

AQUA CULTURE

A s i a P a c i f i c

MCI (P) 008/10/2018 PPS1699/08/2013(022974)

ISBN 1793 -0561

MAY/JUNE 2019
Volume 15 Number 3

Dealing with WSD in Thailand

Early weaning: Facts and trends

RAS and feed enzymes

APA'19 show preview

Aquafeed Production constrained by demand



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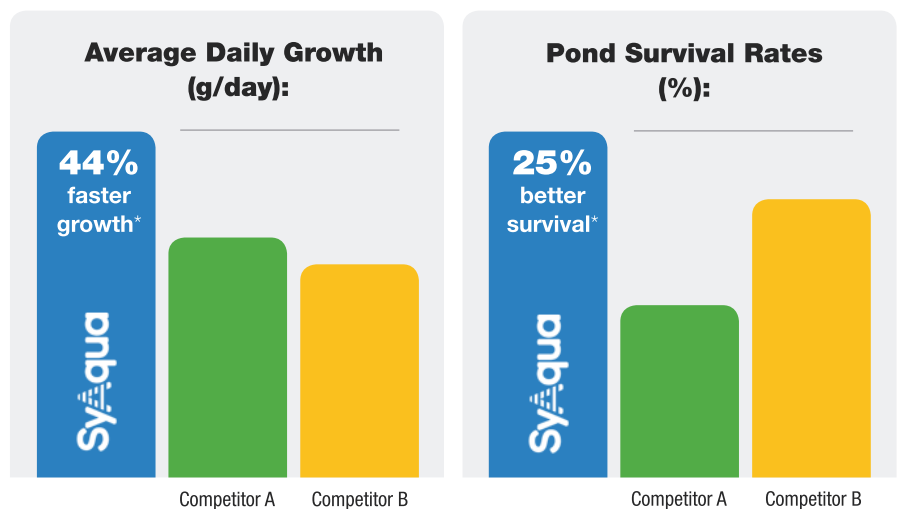
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Feeding vannamei shrimp at PT Delta Marine Indonesia, Sumbawa, Indonesia. Picture provided by Rizky Darmawan.

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AQUA Culture Asia Pacific is published bimonthly by



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3 Pickering Street,
#02-36 Nankin Row,
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Printed in Singapore by

Print & Print Pte Ltd
3011 Bedok Industrial Park E,
#03-2000
Singapore 489977

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Aqua Culture
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Aquafeeds – are we fit for future?



Zuridah Merican

As TARS 2019 approaches around the corner, it is timely to analyse the current feed sector for the aquaculture industry. What are the challenges and is the sector fit for the future?

The aquafeed sector is intricately linked and highly dependent on the farming sector. The past 18 months has seen farm gate prices putting pressure on farmers across all the major species. Coupled with lower survival rates due to disease problems, production costs are increasing, thus limiting the purchasing power of farmers to invest on quality or functional feeds. But aren't functional feeds able to mitigate the very diseases that plague the industry? We have arrived at a Catch 22 situation. Before the feed sector places any blame on the farming sector, it may be wise to review the weaknesses and challenges within the feed sector.

Genetic strains for shrimp have improved significantly over the past decade but feed formulations are based on nutrient requirements from research done in the

1980s and 1990s with the then genetic strains. We know that new genetic strains are capable of ADGs of more than 0.3g per day but to achieve this in commercial ponds, feeds must be designed to meet their higher requirements. Although both monodon and vannamei shrimp are euryhaline, culture conditions at near Oppt and 32ppt require specific feeds which are rarely available today. With increasing use of RAS for the nursery phase, there does not seem to be feeds designed for this life cycle stage and this culture system.

Perhaps the sector with the lowest purchasing power is the freshwater fish sector. Tilapia demand and prices have stagnated over the past 3 years while pangasius supply has to be limited to ensure credible prices. However, freshwater fish nutrition is still stuck in the old school KPI of FCR and feed price. The majority of pangasius is sold as fillet and increasingly so for tilapia and yet we do not advance to formulating for 'feed cost per kg fillet'. Improving fillet yield depends on both genetics and feed. Aquaculture competes with tourism in freshwater bodies. A classic case is in Indonesia where the government is considering banning or limiting fish cage culture in lakes to maintain its pristine environment. Feeds play an important role here and increasing phosphorous efficiency while reducing its output into the water body will certainly mitigate water quality and eutrophication problems.

Growth in marine fish feeds has been limited as Asian farmers concentrate on the live fish market and live with very low survival rates. However, marine fish feeds must advance from its 'one size fits all' strategy. The nutrient requirements of groupers, barramundi and snappers are all different so are feed companies over-formulating for one species while lacking in another?

Finally, there are issues relevant to feed for all aquaculture species. The most glaring may be fish meal replacement on which, shrimp and marine fish feed are still highly dependent. The first wave of protein replacement came from plant meals which were then upgraded to concentrates and fermented products. The new wave now brings insect protein meals and single cell proteins into the picture. The ultimate question is whether the feed sector is able to replace fish meal to 'give the same performance at the same cost'. There is also the question of functional feeds which may cost more but do the benefits justify the cost? Should the farmer or the feed company bear the increase in the cost of adding value in the chain? The jury is still out as functional feed performance is more of an art than a science which leads us to the lack of R&D in this sector. R&D has moved from academia to in-house research but the downside here is always 'mistrust' at the farm level of such data and the results. Basic research is crucial for the next stage of growth in the aquafeed sector and we can see this lacking in the nutrient requirements along the life cycle of all species.

TAR 2019 will not offer solutions to all the issues above but it will create a platform and forum for the discussion. However, it is important that we must first accept that feed is a weak link in the value chain, that we are not fit for future and maintaining the status quo will retard the growth of the industry.

OUR MISSION

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Next level in tilapia farming in Vietnam

Mavin Austfeed has invested heavily in improving the quality and wholesomeness of its aquaculture operation as it targets becoming the country's top producer of premium quality tilapia in 2023, according to Nguyen Anh Tuan, Deputy General Director.

The company took up cage culture of tilapia in 2017, with an investment of more than USD5 million. The fish are reared at the Hoa Binh hydroelectric reservoir which has good water quality such that the tilapia do not have any off-flavour problems. The cage culture system is regulated to ensure that cage culture in the reservoir does not exceed carrying capacity and that producers comply with environmental regulations.

Dr Ngo Phu Thoa, Deputy Director of Mavin Aquaculture said the company is also working with universities and the Penang, Malaysia-based non-profit research organisation WorldFish, to select tilapia that are highly productive and meet customer preferences. Its immediate genetic selection goals are to improve growth, survival and fillet yield.

Tilapia farming can be done all year round in the reservoir; each cycle is 120-135 days. The fingerlings weighing 30g are stocked in round cages and then harvested at 800g. Stocking density is 50,000 fish/cage of 20m diameter. These are Norwegian cage systems. The yield is 30-40 tonnes/cage. Currently, there are 48 cages and the number will be raised to 100 by the end of 2019, said Tuan. In Hoa Binh Lake, Mavin has approval to farm in 100ha of water area with up to 100 cages with a total capacity of up to 10,000 tonnes of red tilapia per year. It is looking at the possibility of replicating the cage culture model at other potential reservoirs in North Vietnam. Sustainable and environmental friendly operations are the keys to Mavin's long-term success, said Tuan.

The company uses a closed-loop supply chain. It enforces stringent quality control and traceability in its breeding and selection program, hatchery, feed manufacturing, grow out, processing, logistics, distribution and marketing. It currently supplies around 6,000 tonnes/year of tilapia.

Genetic improvement of common carp

It plans to introduce new species such as common carp and begin exporting tilapia fillet after it raises production to 10,000 tonnes by the end of 2019. In April 2019, Mavin Aquaculture signed a multi-lateral MOU with Hungary's Research Institute for Fisheries, Aquaculture and Irrigation (HAKI) and Research Institute for Aquaculture No.1 (RIA1) to enhance R&D and approach business opportunities in the region. The three entities will work, among others, on the genetic improvement of common carp, brood stock management, hatching and larvae and fingerling rearing-technologies.

Recently in January 2019, Mavin was officially granted VietGap (VICAS 052-PRO-0021) certificate by Hanoi's Department of Agriculture and Rural Development for aqua products of Hoa Binh Aquaculture Export Project.



Nguyen Anh Tuan (left) and Ngo Phu Thoa. Photo credit: Feed and Livestock Magazine

Mavin Austfeed diversified into aquafeed production in 2016 and with a new aqua feed mill in Hung Yen, south of Hanoi, production capacity rose to 70,000 tonnes/year. Currently, this is the largest aqua feed operation in North Vietnam, supplying the market with around 10,000 tonnes/year and Mavin expects sales to rise to 35,000 tonnes/year. The plant produces primarily carp and tilapia feed. Aqua feed production is separated from livestock feed to eliminate cross-contamination risks. (Source: Feed & Livestock, 2019, vol 13 no 5/mavin-group.com)



Norwegian cage systems are 20m in diameter, yielding 30-40 tonnes/cage. Photo credit: Feed and Livestock Magazine

First taste of commercial shrimp fed traceable protein



Presenting shrimp in various preparations, from left, Allan LeBlanc, Tracy Cambridge, Chef Stephen Parkins-Knight, Allan Shaw and Scott Solar

In May, delegates at Seafood Expo Global in Brussels had the first taste of commercially farmed shrimp fed with protein from natural gas. The shrimp were fed an innovative and sustainable protein, which contains a unique carbon signature that can help the food industry provide traceability and integrity to its supply chain.

This is the joint offer to global seafood buyers by US based Calysta and seafood giant Thai Union Group PCL. Calysta is an innovator in sustainable products to improve worldwide food security. It develops and commercialises FeedKind®, a protein produced from natural gas and an alternative to fish meal ingredient for aquaculture, livestock and pet food markets. Thai Union Group PCL is the world's seafood leader bringing high quality, healthy, tasty and innovative seafood products to customers across the world for more than 40 years.

Fully traceable and zero fish meal shrimp

The pan-fried shrimp served at the Brussels Expo came from a farm in Thailand where shrimp were fed a feed with 11% FeedKind protein, which together with Thai Union's tuna by-products, replaced all of the wild caught fish meal. In this first trial, growth performance of the shrimp was equivalent to shrimp fed a commercial diet. Shrimp were grown over 79 days of culture reaching 70/kg (14g) size. Usually, the farm would be harvesting sizes 41-50/kg or even the larger 21-25/kg. This much earlier harvest was because of the need to have the shrimp ready for this seafood event.

Scott Tarses Solar, Thai Union's Group Director of Global Foodservice and Culinary Development, based in Thailand, assured that all farming factors were kept equal, "For us, in running this trial, it was important to ensure that the farmer followed his usual farming practices. Survival and growth performance achieved were very close to that of shrimp fed commercial diets. We estimate a marginal increase in the cost of production, but really very minimal."

Solar added, "The proof is with the tasting of raw shrimp and I can attest that there was no difference in texture and taste of shrimp fed on diets with FeedKind as compared to shrimp fed commercial diets."

Market pull on sustainability

Presenting this product direct to buyers at this seafood expo is working downstream, influencing the farmer's customers. All is well with the positive review by delegates; texture and taste were similar to shrimp fed commercial diets, usually containing 10-15% fish meal and other protein sources.

On whether there is a market pull for such sustainable and traceable products, Tracy Cambridge, Responsible Sourcing Director, Europe for Thai Union said, "Through very interesting conversations with buyers, in each market whether European or American, we can identify forerunners leading the change for sustainability. Some are innovators and early adopters such as Seafood Watch Monterey Bay, MSC, ASC, while others will wait and see.

"But for us, last year at Thai Union we began to operate under two pillars: innovation and sustainability. With this joint effort with Calysta, we are ticking all the boxes."

Sustainable alternative

As a sustainable alternative to fish meal, this protein also enables shrimp farmers to increase their output to meet growing global demand without putting extra pressure on the planet's natural resources, replacing fish meal from wild fish specifically caught for protein in shrimp feed. Alan Shaw, PhD, President and CEO of Calysta, said, "Thai Union is one of the world's largest seafood producers and, like us, they are committed to improving sustainability and traceability in the shrimp farming industry – making this partnership a significant moment for the seafood sector.

"Calysta's aim is to help create a future where the world's growing population has guaranteed food security. By introducing a sustainable alternative protein that allows us to determine whether a shrimp was fed FeedKind protein with a simple test, FeedKind offers the industry a new level of transparency.

"Today, we see tremendous inroads in the seafood sector. Earlier, we have been communicating on safety studies with FeedKind. We think the farmed shrimp is a huge market opportunity for us and should work to eliminate some bad practices and work on traceability and sustainability in the sector."

Shaw elaborated on how FeedKind combines both sustainability and innovation. "One tonne of FeedKind contributes 72% of crude protein. It does not take anything out of the food system. It is the gold standard for the future.

"There are many competitors with alternatives to replace fish meal in the market. The difference is the level of scale-up. For a global seafood producer like Thai Union, it will need sufficient quantities of any protein ingredient. Calysta's advantage relative to other new proteins in the market is that it allows for easy scale-up."

Allan LeBlanc, Product Manager for FeedKind Aqua, said, "This protein has a similar amino acid profile to fish meal, is highly digestible and can be incorporated into diets across all life stages. Prior to this commercial trial, we initially conducted laboratory studies at Texas A&M followed by several tank trials by Thai Union Feed Mill to validate FeedKind's performance. Growth response and survival in shrimp fed graded levels of the protein continues to be equivalent to fish meal-containing reference diets in the hands of multiple partners. As a reliable and traceable feed ingredient, FeedKind protein can be used by producers like Thai Union to increase consumer confidence in their supply chain."

Innovating to bring greater traceability

Darian McBain, PhD., Global Director of Corporate Affairs and Sustainability at Thai Union, said, "Aquaculture is key to providing a sustainable form of protein for the growing global population. It is vital to ensure that the feed inputs and the production methods are sustainable".

"In line with our SeaChange® sustainability strategy, Thai Union is always looking for innovative ways to bring greater traceability and more sustainable products to market. Working with FeedKind, we are able to offer shrimp that have been grown using feed that has completely replaced the fish caught for fish meal with an innovative alternative protein. The fact that the protein has a unique carbon signature that helps provide traceability and reduce seafood fraud are other significant benefits."

Fishing activities associated with the production of fish meal for feed have been associated with unsustainable practices. For example, fish caught are sometimes from illegal, unregulated



and unreported (IUU) fishing; the fisheries may be unsustainably managed or working conditions on vessels can lead to human rights abuses. By eliminating this proportion of the shrimp feed, in addition to making use of fully traceable tuna by-products, a leap forward in sustainable shrimp production has been made.

Calysta's FeedKind is made via a patented natural-gas fermentation platform. Made using very little land and water by fermenting natural gas, an abundant source of energy, it is a safe, nutritious, traceable and price competitive protein which has been commercially validated through extensive trials.

Related article: Applications of a single cell protein in the culture of whiteleg shrimp by Allan LeBlanc and Josh Silverman, Aqua Culture Asia Pacific, January/February 2018, p42-43

IN BRIEF

F3 Challenge prize money doubles

The F3 Fish Oil Challenge is an incentive prize designed to help accelerate commercial-scale ingredients for aquaculture feed that meet the nutritional requirements of fish to produce healthy seafood for consumers without utilizing wild-caught fish. This prize has doubled thanks to a donation of USD100,000 from the sustainable aquaculture investment fund Cuna del Mar. The competitor who sells the most "fish-free" fish oil for aquaculture that meets the challenge criteria will win the USD200,000 grand prize. "Finding alternatives to wild-caught fish is essential for the future of aquaculture," said Christy Walton, founder of Cuna del Mar. "We are excited to be part of this global effort by industry leaders to make fish-free animal feed a reality."

As of the second sales reporting period, the four competitors have collectively sold 210,265kg of F3 oil during the contest. Veramaris remains in the lead with the most oil sold. The four global competitors China's Guangdong Evergreen Feed Industry Co. Ltd., and Shen Zhen Alpha

Feed Co. Ltd., Netherlands-based Veramaris and the UK/U.S.-based team Aquaculture Innovation/Qualitas Health.

The University of Arizona, University of Massachusetts Boston, Synbiobeta, Anthropocene Institute, Dawson Family Fund, Sustainable Ocean Alliance, The Nature Conservancy, The Campbell Foundation, Tides Foundation and The National Renderers Association are sponsors of the crowdfunded prize, now joined by Cuna del Mar. The contest is sponsored by Future of Fish Feed (F3), a collaborative effort between NGOs, researchers, and private partnerships to accelerate and support the scaling of innovative, alternative aquaculture feed ingredients.

Driving improvements in Indonesian aquaculture

Aquaculture Stewardship Council (ASC) and Fair Trade USA will implement an ambitious new project funded by the Walton Family to drive improvements in the aquaculture sector in Indonesia. Roy van Daatselaar, Producer Support

Manager and project lead for ASC said, "Collaboration is an integral part of the ASC programme. This project will draw on the complementary strengths of our two organisations to bring lasting benefit to the local community through initiatives that will lead to better outcomes for the environment and those that work on, and live near, the participating farms. We are grateful to The Walton Family for making this ambitious project possible."

The two organisations will combine their access, knowledge and experience to encourage improvements in the environmental and social impacts of Indonesian aquaculture. They are working collaboratively to explore ways to streamline joint certification, help update farming practices, and encourage greater responsibility. ASC and Fair Trade USA will also collaborate with Indonesia's Ministry of Marine Affairs and Fisheries (MMAF) to support further development of the local IndoGAP standards and policies. The collaboration will help streamline the approach to implementing more responsible aquaculture practices in Indonesia.



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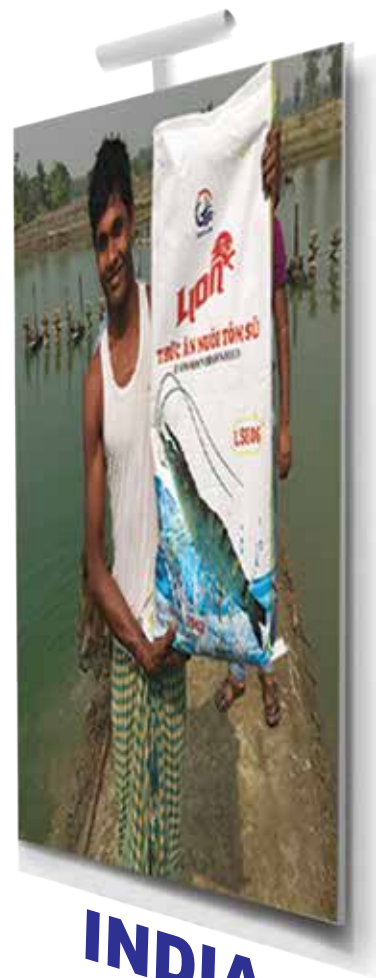
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Dealing with white spot disease in Thailand

Present since 1992, combating the white spot syndrome virus is a combination of early detection and managing risk factors.

By Jumroensri Thawonsuwan

White spot disease (WSD) has a 25-year old history in Asia's shrimp farming industry. It was first reported in 1992 in Taiwan and more recently, in Mozambique (2011) and Madagascar (2012). As we know, Australia has very strict biosecurity measures and yet it reported a massive outbreak in 2016. This demonstrated the difficulty with handling the disease.

In Thailand, WSD was first recorded in 1994, the same year, that I, as a third-year student in university, was working on the histological study on the white spot syndrome virus (WSSV) in black tiger shrimp *Penaeus monodon*. Today, more than 20 years later, the disease continues to be a major threat to industry in Thailand, as well as globally.

At the farm level, Thai farmers are experienced enough to diagnose a WSSV infection. They are familiar with the first signs of WSD when shrimp are not moulting and are lethargic; they show decreased or no feed consumption and abnormal swimming behaviour, i.e. slow swimming, swimming on the side, swimming near water surface and gathering around edges of ponds. Most farmers in Thailand have a field kit for WSSV detection which will then help them to decide on how to manage their shrimp before white spots appear on shrimp carapace. When white spots are seen on shrimp, it will be difficult to control and manage, and likely to lead to a major crop loss.

Farms send suspected samples for diagnosis to any of the laboratories of the Department of Fisheries (DOF). A significant sign of the disease is that the body of the shrimp turns a pink colour, but this is not always the case. Sometimes, there are no signs, i.e. no colour change or white spots on the body but there is still a presence of the virus. There may be some effective protocols in dealing with WSD but even so, it has been very difficult to apply and get consistent and good results.

WSSV

What is now known is that WSSV is a double-stranded DNA virus, measuring 80-120nm in diameter and 250-380nm in length (Durand et al., 1997). It has a large genome size compared to other pathogens and this may be a reason for the difficulties in dealing with the disease. The genetic variety of WSSV causing outbreaks in Thailand, China and Taiwan are the same, with a nucleotide identity of 99.32% but today there could be changes in genetic variety.



Physical agents	Inactivation conditions
Heat	55°C for 90 min, 70°C for 5 min 50°C for 60 min, 60°C for 1 min; 70°C for 0.2 minw
UV light	Total of $9.30 \times 10^5 \mu\text{Ws}/\text{cm}^2$
pH	pH 1 for 10 min, pH 3 for 60 min or pH 12 for 10 min
Ozone	Total residual oxidants concentration of 0.5µg/mL for 10 minutes
Chemical agents	Inactivation conditions
Chlorine	sodium hypochlorite at 100ppm for 10 min and 10ppm for 30 min
Iodine	povidone iodine at 100ppm for 10 min and 10ppm for 30 min
Quaternary ammonia	benzalkonium chloride at 75ppm for 10 min

Table 1 Inactivation conditions for WSSV

“ This wide genetic variety of WSSV in Thailand probably makes it difficult to treat the disease.”

Table 1 shows that the WSSV agent can be inactivated by both physical and chemical ways. However, even though these methods to inactivate the pathogen can be applied to infected shrimp, it is very difficult to execute these treatment protocols. Physical and chemical inactivation of the virus can be applied easily in hatcheries but not in the grow-out facilities in farms.

Genetic variety

There are some studies by researchers from universities in Thailand, working on samples of WSSV causing infections from 2007 to 2014 from eight provinces. Genotyping analysis was done for 124 WSSV isolates from cultured Pacific white shrimp *Litopenaeus vannamei*. At least 33

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genotypes of WSSV were analyzed based on 3 VNTR loci, indicating that the VNTRs of WSSV genome are highly variable. The many different WSSV genotypes shown in this study as compared to previously reported genotypes in Thailand document the current status of disease epidemiology, as well as probable movements of WSSV between countries. This wide genetic variety of WSSV in Thailand probably makes it difficult to treat the disease.

In 2018, a new strain of WSSV infecting *L. vannamei* was reported in shrimp farms in India (Sivakumar et al. 2018). India may be the main source of WSSV in *vannamei* shrimp in Iran where movements of the virus probably occurred via importation of live post larvae from India.



WSSV in *Litopenaeus vannamei* in India.
Source: CIBA Extension Series No. 51

WSSV transmission

It is well known that many shrimp species are susceptible to WSSV infections. This may be the reason why it is very difficult to deal with WSSV which can be transmitted both horizontally and vertically. Vertical transmission can be dealt via the genetic pathway, but horizontal transmission is difficult to deal with at the farm level. Horizontal transmission is via ingestion; $10^{7.54} - 10^{8.03}$ infectious viruses are needed to infect shrimp by peroral inoculation and via feeding. A homogenate of WSSV infected shrimp is highly infectious when injected into shrimp, whereas it is minimally infectious via oral route (Thuong et al., 2016).

Risk management

The major route for disease transmission comes from several sources - broodstock, post larvae and the carriers of vectors: water, farm workers, equipment used in the farm, sediment and waste. It is important that the culture management cover all these risk factors. Managing these risks (Figure 1) requires biosecurity measures which may look easy but is very difficult to be workable at the farm. Good biosecurity can support animal welfare, farm productivity, environmental sustainability, product quality, trade and profitability.

An example of biosecurity implementation is given in Figure 2 which is based on a system in Australia. Here there is a separation of the farm into three levels. The first is entry-level biosecurity to reduce the risk of diseases being introduced into the



Figure 1 Risk factors for white spot disease (WSD)

farm. And next is the internal biosecurity, mainly to reduce the risk of diseases spread within the farm and to other farms. Lastly, is external biosecurity or exit-level biosecurity. This is to reduce the risk of diseases escaping from the farm to other farms.

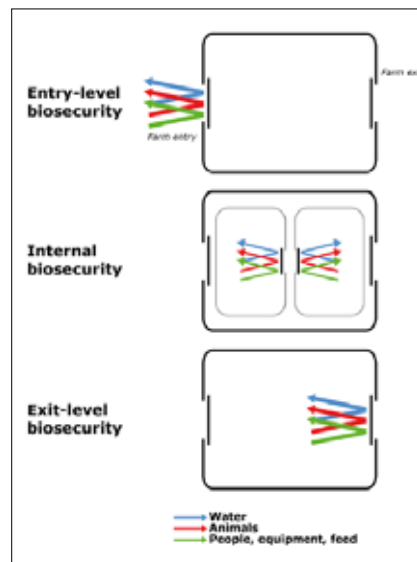


Figure 2 Biosecurity levels of farm
(Source: Aquaculture Farm Biosecurity Plan, © Commonwealth of Australia 2016, with permission.)

Entry-level biosecurity

With regards to entry-level biosecurity of the farm, using post larvae from specific pathogen free (SPF) source is crucial but screening for WSSV is still essential. In Thailand, there is the mandatory standard for disease free nauplii for farms called GAP-TAS Thai Agricultural Standard 7432. This is the first mandatory standard for all *L. vannamei* hatcheries in Thailand producing nauplii. This certification is required to proceed with all operations and is linked to screening of nauplii for pathogens. There is an active surveillance programme at the Songkhla Aquatic Animal Health Research Center (SAAHRC). All farms must participate in the active surveillance programme operated under DOF.

This is important as we found that an outbreak of WSD occurred within 3 weeks in ponds stocked with post larvae from heavily infected nauplii. Only ~20% of the initial population survived through to harvest. The survival of shrimp from either lightly infected post larvae or WSSV-negative nauplii was 70-80%.

To do this, the centre collects samples; broodstock, larvae and some live feed used in the farm are brought to the laboratory and tested. In this way, the stocks are not contaminated with any disease prior to stocking. Up to August 2018, there are 58 farms accredited with this standard. Farms have standard operating procedures (SOP) and they must prepare a biosecurity manual in their farm. When some outbreaks occur in farms, farmers must apply or follow the biosecurity protocol derived in their manual. These are activities in a standard farm, but small farms may not have the capacity to undertake these measures. Building up a low-cost biosecurity facility for small farms is crucial in the fight against WSSV.

Diagnostic services

To support this standard, DOF has diagnostic service laboratories. Along the coastal belt there are 20 laboratories, all equipped with conventional PCRs and 9 have both conventional PCR and qPCR. SAAHRC is a reference laboratory which has ISO/IEC 17025:2005 accreditation since February 2008 by the Bureau of Laboratory Quality Standard (BLQS), Department of Medical Sciences, Ministry of Public Health. Once a year, there is the proficiency testing by the University of Arizona, USA and a ring test for all 20 laboratories.

Screening for WSSV in post larvae, diagnostics and access to services are very important. In Thailand, these are available for farmers, but of concern are methods available and the sensitivity of the method used - PCR vs qPCR. Another aspect of post larvae management is to reduce the virus numbers by using temperature control. We suggest that hatcheries keep their post larvae at 32°C for 7 days in the hatchery before it is sold to the farm, to reduce WSSV. Another recommendation is to nurse post larvae in a nursery, housed in greenhouses before they are released into ponds.



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In terms of the most effective method for WSSV diagnosis, Leal et al. (2013) reported that the two-step PCR produced the most sensitive results for reactions with higher concentrations of shrimp DNA (>150ng) and qPCR showed best performance with low DNA concentrations (<150ng). The standardized FAM-BHQ1 qPCR protocol is a fast, robust and viable tool to diagnose WSSV in clinical samples and is a good alternative to the two-step PCR, as sometimes there are some small particles of WSSV which cannot be detected with the latter. In summary, the method used for the screening of post larvae is very important.

Implementation of farm level biosecurity

Currently, the use of live feeds such as polychaetes is important for broodstock culture. PCR screening of live feed is vital, or the alternative is to use the live feed from a GAP (good aquaculture practices) farm. In Thailand, there are farms culturing polychaetes where the standard is no WSSV contamination. The problem in the industry is that some hatcheries prefer polychaetes collected from the wild which carry high risks of a WSSV infection. The industry should have a standard PCR test but again, we are not quite sure that all users will screen all polychaetes used.

Control of the many WSSV carriers and vectors in the farm is a normal practice. It is also an inter-farm matter. Common practices are water filtering for all farms in Thailand as is bird prevention using nets. Crab prevention fences and other devices are normal for medium and large-scale farms but often absent in small scale farms. The efficacy of water management in farms is dependent on the system used. Another risk factor is, people coming in and out of the farms - staff and farm workers, visitors and harvesting teams, who may introduce pathogens through skin, clothing and footwear. Strict rules are required for them when entering the farm.

Table 2 gives some guidelines on managing risks with people transmitting pathogens. Any equipment and vehicles entering the farm should be assessed for biosecurity risks, and procedures and infrastructure should be in place to clean and disinfect them. The farm should have designated delivery and loading areas. Equipment used in multiple production units, should be cleaned and disinfected prior to movement between units. This includes equipment for grading during harvest and feeding equipment which should be separated between ponds. Again, these practices are common in the medium and large-scale farms, but for small farms, there are some challenges with the application of most of these practices.

Exit level biosecurity

With regards to exit level biosecurity, there was a case control study in Thailand to

1. Staff and visitor access should be managed (through access controls and signage) and the risk they present should be assessed.
2. The farm biosecurity rules should be explained to all visitors.
3. Measures to prevent disease entry should be applied to all persons entering and leaving the farm (for example, dedicated changing areas, farm footwear and hand washing facilities), and for persons moving between production areas of different disease status within the farm.
4. Access to sensitive areas (for example, broodstock units) should be restricted.
5. Production units should be managed separately to reduce the risk of disease spreading within the farm. Staff should be assigned to production units based on risk.
6. If staff must work in multiple production units, higher health animals should be visited first and lower health or diseased animals last, with appropriate cleaning and disinfection protocols followed between visits.
Source: Aquaculture Farm Biosecurity Plan, © Commonwealth of Australia 2016, with permission.

Table 2 Guidelines to manage the risk of people transmitting pathogens

check the risk factors of WSD in farms. Even if only one infected shrimp was detected at a farm, the farm was categorized into the high risk group. They found that WSD outbreaks in previous crops are the most important factor of this study. Sources of outbreaks include shared water resources, sediments and wastes. Decontamination of water and managing waste are important. Containment, handling and disposal of waste products will minimize the spread of WSD.

Culture management

To avoid WSSV, the advice is to avoid stocking ponds during the cold season as well as overcrowding shrimp in ponds, since these are WSSV replication triggers. However, some farmers wish to continue farming during the cold season. Farms should also minimize the number of active ponds so that farmers can spend more time on farm biosecurity and obtain the best benefit. When a WSSV (viral) outbreak is suspected, the farm must quarantine the suspected pond. Next, is to stop all traffic, people, trucks and cars from moving across the infected pond, sampling or casting nets for shrimp size and collecting environmental data. It is also important to ensure that the remaining ponds increase the carrying capacity by increasing the dissolved oxygen by adding aerators and operating to maximum capacity. Farms should not wait for the results of the PCR tests because it may be too late.

When a WSSV outbreak is suspected at less than days of culture (DOC) 45, it is important to assign a staff at the pond site for 24 hours, fence off the pond with 'Do not enter' signs, ensure all inlet and discharge gates are secured with no leakages. Pond water should be disinfected with the aeration running. After ensuring that all shrimp are dead, stop the paddle wheel aerators but leave paddle wheels in the water for at least 7 days until the shrimp become red. Dead shrimp should be burned or buried and the water level should be left as is for 2-3 days. The paddle wheels should be disinfected with chlorine and left to dry.

In summary, the farm level biosecurity to control WSSV starts with the use of clean



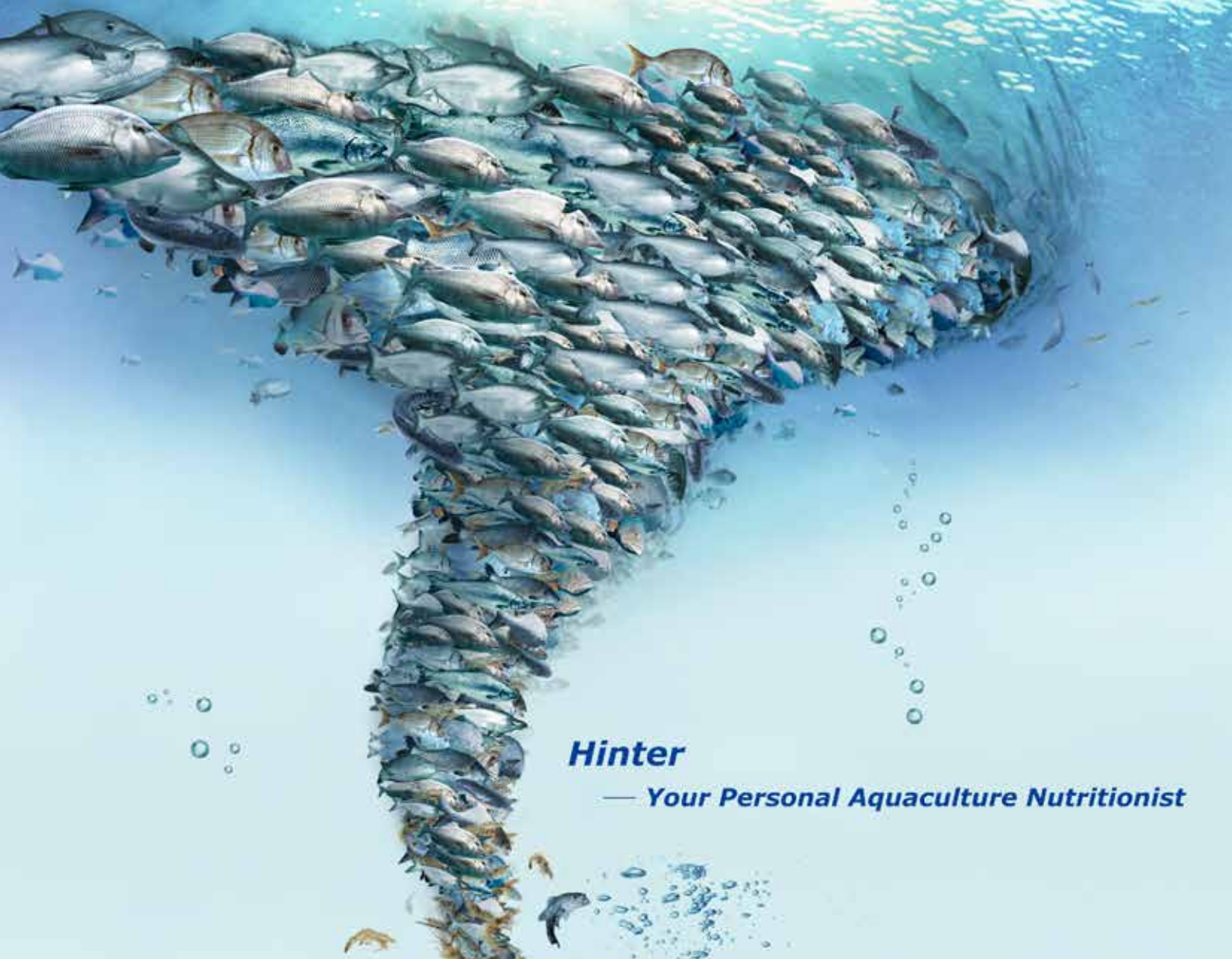
Common practices in Thai farms are bird prevention nets and crab prevention fences. These are normal for medium and large-scale farms but often absent in small scale farms.

SPF post-larvae, use of a reservoir module water treatment system and implementation of the farm SOP well. Physical structures for biosecurity such as crab fences and control of worker and visitor movements, will reduce contamination. Chemicals are used to disinfect all equipment, including screen nets and cast nets. All equipment in operation must be disinfected. But most importantly, is the education on biosecurity in the farm.



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This article is based on a presentation titled, "Good Management Practice Dealing with White Spot Diseases (WSD)" presented at the Post TARS 2018: Shrimp Aquaculture – Need for Change Session on Disease Management, 17 August 2018, Chiang Mai, Thailand.



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Krill - shrimp farming's super ingredient

Antarctic krill, a shrimp-like swarming pelagic crustacean, is receiving increasing attention from forward-thinking aquaculture companies. Krill meal is proven to improve both yield and stress resistance, without increasing production costs.

By Atul Barmann



A natural source of protein and nutrients

Euphausia superba is a small shrimp-like crustacean with big black eyes and a reddish, semi-transparent shell. While only around 6cm in length, they often aggregate in large, dense swarms stretching for kilometres. They represent one of the largest biomasses on earth, estimated at 500 million tonnes. *Euphausia superba* is the dominant krill species in the icy cold waters of the Southern Ocean surrounding Antarctica. Krill use their specialised filtering apparatus in their front legs to help them feed on microscopic algae. Because of this algal diet, Antarctic krill are rich in phospholipid-bound omega-3 fatty acids, the building blocks of cell membranes. They offer the ideal omega-3 delivery system for shrimp production.

Harvested in the wild, krill meal is prepared from an aqueous extract of ground whole Antarctic krill that are cooked and dried. The resulting brownish-orange powder contains around 60% protein, with a nutritionally well-balanced amino acid profile. This makes it an ideal feed ingredient, suitable for various species of shrimp.

Why shrimp prefer the krilliant taste of *Euphausia superba*

Various different attractants are typically used to stimulate shrimp to feed. Krill meal is itself a natural attractant, and as a chemostimulant helps increase the duration shrimp spend feeding, and by connection the amount eaten. Rich in chitin from the exoskeleton, and soluble compounds, such as trimethylamine oxide, krill also contain free amino acids and nucleotides like proline, glycine and glucosamine. This combination, naturally found in Antarctic krill, is proven to increase both feed attractability and palatability, especially in diets low in fish meal. There is an increased need to reduce inclusion of fish meal in diets, since availability stagnates, while aquaculture production has been increasing steadily. Replacement of fish meal with soybean meal is a possibility to increase cost-effectiveness and sustainability of shrimp diets. However, the different nutrient profile, reduced palatability and anti-nutritional factors of soybean meal can cause impaired growth performance. This can be addressed by adding krill meal to the diet.

For example, adding just 2% krill meal to a diet containing 7.5% fish meal delivers the same growth benefits to *Litopenaeus vannamei* as a 20% fish meal diet. Containing 25% fat and 58% protein, Antarctic krill can replace fish meal, fish oil, plant-derived lecithin and cholesterol, without affecting the final shrimp body weight. The feed attractants in krill meal are proven to increase growth performance of shrimp fed fish meal-based diets, but also in diets based on plant or animal by-products protein.

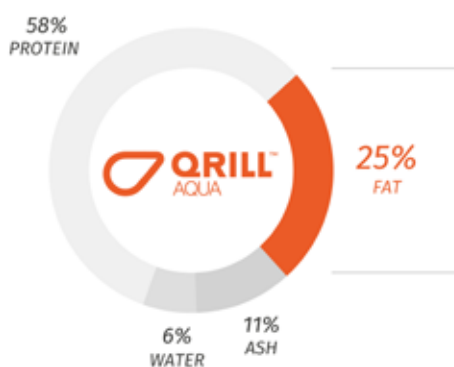
Performance highlights

Among different feeding effectors commercially used in shrimp feeds (betaine, hydrolysates, squids and crustaceans), crustacean and krill meal are proven to be the most efficient drivers of feed intake in black tiger shrimp *Penaeus monodon*. A 6-week growth experiment showed that juvenile shrimp grew 20% faster with the inclusion of 5% krill meal (Smith et al, 2005).

Adding krill meal to a diet increases the number of pellets eaten by the shrimp *L. vannamei* in a concentration-dependent manner by promoting longer, rather than faster consumption (Derby et al, 2016). The study showed that the addition of 6% krill meal to pellets significantly increases consumption by 29% within 1h. After 3h, 6% krill meal increases pellet consumption by a staggering 69% over the control group.

Dealing with stress

It is an established fact that osmotic stress leads to slower shrimp growth, poor feed conversion ratio and lower survival. What is less well known is that the omega-3 phospholipids naturally present in krill can play a key role in the osmoregulation process.



Percentage of fat

Phospholipids	≥ 40%
Total omega-3 fatty acids	≥ 20%
EPA	≥ 10%
DHA	≥ 5.5%
Total omega-6 fatty acids	< 2%

Typical values



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Shrimp depend on dietary phospholipids, especially in larval and juvenile stages, for building cell membranes, lipid digestion, transport in plasma lipoproteins, and cell signalling. They are especially important for shrimp growth as they improve the shrimp's ability to resist stressful conditions (such as low oxygen concentrations, moulting, rapidly changing water temperatures, or high salinity).

The omega-3 phospholipids present in krill meal assure that fats (cholesterol and triglycerides) are efficiently emulsified, digested and stored in the hepatopancreas to be mobilised when needed. A number of studies showed that having sufficient energy stored as fats that can be mobilised for transport to tissues, is of particular importance in overcoming stressful environmental changes (Gong et al, 2004).

Astaxanthin krill oil can mitigate salinity effects (44g/L water salinity) by improving osmoregulation capacity and growth performance. It was tested in a 9-week study comparing three lipid sources (Castro et al, 2017). The results showed that shrimp grew less when fed soybean or fish oil diets compared to those fed the astaxanthin krill oil diet. While higher water salinity reduces the shrimp final body weight when compared to lower water salinity, the astaxanthin krill oil group reached final body weights that were statistically higher than those of soybean and fish oil diets at high water salinity.

Quite simply, shrimp just like the taste of krill. In diets low in fish meal, krill meal's feed attractants increase palatability and improve growth performance. The result is enhanced shrimp growth and yield, meaning shrimp spend less time in the ponds and get to market faster.



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Early weaning in larvae: Facts and trends

By Wilson Pinto, Sofia Engrola and Luís Conceição

Billions of rotifers and *Artemia* are required daily to sustain the aquaculture production of marine fish worldwide. Live-prey brings many benefits for fish larvae at early stages, with larval performance and ease of tank cleaning being its top advantages. However, live-prey such as rotifers and *Artemia* have sub-optimal nutritional value, and live-prey are also potential vectors for pathogenic agents that affect predictability in larval production.

Therefore, the production of high quality microdiets has been a priority for many aquafeed producers during the last few decades. Earlier weaning is becoming a reality for many cultured species, following the progress made in nutrition research and the development of microdiets to sustain fast larval growth and high survival.

At first feeding, the larvae preying capacity is extremely limited; therefore the physical properties of microdiets in water are of high relevance. Criteria such as the dispersion at surface and buoyancy will assure uniform distribution of particles along the water surface, allowing larvae to prey throughout the day. However, an adequate nutrient supply becomes more difficult in smaller particles (100-200µm), as these microdiets tend to leach important water-soluble nutrients due to the high surface-to-volume ratios of these diets.

Despite these difficulties, significant technological R&D efforts have led to noteworthy progresses in microdiets targeting relevant species cultured in Europe, such as the Senegalese sole, greater amberjack, as well as meagre and

gilthead seabream. Knowledge attained from these species can be translated to similar species reared in Asia.

Early weaning in Senegalese sole: a case study for flatfish

Senegalese sole (*Solea senegalensis*; Figure 1) larviculture is an interesting case-study; protocols were successfully established for this species, and are nowadays fairly standardised, with 1g juveniles being routinely produced with fast growth and high survival rates. However, these achievements are quite recent and some challenges still remain, like early weaning as early as the mouth opening stage. During the last decade, a huge research effort was done on the improvement of weaning protocols and on the development of a suitable microdiet that would meet larvae nutritional needs.

Ten years ago, it was standard procedure to wean sole by age (not weight) in a co-feeding strategy. This strategy was not promoting sole digestive maturation and high mortality was commonly observed. The

sole weaning survival and weight increased when feeding protocols incorporated concepts such as sudden weaning, but only when applied after the larvae reach 5 to 10mg dry weight (DW). If larvae presented less weight a co-feeding strategy was a better option.

After these modifications with the weaning protocols, sole weight and survival rates were greatly improved, and gave room to new avenues to pursue, like feeding an inert diet at mouth opening in a co-feeding strategy. Live feed nutritional composition is considered as sub-optimal for Senegalese sole larvae in terms of protein quantity and quality. Using a microdiet to supplement live feed in a co-feeding strategy was a solution to better meet sole nutritional needs. The research (formulation and production technologies) for a commercial microdiet to be offered at mouth opening in sole was mostly done in the last few years. Nevertheless, the first results are very promising for an eventual drastic reduction or even a total replacement of live-prey at mouth-opening.

In recent years, two trials confirmed the progress in Senegalese sole weaning. In

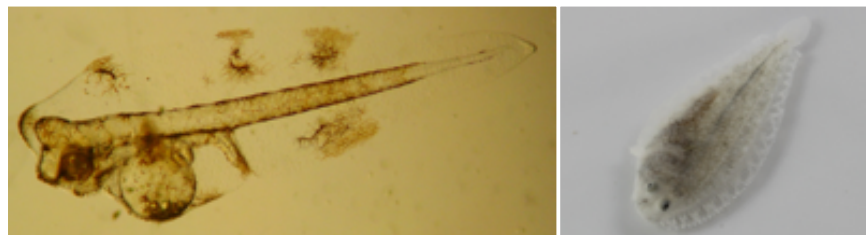



Figure 1. Pelagic (left) and newly-settled (right) Senegalese sole (*Solea senegalensis*).




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the first trial, larvae were co-fed a commercial diet immediately after settling (16 days after hatching; DAH), receiving only 20% of the *Artemia* provided to a control treatment until 23 DAH. Larvae from the control treatment were suddenly weaned at 25 DAH, mimicking a potential commercial feeding protocol. At 60 DAH, dry weight in the co-fed larvae was 25% higher than in the control treatment (184 vs 137mg). Survival was also higher in larvae fed on the microdiet at an earlier age (73% vs 56%).

In the second trial, an even bolder weaning strategy was adopted, with first-feeding larvae being co-fed a commercial diet and only 65% of the *Artemia* provided to the control treatment. At 58 DAH, no differences were observed between treatments in larvae dry weight (co-feeding – 181mg vs control – 148mg) or survival (co-feeding – 34% vs control – 46%). These experiments showed that Senegalese sole benefits from an early introduction of high quality microdiets in the feeding protocol (Figure 2). However, it is also clear that weaning at first feeding will only be possible at a commercial scale when larval survival reaches higher levels. Hence, increasing diet availability in the pelagic phase is mandatory by optimising the physical behaviour of particles in water. Designing microdiets with a reduced leaching of water-soluble nutrients also seems the way forward, with microencapsulation being the foremost eligible technology to surpass the extra mile in larval feeding.

Early weaning in pelagic fish larvae

Here we show how microdiets based on optimised formulations and technology bring better performance. Early larvae of meagre (*Argyrosomus regius*) and greater amberjack (*Seriola dumerili*) have recently been shown to require microdiets with a high lipid content. In a weaning trial of meagre at 20 DAH, the growth was 20% higher when a high lipid (22%) diet was fed over a period of 26 days, compared to a microdiet with a very similar formula except for the lower lipid level (16%). Moreover, survival was also higher in meagre larvae fed the high lipid microdiet. In greater amberjack, results from two trials showed that a microdiet with high lipid levels led to an increase in fish weight from 20 to 40% compared to a commercial diet with lower lipid level. These results suggest that for at least some species, microdiets for early larval stages should have higher lipid content than is normally used at commercial level.

A recent attempt to attain earlier weaning in gilthead seabream (*Sparus aurata*) led SPAROS Lda to create a novel microencapsulated prototype to reduce leaching of water-soluble nutrients. Such prototype was able to reduce leaching of water-soluble protein by 65% following 2h of immersion (Figure 3). Given this achievement, this prototype was included in a commercial diet formulation and tested in

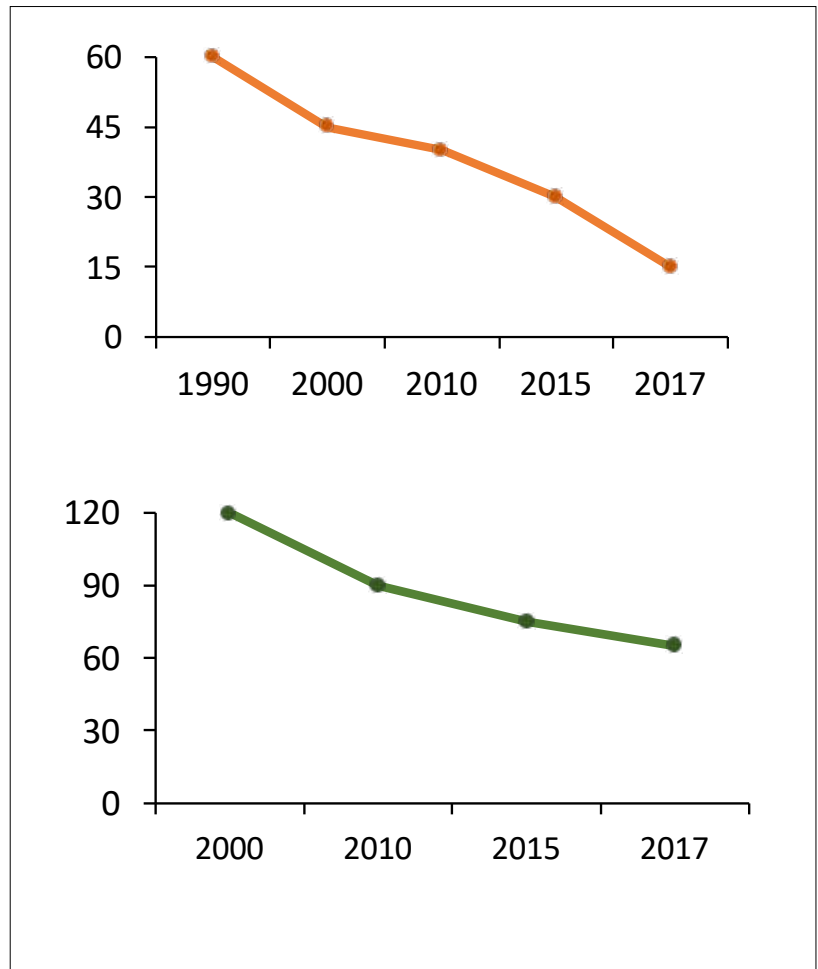


Figure 2. Evolution of age (DAH) to start weaning (top) and days to reach 1 g (bottom; wet weight basis) of *Solea senegalensis*, as a consequence of progress made in microdiet quality during the last decades.

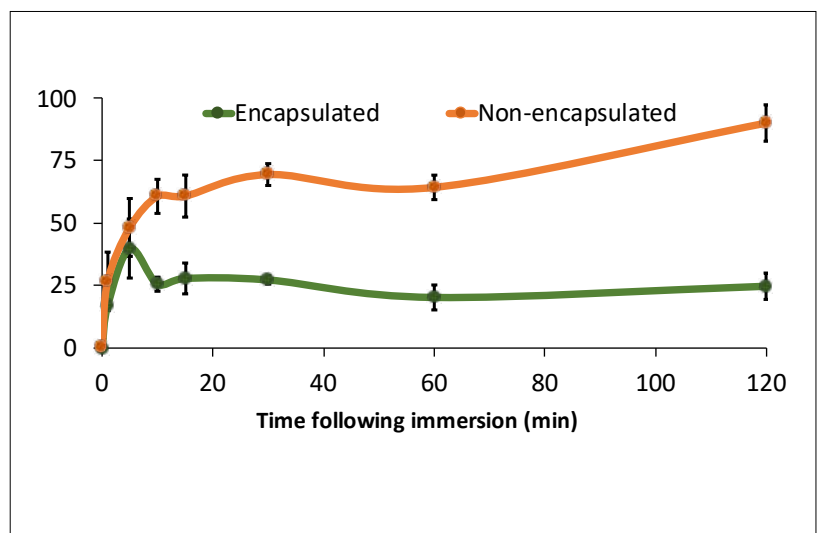


Figure 3. Leaching of water-soluble protein (%) by encapsulated and non-encapsulated prototypes produced by spray-drying technology.

gillhead seabream larvae from mouth opening onwards.

The larvae were co-fed with live prey and inert diet at mouth opening. Three diets were tested, a commercial and two experimental (8.5 and 30 % of novel microencapsulated prototype). The feeding protocols were adjusted to include approximately only 50% of live prey (rotifers and *Artemia*), and the inert diet was offered close to satiation, based on predicted maximum growth and on visual assessment to avoid water quality deterioration. Gillthead seabream larvae of 12 DAH were able to eat the inert diets (visual assessment), and even with the presence of live prey in the rearing tanks, a higher number of larvae was observed with inert diet in the gut than with live prey. It was possible to observe the impact of a diet on larvae weight (Figure 4). Larvae fed the experimental diets with novel microencapsulated prototype (8.5% and 30%) were larger than the larvae fed the commercial diet. This is an indication that there is room for feed technology to bring further improvement in early weaning in marine fish larvae.

Future trends

Recent progress in larval microdiets and feeding protocols is impressive. Hopefully fish larvae requirements will be better understood in the coming years. The industry and the research community are increasingly aware that early nutrition is a key factor in defining larval and juvenile quality. Moreover, sub-optimal nutrition at the early life stages may have long term effects on growth potential, deformities and resistance to stress and disease. The foreseeable benefits in investing in larval nutrition research largely justify the investment that is needed. When our understanding of larval nutritional requirements progresses together with new microdiet technologies and novel highly digestible ingredients, the result will be high performance microdiets for the early stages of fish, including first feeding. This will bring shorter production cycles and higher quality fish to be available for stocking in tanks/cages.

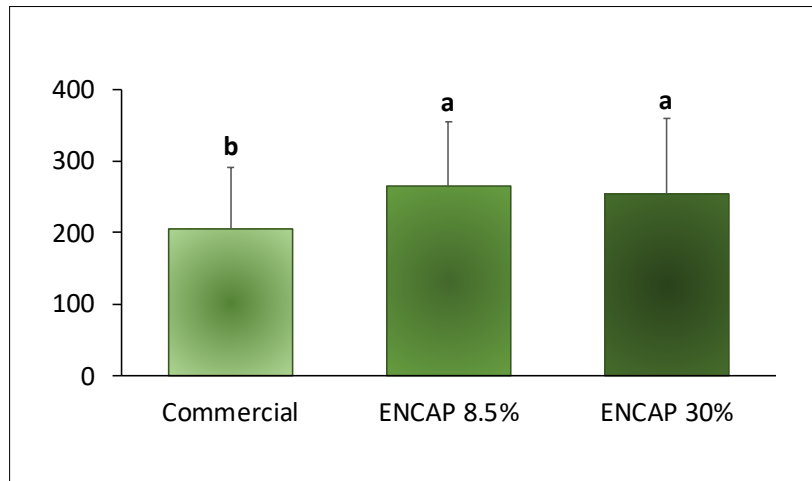


Figure 4. Weight of 12 days after hatching (DAH, µg) gillthead seabream reared under three dietary treatments: a commercial diet and two experimental diets containing 8.5 or 30% of the novel microencapsulated prototype.



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The Artemia Paradox

Vital resource for aquaculture or bottleneck for future growth?

One of the most animated discussions in the global aquaculture community undoubtedly remains the industry's dependence on brine shrimp *Artemia* for larval rearing. Paradoxically enough, one can state that the very thing that has made large-scale aquaculture possible, if not well managed, might also be one of the greatest impediments for further growth of our industry in the future.

In a series of articles published on the INVE Aquaculture website and released to certain aquaculture media, we will gather the thoughts of some of the leading *Artemia* experts and pioneers looking at the success and adequacy of past, present and future *Artemia* feeding strategies in fish and shrimp hatcheries worldwide.



INVE Aquaculture's research labs in Belgium and Thailand conduct some of the world's leading *Artemia* research projects



Continuous R&D efforts result in *Artemia* products that enable optimal hatching results and biosecurity

Importance of *Artemia*

Historically, the major difference between some species in aquaculture and terrestrial animal farming has always been the fact that the larvae of shrimp and most marine species have to be offered a live food, whereas chicken and cattle accept inert diets throughout their life cycle. Furthermore, because culturing of zooplankton (the natural food of fish and shrimp larvae) was either commercially unfeasible or technically hard to realise, the efforts of early aquaculture pioneers were hampered by inadequate larval food supplies.

According to Patrick Sorgeloos (Founder and former Director of the *Artemia* Reference Centre, Ghent University, Belgium), "The beginning of a solution to this problem came from the discovery by Seale in 1933 in the USA and Rollefsen in 1939 in Norway, that new-born fish larvae could be fed with the 0.4mm nauplius larvae of a small crustacean, the brine shrimp *Artemia* spp. They thrive in salty, desert like conditions where few microalgae and bacteria can survive. This discovery was particularly interesting because of the unique reproductive system of this fascinating crustacean species."

He added, "For the species to survive in its typically harsh environment, *Artemia* have developed the ability to produce 'winter eggs'. These 'eggs' are in fact cysts containing embryos that enter a period of dormancy. This is an intriguing biological event when an organism is in a deep sleep, stops metabolising and only wakes up when conditions are favourable. This means that these encapsulated inactive embryos can be stored for a long time and only have to be incubated under the right conditions to produce free-swimming nauplii that are very well accepted as a food source for fish and shrimp larvae. All of a sudden aquaculture had theoretical access to a source of live feed that could be produced on demand."

Development of the *Artemia* market

The first true commercial supply of *Artemia* cysts came from salt ponds in the San Francisco Bay area in California, USA and later from the Great Salt Lake, Utah, USA. The latter remains an example of a sustainably managed and harvested natural resource of quality cysts up to this day.

Very soon however, the increasing demand exceeded the yearly harvest of approximately 30 to 50 tonnes. From the late 1960s, there was an aggravating cyst shortage, and the hatching quality of the available cysts became less and less reliable. It was only after the FAO's Technical Conference on Aquaculture in 1976 in Kyoto that the situation started to change for the better.

Mandated by the FAO to do so and based on his earlier work at the University of Ghent, Sorgeloos, at that time, a young Belgian biologist and researcher, led a number of initiatives from 1978 to turn the limited global *Artemia* supply into a future food resource for commercial aquaculture.

This work later resulted in the founding of the *Artemia* Reference Centre and of INVE Aquaculture. The work done by Sorgeloos and his team focused on finding solutions for the major impediments for the further development of *Artemia* use in aquaculture which include:

- The need to explore new natural sources of *Artemia* in Europe, Asia, North and South America, and Australia and the introduction of brine shrimp in other suitable habitats such as in Northeast Brazil, Vietnam and China.
- Improvement of cyst quality by developing new harvesting techniques such as harvesting at the water surface instead of at the lake shores where dirt particles build up between the cysts and the repeated hydration-dehydration cycles affect the hatching quality and energetic content of the embryos.
- Improvement in terms of yield reliability by developing standard *Artemia* hatching protocols that establish the optimal conditions for the nauplii to hatch successfully and simultaneously.



Patrick Sorgeloos, Founder and former Director of the *Artemia* Reference Centre, Ghent University



At IARC (INVE Aquaculture Research Centre) and ITARC (INVE Tropical Aquaculture Research Centre) all products and protocols are tested in a real-life hatchery environment.

- Classification and fingerprinting of the difference in size, hatching performance, growth rate, nutritional value etc. of *Artemia* cysts coming from different strains, locations and even harvests.

From 'raw' *Artemia* to products

For a long time *Artemia* cysts were simply harvested from the shoreline and distributed as a 'raw' product. But due to seasonal and regional variations, differences between sub-species, contamination of the product with sand and other external substances, the efficient and safe use of *Artemia* as a live feed required a more structured and responsible approach.

"Decades of intensive research and development have led to the sophisticated live feed resource aquaculture knows today: a carefully processed product, namely the dry cysts that produce live nauplii within 24 hours after incubation," explained Alessandro Moretti - Product Manager Fish Hatcheries & *Artemia*, INVE Aquaculture.

He added that thanks to superior processing and fingerprinting techniques, cysts can be packed and labelled according to their specific characteristics such as size, hatching capacity and nutritional value, regardless of their strain or origin. "Advanced and patented technologies make it possible to break the embryos' dormancy on demand for optimal hatching efficiency, to easily separate the empty cyst shells from the nauplii after hatching and to secure the *Artemia*'s biosecurity and energetic content with innovative processes and enrichment (Selco) products.

"This means that in an ideal situation every hatchery can procure the exact *Artemia* that is most suited for its specific application needs, without having to dread any kind of unpredictable outcome," said Moretti.

Current situation and bottlenecks

Today we are at a point where the world's most interesting *Artemia* resources have been identified and are exploited to their full capacity while maintaining a sustainable harvesting rate. All together these sources provide a global supply of more than 3,000 tonnes per year. This is a major industry bottleneck on its own. Because, unlike global aquaculture which is expected to keep on growing exponentially, the *Artemia* supply will remain more or less stable at its current capacity.

"For aquaculture to keep on growing using the available *Artemia* supply, the industry will have to take on the challenge of using *Artemia* as efficiently as possible. This requires adequate knowledge and application strategies. We will elaborate further on this in some of our upcoming articles," said Geert Rombaut, R&D Manager, INVE Aquaculture.

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Patented technologies in aquaculture: blessing or curse?

The considerable ongoing investment in R&D of new technologies continues to open up exciting possibilities to improve the management and productivity of hatcheries and farms worldwide. However, to protect this investment in R&D, often the companies investing in these new innovations will patent the technology. As an industry, how should we look at this? The discussion arose more recently, when Benchmark Holdings (representing its subsidiary INVE Aquaculture) won a case before the IP&IT (Intellectual Property and International Trade) court in Bangkok to protect its patents relating to its *Artemia* hatching technologies.

The company successfully prosecuted infringement of its patented technology in Thailand. In this case, the patents specifically applied to technology that allows INVE to break the naturally long and unpredictable dormancy of certain *Artemia* cysts. The patented treatment elevates the normal hatching percentage of these cysts approximately from 20-40% to 80+% and therefore has brought enormous benefits to its customers and the market.

Article was realised with the collaboration of Patrick Sorgeloos (*Artemia* Reference Centre, Ghent University) and from INVE Aquaculture: Philippe Léger, CEO; Geert Rombaut, R&D Manager; Eddy Naessens, Product Manager Shrimp Hatcheries and Alessandro Moretti, Product Manager Fish Hatcheries & *Artemia*



Specialists offer technical support on site to promote the correct and adequate use of *Artemia* products in hatcheries worldwide.



“We have been pioneers in aquaculture for more than 35 years. Needless to say, that since then countless hours of scientific work and considerable financial resources have been dedicated to the benefit of the aquaculture industry and of our customers – farms and hatcheries worldwide. We have an obligation to ourselves, to our shareholders and to our customers to protect this investment for the future of aquaculture. It is the only way that we can guarantee the effectiveness of our innovations in the field, and the only way that we can keep the development of new breakthroughs viable.” – Philippe Léger, CEO of INVE Aquaculture.



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Aquafeeds in 2018: Constrained by market demand

By Zuridah Merican

Lower feed volume but upbeat in countries with potential demand from new entrants.

The Asian region saw an overall decline in feed volumes due to consolidation in China which was not sufficiently compensated by new entrants with growth potential in countries like India and Indonesia. In most countries, the production capacity well exceeded the feed demand. In countries with growth potential, this situation increased competition. In the shrimp feed sector, declining farm gate prices and squeezed margins have polarised the feed market, creating segments of high and low crude protein markets. While functional feeds are taking off in China, it is poorly received in other countries. It is clear that feed growth is constrained by poor demand.

In freshwater fish feeds, growth was dampened by the restrictions in lake cage culture such as in China and Indonesia. Demand for marine fish feeds remained poor in terms of volume as no single species is able to lead the growth in farming.

Consolidation in China

The will and commitments of the government to improve air quality and control emissions within China's 13th Five-Year Plan (2016–2020) became more determined in 2018. As it pushed feed mills to reduce discharge of pollutants which required more investments, industry reported a further consolidation in China. Small and medium aquafeed mills have closed while leading feed producers with large resources have expanded by increasing the number of

feed plants. However, this was not the only reason for closure of smaller outfits; rising competition was a reason too.

Zhou Enhua, US Soybean Export Council (USSEC) commented, "Consolidation of aquafeed mills is happening and small mills will be out of business." Feed additive companies are not spared either. Felix Chai, De He Bio-Tech Co., Ltd, based in Shenzhen, said that the environmental policies and regulations are now rigorously enforced in China. "However, our production processes are completely natural, clean and does not pollute the air, water or environment, and thus we are not experiencing any restrictions on our production of microalgae raw materials. The local Environmental Department monitors our wastewater closely to ensure that we meet all discharge requirements."

Total aquafeed production in 2018 from the National Feed Industry Statistics (2019) was 22.1 million tonnes. Table 1 shows production estimates by industry for some groups of aquatic species. The major fish feeds are for the carps which are mainly for domestic consumption. Data on tilapia feeds is rather low for 2018 since Globefish (2019) indicated almost 1.7 million tonnes for farmed tilapia harvests in China. In 2018, the good news out of China was that overall, the feed market continued to grow, especially for some species. Little or no growth was reported for the shrimp feed market but that for the crayfish, *Procambarus clarkii* grew more than 30% because of the popular demand for "small lobster" in China.



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Table 1 Some estimates* on China's aquafeed production in 2018

Feed type	*Estimates in 2018 (million tonnes)	Range of prices in 2018 (USD/kg)	FCR
Total freshwater fish feeds, including feeds for:	14.00-16.00		
carps (grass carp, common carp, crucian carps etc)	5.00-8.00		
tilapia	1.20-1.60	0.6-0.75 (extruded) 0.5-0.6 (pelleted)	1.0 -1.3 (extruded) 1.4-1.8 (pelleted)
snakehead	0.4-0.50		
Marine fish feeds (mainly for the seabass, pompano, large yellow croaker)	0.80	1.5-1.7 (seabass)	1.2-1.6 (seabass)
Marine shrimp (vannamei shrimp: 77-95%)	0.90-1.10	1.03-1.5 (vannamei) 1.25-1.5 (monodon)	0.9-1.3 (vannamei) 1.1-1.5 (monodon)
Freshwater prawn, crayfish, crab	0.70		

*Estimates from industry in China; FCR-Feed conversion ratio

Functional feeds have become popular in China and farmers will pay higher prices for such feeds as long as they help in their production. They seek good quality functional feeds, designed according to different fish/shrimp growth stages and situations, mostly for better digestibility, growth, health and performance. In addition, Chai noted, "In the second half of 2018, many aquaculture farmers and feed producers were looking for natural ingredients such as natural pigments. Consumers in China are looking for better quality, and more natural aqua products. An impact of the US-China trade war is that many feed producers are looking for alternate high protein sources. We see the continuous growth in the demand for astaxanthin (from *Haemotococcus pluvialis*) and *Chlorella* microalgae (up to 50% protein content) powders."

More fish feeds in 2019

Zhou expects the market demand for fish feeds to grow, because of the continued intensification and culture of high value marine fish species. However, there are some who believe that growth in 2019 will be curtailed by 2-3% because of the environmental policy and low ex-farm prices in early 2019. The exception is for the pangasius where feed demand will grow by up to 100%. No growth in demand is predicted for shrimp feeds, which is expected to remain at 2018 levels.

More support to push demand in Indonesia

"More aquafeeds were produced in 2018 but the increases were insignificant," said Haris Muhtadi, Chairman of the Aquafeed Division, Indonesian Feedmills Association (GPMT). In the open market, sales reached 1.36 million tonnes of fish feeds, up 8% and 321,028 tonnes of shrimp feeds, up 9.4% (GPMT, 2019). Feed prices rose in 2018; shrimp feeds by 6.2% to IDR16,000/kg (USD1.12/kg) and freshwater fish feed, to IDR 6000-8,000/kg (USD0.42-0.56/kg). Shrimp farmers have accepted these increases, as long as the feed met their expectations (industri.kontan.co.id).

A threat to the industry was the government's move to restrict cage farming in freshwater lakes in late 2018. Feed producers saw a drop in feed sales in certain lake areas. GPMT has urged the government to reconsider this decision as they have been diligently working with farmers to improve water quality around the cages, by developing environmentally friendly floating feeds which are low in phosphorus, and by teaching farmers good feed management. Cage farmers are large contributors to the national aquaculture production. In lakes, feed producers have programs with farmers to clean up water bodies around cages.

Freshwater fish is an important protein source in Indonesia but margins are low for fish farmers with low ex-farm fish prices. Therefore, feed producers are frequently challenged to lower selling prices and support "small family" farmers throughout the value chain. However, on the other hand, keeping feed prices stable is another challenge, due to the government's restrictions in the imports of feed ingredients, often limiting availability.

Keeping with competition

Dr Erwin Suwendi, Head of Nutrition and Feed Technology, PT Suri Tani Pemuka (STP) explained that to keep ahead of competitors, the company optimises R&D. "We develop formulations to closely meet the nutrient requirements of the animal by weight class (starter, grower and finisher). We also create functional diets to modulate immune function of the animals targeting specific bacterial infection.

"On the farming side, we innovated recirculation aquaculture systems (RAS) for super intensive shrimp rearing and adopted a 2-step system to enhance shrimp productivity. We are in the process of designing an early warning system for upwelling notifications in lakes. To support customers and to motivate them to succeed, we have been deploying shrimp technicians 24/7 at our customers farms to help them until harvest. On the hatchery side, we have introduced RAS and automatic feeders to enhance productivity. Recently, we introduced digitalisation in a village in collaboration with Telkomsel and eFishery, using IoT (internet of things) in automatic feeders."

R&D work is a must to support the business unit. STP is the only Indonesian feed producer active in the F3 challenge, which aims to get feed producers work on replacement of fish meal and fish oil and ultimately produce sustainable feeds. "Participating in the F3 challenge broadens our knowledge on what sort of sustainable ingredients can be potentially used in aquafeed formulation. We can learn from the salmonid industry on how it shifts to more sustainable ingredients and responsible farming."

Upside in 2019

Local consumption of freshwater fish will continue to increase to feed a growing population. Fish feed demand is expected to grow in 2019, especially when the government is urging pangasius farming to reach 700,000 tonnes and export pangasius products.

General positivity in Vietnam

In 2018, production of the pangasius increased as ex-farm prices rose with demand from China. Prices reached USD1.08/kg, feed prices averaged USD0.51/kg and the general FCR was 1.5 to 1.6. In 2018, industry estimates on feed production ranged from a high of 2.34 million tonnes to a low of 1.9 million tonnes. According to Globefish (2019), pangasius fish production from Vietnam in 2018 was 1.26 million tonnes.

In 2018, the demand for tilapia feeds rose to an estimated 450,000 -700,000 tonnes. Tilapia is relatively more profitable and have better ex-farm prices (USD1.18/kg) than the pangasius. In November 2018, the Association of Seafood Exporters and Producers (VASEP) said that it expects the US-China trade tensions to benefit Vietnam with a better market share in white fish, such as tilapia. The only downside is the demand for marine fish feeds which remains low at only 50,000 tonnes.

Shrimp feed production rose in line with the better production achieved in 2018. Volumes reached 790,000 tonnes, with 19% of this amount attributed to the monodon shrimp. Average prices of vannamei shrimp feeds rose by 3.1% to an average of USD1.05/kg. The increase was smaller for monodon feeds at 2% to USD1.34/kg.

There is positivity in Vietnam's aquafeed business. Jeff Jie Cheng Chuang, General Manager, Sheng Long Bio-Tech International Co, is upbeat on the potential in Vietnam. In 2019, Sheng Long will expand with new lines, new products as well as a new plant for both shrimp and fish feeds in Long An province. However, he commented, "New regulations, restrictions on imports and taxes sometimes confuse us. They change too frequently. If it is possible, we hope the government will stabilise regulations and restrictions for a smooth aquafeed business."

More monodon shrimp feeds in Thailand

In general, the total feed volume in 2018 was reported at 1.11 million tonnes, much higher than in 2017. Freshwater fish feed total 662,000 tonnes, comprising 285,000 tonnes of feeds for the tilapia and 168,300 tonnes for the catfish. Tilapia feed prices average THB17.5/kg (USD 0.56/kg) for 25% CP feed. The industry estimate for seabass feeds was 30,726 tonnes, based on the FCR of 1.5. However, there are imports of seabass feeds from Vietnam.

The fastest moving feed segment was feeds for the monodon shrimp; feed with 40% CP costs THB45/kg (USD1.42/kg). Demand was from China for live shrimp which according to Soraphat Panakorn, Novozymes Biologicals, was mainly supplied by farms in the south but at low offer prices. More monodon shrimp was produced (20.4%) while the vannamei shrimp production declined by 2.2%. However, the monodon shrimp production is still small at 4.7% of total production of 272,809 tonnes (DOF, 2019). Total shrimp feed usage was estimated at 410,000 tonnes.

In 2019, some in industry expect better shrimp feed demand at 7% as productivity increases. But based on the trends for the first half on 2019, Soraphat anticipates a lower production as farmers face challenges with low prices and poor demand from processors. Thai farmers face stiff competition from regional producers, as their production costs are much higher. Production costs in Thailand were higher by USD1.2/kg for size 100/kg shrimp compared to that in India, but ex-farm prices were lower. The proportion of monodon shrimp will increase to 9% of total shrimp production in 2019.



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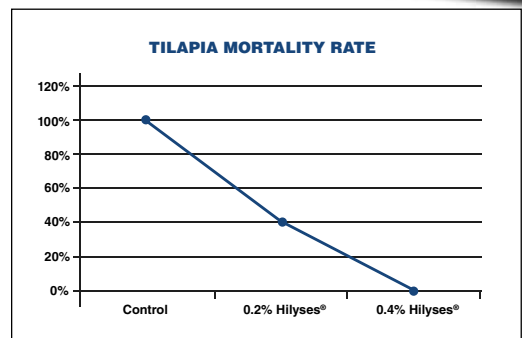
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Rising cost of raw materials and feed prices

In China, the rise in ingredient costs, especially for soybean meal prompted aquafeed mills to raise prices in Q2 2018 by 5-10%. But the breakout of the African swine fever brought down ingredient prices and feed mills reverted back to earlier prices to keep their customers. In Indonesia, 85% of ingredients is imported and there was an overall increase of 12% for raw materials because of the depreciation of the Indonesian rupiah.

In Vietnam, Chuang said, "The cost of raw material as well as the lack of some of them, has been a major challenge for us in 2018. The price of fish meal, soybean meal as well as other ingredients increased very quickly. We had to increase feed prices so as to have a stable feed quality. But then we cannot increase prices too much as we need to take care of our customers. There is a lot of work to do, despite the efforts of our research centre to develop competitive products."

Fish meal and its replacements

The inclusion rate of fish meal in shrimp feeds is usually 5-10% but can rise to 20%, depending on the feed type. Almost no fish meal is used in freshwater fish feeds, except for the carnivorous snakehead feed which uses 35% fish meal (as in China). There is a high reliance on fish meal in formulating marine fish feeds, at around 40%. The illegal, unreported and unregulated (IUU) fishing issue in Vietnam and Thailand has an impact on supplies of local fish meal. Feed producers in Thailand import certified pangasius meal to produce feeds to meet certification standards.

Indian feed producers depend on local sources of fish meal which, according to an industry source is of poor quality but expensive. However, feed producers prefer to buy local fish meal as imported fish meal is not only subjected to import duties but requires a lot of documentation.

Alternatives to fish meal vary. In China, to reduce the fish meal inclusion rate, the common replacement ingredients are soy protein concentrate (SPC), poultry meal, insect meal and meat and bone meal. There are trials with algae meal. In general, feed producers sought good quality ingredients with stable supply and reasonable prices. "Soybean meal remains a favourite alternative, such as in India," said Dr G. Ramesh, Wenger, India. "Some feed formulators opt for fermented soybean meal which is said to be better than soybean meal. Other options are poultry feather meal, poultry by product meal, fish soluble and fish hydrolysates, insect meal, pupae meal and single cell proteins. In vannamei feeds, soybean meal is a major protein source and fish oil is added as attractant."

"Krill meal is used as partial replacement of fish meal and is often added as feed attractant at inclusion levels of 3-4%. Astaxanthin krill oil enhances shrimp growth, pigmentation and omega-3 content of shrimp tails," said Atul Barmann, General Manager, Aker Biomarine, India. In Indonesia, Erwin said that fish meal replacement is not an issue with fish feeds while in shrimp, they have begun to work with digestible protein, especially for the grow-out phase. While in Thailand, Dr Jarin Sawanboonchun said that formulators have to learn to substitute well as sales teams will provide feedback on any poor performance.

"We have done quite a lot of research on fish meal replacement with soybean meal or other alternative proteins to help us with raw material price increases. But we still have lots of questions on fish meal replacements," added Chuang.



Major feed players at the DSM booth during VIV Asia in March 2019. DSM's Supamat Tantipawaswin (left) and Daranee Seguin (middle), with Dr Chen Ming Dang, CPF, Thailand (second left), Erwin Suwendi (second right) and Narendra Santika Hartana, PT Suri Tani Pemuka, Indonesia

New demands by shrimp farmers

Industry active in China discussed a trend in its shrimp farming industry: the demand for high protein shrimp feeds (44% CP) for use in farms stocking shrimp at high densities in RAS (5-10kg/m²). As these farmers had invested heavily in such systems, they continued to invest further with high protein feed. There are less and less outdoor farms. One estimate was that 50% intensive farms use these 44% CP feeds costing around USD1.5/kg. In Thailand, shrimp feeds with 52% CP are available in the market although the common range is 35-38% CP.

In contrast, in Indonesia, a recent development was shrimp farmers' acceptance of lower protein feeds at 26%CP. "Their preference is for low crude protein diets with less fish meal, even though they are farming in intensive systems. But they use probiotics and bioflocs.

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Christopher Co, Overseas Feeds, Philippines (left) with Rudy Purwono (right) and Tsang Joshua Ardy, PT Matahari Sakti, Indonesia

This is related to the ex-farm price of shrimp, higher feeding frequency with auto feeders and maintenance of water quality with low density feeds. These feeds cost USD1/kg," said Erwin.

There is also the common wish for better shrimp colour in China. "Chinese farmers believe in producing farm-made feeds to incorporate astaxanthin to get the preferred colour, high survival and to get a good market for their shrimp. In Hainan, some farmers added astaxanthin into the feeds for the tilapia," said Chai.

At the last Surat Thani Shrimp Club meeting in January 2019, Thai farmers emphasised this demand; on the DSM colour chart, a score of 26 from the current 22, said Dr Daranee Seguin, DSM, Thailand. Feeds with astaxanthin are used towards the end of the crop cycle for shrimp farmed in clear water in HDPE-lined ponds. Daranee added that this trend now seems to be common in Vietnam, Thailand as well as Malaysia. As farmers looked towards the China market, they need to follow buyers' demands, even for the monodon shrimp.

Expansion and new entrants

While existing players in Asia continue to add more lines and new feed mills, there are mixed views on the proposed entry of large feed multinationals from China, as part of the Belt and Road Initiative, in many countries. In India, Cargill, opened its first fish feed plant in Vijayawada, Andhra Pradesh in early 2018. In Indonesia, in October 2019, CJ Feeds will add new lines to the plant in Serang, Banten province. While Sheng Long in Vietnam, plans to diversify into the seafood processing and farming businesses, CJ plans to start a hatchery and farming business.

In Indonesia, initially, there were four new feed mills scheduled to start operations in 2018. "Dutch De Heus (PT De Heus Nutrisi Indonesia) accelerated its entry by acquiring Universal Agri Bisnisindo but still intends to build a feed mill," said Sales Manager Aqua De Heus, Tri Krismiyarto to Trobos (December, 2018). It has begun to produce starter feeds for freshwater fish and targeted 10% of this market by end 2019. This market is estimated at 5,000 tonnes per month. Tongwei has started operations and together with Evergreen Guangdong will have a total capacity of 60,000 tonnes/year. Haris said that Indonesia has an over capacity in shrimp feed milling, at 460,000 tonnes per year (bisnis.com). The positive aspect of this development is that "it will bring in more competition in terms of quality, pricing, services and term of payments," said Erwin.

There are many players sharing the small shrimp feed market in Malaysia, estimated at 60,000 tonnes in 2018. The new addition in 2018 was Green Island Feed Mill (see page 28). Chuang said, "Competition will come and we have to face it. However, we will keep on developing to provide the best quality and best price products for our customers. What we hope to do is to make sure our customers are profitable in farming with our help."

"Sheng Long's achievement in India is the complete set-up of the factory in Chennai in 2018. This is our first feed mill outside of Vietnam. We started operations in March 2019. We have put in a lot of energy on this project and learnt a lot; different countries have different cultures. We need to change our strategy wherever we go.

"We are always optimistic for the international market. In future we will continue to invest in India and Malaysia. We will also focus more energy on our export market; Sri Lanka and other South Asian countries. These markets will increase and will help us achieve our goals."



Felix Chai, De He Bio-Tech Co., China (left) and N.S. Allada, Synergy Biotechnology, India.



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Malaysia's newest entrant

A joint venture which started operations in June 2018

The newest aquafeed mill in Malaysia is this joint venture between Malaysia's GST Group and China's Guangdong Evergreen Feed Industry. Green Island Feed Mills Sdn started operations in June 2018. This fulfils the goals of three initiatives i.e. China's Belt and Road Initiative (BRI), expansion of GST into feed production and the regional expansion of Guangdong Evergreen Feed Industry. As for Green Island Feed Mill, it has targeted some 70% of production for its marine fish cage and land-based farms and the rest is for the open market.

The total production capacity is 4,500 tonnes per month of both shrimp and fish feeds. There is space for expansion of additional lines, one each for fish and shrimp. In this brief interview, **Allen Goh**, Managing Director, and **Tho Ching Ching**, Assistant General Manager, who is also in charge of group marketing, recounted the history behind this joint venture and on their marketing plans.

AAP: How did it all start?

Goh: GST has always wanted to venture into feed milling for some time. We bought this 2 acre (0.8ha) land in Simpang Ampat, Penang, but needed some assistance with setting up a feed mill. This is a "must have" for the GST group as we need better traceability along the value chain, when we start contract farming and buyback products and when we export our products. We first connected with the Guangdong Evergreen team, when we bought feed processing equipment from the company, and quite quickly, forged this partnership. It was a question of trust which drew us to link with this company. In this joint venture, Evergreen has a 51% share.

All the processes at this feed mill will follow the practices of the feed mills in Guangdong Evergreen. However, we have maintained the name of "Green Island". We named the feed mill after Penang Island. GST is synonymous with Penang as we started our marine cage farming business here in the 1980s and even though we will be looking at the feed markets all over Malaysia and in the Southeast Asia region, our base and most of GST's activities will remain in Penang.

AAP: What does Evergreen bring to the partnership?

Goh: From the beginning, Guangdong Evergreen provided expertise to start off all the production processes, setting up the quality control laboratory and assistance with formulations.



By June 2018, we produced our first batch of feeds. Today, the capacity is 1,500 tonnes/month of shrimp feeds from one pelleting line and 3,000 tonnes/month of marine fish feeds from an 8 tonne per hour extrusion line.

Tho: An asset provided by this partnership is the assistance with the total set-up, from raw material sourcing, formulation to final production. There is also assistance in feed formulations and supply of mineral and vitamin premixes. As a small feed producer and a newbie to this industry, I was on the learning curve on procurement of ingredients from global markets, the fluctuations in exchange rates and numerous applications of import permits. There is a complex series of tax exceptions for some ingredients and tax payable for many others.

AAP: How challenging is marketing the feeds and do you expect to go regional?

Tho: Marketing and sales of our feeds are solely the responsibility of Green Island Feed Mill. Our first target is to get a market share in Malaysia in our first year of production. We are lucky that the Evergreen brand name is well recognized in Malaysia as well as in Southeast Asia. Thus, we have retained the brand names of their feed, i.e. for shrimp feeds: Paramount with 45% crude protein (CP); Diamond with 40% CP; and Gold with 38% CP. In the case of marine fish feeds, we market just one brand of 43% CP floating or sinking feed. Fingerling feeds contain 45% CP.

We compete on quality rather than price. The feed market in Malaysia currently is very small and we compete with three well established major players and large volumes of imports from Vietnam and Thailand. Challenges with diseases, trust and background of farms are top considerations on our list in deciding on credit for feed sales. However, as we are planning to do contract farming, to have more traceable products, we foresee a stable feed production in the future.

Goh: We have plans to go regional but initially, we would like to get a good market share in both West and East Malaysia by 2019.



India's aquafeed market in 2018

By D. Ajaya Bhaskar

With lower margins, feed cost rather than quality is the crunch point for shrimp farmers.

As prices of shrimp dropped in early 2018, the impact was on the shrimp feed market. In mid-2017, with projections that India could be producing close to 1 million tonnes of shrimp in 2018, the feed requirement was calculated at 1.5 million tonnes, which could be easily met by existing feed mills and shrimp feed imports by regional feed producers. However, as shrimp prices trended downwards since April 2018, the demand for shrimp feeds was only 1.2 million tonnes at the end of 2018.

The estimate on total aquafeed production in 2018 was almost 2 million tonnes, which also included about 800,000 tonnes of fish feeds. However, with a total installed capacity at more than 3.5 million tonnes, there is a large gap between supply and demand. An opinion in the industry is that the shrimp feed business is a saturated market but even so, feed companies are ever ready to increase supply, expecting shrimp feed demand to increase when shrimp prices are better. In India, many feed companies are integrating, upstream or downstream, to expand their business and stabilise production. Feed companies are supplying feed and post larvae/fish fry and buying back harvested products.

India has 30 big and medium sized feed plants producing feeds for freshwater fish, marine shrimp and freshwater prawn. Feed mills are categorised into three groups: <25,000 tonnes per year (tpy), 25,000–65,000 tpy and >65,000 tpy. Many feed companies have technical tie-ups with international partners or consultants. Most of the companies are still not realising the importance of R&D and focus mainly on production and sales. The several new companies are not posing a serious threat to the existing ones. Sadly, there is a low success rate of new companies running at full capacity.



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A crowded feed market

In the shrimp feed market, Avanti Feeds and CP Aquaculture (India) together continue to maintain their major market share (estimated at 70%). Growel Feeds and Devi Seafoods (which added a second feed mill in Ongole, Andhra Pradesh in 2018) did well in 2018. The shrimp feed market is crowded with around 14 large producers (capacity >25,000tpy) and many medium and small producers vying for the rest of the shrimp feed market. The recent entrants into the shrimp feed market plus shrimp processors (such as Devi Seafoods) integrating upstream, are making headway, especially since they have ready markets with their own farms. But they also target the open feed market. A new entrant in 2018 was Sheng Long from Vietnam which began local production in March 2019.



Various extruded fish feeds

In the fish feed segment, there are fewer players. Indian Broiler (IB) is the market leader, followed by Nexgen Feeds and Growel Feeds. Industry expects the future to be in the fish feed market. Better demand for fish feed will be realised when fish farmers shift to commercial feeds, either pelleted or extruded from the current practice of using farm made feeds for the Indian carps such as the rohu. Recently, there are moves to produce feeds for the tilapia and marine fish, such as the seabass which is being farmed in ponds and cages in south India.

Future will be fish feeds

The actual fish feed requirement is around 6 million tonnes but in 2018, sales totalled less than 800,000 tonnes. This is the case because fish farmers are not fully convinced to convert to commercial pellets. This is also a matter of costs. In general, pelleted fish feeds with 24–28% crude protein (CP) cost INR30–34/kg (USD0.43–0.49/kg) but extruded feeds with the same crude protein composition was INR2/kg higher. Feed conversion ratio (FCR) was around 1:2 without any natural productivity. As the market prices of fish fluctuate at INR15–20/kg based on demand, farmers shift between pelleted, extruded and farm made feeds. In addition, prices for pangasius remained low at less than USD1 (INR69.78 on April 30), resulting in farmers reducing production. With low supply in the first 3–4 months of 2019, prices improved to USD1.1 or 1.2, leading to a subsequent surge in production.

Farmers do not use pelleted feeds throughout the culture period. Some 90% of the market demand is for 3–4mm pellets produced by most fish feed producers. It is very difficult to find pellets less than 1.5mm. The reasons could be due to high operational costs, low production yield and small market segment. However, since small size feed pellets are not available in the market, farmers use conventional rice bran and other deoiled cakes for several months. Weaning young fish from such mash feeds to pelleted feeds takes time and fish growth is also retarded for several weeks. Farmers do not take risks and instead fertilise ponds with organic manure to increase natural productivity.

Market forces with shrimp feeds

As the market price of size 100/kg shrimp dropped to around USD3.00/kg, equal to the cost of production, small scale farmers opted for standard feeds, preferring low cost economy brands and some even began to use 2mm pelleted fish feeds. Poor quality ingredients with unbalanced nutrients reduce immunity thus increasing susceptibility to diseases. The price of shrimp feed with 35%CP was INR70/kg (USD1/kg). FCR ranged from 1.3 to 1.6. To match farmers' needs, some companies offered low cost shrimp feeds, but feed performance maybe compromised.

Most feed sales were during the first crop from March to May. When prices began to drop in April 2018, farmers lost interest and reduced their stocking in the second crop. Along with this, farmers were challenged with diseases such as, white spot, EHP, white gut and white faeces disease. Small scale farmers used low quality post larvae without testing hence leading to repeated disease attacks.

In the shrimp feed market, some companies are producing and marketing extruded functional feeds. Others use feed supplements or feed additives for better performance. In the future, farmers and hatchery operators are expecting good quality hatchery and nursery feeds for both fish and shrimp from local producers since imported feeds are very expensive. Despite these efforts by the feed industry to support shrimp farmers, feed professionals say that 2019 is not likely to be a promising year.

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Feeding Indian major carps for sampling

Feeds for changing farming scenario

A positive development is that aquaculture is key to India's economic development. The government of India formed a separate ministry for fisheries which means that it will allocate a specific budget to develop this sector in the future.

While Andhra Pradesh is an aquaculture hub, states like Gujarat, West Bengal and Orissa are also focusing on aquaculture and are progressing well. Commercial fish farming has started in Uttar Pradesh and Bihar. In the last 3 years the farming area in India has increased tremendously with around 200,000ha used for fish and shrimp farming. In 2017, total fish production reached more than 5 million tonnes while 600,000 tonnes of shrimp were produced in 2018.

Commercial production is mainly of carps and pangasius. Tilapia and red pacu farming are still in the infant stage. In south India, seabass culture is on-going but at a small scale, and fish are mainly fed on trash fish. To create a market for seabass feeds, hatcheries are needed to expand farming. Institutions and government are promoting cage culture. Some farmers are interested to return to farming the black tiger shrimp *Penaeus monodon*, and fresh water prawn *Macrobrachium* spp.



D. Ajaya Bhaskar, 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. Ajaya

started his career in the aquafeed industry with Matrix Bioscience in India, followed by 6 years as Feed Formulator and Quality Control Manager at Thailuxe Enterprises, Thailand (now PP Prime Public Co) and more than a year as General Manager at Shree Vijay Aqua Feeds. His focus includes R&D in aqua nutrition, feed formulations, new product development and educating farmers on latest technology and best aquaculture practises. Email: dasariajay@rediffmail.com

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From jet fuels to fish feeds

Suresh Menon journeys into aquaculture with oligometry for tailor-made functional ingredients.

It all started when **Dr Suresh Menon** received a US Department of Defense contract to create jet fuels using his proprietary CelTherm® technology. As the oils produced were high in long chain polyunsaturated fatty acids (C20-C 22 PUFAs), it dawned upon him to embark on a different path. "It became apparent to me that these hydrocarbons would be more valuable in aquaculture, as a replacement for fish oil. We were able to create n-3, n-6 and n-9 PUFAs using this process. This was a much better option than making jet fuels. Thus, started my involvement in the aquaculture industry," said Suresh, during his recent visit to VIV Asia 2019, Bangkok, Thailand in March.

Those were in the years 2009 to 2012. Fast forward to today, Menon Renewable Products, Inc., San Diego, USA has a global footprint, with a large presence in the aquafeed and livestock markets in 10 countries. In Asia, India is its largest market with shrimp feed, Vietnam and Thailand (shrimp and tilapia feeds), Indonesia (shrimp, tilapia, catfish and pangasius feeds) and Malaysia (shrimp feeds). The company focusses on animal feed products built around its MrFeed® brand which stands for Menon Renewable Feed. "We launched our animal feed ingredient in 2013 and have continued to refine the CelTherm® process to produce a pipeline of animal feed products," said Suresh.

Such an enterprising venture is not new to Suresh. Armed with a PhD in Engineering Science and Mechanics (ESM) from Pennsylvania State University, USA, Suresh had an early jump-start with startups. During his student days, a consortium of companies (small to Fortune 500) funded his research. Menon International (the parent company of Menon Renewable Products) is his third company. His focus has been to scale up new ventures; commercialising core technologies and transitioning these from the laboratory into a commercial environment.

Novel, disruptive technology for aquafeeds

"Back then we were producing oils from cellulosic material (hemi- and cellulose) and with enzymatic hydrolysis, we created cellulosic sugars (xylose, mannose, arabinose etc). The hydrolysates are then fermented in bioreactors, and both fermented biomass and residuals later go through oligomerization and other steps to produce custom-tailored formulations. When we combine these steps, the result is a formulation which contains amino acids, lipids, nucleotides, peptides and other valuable ingredients that can be tailored to end user requirement and be species-specific," explained Suresh. Oligometry is explained as the science of breaking up molecules into smaller monomers.

"Over 1,000 types of feedstocks are available in our technical library, and our team can optimise the sugar levels from the wide variety of feedstocks that may be utilised. Our novel ingredients represent a disruptive technology that significantly enhances the animal's immune systems, leading to higher survival and faster growth. Our oligomerization process and hydrolysis steps allow us to tailor to what the formulator wants; for example, our shrimp ingredient contains 50% crude protein and 4% fat; for tilapia and salmon, 52% crude protein and 10% lipid."

Suresh listed the attributes of the functional ingredient. The presence of non-genetically modified grains helps to overcome anti-nutritional factors in complete diets, ensuring higher digestibility and absorption of nutrients. As an immune-stimulant, it improves survival in the presence of pathogens. It is a sustainable alternative to fish meal, alleviating limitations of energy, water and land resources.



"The earlier the animal starts feeding with this ingredient, the better the benefits."
Suresh Menon

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"Through pond trials as well as at universities, we demonstrated the efficacy of the products. These are all independent third-party trials. In addition, our commercial customers do their own trials.

The functional ingredient has successfully replaced all of the fish meal in a trout trial in the US. Specifically, the product line has demonstrated success in shrimp ponds warding off bacteria, virus and parasites that result in diseases such as early mortality syndrome (EMS), white spot disease (WSD), white faeces disease (WFD) and others. Added in shrimp diets, the effect is 25 to 30% faster growth across all life stages, and around 85% survival as compared to 30 to 40% for the control group."

The recommendation is 15-20% inclusion rates to replace or complement fish meal, fish oil, soy meal and poultry meal. However, Suresh acknowledges that the inclusion rate is a function of the goals to be met in commercial aquaculture or terrestrial animal farming.

"In shrimp ponds, the ingredient replacement strategy is a function of the density of the animals in the ponds, feeding frequency, feeding techniques used, cost of ingredients, and other factors. To enable replacing ingredients such as fish meal, soybean meal and poultry meal, it is important to generate the necessary protein and lipids while also providing the immune boosting function."

From the petri-dish to global markets

While the initial funding to develop the product came from the US government, Suresh himself invested proceeds from two previous ventures to see its fruition to a large-scale commercial production. Between 2013 and 2017, the company focused on scale-up, validation and trials.

Menon Renewable Products began at the "petri-dish scale", working with various feed mills and formulators. "In early 2016, we sold ingredients to make the first tonne of feed and by year-end we reached 60 tonnes. By 2018, we produced 10,000 tonnes of feeds," he said. Starting in 2018, the company focused on commercial scale pond trials for shrimp across 12 countries, including India, China, Thailand, Malaysia, Vietnam, Panama and Honduras. It has also commenced trials for salmon, tilapia, poultry and swine. External validation was with US government and state-sponsored studies along with extensive (and on-going) laboratory and field trials.

Today there are production facilities in India, the USA and Canada to meet market demands. The current production capacity can support 300,000 tonnes of feeds. New facilities in Latin America and Europe, which will come on line during 2019, will support further scale-up in 2020. The company has an active R&D program to continue improving its existing products and develop new products, as well as expand into other animal industries. Furthermore, through the utilization of abundant agricultural products and related by-products, its ingredients reduce environmental pressure and improve the carbon footprint of aquaculture and livestock operations.

The company tagline is MrFeed®-Feed for Life! "The earlier the animal starts feeding with this ingredient, the better the benefits. In terms of cost, we have been scaling up production to be as economical as possible. At 10% inclusion in shrimp feeds, there is no difference in feed cost compared to conventional feeds but at 15% inclusion rate, the feed is 10% more expensive. However, the yield and taste make it worth it," concluded Suresh.

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An opportunity to improve gut performance and immunomodulation with probiotics

There is more to gut modulation than just the positive effects on growth performance and feed efficiency.

By Anwar Hasan and Benedict Standen

Probiotics are widely used in aquaculture with two main purposes: for maintaining optimal water and sediment quality, termed bioremediation, and for improving gut health. In shrimp farming, there is a clear benefit of using water-based probiotics throughout all production stages, from the hatchery, nursery and grow-out as a microbial management tool.

Probiotics for gut health are equally important, since the intestine is one of the main portals of entry for invading pathogens. In order to successfully infect the host, a pathogen must navigate and survive multiple obstacles and attacks executed by the host's immune system. A healthy and efficient gut also leads to positive effects on growth performance and feed conversion, through better nutrient absorption.

Microbial modulation

Probiotic bacteria must be able to survive the digestive process and have the ability to colonise, thus remaining in the gut where they can exert their probiotic benefits. Once established, probiotic bacteria can competitively exclude undesirable bacteria and produce many extracellular substances, some of which have strong antimicrobial properties, e.g. bacteriocins, and others like digestive enzymes, contribute to feed digestibility. These abilities are strain specific, and highlight the importance of strain selection and commercial formulation.

BIOMIN scientists investigated the effects of AquaStar® Growout strains in the gut of tilapia (*Oreochromis niloticus*) and white shrimp (*Litopenaeus vannamei*). After six weeks of feeding at a dosage of 0.5%, it was clear that the application of this probiotic led to an efficient colonisation of the tilapia gut (Figure 1). These data were obtained using high throughput sequencing, using the 16S rRNA gene. This gene is present in all bacterial species, albeit in different numbers.

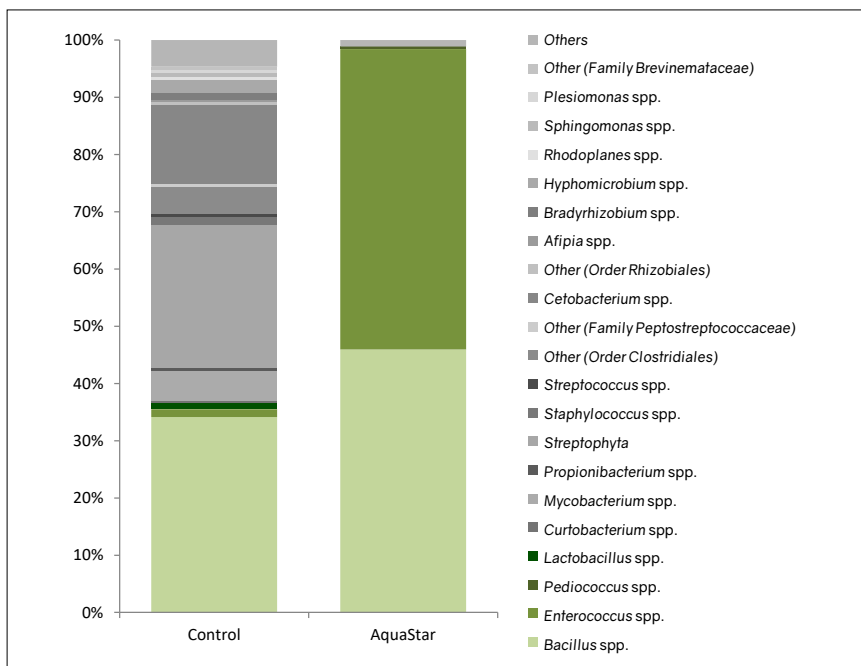


Figure 1. Intestinal microbiota profile of tilapia fed experimental diets. The AquaStar® strains are highlighted in green. All other genera abundance is reported as percentage of total reads.

In the tilapia

Importantly, all AquaStar® bacteria (green) were detected in the fish intestine, and they could persist in the gut for over two weeks after probiotic feeding had ceased, although at declining levels. It is very likely, that the probiotic strains found in the control treatment originated from the probiotic treated fish, since the experiment was conducted in a RAS system.

In the shrimp

Given the physiological differences between a fish and shrimp digestive system, it is also important to demonstrate this colonisation effect in shrimp. Here, colonising the hepatopancreas becomes equally important, due to its critical role in a number of different pathologies, e.g. early mortality syndrome/acute hepatopancreatic necrosis disease (EMS/AHPND). In Table 1, we report the colonisation ability of *Enterococcus*

Treatment	Hepatopancreas		Intestine	
	Total <i>Vibrio</i> spp.	<i>Enterococcus</i>	Total <i>Vibrio</i> spp.	<i>Enterococcus</i>
	(x 10 ⁴ CFU/g)	(x 10 ⁶ CFU/g)	(x 10 ⁶ CFU/g)	(x 10 ⁶ CFU/g)
Control group	68.8 ± 19.5 ^a	-	94.1 ± 68.2	
AquaStar® Growout	1.2 ± 0.6 ^b	39.5 ± 10.2	32.5 ± 28.7	9.6 ± 6.5

^{a,b} different superscripts in the same column indicate significant differences at p < 0.05

Table 1. Enumeration of total *Vibrio* spp. and *Enterococcus* sp. in shrimp digestive tract after feeding with test diet for six weeks (by fluorescent in situ hybridisation, FISH, technique)

sp. in AquaStar® Growout in shrimp gut after six weeks of experimental feeding.

Innate immune response

As with mammals, the immune system of fish can be separated into innate (non-specific) and adaptive (specific) responses, while shrimp only has innate immune response. Compared to mammals, fish are more dependent on the innate immune response for two main reasons. First, the innate immune system has developed to be nonspecific and is therefore capable of mounting an immune response against a wide range of pathogens. Secondly, due to the ectothermic nature of fish, adaptive immunity can take considerable time. For example, antibody production in salmonid species can take up to six weeks, compared to just hours or days for the innate immune system.

Reinforcing the intestinal barrier function

The mucus layer produced by goblet cells provides the first line of defense. The mucus functions to trap and remove pathogens by providing both a physical and chemical barrier, since it contains a number of antimicrobial compounds. The commensal microbiota as well as probiotic bacteria can modify this mucus layer. For example, after feeding tilapia with a commercial probiotic (AquaStar®) for five weeks, there were approximately 60% more goblet cells in

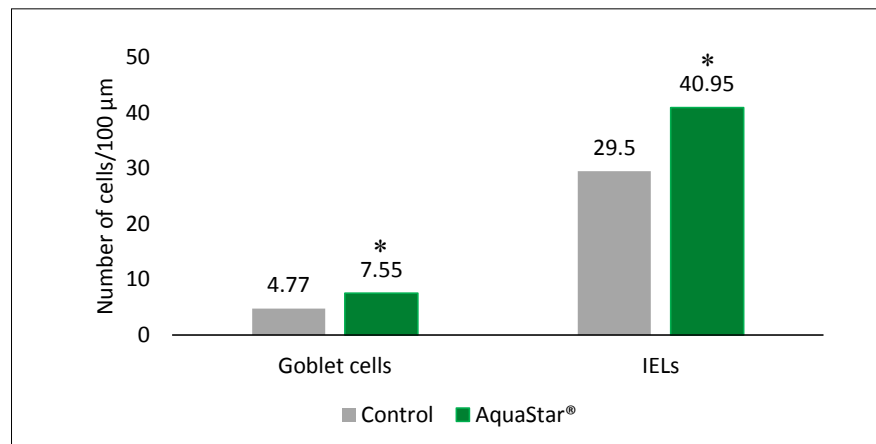


Figure 2. The abundance of goblet cells and intra-epithelial leucocytes (per 100µm) in the intestine of fish fed with and without dietary probiotics.

the intestine (Figure 2). These additional goblet cells could contribute to a greater production of mucus, thus providing a more impenetrable barrier, potentially retarding pathogens and preventing their attachment to the underlying epithelium.

Assuming a pathogen was able to breach the epithelium, an army of white blood cells, collectively known as intra-epithelial leucocytes (IELs), would be waiting to attack the pathogen. In all three trials conducted at Plymouth University, the addition of AquaStar® Growout to tilapia diets resulted in significantly larger populations of IEL. This increase

was between 22-38% depending on the probiotic dosage, as well as the duration of feeding (Figure 2).

Strengthening the barrier: microvilli density

In fish, beneath the mucus layer, lies the epithelium, primarily consisting of enterocytes. These cells are lined with microvilli. Using electron microscopy, it was shown that this probiotic can significantly increase microvilli density in the gut. The benefit of this increase is two-fold. Firstly, more numerous microvilli will increase the surface area so the host can acquire more

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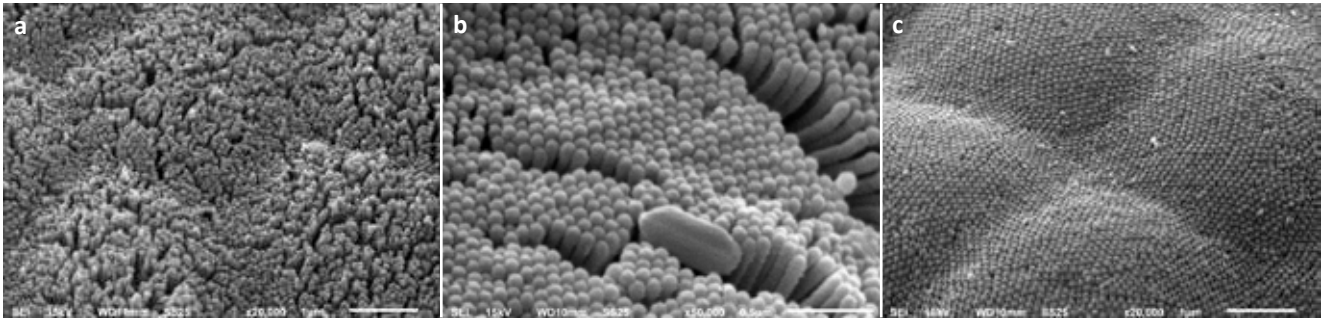


Figure 3. (a) Electron micrographs showing microvilli from fish fed a control diet. (b) Gaps between microvilli represent an opening for potential pathogens. (c) These gaps are not seen in AquaStar® Growout supplemented diets.

Parameter	Control group	AquaStar® Growout
Granular haemocyte (%)	35.58 ± 8.5	40.44 ± 10.7
Total haemocyte (x 10 ⁴ cell/mm ³)	7.47 ± 0.5 ^a	38.17 ± 0.4 ^b
Phenoloxidase activity (unit/min/mg prot.)	693.6 ± 110	724.0 ± 91
^{a,b} different superscripts in the same column indicate significant differences at p < 0.05		

Table 2. Immune parameter condition of shrimp dietary AquaStar® Growout in a six- week test.

nutrients from the feed. Secondly, any gaps between the microvilli present an opportunity for pathogens to penetrate the epithelium and infect the fish (Figure 3). Thus, a higher microvilli density, caused by the probiotic contributes to a more efficient barrier between the inside of the gut and the outside, blocking pathogens.

Shrimp immunity and disease resistance

The shrimp immune system differs from that in fish. Important immune parameters of white shrimp include haemocyte count, haemocyte differentiation and phenoloxidase (PO) activity. A study was conducted to evaluate these immune parameters after six weeks feeding with 0.5% AquaStar® Growout. The results showed that probiotic supplementation significantly increased the haemocyte abundance, with a greater proportion identified as granular haemocytes. These

cell types have important functions in the storage and release of the proPO system. This also explains the higher PO activity in probiotic supplemented shrimp (Table 2).

Improving immunity in aquatic animals is of critical importance, especially as there are many opportunistic pathogens in the aquaculture environment. It is therefore important to confirm if the enhanced immune status in shrimp described above, did indeed correlate to better pathogen protection, and greater disease resistance. In a follow up study, AquaStar® Growout was supplemented at 0.3%, in white shrimp diet for 12 weeks, prior to an IM *Vibrio parahaemolyticus* challenge (5 x 10⁴ CFU/shrimp). Shrimp were observed and dead/moribund animals recorded and removed until the infection had passed (Figure 4).

After the *V. parahaemolyticus* challenge, mortalities were observed in all treatments, eluding to a high virulence of the pathogens

(Figure 4). This probiotic AquaStar® Growout appeared to improve disease resistance with the lowest mortality occurring in the probiotic treatment (51.8%), compared to 66.1% in the control. In real terms, this translates to a 21.6% improvement in survival. Interestingly, the application of AquaStar® appeared to delay the onset of the disease, until 36 hours, instead of 12 hours in the control treatment. In the field, this extra 24 hours could provide enough time for the farmer to identify the disease threat and put additional measures in place. This means that in a commercial setting mortality could be further reduced when using probiotics.

Conclusion

The use of AquaStar® Growout is supported by extensive R&D. The strains can colonise the gut of both fish and shrimp where they can exert their probiotic benefits, which include improved barrier function, enhanced immune status and disease resistance. This opens the door to healthier animals, fewer instances of disease and less chemotherapeutical intervention in aquaculture production.

At the farm level, the probiotic can be top coated onto the feed, using water as a carrier. At the feed mill, the product can be added with oil as a carrier with strong mixing.

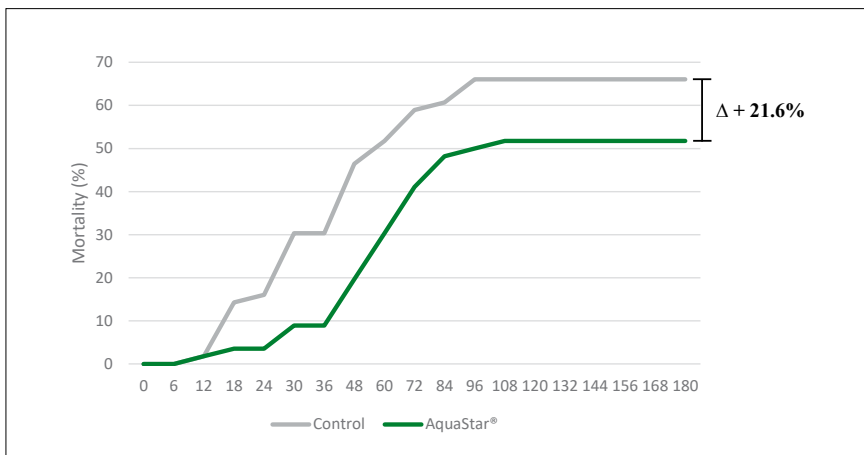


Figure 4. Mortality of shrimp in experimental treatments for a period of 180 hours (approximately 8 days) after *Vibrio parahaemolyticus* challenge.



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Rise of RAS and the need for feed enzymes: a proposition

By M A Kabir Chowdhury

Can enzymes be used to improve nitrogen utilisation and reduce nitrogenous wastes to meet the feed specifications specifically designed for RAS farming?



In recent years, recirculating aquaculture systems (RAS) have been gaining popularity worldwide. Efficiency of a RAS system largely depends on its nutritional wastes removal capacity. To improve the efficiency of the system, there is a need to reduce the nutritional wastes.

Some commercial feeds are already in the market specifically designed for RAS farming system. However, little is known about these feeds' ability to improve system performance. It is a well-known fact that feed enzymes can improve nutrient utilisation by the animals, thereby, reducing nutritional waste output and organic load in the culture environment. In this article, we discuss some examples of using protease enzymes in aquafeed at various experimental set-ups to improve nitrogen utilisation and reduce nitrogenous wastes.

Improving protein efficiency ratio (PER)

The protein efficiency ratio or PER is calculated as body weight gain/protein intake. As we know, crude protein is usually calculated as 6.25 X N. Improving PER will therefore reduce the nitrogenous wastes to the rearing environment.

In Figure 1, data from various commercial trials conducted in laboratories (I) or cage farms (C) are presented. On average, there is a 14.3% increase in protein efficiency ratio, when a dietary protease is added to the diets.

The improvement in PER when a protease is added to the diets, largely depends on the type of raw materials used, crude protein and digestible protein levels, type and level

of the dietary protease as well as the animal density. For example, in the case of the snakehead fish trial, better improvement in PER was reported in high density (HD) treatment compared to those reared in low density (LD) treatment.

Improving nitrogen digestibility

Among the aquafeed components, the most expensive raw materials are the protein sources. To optimise the cost of feed, formulators and nutritionists are forced to utilise more cost-effective raw materials. However, the use of these cost-effective sources in aquafeed has been limited due to imbalance or poor amino acid profiles, poor nutrient digestibility, and presence of some anti-nutrients.

It has been shown that using ex-vivo enzymatic treatment or in-feed enzymes can improve nutrient digestibility of these poor-quality raw materials. In Figure 2, apparent digestibility coefficient of nitrogen (ADC N) is presented. In all cases, the ADC N was increased in all diets containing protease irrespective of species type. However, the increase is more pronounced in poorly digestible diets. For example, in shrimp, the ADC N improved from 1.6% (18% fish meal diet) to 3.6% (10% fish meal diet) to 4.5% (0% fish meal diet) when a protease was added to the diets.

Reducing nitrogenous wastes (NH₃-N)

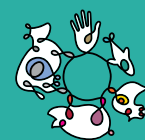
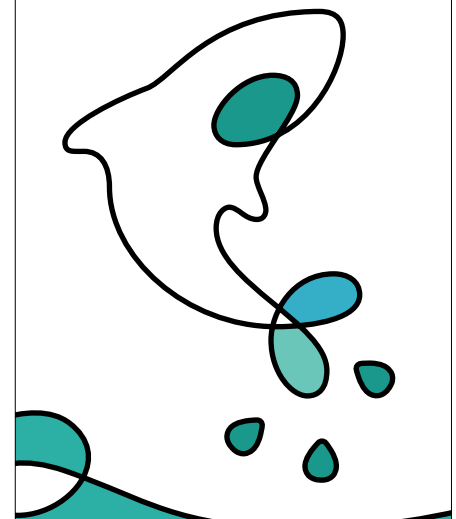
It can be predicted that as utilisation of feed-nitrogen improves by the addition of dietary protease, there will be less wastes to the system.

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Sand Plains Aquaculture producing red tilapia and barramundi in Ontario.

In Figure 3, ammonia excretion by yellow catfish fed protease supplemented diets was measured. This trial was conducted in laboratory environment where graded levels (125, 150 and 175 mg/kg) of a protease were added to the control diet. All treatments were pair-fed (same amount of feed) for two weeks. During this trial, the level of excreted ammonia was measured daily. The data are presented here as the average hourly ammonia excretion (mg/kg/hr).

A linear decrease ($y = -0.14x + 8.9$, $R^2 = 0.93$) in hourly ammonia excretion was observed with the increasing level of dietary protease. Despite the decrease, there were no differences in ammonia excretion between the control and the treatments with 125 and 150mg/kg dietary protease. However, significant differences ($P < 0.05$) were observed between the control and the treatment fed 175mg/kg protease supplemented diets.

Summary

Similar results can be summarised for other enzymes such as phytase for phosphorus utilisation as well as carbohydrase such as xylanase, beta-mannanase and cellulase for better utilisation of dietary non-starch polysaccharides. However, the choice of enzymes must depend on the availability and type of the substrates. Arbitrary use of enzymes without proper understanding of the types and their substrate preference may well be a waste of valuable economic resources and must be avoided.



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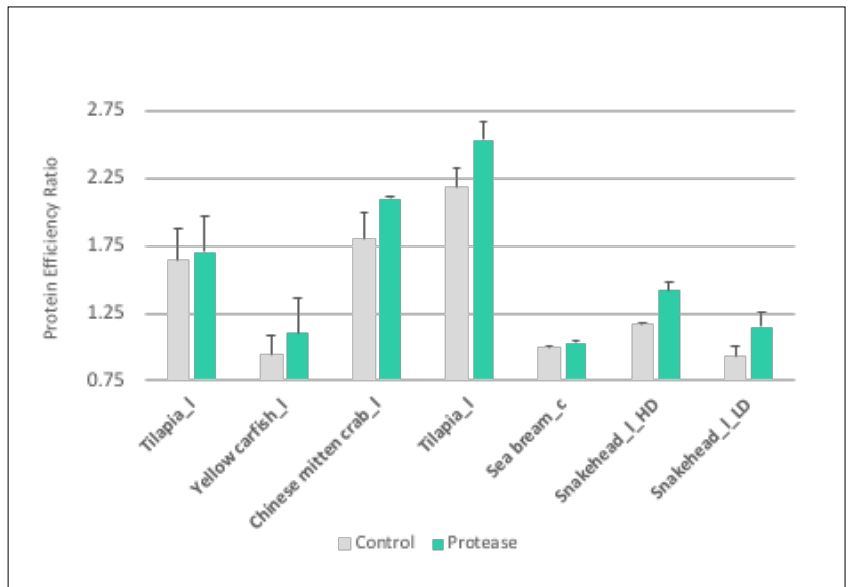


Figure 1. Protein efficiency ratio of diets with and without a protease in various species.

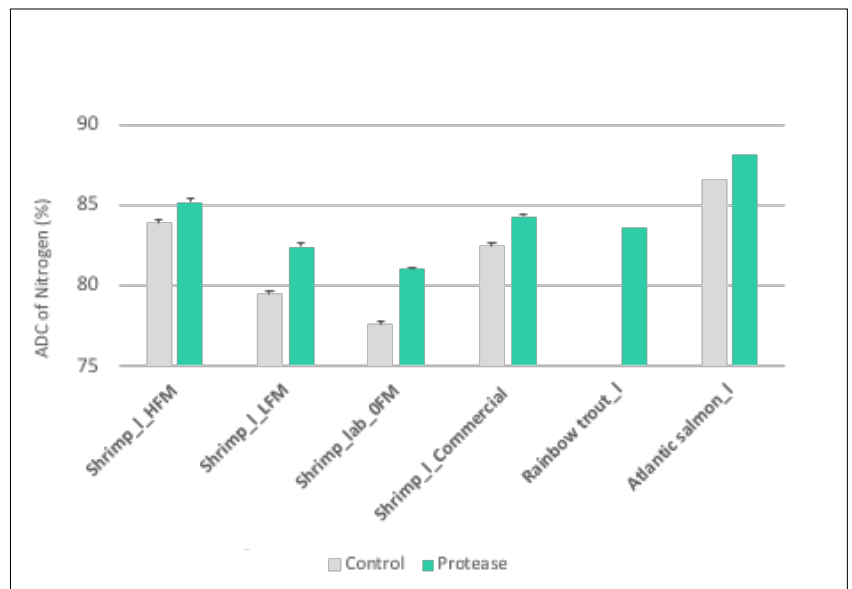


Figure 2. Apparent digestibility of nitrogen (ADC-N) of diets with and without a protease in various species.

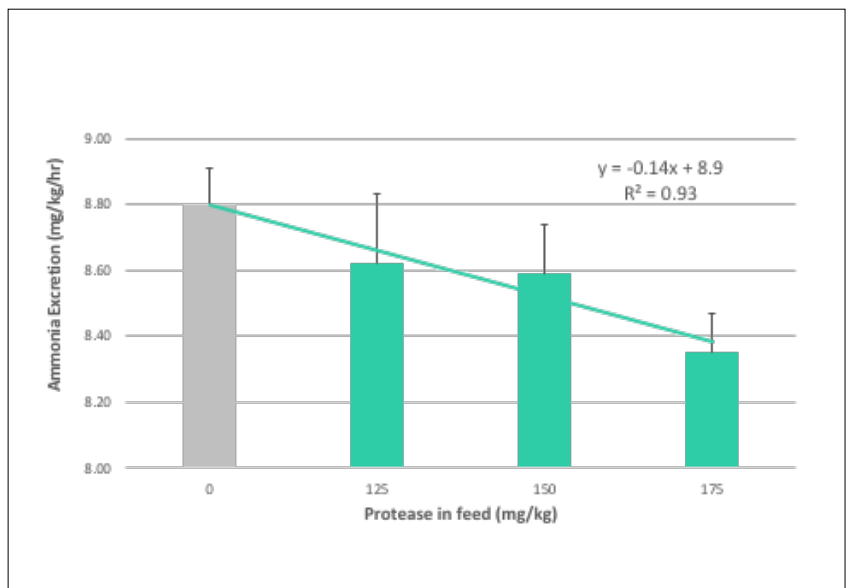


Figure 3. Ammonia excretion by yellow catfish fed diets containing graded levels of a protease

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Novel functional ingredients and shrimp feeds

By Suresh M. Menon

Promoting health and growth through value-added, novel ingredients can support more efficient production.

Part 1. Global production and impact of diseases, new disruptive technology, health and growth promotion and results from commercial farms in India



The inclusion of functional ingredients can improve growth and shrimp survival rates, their overall health and product characteristics, and decrease time to market size – thus increasing key production efficiencies and competitiveness for farmers.

Global production and the impact of diseases on farmed shrimp

During the last four decades, the farming of various marine shrimp species has developed tremendously and farmed production nowadays contributes to over 50% of the world's shrimp demand. Current estimates for farmed shrimp production in 2018 ranged from over 3.5 million tonnes (National Fisheries Institute, Shrimp Panel, January 2019) to almost 4.5 million tonnes according to the last GOAL data (Anderson et al. 2018). Uncertain and shifting global prices are seriously impacting many producers around the world. Thus, the development and expansion of markets as well as greater production efficiency are crucial for the entire industry along its value chain.



The global production of farmed shrimp has grown four-fold in the last four decades.

Many animal producing industries – including aquaculture and shrimp farming – are affected by various production inefficiencies, including the impact of various major diseases and the inability to address these problems. Reduced growth rates, the inability to reach their potential as well as the injudicious use of antibiotics and other substances are common

challenges faced by producers. Improved production efficiency – including faster growth, enhanced survival rates, shorter time to market sizes, improved product characteristics (better organoleptic characteristics) – are key goals for all animal production industries including aquaculture.

Value-adding aquafeeds with the inclusion of functional ingredients can, aside from better growth and survival rates and overall health, provide greater consumer acceptance and decrease time to market size. The ultimate target is better competitiveness for consumers.

The impact of diseases on farmed shrimp

Since the beginning of shrimp farming several decades ago, several major viral, bacterial and parasitic diseases have affected shrimp production. Disease outbreaks are more serious in the last two decades. Foremost among these major diseases are those of viral origin, including the infectious hypodermal and hematopoietic necrosis virus (IHHNV), yellowhead virus disease (YHD), Taura syndrome virus (TSV), white spot syndrome virus (WSSV), and the infectious myonecrosis virus (IMNV). Some of the above have been affecting the industry since the early 1980s and have caused billions of dollars in losses in shrimp farming areas in Asia and the Americas.



Global shrimp production is significantly affected by several diseases caused by bacteria, viruses and other pathogens. Photos by Fernando Huerta.

Other more recent diseases include the acute hepatopancreatic necrosis disease (AHPND) or early mortality syndrome (EMS), caused by *Vibrio parahaemolyticus* – which causes hepatopancreas dysfunction and secondary *Vibrio* infections. Another recent disease is hepatopancreatic microsporidiosis, also called EHP, the acronym for *Enterocytozoon hepatopenaei*, caused by a tiny microsporidian parasite that affects shrimp by disrupting their digestive systems. EHP has affected shrimp production and caused widespread problems throughout Asia. EHP has been reported in the Americas too. White faeces syndrome (WFD) is rampant in many parts of Asia and was recently reported in a Latin American country. There is also the newly discovered iridescent virus called shrimp hemocyte iridescent virus (SHIV) causing high mortality in farmed *Litopenaeus vannamei* in China.

Shrimp diseases have caused significant economic losses to the industry, amounting to at least USD45 billion globally in the past decade, according to Andy Shinn, Fish Vet Group Asia. WSSV alone has caused accumulated losses of around USD15 billion and AHPND causes value-added losses of around USD1.7 to 2 billion annually (Shinn, 2018).

Shrimp diseases also have a very significant, negative effect on investors; the history of the industry is one of periodic, major disease outbreaks and continuous health management issues



Shrimp diseases have caused significant economic losses to the industry, amounting to at least USD45 billion globally just in the past decade.

that upset markets and the supply chain, and is a major concern to potential investors. In fact, at the recent GOAL 2018 meeting in Ecuador, disease problems were once again identified by survey respondents from Asia and posed the top challenge faced by the industry. Many investors see the potential in shrimp farming and consider it a very good profit-making opportunity but are also concerned with the management of disease risks. Improved nutrition of shrimp through novel functional ingredients may be one way forward.

Functional ingredients promote health and growth

There are many functional ingredients or additives that promote the growth, development and health of farmed shrimp. These can improve their immune response and other physiological responses and needs, ranging from reproduction, responses against oxidative stress, susceptibility to some diseases and environmental stressors (water quality, temperature, fluctuations of oxygen and salinity), function of the gastrointestinal tract (including rapid repair of the gut) and improved microbiome.

Several functional ingredients are currently used in commercial shrimp feeds, including phytochemical substances, immune-stimulants, enzymes, mycotoxin binders, organic acids, probiotics/prebiotics and nucleotides. There is an extensive scientific literature on the effects of prebiotics, nucleotides and peptides on the growth performance, disease resistance and immune response, and intestinal morphology in penaeid shrimp, including that for *L. vannamei*.

Nucleotides play an important role in animal growth during the early stages because they promote fast growth and cellular replication, enhance disease resistance and tolerance to stress, support and promote innate and adaptive immunity, and are involved in the biosynthesis of non-essential amino acids.

Dietary nucleotides also promote the growth and performance of penaeid shrimp. Dietary inclusion of nucleotides in diets of young shrimp leads to improved specific growth rates and weight gains to harvest sizes. Improved feed conversion rates and more efficient utilization of lipids and proteins have also been reported. Dietary nucleotides also improve the efficiency of digestion and nutrient absorption, and reproductive performance including egg diameter, absolute fecundity and latency period.

As fishmeal inclusion levels continue to be reduced, driven by economics and sustainability pressures, supplementation with novel functional ingredients will likely have a growing importance for optimal performance of several key production parameters in farmed shrimp production.

Novel, disruptive technology

US based Menon Renewable Products, Inc. is engaged in the development and production of sustainable, high-quality, protein and nutrient-rich animal feed products. Using a patented

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Contacts

Krishna R. SALIN, PhD (Co-Chair) HUANG Xuxiong, PhD (Co-Chair)
Asian Institute of Technology (AIT), Thailand Shanghai Ocean University (SHOU), China

process, hydrocarbon-based sugars from agriculture-based raw materials are converted into functional animal feed ingredients. These ingredients, under the brand name MrFeed®, are renewable alternatives to non-sustainable feed ingredients currently in the market, such as fish meal. These novel ingredients represent a disruptive technology that significantly enhances the health of animal immune systems, leading to higher survivability and accelerated growth.

The inclusion of a spectrum of unique prebiotics, nucleotides and peptides has produced a functional ingredient that reduces the need for antibiotics and other health remediation treatments. The utilization of abundant agricultural products and related by-products in its production has reduced environmental pressure and improves the carbon footprint of aquaculture and livestock operations. In contrast, many competing technologies utilizing grains, animal rendering by-products, insect meal, algae, single cell proteins, fish oils, etc., to make feed, have anti-nutritional attributes or generally have one or more issues including sustainability, scalability, economic viability, operating efficiency and/or digestibility.

Our functional ingredients overcome the anti-nutritional factors of many traditional feeds, and also replace and complement various grains, animal by-products, fish meal and other components currently included in finished aquafeed formulations, fulfilling an increasing worldwide demand for sustainable and renewable feed. A series of trials reported here prove the superior performance achieved versus traditional feeds in terms of survivability, growth and health remediation.



(Left) The patented process at Menon Renewable Products converts hydrocarbon-based sugars from agriculture-based raw materials into functional animal feed ingredients.

(Right) Tests of our shrimp ingredient incorporated into commercial feeds at several commercial shrimp farms in Asia and Latin America have shown distinct and significant improvement in shrimp growth, survival and feed conversion rates, even in the presence of major diseases.

For the last three years we have conducted – and continue to do so – extensive testing of our products in several Asian and Latin American countries and under commercial production conditions with the support of many shrimp farmers.

Our shrimp trials continue as we expand our commercial presence in major shrimp farming areas, and we are also involved in and expanding our research efforts to other commercially-important species like salmon, trout, tilapia, pangasius, pompano, yellowtail, barramundi and others – to responsibly support the improvement of key production parameters, and industry sustainability and profitability.

Performance at commercial shrimp farms

To date, several thousand tonnes of commercial shrimp feeds have been value-added with these functional ingredients and used by commercial shrimp farmers in various states of the country and results show improved survival and growth rates in shrimp with our ingredients. The Figures 1-2 summarize some of these results from shrimp farm in Andhra Pradesh state in India.

Most of these farms that had previously experienced complete pond failures due to various shrimp diseases, such as WSSV, EHP and WFD, reported achieving successful crops when using feeds supplemented with this ingredient.

In part 2 of this article we will present the global results of commercial trials by shrimp farmers and laboratory studies with this functional ingredient added to commercial feeds at several commercial shrimp farms in various Asian and Latin American countries.

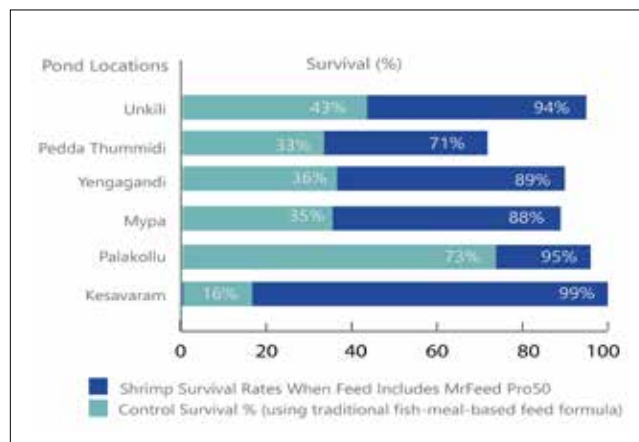


Figure 1. Data from commercial shrimp farmers in India showed that shrimp fed with a commercial feed containing MrFeed® Pro50 showed more than double the survival rates of shrimp fed with control feeds (no addition of the functional ingredient). Note: This functional ingredient replaced 50% of the fish meal in finished feed formulations and represented approximately 15% of the total finished feed weight. Higher survival rates may be possible with full replacement of fish meal. Source: Independent testing by a major Indian feed producer at independent shrimp ponds in Andhra Pradesh state.

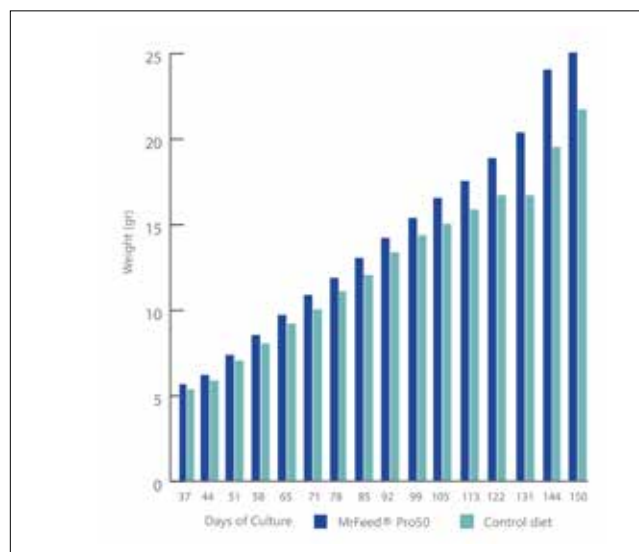


Figure 2. Data also showed that the shrimp fed with a commercial feed value-added with MrFeed® Pro50 had higher growth rates compared to the control feed. Source: Independent testing by a major Indian feed producer at independent shrimp ponds in the Andhra Pradesh state.

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Pepti-day on functional hydrolysates

Sharing research updates on nutrition and health in fish and shrimp and along the value chain, towards a better and sustainable aquafeed business.

In March, prior to the opening of VIV Asia 2019 in Bangkok, Thailand, Diana Aqua, producer of marine ingredients for aquafeeds organised a Pepti-day to share the latest research results and developments with customers from the Asian region. Diana Aqua with its Asian office and production facilities in Thailand, has standardised functional tuna, squid and shrimp hydrolysate product lines under the Aquativ brand. The last Pepti-day was held in conjunction with Asian Pacific Aquaculture 2013 in Ho Chi Minh City, Vietnam. Year 2019 also marked the 10th anniversary in Thailand for SPF Diana (Thailand) Co., Ltd (the Diana Group subsidiary producing both aqua and petfood ingredients in its plant). Here, while Diana Aqua manufactures seven products for the aquafeed industry, Diana Petfood has 25 products.

Diana Aqua, a pioneer in controlled enzymatic hydrolysis process, focuses on delivery of solutions to enhance the nutrition and health of fish and shrimp. In a joint welcome message to the 100-odd participants from the region's aquafeed industry, Jerome Le Friec, CEO, Diana Aqua and Cedric Boistard, SPF Diana Thailand - General Manager, said, "Since 2009, we manage to stay one step beyond market fluctuations, thanks to investments and constant improvements and developments of our products. These achievements could not be reached without the expertise of our local and global teams and, of course, our faithful partners and customers."

Introducing the conference theme, "Trust and consistency for sustainable aquaculture", Paul Seguin, Asia Pac Business Development Director and Dr Fabio Soller, Technical Director Asia Pacific presented some recent timelines. Recognising industry's concerns with ethoxyquin in seafood in the region, Seguin proudly announced that since 2015, Diana Aqua has worked towards ensuring its products are ethoxyquin-free. During 2016, the company doubled its capacity and obtained IFFO-CoC certification for tuna base hydrolysate in 2017. Since 2019, shrimp hydrolysate was added to its portfolio, in addition to tuna hydrolysate which was introduced in 2009.

Adding value to aquafeed: a success story

In the first presentation, Soller described Diana Aqua's partnerships in the aquafeed business. "As with any sustainable business, all partners will wish to grow. In any industry, cooperation is necessary. If we want to grow, we cannot depend on just one researcher or just one feed mill. Progress is learning together to reach



Left photo: Chakrit Ridmontri (left) and Komkiat Kruepengkul.
Right photo: (From left) Fabio Soller, Vincent Fournier and Bundit Yuangsoi.

our goals. Each person and company can have their goals but, in the end, we come together to meet the needs of the clients. Research is to find answers, but we need to ask whether the clients and the farmers are happy." Albeit, he added, that sometimes there can be some short sightedness; what one partner sees as critical may not be the same for the other partner.

When working with a feed miller to develop a diet, Soller said, "The process involves working together - purchaser, production and quality control staff, salesforce and the client. Then we look at developing a tailored feed; we will proceed to analyse the pros and cons of the product. We look at the nutritive value, palatability and immune functions. Thereafter, trials are carried out at the laboratory, feed mill and farm. We need to know the needs of our clients and ensure that they are happy."

The search for answers will lead to feed mill and farm trials. In an analysis of biogenic amines in products, Soller said that these are present in fish solubles, low cost fish hydrolysate powder, low cost fish soluble hydrolysate, standard soluble and liquid tuna hydrolysate. "We compared the composition (ppm) of putrescine, cadaverine and histamine which was high in the first three ingredients. Rarely understood is that putrescine is the by product from degradation of arginine, and cadaverine of lysine. Under European Union regulations, for animal feed, cadaverine should be less than 2ppm, as it damages the internal organs of animals."

In a 72-day farm trial, stocking at 100 post larvae/m² in four earthen ponds to compare growth performance between two commercial diets and two diets with low marine ingredient and 2% hydrolysates, Soller said, "Average body weight and feed conversion improved, but not significantly but survival and production was 12.5% and

27.1% higher, respectively. The farmer's attention was not on the higher feed price, but the fact that the profit was 33.3% higher."

Soller concluded that for Diana Aqua it will be a continuous learning process. His message was, "We need to listen to all parties, and analyse critically their needs without being judgmental. To win, we need to be partners."

Overview of benefits and mechanisms of action

Over the last 10 years in France, Dr Vincent Fournier, R&D Manager, has been working on the functional aspects of protein hydrolysates: palatability, nutrition and health benefits. At this Pepti-day, Fournier discussed results from recent research. "To date, we have conducted more than 100 trials in fish and shrimp to establish proof of concept. Our research covered eight fish and two shrimp species - Asian seabass, tilapia, snakehead, red seabream, olive flounder, European seabass, gilthead seabream, rainbow trout, black tiger and vannamei shrimp. Some of these were published in peer-reviewed journals and Diana Aqua has a patent granted, demonstrating the gut health benefit of dietary crustacean hydrolysate in fish.

Fournier reminded and stressed to the audience that, "Hydrolysis is the process which yields the maximum of bioactive peptides out of the raw material protein. The number of peptides and free amino acids produced could be more than 10 times for powder and 3 times for liquid hydrolysates compared to the best quality fish meal. The peptide profile is like a fingerprint of hydrolysate produced and will vary with raw material freshness, enzyme specification, processing equipment and hydrolysis recipe. Product and process standardisation to guarantee performance consistency are essential."



Kurniawan Ristono, Diana Aqua, Indonesia (right) with participants from left, Hendi, PT. Leong Hup Indonesia, Okdivina Sitepu, PT Aquafarm - Feed Mill Medan and Parsiholan Nairbohu, PT. Leong Hup Indonesia (formerly PT. Feedmill Indonesia - Malindo group).

Palatability benefits

Stress has consequences on feeding behaviour of fish and shrimp, resulting in a decrease in feed intake and growth performance. The palatability of hydrolysates was shown in fish and shrimp under stressful conditions such as low fish meal diets and low/high salinity and low/high temperature culture conditions. The first example given was the European seabass. When the fish meal level was reduced from 50% (premium feed) to 20% (standard feed), the growth performance was significantly reduced and the number of low value skinny fish increased as a result of low feed palatability. The supplementation of 1.5% protein hydrolysates to the standard diet increased growth rate to reach a performance very close to that of fish fed the premium feed. In another trial where a wintering challenge was applied to Nile tilapia, growth performance of fish fed diet supplemented with 2% protein hydrolysate improved compared to the control diet," said Fournier. "Fish have the same taste receptors as in most vertebrates and can detect very efficiently amino acids. Taste buds are stimulated by free amino acids and peptides. This is followed by the enhancement of appetite. We know that chemoreceptors of shrimp can also detect very efficiently free amino acids and peptides but we need to do more work on shrimp feeding behaviour and preferences to identify the best drivers of feed palatability."

In terms of application, hydrolysates can boost palatability of feed formulated with lower grade and level of fish meal and medicated feeds. Dietary hydrolysate application can also allow fish to revert to high feed intake after stressful circumstances such as after weighing, vaccination and veterinary treatment or during challenging conditions (wintering and warmer temperatures of water).



"They quickly and efficiently cross over the intestine membrane to be assimilated by the animal."
Vincent Fournier

Nutritional and health performances

A trial was conducted in vannamei shrimp in South Korea, where 5% squid liver meal was removed in one treatment diet and substituted with 1.5% tuna hydrolysate and soybean meal. Comparing with other treatments, diets with tuna hydrolysate performed better than the commercial diet with squid liver meal. "There was less total marine protein in the diet supplemented with hydrolysate but what we provided was better quality protein and amino acids as evidenced by the higher apparent amino acid digestibility of diet containing hydrolysate. When shrimp were challenged with *Vibrio harveyi* at the end of the nutritional trial, there was a significant improvement in survival as compared to the control," explained Fournier.

"In a trial conducted in red seabream, we reduced the fish meal to 25% from 40% and added 5% shrimp hydrolysate. Growth and feed performances were higher for the fish fed the diet containing the hydrolysate. During the challenge with *Edwardsiella tarda*, we saw higher survival in fish fed dietary hydrolysate."

"In Asian seabass, we showed how adding either 3% or 5% shrimp hydrolysate to a commercial diet, improved growth performances at the nursery and grow-out stages. In addition, during a natural *Flexibacter* outbreak, the diets supplemented with the hydrolysate improved survival significantly compared to the diet containing no hydrolysate. An experimental bacterial challenge with *Vibrio parahaemolyticus* confirmed the better resistance of fish fed dietary hydrolysate compared to the commercial diet."

Fournier explained, "The nutritional performance of hydrolysate is due to the high proportion (more than 70% of the total protein of hydrolysate) of digestible free amino acids and small peptides. They quickly and efficiently cross over the intestine membrane to be assimilated by the animal."

In the discussion on health benefits, Fournier said that more than 1,000 different peptides have been identified in protein hydrolysates developed by Diana Aqua. Some are bioactive peptides that have biological activities ranging from antimicrobial, antioxidant to anti-inflammatory. These peptides will enhance fish and shrimp metabolism resulting in higher resistance to stressful conditions

and pathogens. "We showed that tuna hydrolysate contains many antimicrobial peptides that are active against pathogens such as *E. tarda*, *Yersinia ruckeri*, *Vibrio alginolyticus* and *Vibrio nigripulchritudo* and can also induce innate immune pathways."

Peptides in snakehead fish diets

Dr Bundit Yuangsoi, Department of Fisheries, Khon Kaen University, Thailand, said in his presentation on "The potential and application of protein hydrolysate in snakehead fish" that aquafeed prices can be successfully manipulated and made profitable with the use of fish meal replacements. He discussed the potential and application of protein hydrolysates in feeds for the snakehead fish *Channa striatus*, a carnivorous freshwater fish, popular in Thailand and in the Southeast Asian region.

There is already information on the growth performance of various farmed marine fish species such as the Atlantic cod, European sea bass, Olive flounder, red sea bream and turbot and for freshwater species such as Nile and Mozambique tilapia and Persian sturgeon fed fish protein hydrolysates. "The snakehead fish requires high protein diets, as much as 40% crude protein, usually from marine protein meals. This makes the fish a good candidate for fish protein hydrolysate as replacement for fish meal," said Bundit, when reporting on the study to investigate the effect of culture system on growth performance, feed utilisation and immune response of snakehead fish.



"Immunological parameters studies proved the immune response capability of the tuna hydrolysate fed to the snakehead fish."
Bundit Yuangsoi

There were two phases in this study. The indoor phase I consisted of five treatments and four replicates/treatment in 500L tanks. Fish were stocked at 60 fish/tank and fed 3 times/day. Water was exchanged every 3 days over the 4-week trial. This was followed with phase II in an outdoor system in earthen pond of 8m³. There were five treatments, each with three replicates. Fish were stocked at 70 fish/pond and were fed 3 times/day. Water exchange was 30% over the 2-month trial. Treatment diets comprised diets where



Jerome Le Friec (third row, right) and Paul Seguin (second row, second right) with speakers and participants.

the fish meal component was reduced to 20% with soybean meal, corn protein concentrate, corn and poultry-by product meal. Either 2.5% tuna hydrolysates or poultry hydrolysates were included. These diets had 35.5 and 35.1% digestible protein and 8.6-8.8 crude fat. Their performance was compared against a commercial diet with 37.3% crude protein (CP) and 33.5% digestible protein (DP) and a positive control with high fish meal (32%) and a low fish meal negative control (20%).

With regards to growth performance parameters, Bundit, said, "Feed intake, weight and specific growth rate (SGR) were significantly higher for the treatment diet containing tuna hydrolysates. Immunological parameters studies proved the immune response capability of the tuna hydrolysates fed to the snakehead fish."



"Enhancing feed quality requires accurate additives dosing which in turn, requires proper equipment and good practices."
Komkiat Kruepengkul

Liquid applications

"In aquafeed production, dosing of heat sensitive liquid ingredients requires proper equipment and good practices," said Komkiat Kruepengkul, Technical Manager, Mechsystem. In a presentation titled "Best practices of liquid application in aquafeed mills," step by step, Komkiat shared his experiences in setting up some systems for liquid applications in aquafeed mills. He also discussed methods and technology, existing system survey before application, equipment for liquid application guide and finally applying liquid hydrolysates in feed processing. The applications for liquid dosing range from mixer liquid, preconditioner and post pellet, to coating liquid and continuous dosing. "Enhancing feed quality requires accurate additive dosing which in turn, requires proper equipment and good practices," said Komkiat.

Prior to developing the best application system for a feed mill, Komkiat suggested a survey as each feed mill would already have their processing systems in place. "They also have different needs and types of production lines. It also needs to define the total capacity/day and results expected from the liquid application system. Key factors are physical properties of the liquid, types of equipment and types of dosing." He continued with detailed specifications and flow diagrams for each application system, including that for liquid hydrolysates based on the properties of a standard liquid hydrolysate.

Sustainability in the aquafeed industry

Diana Aqua has clearly indicated its commitments towards sustainability. It focuses on industrial activity to minimise environmental footprint and maximise social impact. In responsible sourcing,

100% of raw material comes from locally sourced products and following strict specifications. Discussing "Sustainability in aquafeed industry: What & Why?" Chakrit Ridmontri, Asian Agribusiness Media, noted that based on FAO data, there is a need to use 43.5 million tonnes of feeds, calculated at an estimated feed conversion ratio of 1.5, to produce 29 million tonnes of fish to feed a growing population. "This requires massive volumes of raw material, ranging from fish meal, fish oil, soybean meal, wheat, corn to rice bran. It is important to know that fish meal and fish oil come from wild caught fish, which are under pressure from overfishing. Even land-based production of soybeans etc is under threat.

"Chakrit gave several examples of efforts by industry in Asia to make the industry, the environment, the communities and the society sustainable. In Vietnam, feed mills rely on renewable energy, by using agricultural by-products such as rice husks, cashew nut shells and straws to fuel boilers and generate steam for conditioning and pelleting of the feed pellets. In India, aqua feed manufacturers, fishery associations and seafood firms are joining forces to conserve stocks of Indian sardine, the main raw material for fish meal and fish oil production. In Thailand, the feed industry supports fish meal producers achieve IFFO's responsible supply standards; fish are caught responsibly and can be fully traceable. In Malaysia, clean energy such as natural gas is used in heating air for better drying of feed from extruder lines.

"The use of sustainably produced raw materials are important to satisfy the move towards sustainability in aquafeed production. In a consumer survey conducted by Aquaculture Stewardship Council (ASC) in 21 countries, it was revealed that sustainability is rated more highly than price and brand."

Integrating next generation sequencing into aquaculture

By Josiah Liew and Ju Lin Tan

Next generation sequencing brings biosecurity and quality assurance to a new level, ensuring safer foods from farm to table.

In 2017, the Malaysian Investment Development Authority reported that the food processing sector contributes 10% to the country's economy. The sub-sectors of Malaysia's food processing sector include cereal products, processed fruits and vegetables, and fishery products. When we talk about fishery products, they include, but are not limited to seafood, cod liver oil, and fish meal. The quality of these products depends not only on the health of caught/farmed fish and shrimp, but also on the environmental conditions of hatcheries and farms.

A rising industry

Aquaculture represents a rising industry for Malaysia and much of the developing world. Fish contributes a significant amount of dietary protein to diverse populations around the globe. Increasing demand from a growing consumer population presents both growth opportunities and challenges for producers and suppliers. At the forefront of the challenges is the establishment of a robust, flexible, and accurate food safety system. Compromised foods, whether from toxins, bacteria, or from adulteration, incur not only losses of economic value and opportunity, but also damage to company reputation leading to loss of customer trust. On the other hand, unadulterated and safe foods translate to economic growth.

This article seeks to provide an overview of a robust food safety system that incorporates molecular techniques. We will focus on the latest addition in investigations on food safety; next-generation sequencing. This powerful technology has the potential to transform the food industry through deep, rich data production and diverse applications.

Future of DNA technology

The cache of DNA-based methods for disease detection is ever-expanding. Some familiar methods include polymerase chain reaction (PCR), quantitative PCR (qPCR), loop-mediated isothermal amplification (LAMP), and pulse field gel electrophoresis (PFGE). Among these methods, PCR is still the most versatile method for disease detection.

PCR essentially functions via 2 primary components: target DNA and selective primers. Selective primers (which can be designed for different pathogens or animal species) attach to a target sequence of DNA. This attachment enables the 'amplification' of the target DNA. This



amplification makes millions of copies of the target DNA, thereby, enabling greater detection sensitivity. Additionally, PCR does not require cells to be cultured. Thus, it is not limited to pathogens that can be grown. Rather, PCR can detect any and every pathogen, provided the necessary primers are developed.

A new level with NGS

Next-Gen Sequencing (NGS) takes PCR to a whole new level. What NGS enables us to do is to test multiple samples at a single time to determine the constituent components within each individual sample. A single NGS run can process anywhere in the region of 60 to 120 samples and identify every constituent component within each sample through bioinformatic analysis. This technique greatly expedites the workflow.

This new technique produces a paradigm shift in biosecurity and food safety testing. The question we can ask has now changed from; "Is pathogen A in my food?" to "What pathogens are in my food?" Nothing is missed. The deep wealth of knowledge that NGS provides enable producers to make better-informed decisions with regards to their products.

Unique NGS Applications DNA barcoding

Seafood processing is one area of the industry that is susceptible to global counterfeit. Processed foods such as fish balls, crab sticks, fish nuggets, and even fish fillets can be counterfeited or spiked. A global seafood supply chain necessitates comprehensive identification of constituent components as an important national biosecurity and quality assurance measure.

More importantly, however, is that food fraud can also be detrimental to the consumer at different levels. A simple example would be the spiking of processed foods with food substances that are

not compatible with certain religious regulations (*halal* or *kosher*). While this may not necessarily be detrimental in terms of health, such an occurrence may cause a complete loss of consumer confidence in the product.

Another example comes from a 2017 study of fish samples to determine their origin. The study found that 37 of the tested samples contained meat from the *Lagocephalus* spp., a genus that includes the poisonous puffer fish. Such a situation implies a potential health issue.

Environmental monitoring for prevention

A unique application of NGS comes through its potential to streamline environmental monitoring and analysis. Two specific areas where environmental monitoring is vital is in the aquaculture facility and in the processing/storage facility.

Every location has a unique microbial community. The composition of this microbial community, called the microbiome, provides a unique monitoring tool for quality assurance personnel. In general, the microbiome within a facility stays regular over time. However, shifts in the microbiome population are signs that a major problem has happened.

Applying this principle to hatcheries or an aquaculture facility, a change in the microbiome of the water may be due to the presence of potentially pathogenic bacteria or some other contaminants that may be detrimental to the product. In the context of processing plants, changes in the microbiome may indicate the presence of *Salmonella* or *Listeria* spp., a signal for biosecurity measures to be enhanced. Microbiomes on conveyor belts, mixing vessels, table tops, and technician locker rooms are areas that can be monitored using NGS.



“Producers can maximize their production through informed decisions supported by data, while the suppliers and distributors are able to maintain the best product quality possible.”

As with everything related to human health, prevention is better than cure. The depth of data and the unique applications of NGS provides a robust system for prevention. From disease surveillance in hatcheries to hygiene levels in processing plants and food quality in the final product, NGS provides a unique and powerful solution.

Integrating NGS into our current food safety

It is imperative for policy makers to work towards increasing consumer confidence in food safety based on sound technical capability and scientific evidence. Such a biosecurity and food safety program increase the consistency and quality of the supply chain. Producers can maximize their production through informed decisions supported by data, while the suppliers and distributors are able to maintain the best product quality possible. All these factors result in value-added products for the consumer who, in turn, can be confident in the quality and type of the product they purchase. In turn, these translates into economic opportunities for both the producers and suppliers.

In conclusion, a strong food system of the future is one that produces not only a lot of food, but a lot of quality assured foods. (NGS) is a novel and powerful tool that is a forward step towards better food safety in Southeast Asia.



Understanding Food Safety Management Systems Certification Standards

Source: http://glenwood.ph/tech/wp-content/uploads/2017/10/Food_Safety_Glenwood_Technologies_Food_Safety_Life_Matters_Food_Safety_Trends_Philippines_Magazine_Food_Safety_Glenwood_Food_Safety_Management_Systeme.jpg



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Dr Ju Lin Tan is scientist at GeneSEQ Sdn Bhd. She graduated from La Trobe University, USA and is an experienced molecular biologist focusing on using the powers of NGS in addressing challenges in food safety. Email: julintan.geneseq@mylabind.com



No two sets of DNA sequence are alike, as each set comes with a different string of characters. These characters, known as nucleotides, have a unique arrangement which gives a distinct identity to each species.



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'Feed to Food in Asia' at VIV Asia 2019



VIV Asia, the no. 1 international trade show from Feed to Food in Asia, since 2017, took another step forward in strengthening its international appeal with a 7% increase in visits from outside of the host country, according to its organizers in a show review released in May. VIV Asia was the 16th edition under the concept of "Feed to Food" and was held from March 13-15 at BITEC, Bangkok, Thailand. Organizers, VNU Asia Pacific Co Ltd and VNU Exhibitions Europe, said, "The enthusiasm and energy distinguishing the Feed to Food Asian markets resonated at BITEC throughout the show time, giving all attendees another memorable experience at VIV Asia."

It was the biggest international industry gathering for animal protein businesses in Asia; 65% of the total 45,023 visits registered were from outside of Thailand, confirming the international flavour of this show. Local visitors comprised 35%, against the 39% Thai visits audited in 2017. Overseas visitors came from more than 120 countries. China, once again led with the most numbers of visitors after Thailand, significantly increasing its attendance by 12% compared to the previous edition. Following China, the top 10 visiting markets this year were: India, the Philippines, Vietnam, Indonesia, Malaysia, Bangladesh, Korea, Taiwan and Pakistan.

The 2019 edition had 1,245 exhibitors - an 18% increase compared to 2017 from 62 countries, using 30% more space than in 2017. There were 10 international pavilions which showcased a number of new companies and brands. In particular, the Canadian and Japanese pavilions proudly marked their new entry into the VIV Asia line up in 2019.

Aquatic Asia 2019

A small cozy pavilion area with exhibitors focused on the needs of some 16.3% of visitors who showed specific interest in fish and shrimp. However, all over the trade show, companies also showed that they too, had products for the aquaculture industry, as indicated in the busy booths of Adisseo/Nutriad, Biomin, Alltech and DSM. Aquaculture had its share of activity with the Aquatic Asia 2019 conference and technical seminars conducted by some exhibitors.



Thayada Plyhirun, TRF Feed Mill Co., Ltd and Mahesh Nekkanti, Devi Seafoods, India.



From left, Rizky Darmawan, Director, PT Delta Marine Indonesia; Anwar Hasan, Regional Technical Manager - Aquaculture, Biomin and Jerry Jianguo Shi, Sales for Kona Bay in China, Vietnam and Thailand.



The team from Ao Kho Farm, Thailand; farm supervisor, Somthida (middle) and Kanokgoen Pakdeepak, and Nonthawit Sae-Hia, Quality Control Aqua/Consultant at TRF Feed Mill Co., Ltd (right).

Feed ingredients and additives

New exhibitors at the Aquatic Pavilion included Atacama Bio Natural Products S.A. a Chilean, biotechnology company marketing natural astaxanthin from *Haematococcus pluvialis* microalgae. A review on pigmentation improvements achieved in fish and shrimp was published in *Aqua Culture Asia Pacific*, issue January/February 2019. Another new exhibitor to VIV Asia was BCF Life Sciences, France which produces natural mixes of free-L form amino acids. Pierrick Kersanté, Application Engineer and Joël Duperray, R&D Scientific Support and Applications Manager, discussed a recent research they launched with Kasetsart University, Thailand, to better understand how the use of Kera-Stim 50, a product of poultry keratin hydrolysis rich in free amino acids, can influence shrimp feed intake. They used 2.5g juvenile shrimp and measured the attractability of pellets coated with powdered Kera-Stim by recording the time taken for the shrimp to pick up the pellets. Feed intake over an hour was measured. Results of these trials will be published in an article in *Aqua Culture Asia Pacific*, issue July/August.

At its booth, Blue Aqua International and Jebesen & Jessen Ingredients announced an exclusive distribution partnership for Blue Aqua's aquaculture and nutrition products in Myanmar, Vietnam, Cambodia, Malaysia and the Philippines (see p52).



Craig Hoines, Business Development Manager, IMV Imaging and team at the IMV Technologies booth demonstrating the systems available in the fish fertilisation chain.



At the Aker Biomarine booth, marketing krill meal and oil. From left, Chaiyot Rawekchom, SEA Sales Director; Simund Nordal, Marketing Director; Dr Alberto J.P. Nunes, Professor Labomar Brazil and Richard Liu, Technical Sales Manager China. At the Aquatic Asia 2019 conference, there was a presentation on krill meal as an alternative sustainable aquafeed ingredient by Dr Panukorn Totubtim, SEA Sales Manager.

Breeding and genetic chain

IMV Technologies is a leader in the genetic chain for farm animals. At the Aquatic Pavilion, the team explained the objective of the Aquaculture CryoLab which is to provide ready to use sperm all year round. The company highlighted its fast and reliable machines to freeze fish milt. There were also products such as Storfish to optimise fish fertility. Hendrix Genetics, the global multi-species breeding company entered into breeding and production of shrimp by partnering Kona Bay. The latter is a leading supplier of specific pathogen free (SPF) shrimp genetics. Today Kona Bay, as part of Hendrix Genetics, is backed by a strong genetics engine, innovative breeding programs, centralised research and technology and a global science network for information dissemination.



José Luis Arenas, CEO, Atacama Bio Natural Products S.A. (left) with guests; Dr Fuci Guo, Corbion Biotec, Inc, Malaysia (second left) and from Marine Leader Co., Ltd, Safit Phanich and Chairot Intaraksa (right).

Health management

At Aquatic Asia 2019 conference, Lallemand Animal Nutrition's Stéphane Ralite gave a talk on "Microbial and health management in shrimp farming" to around 100 participants, highlighting the importance of both gut and water microbial ecosystems on shrimp health and performance (see p50). At this conference, the Olmix Group had Alexandre Vielle presenting on the use of algae extracts for disease prevention; it also launched Algimun®, the latest algae-based innovation to reinforce animals' natural defences. This came after a successful European launch last November at the Breizh

Algae Tour 2018 (Berlin, Germany). There is great expectation on this product, not only due to its positive results in experimental tests and field trials, but also due to its unique composition. Algimun is based on a synergistic association of biologically active sulphated polysaccharides extracted from marine algae (Olmix's MSP).

Insect meal

The workshop on "Insect protein for livestock, aquafeed and pet food applications" was presented by Martin Zorrilla, Nutrition Technologies' CTO and Leo Wein, founder from Protenga. Both companies are focused on insects-as-feed and are based in Johor, Malaysia. They represented the Asian Food and Feed Insect Association (AFFIA, affia.org), an industry group based in Bangkok that promotes insects as human food and as animal feed. Currently, it has 12 members in the feed sector and 19 members in the food sector. Zorrilla and Wein described the new exciting technologies emerging within the insect production sector, the results of recent feed trials with insect proteins, and how their products are being used in aquaculture, swine, poultry and pet feeds. Nutrition Technologies specializes in the vertical production of larvae for protein meal and oil, while Protenga is in the supply of technology-enabled insect farming systems for biomass valorisation.



Besides an Antimicrobial Stewardship Seminar at VIV Asia 2019 discussing antibiotics, mycotoxins, phytochemicals and acidifiers for all species, BIOMIN had an exclusive invitation only Muay Thai Night (Thai boxing) in Khet Ladprao for its partners and clients. With guests, Dr Erich Erber, Founder and President and Dr Jan Vanbrabant, Managing Director.

The potential of balancing shrimp microbial ecosystems, from gut to pond

At Aquatic Asia 2019 Conference, held during VIV Asia in Bangkok, Stéphane Ralite, Aquaculture Product manager Lallemand Animal Nutrition, took a microbiological approach to shrimp health, highlighting the importance of both gut and water microbial ecosystems on shrimp health and performance. This fresh approach to shrimp farm management was well received by an audience of around 100 aquaculture specialists. Based on practical examples, Ralite demonstrated the link between these microbial ecosystems' equilibrium and shrimp health. He then discussed the possibility of securing this equilibrium by managing gut and/or water microbiota, as part of good shrimp farming practices. "Microorganisms play a crucial role in the success of shrimp farming, not only in the gut, but also in the pond water and soil. We start to have a good picture of the microbial composition of these three compartments, even though we are at the beginning of the story and much research still needs to be done in this area."

The link between shrimp health and gut microbiota is reciprocal. It is clear that the digestive microbiota plays a crucial role in shrimp health; it also appears that shrimp health, in particular the immune status of the shrimp, influences the composition of the digestive microbiota. The shrimp's ability to maintain a stable microbiota goes hand in hand with its resistance against pathogenic or environmental challenges. The application of new metagenomics techniques shows that it is possible to influence shrimp gut microbiota with probiotics in order to help enhance their resistance against pathogens or sanitary challenges.

Ralite presented the efficacy of probiotic bacteria *Pediococcus acidilactici* MA18/5M (BACTOCELL), the only probiotic authorized in the European Union for use in shrimp and fish, to help prevent the proliferation of *Vibrio* spp *in vivo*. The mode



Stéphane Ralite (centre) and the Lallemand Animal Nutrition team, from right, Khuong Duy Nguyen, Francois Cellier and. On the left, is Marc Campet, Neovia Asia, Vietnam.

of action of this probiotic in shrimp is well described. It has been shown, for example, to be effective in reducing oxidative stress. In consequence, shrimp are able to overcome important stresses such as pathogen pressure, temperature changes or pond transfer.

In addition, trials have shown that this probiotic, associated with an innovative multi-strain yeast fractions product, is effective in reducing the impact of white faeces disease. Finally, the pond water and soil ecosystems are equally important to maintain shrimp health and ensure optimal growth. It was shown with metagenomic data that, adding selected bioremediation bacteria in the water, improves the water microbial ecosystem, resulting in enhanced nitrogen cycling and ammonia control in the pond. This has a positive influence on the composition of the water, a prerequisite for optimal performance. In conclusion, shrimp microbial management should be a multifactorial approach, involving shrimp nutrition and management, as well as water and pond microbial management.

Vertical insect meal production in Malaysia

Founded in 2014 in Vietnam, by Tom Berry and Nick Piggott, Nutrition Technologies is an early-stage company based in Johor, Malaysia. It currently produces and exports insect proteins and oils from the pilot plant in Johor Bahru, Malaysia with a commercial scale factory in the works for Q1 2020.

"The reasons for placing our production facility in Asia are the low-cost environment, access to raw materials and proximity to the aquafeed market. We first started in Vietnam but the lack of clear regulations there were hurdles for us. In moving production to Malaysia, we found an environment that has been very welcoming to the type of innovative sustainable technology that we represent," said Martin Zorrilla, CTO and Nicholas Robin, during VIV Asia 2019.

"Our insect meal, from the larvae of the black soldier fly (BSF, *Hermetia illucens*) fed on a 100% vegetable diet, is an ideal ingredient (55% CP) for fish, shrimp, pets, poultry, swine and reptiles. The amino acids profile includes 3% lysine and 1.95% threonine. We are already selling our products within Malaysia and exporting to Korea, Japan and the EU," said Zorrilla. The oil which is mechanically extracted from BSF larvae has antimicrobial properties (41% lauric acid-C12) and 13.8% omega-6s.

The strength of each insect meal producer lies with the technological advantage reached. In the case of Nutrition Technologies, Zorrilla explained that they have used a bioprocessing system to optimize their system for tropical conditions. Another aspect is the research on insect nutrition, a very new field. "There is already domestication of the BSF but the key to successful production is to have the right microbiological conditions and feeding process." www.nutrition-technologies.com



Nutrition Technologies is an early-stage company in insect protein production, from right, Martin Zorrilla and Nicholas Robin.

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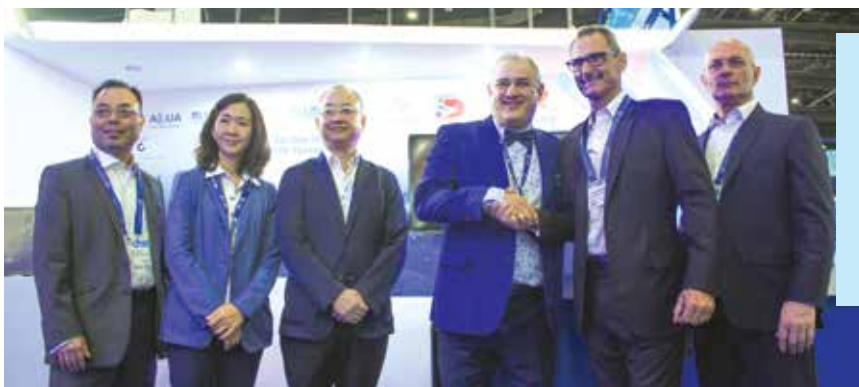
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New distribution partnership



(Left to right) The signing ceremony was attended by Paul Chan, Managing Director, Jebsen & Jessen Ingredients Thailand; Amornrat Boonchuay, Executive Vice President/Co-founder, Blue Aqua International; Viet Tinh Nguyen, Regional Portfolio Manager, Jebsen & Jessen Ingredients Vietnam; Dr Farshad Shishehchian, Marc Deschamps and Kenneth Jul Jensen, Managing Director, Jebsen & Jessen Ingredients Vietnam.

Blue Aqua International and **Jebsen & Jessen Ingredients** announced a new partnership that will see Blue Aqua's aquaculture and nutrition products distributed exclusively by Jebsen & Jessen Ingredients in Myanmar, Vietnam, Cambodia, Malaysia, and the Philippines.

In March, led by Dr Farshad Shishehchian, CEO and Founder of Blue Aqua International, and Marc Deschamps, Regional Managing Director & CEO of Jebsen & Jessen Ingredients, the contract signing took place at VIV ASIA 2019, in Bangkok, Thailand. This new partnership will leverage the combined strength of Jebsen & Jessen Ingredients's distribution service and Blue Aqua's product portfolio to bring outstanding products and solutions to the aquaculture and animal feed industry.

"Jebsen & Jessen Ingredient's deep expertise in specialty ingredients distribution and customer support is a perfect fit. We are excited to be moving forward with this new partnership to provide our customers better access to Blue Aqua's exclusive product lines," said Shishehchian.

Shishehchian, with 25 years of experience in shrimp farming, added "What the industry can do is to go back to the basics; start working on better nutrition and understand the proper nutrition and water quality measurements for the system. We also have to understand the pond system in relation to health, which requires not only looking at growth and survival as indicators. The big lesson is that we have to be more careful with our farming operations. We have to consider the management of the environment and nutrition. In many cases, a good growth rate does not guarantee the ability to have internal resistance to overcome and fight diseases.

"The aquaculture industry has been able to recover from various diseases over the years. A key factor is effective management of

shrimp health, requiring a balance between the host, pathogen, and environment. Disease and production issues vary during the different phases of shrimp culture. Thus, as long as we are able to control these variants then we will be able to recover. We have to be always ready and careful with our biosecurity and approach with nutrients and farm management. Our collaboration with Jebsen & Jessen Ingredients will help to push forth the right mindset and scientific methods to support farmers around the world to reach their production goals."

Deschamps, commented, "We are very happy to share future successes with Blue Aqua International. Strong distribution experience paired with an even stronger technological partner is a good recipe for growth."

Blue Aqua International with its headquarters in Singapore, is a one-stop solution provider for the aquaculture industry in the Asia-Pacific region and the United States. The group is present in 13 countries and provides expert views and solutions for the improvement of health, nutrition and feed quality, technology transfer, and project management services in livestock, poultry, and aquatic animals. The company manufactures and distribute specialty products and services.

Jebsen & Jessen Ingredients promotes and distributes chemical and life science ingredients for multiple industrial and manufacturing applications. It has 350 technical sales and customer service staff to connect technology from more than 100 supplier partners to 6,000 customers across ASEAN. In business for over 54 years, Jebsen & Jessen Ingredients operates six regional business lines with direct presence in nine countries, including ASEAN's emerging markets Myanmar and Cambodia. www.blueaquaint.com/www.ingredients.jjsea.com

NEXT ISSUES

July/August 2019

Issue focus: Sustainable & Responsible Aquaculture
Industry review: Tilapia
Feed/Production Technology: Lipid & Mineral Nutrition/
Production of SPF/SPR/SPT Shrimp
Deadlines: Articles - May 17, Adverts - May 24
Shows: TARS 2019, Bali Indonesia.

September/October 2019

Issue focus: Genetics & Genomics
Industry review: Functional Feeds
Feed/Production Technology: Extrusion & Processing
Deadlines: Articles - July 12, Adverts - July 19
Shows: Aquaculture Europe, Berlin, Germany

Email: zuridah@aquasiapac.com; enquiries@aquasiapac.com for details

Expanding technical and commercial teams for aquaculture

Multinational feed additives manufacturer **Adisseo**, leader in species specific aquaculture solutions for health and digestion following the acquisition of Nutriad, has announced several appointments in its Business Unit Aquaculture. Adisseo is fully committed to grow in the dynamic aqua markets across the world and therefore consistently hires top professionals that bring value to their customers.

"Feed additives are playing an increasingly important role in aquaculture feed formulations and profitability of fish and shrimp farmers. Health promoters in functional feeds have proven to be an essential component of prevention strategies to reduce the impact of diseases and parasites. Digestive and metabolic enhancers improve the efficiency for carnivorous species of new types of formulations based on less marine proteins and fats and maximize feed cost efficiency in omnivorous species. Methionine is the first limiting essential amino acid in fish feed, particularly if formulated with low levels of marine ingredients. Organic selenium is one of the key trace minerals in oxidative stress prevention. Novel sources such as hydroxy selenomethionine prove to be a superior source of available selenium for aquafeed. These wide range of additives require optimization for different aquaculture species and regions. This increases the need for specialized customer support at local and global levels." says Dr Peter Couteau, Business Unit Director Aquaculture for Adisseo.

Francois Pellet, Adisseo's SBU Director Specialties added, "Nutriad has consistently been investing in species specific solutions for the aqua market, which has helped us to create a leadership position in the industry that recognizes us for how we convert science into practical solutions, that builds on a deep understanding of the challenges producers around the world face. The acquisition of Nutriad will help us accelerate our solution offerings to this fast-growing market, by combining technical knowledge across various platforms, combine portfolios and enhance our innovation capabilities for aquaculture research."

Martin Guerin is a MSc in fish nutrition graduate from Auburn University, USA and holds master level degrees in agricultural science and business management from the Institut National Agronomique Paris-Grignon and University of Paris Dauphine, France. He has worked for more than 25 years in the aquafeeds and feed additives industry, 20 years of this in Asia. After having led for 13 years the aqua nutrition division of a feed mill group, overseeing commercial aquafeeds formulation, R&D, research farms, and technical support, he spent the past 3 years as a private technical consultant in aqua nutrition providing advice to commercial feed operations and feed additives companies. Martin supports the aquaculture sales team in APAC/ISC in his function of Regional Technical Manager Aquaculture, based in Malaysia.

Marleen Dehasque joined the central aqua team located in Belgium as Global Product Manager Aquaculture Nutrition. Marleen obtained a Master of Science in Bioscience Engineering: Chemistry and bioprocess technology at the University of Ghent, Belgium. She has over 25 years of experience in R&D, product management and business development in multinational aquafeed companies and, in recent years, as an independent consultant, supporting the development of novel feed ingredients in aquaculture. Marleen will support the regional sales teams and direct applied research for the merged product portfolios for aquaculture nutrition of Nutriad and Adisseo.



Ismail Youssef Mohamed joined the BU Aquaculture as Regional Manager Aquaculture MEA, based in Egypt. Ismail has a MSc in Aquaculture from the Mansoura University, Egypt and an MBA from the Saleh Kamel Center for Islamic Economics in collaboration with Al Azhar University and Garden York University, USA. He has 20 years of extensive experience in sales, marketing and technical consulting of veterinary products and feed additives in the livestock and aquaculture market in Egypt. Ismail will manage sales and technical support to aquaculture customers in MEA for the merge product portfolios of Nutriad and Adisseo.



Acquired by Adisseo in 2018, Nutriad offers species-specific feed additive specialties for aquaculture and helps producers of fish and shrimp across the world to prevent diseases and parasites; and to improve cost efficiency of feeds. Adisseo is one of the world's leading experts in feed additives. The group relies on its 11 research centers and its production sites based in Europe, USA and China to design, produce and market nutritional solutions for sustainable animal feed. With more than 2,100 employees, it serves around 3,500 customers in over 100 different countries through its global distribution network. Adisseo is one of the main subsidiaries of China National BlueStar, leader in the Chinese chemical industry with nearly 23,000 employees and a turnover of €6.4 billion. Adisseo is listed on the Shanghai Stock Exchange. www.nutriad.com/www.adisseo.com



The Adisseo-Nutriad team at VIV Asia 2019 and guest; Martin Guerin (left); Peter Couteau (middle left); Allen Wu, Regional Manager – Aquaculture, Asia Pacific (middle right); Dhanunjaya Goud Regional Sales Manager ISC - South Asia - Aquaculture (second right) and Poonmanee Kanjanaworakul, Aquaculture Manager Thailand (right). On second right is Lintang Mutfi, PT Dian Natura Agrifarm, Indonesia.

Feed solutions targeted towards consumers

BioMar has completed the testing of insect meal in feeds for aquaculture and believe it shows promise as an alternative protein source. This is one among many other novel ingredients like algae oil or single cell proteins that BioMar has been investigating. BioMar believes these raw materials can address some of the needs of the market and are now eager to speed up their adoption through the creation of innovative feed solutions targeting the needs of seafood consumers.

BioMar has been investigating insect meal since 2015 in its R&D centres and from 2017 has been undertaking tests with customers who have been feeding fish on diets containing insect meal. These fish have already made their way to supermarkets in Europe among retailers eager to implement future-oriented food solutions that focus on natural foods.

Michel Autin, Technical Director at BioMar's EMEA Division said, "Innovation of course comes at a cost, but farmers who are the first movers with insect meal will benefit from a strong market position. Insect meal has a future as an alternative protein source in aquaculture feeds if the price of this new raw material can be kept at reasonable limits. We have good test results on insect meal originating from black soldier fly,

mealworms and others, which makes it a promising raw material."

According to research undertaken by Deloitte*, today's consumers are looking for more than just price, taste and convenience when they are shopping. Consumers are seeking more natural food choices that have a minimal impact on nature. BioMar has the capabilities to offer innovative seafood solutions that will help consumers who are in search for healthy and wholesome "back to nature" products that are also mindful of the environment. This is where insect meal can play a role.

Insect meal is only one of the many innovative raw materials in BioMar's pipeline. They are recipe creators and have other game changing ingredients that can be used in crafting innovative feed solutions. What is important here is the ability to identify the opportunities and consumer trends and the capability to craft the solution with the right combination of ingredients and technology know how.

BioMar has for several year undertaken projects with customers who wanted to create seafood brands that address consumer needs and expectations, to



black soldier fly

make changes that will shape the future of seafood. The first collaboration project was 'In the Blue' a sustainable salmon created by partnership with Kavory, Wholefoods and BioMar. Already in the market is Silverside Coho created with Vertisqueros. More branded seafood products making a differentiation through their feed recipe will soon be hitting markets across Europe and the Americas'.

*Source: Jack Ringquist, Tom Phillips, Barb Renner, Rod Sides, Kristen Stuart, Mark Baum, Jim Flannery, 'Capitalizing on the shifting consumer food value equation', Deloitte, 2016, (US)

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Strengthens aquaculture business in North Vietnam



In February, Nutriad/Adisseo was invited to the annual aquaculture seminar organized by GreenVet Joint Stock Company, North partner for aquaculture products of Nutriad in Vietnam. This year, the farmer's seminar was organized in Sapa, North Vietnam. The welcome address was by Huy Tran Quang, Director of GreenVet Ltd and Duc Minh Truong, Vice Director, Tan Sao A. Ltd. Allen Wu, Regional Manager Aquaculture for APAC – Nutriad/Adisseo presented on “A new era of Nutriad aquaculture”. Wu said, “Since shrimp farmers stocked shrimp at higher densities in North Vietnam, farmers showed more interest in our proposed strategies to improve disease management in shrimp nursery systems and grow-out ponds. We shared our experiences with commercial trials on how to manage white faeces syndrome (WFS) in shrimp farms in Malaysia and Indonesia.”

WFS continues to be a main threat in Southeast Asia, particularly Vietnam, Indonesia, Thailand and India. The exact cause of

this disease remains unclear although pathogenic bacteria and microsporidians are often associated with its symptoms. Nutriad has recently obtained promising results via the application of its range of specialty additives in farms affected by WFS. “We observed that shrimp farmers started to not only buy a health-care product but liked to choose high quality aqua products which really benefited their production,” said Huy.

“Shrimp farm customers in Vietnam are used to Nutriad’s specialty products for aquaculture health for many years and are satisfied with the results and performances in most culture areas in the south to central Vietnam. I thank GreenVet, as this our first in presenting at our partner’s aqua technical seminar. We hope to do more in the coming years,” said Wu. www.nutriad.com/www.adisseo.com

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China's Aquafeed industry transformation summit



In March, some 900 participants attended China's Aqua Feed Enterprises Product Upgrade and Operation Transformation Summit 2019 in Wuhan. Participants came from 22 provinces and cities around China as well as from the Philippines, Malaysia, Thailand, USA, France, Canada, South Korea and Spain.



Gui Jianfang

Professor Gui Jianfang, Academician at the Chinese Academy of Sciences provided pathways for the industry in his keynote address. More than ten industry experts shared their practical experiences on cutting-edge technologies. Executives from Zhanjiang Guolian and stakeholders from other aquatic products processing

enterprises shared the latest seafood consumption data. The theme of this summit was "Enterprise product upgrading and operation transformation". Topics covered included perspectives on feed management, industrial chain building, farming models and species upgrading, feed nutrition technology, functional feed development and consumption trends.

The summit was organized by Guangzhou Nutriera Group and Guangzhou FishCloud Plus Co., Ltd, in cooperation with Southern Daily Group and Agriculture Wealth. It was supported by the National Fisheries Extension Center, Jingzhou Feed Industry Association and China-ASEAN Fisheries Resources Conservation and Exploitation program.

Industry prospects

Genetics and breeding are important to build up the aquaculture industry. In his presentation, Gui described how to build a sustainable aquaculture company to promote the transformation of aquaculture models. The development of the right ecological model provides a strong foundation for the industry as well as technical support for the rapid growth of China's aquaculture industry.

The implementation of a suitable environmental protection policy by the government will inevitably affect the current aquaculture models. Professor **Yin Zhan** Deputy Director of the Institute of Hydrobiology, Chinese Academy of Sciences discussed the characteristics of the many models from the past 10 years in

freshwater aquaculture in China and shared the latest technologies for nutrient absorption and treatment of wastewater. He provided a forward-looking idea for future research on "green" freshwater aquaculture in China.

Basic research

Consumers are driving the demand for quality seafood. **Professor Xie Shouqi**, Party Secretary of Institute of Hydrobiology, Chinese Academy of Sciences presented on nutritional regulations pertaining to seafood quality. He reviewed domestic and international feed formulations and feeding technology, emphasizing on nutrient levels, protein and fat sources, additives and feeding technology. This was a valuable reference for regulating the quality of farmed fish and shrimp via nutrition.



Xie Shouqi

There have been numerous studies by the Fish Nutrition Research Laboratory, University of Guelph, Canada. **Professor Dominique P. Bureau** said that studies have shown significant differences in apparent digestibility of protein and amino acid in different batches of raw material. It shows that digestibility is a means of detecting nutrients instead of directly detecting the bioavailability of nutrients. As a pioneer in the assessment of digestibility of fish feed ingredients, Bureau pointed out that the level of cross-linked protein in feed ingredients may be strongly correlated with the bioavailability of protein and amino acids. The simple technical treatment of destroying the cross-links of disulfide compounds can significantly improve the nutritional level of non-digestible protein ingredients.



Dominique P. Bureau

Professor Ye Yuantu, Soochow University discussed how aqua feed enterprises can improve raw material management. The cost performance of various raw materials, the assurance of stable product quality and the optimization of the selection and matching of different cost-effective raw materials, could improve operational efficiency.



INFOFISH WORLD SHRIMP TRADE CONFERENCE AND EXPOSITION

“Modelling for Sustainability”

12 - 14
November **2019**

*JW Marriott Hotel
Bangkok, Thailand*

Jointly Organized by:



Network of Aquaculture
Centres in Asia-Pacific (NACA)



สมาคมกุ้งไทย
Thai Shrimp Association

Supported by:



China Aquatic Products Processing
and Marketing Alliance (CAPPMA)

In collaboration with:



INFOPESCA

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Consumption trends



Wu Liqing

In China, the major focus is now on consumption trends, such as safe, nutritious, convenient and value-added products. Several experts in fish processing and distribution discussed business opportunities with changes in consumption patterns. **Wu Liqing**, Vice Chairman of Zhanjiang Guolian Aquatic Products Group Co., Ltd., analyzed the reasons for the problems encountered in the crayfish industry value chain along the Yangtze River Economic Belt and interpreted the development prospects of crayfish farming using consumption data. She advised on how to avoid risks in the crayfish industry.



Li Youqing

Li Youqing, Vice President, Central China Aquaculture Division, CP Group shared on how to use the aquatic industry eco-chain in central China and build key links in aquatic products. Zhu Changliang, Chairman of Liang Zhi Long Cuisine Express said, "The consumption pattern and product quality of aquatic products are undergoing

fundamental changes. The company that can innovate to meet the requirements of consumers will surely take the lead."

Operations transformation

Changing consumption patterns is driving aquaculture production. "As one of the feed suppliers to farmers, we often asked: how can aquafeed enterprises adapt to this change?" said **Dr Yang Yong**, Nutriera Chairman. He shared a report on "The challenges and breakout strategies of the operation transformation for aquafeed enterprises". He pointed out that aquafeed enterprises must upgrade their products and focus on the development of new species and functional feeds. In addition, enterprises must seize opportunities to develop the aquaculture value chain. In his report, he repeatedly emphasized and reminded the audience to focus on consumption preferences and research on consumption trends, instead of just concentrating on production.



Yang Yong

Before 2014, Nanshan Feed mainly produced conventional pelleted feeds with an annual sales volume of less than 10,000 tonnes. However, Chairman **Gu Ping** seized the opportunities during the golden transformation period and developed high grade and functional aquafeeds. He achieved a 300% growth in 4 years; volumes reached 170,000 tonnes in 2018. In this forum, Gu Ping shared the secrets of Nanshan's success.



Gu Ping

Product upgrading

Dr Zhang Song, Vice Chairman of Nutriera Group presented on an advanced aquaculture functional feed development strategy, from the perspectives of definition, function, precise positioning and design. The report contains many operational and practical cases and provided a professional "standardized operation procedure (SOP)" for the development of functional feeds.

Dabeinong Aquatic Technology Group's fermented feed sales broke the 2,000 tonnes record in its first year of operation. Wang Pan, Senior Researcher, showed how to create popular fermented products, develop a market position and strong R&D capabilities.

The success was attributed to the strength of the product and scientific design. Professor Zhong Guofang, Shanghai Ocean University gave a lecture on a series of studies on the application of aerobic fermentation of soybean meal with *Bacillus* sp. in large mouth bass and the vannamei shrimp.



Otavio Castro

Otavio Castro, Global Director of Phileo-Lesaffre's animal nutrition and health division, pointed out that the yeast cell wall could activate and enhance the animal immune system and improve the anti-stress ability and production performance of fish and shrimp.

Feed formulation

There were four presentations on formulation and product technology. Dr Wu Jianjun, Wuhan SunHY Biological Co., Ltd introduced the progress and effective evaluation of low-protein aquatic feed development. Zhang Guiyang, chief engineer of Jiangsu Famsun Sci-Tech Co., Ltd provided a complete solution from grinding, conditioning, extruding, and drying spray coatings. He also explained on how to obtain high-quality aquafeed with low-starch specifications. Tang Wubin, Deputy General Manager of Guangdong Nutriera group discussed the current understanding on palatability, liver health problems, body colour, growth rate and processing issues for the large mouth bass. The report introduced the key points on formulation technology and combining the different farming methods in different regions to put forward suggestions for large mouth bass feed development. Technical General Manager of Guangdong Nutriera group, Peng Zhidong introduced the core product design ideas for crayfish which include faster growth, stronger immunity, earlier incubation and feed consumption. At the same time, he also gave some practical suggestions for formulators, from the selection of high-quality raw materials to process evaluation.

Forum on impact of consumption and supply

It is imperative for any business to focus on market trends and the preferences of customers. All those in the aquaculture industry chain especially feed enterprises must look at demands of consumers and adjust product upgrades and business operations accordingly. The forum on "The Impact of Consumption Upgrade on the Supply Side of Aquatic Products" had experts conducting in-depth analysis and generated heated discussions on the current situations and trends of aquatic product consumption, the development prospects of pangasius fish in China, and suggestions for aqua feed enterprises.

Year 2019 is expected to be an extremely difficult year for China's aquafeed industry. The whole industry is facing tremendous pressure. This summit has clearly defined the direction for the industry. Learning from the summit, many participants said that they will actively promote product upgrades and operational transformations. Some foreign participants highlighted the tough competition in the Chinese market and the diversity of China's aquatic production. In future, the market will be globally integrated, and Chinese experience and wisdom will be a strong reference for foreign enterprises.

Nutriera is committed to serving and leading the healthy development of the industry as well as ensuring the safe production of aquatic products. In the future, it will continue to actively organize forums such as these where scientists and entrepreneurs can exchange and share information and ideas for the benefit of the global aquaculture industry.



Trade at APA'19

The Asian Pacific Aquaculture 2019 will be at the Chennai Trade Centre (CTC), India from June 19 to 21. It will comprise a conference and trade show. The latter will have around 200 booths and below is a preview on some exhibitors.



Sheng Long Bio-Tech International Co., Ltd is a leading provider of high performance aqua-nutrition and animal health products, formulated by experienced nutritionists, for the best performance of

aquaculture species. It also has specific pathogen free (SPF) post larvae. Currently, it supplies complete aquafeeds in Vietnam, India and the Asia-Pacific region from 4 production units with a total annual capacity of 500,000 tonnes. At APA 2019, it will display products: Super Mix, Nutri Pro and Aqua Chip.

On June 19, Sheng Long, gold sponsor for APA 2019, will organise a seminar from 13:40-18:00 pm on "The Advanced Research Developments on Shrimp Culture" (see page 62)

Booths 125-128/139-142
www.shenglongbt.com
 Dr. Hu Haibin (haibinhu@yeah.net)



Uni-President is a 50-year old company specializing in the production and marketing of aquafeeds, including various prawn and fish products. They have a series of animal

healthcare products and probiotics to provide a complete farming solution. Unilight PSB improves the bottom of the ponds, maintains the water colour, also reduces *Vibrio* and improves water quality.

Booths 89-92/103-106
<http://uni-president.com.vn/uninew/>
 Tina (aquafeed@upvn.com.vn or nhutthien@gmail.com)



Zeigler Feeds has been at the forefront of aquaculture nutrition and innovation since the early days of its commercial development. Today, Zeigler draws on this experience to serve as a leading

innovator in the field of aquaculture nutrition and feeds. Dr Browdy, Director of R&D at Zeigler will be presenting a talk on "The Role of Hatchery Feeds in Shrimp Health Management. Zeigler will present:

- Redi-Mate - Zeigler's newest semi-moist shrimp broodstock diet sets a new standard for quality and performance in this product category.
- Z Pro - A brand new dry larval diet designed to optimize growth and performance under challenging market conditions.

Booths nos 107-108/123-124
www.zeiglerfeed.com
 Chris Stock (chris.stock@zeiglerfeed.com)
 Craig Browdy (craig.browdy@zeiglerfeed.com)
 Ramir Lee (ramir.lee@zeiglerfeed.com)
 Cao Khanh Ly (cao.khanhly@zeiglerfeed.com)
 Ch. Satyanarayana Murthy (satya.murthy@zeiglerfeed.com)
 Mark Napulan (mark.napulan@zeiglerfeed.com)



Lallemand Animal Nutrition offers a complete range of microbial solutions such as probiotics and yeast derivatives for fish and shrimp for feed and water applications targeting gut health and

pond environment management. During the conference, Eric Leclercq, PhD, Aquaculture R&D Manager, and Stéphane Ralite, Aquaculture Product Manager, will present the latest scientific results on the effects of microbial solutions on shrimp gut and pond microbiota:

- The potential of complementary microbial solutions against the risk of interacting diseases in pond aquaculture
- Gut microbiota and histopathological changes associated with WFD in juveniles *Litopenaeus vannamei* and the modulating effect of a multi-strains yeast fraction product

Booths 55-56/67-68
<http://lallemandanimalnutrition.com>
 Stéphane Ralite (sralite@lallemand.com)
 Thanna Jayashankar (tjayashankar@lallemand.com)



Kasipantarut Co. Ltd. is a Thai distributor and exporter of plastic and rubber related products with more than 50 years of experience. For aquaculture, it has the O2 Bubbles

aeration system which are easy to set up, saves electricity, has low investment and is very efficient. At the booth, the team will display products and provide suitable solutions for specific farm conditions.

Booth 149
www.kasipantarut.com, www.facebook.com/o2bubblesinter/
 Piyawan Jiravansit (kasipantarut@gmail.com)



Leiber GmbH is one of the leading manufacturers of special yeast products "made in Germany" since 1954. The natural raw material brewers'

yeast is processed using an innovative method to form high quality products which are used in the areas of animal nutrition, food, food supplements and biotechnology. For example, the key products in aquaculture, for larval and juvenile nutrition and in grow-out stages are:

- Leiber® Beta-S - highly purified β -Glucan for strong, immunocompetent fish
- Biolex® MB40 - Mannan oligosaccharides (MOS) for gut protection & health
- CeFi® pro - Nucleotides for optimal cell regeneration & cell repair

Booth 148
www.leibergmbh.de
 Dr Holger Kühlwein, Key Account Manager Aquaculture
 (h.kuehlwein@leibergmbh.de)



The **Pioneer** Group's main business is in the field of aquaculture equipment & fish cage farming system. Its staff possess solid professional backgrounds, including aquaculture, mechanical engineering and geo-technical specialisation of more than 20 years. The philosophy is to provide top quality and genuine professional services to the customers.

At the show, it will present paddlewheel aerators and sea cage farming accessories. The cage accessories include the removable handrail T and one-piece injection molded HDPE 80 bracket, which is extremely sturdy, easily assembled, convenient for harvesting and efficient in maintenance. Both round and square sea cages can be tailor-made.

Booth 17

www.pioneer-tw.com

Paula Liao/Lannie Chen (sales@pioneer.tw.com)



Jefo is a global leader in high-performance non-medicated nutritional solutions for animals. Founded in 1982 in Canada, Jefo markets its species-specific products worldwide and

massively invests in innovation and development to be the supplier of preference for those striving to reduce or eliminate the use of antibiotics. With its *Life, made easier commitment in mind*, Jefo uses a practical approach to share its results based on complex scientific research. To improve animal health and increase human longevity by feeding growing populations with better protein sources, Jefo proposes different solutions in their programs: Jefo Care – Health & Prevention, Jefo Peak – Performance & Production and Jefo Cycle – Reproduction.

Booths 121 - 122

www.jefo.com

Kabir Chowdhury (kchowdhury@jefo.ca)



Ictyogroup is a veterinary pharmaceutical company which develops, manufactures and commercializes:

- GMP tailor-made vaccines for warm-water fish. Our products are laboratory tested for efficacy and safety before field use
- Fish anaesthetics/sedative: Ictyoclove is our new generation fish anaesthetic,
- Adjuvant for fish vaccines including all vaccination routes: Immersion, injection and oral,
- Vaccines adjuvants for other animal species such as poultry, swine and cattle

Additionally, Ictyogroup, is active in contract research for feed additive development in aquaculture and serves the leading feed and feed additive companies in aquaculture.

Booth 226

www.ictyogroup.com

Cedric Komar (cedric.komar@ictyogroup.com),

Roberto Cascione (Roberto.cascione@ictyogroup.com)

Francis Courault (francis.courault@ictyogroup.com)



Soon Strong Machinery Works Co. Ltd., Taiwan established in 1978, is involved in the fabrication and manufacturing of poultry, aqua and pet feeds equipment. It was first to

develop 0.5 mm diameter (dies) floating fish feed extruder in the world. The extruder can do continuous production without dies blocking, run for 8 hours and produce various products in one machine. These tiny feeds are suitable for small fish, shrimp larvae etc.

Booth 145

<https://soonstrong.en.taiwantrade.com/>

Email: soon.strong@msa.hinet.net



Menon Renewable Products, Inc. is a biotechnology company that develops and manufactures sustainable, high-quality, functional animal feed

ingredients. Products provide a renewable alternative to non-sustainable feed ingredients currently in the market, including fish meal. The ingredients are manufactured using Menon's proprietary process, called CelTherm™, which converts organic, plant-based materials into proteins, nucleotides and peptides proven to enhance overall animal growth, health and immunity. At APA2019, the company will introduce MrFeed Pro50 for shrimp and MrFeed Pro50 FF for finfish applications. It will exhibit alongside its client, Growel Feeds India.

Booth 32

www.menon.us

Email: info@menon.us



Olmix is a specialist in marine biotechnology for more than 20 years. The Olmix Group brings natural solutions for nutrition and health to plant, animals and humans, to build a

healthy food chain, thanks to algae! In the Aqua Care division, Olmix develops algae based solutions using innovative technologies to target the major factors influencing welfare and performance in aquaculture species.

At APA2019 oral sessions, the Aqua Care division will present on the most recent breakthrough of immune modulation using specific, refined marine sulfated polysaccharides (MSP) to improve the overall animal health. The new product will be Algimun.

Booths 119-120

www.olmix.com



In-Situ Inc. is known for top-quality water level, water quality and flow monitoring instrumentation for many

applications, including aquaculture. At the booth, it will present solutions to help increase fish and shrimp yields and reduce costs at hatcheries, even in harsh conditions. It will feature the versatile and cost-effective Aqua TROLL 500 Multiparameter Sonde, ideal for monitoring pH, DO, conductivity, temperature, and in fresh water, ammonium and nitrate. In-Situ operates globally and has its headquarters in Fort Collins, Colorado, USA.

Booth 113

<https://in-situ.com/applications/aquaculture-management/>

Kanaiya Naik (knaik@in-situ.com), Alex Hing (ahing@in-situ.com)



Blue Aqua thrives on the continuous development of knowledge and technology for the implementation of sustainable production in aquaculture.

It strives to be at the forefront of intensification technology for the improvement of food security globally and provides cutting-edge solutions in two main areas quintessential to farming and aquaculture: the controlled management of the culture environment and the optimisation of animal nutrition. At APA 2019, it will be launching a campaign to prevent and treat white faeces disease (WFD) in shrimp.

Booths 39-40/47-48

www.blueaquaint.com

Email: info@blueaquaint.com



MARINE LEADER CO., LTD.

Marine Leader Co., Ltd. established in 2000 is a supplier of aquaculture products for shrimp and fish farming, such as feed, larval feed, frozen feed, probiotic, supplement, water test kit, etc. It has effective frozen feed for broodstock-frozen polychaetes, krill, squid, etc. It has high quality larval feed to improve survival rate. Bio-MPL and Higashimaru PV are the keys of to successful farming; the latter, is the newest premium feed, produced and authorized by the original Higashimaru in Japan. Biomega, Hydromac and Bio-Asta are supplements for diets to help improve animal health, hepatopancreas and survival rate. New innovations are portable DO & pH meter and water chemical reader machine.

Booth No 146
www.marineleader.co.th/
 Email: marineleader@hotmail.com



Growel Feeds Pvt. Ltd. is one of the leading aquaculture feed producers in India and has a wide presence in national and international markets. It provides a variety of scientifically formulated and well-balanced nutritional solutions for shrimp and fish. All its facilities are BAP, HACCP and HALAL certified. Currently, Growel exports aquafeeds to 12 countries. Growel has an in-house R&D centre with RAS facility where it continuously tests its feed and develops new products to meet the ever-growing customer needs. It has recently introduced a new generation functional feed called 'Nutriva F15'. It is an immunity enhancing extruded shrimp feed developed in collaboration with Menon Renewable Products, Inc., USA.

Nutriva F15 has been thoroughly tested for its effectiveness in improving shrimp health and in delaying the pathogenicity of disease-causing agents such as delaying WSSV outbreaks. It was also found to be quite effective in controlling the severity of white gut disease.

Booths 31-32
www.growelgroup.com
Sandip Ahirrao, Vice President - Sales & Marketing
sandip.ahirrao@growelfeeds.com



CARE FOR GROWTH
 A Benchmark Company

INVE has always been about growth. By uniting the experience with the biotechnology expertise of Benchmark, it has been developing innovative products, which improve yield, quality and animal health, and welfare for customers. Together it provides advanced technological solutions for:

- Nutrition: the best balance between enriched live feed and formulated larval & nursery diets
- Health: controlled biosecurity supported by nutraceuticals, probiotics, vaccines & veterinary services
- Environment: optimal living conditions thanks to water & soil treatment and algal substitutes
- Genetics: perfected selection strategies for the most resilient brood stock, fingerlings & juveniles

Peter De Schryver will be presenting in the session on biofloc technology (June 20, 13h40-15h40) on "Managing bioflocs operational parameters and use of probiotics can minimize the risk of acute hepatopancreatic necrosis disease (AHPND) outbreaks."

Booth 134-135
www.inveaquaculture.com or www.benchmarkplc.com



Vaisakhi Bio-Marine & Bio Resources is one of the leading shrimp hatchery operators in the country. It also operates one of the larger farms in the country. Soon it is going to make its foray into seafood exports as well. During SAP shrimp session, technical director V. Surendran will present in on nursery operations. The company will for the first time introduce tolerant - All Pathogen Exposed - vannamei fry to the Indian industry from July onwards. It also announced that those interested can visit the hatchery, located 90 km from the venue.

Booth 194
 Email: vaisakhibioreources@yahoo.co.in
biomarines@rediffmail.com



Liptosa is a Spanish company specialized in natural solutions. Phytobiotics and nutraceuticals are eco-friendly solutions able to get an effective protection against fish and shrimp diseases. Liptosa offers to fish farmers an interesting product portfolio with different aims: growth promoters, antiparasitic, antibacterial and antifungus, all of them able to give efficient solutions in favour of a sustainable aquaculture.

Parasitic diseases are one of the most often and serious pathologies in aquaculture activity with high influence in farm profitability. Liptosa will present Carp forte 19, a phytobiotic to control fresh water parasites affecting carps and pangasius. It is new natural alternative to biocides with efficient results. It is a tool to increase fish yield with a healthy status and free of copepods parasites (Argulus and related parasites) and gill and skin trematodes (Dactylogyrus and Gyrodactylus).

Booth 223-225
www.liptoqua.com
Alvaro Rodriguez (ara@liptosa.com) and Carlos Lopez (carlos.lopez@liptosa.com)



SyAqua Group, and its subsidiary **Gold Coin Biotechnologies**, are some of the market's leading pioneers of aquaculture solutions. They are specialists in helping hatcheries and farmers improve yields and productivity through the use of advanced technologies and innovative methods. SyAqua was first established in 2001 by SyGen, a globally recognized livestock breeding company and in 2011 collaborated with Gold Coin, a reputable Southeast Asia-based aqua and livestock nutrition company. Driven by vast experience and cutting-edge expertise, SyAqua and Gold Coin Biotechnologies carry on a legacy of pioneering new technologies to ensure fast growth with enhanced survival rates for shrimp breeding. Today, the genetics and nutritional research have resulted in many highly recognised products and programs trusted by top hatcheries and farms worldwide.

Gold Coin Biotechnologies will present its list of hatchery products: encapsulated larvae and post larvae feeds, Hi Pro and microparticulate post larvae feeds; microencapsulated feeds for zoea, mysis, EPL and LPL; larval feed (Hipro EPL 1-5 and Hipro LPL 6-12); microparticulated feeds (EPL 1-5/LPL 6-12) and a maturation diet (GC Mat).

Booths 178-179
www.syaqua.com
Balu S, Country Manager (Balu.shanmugam@gcaqua.com)



Neovia is a global leader in aquaculture committed to help the aquaculture industry grow by supplying a full range of solutions to shrimp and fish farmers. Through subsidiaries; Bernaqua, Ocialis and Epicore, the group provides high quality hatchery nutritional solutions, grow-out feeds as well as probiotics for feed and bioremediation.

There will be a presentation at the conference on "Reducing early impact on shrimp of white spot syndrome virus in field conditions". Sjoerd Bakker - Aquaculture Project Manager-Asia will present the results of the speciality offering B-Safe on white spot syndrome virus in shrimp on Friday, June 21. The team will also talk on Biosipek, an intensive and innovative shrimp farming system involving feeding, biosecurity, water treatment, and traceability and introduce new nutritional solutions for shrimp hatchery and grow-out.

Booths 170-171/180-181

www.bernaqua.com / www.ocialis.asia/
www.epicorebionetworks.com

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The Poseidon Group, owned by aquaculture technocrats and run by more than 100 aquaculture professionals is one of the pioneers in the aquaculture sector. It is entering its 25th year in 2020. To commemorate the silver jubilee celebration, Poseidon unveils its iconic logo to emphasize

their continuing mission of living and growing together with nature. Poseidon is always committed for continuous development of the aquaculture sector by introducing new technologies which are environment friendly, sustainable and proven.

It is introducing a new range of products for farmers and hatchery operators this year. Apart from the above it is also continuously working on automation systems to help farmers, especially with auto feeders to optimise feed usage and reduce feeding cost.

Booth 159

www.poseidonbiotech.com

P.K.Senthil Kumar (aquaguys@gmail.com)



BIOMIN harnesses the power of science to support animal health and performance. By applying state-of-the-art and proprietary technology, it

delivers natural, sustainable and profitable solutions for livestock and aquaculture. For over 30 years, it has pioneered innovative solutions for mycotoxin risk management and gut performance. The in-house R&D at the Biomin Research Center is staffed by more than 100 scientists and researchers, supported by seven Centers for Applied Animal Nutrition and a global network of 200 universities and research institutions. Clients are in the poultry, swine, cattle and aquaculture sectors, located in more than 120 countries worldwide.

Product on display is FUMzymesol, designed for fumonisin biotransformation in all aquafeeds, easily dissolves in water or with emulsifiers in oil for spraying onto heat treated/extruded pellets.

Booths 129-130/137-138

www.biomin.net

Invitation



ASIAN-PACIFIC AQUACULTURE 2019

June 19th-21st, 2019

Chennai Trade Center

Chennai,

Tamilnadu-India

Stall No.

125,126,127,128,
139,140,141,142,

We are looking forward to meeting you at our special farmer's day session.

SHENG LONG INDUSTRY SESSION JUNE 19th 2019

"The Advanced Research Developments on Shrimp Culture"

Session Chair : **Dr. SHIAU SHI-YEN**, (National Endowed Chair Professor, National Taiwan Ocean University)

Dr. YEW-HU CHIEN, (Professor, National Taiwan Ocean University)

PROGRAM :

13:40-14:20 : **Dr. TRAN HUU LOC**, (Assistant Professor, Nong Lam University)

Lessons Learned from the Emergence of AHPND, EHP and White Feces Disease

14:20-15:00 : **Dr. YEW-HU CHIEN**, (Professor, National Taiwan Ocean University)

Besides Pigmentation, the Nutraceutical Roles of Carotenoids in Penaeids

15:00-15:40 : **Dr. MARC LE GROUDELLEC**, (Doctor, UNIMA Group)

The Update Farming and Latest SPF Broodstock Development of P. Monodon

15:40-16:00 : **Coffee Break**

16:00-16:40 : **Dr. GIRIDHAR RAHUL GADDIPATI**, (International Sales & Business Development, SILO Spa)

Use of Monoglycerides as an Antibacterial Tool in Fish and Shrimp

16:40-17:20 : **Mr. MING HSIEN CHEN**, (Vice General Manager, Hisenor (Vietnam), Aquatic Breeding Co.Ltd)

Management and Production of Good Quality Litopenaeus Vannamei Seeds.

17:20-18:00 : **Mr. THANGAVELU IYAPPAN**, (Technical Regional Manager, Sheng Long Bio-Tech (India) Pvt. Ltd.)

How SLBI AHP Helps Farmers to Maintain Good Water Management For Better Culture



GOLD SPONSORS



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No. A-11/1, Part A, Sipcot Industrial Park,

Thervoy Kandigai Village, Gummidipoondi Taluk, Thiruvallur District,

Tamil Nadu-601 202. Ph : 044-6790 1001.

Email : info@shenglongindia.com | Web : shenglongindia.com



The Society of Aquaculture Professional (SAP) is a non-profit, non-government organization established for and by a group of aquaculture professionals in India in the year 2003.

As the professional partner for APA 2019, SAP will organise a Shrimp Session on 20th June, 2019 from 16.00

– 18.00h. SAP will also launch its students membership during APA 2019. SAP's flagship program Aqua India 2020 announcement will also be made during the program.

Booth 33-34
www.aquaprofessional.org
P.K.Senthil Kumar (aquaguys@gmail.com)



I&V BIO is an innovative hatchery supplier offering products and services which are unparalleled in the aquaculture industry. The goal is to become a market leader on speciality

fresh feeds and health products with daily deliveries and services catering to hatcheries across geographies. I&V BIO has its headquarters in Thailand. At its booth, I&V BIO India Pvt Ltd will introduce new products:

- PL diets
- Enriched Artemia Nauplii

Booths 42-43 www.iandv-bio.com
Srinidhi (srinidhisivakumar@yahoo.com)



xpertSea is a Canadian technology company that is transforming how the global aquaculture industry farms

seafood to help feed the world. Combining smart aquaculture equipment with a farm management platform, the collaborative solution uncovers actionable insights driven by artificial intelligence. These insights enable farmers and industry experts to optimize feed efficiency, reduce environmental waste, take preventive actions against diseases and use data to bring transparency and knowledge to the entire supply chain. With customers in over 50 countries, it is using Canadian ingenuity to make aquaculture profitable and sustainable.

Booth 65 www.xpertsea.com
Arun Natarajan (arun@xpertsea.com)

SOCIETY OF AQUACULTURE PROFESSIONALS
SHRIMP SESSION

16.00 - 18.00 Hrs
 20th June, 2019

Session on shrimp aquaculture: Possible remedial pathways -
 Dr. Alan K. Diaz, University of Arizona, USA

Indian shrimp culture in 2018 and beyond
 Mr. S. Chandrasekar, Project Feeds Corporation, India

Inherent risks: The hidden of sea for shrimp farming -
 Mr. Robin Pearl, American Penaeid Inc., USA

Weathering headwinds: A challenge for the Indian shrimp hatcheries -
 Mr. S. Ramya, President, All India Shrimp Hatcheries Association

Farm based pond type nursery operation at P. Yamunan: a case study -
 Mr. V. Sureshbabu, Vaisakhi Bios, India

Shrimp farm management in the current scenario -
 Mr. S. Senthil Kumar, Society of Aquaculture Professionals, India

Professional Partners of APA'19

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Visit Aqua Culture Asia Pacific at
Booth 19

VICTAM ASIA 2020 • March 24 - 26, 2020 Bangkok, Thailand

At a press conference held in Bangkok on March 12, Victam International announced dates for Victam Asia 2020 to be held, at the BITEC in Bangkok, Thailand. Victam Asia is firmly established as the event dedicated to the animal feed processing industry within Asia. In parallel, will be GRAPAS ASIA, the event for the grain and rice processing industries.

Sebas van den Ende, General Manager for Victam International said that Victam Asia 2018 attracted 227 exhibitors from 33 countries. The visitor profile indicated 47% CEO, 11.5% nutritionists and feed formulators and 30.5% from

management. The 2020 edition will be held in collaboration with the Thai Feed Mill and Thai Rice Mills associations. Pornsil Patcharin Tanakul, President of the Thai Feed Mills Association, said that in feed production, reducing costs is a priority and thus sourcing raw material is important. In 2019, production increased 1-2% as compared to 5-6% for the last 40 years.

In 2020, van den Ende expects the number of exhibitors to grow by 15%. The foundation will work with Wageningen University to focus more on the needs of nutritionists. With some 50% of booths sold and major feed additives and feed processing

manufacturers already confirmed to exhibit, van den Ende is upbeat on the response to date. www.victam-asia.com



Sebas van den Ende (second right), Pornsil Patcharin Tanakul (third right), Patricia Heimgartner, Exhibition Manager (left) and Catelijne De Gooijer, Marketing Communications Manager (second left) and guests.

GIANT PRAWN Conference goes to China in 2019

GIANT PRAWN 2019 Conference is the fifth in a series on the farming of *Macrobrachium* spp. This 2019 edition will be in China for the first time. Although the name could be taken to refer only to the Giant Malaysian prawn *M. rosenbergii*, in fact, the event will encompass all species of *Macrobrachium* currently farmed. GP2019 is jointly organized by the Asian Institute of Technology (AIT), Thailand and Shanghai Ocean University (SHOU), China. The event will be held at the SHOU, Lingang Campus, Pudong District, Shanghai, China, about an hour's drive from Shanghai city.

GIANT PRAWN series of conferences on the farming of freshwater prawns, *Macrobrachium* spp. was started by Michael New, OBE with the first one, organized in Bangkok in 1980. GP 2019 follows GP2017, organized by Dr Salin Krishna and New, held at AIT, Thailand. GP 2019 is poised to be another significant event highlighting the global farming and conservation of the genus *Macrobrachium*.

China is the world's biggest producer of freshwater prawns and has a unique prawn industry by developing both native prawns as well as those introduced to the country. The major freshwater prawn species farmed in China are *M. nipponense*, which is a native prawn and locally known as 'river shrimp' while *M. rosenbergii* is an exotic species introduced in the mid-1970s.

GP2019 will be an excellent opportunity for the global freshwater prawn farming industry to review the latest research and development and to brainstorm what the priorities should be for its future expansion. The

sessions include hatchery technology, traditional and novel monoculture systems, integrated grow-out, hatchery nutrition, feeds and feeding, grow-out nutrition, feeds and feeding, genomics, health management, marketing, processing and economics, and gender dimensions in giant prawn aquaculture and fisheries, among others. Selected papers presented will be published in a special edition of the SCOPUS-listed, Open Access Journal, Aquaculture and Fisheries, published by Elsevier. Besides, other papers presented may be considered for publication in the conference proceedings.



More information: Krishna R. Salin, Aquaculture and Aquatic Resources Management (AARM) Program, AIT, Thailand and Xuxiong Huang, College of Fisheries and Life Sciences of SHOU, China.
Website: www.giantprawn.org Email: info@giantprawn.org

Deadline for Abstract submission and Early bird

Registration: 31 July 2019

Onsite Registration: 15 November 2019

Main Conference: 16 - 17 November 2019

Farm Tour: 18 November 2019

Aqua Culture Asia Pacific in 2019

Volume 15 2019			
Number	4 – July/August	5 – September/October	6 – November/December
Issue focus <i>Trending issues and challenges for the next step</i>	Sustainable & Responsible Aquaculture	Genetics & Genomics	Integration and supply chain
Industry Review <i>Developments, outlook, demand & supply</i>	Tilapia	Functional Feeds	Catfish & Freshwater Fish
Feeds & Processing Technology <i>Technical contributions from feed industry</i>	Lipids & Minerals Nutrition	Extrusion & Processing	Larval & Nursery Feeds
Production Technology <i>Technical information and ideas</i>	SPF/SPR/SPT shrimp	Post-Harvest Technology/ Processing	Organic Aquaculture
Market and product developments, market access, certifications, branding, food safety etc)	China	USA	Marine Fish
Aqua business <i>Feature articles</i>	Experiences from industry and opinion article covering role models, benchmarking, health management, SOPs, social investments, CSR, ancillary services, self-regulation etc		
Company/Product news	News from industry including local and regional trade shows		
Technical articles	May 17	July 12	September 13
Advert booking	May 24	July 19	September 20
Show Issue & Distribution at these events as well as local and regional meetings	*The Aquaculture RoundTable Series, (TARS 2019) Aquafeeds: Fit for Future August 14-15, Bali, Indonesia Vietfish 2019 August 29-31 Ho Chi Minh City, Vietnam	Taiwan International Fishery and Seafood Show September 26-28, Kaohsiung Aquaculture Europe 2019 October 8-10 Berlin, Germany	INFOFISH World Shrimp Trade Conference and Exposition November 12-14, Bangkok, Thailand Giant Prawn 2019 International Conference November 15 - 18, Shanghai, China
*Show preview			

ASIAN PACIFIC AQUACULTURE 2019

Aquaculture for Health, Wealth and Happiness

June 19 -21, 2019

Chennai Trade Center

Chennai

Tamil Nadu - India



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THE AQUACULTURE ROUNDTABLESERIES® 2019

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August 14-15, 2019 • The Westin Resort Nusa Dua • Bali, Indonesia



The Aquaculture Roundtable Series (TARS®) 2019 will focus on development of a sustainable aquafeeds industry. This marks the third time, the series is addressing Asia's aquafeeds sector, following the two held in 2011 and 2015.

Today, Asia is left behind with a 'one size fits all' feed specifications for marine fish; feed price-centric freshwater fish farmers have to move with feed cost/kg fillet yield and new formulations to fit into new genetics and new culture systems for shrimp are required. It is not just feeds but best feed management practices and technologies are critical to maintain a sustainable and viable future. Replacement of fish meal and fish oil is critical for the development of sustainable feeds. Zero-fish meal for same performance and cost, remains elusive.

TARS 2019 features a dynamic plenary program with 16 presentations including state of industry and country-specific

challenges; species-specific nutrition and nutrient requirement-based diets; new protein meals and oil as fish meal/oil replacements; feeds and its management for disease prevention and health, growing the feed segment in the value chain and R&D for improving feed performance and efficiency.

Highlights of TARS 2019 include the Hard Talk with C-suite Executives of aquafeed companies, featuring hard-hitting questions on successful business models, challenges, and strategies.

Unique to each TARS is the Interactive Breakout Roundtable Sessions and panel discussions that will stimulate open dialogue among participants. Together participants will identify areas of concern and solutions in feed production for marine shrimp, freshwater fish and marine fish.

INTERACTIVE BREAKOUT ROUNDTABLE SESSIONS & PANEL DISCUSSIONS

SHRIMP FEEDS

- High density feeds to match growth genetics?
- Fish meal/oil replacement - same performance and same cost?
- Specialised nursery diets for RAS & early care nutrition

MARINE FISH FEEDS

- Bespoke feeds for top three marine fish species
- Functional feeds against stress and parasites
- Semi-moist feed for improved ingestion

FRESHWATER FISH FEEDS

- Specialised nutrition for fillet yield
- Feeds for environmental sustainability
- Functional feeds for hot weather conditions

HARD TALK WITH C-SUITE EXECUTIVES: Hard-hitting questions with C-suite executives of aquafeed companies on their experience with business and technical challenges, and strategies for success.

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REGISTRATION IS LIMITED TO 200 PARTICIPANTS.

Early bird registration ends on June 19. Walk-ins are not encouraged.

For more information and updates, visit www.tarsaquaculture.com • Email: conference@tarsaquaculture.com

Speaker Highlights

Aquafeeds in Indonesia: Different strokes for different species



"While the industry struggles with changing demands in feed prices, composition and quality, rising costs of energy and the push to develop sustainable feeds, it has to support the farming sector, upstream and downstream. At the same time, new entrants into the industry, will increase the competitive landscape."

Haris Muhtadi, *Aquafeed Division, Indonesian Feedmills Association & CJ Feeds, Indonesia*

Challenges in Thailand: A view from the next generation



"Today, Thai feed mills operate in a highly competitive market which demands production of the best performance feeds at the lowest cost possible. Social media is useful for us to follow aquaculture production trends and understand real time monitoring of emerging issues."

Jarin Sawanboonchun, *Aquaculture Nutrition and Feed Specialist, Thailand*

Growing pains and technology changes in India



"Feed producers need to apply innovations and come up with more efficient feeds and application methods to preserve margins. Sustainable production through disease management and profitable farming technology, promotion of seafood for export and domestic markets fall on the shoulders of feed manufacturers."

Ravikumar Bangarusamy, *Growel Feeds Pvt Ltd, India*

Overcoming constraints and maximizing benefits with feed additives



"Feed additives components are often heat sensitive so their successful inclusion can be difficult, especially in extruded feed where temperatures and pressures are usually higher than its pelleting equivalent. These constraints can be overcome by different technologies, from enzyme engineering, to encapsulation and post pellet application."

Benedict Standen, *BIOMIN Holding GmbH, Austria*

Different strategies towards quality feeding



"Recent market trends have led many farmers to reduce their costs, with consequences to biosecurity, environment management and nutritional quality of feed. Lower investment at the farm leads to lower performance, affecting production efficacy. Benefits in quality feed in early stages of production extend to later stages of production."

Oliver Decamp, *Inve Aquaculture, Thailand*

Alternatives to omega-3 PUFAs in aquafeeds: Addressing rising demand and critical animal health needs



"When we discuss replacement of fish oil in diets for marine species, the focus is around satisfying the requirement. Oils from marine microalgae and transgenic oilseed crops are the two most promising options but need consistent supply."

Fuci Guo, *Corbion Biotec, Inc, Malaysia*

Fishmeal replacement strategies: Just a question of protein?



"Nutritional knowledge improved, fish meal was no longer seen as mainly a source of protein and fat, but also of other important nutrients that plant proteins are unable to supply. Plant proteins and animal by-products proteins come with their own set of nutritional issues such as impaired gut health, reduced digestibility and often lower nutrient density."

Martin Guerin, *Adisseo Asia Pacific PL, Singapore*

Next generation aquafeeds: EPA and DHA from marine algae to support sustainable aquaculture



"Feed producers and farmers need a solution to reduce dietary inclusion of fishmeal and fish oil without compromising the health of the animals or the omega-3 EPA + DHA nutritional benefits for the final consumers."

Ester Santigosa, *Research Centre for Animal Nutrition, DSM, France*

Shrimp feeds: Fit for new genetics and new culture systems?



"Most of the feed specifications continue to be based on criteria defined last century. What are the appropriateness of these feed specifications with respect to modern shrimp genetics and farming systems? How far have we come and how far can we go?"

Brett Glencross, *Institute of Aquaculture, University of Stirling, Scotland*

Feed for thought: Shrimp feeds



"We have set the rules on choices of feeds and select based on consistency – in quality and performance. As a user of feeds, I have hopes and dreams on specifications for feeds to be used at each stage of the production cycle, for the final harvest quality as well as for disease interventions and conservation of pond environment."

Rizky Darmawan, *PT Delta Marine Indonesia*

Quality research: A pre-requisite fit for future feed



"Nutritional requirement of an animal is rather dynamic, not static as perceived. With precision nutrition for biological, environmental and economic reasons, the need for quality research to generate data pertaining to specific conditions are more important than ever."

M A Kabir Chowdhury, *Jefo Nutrition Inc, Canada*

26th Annual Practical Short Course on Aquaculture Feed Extrusion, Nutrition and Feed Management

August 25-30, 2019, Texas A&M University, USA

A one-week Practical Short Course on Aquaculture Feed Extrusion, Nutrition and Feed Management will be presented on August 25-30, 2019 at Texas A&M University by staff, industry representative and consultants. This program will cover information on designing new feed mills and selecting conveying, drying, grinding, conditioning and feed mixing equipment. Current practices for preparing full-fat soy meal processing; recycling fisheries by-products, raw material, extrusion of floating, sinking, and high fat feeds; spraying and coating fats, digestes and preservatives; use of encapsulated ingredients and preparation of premixes, nutritional requirements of warm water fish and shrimp, feed managements and least cost formulation are reviewed.

Practical demonstration of sinking, floating, and high fat aqua feed, are demonstrated on four major types of extruders-dry, interrupted flights, single and twin screw), using various shaping dies. Other demonstrations include vacuum coating and lab analysis of the raw material for extrusion.



Reservations are accepted on a first-come basis. More information, programs and application forms:

Mian N. Riaz, Ph.D., CFS, Director, Process Engineering R&D Centre, (Formally, Food Protein R&D Centre)

Email: mniaz@tamu.edu (Web: <https://perdc.tamu.edu/>; <https://perdc.tamu.edu/extrusion/>)

2019

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@aquasiapac.com

June 19-22

Asian-Pacific Aquaculture 2019
Chennai, India
www.was.org

June 26-28

Aquaculture Philippines 2019
Pasay City, Metro Manila
www.livestockphilippines.com

August 14-15

TARS 2019: Aquafeeds
Bali, Indonesia
www.tarsaquaculture.com



August 25-30

26th Annual Practical Short Course on Aquaculture Feed Extrusion, Nutrition and Feed Management
Texas A&M, USA
<https://perdc.tamu.edu/extrusion/>

August 29-31

Vietfish 2019
Ho Chi Minh City
<http://vietfish.com.vn>

August 28-30

14th Shanghai International Fisheries and Seafood Exhibition
Shanghai, China
<https://www.worldseafoodshanghai.com>

September 3-5

Seafood Expo Asia
Wanchai, Hong Kong
www.seafoodexpo.com/asia/

September 26-28

Taiwan International Fisheries and Seafood Show 2019
Kaohsiung
www.taiwanfishery.com

October 7-10

Aquaculture Europe
Berlin, Germany
www.aquaeas.eu

October 21-24

Global Outlook for Aquaculture Leadership (GOAL)
Chennai, India
www.aquaculturealliance.org/goal/

November 5-8

LARVI 2019
Bangkok, Thailand
<https://www.ugent.be/bw/asae/en/research/aquaculture>

November 12-14

INFOFISH World Shrimp Trade Conference and Exposition
Bangkok, Thailand
www.shrimp.infofish.org

November 15-18

Giant Prawn 2019
Shanghai, China
www.giantprawn.org

November 19-22

LACQUA19
San José, Costa Rica
www.was.org

aquaculture
europe 19

BERLIN, GERMANY
OCTOBER 7-10

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