5        | 1.69            |
| NDF             | 36.9               | 39.5             | 44         | 9.1             |
| ADF             | 22.6               | 20               | 18         | 5.9             |
| ME (kcal)       | 4,092              | 3,766            | 2,541      | 3,660           |
| Lys             | 1.34               | 2.17             | 0.76       | 3.29            |
| Met             | 1.02               | 0.95             | 0.66       | 0.73            |
| Ash             | 3.0                | 3.9              | 5.6        | 7.0             |
| P               | 0.80               | 1.0              | 0.75       | 0.79            |

NRC 2012. National Research Council  
The International Aquaculture Feed Formulation Database (IAFFD)



Dr Nguyen Lay with Marc Campet (left) and Dr Minh Anh Pham, ADM Animal Nutrition

During the seminar in Vietnam, several producers discussed new products and those in development. CHS Asia with its regional headquarters in Singapore is a global agribusiness owned by farmers, ranchers and cooperatives across the US. CHS is also a global leader in marketing DDGS. Ivan Yong, Marketing Manager, CHS Singapore introduced the United Wisconsin Grain Producer, LLC (UWGP) A+ Pro Yeast produced from corn gluten and spent yeast. Yong said that this is a vegetarian ingredient and drew attention to the fantastic colour and flowability. Typical product specification is 46% crude protein, but the value can be 50% or more. More product research is ongoing.

The Andersons Inc. exports DDGS to markets in Southeast Asia such as Indonesia, Thailand, Taiwan, Malaysia and Vietnam. The latter is an excellent market for the company. "Most customers are looking for consistency, but depending on the plant, the composition profile of corn kernel can change," said John Hagios, Vice President, Feed Ingredients, adding that there can be extra costs for exports to Vietnam since there is a requirement for fumigation.

The company has created Gen1.5 High-Protein DDGS from an innovative ethanol processing technology. This removes corn fibre and processes this separately from the remaining starch and germ. The product also has additional yeast protein which increases digestibility of amino acids beyond that in conventional DDGS. On dry matter basis, this gen1.5 product has 40.3% crude protein; 6.7% crude fat and 8.6% crude fibre. Lysine is 1.0% and methionine

1.1%. The % crude protein baseline that The Andersons Inc strives is 40-44%. Exports to Southeast Asia are from its Kansas plant.

The fifth largest ethanol producer in the US, Flint Hill Resources has NextPro™, with 50% CP, produced at its plant in Fairmont since 2018. A new plant in Iowa is scheduled for 2020. It uses the Fluid Quip Technology for its production. The highly digestible product has 90% more lysine and 50% more methionine as compared to levels in its conventional DDGS. Energy levels are also higher than that in soybean meal. The company targets NextPro as replacement for soy protein concentrate (SPC), corn protein concentrate (CPC) and corn gluten meal in feeds. Flint Hill Resources expects 150,000 tonnes production of the high protein DDGS and is carrying out 30 research studies across the US on this product.

Based in Illinois, the family company Marquis Energy has two ethanol plants. It can customise products and since 2018, has an export programme. Marquis ProCap is a high protein feed produced using its ProCap Gold process, developed in-house after two years of R&D. The product will roll out in the first half of 2020 with a target of 120,000 tonnes/year production. Some features are 1.5 times more lysine, finer particle size, high digestibility, higher metabolisable energy and lower fibre as compared to conventional DDGS. The strategy is to maintain high oil levels at 10-12% fat and high protein levels. Marquis Energy is working with Illinois University on studies for swine and poultry and Auburn University for aquaculture species.

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# Diversification options in India with Asian seabass and murrel

At AquaIndia 2020, Dr S Kandan described a nursery business for the seabass and Dr TCV Narasimha Rao, a farming model for the murrel.

By Norlyana Mohamad Termidzi and Zuridah Merican

Although in fourth place in the global aquaculture sector, Dr S Kandan, Project Director at MPEDA-RGCA said that India is too centric on shrimp aquaculture. "India is lagging behind China in the seafood export race because it largely depends on shrimp and land-based aquaculture systems," adding that India lacks the technology to introduce new species and new culture systems for diversification of aquaculture. Compared to China which uses seven culture systems (indoor raceways, earthen ponds, open seas, bays, rivers, reservoirs and lakes) to farm more than 75 species, in India, culture systems are limited to brackish water and freshwater ponds and reservoirs for less than 15 species, mainly freshwater. The main reason for the wide gap in production is the under utilisation of resources available in India.

Dr TCV Narasimha Rao, Uno Feeds, who gave his experiences in developing commercial farming of the snakehead fish or the murrel as it is known in India, said that the introduction of new species have been rather slow. The farming of the Indian major carps (IMC) started in 1998, followed by the pangasius in 2007 and later came that of the pacu, murrel and more recently, the tilapia.

## Asian seabass farming

During his presentation on "Seabass farming in India as an alternative to shrimp", **S Kandan** listed the merits of farming the Asian seabass *Lates calcarifer* and other marine finfish species based on the 17 years of research and introduction of farming technology. The Rajiv Gandhi Centre for Aquaculture (RGCA) which is the R&D arm of the Marine Products Export Development Authority (MPEDA) has standardised seed production and grow-out farming technology of the seabass at its hatchery facility at Thoduvai, and aquaculture demonstration farm at Karaikal, respectively. It now produces fingerlings by bringing fry from its seabass hatchery in Thoduvai in Tamil Nadu on the east coast to the Multispecies Aquaculture Centre (MAC) in Vallarpadam, Kerala (see issue March/April 2020). In the west coast there is no hatchery to meet the demands of surrounding farmers.

"I propose that the country should shift its focus to farming seabass to overcome the loss met by shrimp aquaculture affected by diseases. This is the best alternative species," said Kandan. "As we have determined that the seabass is the best candidate species for fresh and brackish water and mariculture farmers. RGCA can supply fry and fingerlings year-round besides that from the hatchery of ICAR - Research Institute, CIBA. A total production of 2.8 million fry/fingerlings is possible for 2019-2020 where RGCA's capacity is 3 million fry annually and 0.5 million fingerlings/year. Seabass is a species that can be bred in captivity, has a fast growth rate and a high market price."

Kandan added, "When it comes to seabass farming, small and marginal farmers can easily adopt the methods evolved by RGCA in a cost-effective manner." RGCA provides consultancy services for establishing seabass hatcheries and nurseries, training programmes on best husbandry practices as well as technical assistance for seabass grow-out. In promoting seabass farming at AquaIndia 2020, Kandan divided the production into three phases; nursery, pre-grow-out and grow-out. He discussed how the nursery phase could be a business unit.

## Nursery phase

In this phase, the example given was stocking 2x2x1.3m cage with 800 fingerlings/cage or at a stocking density of 14,379 seabass fry (ranging from 1.4g - 5.0g sizes) in 20 cages. Kandan also said that the larval feed by Growel Feeds, an Indian feed miller is suitable for their use but has suggested some improvements. "We feed fingerlings with slow-sinking 0.8 and 1.0mm extruded floating pellets (Skretting) and slowly change to floating pellets with 45% - 50% crude protein (% CP) 4 times/day (UniPresident Vietnam). Cannibalism can be high resulting in low survival rates. To minimise cannibalism, grading was done periodically (once every 15 - 20 days) depending on the size variation. After 40 - 45 days, the fingerlings reach the average growth of 12.2g with 97% survival rate," said Kandan.

AquaIndia 2020, held from January 31-February 1 in Kochi, India had a session covering the diversification into finfish and into *Penaeus indicus*, a species endemic to India. ICAR-CIBA's Dr KK Vijayan proposed its selective breeding. CIBA has been researching on the indicus extensively since 2015 and its full genome has been assembled. Vijayan suggested a consortium concept for this project.



Presenters at this session and guest panelists, from left, Dr Narasimha Rao, Dr Kailasam M, Principal Scientist, CIBA, Dr S. Kandan, Dr Thomas Wilson, Aquafeed Consultant, Thailand and Dr KK Vijayan. Wilson presented on the nutrition and feeding of Asian seabass.

As RGCA encourages the take-up of this nursery phase as a business, Kandan presented the economics of nursery production in a 0.25ha pond (Table 1). The cost of production for each fingerling was INR 33.5 (USD 0.47) and the profit margin per fingerling was INR 11.5 (USD 0.16). Fingerlings can be harvested at 10g to 12.5g.

|  |                    |
|--|--------------------|
| <b>Costs of operations</b>                                     | <b>INR 467,513</b> |
| Pond preparation, maintenance, pond inputs, labour and packing | INR 64,500         |
| Fry cost (14,379 fry @ INR 17 each)                            | INR 244,443        |
| Feeds, additives and probiotics)                               | INR 158,570        |
| <b>Cost of sales (13,950 fingerlings sold @ INR 45)</b>        | <b>INR 627,750</b> |
| Profit   | INR 160,237        |
| Profit/kg  | INR 11.49          |

**Table 1.** Economics of 0.25ha seabass nursery

### Pre-grow-out in cages and a pen system

Seabass fingerlings were transferred into grow-out cages of 2x2x1.3m of different mesh sizes, according to the size of the fish. "We feed the fingerlings with floating feeds, and when the feeding behaviour was found to be very aggressive, grading was done at 20 – 30 day intervals. This avoids cannibalism and separates sizes. The sizes attained were from 100g to 300g within 125 – 145 days," said Kandan.

An alternative culture system developed by RGCA with local farmers is grow-out in pens. Within a pond, seabass fingerlings were kept in small impounded 300m<sup>2</sup> pens. In the first pen, fingerlings of between 200g and 330g were stocked. In the second pen, were fingerlings of 160g to 210g; and of 100g to 150g in the third pen. Growing seabass in the pen system evens out feeding. After 40 – 54 days of culture and reaching sizes of 190g – 450g, fish were released to the same open pond. Over the grow-out culture period 80% of the fish were of uniform sizes.

### Grow-out culture

In the open pond system, there is a PVC floating frame that acts as a feeding point to avoid floating pellets from drifting towards the pond's shallow areas and remain uneaten. Feeding was done 3 times/day and sampling for growth was done every 30 – 40 days. Once the seabass reached average body weights (ABW) of 1 – 1.5kg after 160 – 190 days in the open pond, partial harvesting begins. Kandan commented, "It is important that the fish were fed using the spot feeding method. The timing of feeding is important as well." He also noted the interesting observation that the seabass is averse to different people feeding them; the same person must do the feeding every day. Through this split-up techniques of seabass culture survival rate of 90.1% was easily achieved in the grow-out phase.



In grow-out phase, 190 – 450g fish are released into the open pond system, from pens. PVC floating frames act as feeding points to avoid floating pellets from drifting towards the pond's shallow areas and remain uneaten.



Once fish reach 1 kg, partial harvest is done for marketing.

Kandan convinced the audience on the profitability of seabass farming. He showed that production could reach 15.7 tonnes over one cycle. Survival rates were high in their trials at 90%, although he did report a low of 60%. The cost of production was INR252/kg (USD3.6/kg) and the profit margin was INR149/kg (USD2.12/kg). Fish was sold at INR400/kg (USD 5.71/kg, Table 2).

|  |                      |
|--|----------------------|
| <b>Costs of operations</b>   | <b>INR 3,970,593</b> |
| Pond preparation, maintenance, chemicals and other inputs, labour and harvesting | INR 675,000          |
| Feeds and feed additives (fish oil and probiotics)                               | INR 2,690,390        |
| Seed cost (14,379 juveniles)   | INR 605,203          |
| Cost of production (kg)  | INR 252.2            |
| <b>Cost of sales for 15.743 tonnes of fish (1.22kg)</b>                          | <b>INR 6,309,557</b> |
| Profit   | INR 2,338,964        |
| Profit/kg  | INR 149              |

**Table 2.** Economics of seabass farming in India

### Advantages and disadvantages

The seabass is very adaptable, growing well in freshwater and brackish water environments. Therefore, Kandan suggested that shrimp farmers grow seabass in unused shrimp ponds, particularly in Andhra Pradesh. "When compared to the shrimp, the Asian seabass is less prone to diseases because the fish must be screened for diseases before they are released to the farmers." He added that there is high demand in the domestic markets for seabass, as the farm gate price is very low. Seabass readily accepts pelleted feeds.

With regards to its disadvantages, it is the unavailability of fortified feed; the minimum 2m depth of water required; shortage of hatcheries; severe cannibalism, which can be risky when ignored; long culture duration and a high investment for cages. "This calls for some support from the government. There is a mindset to change and to persuade farmers to farm seabass and other new species instead of just shrimp."

His take-home message was, "We can have seabass farming in the open sea but today, there is no open sea lease policy for cage culture. An option is pond-based cage culture that is less expensive for medium-scale entrepreneurs. However, I believe that open pond culture is the best method for marginal farmers to have good profit margins by adopting the 3-phase culture system. This alleviates risks with cannibalism and maintain an effective even feeding regime during the pre-grow-out period for a uniform growth in the grow-out phase."

## Experiences in farming the murrel in India

In 2015, **TCV Narasimha Rao** began his research into the commercial farming of the murrel or snakehead *Channa striatus* with assistance from a feed premix and additive company in China. The first crop was in 2016/2017 and since then, he has increased production 100%. At this conference, Rao described his experiences and his search for the best culture model and practices for this fish.

"Consumers in South India, with higher disposable incomes, want traditional fish choices while those available now are mostly imported species or species preferred in West Bengal and Bangladesh. The murrel or snakehead fish *Channa* spp. could fulfill this gap," said Rao, adding "In Hyderabad, consumers are paying INR700 to 800/kg (USD11.4/kg) at the retail level."

As snakehead farming is extremely popular in China and Vietnam, Rao compared culture practices and whether Indian farmers should follow the same path. China is a global leader in snakehead fish production, farming a hybrid *Channa asiatica* x *Channa argus*. Vietnam farms a strain of *Channa striatus*. "However, their farmers use intensive systems; after 6–8 months, they obtain a production of 35–50 tonnes/acre (87.5–125 tonnes/ha) in China and 33 tonnes/acre (82.5 tonnes/ha) in Vietnam. In recent years, there has been a slump in farm gate prices, as low as USD1 to USD1.2/kg. But their cost of production is also low."

### Moving to commercial farming

Since 2015, Rao has been farming a strain of *C. striatus* and in the last two years has produced more than 100 tonnes/year. "We had three successful crops and have published information on hatchery and farm operations to gain the interests of farmers. The focus is on *C. striatus* and we do not wish to develop an alien species." In 2019, he has supplied fingerlings to one farmer and in 2020, will begin to supply to 10 farmers.

The breeding technology is not new and fish breeds naturally in ponds. "Our challenge is to wean wild brood fish onto trash fish as it is expensive to provide live fingerlings to maintain brood fish. When brood fish are fed live tilapia/carps, egg quality and fish health are better than when fed trash fish," said Rao. Early stage rearing is in indoor tanks and grading is important as the fish is cannibalistic. Weaning fingerling to artificial feeds is easy. "After 3–4 gradings every 3 days, when the fingerlings weigh 10 to 20g, you will see that cannibalism is almost zero. At 20g, we shift them to a nursery farm where we get 80% to 90% survival." Once the fish reach 50g and above, they are put into grow-out ponds where the survival is more than 98%. Starter feeds from 0.4mm to 0.8mm are imported and Uno Feeds produce extruded floating feeds larger than 1mm.

India's freshwater fish farming is usually in massive ponds, from 10 acres (4ha) to as large as 100 acres (40ha). "But for the murrel, we have seen grow-out success in 3–4-acre (1.2–1.6ha) ponds. Ideally, 1-acre (0.4ha) ponds are better for this species. One issue is deterioration of pond bottoms especially since we are feeding high protein diets. One suggestion is to have the murrel pond next to pangasius and carp ponds and regularly exchange water between the two ponds. In Vietnam, they can have high stocking densities as the water exchange rate is high." As the fish is marketed live, there is regular harvesting. "We have been able to successfully transport live fish over 700km from the farm to Tamil Nadu with very low mortality."

### The ideal culture model

As most carp farmers have small nursery ponds, Rao suggested that these nursery ponds be used to farm the murrel. Rao calls this a "modified split pond model" where small ponds are for murrel farming and water is exchanged over 2–3 hours per day with the bigger carp pond which can be 10 (4ha) to 50 (20ha) acres in size.

Recently, ponds have PE liners on the sides. Another recent model is using a large reservoir stocked with Indian major carps (IMC) and exchanging the water from this reservoir with multiple small murrel ponds. However, this model encourages the spread of diseases and biosecurity needs to be built-in.

The bio floc model was also tested in indoor ponds of 10,000 to 20,000L but so far, it has been successful only for fish up to 300g. USSEC has a raceway system for snakehead farming in China. Rao has been trying out a raceway model too. "If this works well with a large pond for IMC culture for water exchange, it will be a sustainable model. The only drawback is that murrels tend to jump a lot, injuring themselves on the walls of the raceway which leads to infections."

### Profitability

Results from a 1.5-acre (0.6ha) farmer's pond, where the fish were stocked at 26,000 of 40g fingerlings, showed a harvest of 20.9 tonnes of 800g fish (Table 1). The survival rate was 95% at the end of the 8-month culture period. "We only supplied fingerlings for one pond. The return of investment of 92% was attractive because the farmer was able to sell the fish at an average farm gate price of INR350/kg (USD5/kg). Of course, as more farmers produce the murrel, the farm gate price will go down," said Rao.

|                             |                  |
|-----------------------------|------------------|
| Stocking quantity @40g      | 26,000 juveniles |
| Harvest size (ABW)          | 845 g            |
| Total production            | 20,930 kg        |
| Final survival              | 95%              |
| Feed usage (Uno Feeds)      | 31,400 kg        |
| FCR                         | 1.5              |
| Unit production cost per kg | INR 182          |
| Total production cost       | INR 3,809,260    |
| Farm-gate price per kg      | INR 350          |
| Total output value          | INR 7,325,500    |
| Total profit margin         | INR 3,516,240    |
| Return on investment (ROI)  | 92%              |

Table 3. Results from stocking in 2019 at a farm in Machillipatnam

### Feeds: Getting it right

Both feeds for the murrel and seabass have high protein levels (45–48% CP) but for the murrel, Rao said that the lipid level must be lower at 7%–8% as compared to 10% to 14% in seabass. "Feeding seabass feeds to the murrel resulted in fatty liver. All the feeds are floating feeds and auto feeders are used."

Like the seabass, the lower the starch content of the feed, the better the growth rate. "Using the single screw extruder, we were able to reduce the starch content to 18–20%. If we can bring it lower, the performance would be even better and we can have more space in the formulation for more protein. Possibly with twin screw extruders, I can bring down the starch content in floating feeds up to 15%," he added.



Murrel or snakehead fish juveniles



**“In Hyderabad, consumers are paying INR700 to 800/kg (USD11.4/kg) at the retail level.”**  
-Narasimha Rao

### Disease challenges

In Vietnam, the nutritionally related poor liver condition and spinal deformities are common. The “flower head” problem has not been reported in India, possibly because of lower stocking density. Poor liver condition is managed by adding a functional liver additive and bile salts.

“Murrels are extremely sensitive to epizootic ulcerative syndrome (EUS). This has been quite serious in the last 3 years. We have managed EUS with traditional medicine which has antiseptic and antibiotic effects. The fish is also prone to intestinal worms which impact growth. We need to sample the intestines frequently for the presence of worms and apply medication,” said Rao.

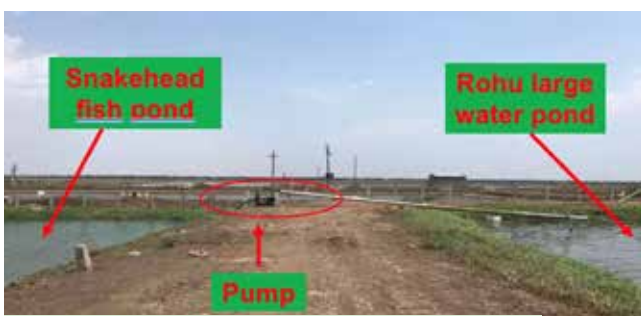
A recent problem is the cotton mould disease with 95% mortality within 3-4 days. Rao believes that with a suitable stocking density, good water quality and good pond bottom, this disease can be managed. “If water temperature does not fall below 28 to 30°C, some of these serious health conditions and diseases can be prevented. I also think that growth is particularly good at a salinity of 3 to 4ppt which will protect the fish, especially from fungal infections. I believe that the maximum salinity tolerance is up to 10ppt which I will need to confirm.”

### Market acceptability

There are differences between the Vietnamese and Indian strains of *C. striatus*; the former was recently introduced to India. “Because the Vietnamese strain is domesticated for many generations, we found that its immunity to diseases is slightly better and the species grows much faster. However, we need to farm both to confirm the differences. There are clear differences in skin patterns and our preliminary results show that the Vietnamese strain is less favoured by our consumers, especially those around Hyderabad.”

For the future, Rao suggested, “We could consider domesticating the endemic *Channa marulius* which grows to 2-3kg or perhaps develop its hybrid with *C. striatus*. We also should breed for disease resistance and immunity against fungal infections. There is still a high inclusion of 30% to 40% fish meal in feeds. Today, this is acceptable as the fish has a premium price. But such feeds are not sustainable. We also need to see the impact on taste and texture and what the consumer thinks with lower fish meal feeds.”

A caution is that in 3 years, with more murrel produced, prices will fall. However, retailing live murrel is easy as the fish can easily be transported live and perhaps can be the anchor fish to attract crowds and encourage the retail of other freshwater fish. “Basically, we need to drive fish consumption within India,” said Rao.



Graphic to show the modified split pond model. The smaller nursery pond is used for murrel farming and the larger pond for the rohu. Water is exchanged regularly using a pump.



Extruded 6.0mm pellets for snakehead farming, produced by Uno Feeds

# Dietary mannan oligosaccharide as a tool against AHPND

In challenge trials, supplementation improved survival and resistance against *V. parahaemolyticus* with less histopathological damage to the hepatopancreas

By João Fernando Albers Koch, Nadira Afina Ismail, Kok-Onn Kwong and Wing-Keong Ng



In these photos, top are AHPND-infected shrimp and bottom, healthy shrimp. Gross signs of AHPND includes a pale atrophied hepatopancreas and an empty stomach and mid-gut. During AHPND infections, early mass mortality usually takes place within 30 days after pond stocking of shrimp post larvae.

Farmed shrimp is among the fastest growing food products globally with Pacific white shrimp *Litopenaeus vannamei* contributing a large proportion of shrimp production. Although, not indigenous to Asia, about 80% of this shrimp is produced by Asian countries such as China, Thailand, Vietnam, Indonesia and India. With the intensification of shrimp farming systems, disease problems have become an increasing threat to the global shrimp farming industry.

*Vibrio* spp. are among the most important pathogens affecting farm-reared shrimp. These bacteria cause acute hepatopancreatic necrosis disease (AHPND), which is also known as early mortality syndrome (EMS) and causes a devastating impact on the global shrimp industry since 2009. AHPND is caused by pathogenic strains of *Vibrio* species, including *Vibrio parahaemolyticus*, which contains a unique plasmid encoding two different toxins genes (pirA and pirB). The genes allow the cell to produce a binary toxin which causes the destruction of the shrimp hepatopancreas.

In such cases, antibiotics are often used to treat or even prevent bacterial infections. However, the overuse and misuse of antibiotics during treatments are also key factors contributing to antibiotic resistance, leading to the ineffectiveness of treatments.

Due to environmental and human health concerns associated with excessive antibiotic use, prebiotics are increasingly being viewed as potential alternatives. Other than promoting the colonisation of beneficial gut bacteria, prebiotics may improve the structural health of the shrimp gut mucosa and prevent pathogenic *Vibrio* bacteria from adhering to the intestinal wall.

Mannan oligosaccharides (MOS), known for their pathogen agglutination capacity, favour the balance of microbiota and intestinal health. Therefore, a MOS-supplemented diet may help to improve nutrient utilisation and health of the shrimp digestive tract. In animal production, MOS is known to improve natural defenses, build up disease resistance and assist in critical periods, such as during initial production phases.

## Short-term feeding trial

An experiment was conducted to investigate the effect of dietary MOS (HyperGen<sup>®</sup>, Biorigin) supplementation on growth and disease resistance of Pacific white shrimp. HyperGen<sup>®</sup> is a prebiotic obtained from a proprietary process that guarantees a high content of functional water-soluble MOS and is considered a second generation MOS product from Biorigin. Specific pathogen free (SPF) post larvae (PL9) were used in the study. All shrimp were kept for two weeks in a round fiberglass tank filled with 300L of artificial seawater (InstantOcean<sup>®</sup>) at a salinity of 25±1‰ before being randomly distributed into a series of experimental aquaria.

Three isonitrogenous and isolipidic practical diets were formulated and analysed to contain 42% crude protein from fish meal and soybean meal as the major source of protein and 6% lipid from squid liver oil as the major lipid source. Two MOS-supplemented diets were prepared in order to contain 0.2 or 0.4% of HyperGen<sup>®</sup>. Two control (0%) groups were designed to receive the basal diet without any functional additives, making up a total of four treatments. Two control groups (positive and negative) were necessary for the subsequent assessment of the bacterial challenge.

At the start of the feeding trial, groups of 13 apparently healthy shrimp were weighed and then transferred to 1L aquaria and randomly assigned to one of the dietary treatments. Quadruplicate groups (four treatments and four replicates) of shrimp were hand-fed with their respective diet three times daily at 09:00, 13:00 and 17:00h to apparent satiation. Water exchange of about 10% was done daily and faecal matter and leftover feeds siphoned out.

Throughout the feeding trial and disease challenge period, the salinity, pH, temperature, dissolved oxygen, ammonia-N, nitrite-N and nitrate-N were measured and ranged between 25-26‰, 8.0-8.4, 29.1-29.3°C, 5.0-7.1 mg/L, 0.0-1.0 mg/L, 0.0-1.0 mg/L and 0.0-30.0 mg/L, respectively. The growth trial was carried out at the Aquaculture Research Complex, School of Biological Sciences, Universiti Sains Malaysia, Penang, Malaysia.

After 14 days, the feeding trial was completed and all remaining shrimp were weighed to obtain the final weight and the production parameters were calculated. Shrimp fed MOS supplemented feeds

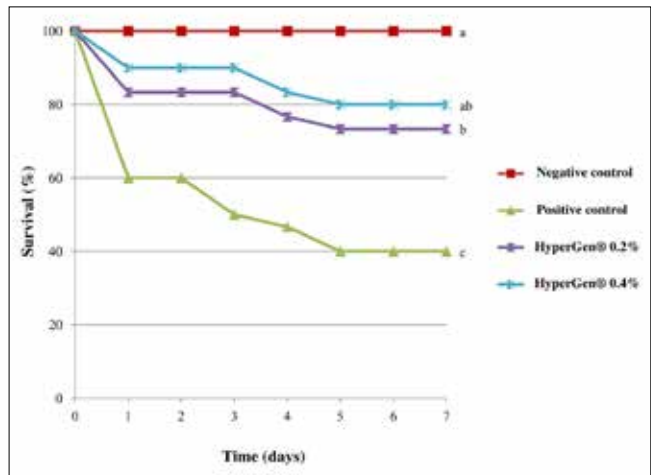
showed good growth performance, feed utilisation efficiency and survival. Shrimp in the group fed diets containing 0.2% HyperGen® had 6.25% higher survival compared to control groups. However, MOS supplementation did not significantly ( $P > 0.05$ ) enhance growth performance, which may be explained by the short-term duration of the feeding trial.

### AHPND challenge test

After the 14-day feeding trial, shrimp from each dietary treatment were randomly removed from each aquarium, pooled and then re-stocked at 10 shrimp/aquarium in a static system consisting of a series of 100L (filled with 15L) glass aquaria housed within a temperature-controlled biosecure disease-challenge laboratory.

Each dietary treatment consisted of three replicates for the disease challenge test. Then, *V. parahaemolyticus* causing AHPND (3 HP strain), which had been cultured in tryptic soy agar (TSA) and resuspended in tryptic soy broth (TSB), was added into each tank at a final dose of  $10^6$  CFU/mL. Shrimp from one of the control groups, which received a basal diet during the feeding trial, were immersed in sterile TSB (not challenged) and was considered as the negative control group. The positive control group consisted of shrimp fed a control diet and challenged with *V. parahaemolyticus* causing AHPND.

Over the course of seven days, shrimp were hand fed twice a day. The specific signs and symptoms of AHPND were observed and the number of dead and moribund shrimp was recorded every 4 to 6 hours. The negative control (not challenged with *V. parahaemolyticus*) showed 100% shrimp survival. Shrimp fed diets with 0.2% or 0.4% MOS had significantly ( $P < 0.05$ ) higher survival (73.3 and 80%, respectively) than the positive control (40%) group (basal diet-fed shrimp and challenged). Both groups fed the MOS supplemented diets had similar survival and did not differ statistically (Figure 1).



**Figure 1.** Survival of *Litopenaeus vannamei* fed mannan oligosaccharide HyperGen®-added diets and challenged with AHPND-causing bacteria, after a feeding trial period of 14 days. Different letters indicate significant difference among groups (ANOVA followed by Duncan's post-hoc test,  $P < 0.05$ ).

### Bacteria counts and histology

The total cultivable bacteria count (TCBC) and presumptive *Vibrio* spp. count (PVC) of the hepatopancreas of shrimp were determined after the disease challenge. The hepatopancreas were aseptically dissected, pooled, weighed and then homogenised with sterile normal saline in 10-fold serial dilutions. The supernatant (0.1 mL) was spread onto tryptic soy agar (TSA) containing a selective medium for the cultivation of *Vibrio* spp. and the results were expressed as log CFU/g. The presumptive *Vibrio* count (PVC) of the hepatopancreas from shrimp fed MOS supplemented diets were significantly lower compared to the positive control. The

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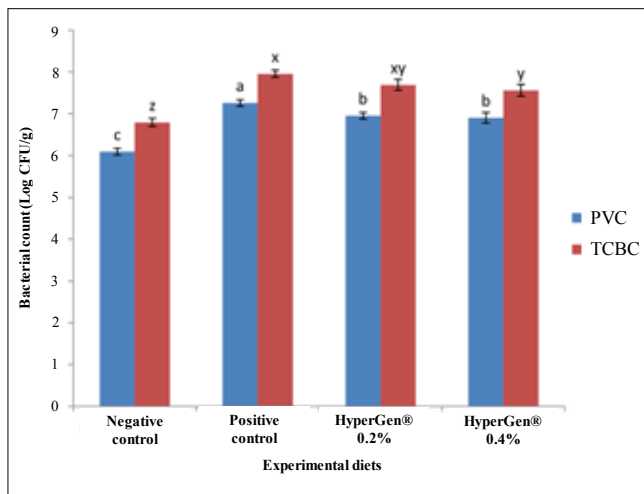
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total cultivable bacteria count (TCBC) also showed a similar trend with shrimp fed the 0.4% MOS diet having significantly lower TCBC compared to positive control. The highest hepatopancreatic bacterial count was in the positive control group, while the negative control showed the lowest bacterial counts. The results indicate that the addition of HyperGen® in the diet may positively modulate the bacterial population in the shrimp hepatopancreas (Figure 2).



**Figure 2.** Presumptive *Vibrio* spp. count (PVC) and total cultivable bacteria count (TCBC) in the hepatopancreas of *Litopenaeus vannamei* fed mannan oligosaccharide HyperGen® supplemented diets and challenged with AHPND-causing bacteria. Data are reported as the mean ± SEM of three replicates. Histogram bars of the same colour with different superscripts are significantly different (ANOVA followed by Duncan's post-hoc test,  $P < 0.05$ ).

### Histological investigations

Lastly, the hepatopancreas from three shrimp in each tank, from the challenge test, were also aseptically dissected for histological investigations to evaluate tissue damage caused by AHPND and possible protective effect of the MOS-supplemented diets. The tubule lumen of *L. vannamei* hepatopancreas without being infected with AHPND (negative control group) was found to have a normal "star like" structure.

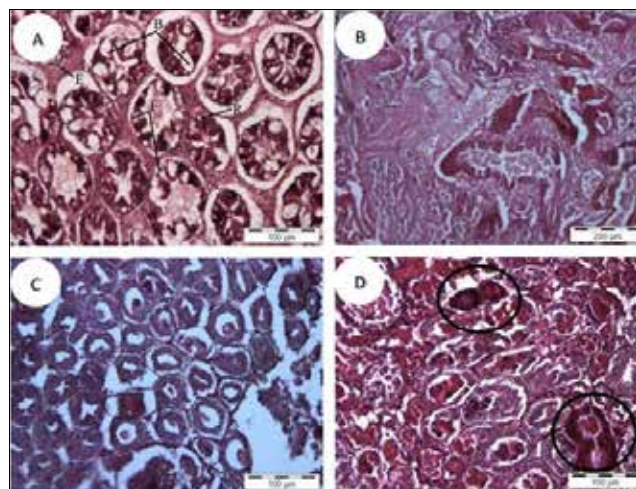
Different epithelial cells comprising B-cells which are secretory (from the German *blasenzellen*, cells in bulbs), E-cells (*embryonalzellen*, embryonic cells), F-cells (*fibrenzellen*, fibrillar) and R-cells (*restzellen*, reserve cells) were distinctly present. The B-cells were the largest among the cells, often placed proximally and medially from the lumen. The E-cells were relatively large nucleus with undifferentiated cells while F-cells were basophilic and less common than the other cells. Meanwhile, R-cells were comprised of lipid droplets and mostly located distally and medially from the lumen in each tubule. No mortality was observed in the negative control group and the histology showed a normal appearance of the hepatopancreas.

The infected shrimp in the other treatment groups showed clinical signs of the AHPND disease that included lethargy, a pale atrophied hepatopancreas and empty gut. Moribund or dead shrimp from different treatment groups were confirmed to have AHPND by histological examination. Histopathology signs of infected shrimp (especially in the positive control group) showed severe damage of hepatopancreas tubules, acute sloughing of epithelial cells, absence of B-, F-, and R-cells, and prominent karyomegaly. Furthermore, massive haemocytic aggregation and formation of melanised granulomas were observed from the late stage of infected shrimp. Hepatopancreas of shrimp fed diets with MOS supplemented at 0.2% or 0.4% showed less damage compared to

the hepatopancreas of the positive control group. The addition of this MOS in shrimp diets seemed to offer some hepatopancreatic protective properties which might partly explain the significantly lower mortality observed in these two groups of shrimp compared to the positive control group fed diets without any added MOS (see Figure 3A – D).

### Conclusions

The benefits of HyperGen®-supplemented diet were consistent in terms of improving survival and resistance against the pathogen *V. parahaemolyticus*. Shrimp fed the treatment diets showed a 45–50% better survival when compared to the non-supplemented infected group. In addition, the hepatopancreas of shrimp fed supplemented diets showed lower bacterial and *Vibrio* counts and had less histopathological damage compared to hepatopancreas of shrimp fed diets without added MOS when infected with AHPND-causing *Vibrio* bacteria.



**Figure 3.** Representative histopathological morphology of the hepatopancreas of *Litopenaeus vannamei* in 7-day-immersion challenge with *Vibrio parahaemolyticus*. Scale bars= 100µm (A,C,D) and 200µm (B).

A: Shrimp from the negative control group showing normal appearance of the hepatopancreas. Normal tubule structure with B-, E-, F- and R-cells.

B: Shrimp from the positive control group showing extensive severe damage in hepatopancreas structures including acute sloughing and necrosis of hepatopancreatic tubule epithelial cells with no B-, F-, and R-cells.

C: Hepatopancreas from shrimp fed 0.2% HyperGen® showed less damage and some sloughing of tubules surrounded by haemocytic infiltrates.

D: Hepatopancreas of shrimp fed 0.4% HyperGen® showed less damage with some melanised tubule epithelial cells (circled). Hematoxylin and eosin staining were used.



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# Organic acids - synergy at work to prevent vibriosis and promote growth in shrimp

By Waldo G. Nuez-Ortín, Maria Mercè Isern-Subich and Martin Guérin

Disease imposes major yield-limiting effects on production and represents the most significant constraint on the development and sustainability of the shrimp industry. Infections by bacterial diseases such as the acute hepatopancreatic necrosis disease (AHPND) associated to *Vibrio parahaemolyticus*, or other vibriosis, are generally triggered by stressful environment (i.e. poor water quality, low oxygen, high temperatures, etc.) and can cause up to 100% mortality in post-larvae shrimp (Dash *et al.* 2016).

The increasing levels of disease are associated with the intensification in culture practices, thus there is an ever-growing importance on the containment of pathogens. In this aspect, shrimp farming brings some unique challenges as compared with fish production. As an invertebrate, shrimp do not possess an acquired immune system and rely solely on their innate immune responses that are generally characterised as rapid (i.e. hours to days). This translates into higher susceptibility to pathogens than fish and in greater need of antimicrobial treatments, hygiene, and biosecurity measures.

The use of antimicrobial agents such as disinfectants and fungicides has become an integral part of many shrimp farming operations. Antibiotics are still being used, often as immediate resort to control infections. However, antibiotic usage without adequate protocols is inefficient due to the risks associated to antimicrobial resistance dissemination (Thornber *et al.* 2019). Indiscriminate usage also poses a significant economic risk since positive testing for prohibited antibiotics or residues above maximum permitted levels can result in the rejection of importations from a whole country.

The use of alternative antimicrobial options such as phytobiotics, probiotics or organic acids is common across production species. Specifically, organic acids are characterised by their antimicrobial and growth-promoting actions as well as cost-efficient application. Maximum antimicrobial efficacy is achieved by specific combinations of organic acids that act synergistically to damage the integrity of the bacterial cell wall and alter cytoplasm pH. This synergistic action occurs under a species-specific digestive environment, particularly pH, that must be considered when formulating organic acid blends. This also explains why single organic acids or blends that have proven efficacy in poultry or swine do not show any effect in tilapia or shrimp (Hosein *et al.* 2017).

Bacti-nil®Aqua is a cost-effective blend of organic acids, specifically formulated for aquatic species and with long-established use in shrimp feed. The additive can be applied during feed manufacturing in the feed mill as well as top-coated on the feed in the farm. In this article, we present two separate studies that contribute to the proven efficacy of this additive, firstly as

preventive strategy to reduce the impact of *Vibrio* spp. infection, and secondly as growth promoter.

## A preventive tool to reduce the impact of *V. parahaemolyticus*

The first study focused on the bactericidal efficacy of Bacti-nil® Aqua against *V. parahaemolyticus*, both under *in vitro* and *in vivo* conditions. This study was conducted at the Centro de Investigación en Alimentación y Desarrollo (CIAD) in Sinaloa (Mexico).

The minimum inhibitory concentration (MIC), the lowest concentration at which a substance inhibits bacterial growth after incubation is a commonly used *in vitro* method to assess the potential susceptibility of a bacterial pathogen to a feed additive. Here, the tube dilution method according to McDermott *et al.* 2005 was used to test the additive efficacy against *V. parahaemolyticus* (M0904). The test was carried out under a pH range of 7-8 to mimic the digestive pH of shrimp. The additive was compared against two other commercial products. Product A was a blend based on different short-chain organic acids at overall concentration similar to Bacti-nil®Aqua, while product B was a monoacid solution with double overall concentration than the other two treatments. Table 1 shows that the additive generally resulted in the lowest MIC in relation to the other two commercial products. Given the similar and lower acid concentrations of the additive in relation to products A and B, respectively, the more positive results can be likely attributed to the superior synergistic action of its active components under the tested pH range.

*In vitro* antimicrobial effects by the additive were further validated under *in vivo* conditions. *Penaeus vannamei* of 4-5g were stocked in nine aquariums of 10L capacity at a density of 10 shrimp/aquarium, with saline water (35ppt) maintained at 29°C during the 24-hour experimental period. Infection by *V. parahaemolyticus* (M0904) was via immersion with a 50mL inoculum per aquarium ( $1 \times 10^8$  CFU/mL). A commercial shrimp feed formula was top coated with the additive. A total of three groups were evaluated: 1) negative control (non-supplemented and non-infected, n = 3), 2) positive control (non-supplemented and infected), and 3) Bacti-nil® Aqua at 0.3% (supplemented at 3kg/tonne feed and infected, n =3). Shrimp were fed 15 minutes after infection and then every 3 hours. Symptoms of infection such as reddish colouration of antenna, muscular opacity, discolouration of hepatopancreas and decubitus position, were detected 1-hour post-infection.

Shrimp consumed feed during the experimental period and intake by additive supplemented groups did not differ from that by positive control. After 24 hours, survival of the positive control group was reduced to 13%, while it was almost five times significantly higher (60%) in the groups supplemented with the additive (Figure 1A).

| pH 7.0          |           |           | pH 7.5          |           |           | pH 8.0          |           |           |
|-----------------|-----------|-----------|-----------------|-----------|-----------|-----------------|-----------|-----------|
| Bacti-nil® Aqua | Product A | Product B | Bacti-nil® Aqua | Product A | Product B | Bacti-nil® Aqua | Product A | Product B |
| 3000            | 9000      | 5000      | 3000            | 9000      | 3000      | 3000            | 5000      | 5000      |

Table 1. Minimum inhibitory concentration (mg/mL) of Bacti-nil® Aqua and other commercial products based on organic acids under pH 7-8.

The shrimp's defense mechanisms against external agents such as *Vibrio* spp. include the production of haemocytes, which are defense cells present in the haemolymph (Aguirre-Guzmán *et al.* 2009). The main two types of haemocytes are hyaline, responsible for absorbing pathogens or foreign particles through phagocytosis and for the process of coagulation, and granular, responsible for destroying invading elements through encapsulation and enzyme secretion. A third type is semi-granular, a transitional state between granular and hyaline states. Under infection, the haemocyte defense mechanisms stimulate hyaline haemocytes to become granular as a mechanism to increase the rate of pathogen elimination. This pattern was confirmed in the non-supplemented groups, with the infected group (positive control) showing a four-times higher ratio of granular:hyaline haemocytes (4.8 vs. 1.2) in relation to the non-infected group (negative control) (Figure 1B). However, in the infected and additive supplemented group, the ratio (1.8) was maintained more in line with that of the non-infected group (negative control). This compensation can be attributed to the bactericidal efficacy of Bacti-nil® Aqua against *V. parahaemolyticus* that likely reduced pathogen presence in haemolymph and therefore the need of an immunological reaction via haemocyte transformation.

Histopathological symptoms by *V. parahaemolyticus* include sloughing of the hepatopancreatic tubule epithelial cells and haemolytic infiltration as a result of toxin secretion (Li *et al.* 2017). This is consistent with the observations found in surviving animals at the end of the infection challenge. The infected but non-supplemented group (positive control) was characterised by cellular detachment of hepatopancreatic tubules and infiltration of haemolymph and haemocytes in proximal intestine (Figure 2). Conversely, these signs were partly mitigated by the additive, since despite haemolymph and haemocyte infiltration in the hepatopancreas, the structure of hepatopancreatic tubules was maintained. The reduced hepatopancreatic damage can also be explained by the bactericidal activity of the additive and the overall lessening of the *V. parahaemolyticus* virulence in the digestive tract. Additionally, less damage also suggests better tissue recovery.

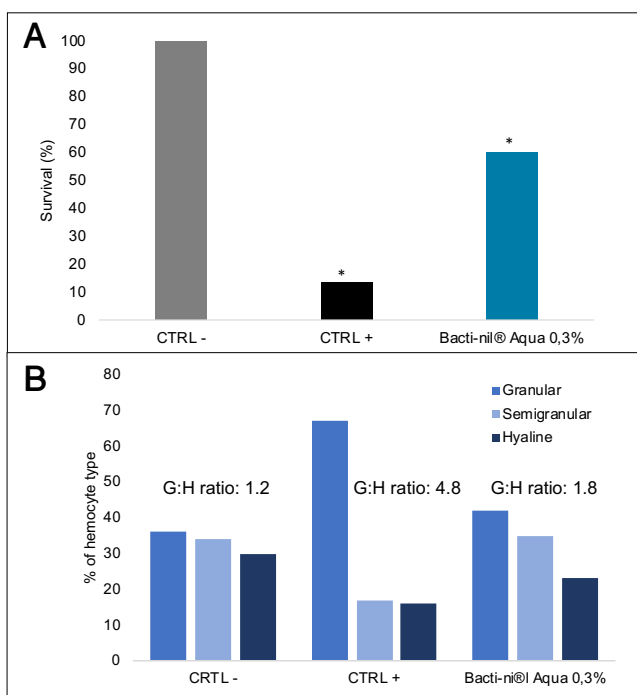
### A tool to support growth under increasing stressful culture conditions

The second study aimed to evaluate the growth promoting effect of Bacti-nil® Aqua in shrimp cultured under stressful conditions. The study was conducted at the Government Research Centre for Marine Aquaculture (BBPBAP) in Jepara, Indonesia.

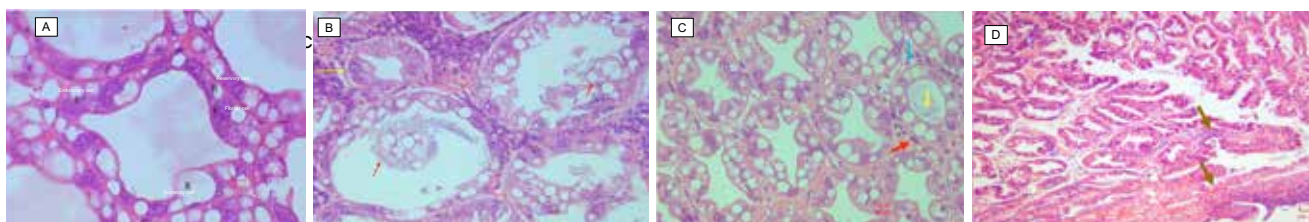
A total of ten tanks with 100L capacity each were arranged in a recirculating seawater system. After acclimation, shrimp were individually weighed and averaged 2.47g. Stress was induced by increasing the stocking density (40 vs. 10 shrimp/tank). The mash of a basal feed formula based on fish meal, soybean meal, tapioca, wheat flour and vegetable oil, was supplemented with the additive. A total of three groups were tested: 1) negative control (10 shrimp/

tank and non-supplemented, n=2), 2) positive control (40 shrimp/tank and non-supplemented, n = 4), and 3) Bacti-nil® Aqua at 0.2% (40 shrimp/tank and supplemented, n = 4). Bulk weight of each tank was measured every 2 weeks during the eight-week trial duration, while weights were measured individually at the end of the trial. Water temperature, salinity and quality were monitored daily and remained within the standard conditions for shrimp.

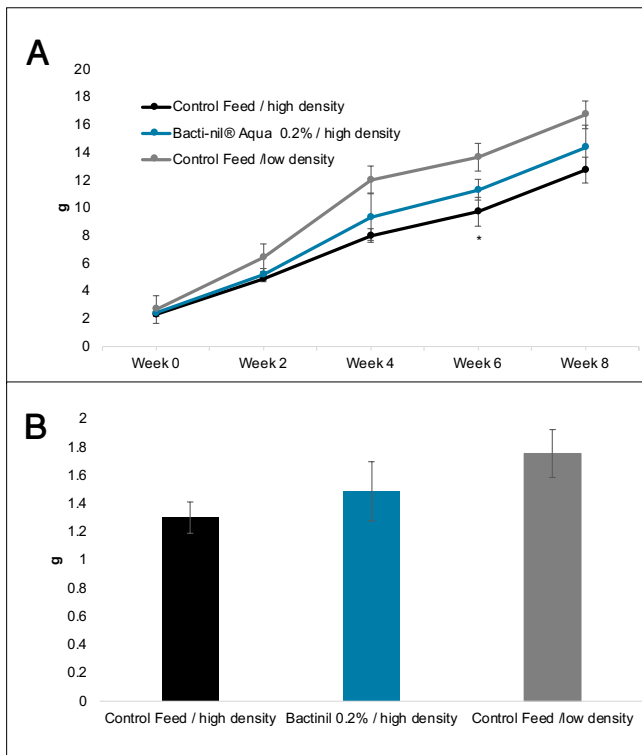
Shrimp cultured at low densities achieved better weight gain starting from the second week (Figure 3A). Weight gain was negatively affected by high densities, while Bacti-nil® Aqua at 0.2% compensated for this negative effect. The positive growth effect by the additive was consistent along trial duration and statistically significant at the sixth week. At high densities, the additive supplementation improved average weekly gain by 13% (Figure 3B). In line with the conclusion reached in the infection trial, the growth promotion action of the additive can be explained by the antimicrobial effects against pathogenic bacteria in the digestive tract, leading to a more stable gut microbiota, a more efficient nutrient digestion and absorption, and overall to a healthier digestive system.



**Figure 1.** Infection challenge of *Penaeus vannamei* with *V. parahaemolyticus* (M0904) to evaluate the impact of Bacti-nil® Aqua. A) Survival after 24-hour infection. B) Haemocyte proportions after 24-hour infection. Negative control (CTRL -), positive control (CTRL +) and Bacti-nil® Aqua 0.3% (n=3). G.H ratio: ratio of granular to hyaline hemocytes. (\*) indicates statistically significant difference.



**Figure 2.** Histopathological analysis of hepatopancreas and proximal intestine in *Penaeus vannamei* after 24-hour infection with *V. parahaemolyticus* (M0904). A) Negative control (CTRL -): Normal hepatopancreatic tubules without infiltration of haemolymph. B) Positive control (CTRL +): Cellular detachment of hepatopancreatic tubules. C) Positive control (CTRL +): Infiltration of haemolymph and haemocytes in proximal intestine. D) Bacti-nil® Aqua 0.3%: Normal hepatopancreatic tubules with infiltration of haemolymph and haemocytes.



**Figure 3.** Feeding trial of *Penaeus vannamei* evaluating the impact of Bacti-nil® Aqua on growth. A) Average weight during the eight-week trial duration. B) Average weekly gain. Control feed and Bacti-nil® Aqua 0.2% at high densities (40 shrimp/tank) (n=4). Control feed at low densities (10 shrimp/tank) (n=2). (\*) indicates statistically significant difference.



### Conclusion

The use of dietary organic acids to prevent disease in shrimp production must undoubtedly go in hand with additional strategies such as improved water quality, better hygiene, and stricter biosecurity measures. With that in mind, Bacti-nil® Aqua has proved to be an efficient antimicrobial to reduce the impact of vibriosis, specifically against *V. parahaemolyticus* infection. Such direct antimicrobial efficacy is attributed to the synergetic combination of specific short- and medium-chain organic acids. Indirect benefits of supplementation include a better preservation of the immune response, reduced hepatopancreatic damage, and growth promoting action. Overall, this is an effective tool to prevent disease and promote growth.



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# Insight into Chinese mitten crab farming

Developments in hatchery and farming technology have led to an important economic activity with 850,000 tonnes of production and 500,000 tonnes of commercial feeds in 2019.

By Xiao Haidong, Zeng Ji and Dong Qiufen



The body weight of mitten crab broodstock is above 250g. Left; male and right, female broodstock.

Chinese mitten crab (*Eriocheir sinensis*), known as the Shanghai hairy crab or 大闸蟹 (Da Zha Xie), is a medium-sized burrowing crab, named for its furry claws, resembling mittens. It is native to rivers, estuaries and other coastal habitats of eastern Asia from Korea in the north to the Fujian province of China in the south. Archaeological studies indicate that the mitten crab has been in the Chinese food culture since 5,000 years ago and that research on this freshwater crab was started 1,000 years ago. But there were few breakthroughs in its domestication and farming technology and all mitten crabs were captured from the wild until recent years. In the 1980s, driven by advances in artificial breeding technology, soaring demand and high profit margins, its farming took off. Currently, after decades of rapid development, the Chinese mitten crab farming is economically important with over 600,000ha farming area and around 850,000 tonnes of annual production.

## Life cycle

In nature, the mitten crab inhabits freshwater and breeds in marine waters. Every year in late summer or early autumn, the adult mitten crab start to migrate from the rivers to the seas for spawning and in March to May of the following year, juvenile mitten crabs return upstream to complete the adult life stages.

In mitten crab aquaculture, broodstock selection starts before or after the 'beginning of Winter', which is the 19th solar term of the Chinese lunar calendar (In 2020, this falls on November 7). The preferred body weight of the broodstock is above 250g, and the male and female broodstock should be cultured separately at a density of 4-7/m<sup>2</sup>. The broodstock culture pond is usually 666m<sup>2</sup> in area and above 1m in water depth. A safeguard net is required to prevent broodstock escaping from the pond.

After winter, which is normally from January to March in the Yangtze River basin, male and female broodstock are stocked at a density of 3-5/m<sup>2</sup> and paired at a ratio of 1:2-3. The optimal water temperature and salinity for pairing is 10°C and 17-20ppt, respectively. The

mating pond is 667-1,334m<sup>2</sup>, with a sandy bottom. In order to avoid repeated mating, the male broodstock should be removed after 15 days when 70-80% of the female broodstock are pregnant. Then, every 10-15 female broodstock with eggs in the abdomen are packaged into one cage and moved to the larval rearing pond for hatching. When the density of the shrimp-like zoea in the larval rearing pond reaches 100,000-300,000/m<sup>2</sup>, the redundant female broodstock should be moved to empty larval rearing ponds. After 18-22 days, zoea will morph into lobster-like megalopae which will grow to juvenile crab over approximately 7-11 months.

| Culture parameters                                 |  |
|--|--|
| Water depth (cm)                                   | 50-80                                      |
| Pond area (ha)                                     | 2-13                                       |
| Stocking density (crab/m <sup>2</sup> )            | 1.2-1.8                                    |
| Stocking size (g/pcs)                              | 2.5-6.25                                   |
| Stocking date                                      | February-March                             |
| Harvest date                                       | End of September                           |
| Culture duration (month)                           | 6-7  |
| Harvest size (g/pcs)                               | 150-300 (male crab); 100-250 (female crab) |
| Yield (tonnes /ha)                                 | 1.13-1.50                                  |
| Commercial feed consumption (tonnes/ha)            | 1.13-1.88                                  |
| Snail and trash fish consumption (tonnes/ha)       | 4.5-6.0                                    |
| Costs of production/ha                             | USD  |
| Pond rental  | 2,143                                      |
| Fry cost   | 1,072                                      |
| Utilities  | 214  |
| Costs of chemicals (bactericides and insecticides) | 642  |
| Labour cost  | 1,714-2,143                                |
| Feeds  | 2,143-3,214                                |
| Total inputs                                       | 8,571-9,643                                |
| Net profit   | 12,857-21,430                              |

Table 1. Culture details and benefit analysis of intensive pond farming practice in Jiangsu province



The Chinese mitten crab is also called the Shanghai hairy crab because of its furry claws, resembling mittens and as Shanghai is famous for crab cuisine.

## Rapid expansion

In recent years, the Chinese mitten crab hatchery industry has grown rapidly both in quantity and quality. Official statistics showed that the output of mitten crab juveniles (usually above 2.5g) reached 891.8 tonnes in 2018 and Jiangsu province accounted for 88.8% of this volume. The province has laid a solid foundation for Chinese mitten crab farming.

Today, the hatchery and culture technologies for several new varieties including Changjiang-1 and Changjiang-2, authorised by the government have been developed and applied successfully. There have been significant advances in unit yield, growth and survival rate. With the development of indoor hatchery technology in greenhouses, the supply of quality juveniles is available throughout the year.



Juvenile mitten crab and in feed tray

**“Therefore, farm management of moulting stages is the key to success and it has been proven that feeding the mitten crab with high protein and commercial feeds can significantly improve the success rate of moulting and avoid soft shell symptoms.”**

## Farming

In the 1980s, Chinese mitten crab culture originated and spread in Jiangsu province due to its unique natural environment. However, as breeding and farming technology improved year by year and supported by the potential of high profits, farmers from other provinces began to invest in the farming of the mitten crab. Today, the Chinese mitten crab is cultured nationwide. According to government statistics in 2019, Jiangsu, Hubei and Anhui provinces are the top three producers with annual production of 357,000 tonnes, 157,000 tonnes and 98,000 tonnes, respectively.

Farming practices are diversified due to differences in regional geography and climate. There are several kinds of farming practices, including intensive or extensive pond farming, lake cage farming and paddy field farming. Intensive pond farming is the main farming practice (Table 1). Notwithstanding the culture system, mitten crab farming is typically divided into two stages: nursery and grow-out stages.

In intensive pond systems, mitten crabs are reared in a central flat area surrounded by water channels which are 50-80cm deep. Big



In an intensive mitten crab pond, mitten crabs habit the central flat area which is surrounded by 50-80cm deep water channels. Three aquatic plants; *Hydrilla verticillata*, *Elodea nuttallii* and *Vallisneria spiralis* are indispensable in mitten crab pond farming

head carp and silver carp are cultured together with mitten crabs to remove the redundant plankton and prevent blue algae blooms. Aquatic plants such as *Hydrilla verticillata*, *Elodea nuttallii* and *Vallisneria spiralis* are grown in the pond; these plants regulate water temperature and water conditions, provide supplemental feed, as well as shelter when the crabs moult. The aquatic plants should be cultivated or removed based on the situation of the pond. During the whole culture cycle, mitten crabs moult several times and in this way, achieve body weight gain. Therefore, farm management of moulting stages is the key to success and it has been proven that feeding the mitten crab with high protein and nutritive commercial feeds can significantly improve the success rate of moulting and avoid soft shell symptoms.

## Feeding

The Chinese mitten crab is an omnivorous species and consumes snails, small fish, shrimp, mussel, corn, peanut cake, etc. Currently, most farmers supplement natural food with commercial feeds. The commercial feed proportion in the mitten crab diet is increasing as more farmers see its benefits. In 2019, the production of mitten crab commercial feed in China was approximately 500,000 tonnes, and this is expected to increase to 1 million tonnes in the near future. Commercial feeds are mainly pelleted sinking feeds, which are easily accepted by the mitten crab. Recently, extruded sinking feeds are emerging; the sinking specification of these feeds are maintained and they have good digestibility and water stability. Crude protein of commercial feeds in the market normally ranges from 32-42%. The retail price is USD0.8-1.1/kg.

## Disease challenges

Symptoms of soft shell and failed moulting are two major issues during mitten crab farming. These are attributed to five factors: unbalanced diet, especially a high proportion of natural food; water deterioration; disease pathogens; abuse of insecticides and disinfectants and attack by predators. Among these, it is apparent



Post moult mitten crabs

that diets poor in nutrition and inferior water quality are determinant factors. As a leading aquaculture technology provider in China, Guangdong Nutriera Group is dedicated to assisting the farmers to achieve success in farming with technological guidelines to improve their farm management, as well as to assist the feed mills in optimising feed formulation and developing functional feeds targeted for moulting stages and crab roe quality.



Three different types of commercial feeds for the mitten crab in China. Emerging are extruded sinking feeds with better digestibility and water stability.

### Consumption

Decades ago, when artificial farming was not yet successful, the Chinese mitten crab was just a seasonal delicacy. It is highly valued, with an umami taste and is nutritious with proteins, calcium, vitamins, crab roe and erythropoietin. For instance, the content of vitamin A, vitamin B and phosphorus are 6 to 10 times higher than in fish. Presently, commercial Chinese mitten crab is available in the market throughout the year, due to the rapid development of fresh food logistics, e-commerce and new retailing. Live mitten crabs can be delivered to consumers in an extremely short time, no matter where they are. Buyers need only to click the icons on their mobile shopping Apps such as JD, Tmall and He Ma Xian Sheng, which is part of the Alibaba Group.

Previously, Chinese mitten crab was only available in southern China's luxurious seafood restaurants frequented mainly by high income customers and businessmen. Today, it has become a national food favoured by ordinary consumers and home cooking is a major consumption pattern. The price of mitten crab varies with its gender and size; basically, female or large mitten crabs are more expensive. The market size of mitten crab is normally 100-300g/crab, with prices ranging from USD 4.2-37/kg. The best time to eat mitten crab is before or during the traditional Chinese Mid-Autumn Festival, when mitten crab is rich in crab roe, so the price of mitten crab at that time is usually the highest.

### Outlook

Over the past decades of development, the value of the Chinese mitten crab industry has reached about USD11.4 billion per year. The sector has also driven the growth of related industries covering catering, fresh food logistics, e-commerce, tourism and trading. However, there are some urgent challenges we have to overcome to achieve a sustainable development. Firstly, serious pollution in

nearby farming areas and water deterioration in ponds brought by the high proportion of natural food and high application rates of bactericides and insecticides should be addressed by increasing the use of commercial feeds and adopting environmentally-friendly farm care products during the farming cycle. Secondly, diversified ecological farming practices such as paddy field farming practice should be actively encouraged to meet the consumers' increasing pursuit of a crabs with a natural taste. crab. Thirdly, a transparent traceability system monitoring every segment in the supply chain, from hatchery to plate, should be set up to mitigate consumers' concerns on food safety.

### Acknowledgement

The China-ASEAN Fisheries Resources Conservation and Exploitation Fund supported the research project on the Chinese mitten crab.



Xiao Haidong, Zeng Ji and Dong Qiufen, are experts in aqua nutrition and aquaculture from Guangdong Nutriera Group Co., Ltd. Together, they provide holistic practical solutions for aquafeed mills to help them produce high quality aquafeed and create value for farmers. Email: qiufendong@gmail.com



Range of Chinese mitten crab delicacies

## Registration of antioxidant in China

**L**iptosa is a Spanish company actively present in more than 60 countries and has more than 25 years of experience. It works to continuously search the best solutions in animal nutrition and periodically review formulas to improve and update them. Together with the R&D department, it develops new alternatives to cover the growing needs of the market.

Feeds used in aquaculture has a high risk of oxidation, due to the diversity of raw materials and their lipid content. The incorporation of LIPTOANTIOX PLUS as an antioxidant is based on the synergistic effect between its components, thus achieving a better assimilation of nutrients and, therefore, a better production result. Other advantages of use include the preservation of liposoluble vitamins and pigments.

In March, Liptosa registered in China its product LIPTOANTIOX PLUS. This is a chemical antioxidant in a powder form and is free of ethoxyquin and is specifically designed for extruded aquaculture and pet feeds. Due to its use at low dosages in raw materials and feeds, the product is a very profitable choice for feed mills; achieving a lasting effect over time versus the oxidation process and ensuring the shelf life of manufactured feeds. The composition of LIPTOANTIOX PLUS is based on butylated hydroxyanisole (BHA), butylated hydroxytoluene (BHT), propyl gallate, citric acid, cinnamon oil (CAS No 8015-91-6) and sepiolite. [www.liptosa.com](http://www.liptosa.com)



## BioMar delivers first products from new JV factory in China

**I**n China, the BioMar-Tongwei JV has now begun commercial production of aquafeeds in their new factory based in Wuxi. The new facility has already proven to deliver high and consistent quality making it possible to transfer production of high-end aquafeeds for China that were previously produced in Denmark.



Alan Xiaoqing Qian

The green field factory in Wuxi was announced as a strategic and important growth initiative back in 2016, to bring BioMar production knowledge from high-end species into the Chinese market. Together with the existing factory in the south of China, the new factory is going to service a wide range of species all over China.

"We are very happy with this important next step to expand our activities. We have established a good business in China through a combination of local production and imported products. We are serving traditional customers as well as those striving to bring new value propositions to retailers and end consumers. The Wuxi factory will allow new possibilities for customers with advanced product requirements through all production life stages", said Carlos Diaz, CEO BioMar Group.

"We have experienced an incredible dedication from employees in our JV, as well as from the supporting project team. During the coronavirus crisis, we have managed to find new ways of collaborating and bring people together across the globe, exchanging process knowledge, formulation experience and innovation ideas. It has been amazing to witness, how we can work closely together, while at a distance, and obtain such high product quality. I envision a 'New Normal' in terms of global collaboration, when we open up borders and countries."

During the commissioning phase of the new Wuxi factory, BioMar has been able to achieve product nutritional values and physical quality comparable to the standards seen in high-performing, well



established aquafeed factories. Key customers have started to place orders in the new factory for products previously delivered from Denmark.

"After some delays in the construction of the factory, we are extremely happy to have come through an uncomplicated commissioning phase, where we obtained a consistently high nutritional and physical quality. Feeds for sturgeon, rainbow trout, Californian sea bass and large yellow croaker are ready for the market. We have agreed with our customers, that we will start moving some orders from the BioMar factory in Denmark now to be produced in China," said Alan Xiaoqing Qian, General Manager of BioMar-Tongwei. [www.biomar.com](http://www.biomar.com)

## Single cell protein for aquafeeds from the carbon circular economy



CEO Brian Reddy said, "Working with feed companies and feed integrators, Kinnva has been conducting trials on salmon and shrimp. Inclusion rates in shrimp feed is between 5-10%."

Singapore's **Kinnva** is a biotechnology startup which uses waste materials such as methane, methanol and ligno cellulose to develop alternative proteins for the animal feed industry. During the Hatch's accelerator program for aquaculture startups, which involves visits to Hawaii, Bergen and Singapore, founder and CEO Brian Reddy said, "We attribute ourselves as a disruptive player in the feed production chain with an alternative feed protein. In terms of processes, we do not stick to methanotrophs but also have a liquid process using methanol and a waste stream process using agriculture waste."

For the aquafeed industry, Kinnva has developed a 65-70% crude protein ingredient called KinnFeed™ and KinnFeed™Aqua Plus with 80% crude protein. There are other feed ingredients for swine, poultry, cattle production as well as for the pet foods. Kinnva

started in Singapore in 2017 and has achieved seed funding and will be scaling up production. The startup also gave a 5' minute pitch at the Rethink conference, held in November 2019 in Singapore.

"We have been using third party facilities for production of trial volumes of the single cell protein for feed trials. We have produced in a 1000L capacity in India and in Europe. The aim is to scale up in Europe and Asia, with plants planned for Norway, India, China and in Southeast Asia. In Asia, the production will be for the swine, chicken and shrimp feed markets whereas in Europe, it will be for the salmon feed business. At the same time, for the production of larger quantities, we will need to have a commitment of at least 50,000 to 100,000 tonnes production per annum."

Working with feed companies and feed integrators, Kinnva has been conducting trials on salmon and shrimp. Inclusion rates in shrimp feed is between 5-10%. In shrimp, Kinnva is using trial facilities in Singapore, Vietnam and Indonesia. "We can scale up trials on shrimp when needed. In shrimp, the Kinnfeed™ Aqua Plus has a beneficial gut health function too; an antibacterial which will help in shrimp health, improve growth and survival rates. We want to deliver a product which gives farmers a saving in their production.

With regard to selling prices of this single cell protein, Brian said that they have looked at shadow pricing as a sustainable alternative for fish meal and to replace soybean meal where enteritis is commonly reported.

"In general, we offer the global feed industry an organic product from certified processes which discerning retailers in certain markets are demanding from their suppliers. Added to this, our LCA (life cycle analysis) shows a 50% saving in carbon efficiency and we are part of the carbon circular economy," added Brian. <https://www.kinnva.com>

## Ova arriving safely in China despite coronavirus logistic issues

**Stofnfiskur hf.**, a Benchmark Genetics company, successfully shipped Atlantic salmon ova out of Iceland to regular customers in China. This is the second delivery of ova to China. The consignment of almost 400,000 eggs, was sent from Reykjavik on April 16 and arrived safely in Beijing the following day. After quality checks on arrival, via domestic flights, the boxes were delivered to three different customers: two operating land-based farms, and a third, cage-farming in a freshwater lake.



Robert Rúnarsson, Global Sales Manager of Benchmark Genetics, said, "It is a challenge to plan airline shipments these days due to the Coronavirus crisis. Cancellations and changes of flights are made on short notice. Fortunately, there are still daily connections

between Iceland and Europe that makes it possible to get our products further exported to the global market."

StofnFiskur is the largest supplier of ova to the growing land-based aquaculture industry. This type of customer is concerned on biosecurity and the production model of StofnFiskur gives confidence that they do not get unwanted pathogens into the RAS-systems through the eggs. In Iceland, broodfish are kept ashore throughout the entire life cycle. The water supply is from deep boreholes, entirely free of infectious pathogens. The company's closed compartments have been approved by MAST in Iceland according to the OIE standard.

"The aquaculture companies that run full-cycle land-based production also require deliveries every single month of the year and we are proud to be able to fulfil their needs," concluded Rúnarsson. [www.stofnfiskur.is](http://www.stofnfiskur.is); [www.benchmarkplc.com](http://www.benchmarkplc.com)

## Benchmark appoints seafood expert as new CEO

**B**enchmark has announced the appointment of Trond Williksen as Chief Executive Officer. Trond will officially join Benchmark on June 1.

Trond Williksen is highly experienced in the international aquaculture and seafood industries, having held senior executive positions in the sector for over 20 years. Most recently he was CEO of SalMar ASA, the Norwegian fish farm company and one of the world's largest producers of farmed salmon. Prior to this, he was CEO of AKVA group ASA, the leading global aquaculture technology and service provider for six years. He previously held several senior roles in Aker ASA's Seafoods, Ocean Harvest and BioMarine divisions.

Trond has also held a number of advisory and non-executive director roles in the industry including as Chairman of the Board of The Research Council of Norway, Oceans Portfolio; Chairman of Mørenot Group, which provides solutions to fishery and aquaculture customers; Chairman of the Board of Calanus AS, a biomarine company; and Board Member of SinkabergHansen AS, a Norwegian integrated aquaculture company.

Chairman, Peter George said, "I am delighted to welcome Trond to Benchmark. He brings deep, relevant aquaculture expertise and has proven operational, strategic, M&A, and managerial experience spanning both producers and technology providers in the industry.

"I am confident that under his leadership and with his industry expertise, Benchmark will emerge from the current more difficult



environment to realise its potential to become a profitable leading provider of sustainable solutions to the global aquaculture industry."

Trond commented, "I am pleased to have the opportunity to join Benchmark, a leading provider of sustainable solutions to the global aquaculture industry. Benchmark is strategically well positioned within a sustainable industry that holds vast opportunities and potentials for the future. I am looking forward to enter a very competent team, positioning and executing on a strategy for profitability and growth in the future"

## Philippe Léger ends 37 years with INVE Aquaculture and Benchmark

**A**s Benchmark's new CEO Trond Williksen takes up his position, Benchmark have announced that Philippe Léger will complete his plans for a new episode in his life.

Philippe has had an extraordinary 37 years with INVE Aquaculture. Philippe started his career in 1979 as a 25 year old research scientist at the University of Ghent, was part of the spin-off company that evolved into INVE Aquaculture, led INVE Aquaculture through many successful years, and in 2019 stepped in to lead Benchmark's Executive Management Team. Now that Athene Blakeman has taken over the helm of the INVE Aquaculture (Benchmark's Advanced Nutrition Division) and Benchmark has a new permanent CEO coming on board, Philippe is stepping back to spend more time with the family. He will remain available as a freelance advisor to the company.

Philippe Léger, said, "My career has been driven by our customers, who are the reason we are dedicated to supporting successful aquaculture production around the globe. I have worked with many customers for several decades, making developments and advancing together. I leave the business in Athene's very capable hands and I look forward to watching from the side lines the continuing success and growth of the industry. I want to thank all of our customers for the collaboration and loyalty, and the fun along the way."



Athene Blakeman, Head of Advanced Nutrition (INVE) added, "We thank Philippe for his tremendous contributions to the aquaculture industry. I have been working closely with Philippe over the last twelve months to complete a successful handover and look forward to building the business and supporting the growth of our customers' businesses and the industry. In the meantime, we wish all our customers safety, health and resilience through these extraordinary times".

## BioMar enters partnership in Vietnam

To confirm a mutual interest in entering into a partnership, BioMar and Vietnam's leading shrimp hatchery Viet-UC have signed a memorandum of understanding with the intention of BioMar becoming part owner and operational lead in the feed factory currently owned by Viet-UC.

BioMar Group and Viet-UC are to establish a partnership developing and producing aquafeed in Vietnam. The two companies see a strong match in terms of values, focus and visions: Viet-UC being one of the leading shrimp hatcheries in the world with the ambition to build an integrated seafood group and BioMar Group being a leading global supplier of high quality aquafeeds based on extensive R&D and market insights.

"We believe that a feed partnership with Viet-UC in Vietnam will bring important synergies to the feed business as well as the hatchery and grow-out business of Viet-UC. Both companies have a common focus on sustainability, food safety, traceability, quality and performance, which we believe will be strong drivers to strengthen and develop both companies as well as the aquaculture industry in Vietnam. There is no doubt that there will be a growing market for high quality feed in Vietnam", explains Carlos Diaz, CEO in BioMar Group.

BioMar is already a significant shrimp feed producer in South and Central America with factories in Ecuador and Costa Rica. Since 2012, BioMar has been engaged in the development of feed and technical services for shrimp utilizing the capabilities of global R&D in combination with trial facilities around the world, most recently through its advanced Aquaculture Technology Centre in Ecuador dedicated to shrimp. Moving into Southeast Asia will strengthen the position of BioMar in the global shrimp industry and make it possible to share know how and best practice across the continents.



"We strongly believe in the increasing importance of high quality post larvae and in the relation between genetic and nutritional development, so partnering with one of the leading companies within this field in order to develop high performance feeds, concepts and value chain collaborations makes a lot of sense in order to promote a positive development of the shrimp industry", continues Carlos Diaz.

The memorandum of understanding will ensure that the two companies exclusively can focus on exploring the possibilities further, before signing a final agreement. [www.biomar.com](http://www.biomar.com)

## Aquaculture expert joins Diamond V Aqua team

Cargill's Diamond V® business has hired **Dr Wee Kok Leong** as Senior Consultant – Technical Services, Aqua. Wee brings with him over 37 years of extensive academic and commercial experience. His collective competencies lie in research and development of innovative products and new applications, feed and nutrition formulation, technical review, and training. In addition to comprehensive experience in the aquaculture industry, Wee has collaborated with and led diverse teams of individuals from broad backgrounds, professional experiences, and geographies. He holds an M.Sc. in Aquaculture and Fishery Management and a PhD in Fish Nutrition from the University of Stirling, Scotland, UK.

Prior to joining Diamond V, Wee served as a university lecturer, academic supervisor and technical consultant for various reputable universities and companies. He has become well-known and recognized in the aquaculture industry for both feed milling and feed additives.

Mike Goble, Diamond V's Global Managing Director said, "We are excited to have Dr Wee on board. His depth of experience, knowledge, and management capabilities are exceptional and will complement our growing team." [www.diamondv.com](http://www.diamondv.com)



# Industry lecture on sustainable aquaculture and functional brewer's yeast products

At the University of Plymouth, students on the MSc Sustainable Aquaculture course are offered an excellent training programme on the sustainable use of resources for aquaculture production, aquatic animal health, reduction of environmental impacts and addressing socio-economic factors. As part of the programme a series of industry guest lectures is delivered by representatives from leading companies and organisations along the value chain in order to give students first-hand insights from a commercial perspective.



Dr. Holger Kühlwein (left) with the MSc Sustainable Aquaculture students

This year's initial lecture was given by Dr Holger Kühlwein, Global Key Account Manager Aquaculture at **Leiber GmbH**. He presented an overview of the wide brewer's yeast product range using different fractions of the yeast cell, their quality aspects and applications in aquafeeds and aquatic animal health, and how these products can contribute to overall sustainable aquaculture.

The focus however was on highly-purified  $\beta$ -glucans extracted from the yeast cell wall. These are fed prophylactically via functional feeds, and they can increase immune competence of animals leading to higher stress and disease resistance. Core markets for these purified  $\beta$ -glucans are salmon and rainbow trout, sea bass and sea bream as well as the shrimp production.

## Industry scholarship programme

As part of the extended collaboration and commitment to sustainable aquaculture Leiber GmbH is also investing in the Aquaculture Sustainability Industry Scholarship Programme by providing funding for two of the students. Each of them will be able to apply and further develop acquired knowledge and laboratory skills by being part of the testing of two selected brewer's yeast products. Their specific functionalities require scientific evaluation across various species and their life stages, as well as a constant adjustments according to scientific developments and the changing requirements within the aquafeed industry.

"This, in combination with the predicted high annual growth rates of the aquaculture industry and the consequential increasing need for a highly-skilled workforce, is the incentive for us to contribute to aquaculture education and in the development of the industry" said Kühlwein. "This MSc programme, backed by the extensive scientific experience of the programme leaders and the research group in the field of functional feed ingredients for aquaculture, offers great opportunities in that direction."

Dr Daniel Merrifield, Associate Professor of Fish Health and Nutrition and Programme Lead on the MSc Sustainable Aquaculture course, added, "One of the key strengths of our programme is the diversity and depth of industry engagement through the curriculum. Leading figures from across various sectors of the industry contribute to the programme by providing guest lectures, resources, hosting placements, supporting projects and providing scholarships. Over a number of years, our students have benefited from our long-standing relationship with Leiber GmbH which provides a fascinating insight into current innovations and industry requirements." [www.leibergmbh.de](http://www.leibergmbh.de)

## NEXT ISSUES

### July/August

Issue focus: Sustainable & Responsible Aquaculture  
Industry review: Tilapia  
Feed/Production Technology: Health/Nutrition/IoT Innovations  
**Deadlines: Articles – May 18/ Adverts – May 22**

### September/October

Issue focus: Demand and Supply Equilibrium  
Industry review: Aquaculture Start-ups  
Feed/Production Technology: Larval and Nursery Feeds/  
Post Harvest Technology  
**Deadlines: Articles – July 13/ Adverts – July 24**

Email: [zuridah@aquasiapac.com](mailto:zuridah@aquasiapac.com); [enquiries@aquasiapac.com](mailto:enquiries@aquasiapac.com) for details

## Cargill launches its first shrimp feed in Indonesia

In May, Cargill announced the launch of Harvestar®, the first shrimp feed offered by the Cargill Aqua Nutrition (CQN) business in Indonesia. In April, the first shrimp feed product from the CQN plant in Serang, Banten was delivered to its first customers in Lampung, South Sumatera and West Java. The official launch was commemorated through a video conference meeting attended by the Deputy Director of Feed from the Ministry of Marine Affairs and Fisheries. The launch was done in accordance with COVID-19 response guidelines provided by the Indonesian government where safe social distancing was implemented.

"The Ministry of Marine Affairs and Fisheries appreciates the cooperation and commitment from Cargill to support our government's program, especially in the aqua nutrition business. Harvestar was officially registered in Indonesia since 2019 and from the testing we did, it has proven to be a good quality formula with good performance. The Ministry of Marine Affairs and Fisheries supports Cargill in entering the shrimp industry in Indonesia through its Harvestar product. We hope Cargill will continue to expand its shrimp portfolio and to support shrimp farming in Indonesia for the long run," said Christian Maikel Eman, Deputy Director of Feed Distribution.

Today's shrimp farmers in Indonesia are faced with fluctuating prices, expensive feed and increasing demands. Recognising these challenges, the CQN Indonesia team used its worldwide expertise to develop this shrimp feed product, which meets the needs of local farmers for a more efficient shrimp feed with a more bountiful shrimp yield.

Harvestar shrimp feed is formulated for vannamei shrimp with premium quality raw materials and an immunostimulant to increase the shrimp survival rate. The product design, which includes formulations for the different shrimp life stages, utilises Cargill's global expertise and extrusion technology for better feed performance. In product trials, Harvestar demonstrated a feed conversion ratio of 1.3, which is better than the 1.4 industry average and the 1.6 resulting from other feeds in the market.

CQN strives to offer the right nutrition to support healthier shrimp growth, helping serve the needs of the producers and consumers. Rohidin, a shrimp farmer from Subang, West Java who is one of Cargill's first Harvestar customers, said during the first delivery, "I have been a shrimp farmer for almost four years. I am excited to try Cargill's new product, because Cargill has a reputation for



producing good quality feed. Now that they have entered the shrimp feed arena, I am confident that Harvestar will be a good quality product that can help improve my shrimp health and weight, which at the end will help improve my yield as well as my income."

"Cargill Aqua Nutrition's expertise in the global supply chain and risk management allows us to offer distinctive value to our customers through the production of high-quality feeds and efficient distribution," said Sarawoot (Pop) Chittratanawat, Managing Director of Cargill Aqua Nutrition, Malaysia and Indonesia. "At Cargill Aqua Nutrition, we believe in better nutrition for better lives. In this unusual business environment, Cargill is committed to serve the nation as part of our role in the essential food supply chain. This is how we help farmers improve their productivity, sustainability, health and well-being."

Cargill began doing business in Indonesia in 1974 by establishing a feed mill in Bogor, West Java. Today, Cargill has its headquarters in Jakarta and has more than 19,000 employees. Cargill has 59 locations with offices, manufacturing plants and facilities throughout the country and business activities comprise animal nutrition, cocoa, copra, seaweed, processed food exporting, grain and oilseeds, palm oil, as well as starches and sweeteners. [www.cargill.co.id](http://www.cargill.co.id)

## Aquafeed mill acquisition in Vietnam

In March, **Leong Hup International Berhad** (LHI) announced it has signed agreements to acquire a feed mill in Vietnam, including its plant, equipment, machinery and motor vehicles, for a total consideration of approximately RM67.03 million (USD 15.4 million).

Strategically located within the thriving Mekong delta region, the acquisition is LHI's diversification into aquafeed in Vietnam. Currently, LHI and its subsidiaries in Vietnam produce a wide range of feed products, including those for parent stock chickens, broiler chickens, layer chickens, colour birds, ducks, cattle, goats, swine and quail. The aquafeed mill has a capacity to produce up to 118,800 tonnes of aquafeed/year, while the group has plans to enhance the asset's capacity and begin poultry feed production by the end of 2020. Aquafeed complements and extends the offerings of LHI's range of feed products.

Executive Director/Group CEO LHI, Tan Sri Francis Lau shared, "Vietnam is one of the group's burgeoning markets in Southeast Asia and we continue to sharpen our focus on expanding our growth in this region. This acquisition presents us with an opportunity to introduce feed products to capture more pockets of the region's rising protein consumption and enables us to strengthen our market position in Vietnam, particularly around the southern region."

LHI is a Malaysian-incorporated company listed on the KL Stock Exchange. It is one of the largest fully integrated producers of poultry, eggs and livestock feed in Southeast Asia. The LHI group has a strong and growing presence in Malaysia, Singapore, Indonesia, Vietnam and the Philippines – all of which are attractive consumer markets with significant growth potential. It employs more than 10,400 people across its operations which consist of feed mill and livestock business. [www.leonghupinternational.com](http://www.leonghupinternational.com)

## New leadership positions at Zinpro

Zinpro Corporation, the industry leader in performance trace mineral nutrition for livestock, poultry, aquaculture and companion animals, announced that it has promoted two employees in Southeast Asia and India, **Dr Itsara Suannakhan** and **Dr Sutep Luengyotluechakul**. These promotions recognise both individuals for their hard work and dedication, not only to the company's success, but also to the success of the customers with whom they work.



Dr Itsara Suannakhan has been promoted to Regional Business Enterprise Manager for Southeast Asia and India. In December 2011, he joined Zinpro as territory manager for Southeast Asia, responsible for technical support and product sales in the countries of Thailand, Indonesia, Singapore, Sri Lanka and Malaysia. In 2017, he was promoted to lead a larger territory as account manager, adding Laos, Cambodia and Myanmar to his responsibilities. In his

new role, Itsara will be responsible for building and leading sales teams across the countries within his earlier responsibilities, as well as in India, Vietnam and Nepal.

Dr Sutep Luengyotluechakul has been promoted to Technical and Business Development Manager for Southeast Asia and India. Sutep joined Zinpro in October 2008 as business development manager for Southeast Asia. In 2017, he was promoted to account manager to lead the company's expansion into India, Sri Lanka and Vietnam while continuing his earlier responsibilities in Southeast Asia. In his new role, he will lead technical services and training programs for the company's customers and identify new products and market opportunities to help further expand the company's customer base and drive sales in the region.



"Over the course of their careers with Zinpro, Itsara and Sutep have worked hard to be successful in their individual roles. These promotions are very much deserved," said Dr Supunee Jiarakhun, Vice President of Sales – Southeast Asia and India. "Their considerable knowledge and expertise in animal nutrition and production agriculture will ensure our continued success in the Southeast Asia and India regional markets." [www.zinpro.com](http://www.zinpro.com)

## Technical Director of Aquaculture for Calysta in Asia

Leading alternative protein producer, Calysta has appointed **Dr Jarin Sawanboonchun** as its Technical Director of Aquaculture. Jarin joined the company in March and will be based in Bangkok, Thailand. She will be responsible for further developing applications for FeedKind® protein in the aquafeed industry worldwide, with a focus on applications in shrimp and other warm water species in Asia. She brings with her a strong background in farm management, feed development, nutrient technology and experience on technical support to fish and shrimp farmers in Thailand.

"Her background in aquaculture, extensive experience as a feed formulator as well as her industry knowledge and network in Asia gives her great insight into the needs of feed companies and farmers and will enable her to identify additional benefits FeedKind can bring to the table. In addition to her product development responsibilities, Jarin will also support the newly formed Calysseo Joint Venture with Adisseo and be a technical resource to the sales team," said Allan LeBlanc, Calysta VP of Market Development.

Jarin said, "I have this strong conviction that for the future of the aquaculture industry in Asia, we need to look to alternative feed ingredients to continue to grow the industry sustainably. I believe we have this in FeedKind and am happy to be working with the team at Calysta to bring this product to market."

Prior to joining Calysta, Jarin worked with Ridley Corporation (Thailand) providing technical and nutritional support, product improvements and identified new business opportunities. Additionally, she has worked in shrimp feed formulation at Gold Coin Specialities (Thailand) and as technology deployment manager at Cargill Animal Nutrition Thailand. She has an MSc and PhD in Fish Nutrition from the University of Stirling, Scotland. [www.calysta.com](http://www.calysta.com)



## Land-based Atlantic salmon as an ocean-friendly farmed fish option



Neder Snir, Chief Technical Officer, Yoav Dagan, Vice President, Business Development and Gary Myers, Senior Technology Officer, AquaMaof Aquaculture Technologies Ltd.

In March, Pure Salmon Poland SP. Z.O.O. (formerly "Global Fish"), a land-based Atlantic salmon farm located near Warsaw, Poland, announced its product has officially been recommended by the **Ocean Wise Seafood** program as an ocean-friendly farmed fish option. The company is co-owned by AquaMaof Aquaculture Technologies Ltd and 8F Asset Management Pte. Ltd's private equity funds and operates as both a commercial business and a R&D and training centre.

The Ocean Wise Seafood program is a conservation program that helps consumers and businesses to choose sustainable seafood options based on the most recent scientific information. The Ocean Wise symbol next to a seafood item is an assurance that the product is ocean-friendly and is harvested with the long-term health of oceans, lakes, and rivers at top priority. As an approved partner, Pure Salmon Poland has been verified to comply with Ocean Wise Seafood standards for sustainable aquaculture practices. "We are proud to partner with companies like Pure Salmon Poland," said Sophika Kostyniuk, Manager of the Ocean Wise Seafood program. "Their sustainable farming practices ensure more Ocean Wise recommended Atlantic salmon options will be accessible long into the future." The company has also received the ASC certification for responsibly farmed seafood. The ASC logo on a product guarantees full traceability throughout the supply chain, from farm to fork.

Pure Salmon Poland is a fully operational, land-based commercial facility that produces and markets Atlantic salmon of 4kg and above. With the goal of producing a combined 260,000 tonnes

of salmon/year, this global initiative uses AquaMaof's proprietary recirculating aquaculture system (RAS) technology and design. As a R&D and training centre, it conducts trials and experiments to enhance the technology's sustainability and streamline operations, as well as a global training centre to train staff on operating and maintaining the AquaMaof technology.

"We're extremely excited to receive another endorsement that assures our commitment to producing sustainable fish," said Eran Huppert, General Director of Pure Salmon Poland. "Now, more than ever, we understand the importance of promoting a sustainable and disease-free environment, especially in food production, and we have been making every effort to achieve just that. These endorsements are a confirmation that we are providing a safe, traceable environment that is also environmentally-friendly."

In April, AquaMaof announced the kick-off of a new RAS facility in France for the production of Atlantic salmon, commissioned by 8F Asset Management Pte. Ltd. The 10,000 tonnes French facility is currently in the design stage, with first eggs to be put in the system by 2021 and first harvest expected by 2023. This new facility joins other under-development projects with a combined capacity of 60,000 tonnes of Atlantic salmon annual production. AquaMaof is now working on facilities in Canada, US, Japan, Russia, central Europe, Southeast Asia, and Chile.

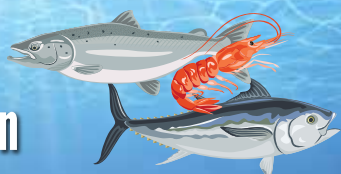
"We are excited to kick off this project that will integrate all the latest advancements in RAS technology. These projects will provide important local production capabilities to markets that today import most of their fish and seafood," said Shai Silbermann, VP of Marketing and Sales at AquaMaof. "Today more than ever, the capabilities of maintaining a clean, biosecure, disease-free environment in fish and seafood production, as well as enabling local production in a time of disrupted food production and international supply chain and transport, are much sought after. Governments, investors, and big retailers are seeking food-production technologies that promote food safety and local production capabilities."

AquaMaof's RAS technology provides a solution for responsibly farmed and harvested aquaculture practices, for various aquaculture species. Its facilities are strategically located adjacent to large cities, which dramatically reduces transportation costs and produce fresh, natural, and high-quality fish at competitive prices. The company promotes sustainable practices that include proprietary water-recycling techniques with minimum discharge and low power consumption. There are no antibiotics, or chemicals used in the farming process. The integrated RAS technology enables year-round harvest.

**F3 Challenge**

### Carnivore Edition

Got a fish-free feed that works for carnivores?  
Join the global competition to replace wild fish in aquafeeds.



**UPDATE:** Due to the fast-changing situation with COVID-19, the F3 Team has made the decision to extend the registration period for the F3 Challenge - Carnivore Edition.

Companies may continue to register until a new deadline is announced. A new contest timeline and dates for informational webinars will be shared at that time. [www.carnivore.f3challenge.org](http://www.carnivore.f3challenge.org)

# SEAFDEC upgrades feed mill to boost production of low-cost aquaculture feeds

The quest for low-cost and eco-friendly aquafeeds received a boost with the recent USD 30,800 upgrade of the feed mill of the Southeast Asian Fisheries Development Center (SEAFDEC) in Tigbauan, Iloilo. This centre acquired a 5-layer dryer and an extruder for its feed mill to further increase its capacity by 300kg/hour or 2,400kg per 8-hour workday. The extruder is for production of both sinking and floating aquafeeds.

“The recent upgrade boosted the production rate by almost 400%. With the additional extruder, production will not be interrupted by the periodic downtime for maintenance or unexpected breakdowns,” said Joseph Biñas, head of the Nutrition and Feed Development Section of SEAFDEC’s Aquaculture Department (AQD).

Before the upgrade, the feed mill can only produce 500kg/day due to the limited capacity of the drying ovens. The feed mill produces diets for abalone, grouper,

mangrove crab, milkfish, pompano, sea bass, shrimp, siganid, and tilapia as well as feed ingredients that are utilised for research projects. It also accepts orders from private hatcheries that needs feeds for marine fish broodstock and larvae which are not readily available commercially.

## Cheaper and more eco-friendly

With feeds accounting for over 50% of the production cost in aquaculture, SEAFDEC’s role is to formulate and test feeds using cheaper alternative ingredients. It’s fish

nutrition experts are looking for sustainable alternative sources of protein from aquatic and terrestrial plants as well as animal by-products.

“Our fish nutrition experts are currently developing low-cost feeds for various aquaculture species that could greatly benefit fish farmers to lower their production cost,” said Dan Baliao, chief of SEAFDEC/AQD. “With the improvement of the production capacity of our feed mill, we are most likely to achieve our goal.”

By Rossea Ledesma



The new 5-layer dryer replaces the ovens previously used to dry feeds.



The new extruder



## 11TH SYMPOSIUM ON DISEASES IN ASIAN AQUACULTURE

29<sup>th</sup> September – 2<sup>nd</sup> October 2020

Land of Adventure: Exploring Aquatic Animal Health for Sustainable Aquaculture

| Plenary Speakers  |  | Keynote Speakers   |  | Date                              | Item                                |
|---|--|--|--|-----------------------------------|-------------------------------------|
| <br><b>Plenary I : State of Aquaculture</b><br>Dr Rohana Subasinghe (Sri Lanka)  | <br><b>Session I : Biosecurity in Aquaculture</b><br>Dr Edgar Brun (Norway)   | <br><b>Session III : Detection method/Diagnostic (Parasitic, Bacterial &amp; Viral diseases)</b><br>Prof Karin Pittman (Norway) | <br><b>Session V : Trends in Fish Health Management</b><br>Dr. Kua Beng Chu (Malaysia)  | JUNE 15 <sup>TH</sup> 2020        | Abstract Submission Dateline        |
| <br><b>Plenary II : Drivers and pathways of disease emergence in aquaculture</b><br>Dr Melba B. Reantaso (Philippines/Italy) | <br><b>Session II : Epidemiology (Parasitic, Bacterial &amp; Viral diseases)</b><br>Prof. Dr. Kenton L.L. Morgan (United Kingdom) | <br><b>Session IV : Prevention &amp; Control Measures</b><br>Dr Huang Jie (China/Thailand)                                      | <br><b>Session VI : Trends in Shrimp Health Management</b><br>Prof Chu-Fang Lo (Taiwan) | JULY 30 <sup>TH</sup> 2020        | Notification of Abstract Acceptance |
|   |  |  |  | AUG 15 <sup>TH</sup> 2020         | Early Registration Deadline         |
|   |  |  |  | AUG 15 <sup>TH</sup> 2020 ONWARDS | Normal Registration                 |

  
[www.daa11.org](http://www.daa11.org)

Organized by



## All systems go as BioMar Australia begins production

BioMar Australia have commenced aquafeed production at their state-of-the-art €40 million facility in Tasmania, Australia, which is welcome news for the local aquaculture industry at a time when many businesses are facing COVID-19 operating restrictions. In a virtual media conference to comply with social distancing requirements, Minister for Primary Industries and Water Guy Barnett congratulated BioMar on achieving this milestone.

BioMar Australia's Managing Director, David Whyte, who was onsite during the virtual launch, thanked all parties involved for helping BioMar deliver the project on schedule and budget.



This €40 million facility in Tasmania, Australia will support the Australian and Oceania aquaculture industry with aquafeeds

"While it is not currently possible to formally celebrate our opening together with our staff, customers and community, we must acknowledge all those involved in bringing the project to life. We are now up and running in Tasmania and we're excited to add our technical and production capacity to the region's aquaculture industry," said Whyte.



David Whyte

"Trials of our products are already underway in a variety of species in Australia and New Zealand, and we are bringing BioMar's global best practices and nutritional know-how into our region helping to support sustainable innovation in aquaculture."

Carlos Diaz, CEO of BioMar Group also attended the virtual opening event from Chile, said, "Globally aquaculture is a growing industry with growth expected to double by 2050. BioMar is committed to helping Tasmania and our wider region play an important role in this endeavour, supporting farmers to grow healthy, sustainable and safe food."

BioMar announced plans to establish production in Australia back in 2017 and after two years, the first trucks of fish feed have started to roll out of the facility. The production facility will produce up to 110,000 tonnes per annum of aquafeed to support the Australian and Oceania aquaculture industry. Despite COVID-19, it is business as usual production-wise at the facility with the adoption of key social distancing measures to ensure the wellbeing of BioMar employees. [www.biomar.com](http://www.biomar.com)

## Research partnership with Barramundi Asia and Temasek Life Sciences Laboratory

In March, **Louis Dreyfus Company** (LDC) announced a research partnership with Barramundi Asia and Temasek Life Sciences Laboratory (TLL) to develop optimal aquafeed formulations for the rearing of the barramundi on a commercial scale. The tripartite agreement is the first collaboration to result from the MOU between LDC and Temasek Lifesciences Accelerator (TLA), signed in November 2019 to support the commercialisation of promising technologies for the advancement of agri-food innovation in the region.

It also strengthens LDC's participation as a shareholder in Barramundi Asia, following Barramundi Asia's recent merger with Allegro Aqua, of which LDC held a 30% stake. Thomas Couteaudier, Head of LDC's South & Southeast Asia region, said, "In line with LDC's growth ambitions to pursue downstream diversification and food innovation through strategic partnerships, we are pleased to embark on this venture with Barramundi Asia and TLL, which builds upon our strong relationship with both partners. Leveraging LDC's commercial and logistics expertise and presence across the global food, feed and ingredients value chain, we look forward to contributing to the realisation of innovative and sustainable solutions to help meet rapidly growing consumer demand for fish protein as a healthy meat alternative."

Peter Chia, CEO of TLL and TLA, said, "We believe that through this partnership, we will be able to significantly enhance the economic equation of fish farming through better genetics, improved feed, logistics and optimised farming protocol to help pave the way for the barramundi to become the species of choice for the tropics."

"As a company that operates Singapore's and Australia's largest ocean farms and considering our planned expansion into a 6,600ha site in Brunei, the strategic benefits of improving our feed conversion ratios and utilisation of more environmentally friendly feed cannot be overstated. This tripartite endeavour is a major win and a step forward for the farming of barramundi globally," added Andreas von Scholten, CEO of Barramundi Asia.

The research program will involve developing and testing new formulations that deliver benefits including improved feed efficiency, strengthened immunity and the practice of sustainable aquaculture using sustainable and healthy ingredients. TLL will lead the R&D component of the program, with Barramundi Asia providing access to its aquaculture farms and nurseries for real-world trials and LDC contributing to research funding and supporting the implementation of trials. [www ldc.com](http://www ldc.com)



# SAVE THE DATE

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## GOAL 2020 goes virtual with unifying global conference platform

The Global Aquaculture Alliance (GAA) announced on May 12 that its annual Global Outlook for Aquaculture Leadership (GOAL) conference will be a virtual event this year, and the live event scheduled to be held in Tokyo, Japan, in October 2020 has been postponed to October 2021.



Since its inception in 2001, GOAL has built a reputation for quality content, attracting aquaculture thought leaders determined to stay ahead of the curve on emerging challenges and solutions. Featuring a dynamic conference platform and application, this year's virtual event will deliver the same quality program but with much greater reach and versatility and a more interactive experience between speakers, moderators and the audience.

"The silver lining of this terrible COVID-19 cloud is the unifying force of virtual meetings. This presents new opportunities to broadly share the latest information and advances to accelerate progress toward our collective goal of responsibly producing more healthful seafood," said GAA Founder and President George Chamberlain.

Individual and corporate members will be able to access to the functionality of the conference platform and application, including livestreaming, live Q&A and polling, and virtual meetings. They will also be able to access PDFs of presentations and reports as well as recordings of the livestream on-demand. Corporate members will be able to access virtual networking and matchmaking opportunities, with the ability to "call" face-to-face meetings

within the conference platform. To help unify the global seafood sector, Day 1 of the conference will be offered free of charge to members of seafood associations and other strategic partners worldwide.

GOAL 2020 will be held from October 6 to 8, as previously scheduled, with six to eight program sessions occurring throughout the week of the conference.

GOAL 2021 will be held at the Okura Tokyo in October 2021; dates are yet to be announced. Though GAA anticipates the return of the live event next year, this announcement signifies a transition of the GOAL conference to a "hybrid" model with a cohesive live and virtual event.

"At GOAL 2019, we live streamed Day 1 of the conference to four shrimp-farming and -processing hubs throughout India as well as six Southeast Asian cities, and it was a big success, attracting hundreds of aquaculture professionals who were unable to join us in Chennai," said Steven Hedlund, GAA's communications and events manager. "The success of that virtual event, coupled with the travel and meeting uncertainties caused by the COVID-19 pandemic, inspired us to evolve GOAL beyond the traditional format. The in-person event draws 400 to 500 seafood professionals from 30-plus countries. But a virtual event held simultaneously has the potential to draw thousands. We are excited by what the future holds."

The GOAL 2020 conference program will be published in June. [www.aquaculturealliance.org](http://www.aquaculturealliance.org)

## Taiwan International Fisheries & Seafood Show

**The most precise match-making platform in Taiwan for local and global fishery professionals.**

At TIFSS 2020, there will be more than 300 one-on-one procurement meetings. A number of debut international forums will be held in collaboration with international media.



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[www.taiwanfishery.com](http://www.taiwanfishery.com)

In conjunction with  
**Taiwan International Fishing Tackle Show**



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## Aquaculture Europe 2020 will not take place this year, but EAS will organise events in both Cork and Madeira in 2021

The European Aquaculture Society (EAS) Board of Directors have decided that their Aquaculture Europe 2020 event cannot go ahead as planned in Cork from September 29 to October 2 this year. There will therefore be no Aquaculture Europe event this year. Gavin Burnell (EAS President 2018-2020) and Herve Migaud (EAS President 2020-2022) said, "However, to maintain our commitment to our chosen locations, delegates, exhibitors and attendees, EAS will organise two events in 2021."

The new date for **AE2020 Cork**, Ireland will be from April 12-15.



**AE2021 Madeira** will be held in Funchal, Madeira, Portugal, 6 months later from October 5-8



### AE2020 Cork April 12-15, 2021

Abstract deadline: December 31

Early Bird registration deadline: February 15



### AE2021 Madeira October 5-8, 2021

Abstract deadline: May 1

Early Bird registration deadline: July 15

More information will soon be available on the website concerning the programme for each event and sessions for online abstract submission. Organisers will also be contacting those that have already submitted abstracts for Cork. New abstracts for both AE2020 Cork and AE2021 Madeira can be submitted online.

More information: General conference: [eas@aquaeas.eu](mailto:eas@aquaeas.eu)  
Booth sales, exhibitor contracts, sponsorship and media partners: [mario@marevent.com](mailto:mario@marevent.com)



## 11th Symposium on Diseases in Asian Aquaculture

September 29-October 2 | Kuching, Sarawak, Malaysia

Organised by the Fish Health Section of the Asian Fisheries Society (FHS-AFS), the triennial symposium series, Diseases in Asian Aquaculture (DAA) covers core aspects of aquatic animal health including current research developments, trends, and the future of the aquatic animal health industry. Topics are from classic parasitic, bacterial and viral diseases to emerging trends and cutting-edge research in aquatic animal health and its implementation into better biosecurity. The last DAA10 symposia was held in Bali, Indonesia, in 2017.

The DAA11 symposium aims to combine intellectual stimulation while exploring the nature of Sarawak, Malaysia's largest state on Borneo Island, which has the nickname 'Land of the Hornbills'. DAA11 anticipates the attendance of 400-500 delegates from 20-30 countries. With the chosen theme: "Land of Adventure: Exploring Aquatic Animal Health for Sustainable Aquaculture", there will be ample time for networking, field trips and social functions during the symposium. There will be trade displays throughout the 4-day event. The venue is the Borneo Convention Centre, Kuching (BCKC).

DAA11's National Organising Committee, the Department of Fisheries has announced the introduction of the 3-Minute Pitch (3MP), at the end of each session. This session is an extended form of an elevator pitch that was introduced at DAA10. The 3MP session aims to encourage more oral presentations and serves as a platform for researchers to highlight the impact of their research to a wider audience.

### Student travel grants

FHS-AFS will provide up to 10 student travel grants which will cover full registration fees, and a round trip economy airfare. The criteria for application includes registration for the conference before May 1. Submission of full research paper directly to Dr C V Mohan at [v.chadag@cgair.org](mailto:v.chadag@cgair.org) is on or before June 30 2020

### Deadlines

Abstract Submission: June 15, 2020

Early Registration: August 15, 2020

More information: [www.daa11.org](http://www.daa11.org);

Email: [daa11@dof.gov.my](mailto:daa11@dof.gov.my)



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## VIV WORLDWIDE **FULL EVENTS CALENDAR** 2020-2022

VIV **MEA** 2020

Abu Dhabi, August 31-September 2

VIV **QINGDAO** 2020

Qingdao China, September 17-19

POULTRY **AFRICA** 2020

Nairobi, October 14-15

VIV **ASIA** 2021

Bangkok, March 10-12

VICTAM AND ANIMAL HEALTH AND NUTRITION **ASIA** 2022  
BY VICTAM & VIV

Bangkok, January 18-20

VIV **EUROPE** 2022

Utrecht, Amsterdam 📍 30 min, May 31-June 2

## PARTNER EVENTS SUPPORTED BY VIV WORLDWIDE

MEAT & POULTRY INDUSTRY **RUSSIA** 2020

Moscow, October

ILDEX **VIETNAM** 2020

Ho Chi Minh, December 9-11

VIV **TURKEY** 2021

Istanbul, June 10-12

ILDEX **INDONESIA** 2021

Jakarta, September 15-17

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## VICTAM and Animal Health and Nutrition Asia postponed to January 18-20 2022

Due to the worldwide COVID-19 crisis, the management teams from the VICTAM Corporation and VIV worldwide had decided earlier to postpone VICTAM and Animal Health and Nutrition Asia in Bangkok to the second quarter of 2020. In a joint press release, organisers; Sebas van den Ende, General Manager VICTAM Corporation and Heiko M. Stutzinger, VIV worldwide Director and Managing Director, VNU Asia Pacific, said, "As the worldwide situation is still very critical and a long way from being solved, we cannot take the risk of organising an event as early as July 2020. COVID-19 is still disrupting businesses around the world and we have concluded that being present at the exhibition is, at the moment, not our client's priority.

"We evaluated an alternative date in the second half of this year, but as both health and financial situations in the world by then are very unclear, we believe postponing the event to the beginning of 2022 is in the interest of the market and the participants. This way there is more time to let the situation and business get back to normal. Another reason to choose January 2022, instead of the second half of this year, is the full event calendar, which could create a conflict of dates for our visitors and exhibitors."

They added, "Postponing the event to January 2022 will give all stakeholders room to breathe and pay attention to other vital issues. The mission is to present a strong, value-adding event to the industry with high benefits for all parties. Due to the consequences of the COVID-19 outbreak, we are unable to succeed in this mission and therefore we believe it is the right decision for the market and we will come back stronger together in 2022."

VICTAM and Animal Health and Nutrition Asia is re-scheduled to **January 18 – 20, 2022** at BITEC, Bangkok, Thailand. The objective remains the same: to realise the total animal feed and health event organised by VICTAM and VIV.

The Victam Corporation and VIV worldwide will also continue their partnership in Europe in 2022 by organising VICTAM International and VIV Europe together at the Jaarbeurs exhibition grounds in Utrecht, the Netherlands, from May 31 – June 2, 2022. The set-up of this exhibition is different from the Asia event, as VIV Europe and VICTAM International will be co-located but with each exhibition in their own halls. [www.victamasiam.com](http://www.victamasiam.com) or [www.vivhealthandnutrition.nl](http://www.vivhealthandnutrition.nl).

## AQUA CULTURE Asia Pacific in 2020

| Volume 16 2020  |  |  |  |
|---|--|--|--|
| Number & Month  | 4 - Jul/Aug  | 5 - Sep/Oct  | 6 - Nov/Dec  |
| <b>Aqua Business</b><br><i>Feature articles and contributions from industry players</i>                             | Experiences from industry and opinion articles covering role models, benchmarking, health management, SOPs, social investments, CSR, ancillary services, self-regulation etc |  |  |
| <b>Issue focus</b><br><i>Recent developments/spotlight on emerging challenges</i>                                   | Sustainable & Responsible Aquaculture  | Demand & Supply Equilibrium  | Aquaculture Education                                      |
| <b>Industry Review</b><br><i>Developments, outlook, demand &amp; supply</i>   | Tilapia  | Aquaculture Start-ups  | Catfish & Freshwater Fish                                  |
| <b>Feeds &amp; Processing Technology</b><br><i>Technical contributions from industry</i>                            | Health Nutrition   | Larval & Nursery Feeds   | Processing Technology/ Feed Safety                         |
| <b>Production Technology</b><br><i>Technical information along the value chain</i>                                  | IOT/Innovations  | Post-Harvest Technology/ Processing  | Organic Aquaculture  |
| <b>Marketing activities</b>   | Market and product development, market access, certifications, branding, food safety etc   |  |  |
| <b>NEW Post Harvest Quality &amp; Processing</b>  | <b>Technical contributions from industry players on assuring quality at pond site to processing technology</b>   |  |  |
| <b>Company/Product news</b>   | News on activities at international, regional and local conferences and trade shows  |  |  |
| <b>Deadlines</b>  |  |  |  |
| <b>Technical articles</b>   | <b>May 11</b>  | <b>July 13</b>   | <b>September 14</b>  |
| <b>Advert booking</b>   | <b>May 22</b>  | <b>July 24</b>   | <b>September 25</b>  |
| <b>Show Issue &amp; Distribution at these events as well as local and regional meetings</b><br><i>*Show preview</i> |  | <b>11th Symposium on Diseases in Asian Aquaculture (DAA11 2020)</b><br><b>Kuching, Sarawak, Malaysia</b><br>September 29-October 2 | <b>*World Aquaculture 2020 Singapore</b><br>December 14-18 |

# Updates for WA2020 rescheduled to December 14 to 18, 2020



In March, the World Aquaculture 2020 (WA2020) conference organiser and the WA2020 Steering Committee members announced that WA2020 will be rescheduled from June 8-12, 2020 to **December 14-18, 2020**, at the Singapore EXPO Convention and Exhibition Centre, Singapore.

Organisers assured that everything in the WA2020 meeting will proceed as planned, except for the dates. Therefore, all the previous abstracts submitted will continue to be processed by the Program Committee and all registrations will continue to be valid.

The Steering Committee is working hard to keep track of the developing guidelines and regulations from the Singapore government, international health organisations and other authorities. "As these develop, we will be incorporating them into WA2020 to make it the safest and most effective Conference and Exposition possible. We will be keeping you informed of updates on our website as they develop."

## Keynote speaker for WA2020

The theme of WA2020 is "Next Generation Aquaculture – Innovation and Sustainability will feed the World". WA2020 announced that the keynote speaker will be **Masagos Zulkifli**, Minister for the Environment and Water Resources and Minister-in-Charge of Muslim Affairs Republic of Singapore. The Ministry oversees the National Environment Agency, PUB – Singapore's National Water Agency, and the Singapore Food Agency. In 2019, it also announced that FAO's **Dr Matthias Halwart** will be the plenary speaker. His presentation will address the theme of WA2020, "Aquaculture for Food Security and Sustainable Development".

## New session

In light of the ongoing pandemic associated with COVID-19, WA2020 is making a call for abstract submissions for the special session:

### COVID19 and Pandemics – Aquaculture and Food Security.

The brainstorming session welcomes ideas and solutions to address the impacts of current and future pandemics on production, supply chain, financial biosecurity, marketing channels and e-commerce, science and technology, recovery, sustainability and development, society, and governance. The abstract deadline has been extended to **August 3, 2020** to allow for submissions for this new session.

## Farm tours

Several pre and post farm tours will include visits to up five sites. The First farm tour # 1 bring the participants from Singapore Harbourfront Ferry Terminal to Batam Island, Indonesia.



The first farm tour on Batam Island, Indonesia will include a visit to facilities in Batam Nara Indonesia (Shrimp Production) and Mariculture Development Centre.



Barramundi Asia's Raffles cage culture site.

Within Singapore.

- Farm tour A will be to Barramundi Asia and Marine Aquaculture Centre
- Farm tour B will be to a coastal fish farm
- Farm tour C will be to land-based food fish and dragonfish farms
- Farm tour D will be to AIC & ornamental fish farms.

### More information

<https://www.was.org/meeting/code/WA2020>  
Conference Management, contact John Cooksey,  
email [worldaqua@was.org](mailto:worldaqua@was.org)  
For Booths and Sponsors, contact Mario Stael, email: [mario@marevent.com](mailto:mario@marevent.com)  
WAS-APC Chapter secretariat executive officer, email: [apcsec@was.org](mailto:apcsec@was.org)

## SPACE 2020 will not go forward

Due to the COVID-19 pandemic and the resulting crisis, SPACE 2020, which was scheduled for September 15-18 at the Rennes Exhibition Centre, Rennes, France, will not go forward as planned. Given the uncertain situation and the state of health emergency that has now been extended for several more months, organisers believed it was important to take this decision earlier than initially intended.



The infection control measures will most likely still be required in September, and it would be nearly impossible to strictly comply with these measures at SPACE, due to the large numbers of people at the Expo. It would be extremely difficult to achieve physical distancing at the stands, in queues, conference areas, restaurants and receptions. Every year, SPACE brings together more than 1,400 exhibitors, a third of whom are international, and more than 100,000 visitors, including more than 14,000 from 120 different countries.

In a press statement, organisers said, "It is therefore in full knowledge of the importance of all these issues and the consequences for our participants and partners, but above all driven by the concern to avoid uncontrollable risks for our participants that we have taken the decision not to go forward with SPACE 2020."

SPACE in 2021 will take place from **September 14-17, 2021**, at the Rennes Exhibition Centre. [www.space.fr](http://www.space.fr)

# WELCOME

## Singapore - December 14-18, 2020

Singapore EXPO Convention and Exhibition Centre

**NEW  
DATES**

**WORLD  
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# WA 2020

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**INNOVATION AND SUSTAINABILITY WILL FEED THE WORLD**



For more info on the CONFERENCE: [www.was.org](http://www.was.org) - [worlداqua@was.org](mailto:worlداqua@was.org)  
For more info on the TRADESHOW: [mario@marevent.com](mailto:mario@marevent.com)



## Announcement on new dates:



**October 7-9, 2020,  
Can Tho City, Vietnam**

**VIETSHRIMP Aquaculture International Fair 2020** has been rescheduled to October 7-9 2020. The location is the Can Tho Promotion Agency, 108A Le Loi Street, Cai Khe Ward, Ninh Kieu District, Can Tho City, Vietnam. The organising committee will monitor the situation with COVID-19 closely and will provide details of the rescheduling arrangements to all exhibitors and visitors.

For enquiries, the service hotline is (+84) 944663828 (Mr. Nghia), Email: vietshrimp@gmail.com. <https://vietshrimp.net/reschedule-notice/>



**September 13- September 18 2020, Busan Korea**

The local organising and international scientific committee of International Symposium on Fish Nutrition and Feeding (ISFNF) has rescheduled the symposium to September 13-18. The meeting will be held at BEXCO, Busan, Korea. Some changes to dates are as follows:

Early registration deadline date: **June 15**

Abstract submission date: **July 31**

Everything in the symposium will remain as planned except for the dates. Submitted abstracts will continued to be processed by the ISNFN Scientific Committee. Registrations and sponsorship contracts will continue to be valid.

The aim of ISFNF is to advance all aspects of aquatic animal nutrition research. It brings together researchers, industry, government and other stakeholders to identify and address constraints limiting aquaculture production, fish health and food safety, with a view to recognizing the need for adopting approaches based on new knowledge, emerging technology and novel ideas.  
[www.isfnf2020busan.com/](http://www.isfnf2020busan.com/)

# 2020

Details on the events below are available online at <http://www.aquaasiapac.com/news.php>  
To have your event included in this section, email details to [zuridah@aquaaasiapac.com](mailto:zuridah@aquaaasiapac.com)

**August 26-28**  
**Vietfish 2020**  
Ho Chi Minh City, Vietnam  
[www.vietfish.com.vn](http://www.vietfish.com.vn)

**August 31-September 2**  
**VIV MEA 2020**  
Abu Dhabi, U.A.E  
[www.viv.net](http://www.viv.net)

**September 8 - 10**  
**Livestock Malaysia 2020**  
Melaka, Malaysia  
[www.livestockmalaysia.com](http://www.livestockmalaysia.com)

**September 13 -18**  
**ISFNF 2020**  
Busan, Korea  
[www.isfnf2020busan.com](http://www.isfnf2020busan.com)

**September 29-October 2**  
**11<sup>th</sup> Symposium on Diseases in Asian Aquaculture (DAA11 2020)**  
Kuching, Malaysia  
[www.daa11.org](http://www.daa11.org)

**September 30-October 2**  
**22nd Japan International Seafood & Technology Expo**  
Tokyo, Japan  
[www.exhibitiontech.com](http://www.exhibitiontech.com)

**October 7-9**  
**VietShrimp Aquaculture International Fair 2020**  
Cantho City, Vietnam  
<https://vietshrimp.net>

**December 14-18**  
**World Aquaculture 2020**  
Singapore  
[www.was.org](http://www.was.org)

## New Dates 2021

**April 12-15**  
**Aquaculture Europe (AE2020 Cork)**  
Cork, Ireland  
<https://aquaas.eu/>



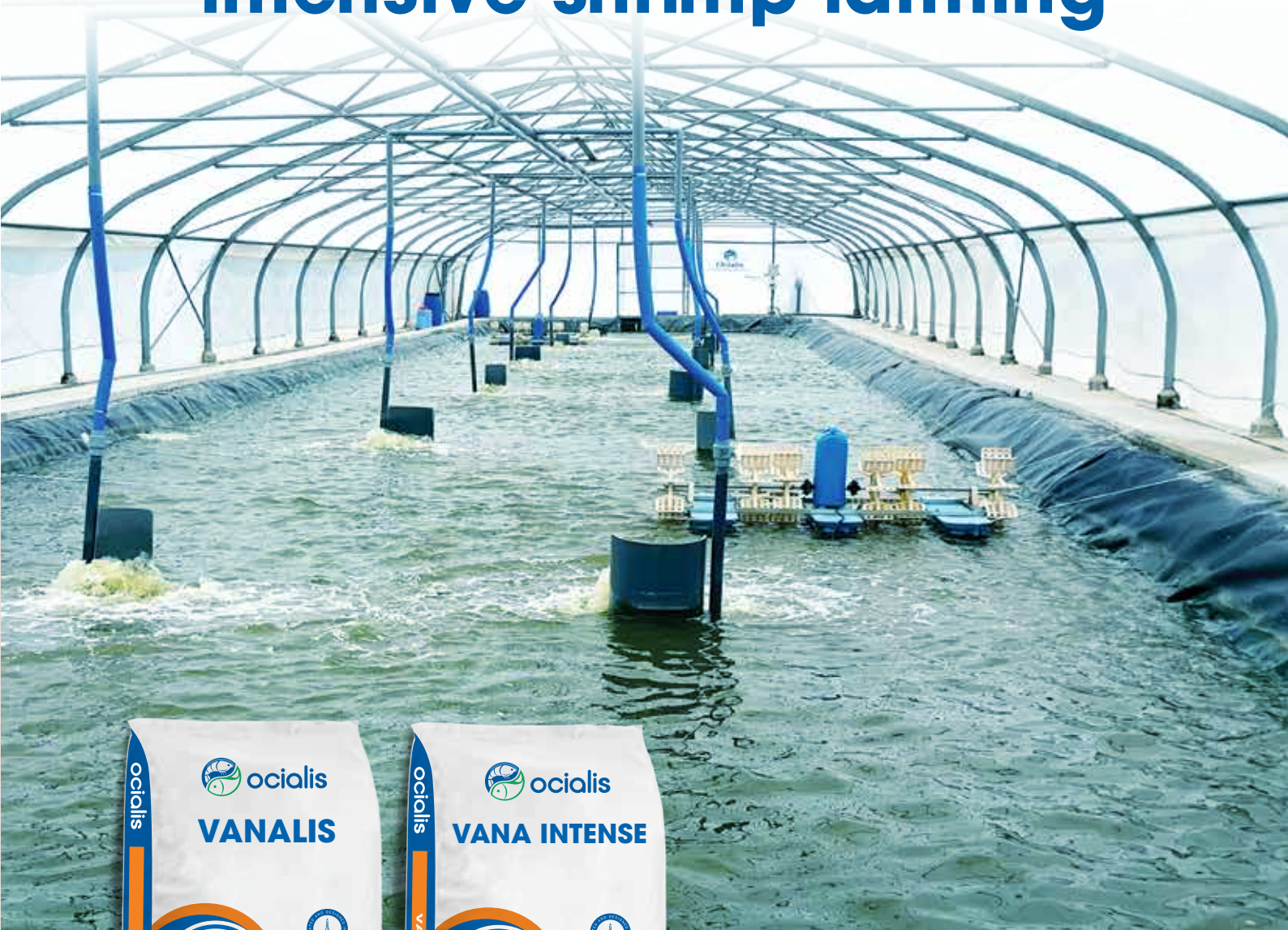
**August 18-19**  
**TARS 2021: Shrimp Aquaculture**  
Ho Chi Minh City, Vietnam  
[www.tarsaquaculture.com](http://www.tarsaquaculture.com)

**September 14-17**  
**SPACE 2021**  
Rennes, France  
[www.space.fr](http://www.space.fr)



# ocialis

## Feeding solutions for intensive shrimp farming



FEEDING SOLUTIONS OF **biosipec**

**Ocialis Asia**  
Unit 2408 - 2411, Floor 24, Saigon Trade Center, 37 Ton Duc Thang Street, District 1,  
Ho Chi Minh City, Vietnam - Tel.: +84 (0) 28 39 11 04 84/ 85/ 86  
Contact: asia.ocialis.contact@adm.com  
www.ocialis.asia

ISO 9001 : 2015  
**GLOBAL GAP**  
NO ANTIBIOTICS USED





Uni-President

# CREATES THE VALUE OF PRAWN



Uni-President implements traceability through all sectors along with supply chain. Biosecurity hatchery produces SPF (Special Pathogen Free) and SPR (Special Pathogen Resistant) larvae. Quality program of prawn feed plants was certified by ISO 22000 & HACCP.



- No.16-18-20, DT743 Road, Song Than II Industrial Zone, Di An Ward, Di An City, Binh Duong Province, Vietnam
- Tel: +84-274-3790811 (Ext: 1711)
- Fax: +84-274-3790819
- Email: aquafeed@upvn.com.vn



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