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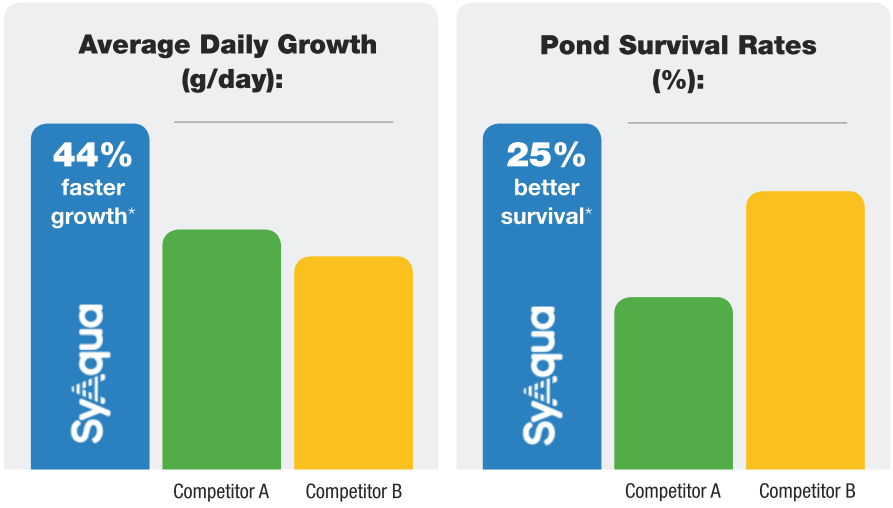

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Zuridah Merican

Can the feed segment lead the aquaculture industry again?

Having just completed The Aquaculture Roundtable Series (TARS 2019) where we focused on developing a Fit for Future aquafeed industry in Asia, it is timely that we take the opportunity to honour the feed segment. The feed milling segment is often regarded as a support service for supplying the correct formulated compound feed to ensure optimal growth of the species, but they have been more than that. If we rewind to the 1970s, it was President Enterprise Corporation, Taiwan that produced shrimp feed and promoted monodon shrimp farming in Taiwan and Southeast Asia. In the 1980s, Charoen Pokphand Feeds and San Miguel Foods did the same to supply feed and promote commercial shrimp aquaculture in Thailand and Philippines, respectively. Amongst others, these were the godfathers - companies that brought aquaculture to Asia and catalysed the industry.

What leadership roles did they take? First and foremost, they were more international and able to bring new technology prior to the age of the internet. Most farms were small and focused on day-to-day operations and they were fragmented. There was little exchange of information between farms or learning from mistakes. Feed companies provided a platform for local seminars and farmers to get together. Obviously, these actions were not altruistic as they created markets for their feed and products associated with improving culture conditions.

It is a common business model for farms to spend 80% of their investment on capital expenditure heavily associated with pond infrastructure. With only 20% left for operational expenses, any assistance is valued. As 50% of production costs is attributed to feed, feed companies would extend credit to sustain culture operations until harvest when farmers would get paid for their produce. This credit spurred the industry and the risk burden was shared between the farmer and the feed supplier. Feed companies also knew that good seedstock had to accompany feed for a successful agribusiness and hence, they invested in hatcheries to ensure fry was not a limiting factor in the supply chain, and later added genetics and breeding into the chain.

There seemed to be an unwritten business contract and relationship, and the feed companies played a supporting role, as well as catalysing the growth of the industry with a push and pull effect. These feed companies benefitted as feed sales are intrinsically dependent on the growth of the industry, and if the customer base grows, feed companies grow too.

Enter the 21st century with the rise of the internet and start-up companies – how can feed companies continue to play a similar role and offer farmers a service they cannot access easily?

The aquaculture industry has changed significantly over the past 10 years. Sustainability has overtaken quality as the priority. Not that quality is unimportant but everyone today can produce quality products, so much so that, that it has become a norm and the expectation, instead of a premium. Asia today is focusing on the same feed criteria that Northern Europe did 30 years ago. There is a need for high performance – low environmental impact feed. The past decade has also seen the emergence of new diseases in the shrimp sector while the freshwater and marine fish sector continue to be challenged by existing diseases.

Feed companies have rightly focused on preventive solutions as they tend to be more efficient. Furthermore, fish do not consume feed once infected and hence, mode of delivery of a therapy poses a challenge. However, these functional feeds do not seem to be gaining ground. It is often compared with insurance that requires upfront payment whether needed or not. Instead, shrimp farmers are prone to administering their own 'treatments' at the pond side. One must question why there is this trust deficit between farmers and the feed companies. This situation must be resolved in the near future as Asian aquaculture may be losing ground as a cost leader. Asian shrimp provides the best example where survival rates have drastically been reduced due to disease. As a consequence, cost of production has increased and in the impending high supply scenario, Asian shrimp producers may be the losers.

It is the opinion of Aqua Culture Asia Pacific that feed companies still have a leading role to play.

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State of the aquafeed industry in Indonesia

The aquafeed industry in Asia has always played a supporting role in the development of aquaculture. Following the focus on Asia's aquafeed industry at The Aquaculture Roundtable Series (TARS) in 2015 and 2011, this year the program moved on to developing an aquafeed industry that is "Fit for Future". It is a prerequisite that the aquafeed industry moves in tandem with aquaculture - catalysing and incentivising aquaculture.

"Asia's aquaculture sector needs to increase production to supply fish protein to the estimated 10 billion global population expected by 2050. The aquafeed segment has a supporting role and as such, feed producers need to keep up with developments," said **Mimid Abdul Hamid**, Director of Feeds and Drugs at the Directorate General of Aquaculture (DGA), Ministry of Marine Affairs and Fisheries (MMAF) in his welcome address to participants at TARS 2019, held in Bali, from August 14-15. With regards to Indonesia, he added, "Currently, our farmed fish production, from tilapia to the Asian seabass totalled more than 6.8 million tonnes. Indonesians consume a lot of fish and demand for fish is increasing as the population expands and as incomes rise.

"Small scale farmers are the back-bone of our aquaculture industry and the government is frequently faced with calls to reduce the costs of feeding the catfish and other freshwater fish. Therefore, to solve this problem, DGA initiated a feed self-sufficiency movement or simply abbreviated to GERPARI (Gerakan Pakan Mandiri), a program which aims to produce affordable feeds by using local raw materials," added Mimid.

"Most of our feed producers are members of the Gabungan Perusahaan Makanan Ternak (GPMT) or in English, the Indonesian Feedmills Association. Through this association, we have a partnership to help the aquaculture industry, such as the farming of freshwater fish in floating cages, using efficient and eco-friendly feeds."

Different strokes for different species in Indonesia

The aquafeed demand comes from the farming of various aquatic species with different characteristics. In 2015, Indonesia produced 947,000 tonnes of tilapia, 575,000 tonnes of milkfish and 1.4 million tonnes of carps, *Clarias* catfish and pangasius (Phillips et al.,2015). However, feed producers focus on the production of shrimp and tilapia feeds.

"The GPMT aquafeed division, comprising 10 members, have been trying to develop marine fish feeds but the progress is slow compared to that for various freshwater fish," said **Haris Muhtadi**, current chairman of the Aquafeed Division (GPMT) and Associate Director at PT CJ Feed and Livestock Indonesia. His presentation titled "Aquafeeds in Indonesia: Different Strokes for Different Species" was on the current state of the aquaculture industry in Indonesia.

> "We expect disruption in industry causing the oversupply of fish and shrimp feeds, when these new companies launch new products into the Indonesian market next year."
> Haris Muhtadi

In the Indonesian shrimp feed sector, demand is mainly for vannamei shrimp feeds, similar to that in countries like Thailand and Vietnam. As most monodon shrimp farmers have converted to farming the vannamei shrimp, almost 90% of the farmers in Indonesia are culturing the latter. Most GPMT members produce only shrimp feed, while the others produce both shrimp and fish feeds.

"The marine fish feed market is still very small as Indonesia only produces groupers and seabass in some parts of the country, namely Bali, Lampung, north of Jakarta and around Medan in Sumatra. Furthermore, the government has drastically changed the regulation on selling live grouper to well-boats for Hong Kong and mainland China markets. This affected production and we are working to find the right solution."

Indonesia's aquafeed challenges

GPMT data on aquafeed production varied with official government figures. Total aquafeed production in 2018 reached almost 1.7 million tonnes, comprising 1.4 million tonnes of fish feeds and 321,000 tonnes of shrimp feeds.

The Indonesian aquafeed industry has been facing many challenges such as feed pricing, purchasing capacity of farmers and requests for lower feed prices from the farmers. The main challenge is on producing high-quality yet cost-effective feeds. Haris noted, "The competitive landscape is changing with the entry of new foreign companies with lower prices and longer credit terms. We expect disruption in industry causing the oversupply of fish and shrimp feeds, when these new companies launch new products into the Indonesian market next year."

Mimid Abdul Hamid (third left) with Indonesian feedmillers and stakeholders, from left: Anwar Hasan, Biomin; Haris Muhtadi; Rizky Darmawan, PT Delta Marine Indonesia; Fauzan Bahri, Skretting Indonesia and Rudy Purwono, PT Matahari Sakti.

Acceptable prices

"From the perspective of feed millers, the challenge is to meet market demand on acceptable prices. We classify fish species by their value. High value species are used for export products and value-adding for the domestic dry market segment, such as for supermarkets." Examples of high value species are monodon and vannamei shrimp, grouper, seabass and tilapia, while low value species are carp, *Clarias* catfish, pangasius and milkfish. Haris also listed some innovations required in the feed supply chain such as pre-

At the Q&A session, on day 1, from left, Dr Orapint Jintasataporn, Kasetsart University, Thailand; Dr Jarin Sawanboonchun, Thailand; Haris Muhtadi, Aquafeeds Division, Indonesian Feedmills Association; Ravikumar B, Growel Feeds Pvt Ltd, India; Dr Brett Glencross, University of Stirling, Scotland and Marc Campet, ADM Animal Nutrition, Vietnam.

treatment of raw materials, application of feed additives, dietary essential amino acids, mill efficiency and raw material quality management, efficient milling process to increase bioavailability of nutrients and improving farm and health management.

Internal factors

Internally, the Indonesian aquafeed industry is faced with many challenges in tandem with the global trend of sustainable aquaculture, with regards to sources of raw materials and responsible use of resources. "At the same time, we in the industry need to meet the minimum standard for feeds, be profitable and to ensure food safety; at the farm, we need to ensure good feed conversion ratios (FCR), high survival rates and high average daily growth (ADG). In addition, lowering waste from feed production and feed application, while ensuring the safety of employees and customers by using non-hazardous chemicals and antibiotics are important. Lastly, it is providing workers with a safe working environment," said Haris.

In feed production, challenges include reining in the costs of energy, labour costs and other costs such as certification. On raw materials, "We depend on imported raw materials, calculated at 80-85% in the production of fish and shrimp feeds. GPMT is also facing a problem in local production of fish meal and fish oil in some parts of Indonesia. We have an abundance of by-products from fisheries, but post-harvest processing is a big challenge. We have a centre for fish meal production in Banyuwangi, but in terms of supply consistency and quality, we still have a long way to go."

External factors

"Our vision is to provide the essential nutrients needed by fish and shrimp, high-quality feed for optimum performance and better profit for the customers," said Haris. "Some government policies have been difficult for the industry such as feed standards based on crude protein levels. But recently, the government has adjusted regulations on feed standards and on registration to fit the needs of industry. To fulfil the nutrient requirements of different species, feed producers can also apply composition of amino acid and minerals to register feeds. Recently, GPMT met with the government to change the feed standard on the minimum crude protein level for milkfish and for some freshwater and brackish water fish species, from 18% to 15%. This will be profitable for the feed industry and will help farmers farming milkfish in semi-intensive and traditional systems. Previously, 15% crude protein feeds were banned for distribution in the Indonesian market," added Haris.

Future in shrimp feeds

The size of the current shrimp feed market is small with an estimated 500,000 tonnes per year (tpy). Competition is tough and feed companies are pushed to extend credit terms, as well as reduce selling prices. "Most aquafeed plants are concentrated in the eastern and western parts of Java Island. The logistics and distribution to other parts of this large country (e.g Sumatra, Sulawesi) and maintaining feed quality are major challenges.

"Today, in shrimp feed production, only 51% of the existing capacity of 620,000 tpy is utilised while the market growth is only 8.5% a year. By 2020, three new investments will add another 140,000 tpy, which is equivalent to 22.6% of current capacity, while the overall utilisation rate of future capacity will decrease to 44%," explained Haris.

Future: Some possible scenarios

"With a crowded market, a price war will soon be looming. Usually feed price is related to quality and with the pending price war, there is a possibility where aquafeed producers will adjust the feed quality. Inevitably this may mean lowering quality to sell the feed at an 'acceptable price'. Once feed quality is reduced, we may have reduced shrimp or fish performance. The negative effects are that fish and shrimp will be more susceptible to disease outbreaks. For the aquafeed industry, more bad debts can occur with crop losses. The future is not bright when we consider the scale-of the industry and current demand."

In conclusion, Haris said, "Despite its current state and the many challenges presented to the Indonesian aquafeed industry, there will always be a demand for cost effective feeds from the aquaculture industry to fulfil the need for protein from a burgeoning population. In order to produce cost-effective and high-quality feeds, the industry needs to reduce its reliance on imported raw materials by improving the quality of local raw materials to be used in the feed for optimum aquatic animal performance.

"Lastly, to grow the market for marine fish feeds, the industry must work together with the government to solve the issues pertaining to the export of live fish from sea cage farming. We need to create a demand for marine fish feeds which will be beneficial to the aquafeed industry and marine fish farmers as well."

From left, Adnan Kharisma and Andri Budi Santosa, Alltech Indonesia; Dr Erwin Suwendi, PT Suri Tani Pemuka and Erik Harjadi Lisnan, Japfa Comfeed Indonesia.

Indonesian aquaculture startup secures seed funding

Jala Tech, an Indonesian startup looking to empower shrimp farmers through tech and smart data has secured seed funding in a round led by 500 Startups. US-based Conservation International Ventures and Hatch, an early-stage investor focused on aquaculture startups, also participated in the round. In 2018, Jala received funding from Hatch's aquaculture-specific accelerator program, Hatch Blue. Founded in 2017, Jala Tech is an internet-of-things water management software firm developing its own hardware products, which are used to monitor water quality in shrimp ponds. It allows aquafarmers to access the data online in real time to minimize the risk of harvest failure. Jala's CEO Liris Maduningtyas is committed to changing Indonesian farmers' operations and create a data-driven shrimp industry.

Jala plans to use the new investment to become an early adopter in Indonesia and fund the development process of its products. It claims to have 1,100 users across Asia.

Friend of the Sea recertifies land based aquaculture producer of caviar and sturgeon in China

Hangzhou Qiandaohu Xunlong Sci-Tech Co. Ltd., a top producer of caviar and sturgeon from fish farming has been certified for land-based aquaculture by Friend of the Sea. With this certification, Hangzhou Qiandaohu Xunlong Sci-tech can continue to display the Friend of the Sea eco-label on its products. "You might think that land-based aquaculture is easy to certify for sustainability. After all, it's theoretically easier to control all the moving parts of the operation when they're all rooted on dry land. However, it's actually quite a lot harder than you might imagine," said Paolo Bray, Director of Friend of the Sea. "Hangzhou Qiandaohu Xunlong Sci-tech is a great example of the kind of commitment it takes to produce a great seafood product on land but do it in a truly sustainable way."

The Sino-foreign joint venture was first certified by Friend of the Sea in 2018. The processing factory is located in Quzhou, China, at the source of Qiantang River. The company integrates breeding, farming, processing and marketing of sturgeon. Aquaculture is the best way to produce eggs of the sturgeon (popularly known as caviar), given the complexity of wild caviar fishing, overfishing and pollution worldwide. To enter the competitive international caviar market, the company drew on its background with the Chinese Academy of Fishery Sciences. This provided strong technological support in farming and production.

F3 Challenge – Carnivore Edition

In September, the Future of Fish Feed (F3) announced its third contest—F3 Challenge – Carnivore Edition. This is open to companies that produce and sell "fish-free" feed for farm-raised carnivorous species. Contest registration is open until April 30, 2020. A USD35,000 prize will be awarded in three categories—salmonid, shrimp, and other carnivorous species—to the contestant that produces and sells the most feed made without using wild-caught fish or any marine-animal ingredient. "We were told after our first contest that the real challenge was fish-free feeds for carnivorous species," said Kevin Fitzsimmons, F3 Challenge chair and professor at the University of Arizona. "Fortunately, there's a lot of great research happening on alternative feed ingredients for carnivores, so we are excited to see what emerges from our third contest."

This competition, designed to accelerate the development and adoption of alternative "fish-free" feeds for aquaculture, will accept aquafeed entries formulated in three categories: salmonid, shrimp, or other carnivorous species. Feeds for all categories must not contain any ingredients consisting of or derived from marine animals, including but not limited to, fish, squid, shrimp, or krill. Chinese aquaculture expert Ling Cao, an associate professor at Shanghai Jiao Tong University and affiliated research scientist at Stanford University, joined Fitzsimmons and Michael Tlusty, associate professor at the University of Massachusetts Boston, as a judge for this competition (https://carnivore.f3challenge.org/) (related news on page 62).

King salmon in open ocean farming in New Zealand

New Zealand King Salmon has applied for resource consent to farm in the open ocean, north of Marlborough in the Cook Strait. Once approved, the company will commission an initial farm with the potential to grow 4,000 tonnes of king salmon, about twice the output of its largest existing farms. Pending approval, the first salmon stocks introduced at the end of 2020/start of 2021 can be harvested 12-18 months later. NZKS CEO Grant Rosewarne said, "We've named our first open ocean farming project Blue Endeavour to signify the future-focused strategy we're putting in place to harness the ocean's potential in a sustainable way. The pens on these farms will be so spacious that we're calling them sea ranges." Developing the first open ocean farm will initially require the commissioning of suitable vessels and pen infrastructure based on international technology, as well as the training of team members. Eventually, the resource consent will allow for the implementation of a second farm nearby, taking the overall production capacity for this region to around 8,000 tonnes of salmon/18-month cycle.

Research into temperature, wave heights, currents and other key environmental factors was carried out by the company and independent scientists over the last year, identifying a 1,792ha area. Cawthron Institute aquaculture scientist Kevin Heasman says, "from a New Zealand perspective, open ocean aquaculture has massive potential. We've got a huge marine estate, no close neighbours, and by combining appropriate environmental and site planning with smart farming systems, we can sustainably realise the value of our open ocean resources." www.scoop.co.nz

Industry-wide survey on women in agriculture

To obtain real-world insights into the professional landscape for women in agriculture, Alltech has announced its support of an industry-wide survey. Launched September 10, this global survey, conducted in partnership with AgriBriefing, aims to collect feedback on the barriers that impede progress and to identify the resources needed to ensure workplace equality. The survey is open to women and men across all sectors of the agri-food industry, and the results will be revealed at the Women in Food & Agriculture Summit(wfasummit.com/#WFA19), to be held December 3–4, 2019, in Amsterdam, the Netherlands. This collaborative effort to reach across sectors and geographical boundaries in an attempt to improve the industry's outlook reflects Alltech's vision for a "Planet of Plenty." During ONE: The Alltech Ideas Conference in Lexington, Kentucky, in May, Dr Mark Lyons, president and CEO of Alltech, said, "It is my experience that the most effective organisations embrace diversity and support inclusion." Women and men in all sectors of the food supply chain are encouraged to contribute to this important global conversation about gender equality in agriculture by taking the survey here. https://www.surveymonkey.co.uk/r/WFA19survey

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Experiences at a farm-based, pond-type *Penaeus vannamei* nursery in India

In Andhra Pradesh, higher survival rates and success were achieved in grow-out ponds stocked with juveniles from an on-farm nursery project.

By Surendran V, Ravikumar Y, Chandrashekhar JYR and Anantheswara Bhat D

Part 1: A general description of the overall nursery concept, success criteria and investment costs.

Shrimp aquaculture production in India is expected to fall by 30% this year. Unfortunately, in terms of production, 2019 is considered by many as the worst year ever since *Penaeus vannamei* was introduced to India, 10 years ago in 2009. There are many technical and disease related problems for this debacle namely: slow growth, white gut, *Enterocytozoon hepatopenaei* (EHP), running mortality and white spot syndrome virus (WSSV).

Juveniles from the nursery ready for transfer to the grow-out ponds.

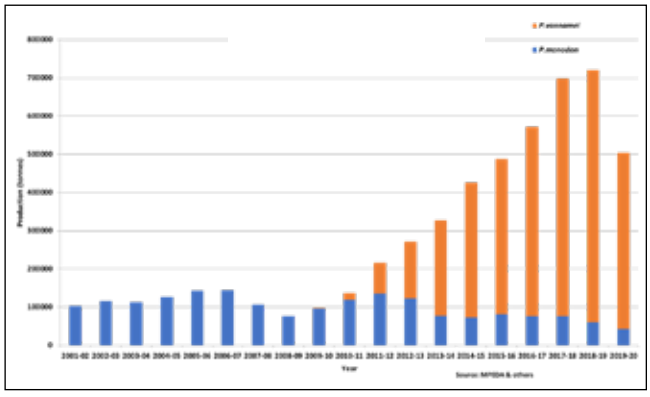
In India, similar to other parts of Asia, direct stocking of ponds with post larvae (PL8 to PL15) is the most common farming practice. However, with frequent outbreaks of diseases leading to poor survival rates and crop failures, an alternative has been to stock juveniles, usually PL 28 to PL 45 (after 20 to 30 days of nursery phase). With this recent trend, various nursery systems have been developed; extension of a farm/hatchery or a stand-alone nursery.

This farm based nursery has HDPE-lined 1000m² and 1.8m deep ponds. Each nursery run will take 30-41 days

Today, we realise that a nursery phase is not a panacea to solve all our problems, but in our opinion, it does help. It may help the industry to stay ahead of the game! Over two years (2018-2019), the team at Vaisakhi Bio-Marine (P) Ltd. has been researching the concept of a farm-based, pond-type nursery located near Adaripeta village, Tuni, East Godavari district, Andhra Pradesh. In this two-part article, we discuss some findings from field trials, project details in setting up a farm-based, pond-type nursery and follow up with standard operating procedures for the nursery, including water and feed management.

Benefits of nursery operations

Generally, the benefits of a nursery can be divided into two areas: technical and management. Technical issues are many and include improved biosecurity, control on initial stocking density (ISD), disease mitigation and better control on feed conversion ratios (FCR). In general, with better pond preparation and management, there can be a healthy pond bottom with lower levels of organic load and bacterial build-up. There can be better control on seed quality after testing at the juvenile stages and with some nutritional fortifications with functional additives and probiotics for bacterial control. There will be compensatory growth. (The size of the shrimp at harvest at the end of the nursery phase is relatively smaller



Farmed shrimp production in India since the 2001-2002 crop cycle

The nursery is located in Adaripeta village, Tuni, East Godavari District, Andhra Pradesh.

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Figure 1. Comparison of average daily growth (ADG) of shrimp in grow-out ponds stocked with juveniles (with nursery phase) or directly stocked with post larvae.

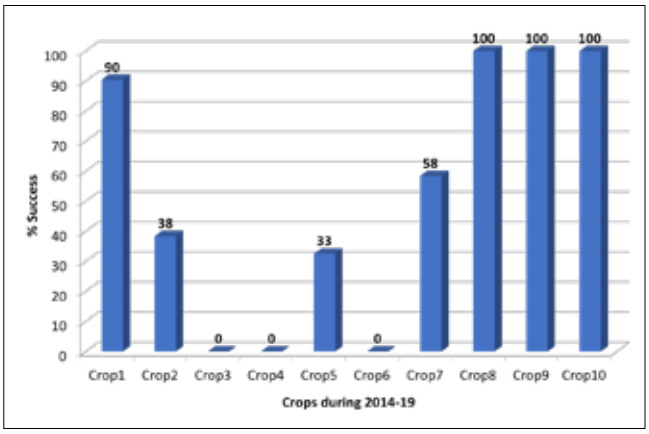

Figure 3. Comparison of the success rate (%) of crops from 2014-2019.

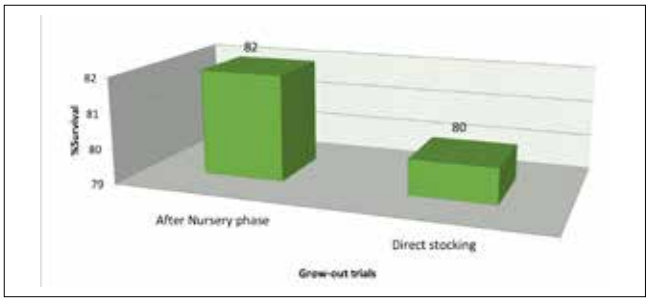

Figure 2. Comparison of survival rate (%) at 135 days of culture (DOC 135) of shrimp stocked as juveniles or direct stocking as post larvae.

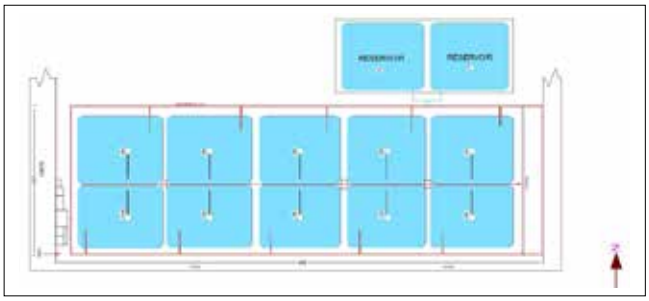

Figure 4. Diagram of the nursery layout.

compared to the shrimp of the same age directly stocked in the grow-out pond, obviously due to the high stocking density in the nursery. However, after transfer from the nursery, the juveniles grow at a relatively faster rate compared to the post larvae stocked directly into grow-out pond.) Generally, during the first and second months of grow-out rearing, due to this 'compensatory growth', shrimp from the nursery phase overtake in terms of growth and size.

In terms of management, a nursery allows for an efficient use of time, space, seed stock and other resources. Overall, there will be costs control and efficiency in operations.

The farm-based, pond-type *P. vannamei* nursery has 10 HDPE-lined ponds, each of 1,000m^2 and 1.8m deep. Each nursery run will take 30-41 days. In the last two years, we have produced over 72 million juveniles (0.5-1g) in our nursery from 24 nursery pond runs.

Growth and survival during grow-out

Some observations are with regards to growth, survival and successful crops. We compared these parameters in 50 ponds stocked with juveniles from our nursery at a stocking density of 30 to 36 PL/m^{2}and 20 ponds directly stocked with post larvae (PL12) at a stocking density of 30 to 36 PL/m^2 from our hatchery.

The average daily growth (ADG) of shrimp stocked directly as post larvae and that of our juveniles are shown in Figure 1. In the first crop of 2018, we observed that ADG reached 0.203g in ponds stocked with juveniles from the nursery. As a comparison, the ADG of shrimp in a previous crop with PLs stocked directly into ponds was 0.17g. However, we have been experiencing an unexplained phenomenon since the second half of 2018. ADG dropped to 0.18g in ponds stocked with juveniles. In direct-stocking ponds, a relatively lower ADG of 0.15g was also observed. During grow-out, growth slowed further in 2019; ADG was 0.15g and 0.12g with nursery phase and direct-stocking ponds, respectively.

With regards to survival rates (Figure 2), after DOC 135, the survival of shrimp in ponds stocked with juveniles was higher at 82% compared to 80% of shrimp in direct-stocking ponds. However, the difference was not significant.

Successful crops

When we compared % success of crops, the benefits of a nursery phase became more obvious. We calculated % success of a crop as

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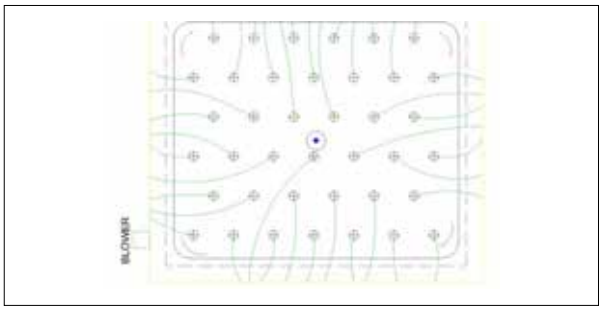

Figure 5. Schematic representation of bottom aeration in the nursery.

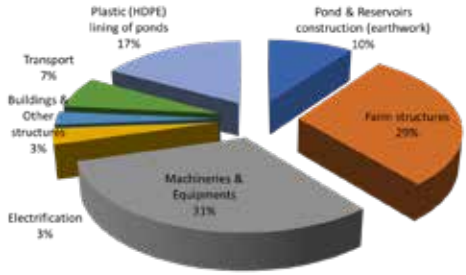

Figure 6. Cost components for the construction of a third nursery phase when land cost is excluded.

follows:((Actual yield/Planned yield) x (Number of ponds successfully operated/Total number of culture ponds) x 100).

As shown in Figure 3, with the introduction of nursery operations in 2018, successful crops became more consistent and even reached 100%. Prior to this, there was a certain level of inconsistency and even crop failures. In our opinion, if one needs to select one trait or benefit that is most significant with nursery operations, it would probably be % success rates.

Nursery design assumptions and layout

In planning for the nursery, prior to a final conceptual layout, several design assumptions and calculations were made. These include:

- Target production = 24 million juveniles.
- Post larvae requirements from a hatchery (assuming 80% survival) = 30 million post larvae.
- Initial stocking density planned = 2PL/litre.
- Size of each nursery pond=1,000m^2 ; depth-1.8m
- Total WSA of 2.6ha calculations =1,000m^2 X 1.8m x 10 ponds + 0.8ha x 2 reservoirs.
- Total land area (@65% area utilisation) required = 4ha.

Design details

Ideally, from a bio-security perspective, an indoor nursery facility would have been preferable. However, pond-type nursery was conceptualised and designed for two basic reasons:

- The cost of construction of an indoor nursery facility would be extremely expensive.
- Prior to considering a substantial investment in a nursery, it was imperative to standardise the operational protocol of the nursery operations, including water and feed management.

The key features of the nursery design are shown in figures 4 and 5:

- 0.1ha x 10 square nursery ponds.
- Pond sides and bottom were lined with HDPE sheets.
- Central drainage pit and pump.
- Bottom aeration (blowers: 6 units of 10 HP) + paddle wheel aerators (4 units of 1HP/pond).
- Ponds were covered with mesh netting.
- Reservoir capacity at 200% of the nursery rearing volume.

Capital cost

The total capital cost for a 1ha water surface area (WSA) nursery (0.1ha with 10 nursery ponds) without considering land cost was found to be INR15,122,424 (USD214,286). Therefore, the cost/nursery pond works out at INR15 lakh. If land costs are included, at the rate of INR15 lakh/acre (or INR37.5 lakh/ha) it would be INR1.5 crore for 4 ha. The total area required to construct the above facility was calculated on 65% of WSA (Table 1).

The total capital cost including land cost for 1ha of WSA would be INR30,122,424. This means that the unit cost (per nursery pond) worked out at approximately INR30 lakh. The contribution of capital cost of the juveniles produced just in one production cycle is about INR0.504 (or 50 paise per juvenile or USD7.14/1,000 juveniles). As the nursery facility is expected to last for about 5 years (10 production cycles), the contribution of capital cost of the juveniles produced is only INR0.05 (or 5 paise per juvenile or USD0.71/1000 juveniles).

Items	Cost (INR)	Cost (USD)*
Cost of land (4ha@ INR 37.5 lakh/ha)	15,000,000	214,286
Pond and reservoirs construction (earthworks)	1,506,730	21,525
Farm structures	4,419,025	63,129
Machinery and equipment	4,732,249	67,604
Electrification	500,000	7,143
Buildings and other structures	416,420	5,949
Transport	1,000,000	14,286
Plastic (HDPE) lining of ponds	2,548,000	36,400
Total capital cost (INR) for nursery (1ha WSA)	30,122,424	430,320
Capital cost (INR) for 0.1ha nursery (3 million juveniles output)	3,012,242	43,032
Capital cost for one ha WSA nursery without considering land cost	15,122,424	216,035
Capital cost for 0.1 ha WSA without considering land cost	1,512,242	21,603
Capital cost contribution per juvenile in one cycle	0.504	0.007
Capital cost contribution per juvenile in ten cycles (5 years)	0.050	0.001
* INR exchange at 70.57 to one USD		

Table 1. Capital cost estimates for 10 nursery ponds, each 0.1ha with 24 million juveniles output, including two earthen pond reservoirs (0.8ha each).

Output	24 million juveniles
Initial stocking density	2 PL/L
Culture duration	30-41 days
Water exchange (%)	5 – 40%
Feed as % biomass	36% to 6%
Targeted % survival rate	>80%
Targeted ABW(g)	0.5-1.0g

Table 2. Operational plan targets.

Without considering the land costs, the major part of the capital cost of the project is civil works, including the earthworks which contribute to about 40% of the capital cost. This is followed by costs of machinery and equipment which contribute to about 30% of the capital cost. The cost of HDPE lining of the ponds contributes to about 17% of the capital cost. The remaining 13% of the capital cost is contributed by various items such as electrification, transport etc. Cost components are shown in Figure 6.

Operational plan

The main features of the operational plan are shown in Table 2. In summary, the plan is stocking at 2 PL/L to produce 24 million juveniles over DOC 30-41. The size range of juveniles is 0.5g to 1.0g.

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The operational plan also included the following:

- Zero antibiotics use.
- Regular use of fermented rice bran and probiotics.
- Regular use of lime and minerals.
- Regular water exchange (pre-determined regime).
- Central sludge pit and sludge pump operation.
- Aeration with paddlewheel aerators; and bottom aeration with blowers.
- Broadcast feeding (from the bund) every two hours; combination of feeds (premium feed (PF) + regular feeds (RF) + grow-out feeds (GF) - every two hours. The combination of all the three varieties of feed were tried to optimise feed cost, without compromising too much on nutritional value.

Days of Culture (DOC)	30	41
Water Exchange (%) - total	500	900
Feed as % biomass	36% - 8%	36% - 6%
Survival %	86.0	82.0
ABW (g)	0.5	1.0
Feed cost (paise/juvenile)/USD (per 1,000 juveniles)	18.0/0.26	26.0/0.37
FCR	1.2:1	1.2:1

Table 3. Operational summary

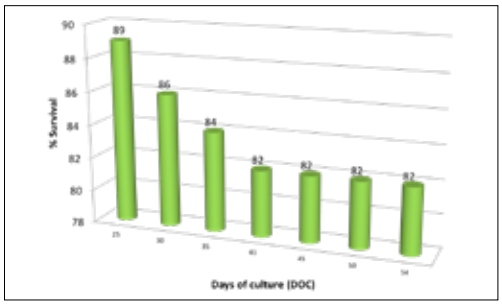

Figure 7. Survival (%) in nursery over days of culture (DOC 25-54)

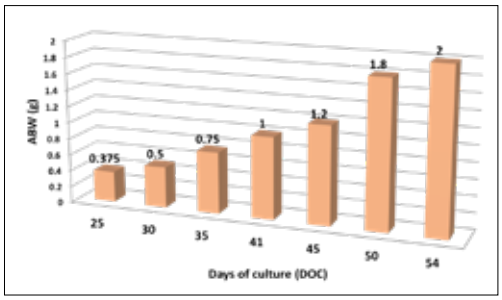

Figure 8. Growth of post larvae in the nursery from days of culture (DOC 25-54).

Summary of results

Over the last three production cycles in our nursery operations we have achieved the following results as shown in Table 3. Survival rates ranged from 89% at DOC 25 to 82% at DOC 54 (Figure 7). Post larvae growth reached 0.5g at DOC 30, 1g at DOC 41 and 2g at DOC 54 (Figure 8).

Next issue: In part 2, the authors will discuss in detail their standard operating procedures for the nursery, including water and feed management and transfer of juveniles to ponds.

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A parabiotic positively impacts shrimp production in laboratory and field trials

Cost benefits justify the use of parabiotic as part of a standard operating procedure, particularly late in the hatchery cycle or just before stocking ponds.

By Stephen Newman

A farm in Indonesia

The most widely farmed shrimp species, *Litopenaeus vannamei*, has found its global niche largely as a result of the availability of specific pathogen free (SPF) shrimp. SPF shrimp are not free of all pathogens nor are they resistant or even necessarily tolerant to the pathogens that they are free of. Nonetheless they are valuable tools in many production environments that can lessen the overall impact of diseases (Newman, 2009). SPF shrimp are, however, only one tool out of many that can help farmers.

Vertebrates produce white blood cells that remember the exposure to a pathogen so that they are able to react quickly should they be exposed to the pathogen again. Shrimp do not have this mechanism. As with almost all living organisms, shrimp also have the ability to produce heat shock proteins (chaperone molecules) in response to stress. These proteins are also involved in how the shrimp deal with the presence of pathogens (Junprunga et al, 2019).

Despite the fact that many consider invertebrates to be phylogenetically primitive, they are far from it. Early workers showed that it was possible to exploit penaeid immune systems (Lewis and Lawrence, 1983). However, we now know that their mechanisms of protection are not solely due to the presence of different classes of lymphocytes (Newman, 2009). They have a sophisticated mechanism for dealing with pathogens (Tassanakajon, 2012). The shrimp immune response is complex and while the subject of a great deal of ongoing research, the exact mechanisms remain to be elucidated. It is non-specific in nature although some aspects of it suggest that there may be some specificity. Shrimp appear to have no memory of prior exposure to pathogens and do not form antibodies.

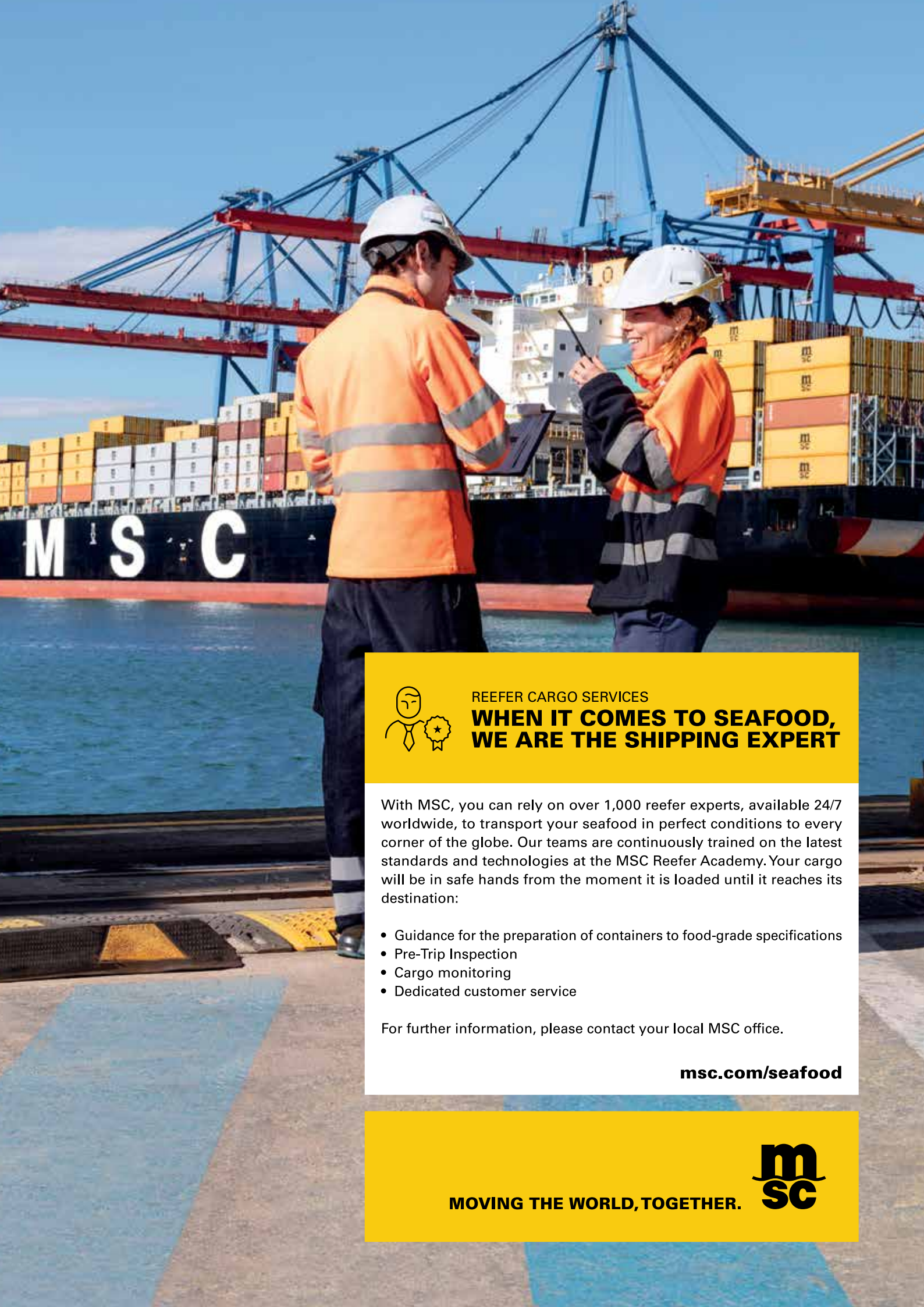
Parabiotic bacteria

Aquaintech Inc (USA) has developed and field tested a parabiotic that clearly benefited shrimp in laboratory trials and large-scale field trials. This parabiotic is a very high density fermentor produced suspension of a proprietary strain of bacteria. The data show a cost benefit and while not all tests were significant at $p < 0.05$, many were.

Extensive laboratory trials were conducted with the parabiotic before it was field tested. The manner in which shrimp are tested can be problematic. Many trials that appear to offer benefits in the laboratory fail to do so in the field. One of the reasons for these failures relates to how shrimp eat (Tacon, 2002). Most products are initially screened for efficacy by direct or indirect addition to feed in aquarium trials.

Shrimp masticate feed before they ingest it. After feed is ingested, it is ground further by the gastric mill before it enters the hepatopancreas and the intestinal tract. The results of aquarium trials can be misleading because of this. As feed is consumed, the shrimp are shrouded in a cloud of particulate materials; a result of grinding any food they ingest to a particle size small enough to pass through the pores in the gastric mill, less than one micron (Pattarayingsakul et al. 2019). This ensures that any material that is tested in an aquarium study is more than likely also being consumed via gill uptake as well as with water that is consumed, etc. Thus, experimental animals may ingest potentially biologically active materials repeatedly. This does not occur in the field where these clouds of particulate materials are rapidly diluted.

The parabiotic is added to post larvae (PL) tanks. PLs are held at high concentrations for the duration of the feeding with supplemental



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oxygenation. The parabiotic is fed at a range of dilutions, from 1:500 to 1:5,000, depending on the particular approach used. Typically, water levels in tanks are lowered to facilitate uptake of the concentrated material. High levels of aeration are used to minimise stress and the PLs are held for a minimum of 3 hours. They are then removed, and the process is repeated with naive shrimp.

Survivals post challenge

Laboratory trials have been conducted by many different groups and the results demonstrated that fed shrimp were able to tolerate exposure to both viral and bacterial pathogens at higher levels than naive shrimp.

Figure 1 describes the results of aquarium trials in which PL15 fed the parabiotic at mysis 3 (M3) were challenged with by a waterborne exposure of 10^5 CFU/mL of *Vibrio parahaemolyticus*. Each group consisted of 30 PLs. Experiments with a natural challenge showed a similar impact. The test results showed that under the challenge conditions, the parabiotic fed shrimp were less susceptible to this strain of *Vibrio*. The control groups experienced 60, 50 and 80% survivals with an average of 63%. The parabiotic fed animals experienced 70, 100 and 90% survivals, respectively, with an average of 87%.

Another series of experiments involved exposing parabiotic fed shrimp to tissues containing high levels of the Taura Syndrome Virus-TSV (Figure 2). The results clearly demonstrated that shrimp fed the parabiotic were better able to tolerate exposure to TSV. In replicate studies, 98% of the control shrimp died, whereas in the parabiotic fed groups, one had a 98% survival and the other a 28%. The differences in the results are a reflection of differences in the viral loads in the infective tissues. Other tests confirmed that shrimp fed the parabiotic required much higher exposures to TSV to produce the same level of mortality as in the control group. A similar observation was noted with white spot syndrome virus (WSSV).

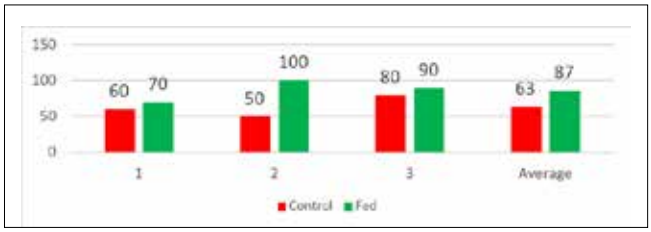

Figure 1. Challenge against *Vibrio parahaemolyticus* (Thailand).

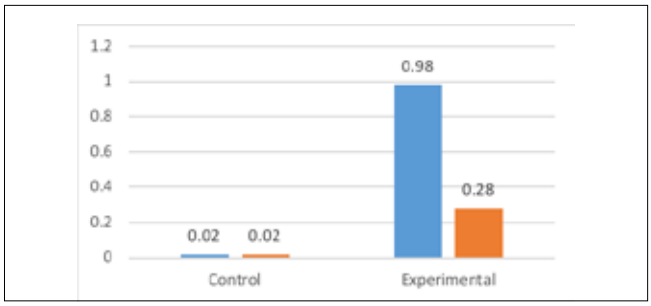

Figure 2. Survival of parabiotic fed shrimp in a TSV challenge.

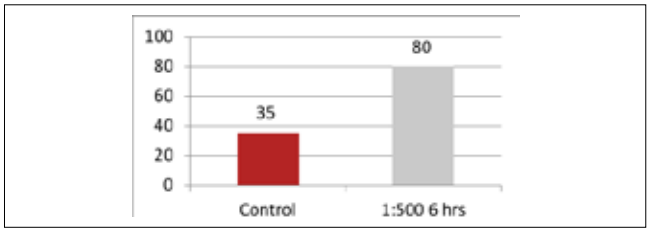

Figure 3. Post exposure survival (%) to EMS/AHPND causing pathogen.

Another test of the parabiotic involved exposing fed PLs to a *V. parahaemolyticus* strain that causes early mortality syndrome/acute hepatopancreatic necrosis disease-EMS/AHPND (Figure 3). These results were the average of three replicates. There was a clear-cut impact. PLs fed the parabiotic at a 1:500 dilution for 3 hours were largely refractory to infection with the bacteria that causes EMS/AHPND, with 80% of the animals surviving, compared with 35% in control group.

Testing in the field in cages

Figure 4 shows the average survival of shrimp in two cage studies. Four control cages and four experimental cages, each containing 40 PL12 (20/m^2) were stocked into a single pond at two different sites on the same farm (sites A and B). At 56 days, the experiment at site A was terminated. Only 16% of shrimp in the control group were alive compared with 44% of the parabiotic fed shrimp. This 28% difference was a 175% increase in survival. After 59 days, the experiment at site B was terminated, 32% of the control group shrimp were alive compared with 40% of the parabiotic fed shrimp. This 8% difference was a 25% increase in survival.

In another series of experiments (Figure 5), a single cage was placed into each of six ponds. PL12 placed in the cages of three of these ponds were naive controls and three in other ponds were fed the parabiotic prior to stocking. At the end of the experiment, there was a significant difference in survivals with the parabiotic groups consistently outperforming the controls. These tests demonstrated once again that shrimp fed the parabiotic prior to stocking had increased survivals.

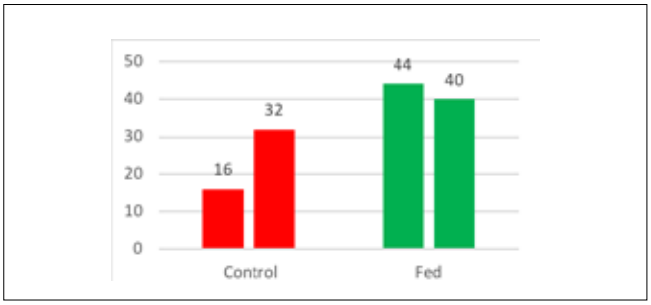

Figure 4. Shrimp survival (%) at termination of study (GMSB-Honduras).

These results highlighted an important observation. There must be something occurring in the shrimp population such that exposure to the biogenic parabiotic had an impact, i.e. there must be a pathogen present that was affecting the shrimp negatively. When survivals in control groups were high, which indicated little or no problems due to the presence of pathogens, it was expected that survivals should be slightly higher or about the same in the fed shrimp. Conversely if the controls had a very high shrimp mortality, which could be indicative of a highly virulent pathogen or the presence of any number of mitigating factors affecting susceptibility, any beneficial impact could be overwhelmed.

The results from extensive experiments in the field corroborate that feeding the parabiotic to PLs is beneficial. Additionally, we observed a wide range of impacts on fed shrimp which were clearly cost-beneficial but were not always related to any overt health issues. The mechanism of action is likely to be complex.

Field trials

This parabiotic has been used on PLs in the field, in shrimp farms in many different countries. For the most part, there were significant cost benefits that justified the use of the product as part of a standard operating procedure.

Table 1 describes the results of one such trial. There were three control and three fed ponds in the trial as described in Table 1. PL12s were stocked at 8/m^2. The cost benefit was significant. For every dollar spent on the use of the parabiotic the farmer saw more than an USD9.00 increase in profit. This was calculated using a

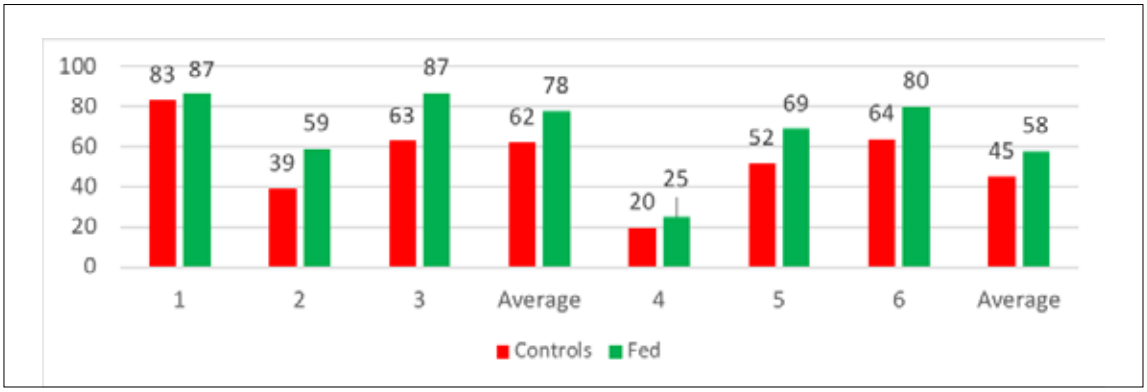

Figure 5. Shrimp survival (%) in field trails in cages (GMSB-Honduras).

	With parabiotic	Control	Difference (%)
Survival (%)	57.6	48.4	19
Weight at harvest (g)	9.2	9.6	-5.2
Yield (kg/ha)	733.6	641.8	14.3

Table 1. Nursery pond trial in Ecuador.

	With parabiotic	Control	Difference	Increase (%)
Survival (%)	30.7	29.04	5.8	1.6
Weight (g)	10.6	10.4	0.2	1.7
Yield (kg/ha)	569.9	530.6	39.3	7.4
FCR	1.89	2.04	0.15	7.35

Table 2. Field trial in production ponds (463 ha, 24 ponds, 83 million PL, Naturisa, Ecuador).

	With parabiotic	Control	Difference	Increase (%)
Survival (%)	57.3	56.7	0.6	1.1
Weight (g)	14.24	13.29	0.95	7.1
Yield (kg/ha)	785.5	731.36	54.1	7.4

Table 3. Field trial in production ponds (181 ha, 18 ponds, 18 million PLs (Naturisa, Ecuador).

computer program that plotted a regression curve based on the costs of all inputs and that predicted the time at which the profit from the harvest was maximised.

Cost benefit through harvest

Results from many field trials showed that there was a cost benefit when the parabiotic was fed late in the hatchery cycle or immediately before stocking the ponds. It also showed a strong benefit in the hatchery (data available). Moreover, the field trials also showed a number of other results as well. No two shrimp farms are the same. The benefits varied. Feed conversion ratios (FCRs) improved in a number of tests. Animals were sometimes larger. Sometimes, whatever was impacting the shrimp did not seem to be affected by consuming the parabiotic. There were trials in which there was no apparent difference between the groups. Usually this was a result of the presence of pathogens accompanied by serious stressors overriding any benefits that can be derived from the parabiotics.

Based on the accumulated data from laboratory, cage and full cycle tests, we postulate that the parabiotic affected the shrimp in a short-term effect. Cage studies and early harvested field trials showed a fairly consistent effect and the laboratory studies demonstrated that the shrimp were stronger in some way. Exposure to the parabiotic appeared to strengthen the PLs, in a manner that is not yet clearly understood. This increase in fitness gave the fed shrimp an advantage under some culture conditions.

Table 2 shows results from a very large field trial in production ponds. Shrimp did poorly in terms of survival rates, although the shrimp in the parabiotic fed group averaged slightly better and their average weight was better at harvest. These small differences resulted in a 7.4% increase in harvest yields between the groups. Even if one assumes that survivals and weights are all basically the same, the 7.35% difference in FCR was significant across 12 ponds.

The results in Table 3 demonstrated that the final average weight of shrimp at harvest was almost a gram greater when they were fed the parabiotic than naive controls. A significant cost benefit was demonstrated.

Cage used in studies

Conclusions

Shrimp farming is constantly plagued by production challenges. It is largely practised by small scale farmers often with little understanding of what is required to be truly sustainable. Failure to consider the role of maturation and hatcheries in the transmission of pathogens combined with a failure to ensure that shrimp are not produced under highly stressful conditions are serious profit limiting issues. Pathogens that can be controlled in some manner, such as lower overall loads in the environment, can impact shrimp that are weakened by these stresses. There is evidence suggesting that by not controlling stress, there is a negative impact on shrimp physiology.

A proprietary parabiotic was tested in the laboratory and in the field in both short term and full cycle trials in several countries in South America and Southeast Asia. The short-term benefits were consistent in terms of improving resistance to a variety of pathogens. Cage experiments and short-term field trials suggested a benefit lasting at least 60 days. Full cycle use showed that there were a variety of possible impacts on the final outcome of the crop. The use of the parabiotic was cost effective and frequently resulted in increased profits from improved feed conversions, better growth and higher survivals.

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Genomics to address disease resistance in tilapia

Major developments in tilapia genetics has led to a breakthrough in disease resistance to *Streptococcus iniae*.

Tilapia enjoys a good reputation in the US white fish market and Asia is a leading producer. Leading Asian producers (China, Indonesia, the Philippines, Bangladesh, Thailand and Vietnam) shared the estimated production of ~6.5 million tonnes in 2018 with Egypt and Latin American countries, Brazil, Mexico, Honduras and Costa Rica (Fitzsimmons, 2019). The major share of Nile tilapia commercially produced today have some links to the pioneering genetically improved farmed tilapia or GIFT project run by ICLARM (now WorldFish Center), Institute of Aquaculture Research, Norway (formerly AKVAFORSK, now NOFIMA) and several collaborating institutions in the Philippines in the late 1980s and 1990s. Growth is the most common target trait. In Hainan, China there was work on the Nile tilapia for fast growth, fillet yield and on the blue tilapia for cold tolerance (Thodesen et al., 2012; Thodesen et al., 2013; Rye, 2013). Today, globally, there are also government or privately-run breeding programs, with fast growth and improved fillet yield as the main target traits.

Globally, tilapia survival rates are mainly adversely affected by *Streptococcus* outbreaks, particularly when water temperatures rise above 30°C. Bacterial infections from *Streptococcus agalactiae* and *S. iniae* were estimated to cost the industry USD713 million in losses (Shinn et al., 2018) while the global tilapia production was valued at USD22.4 billion in 2017 (FishstatJ FAO, 2019). Mortality rates from *Streptococcus* outbreaks differed from country to country. A 2014 study in Bangladesh indicated a general mortality of more than 26% for tilapia of which 70% was attributed to *Streptococcus* making it the most prevalent pathogen affecting the tilapia. Losses around 20% of production in the hot season was reported in a Thai study. Outbreaks caused serious losses, such as 80-90% in Leizhou Bay, China, in May 2015, and 83.4% in Malaysian farms (Shinn et al., 2018). Specific vaccines for serotypes of *S. agalactiae* and *S. iniae* have been developed and marketed by local and international health companies, but often, farmers use antibiotics as treatment alternative.

The emerging tilapia lake virus (TiLV) is under close surveillance. Now reported from several countries, mortality rates range from 20-90%. TiLV is currently a concern in Asia. In Thailand, mortality levels between 20% and 90% have been reported, with mortality usually seen within the first month after transfer to grow-out cages (Dong et al. 2017a; Surachetpong et al. 2017). In May 2017, co-infection of TiLV and *Aermonas veronii* resulted in mass mortality over three weeks of red tilapia in a Malaysian farm. Mortality occurred after 45 days of stocking in earthen ponds (M.N.A. Amal et al., 2017).

Picture credit: Benchmark PLC

The Network of Aquaculture Centres in Asia (NACA, 2017), in collaboration with key researchers in Thailand who worked on this disease for the past few years, had issued a warning and developed an improved PCR method for TiLV disease in Thai tilapia farms.

Genetic improvement in bacterial resistance enhances the health and welfare of tilapia since less fish will suffer from infections. Therefore, less infection will result in lower antibiotic usage, making tilapia production more sustainable and efficient.

Continuous genetic improvements

Farm animal breeding has moved from conventional pedigree breeding to genomics, where individual performance can be predicted using analysis of the DNA sequence. This technology is particularly effective in developing farm animal strains with improved disease resistance. Benchmark has been using genomic methods extensively in Atlantic salmon, where resistance to major pathogens is now routinely improved using genomic selection through high density genotyping and marker-assisted selection on major genes or QTL's (DNA segments with large effect on the phenotypic expression of the trait). For example, the use of a major QTL for selection against infectious pancreatic necrosis (IPN), a viral disease that affects Atlantic salmon, has reduced incidence of IPN to negligible levels, thus resulting in a tremendous positive economic impact in the salmon industry.

Spring Genetics, part of the Benchmark group operates an advanced selective breeding program for Nile tilapia *Oreochromis niloticus*. The Spring Genetics stock has successfully completed

Picture credit: Benchmark PLC

more than 15 generations of selection for key traits such as fast growth, survivability and yield, and more recently, advanced genomic selection for resistance to *S. iniae* and *S.agalactiae*. Today, Spring Genetics distributes genetically improved high performing tilapia to integrated companies and affiliated multiplication hatcheries throughout the world.

Technology and progress

Together with Akvaforsk Genetics, Spring Genetics has developed an exclusive high-density SNP chip and performed extensive genomic analysis to better understand the genetic basis for resistance to *S. agalactiae* and *S. iniae*. Initial genomic analysis for resistance to *S. agalactiae* demonstrated that this trait was controlled by many genes, each with small effect. Genomic selection based on the high-density SNP chip has begun. The most resistant individuals from each family are identified by genotyping, thus increasing the rate of genetic improvement and allowing effective genetic progress in health and welfare traits.

Benchmark's work on *S. iniae* resistance is part of a comprehensive, pioneering effort to bring tilapia genetics up to the standard of the most advanced programs developed for salmonids. Routine large-scale controlled challenge tests of individual nucleus families for *Streptococcus* were first conducted for *S. iniae* in 2014, followed by *S. agalactiae* in 2015 and *S. francisella* in 2018. Work on TiLV is scheduled later in 2019. The testing has allowed the team to incorporate family selection for specific disease resistance into the breeding goals for Benchmark's Spring Genetics® stock.

In parallel, Benchmark has developed an exclusive high-density SNP panel for Nile tilapia, based on the extensive genotyping of reference materials from the US and Asia. Combined with phenotypic reference data from family testing, the high-density SNP panel facilitates the extensive search for markers linked to a major QTL.

This technology creates the opportunity for marker assisted selection (MAS) on those specific major QTL, as well as for genomic selection (GS) for traits influenced by a high number of genes each with smaller effect. In both cases, utilisation of genomic information allows for not only selecting breeders from the best families, but also the best individuals within the best families. For disease traits, this significantly increases the accuracy and intensity of selection, boosting the genetic progress compared to conventional family selection.

Family selection for disease resistance was introduced in the Spring Genetics® breeding program in 2015. This year, Benchmark is implementing MAS for *S. iniae* and genomic selection for *S. agalactiae* for the first time in tilapia. The company also has extensive on-going R&D programs for improved resistance to additional disease resistance as well as for other key traits.

Following the announcement of the breakthrough with *Streptococcus* resistance in tilapia with discovery of a significant QTL for resistance to *S. iniae* in Nile tilapia, Aqua Culture Asia Pacific posed several questions via email to **Morten Rye**, Genetics Director, Benchmark Genetics and **Malcolm Pye**, CEO Benchmark Group on the significance of this breakthrough and their future steps.

Malcolm Pye

Morten Rye

S. *iniae* is known to have two serotypes. How effective will the new genetics be against these two serotypes?

Based on genome wide association studies (GWAS), Benchmark has identified a major QTL for resistance to *S. iniae*, which explains for a large part the high genetic variation found for this trait.

Our genetics teams ensure that the pathogens we work with are the most relevant for the species we are focusing on. In this case, Benchmark is working with a virulent strain of *S. iniae*, provided by our research partner USDA-ARS Aquatic Animal Health Research Unit in Auburn Alabama, US. The strain was isolated from a natural outbreak in the US. Benchmark's teams will continue to test additional relevant serotypes as the work proceeds and are working with international research partners and in-house animal health experts to identify the most prevalent strains.

What improvements in survival rates can we expect with the use of the new genetic strains? As a guide, can you compare the growth with GIFT strains or other strains?

It is difficult to generalise. Effect on survival depends on the pathogen load and there is a high genetic variation to resistance to *S. iniae*. In controlled challenge tests, offspring groups produced from parents selected from families in the high and low end of the distribution of families, demonstrated a very high realised response - with average survival of offspring from parents from high and low ranked families at 88% vs 10%, respectively.

Benchmark selection happens at two levels:

- Reproduction of nucleus families - selection is broad, based on a combination of traits for sustained long-term improvements and maintaining the populations genetic integrity and variability
- Production of dissemination lines for multiplication and production of commercial fry - the selection of breeders for dissemination lines are selected and targeted for individual traits or combination of few traits.

This enables Benchmark to offer a portfolio of products tailored to target production environments and clients' priorities.

It is also important to note that survival rates in commercial production are determined by much more than the stock's genetic level of resistance to specific pathogens and robustness. A range of additional factors such as disease control by use of vaccination, health management programs, biosecurity, environmental conditions, production practices, and nutrition also strongly affect survival. Therefore, Benchmark is a strong advocate for a balanced health approach to good farm management, through the use of robust genetics, effective health products and advanced nutrition.

As selection for growth rate and specific disease resistance are opposite traits, how is the growth rate of the new strain?

Selection for improved disease resistance in tilapia is not expected to affect the animals' growth rate. Developing robust, healthy and fast-growing tilapia is the key priority for Benchmark's Spring Genetics program and our stock is recognised as one of the fastest growing in the Americas.

Spring Genetics® stock is currently undergoing its 8th generation of selection in the US and its base material originated from the GIFT project in the Philippines. It was introduced to Benchmark's breeding program in Miami in 2009.

What would be the cost of the broodstock of such a strain or can farmers buy fingerlings?

Benchmark introduced *Streptococcus* resistance in its Spring Genetics® nucleus in 2015. Stock are priced competitively, and farmers will benefit from genetics with the latest advances in technology. We are increasing the accuracy of selection by implementing genomic information, as well as offering specific dissemination lines for combination of resistance traits from early 2020.

To buy broodstock, producers need to have or obtain a long-term broodstock license. Benchmark can then provide broodstock selected to reflect the client's priorities with respect to growth, robustness/disease resistance.

What prevents buyers from using the F1 generation to create their own broodstock?

Buyers who create their own broodstock are at risk of losing their competitive advantage as stock reproduced other than from original broodstock may lead to rapid inbreeding and rapid loss of resistance. It takes genetic experts decades to build an effective breeding program and requires significant investment to maintain and advance the stock. Benchmark's genetics teams ensure that our stock is fit for the target environments and we are continuously upgrading our products to meet customer requirements to deliver desirable traits such as growth, quality and disease resistance.

The tilapia industry is becoming more professional, with a focus on quality as well as price and Benchmark is committed to the continuous development and improvement of strains and allocates significant resource in research and development to take a leadership position in aquaculture genetics.

Which region of the world will see the initial roll out of the new strain and why this region?

Our Spring Genetics fry is available in Latin America where we have a strong presence and established sales and distribution channels. Our upgraded QTL product is expected to be launched in the Latin American market in spring 2020.

Asia is a very important market for us, and we believe we can help producers improve the resilience of their stock. We are currently in the process of establishing a network in Asia and seeking strategic partnerships.

Will this strain reduce or annul the use of vaccinations against *Streptococcus* sp. in the tilapia?

We must remember that although the genetic strain is highly effective, it is not 100% resistant to *Streptococcus*. Tackling any biological issue effectively requires a multi-disciplinary solution. In this case, both genetics and vaccines will together build the animals' resistance to *Streptococcus*.

Benchmark's mission is to help producers improve their sustainability and profitability. By implementing a vaccination program combined with using genetic stock with high level of resistance to key pathogens we are helping producers to create a more robust system.

What is the business model to monetise such a scientific breakthrough?

The business model is similar to our salmon genetics models, where our customers recognise the value of using Benchmark genetic strains to increase the quality, yield, health and welfare of their stock. We have seen first-hand how devastating *Streptococcus* is to the industry and with the introduction of this new technology we can drive improvements in sustainability and profitability for our customers. The cost/benefit of this improved performance is clear.

We expect to see increased consolidation and professionalism in the tilapia industry and genetics will be a key aspect of any health management program. This breakthrough is the result of our many years of investment and commitment to bringing state-of-the-art breeding technology to this important farmed species and we believe that this will allow the industry to expand production of this cost effective, high-quality, protein source to meet the increasing global demand for protein.

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Successful business models to meet customer demands

C-suite aquafeed executives from Denmark, India and the Philippines give their views on developing an aquafeed business

C-suite aquafeed executives, from left, Christopher Co, Palanisamy Ravi and Henrik Aarestrup

TARS 2019 featured a Hard Talk with three C-suite executives of aquafeed companies. The aim was to identify successful business models and to see what opportunities and threats they could foresee in the near future. They gave some directions in line with the "Fit for Future" theme of TARS 2019.

Henrik Aarestrup is Vice President, Emerging Markets Division, BioMar Group since 2016. He is responsible for driving the group's expansion into new market areas in both Latin America and Asia; his achievements include the company's successful entry into the shrimp feed segment and the establishment of two joint venture factories in China. Henrik is a key player in developing and promoting BioMar's global sustainability initiatives under the BioSustain umbrella.

BioMar, founded in 1962 by a group of Danish fish farmers who decided to improve their productivity is among the first in Europe to introduce pelletised dry feed, eliminating the need for the more polluting wet feed. Today, it is one of the leading companies in the production of high-performance feeds for the global aquaculture industry. The group supplies feed to around 80 countries and to 45 aquaculture species from 14 feed factories and is currently constructing another two.

Palanisamy Ravi is Senior Vice President of Operations at The Waterbase Limited, India. He was part of the initial project team tasked with the founding of TWL in 1992. He is credited with the introduction of the smallest size pellet (1.8mm) in India and Southeast Asia in 1996 ; the development and introduction of India's first vannamei shrimp feed (Baywhite) in 2009; in-house development of high value by-product meals and hydrolysed additives; set-up and management of the R&D centre.

The Waterbase Limited (TWL), India's first integrated aquaculture company, established in 1993 was initially setup with the technical assistance of LUXE, Taiwan. Today, it has two feed mills in Ananthapuram and Bogole in Nellore, Andhra Pradesh. TWL produces starter to grow-out pelleted shrimp feeds for the marine shrimp, *Litopenaeus vannamei* and *Penaeus monodon* and freshwater prawn, *Macrobrachium rosenbergii*. It has shrimp processing and hatchery operations and 12.1 ha (30 acres) of shrimp farms and a R&D centre. TWL is part of the Karam Chand Thapar Group, KCT.

Christopher Co is Vice President Marketing of Oversea Feeds Corporation, an integrated aquafeed producer based in Cebu, Philippines. Christopher is very active in the aquaculture sector in the Philippines and has considerable experience in the growing and breeding of different species: monodon and vannamei shrimp, grouper, snapper, pompano, crab and tilapia.

Oversea Feeds Corporation is a pioneer in aquafeed production in the Philippines. Starting with fish farming in 1987, it then went into feed milling in 1988 and the hatchery business in 1989. Aside from feeds and hatchery, Oversea's aquaculture business covers several company-owned and joint venture grow-out farms for vannamei shrimp and milkfish fingerling production to supply their offshore fish cages and pens. Species wise, the focus is on vannamei and monodon shrimp and milkfish.

On business models contributing to success and challenges faced in the immediate future

Henrik: We are fully focused on aquafeeds and that is also the base for being successful in China. China is a huge complex and fragmented market and very few companies have successfully entered the feed market. Sales in China are related to long term relationships and giving a lot of credit can run very high risks. It is also a market where tremendous change is occurring.

In China, environmental rules which drive better regulations and enforcement, are becoming stricter. This is where our joint venture with Tongwei shows its strength. Together we have a factory in Zhuhai and another one in the pipeline. It has access to the right customers via Tongwei and immediate access to technology via BioMar. This joint venture has been profitable from day one; its success required both investment and willingness, and both partners are in it for the long term. There is good focus on certain species.

> "We have to look at the Philippines as a country within a country and one business model cannot be applied to different regions. Shrimp culture varies from island to island."
> Christopher Co

> “Apart from feed performance, we now look at sustainability with the mantra of ‘making our farmers profitable’. As farmers have multidirectional issues, a company providing an integrated solution is better at addressing their problems.” Palanisamy Ravi

Palanisamy: Back in the 1990s, Waterbase went straight into an integrated strategy for commercial aquaculture business, comprising hatchery, farm, feed and processing for export. This extended to franchisee farmers. In 1996 India encountered disease problems with monodon shrimp and saw its worst in 2000.

There was stagnation until 2007 when the Indian government allowed trials to introduce vannamei shrimp farming. The boom time began after 2009, with a few companies expanding and feed demand increased several fold. However, at this time, Waterbase had shutdown most of its supply chain, only producing feed, thus leaving the integrated approach. We now have returned to our original integrated approach.

Today, India has 14 companies with 38 feed mills only for shrimp and if fish is included, there are 68 companies creating huge competition. Apart from feed performance, we now look at sustainability with the mantra of ‘making our farmers profitable’. As farmers have multidirectional issues, a company providing an integrated solution is better at addressing their problems and there are only two listed companies including Waterbase doing this today.

Christopher: We have to look at the Philippines as a country within a country and one business model cannot be applied to all the regions. Shrimp culture varies from island to island. Culture practice ranges from extensive farming to super intensive with 200 post larvae/m^2. With competition, I believe integration into farming and hatchery helps keep control over many aspects. It is necessary to form alliances with other players. Despite the belief that Philippines seems like a protected market, it’s actually cheaper to import than to produce feed locally and this is due to the high cost of electricity. It is estimated that 50% of the shrimp feed used is imported or of a foreign brand.

On species focus..

Henrik: We are principally a salmon feed company but are also very strong in the production of feed for other marine fish. Shrimp has taken a big role and is expected to be the third leg. It is noted that in our feed pie, shrimp feed only comprises 9%. The company could grow organically but this will take a longer time so we are also looking at a collaboration and acquisition strategy as well. Building on shrimp feed in Central America, we can now introduce shrimp feeds in China. The target is not to be number one in shrimp feeds but focus on customers who value innovation and sustainable solutions.

Palanisamy: Waterbase focused on vannamei which now comprises 95% of the shrimp produced in India. From 2009-2018, the CAGR has been at double digits. It is true that the risk is huge but we do not have any other choice. We have been operating a crab meat export unit and exploring soft shell farming. The freshwater fish business is not our focus as it is for the domestic market

Christopher: Oversea Feeds actually started in shrimp grow-out and then went into feed milling and hatchery and that was 30 years ago in the heydays of the monodon shrimp. After this shrimp failed, we shifted to vannamei shrimp but there is also the local fish, milkfish and tilapia and marine fish.

Is integration the future or will it be just focusing on the core business of feed?

Henrik: We understand the benefits of integration; with transparency in the value chain we hope to reap the benefits along this chain. However, there is the question of whether one is capable of being the champion at each stage. We have chosen to be the best at feed and using this best practice around the world. This allows for opportunities with partners in various geographies and countries across the world.

Christopher: It is possible to rely only on one segment of the value chain but how can we relate to the farmers if we ourselves have no grow-out experience? How does one control the stocking without our own hatchery? This applies to other species of fish where we do not have a hatchery. Oversea is not integrated into processing as it requires a full-time operation and can be a stand-alone business. When it is a species which does not require feed, that will not be our focus. In the Philippines, the domestic price of shrimp is better than the export price, so processing today does not seem to be a viable business.

On strategies for geographical expansion in Asia..

Henrik: Markets undergo development over time so the question is when should one enter different markets. In our case, entry into China was about timing. There are much stricter environmental regulations implemented now which easily compare to regulations introduced in Europe 20-30 years ago. Northern Europe had to overcome this with innovative products, specialised systems, high performance and low impact feeds. Today the Chinese market is mature enough to accept these exact same products and systems. If we had entered China alone without Tongwei, we would have lost our first mover advantage. As we discussed during our roundtable session this morning, it's about applying new technology at the right time when there is market pull.

Palanisamy: India has opportunities for expansion. The east coast from Tamil Nadu to Odisha has aquaculture activities which has grown over the past 15 years but there are new areas on the west coast such as Gujarat, Karnataka and Goa all the way up to the Pakistan border. As transport cost is expensive in India and can amount to 5% of feed costs, it will impact Waterbase as we are in the south. We are more than 400km away from our customers in Gujarat, so we have been looking at sites for a new feed mill. Transport costs aside, we have to be close to our customers. We are also interested to work globally through joint ventures.

Christopher: There are numerous feed mills north of Manila which service farmers in Luzon. This is a great advantage over our feed mill which is based in Cebu. Our strength is in central and south Philippines. However, most of the farmed shrimp is sold in Manila. This is where the economy is and the increasing tourism from China is creating a large seafood market. Oversea studied and rejected the idea of putting up a feed mill in Manila. The study showed that whatever savings garnered by being close to the customer were negated by the transport of bringing in feed ingredients.

> "However, there is the question of whether one is capable of being the champion at each stage. We have chosen to be the best at feed and using this best practice around the world. This allows for opportunities with partners in various geography and economy across the world." Henrik Aarestrup

On common demands from customers..

Henrik: Most customers ask for lower prices and longer credit but fortunately there are also customers like Troy Keast of Phillips Seafood Indonesia who expressed the importance of partnership in his presentation this morning. It is important for feed companies to listen to customers but also see the global developments and look ahead for the needs of the farmer. Innovation is a major focus for us, implementing best practice across markets. We see a lot of novel ingredients that help aquaculture's sustainability which is not driven by the customer but by the value chain. For BioMar, it is innovation, sustainability, environmental performance and the capacity to grow.

Shrimp farming systems differ in Central America due to the lower stocking densities, but they have started focusing on sustainability and branding themselves as such. This is where they sell at a premium compared to Asia. Their approach seems to fit well with ours on the sustainability brand.

Palanisamy: India is a tough competitive market now with a number of feed companies supplying good quality feed. Hence the next criteria of farmers is better monetary benefits, i.e. more credit. But in today's situation, disciplined farming practices will enable them to sustain. Gujarat farmers seem to have more teamwork and discipline. They adhere to guidelines to ensure biosecurity. So, when one farm is affected by disease, there is no discharge of water to affect the neighbours. Gujarat only does one cycle per year and there are fewer farmers. Gujarat has a market size of 100,000 tonnes of feed per year. Almost 80% of the fry come from one hatchery, so perhaps there is more trust amongst the smaller industry there.

Christopher: With any feed complaint, we have to give it serious thought. The vannamei shrimp is more tolerant to formulation fluctuations compared to the monodon shrimp but the feed company always gets blamed for any problem. It is important to ensure that the hatchery provides quality fry. Even with good genetics, one sees variation among different batches. Weather is also a huge contributing factor. Feed companies do have a role to play to provide technical service for farmers. Farmers tend not to adapt so an operating procedure that worked years ago may not work today and hence education is crucial.

State of industry and challenges

Part 1: Feed industry experts discussed how shrimp and fish farming are shaping the feed business in India and Thailand

AQUAFEEDS: FIT FOR FUTURE

The Aquaculture Roundtable Series (TARS) 2019 held from August 14-15 in Bali, Indonesia was attended by 247 participants from 26 countries. The series returned to focus on Asia's aquafeed sector, the third time in its nine-year old history. Previously, the aquafeeds industry was covered in 2015 (Hanoi, Vietnam) and in 2011 (Singapore, its inaugural year). Focusing on developing "Aquafeeds: Fit for Future", plenary speakers discussed the state of the aquafeed industry in four major producing countries, nutrient requirements for fish and shrimp, new ingredients for fish meal and oil replacement, disease control and health management, and how the industry can be fit for the future via technology and sustainability.

Organisers, Aqua Culture Asia Pacific and Corporate Media Services, Singapore invited three C-suite executives from the aquafeed industry in Denmark, India and Philippines for the Hard Talk (pages 26-28). The breakout session had participants networking and discussing the next steps in marine shrimp, marine fish and freshwater feed production. Industry sponsors at TARS 2019 were: Inve Aquaculture, DSM, Corbion, Biomin, BASF, Adisseo, BioMar, Calysta, Jefo Nutrition, Veramaris, Phibro Aqua and Skretting.

TARS 2019 started with state of industry presentations on four major aquafeed producing countries in Southeast Asia- Indonesia (see pages 4-5), India, Thailand and Vietnam. Common to these countries is stable and upward demand for various freshwater fish feeds although that for shrimp feeds fluctuates as farms face disease outbreaks. Feed producers continue to play a large supporting role throughout the production cycle. In discussing the growing aquafeed business in Asia, Dr Zhang Song, Vice President, Guangdong Nutriera Group, China showed how consumers in China are determining trends in fish consumption, impacting specific feed demand of species.

M V D Malleshwarrao (left) and A.V. Seshadri, Deepak NexGen Foods and Feeds, India and R Sriram, The Waterbase Limited, India (right).

India: Growing pains and technology changes

India's aquafeed industry has been growing; for shrimp feeds since the vannamei shrimp was introduced in 2010, and for fish feeds with rising production from domestic demand. In his presentation "Growing pains and technology changes in India" **Ravikumar Bangarusamy**, Technical General Manager, Growel Feeds Pvt Ltd, India discussed state of the aquafeed industry in India and the recent threats from the farming sector.

> "The farming and feed sectors can benefit if domestic shrimp consumption can reach 20 to 30%. Then on, we can expect some consolidation; merger and acquisition of independent feed mills by multinationals." Ravikumar Bangarusamy

Shrimp production rose from 480,000 tonnes in 2015 to 690,000 tonnes in 2017. However, production dropped to 630,000 tonnes in 2018. In 2019, a lower production of 530,000 tonnes is expected. In contrast, fish production is continuously growing. In 2019, the estimate is 6.74 million tonnes where Indian major carps account for 77% of production.

India's aquafeed industry has 68 aquafeed mills with almost 68% located in Andhra Pradesh state. There 18 dedicated shrimp feed mills, 16 for fish feed production and 12 feed mills producing both shrimp and fish feeds. Fifteen feed mills have large capacities (>100,000 tonnes per year (tpy)). In 2018, installed aquafeed capacity totalled 4.8 million tpy but the utilisation rate was only 50%.

For India's aquafeed producers, the advantage is that most feed ingredients are available locally, particularly for fish feed production. There are restrictions on the imports of animal origin ingredients, genetically modified organism (GMO) crops and soybean meal which limit the industry's competitiveness. Spiralling prices of ingredients against stagnant or declining prices of fish and shrimp, have forced feed manufacturers not to increase feed prices.

Shrimp feed demand and supply

In India, the vicissitudes in shrimp farming are not just due to disease outbreak, although these are major, said Ravikumar. "In 80% of areas, since late 2018, we see that farmers have started to reduce stocking density. Today, average stocking density is only 30 post larvae (PL)/m^2 instead of the previous 40 to 60 PL/m^2. As they have just completed the first crop, there is already a 15 to 20% drop in production this year. Clearly, farmers are challenged by disease outbreaks and low prices. The microsporidian *Enterocytozoon hepatopanaei* (EHP) is a major problem in India. Then we have extreme high temperatures particularly in Tamil Nadu and Andhra Pradesh, intermittent rains in Orissa and West Bengal and floods in Gujarat. Late arrival and absence of monsoons is another factor.

"Generally, in well managed ponds and good shrimp growth performance, feed conversion ratio (FCR), can be between 1.2-1.3. In EHP affected farms, FCR will be very poor. At the end, the crop will either be at breakeven or a loss. Premature harvest due to disease outbreaks impacted all support industries including feeds."

In 2018, 46% of installed capacity for shrimp feeds (2.8 million tpy) was utilised with 1.3 million tonnes of shrimp feed sold. According to Ravikumar, data on the monthly consumption pattern for shrimp feed collected over three years (2016-2018) showed feed consumption peaked at 72% of installed capacity during May-June and was lowest at 22% in December.

Auto feeders and functional feeds

Ravikumar emphasised that the feed industry can offer shrimp health solutions, but it cannot substitute good farm management. Today, some of corporate farms use sensor-based auto feeders which are highly recommended to reduce organic loads of ponds. Part of his role in Growel is to conduct R&D and advise farmers on pond management including using functional feeds.

Data from his R&D work comparing pelleted feeds versus extruded functional feeds in about 1,000 ponds across India for the past 3 years at various locations, at different salinities and over winter and summer, showed better survival rates by 24%, better average daily growth rate by 30% and improved FCR by 21% with extruded functional feeds.

Shrimp feed: growing pains

These range from ingredients to impact along the supply chain. "Less fish meal is available while there is a decline in quality of local fish meal. There is also a lack of good quality animal proteins. We depend on local soybean as there are restrictions on the import of soybeans. As most of the feed mills are in Andhra Pradesh, feed prices can increase by as much as 6% for farmers in West Bengal," said Ravikumar.

With shrimp growing slowly, premature harvests, repeated crop failures and reduced stocking density by 50%, farmers have cash flow problems which will filter to poor repayment to the input suppliers. Ravikumar continued, "Dealers have high risks with slow or poor recovery of credit. In turn, dealers expect more discounts from feed companies to compensate for the extended credit period to farmers.

"With such uncertainty, feed companies have difficulty in forecasting feed demand and producing feed at competitive prices, limited scope to increase prices and face unhealthy competition."

Ravikumar said, "Growth of the shrimp feed segment will depend largely on farmers overcoming disease challenges and introduction of disease tolerant stocks, especially for WSSV and EHP. It can benefit if domestic shrimp consumption can reach 20 to 30%. We can expect some consolidation; merger and acquisition of independent feed mills by multinationals.

Raising questions on moisture content to stability of vitamins in feeds, From left, Md Akteruzzaman, Jefo Nutrition, Bangladesh; Hendi, PT Leong Hup Jayaindo, Indonesia and Steven Goh, Delstasia Sdn Bhd, Malaysia

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Fish farming: The big change

There has been a steady demand for fish feeds. In 2018, utilisation of installed capacity for fish feed production (2 million tpy) was 47.5% at 950,000 tonnes. However, for such low cost fish feeds, the transport cost of supplying to distant markets is prohibitively high by as much as 9%, since most fish feed mills are in Andhra Pradesh. "Compared to shrimp feed, demand is stable throughout the year; the highest is 74% in October/November and 40% of installed capacity in May," said Ravikumar.

"The big change is that farmers use extruded and pelleted feeds. In the beginning it was only for 2 species and now, 4 species. The farmed fish market is also improving; more diversified with improved pond productivity and post-harvest handling. But prices drop with an oversupply and we can stabilise prices with species diversification which will also increase feed usage." Some corporate farms have started to farm tilapia and murrel (snakehead) is being farmed in cages in reservoirs.

To increase feed performance some feed mills have been conducting trials on post pellet application of enzymes. They are however limited in the selection of application methods in terms of cost and efficiency. "However, there is a cost increase. Changing farmers' mindset is an issue, especially if fish prices continue to drop. Such a technology may be more suitable for high value species. Another change is the introduction of high fat feeds for marine species such as 16% fat in seabass feeds.

Ravikumar concluded, "India's aquaculture and aquafeed sectors are expanding and have long-term growth potential. Both are undergoing various challenges but we are positive that eventually we will overcome them and continue to grow and meet our production targets."

Thailand: Traceability and towards zero fish meal in aquafeeds

Dr Jarin Sawanboonchun, aquaculture nutrition and feed specialist gave her views on the state of the industry in Thailand in her presentation titled "Challenges in Thailand: A view from the next generation". In Thailand, the commercial aquafeed industry began around 1988; now 30 years later, it is the next generation that is taking over.

"Today, Thai feed mills operate in a highly competitive market where the demand is for the production of the best performance feeds at the lowest cost possible. To do this, feed mills need good nutritional knowledge, technology (software and production), quality raw materials available at low costs and R&D facilities to trial changes in formulation. A good technical team is also needed to provide advice and services to farmers. The emerging social media has been useful for us to follow aqua production trends and understand real time monitoring of emerging issues," said Jarin as she discussed the direct challenges faced by aquafeed producers and indirect ones affecting the aquafeed industry.

Fish meal supply and demand

This is a problem quite unique to Thailand as in 2015, it was issued the "yellow card" for IUU (illegal unregulated and unreported) fishing. This was removed in early 2019. "For a long time, Thai feed producers prefer to use local fish meal. While the government was settling the IUU issue, fish meal production went down, but more importantly, a lack of certified fish meal which is desperately need by feed producers with certification," said Jarin, adding that this pushed for R&D to find alternatives to fish meal in aquafeeds.

Disease outbreaks and lower prices

While disease outbreaks brought down shrimp production by 12%, the drop in global shrimp prices discouraged farmers from investing. "The impact was not only low demand for feed, but also loss in confidence of farmers. Most shrimp feed millers reduced prices to help farmers." A cost analysis showed feed costs ranging from 40-70% of production costs. On whether feed mills can produce cost-effective feed just to help farmers lower costs, Jarin answered, "Yes, in Thailand, the industry is constantly working on this; cheaper feeds with lower crude protein and has developed functional feeds. However, it is efficient feeding practices together with good farm management that can reduce feed cost."

Therefore, there are recommendations to use automatic feeders to improve feed intake while reducing labour costs. The Department of Fisheries (DOF) has also created a mobile phone feed application for farmers to use. The aim is to lower cost of production with DOF recommending not to over feed and improve feed conversion ratio (FCR) with prudent management, such as not rushing to increase feed for the next day even if shrimp has eaten all.

> "In Thailand, R&D remains core to industry's progress from the current low use of fish meal in feeds to zero fish meal."
> Jarin Sawanboonchun

Standards, certification and traceability

Today, good manufacturing practices (GMP) is a minimum requirement for industry. Thailand has 12 Best Aquaculture Practices (BAP) certified feed mills and they need to keep up with certification standards such as control of feed formulations to reduce fish meal inclusion rates and traceability of ingredients along the supply chain. "Traceability is a priority for export to most countries. The latest BAP feed mill standard requires use of responsible soymeal by 2022; use of at least 50% of soybean that are certified. These add costs for aquafeed producers. Certified fish meal is 5% more expensive than the standard fish meal. At the same time, the industry has to catch up and invest in R&D to remove fish meal and fish oil from feed formulations."

Alternative protein sources

Over the years, the inclusion rate of fish meal dropped in feeds for every species. "In shrimp feeds, we use less than 10% fish meal in feed formulations. For freshwater species, fish meal is used at at least 1%. When we remove fish meal in the formulation, it can affect growth performance. Feed producers do this by using software that develop formulations based on the amino acids composition of ingredients. However, we need to ensure feeds are palatable, attractive, and also perform well.

R&D and innovation

As the industry is on track to move from low fish meal to zero fish meal, R&D is critical. At the same time, the industry is seeking suitable protein replacement ingredients and additives for its functional feeds or when formulations have low fish meal. The latter is new in Thailand and requires more R&D. "The challenge is to prove that the functional feeds work. While farmers do not know what to expect, feed producers are also concerned that these functional feeds might not be the correct solution for the farmer."

In red tilapia, Thai farmers prefer the dark red colour and thicker body, more than the pale colour variety. In the catfish, farmers

K.Venkata Raju, Avanti Feeds Ltd, India (left) and Preecha Bangnokkhwaek, Thai Union Feedmill, Thailand

Sawasporn Jaklerdchai, SPF Diana, Thailand (right) and Ngo Xuan Tuyen, Pilmico Vietnam JSC.

prefer the yellow colour instead of a darker colour. "The constraint is that prices of red tilapia and catfish are very low. An additive might not work and so we may seek raw materials containing for example high levels of carotenoids instead," said Jarin. "R&D in feeds also have to catch up with genetic improvements in the vannamei shrimp. The current feed requirements for the vannamei shrimp is between 20% to 45% crude protein; should there be nutrient dense diets for the fast-growing strains which in turn may pollute ponds?"

Industry constraints

While industry is undertaking R&D to help farmers with cheaper feeds and innovate to produce sustainable feeds, it is limited on how it can change feed composition. Feed standards regulate that the protein in shrimp feeds must start from 32%. "In terms of replacement of fish meal with insect meals, this is not allowed at the moment. Microbial proteins are now available in the market. The first consideration on whether to use insect meal or microbial proteins, will be price, i.e. will they be more expensive than fish meal? Next is quality and supply. A third would be nutritional and toxicology aspects as well as consumer acceptance," said Jarin.

Jarin summarised her views, "In Thailand, R&D remains core to industry's progress from the current low fish meal to zero fish meal in feeds. In the future, we can expect more feed types in the market such as functional feeds. As farmers are also trying their best to improve farm and feed management and using more and better technology, I believe that Thailand's feed industry will keep moving forward. We might be slow but we will be sustainable.

"However, the aquafeed industry is just part of the production cycle. Together with the farming segment, we need also to think about the environment, disease and management. To address these challenges, the private sector, universities and government need to work together."

Part 2 in the next issue, will cover the state of industry in Vietnam and growing the aquafeed business in Asia.

TARS 2020 will be on Shrimp Aquaculture from 19-20 August, venue: TBA

Marketing krill meal in India

Venturing into the Indian aquafeed market requires regulatory approvals and convincing feed producers

Fish as a good source of protein containing omega-3 brings up the vast potential for aquaculture to supply to the needs of a rising global population. In parallel, as fish and shrimp farming expand, the need for a sustainable sourced marine ingredient has never been higher. Norway-based Aker BioMarine harvests the Antarctic krill *(Euphausia superba)* which is a source of marine proteins and lipids. It is also a sustainable alternative, low in the food chain, used to replace fish meal in diets for marine species.

Aker BioMarine CEO, Matts Johansen qualifies this to the company being awarded the title "Europe's most innovative company" in 2018. "This is due to our forward leaning approach in developing the fishery and the markets for our product. Aker BioMarine do not only want to be a standard setter in the krill harvesting industry, we want to be a standard setter in the global feed sector in general.

Frontrunner in use of resources

"We strongly believe that aquaculture has an important role to play as a frontrunner of one of the biggest challenges we face today, which is to produce enough food for our growing population. We need to increase production using the same amount of resources as we currently do today. Aquaculture has a great opportunity to be part of the solution, with the development of new ideas, technologies and focus on sustainability," says Johansen.

Asian-Pacific Aquaculture 2019 (APA'19), held in Chennai, India, from June 19-21 was an opportunity for experts within krill aquaculture science in Norway to share their knowledge and know-how with industry in Asia, and the team from Asia and Norway to promote QRILL Aqua krill meal for the aquaculture sector. India has a large aquafeed market, producing an estimated 2 million tonnes in 2018 (Ajaya Baskar, 2019). At this event with such a large gathering of industry from all over Asia, the focus was however, not only on India, but on the total aquafeed market in Asia.

According to **Simon Seward**, Vice President QRILL Sales Asia, Aker BioMarine is very committed to the Indian market and continues to invest in building a strong customer focused team to serve new and existing customers in the market. To support this customer focus, Aker BioMarine is investing in its supply chain to make faster deliveries and ensure immediate availability of its products in the market.

"Our marketing strategy is designed to drive awareness of our Antarctic krill products and its many benefits for aquaculture feeds. We also focus our communication on how Aker BioMarine, as the world's leading supplier of krill, has its foundation built on sustainability and how we improve people's health without compromising the health of our planet and its oceans."

Seward explains that in aqua diets, QRILL functions as a feeding stimulant leading to increased feed uptake and enhanced growth. "It enables similar or improved performance at lower cost through replacement of other ingredients. QRILL is also proven to increase stress tolerance, such as high salinity.

"Our main product for the Indian market is QRILL Aqua which contains phospholipid-bound omega-3 fatty acids, astaxanthin, the biologically active antioxidant, minerals and proteins. This combination delivers a compelling aquafeed solution proven to improve the health of fish, shrimp, as well as their stress tolerance."

Focus on India's aquafeed market

Marketing of krill meal for India's large aquafeed industry is the responsibility of **Atul Barmann**, General Manager at Aker BioMarine India Pvt Ltd, in addition to marketing other product lines for human nutrition and pet foods. At APA'19, Barmann recounted his journey in introducing krill meal and oil into the Indian market.

"Our focus is both the aquafeed and human nutrition markets. However, we are still in the exploratory stage for the pet food market in India. Here in India, we just do not see ourselves as marketing the krill meal and oil, but we want to help and support the Indian aquaculture sector to produce more.

"I have been with Aker BioMarine since early 2012. However, we entered India's aquafeed market in 2016 and our first activity was to get regulatory approvals, as krill meal at that time was really new in India. Ingredient-wise, krill meal was being confused with fish meal, squid meal and others. It took us a while to explain the differences."

Consequently, the product entered the market in 2017, after submission of a special health certificate. The next step was working with feed producers.

"Feed producers are our customers, and our approach is to work closely with them to help their customers – the farmers. Some of the issues here are typical to India, although many are global," says Barmann. "What we are trying to do is to apply our global

At APA'19, Simon Seward (second left) and Atul Barmann (third left) with guest and team members: Chaiyot Rawekchom, Sales Director (left) and Dr Panukorn Totubtim, Sales Manager (right), Qrill SEA Aker BioMarine - Thailand; K. Anand, Lakshmi Feeds, India (centre left); Sandra Mondonga, QRILL Sales (centre right) and Dr Lena Burri, Director R&D, Animal Nutrition and Health (third right), Aker BioMarine, Norway and Dr Alberto J.P. Nunes, Labomar- Instituto de Ciências do Mar, Brazil (second right). Photo credit: Aker BioMarine

knowledge and experience to provide local solutions. With 12 PhD qualified researchers carrying out science projects and clinical studies, we are learning more about the fundamental functionalities of krill nutrients," adds Barmann. "To address India's specific issues, we have started a collaborative study with CIBA (Central Institute for Brackishwater Aquaculture)."

This collaboration is on the use of krill meal and its benefits for shrimp, under local farming conditions. It will focus on effects of krill meal on stress tolerance. Barmann clarified that this study is quite specific as farming conditions vary in India. "Water salinity varies with regions causing stress to shrimp. If salinity is high, feed intake is affected and consequently shrimp growth is adversely affected."

Asta oil is another interesting product that the company is working on in regulatory approval. The regulations are different than for the krill meal, since the oil is high in astaxanthin. There is an advantage as astaxanthin is a powerful and potent antioxidant which makes it very useful, particularly during the larval and post larval stages and helps with better stress tolerance. "Some Indian hatcheries have already shown interest in the product," Barmann adds.

Market inroads

During the APA conference, the Aker BioMarine team conducted a session on fish meal replacements. The recommendation at this session was to reduce the dependence on fish meal from the current levels of more than 15% to below 10%. Krill meal acts as a feed attractant and provides essential nutrients.

The shrimp feed segment is a target for Aker BioMarine. "After this, we want to look at how we can support freshwater fish farmers and at the same time focus on brackish water fish farming, which is a major activity in many parts of India such as in Kerala, Tamil Nadu and West Bengal."

On challenges at the feed producer level, Barmann explains, "As an ingredient, though krill meal is perceived to be costly, but actually it is very cost effective. Already small dietary krill meal inclusions allow the reduction of costly ingredients such as fish meal, cholesterol and phospholipids."

In addition, krill meal provides the antioxidant astaxanthin. By not just adding the krill meal on top of the formulation, the feed formulation can be reworked and costs saved. "We are able to explain this to forward-thinking feed producers who can in turn explain it to the farmers."

> **"The final goal is to see that krill meal enhances shrimp growth; thus, shrimp spends less time in ponds and goes to market faster." Atul Barmann**

Atul Barmann and Simon Seward with guests at APA'19, K.Anand and A. Koodeeswaran, Lakshmi Feeds, India. Photo credit: Aker BioMarine.

To demonstrate the cost advantages, the company has been conducting field trials with feed producers. "In this way, they can see the changes in formulation costs. Feed producers also do their own independent trials and we support them. Others depend on studies we have done in the other parts of the world. The final goal is to see that krill meal enhances shrimp growth; thus, shrimp spends less time in ponds and goes to market faster."

Barmann, who is based in Mumbai, says "Our mission is improving human and planetary health. Planetary health means that whatever we do should be sustainable and without having a negative impact on our planet."

Bioactive peptides and animal hydrolysate proteins in aquaculture

The benefits of bioactive functionalities were demonstrated in adult tilapia in Vietnam where an inclusion of protein hydrolysate in feed increased the fillet yield as anti-adipogenic bioactive peptides promoted a rational utilisation of nutrients in protein deposition.

By Thaís Costa Andrade and Wilson Rogerio Boscolo

According to the Food and Agriculture Organization of the United Nations (FAO), global fish supply is projected to reach 201 million tonnes in 2030. Production from aquaculture is expected to hit 109 million tonnes, representing a 36% increase from the 2016 production of 80 million tonnes.

Aquaculture production still relies heavily on fish meal and its supply chain faces many challenges. First, we know that the demand for fish meal is growing faster than the available supply, leading to price increases. In terms of costs, in 1983, the average fish meal price was around USD400/tonne but in recent years it has gone up to USD1,600/tonne. As a comparison, soybean meal price increased eight times less in the same period.

Other than increasing prices, there is also the issue of availability of high-quality fish meal, which are produced with whole fish and contain less ash content. The supply of such fish meal (~68% crude protein), is getting less. This is because of lower catches from capture fisheries which in turn limit the fish meal supply for aquaculture. In addition, the use of this raw material is considered unsustainable in the medium or long term.

As our source of fish protein evolves from capture fisheries to aquaculture, it also means that we need to provide farmed fish with all the required nutrients in a complete and balanced feed. Furthermore, each time we move further to more intensive productions, there is less dependence on natural feeding. The quality of ingredients used in feed formulations and the type of feed processing used have a direct impact on fish productivity.

Different processes for producing ingredients and their characteristics

To understand these differences, this article will provide some explanations on three types of ingredient processing; the most common is thermal processing or cooking. This happens when the raw material is subjected to high temperatures in a digester. This process has the benefit of being simple and cheap, but it may be detrimental to the proteins and impacts the digestibility and availability of amino acids. For this process, studies indicate that the longer the raw material is exposed to high temperatures, the lower the digestibility and nutritional value.

The second process is chemical hydrolysis, which can be acid or alkaline. This is when the raw material is subjected to severe pH changes. This type of hydrolysis is also considered a low-cost process. Acid hydrolysis is often used to enhance flavour but a negative point is that with this process, there will be a partial destruction of some amino acids, such as tryptophan. When we talk about alkaline hydrolysis, the impact on amino acids is even worse than of acid treatment. Another fact is that chemical hydrolysis will increase the ash content in the ingredient, since you are adding other components during the process.

Lastly, we have the enzymatic hydrolysis, which often happens at low temperature and low pressure and does not result in any loss of amino acids. Furthermore, it improves the digestibility of protein and availability of amino acids to the animal. Enzymes are also more precise in controlling the degree of peptide-bond hydrolysis, making it possible for a greater consistency of the final product. Another advantage is that in this process, we have less use of energy and steam compared to the cooking process.

Enzymatic hydrolysis and bioactive peptides

To understand more on how enzymatic hydrolysis generates high quality ingredients with functional benefits, we will review some concepts. By definition, a protein is a macromolecule that usually has 20 different amino acids (AAs) that are linked via peptide bonds. Amino acid contains both amino and acid groups. The peptide bond is the link between the nitrogen from the amine group with the carbon from the acid group. The sequence of AA is what defines the different proteins and its biological value.

When we have a protein with a low molecular mass, and a low number of amino acids, we call it a peptide. Another important fact is that peptides may have different bioactivities such as antimicrobial, antioxidant, antihypertensive and also immunomodulatory. These are called bioactive peptides, and are defined as specific sequences of amino acids, with low molecular mass and a specific biological activity in the organism.

One way to produce bioactive peptides is through enzymatic hydrolysis of the intact protein. The word "hydrolysis" means breaking through the water. The enzymatic hydrolysis is a chemical reaction accelerated by an enzyme that uses water to break one molecule into two other molecules. In the case of proteins, the hydrolysis forms smaller chains of amino acids (peptides).

These small peptides are easily absorbed into the animal's organs than a whole protein. In addition, the animal will spend less energy absorbing them. This extra energy can be used to grow, to gain weight and to fight challenges. The protein digestive capacity depends on several factors, among which are the age of the animal (i.e. larval stage or adult) and the protein form (if it is a small peptide, a free amino acid or an intact protein). Usually, more mature animals will absorb food more efficiently than animals in the early stages; thus, hydrolysed proteins will be more easily absorbed than intact proteins. Besides the benefit of *in vivo*

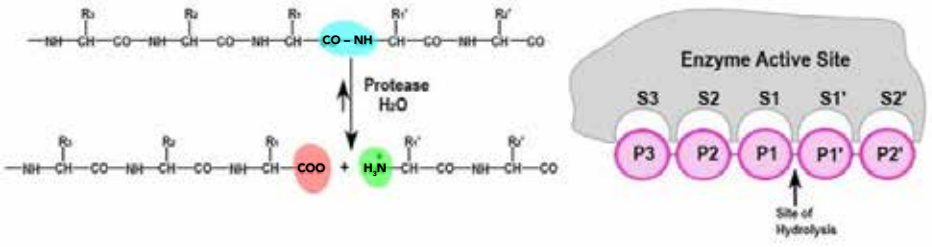


Figure 1. Peptide bond enzymatic hydrolysis scheme. *(https://www.intechopen.com/books/polymer-science/polymerization-of-peptide-polymers-for-biomaterial-applications)*

protein absorption, enzymatic hydrolysis also generates bioactive peptides.

There are extensive experimental stages involving enzymatic engineering knowledge to determine which is the best enzyme for which raw material, and what processing conditions are needed to achieve the desired bioactivities. The bioactivity can vary depending on the type of enzyme used and each enzyme can create a peptide with a different AA sequence.

Different types of raw materials have different specific peptides and bioactivities, such as immunomodulatory and antimicrobial. Those bioactive peptides identified can be further explored in the future for benefits in animal nutrition, opening a wide variety of applications for protein hydrolysates.

Protein hydrolysates as functional ingredients

There is a clear relationship between the way how ingredients are processed (and hence their nutritional value) and the animal performance. With that in mind, BRF Ingredients has designed a new method of processing ingredients based on enzymatic hydrolysis; this process has given better results for animal performance.

After enzymatic hydrolysis of the raw material, almost all the solids are removed through filtration, thus decreasing the final ash content to approximately 4%, and concentrating the protein content to more than 75%, with a digestibility of more than 90%. The stability of these parameters is another characteristic of the process. Furthermore, with the selection of enzymes and process conditions most of the protein content is in the form of small peptides with less than 3 kDa of molecular mass, that is considered to be the band with greater bioactivity.

In addition to the advantages of the process itself and the characteristics of the final ingredients, BRF as a 100% integrated company can easily guarantee the traceability and freshness of the raw material used.

Impact on animal performance

In *in vivo* trials with tilapia, the protein digestibility was 93.61% and the inclusion of 2.5% of chicken protein hydrolysate in formulations of tilapia in initial stages increased the final weight by 23% in comparison with the control group with 10% fish meal. The experiments also showed a gut health promoter effect with the inclusion of 3% of protein hydrolysate, which increases the number of villi by 49% compared to fish meal control group.

In adult tilapia, the inclusion of 2.7% protein hydrolysate in their feed increased the fillet yield by 6% compared to the fish meal control group. Besides that, the analysis of the plasma lipid profile of the tilapia showed that, with the inclusion of protein hydrolysate, the levels of triglycerides and VLDL (very low density lipoproteins) decreased, while levels of HDL (high density lipoproteins) increased significantly (Figure 3). This result is an indication of the presence of anti-adipogenic bioactive peptides, which improved the energetic metabolism and promoted a rational utilisation of nutrients in protein deposition.

In a study developed in Vietnam, 2% of protein hydrolysate was shown to be able to replace 5% of fish meal and was able to maintain growth performance of the tilapia. In this case, besides the benefit of bioactive functionalities, the change from fish meal to protein hydrolysate has the advantages of ingredient restorability, price and quality parameters stability, with no significant effect in formulation cost.

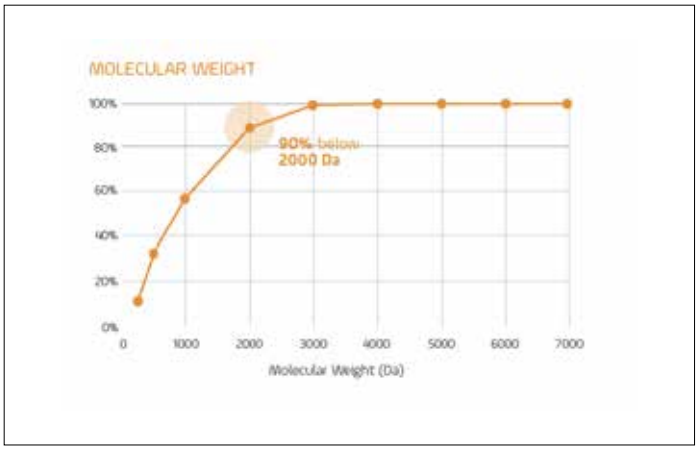


Figure 2. Molecular mass distribution of BRFi hydrolysate product.

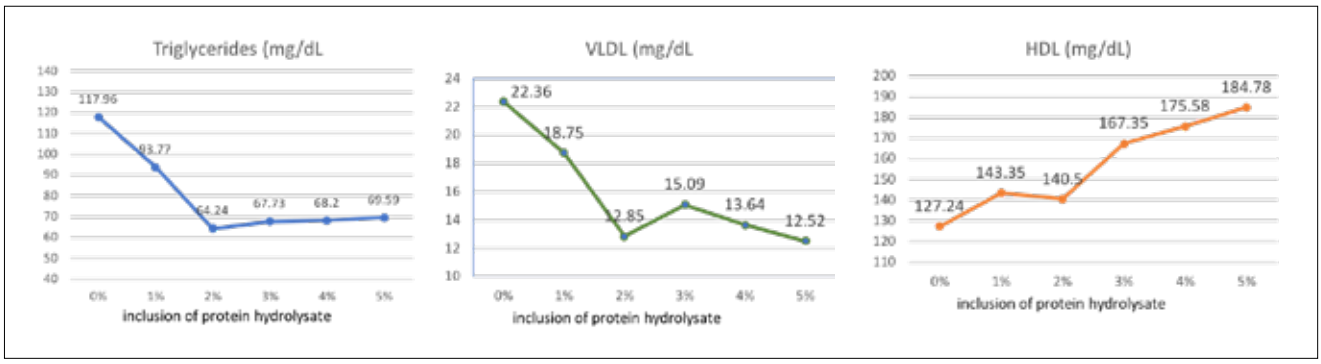
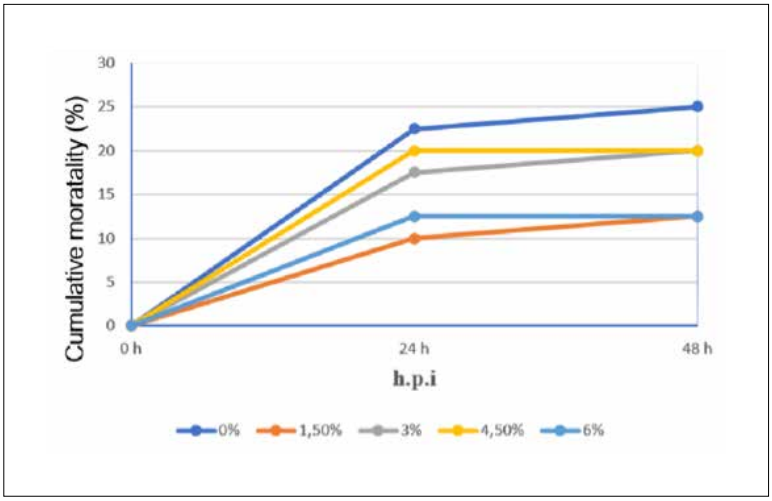


Figure 3. Plasma lipid profile of tilapia fed with diets containing different levels of inclusion of protein hydrolysate ingredient(experiment performed at the Western Paraná State University-Unioeste, Brazil).

Figure 4. Cumulative mortality of *Litopenaeus vannamei* fed with diets containing different levels of aminEAU shrimp after 48h post-infection (h.p.i) with *Vibrio parahaemolyticus* at the concentration of 9 x 10^7 CFU/mL (experiment performed at Universidade Federal de Santa Catarina, Brazil (UFSC).



With regards to results on the application of protein hydrolysates in shrimp feed, enzymatic hydrolysate ingredients yielded 94% of digestibility coefficient of the protein for this specie. In growth experiments, the inclusion of 5% of hydrolysate proteins in the formulation improved the final weight by 7% and the feed conversion ratio (FCR) by 14.3% compared to the salmon meal control group.

In a challenge test to evaluate the resistance of shrimp intentionally infected with a *Vibrio* bacterium, all the treatments that had inclusions of protein hydrolysate ingredients in the formulation showed a reduction between 20% and 50% in the cumulative mortality compared to the control group which contained only fish meal (Figure 4). This is a strong indicator of the immunomodulatory and/or antimicrobial effect of bioactive peptides.

In aquaculture, the short supply of some important ingredients can act as a catalyst for the development of smarter alternatives bringing better value to the business. There are still many secrets on hydrolysate proteins and bioactive peptides, but there are already many studies reporting benefits in medicine, cosmetics, human nutrition and also in animal nutrition. In animal nutrition specifically, results from the application of peptide products and hydrolysed proteins in diets of different species have shown benefits including improved intestinal health, immune system, growth and production performance. In an increasingly competitive market, these advantages should not be neglected. The whole world is changing and evolving rapidly and in the area of ingredients for animal nutrition it is not different. New technologies and smarter processes arise all the time and it is up to us to enjoy the benefits and contribute to a more efficient and productive chain and business.

Thaís Costa Andrade is R&D Specialist and **Wilson Rogério Boscolo** is R&D Consultant at BRF Ingredients Brazil.

Phytogenic feed additive increases low fish meal shrimp feed performance

The active components, phenols and flavonoids can exert multiple effects while matrix-encapsulation strategies stabilise volatile essential oils to remain active throughout a greater section of the GI tract.

By Anwar Hasan and Benedict Standen

Due to recent losses caused by disease outbreaks and declining shrimp selling prices, the industry is adopting ways to increase biosecurity and animal health. The use of feed additives and cost minimisation strategies have several benefits for overall gut health. Phytogenic feed additives, consisting of herbs, spices, essential oils and extracts have gained considerable attention as a solution to some of these challenges.

How feed affects gut health

Nutritionists have the responsibility to optimise formulation costs and growth performances while facing challenges such as rising raw material prices and decreasing availability, market trends, industrial process limitations, competition for market share and the strive for higher quality standards. In this dynamic environment, entrepreneurs often need to make difficult decisions to stay on the narrow road towards profitability. The cost reduction orientation, especially in grow-out diets, can lead to situations where optimal profitability is not attained. A misstep can generate significant economic losses, leading to lower growth performance or long-term health problems.

The main objective of aquafeed is to ensure the supply of essential nutrients to the animal to regulate its lifecycle and production. The use of less costly protein sources and low-nutrient dense diets often leads to lower protein digestibility, higher amino acid imbalance, higher carbohydrate and fibre content in feeds. This can lead to inefficient nutrient use, resulting in increased feed usage and higher ammonia emissions, which in turn can lead to higher production costs and an increase in the ecological footprint. A nutritional imbalance can directly impact growth, cause gut inflammation and adversely affect health status.

In ideal conditions when animals have good gut health, nutrient digestion and absorption occur efficiently while an intact gut structure and balanced gut microbiota help protect animals against external threats. However, even a well-designed nutritional formula can contain hidden surprises that disrupt diet performance, affecting gut health directly or indirectly. Raw material quality, storage problems, feed processing deviations and formulation imbalances can all have negative unintended consequences.

The fish meal dilemma and the benefits of additive

Reliance upon scarce and costly raw materials, such as fish meal, and the optimal use of alternative ingredients constitute a main challenge in aquaculture. Consumer awareness on environmental sustainability encourages producers to improve production through sustainable aquaculture practices.

Recent studies have demonstrated that premium fish meal can be successfully replaced with alternative protein sources at different levels for several aquaculture species.

In commercial operations, management of time and resources is crucial, and even with a good surveillance program, some risky situations cannot be avoided. In this scenario, innovative feed additives can act as nutritional tools which, in combination with functional nutrients, can mitigate the risks of alternative feedstuffs and ensure gut health and increased performance (Table 1). In this article, we will discuss the mechanism of a phytogenic feed additive and focus on its several benefits.

Additive	Benefits
Phytogenic	Decrease pro-inflammatory responses in gut mucosa, support antioxidant system, stimulate endogenous secretion, act as immunostimulant, protect cells, reduce toxin challenges
Mycotoxin deactivators	Counteract the negative effects caused by mycotoxins
Probiotic	Enhance intestinal epithelial barrier function, control pathogenic bacteria, improve gut immune response, produce enzyme
Organic acids	Control pathogenic bacteria, increase nutrient and energy digestibility
Prebiotic	Act as immunostimulant, adhere to pathogenic bacteria
Adapted, NRC (2011)	

Table 1. Gut health support mode of actions of several categories of feed additive.

How do phytogenics work

The active ingredients such as phenols and flavonoids, can exert multiple effects in animals, including improvement in feed conversion ratios (FCR), digestibility and growth rate, reduction of nitrogen excretion and improvement in health status. Phytogenics also have anti-viral, anti-microbial, anti-inflammatory and antioxidant properties.

Phytogenics may stimulate digestive secretions, increase villi length and density, improve gut microbiota and increase mucous production through an increase in the number of goblet cells. Through different strategies, such as matrix-encapsulation, volatile essential oils can be stabilised and may remain active throughout a greater section of the gastrointestinal (GI) tract.

Fish meal content and feed efficiency

The replacement of fish meal by plant protein, whether for economic or sustainability reasons, can decrease feed efficiency and suppress an animal's immune system due to less digestible raw materials or side effects in the GI tract. In the shrimp, Digestarom® (BIOMIN Holding GmbH, Austria), a matrix-encapsulated phytogenic additive, has been shown to overcome these challenges and minimise the negative effects of feed where the fish meal level was reduced, or fish meal was replaced by an alternative protein source.

A feeding trial in shrimp was conducted to evaluate the efficacy of phytogenic (Digestarom® P.E.P. MGE) as a tool to increase feed performance while using a low level of fish meal in shrimp *Litopenaeus vannamei* diets. The treatments consisted of four different diets. The control was a high fish meal diet (24%) and the phytogenic was supplemented in low fish meal (LFM, 5%) diets (Table 2).

Each diet was randomly assigned to 9 replicates, each with 15 juveniles of white shrimp (weighing approximately 3g) fed over 8 weeks.

Treatment	% fish meal	Supplementation of phytogenic
Control -high fish meal	24%	
LFM	5%	-
LFM + PEP 0.2	5%	0.2g/kg
LFM + PEP 0.4	5%	0.4g/kg
*PEP = Digestarom® P.E.P. MGE		

Table 2. Description of test diets in the feeding trial with a matrix-encapsulated phytogenic additive supplemented into the low fish meal diets.

Parameter	Control	LFM	LFM + PEP 0.2	LFM + PEP 0.4
Initial body weight (g)	3.03±0.01	3.02±0.02	3.04±0.02	3.04±0.02
Final body weight (g)	11.40±0.82	10.60±2.54	10.91±0.80	11.14±1.29
SGR (%)	2.10±0.12	1.95±0.38	2.03±0.12	2.05±0.19
Survival (%)	89.63±10.60^{b}	44.44±8.82^{a}	73.33±20.00^{b}	76.30±19.18^{b}
FCR	1.65±0.26^{b}	2.72±0.28^{a}	1.93±0.30^{b}	1.88±0.21^{b}
Different superscript letters indicate significant differences (P <0.05).				

Table 3. Growth performance and condition of *Litopenaeus vannamei* (mean ± SD) at 63 days after feeding with different experimental diets.

> “ This can be included as part of a strategy to improve cost efficiency through better growth performance, even in low fish meal shrimp feed. ”

The results indicated that the blend of essential oils tested compensated for the negative performance and health consequences of the low fish meal diet. Specific growth rate (SGR), survival rate and FCR were determined (Table 3). There were improvements of total haemocyte count, and respiratory burst of the shrimp fed a low fish meal diet supplemented with phytogenic up to the levels recorded for shrimp fed a high fish meal diet (Table 4).

In another study, a field trial was conducted on the application of phytogenic for 45 days to evaluate the feed performance in *L. vannamei* in the early stage. There were two treatment diets. The control diet contained 35% protein and the treatment diet (control + PEP 0.4) had the phytogenic top dressed at 400g/tonne of feed. Each treatment has three replicates.

The stocking density of each pond was 100 post larvae (PL)/m^{3}. The result obtained after 50 days with three times body weight sampling at days of culture (DOC) 35, 42 and 49. The estimated survival rates in both control and treatment ponds ranged from 90-95%. However, there was improvement with the average body weight (ADG) of shrimp fed diets supplemented with phytogenic (Figure 1).

Parameter	Control	LFM	LFM + PEP 0.2	LFM + PEP 0.4
Total haemocyte count (10^{6} cells/mL)	9.94±4.90^{ab}	7.02±2.65^{a}	10.01±2.88^{b}	9.78±3.95^{ab}
Phenoloxidase activity (OD 490 nm)	0.08±0.03	0.07±0.03	0.09±0.02	0.08±0.02
Respiratory burst (OD 620 nm)	0.09±0.03^{a}	0.08±0.03^{a}	0.11±0.02^{ab}	0.12±0.02^{b}
Different superscript letters indicate significant differences (P <0.05).				

Table 4. Haemolymph of *Litopenaeus vannamei* (mean ± SD) at 63 days after being fed with different experimental diets.

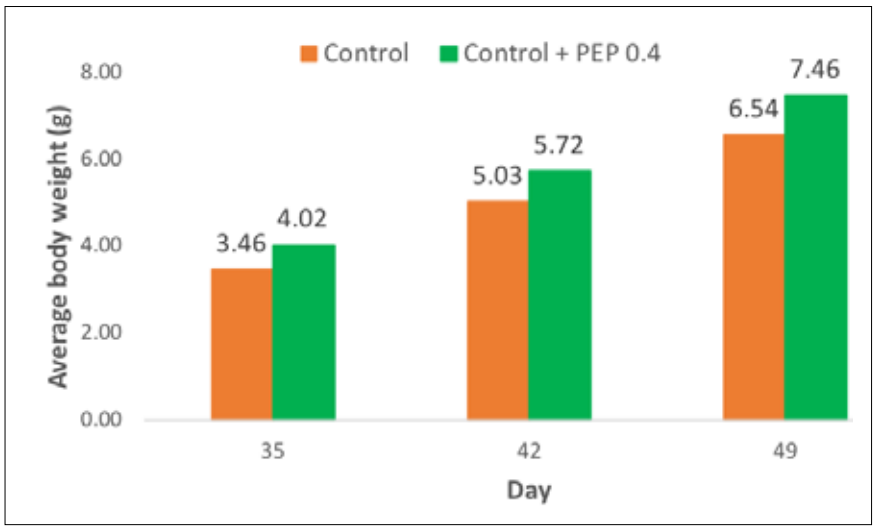


Figure 1. Average body weight (ADG) of *Litopenaeus vannamei* improved with the supplementation of phytogenic.

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In conclusion, improved performance was seen in shrimp fed lower fish meal diets supplemented with phytogenic feed additive (PFA); this improvement was also seen in shrimp fed with high fish meal level on diets (also supplemented with PFA). This can be included as part of a strategy to improve cost efficiency through better growth performance, even in low fish meal shrimp feed. Phytogenics can be a potential feed additive to help shrimp farmers overcome some of today's challenges in the production cycle.

Alternative ingredients to satisfy farmers' perceptions towards feed quality and performance

While feed appearance and feeding activity will determine the farmers' choice, the aquafeed producer will seek hydrolysates with high standardisation to ensure high and consistent quality feed.

By Paul Seguin and Clement Martineau

Variable supply and quality, unsustainability issues and volatile prices of marine resources are daily routine challenges for feed manufacturers. They have to grapple also with inconsistency of feed cosmetic (smell and colour) and feed performance (palatability and feed efficiency) which have direct consequences on marketing and sales success.

In an article published in the January/February 2018 issue of Aqua Culture Asia Pacific, we detailed how functional hydrolysates made by Diana Aqua could support the development of the next generation of aquafeeds in terms of standardisation and performance consistency. Beside the contribution of functional hydrolysate to sustainability in aquaculture, such products are recognised for their high palatability and digestibility, and positive effect on the immune system that will bring benefits to feed producers (in terms of flexibility in feed formulation) as well as to farmers (in terms of higher and standardised production).

Aquativ functional hydrolysates, the ACTIPAL range of Diana Aqua, are made from enzymatic hydrolysis of seafood processing by-products. The resulting product contains a high level of peptides and free amino acids that are involved in many metabolic pathways of fish and shrimp. The high level of control applied on the raw material and during the hydrolysis process allows producing standardised ingredients from batch to batch.

Feed appearance and feeding activity: farmers will notice and judge!

The volatility of price and quality of fish meal, combined with its inconsistent availability have led feed producers to reduce fish meal incorporation in diets and to increase significantly the use of more economical feed ingredients (e.g., soybean meal, corn gluten meal, feather meal, poultry by-product meal, meat and bone meal, canola meal, lupin meal, etc.). However, and particularly in Asia, such replacements might influence farmers' perceptions toward feed quality and performances. In the same way, such modifications of feed formula might change the appearance, feel and taste of the diet that are key factors in determining whether food will be eaten or rejected by fish and shrimp. It is the farmers who will notice and judge!

In a highly competitive aquafeed market, the main objective of a feed producer is to capture the farmers' attention when they receive their feed, with the smell, appearance and fines content of the feed. The animal behaviour during first feeding, linked to the feed attractability and palatability, will then confirm this first perception. Finally, if the feed passes these two first selection steps, zootechnical parameters (survival, growth rate and feed efficiency) will definitely validate their feed selection. Behavioural responses of fish and shrimp have been linked to feed preference and habits, mechanisms of food detection, methods and frequency of feeding. Farmers will be the one who will pay full attention to compare different brands of feeds.

The aquaculture industry has been using feeds with significant levels of fish meal for years. Removing or reducing fish meal will not go without impacting the market. Like the salmon industry, stakeholders have well accepted and understood this switch, resulting from many years of research, availability of high-quality raw material substitutes, a more advanced knowledge of nutritional needs for the species concerned and good marketing. For other species, this is more challenging and will take more time to reach the same level of maturity. Today, for these developing markets, various ingredients are added to low fish meal feed formula at 2 to 5% rate in an effort to not only enhance palatability and feed acceptance, but also to secure farmers' satisfaction. Both benefits (animal response and farmers' acceptance) can be combined but important parameters must be considered to guarantee optimum results.

Shrimp hydrolysate powder. Picture by Diana Aqua

Marine ingredients availability in Asia

Asian aquaculture production (excluding China) and wild catches are reaching approximately 20 million tonnes and 30 million tonnes, respectively (FAO, Fisheries Department). Fish meal, marine solubles and similar feedstuffs of aquatic animal origin in main producer countries (Thailand, Vietnam, India, Japan and Malaysia) totalled approximately 1,1 million tonnes (IFFO and ISTA Mielke GmbH). A wide variety of ingredients is targeted at enhancing animal feeding behaviour and also used as "feed cosmetic enhancer". Liquid based aquafeed products are popular in Asia due to their simplicity of production and close proximity between processing plants and feedmills. Fish and shrimp solubles, fish silages and marine hydrolysates are common products. Figure 1 shows the specifications of a non-exhaustive list of different ingredients sampled from the Asian market.

The easy availability of such marine liquid ingredients allows feedmills to enhance their market differentiation when these ingredients are added in feed diets. However, depending on the ingredient origin (species and manufacturer), specifications can change a lot and make it difficult to standardise feed formulations. Some important

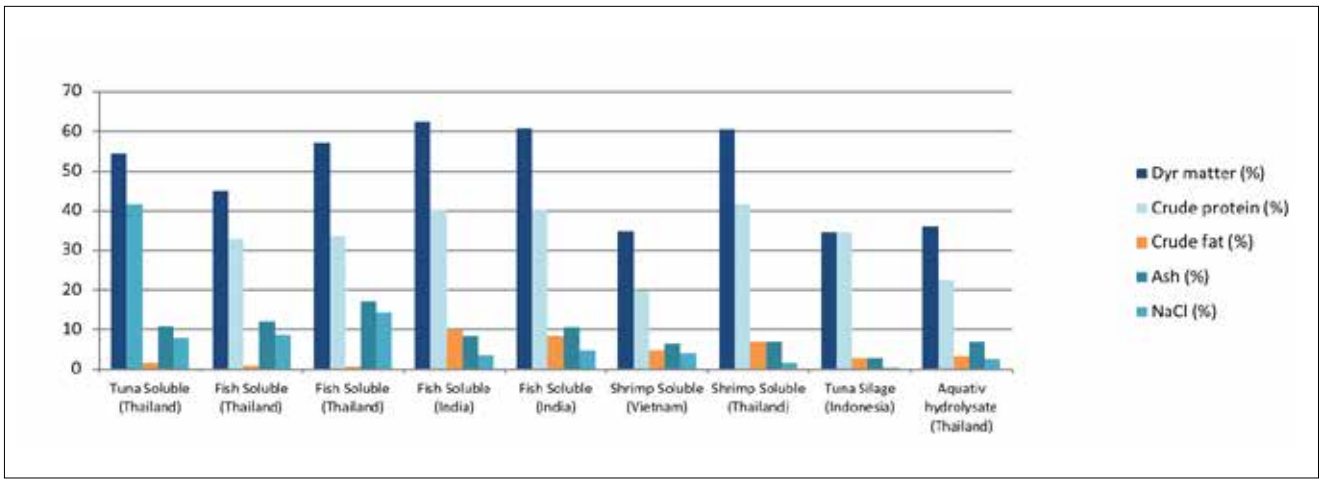

Figure 1. Specifications of different marine ingredients from South East Asia (source Diana Aqua).

parameters must be taken into account to guarantee product reliability: quality, supply consistency and technical application. Audits of manufacturers and ingredient qualification (industrial trials, biochemical analysis of several batches, performance evaluation etc) are therefore essential.

Managing the quality of marine ingredients

During aquafeed production, freshness monitoring of raw material is important as it will impact the quality of protein and fat, and hence the performance of the finished product (palatability and digestibility).

Marine by-products, especially when they contain viscera, deteriorate very rapidly and it is critical to preserve their freshness. Spoilage of marine by-products is mainly due to endogenous enzymes and bacterial activities and starts as soon as the animals are caught/harvested. Raw materials must be stored at a low temperature during the various steps of the manufacturing process to minimise this phenomenon. It is also very important to reduce the time spent between catching/harvesting, processing the animal for human consumption and the processing of the by-product into fish meal or other ingredients (soluble, silage or hydrolysate).

TVN (Total Volatile Nitrogen) measurement is a quick and easy indicator of raw material freshness and is historically used to assess

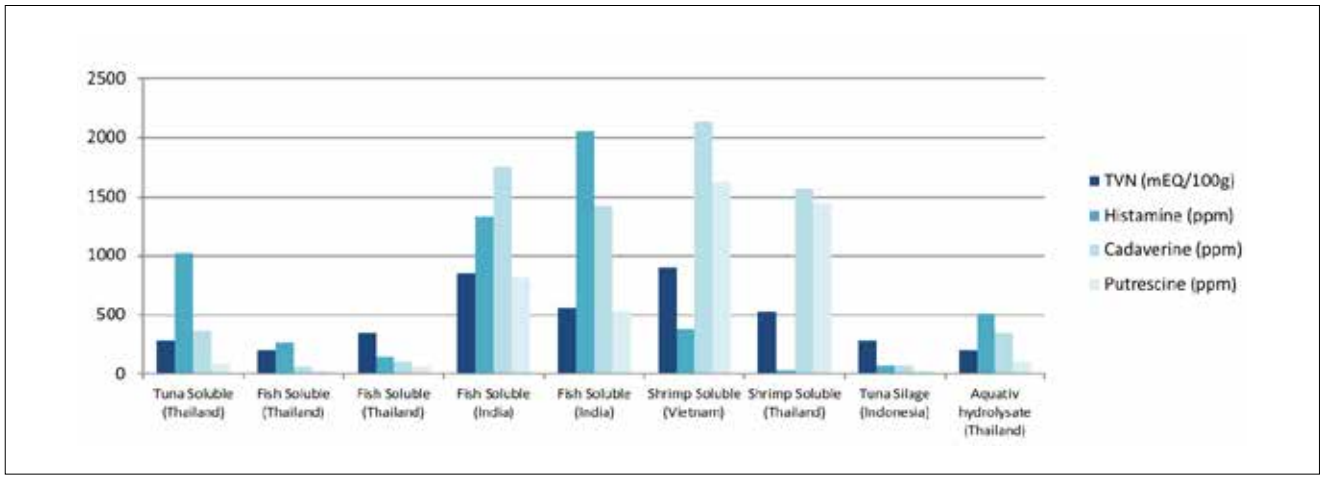

Figure 2. TVN and biogenic amine levels of different ingredients from South East Asia (source Diana Aqua).

fish meal qualities. Like biogenic amines (histamine, cadaverine and putrescine), it is produced during fish muscle amino-acid degradation by bacteria and should be used as an alternative indicator for processed fish raw material. A too high level of TVN (>200mg/100g) combined with a high level of biogenic amines (>1000ppm for histamine or putrescine or cadaverine) are signs of poor raw material quality, that will have negative impacts on ingredient functionality. Figure 2 shows the variability of quality of some ingredients depending on their origin. For fish solubles, the quality could vary a lot between products and performances will be definitely impacted.

Optimal feed physical properties are key to secure farmer satisfaction

Fish and shrimp have the ability to discriminate between high-quality and poor-quality feeds and will refuse to ingest the latter. Certain compounds found at high levels in feeds (biogenic amines and molecules resulting from fat oxidation) are known as feeding deterrents and can also affect negatively feed nutritional performance. Improper storage and use of poor-quality feed ingredients in feed plants are the common cause of rancidity in commercial feeds. Consequences at the farm can be irreversible: dissatisfied customer after feed sensory evaluation (e.g. smell and mould) and high risk of poor zootechnical performances.

Importance of protein characterisation: A disparity depending on product origin

Since the price, specifications and freshness of the ingredient usually determine the initial choice of the feed producer, it is important to further analyse the protein quality to better understand ingredient functionalities and performances. Beside its amino acid profile, a protein can also be characterised by its peptide profile and free amino acid content that will drive its palatable, nutritional and health performances.

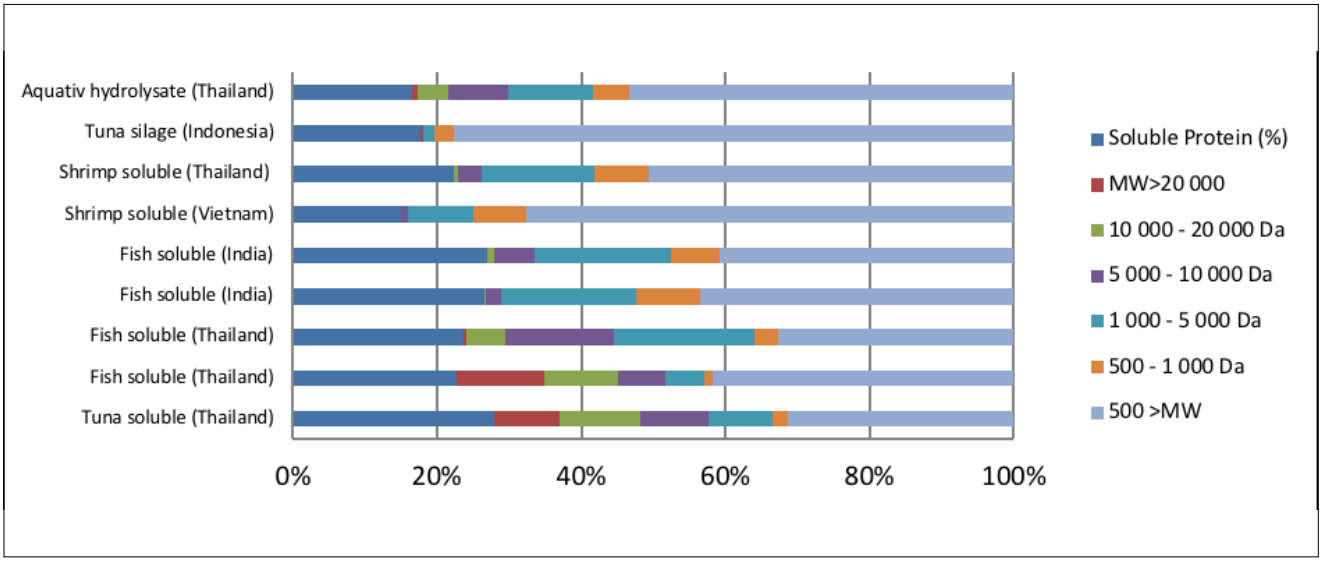

Figure 3. Soluble protein (% of product) and peptides profiles (% soluble protein) of different marine ingredients from South East Asia (source Diana Aqua)

With more than 10 years' experience in functional hydrolysate production and peptide concept, Diana Aqua is able to correlate the performance and the peptide profile of feed ingredients. Peptide profiles of some marine liquid ingredients have been analysed (Figure 3). Marine liquid ingredients are rich in soluble proteins due to the manufacturing process used to produce them (silage, hydrolysis, extraction). Water soluble protein could represent 70 to 90% of the total protein. The product itself can contain up to 20 to 40% of soluble proteins. If water soluble proteins are highly digestible, only the low molecular weight protein (small peptides and free amino acids) will improve the attractability and palatability of the feed. If solubles are rich in high molecular weight polypeptides (>10,000 Daltons), protein hydrolysates are composed of very small peptides (<1000Da) mostly represented by palatable, digestible and functional di-, tri-peptides and free amino acids.

Results also show that the peptide profile of one soluble can differ greatly from that of another. Since the peptide profile determines the functionality of marine ingredients, it is very important to standardise it from one supplier to another, and also batch by batch for a supplier, to ensure performance consistency. Today, only protein hydrolysates guarantee high standardisation due to their very specific manufacturing process and control plan.

Diana Aqua has also driven the hydrolysis process to produce very specific peptide profiles that will bring the best balance of functional benefits, guaranteeing high feed palatability, fast protein absorption and stimulation of animal metabolism to enhance resistance to disease and change of environmental parameters.

Conclusions

The multiple constraints of the aquaculture market along the supply chain compel raw material and ingredient suppliers and feed manufacturers to perpetually innovate and differentiate themselves by developing attractive, better performing and cost-effective feeds.

Ingredients produced from marine or aquaculture by-products to replace fish meal are excellent alternatives to enhance feed organoleptic properties (including taste, sight, smell and touch). Solubles, silages or hydrolysates may have similar "captivating" properties, for the farmer and for the animal, but ultimate targeted performances are much more complex. Freshness, peptide profiles and standardisation of the product are key parameters to guarantee consistent feed performance, and thus farmers' satisfaction. Functional hydrolysates manufactured by Diana Aqua are highly recognised for their quality and their excellent stability. Their superior modes of action will be detailed later in a follow-up article by Dr Vincent Fournier, R&D Manager at Diana Aqua.

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It is not what, but how, commercial sources of vitamins are produced

Extreme feed processing conditions require not only formulated vitamins but formulation technologies to improve stability, flowability and homogeneity to ensure the required amounts of vitamins in aquafeeds.

By Moises John Reyes and Thau-Kiong Chung

Vitamins are organic compounds essential to the life and well-being of fish and shrimp. They are vital for animal growth, development, maintenance, reproduction and health. Although required in small quantities, usually measured in milligrams or micrograms per kilogram feed, vitamins are involved in 100% of metabolic functions, a fact that makes them micronutrients with "macro-importance" (Hernandez et al, 2012).

Unfortunately, vitamins cannot be synthesised by fish and shrimp. Yet still, most feed ingredients contain vitamins in minute and variable amounts and are in their natural, unprotected form. These vitamins are destroyed during ingredient processing and feed manufacturing (Wilson, 2018). For these reasons, it is recommended to incorporate formulated vitamins that can survive extreme feed processing conditions at adequate levels in fish and shrimp feeds.

Critical features of non-formulated vitamins

Vitamins in their pure and non-formulated forms are not advisable to be used in feed processing because they are sensitive to physical and chemical factors. They can be degraded easily when subjected to certain feed processing conditions. Depending on the physical and chemical traits of each vitamin, non-formulated forms have varying sensitivities to temperature, oxygen, humidity and light (Table 1).

Vitamin	Temperature	Oxygen	Humidity	Light
Vitamin A	++	++	+	++
Vitamin D	+	++	+	+
25-OH-D_3 (Calciferol)	++	++	+	+
Vitamin E	0	+	0	+
Vitamin K_3	+	+	++	0
Vitamin B_1	+	+	+	0
Vitamin B_2	0	0	+	+
Vitamin B_6	++	0	+	+
Vitamin B_{12}	++	+	+	+
Pantothenic Acid	+	0	+	0
Nicotinates	0	0	0	0
Biotin	+	0	0	0
Folic Acid	++	0	+	++
Vitamin C	++	++	++	0
++ Marked Effect | + Moderate effect | 0 No effect				
Source: DSM Product Forms Brochure, 2013.				

Table 1. External factors influencing stability of non-formulated vitamins

According to Marchetti et al. (1999), when these non-formulated vitamins are incorporated in the processing of pelleted or extruded fish and shrimp feeds, significant vitamin activity losses were observed (Table 2). During the extrusion of fish and shrimp feeds, Wilson (2019) identified the "hotspots" where most vitamin activity losses occur. Losses happen during the grinding, preconditioning, extrusion and drying stages where heat, oxygen, moisture and pressure are present. These affect the stability of non-formulated and/or suboptimal-formulated vitamins. Aside from the manufacturing process, vitamin activity losses are also observed during storage and transportation.

Feed vitamin content (mg/kg)			
Vitamin	**Before**	**After pelleting**	**After extrusion***
Ascorbic Acid	207 ± 16[a]	107 ± 12[b]	40.8 ± 5.4[c]
Biotin	1.47 ± 0.2	1.39 ± 0.2	1.38 ± 0.2
Cyanocobalamin	0.26 ± 0.03	0.23 ± 0.04	0.22 ± 0.04
Folic acid	6.36 ± 0.8[a]	4.05 ± 0.4[b]	3.05 ± 0.5[b]
Menadione	31.6 ± 3.6[a]	16.1 ± 3.1[b]	10.9 ± 2.2[c]
Nicotinamide	396 ± 35	380 ± 42	364 ± 44
Pantothenic acid	226 ± 21	201 ± 19	194 ± 18
Pyridoxine	79.7 ± 56[a]	60.2 ± 7.9[b]	53.0 ± 6.2[b]
Riboflavin	38.7 ± 4.5	33.8 ± 4.6	33.3 ± 5.6
Thiamin	32.2 ± 2.5	26.3 ± 2.9	28.3 ± 3.5

** Temp at outlet 96°C*
Values are given as means (SEM) of results of assays carried out on three replicate feed preparations.
Means within a row with different superscript letters are significantly different (P < 0.05). Source: Marchetti et al.,1999.

Table 2. Levels of vitamins in crystalline form after feed manufacturing process.

Moreover, non-formulated vitamins have critical features, which make them unsuitable for premix and feed manufacturing. Aside from stability, other critical features include flowability, handling and uniform mixability (Figure 1).

Vitamin formulation technologies

Fortunately, these critical features inherent to non-formulated vitamins can be addressed by vitamin formulation technologies where properties are modified and added to an active substance or the non-formulated form to improve its physical and chemical attributes. This technology ensures the survival of the active substance during feed manufacturing and thereby contributes to animal nutrition, health and performance.

Through a combination of technologies, a non-formulated vitamin is processed to its appropriate physical and chemical form to

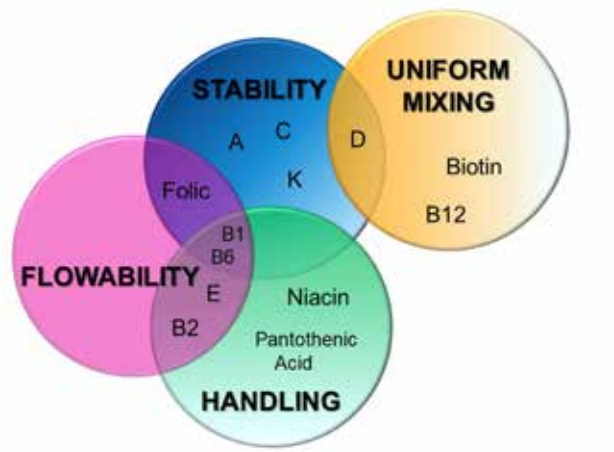

Figure 1. Critical features* of pure or non-formulated vitamins
Source: DSM Product Forms Brochure, 2013.
*Problems associated with the use of pure or non-formulated vitamins

make it stable. Modification of vitamins could be done through esterification and phosphorylation (chemical approach), or crystallisation (physical approach).

In esterification, a reaction between an organic alcohol and an organic acid produces a more stable molecule as in the case of modification of retinol to retinyl acetate (vitamin A) and tocopherol to tocopheryl acetate (vitamin E). Meanwhile, phosphorylation is used to produce a heat-stable form of a vitamin such as ascorbyl monophosphate from ascorbic acid. Synthesising other vitamins involve the production of organic salts as in the case of thiamin mononitrate, which is more stable than thiamin hydrochloride.

After chemical modification, additional technologies are applied to further improve the properties of the final form of a vitamin. Some of these processes involved the adding of antioxidants and auxiliary substances to further stabilise the vitamin. Some vitamins are encapsulated to build a physical barrier and protect them from oxidation, heat, moisture and light. In addition, some other processes are applied to make the vitamins virtually dust-free, less hygroscopic, non-electrostatic, homogeneous and easy to handle. The vitamin product forms, which are now offered for use in premix and feed manufacturing, include cross-linked beadlets, adsorbate, spray dried, crystalline and coated.

Cross-linked beadlet

Vitamin A is offered for commercial use in animal feed production as a cross-linked beadlet. After the esterification of retinol to retinyl acetate, it is emulsified with an antioxidant and embedded in particles with other ingredients such as fructose and glycerin, which are formed by the three-dimensional protein structure of gelatin (Altemueller & Gadient, 2009). These cross-linked bonds create a more rigid structure, making it stable during pelleting and extrusion conditions.

Adsorbate

Vitamin E in retinyl acetate form is adsorbed by suitable carriers such as silica particles. Adsorption has an advantage of delivering vitamin E in dry form and results in a free-flowing, dust free and mixable material.

Spray-dried

Spray drying is applied to water- and fat-soluble vitamins. It enhances stability, handling, and distribution during premix and feed manufacturing. Spray drying also addresses electrostaticity issues (such as those of vitamin B2, folic acid), and hygroscopicity of vitamins (such as those of Biotin, Calpan, Stay C-35), and makes handling easier. A proper spray drying process allows the production of vitamins with finer particles (such as those of Biotin, vitamin D and Hy-D) while eliminating dust, lumps and caking tendencies. As a result, these vitamins are homogeneously dispersed in premixes and in feeds.

Crystalline

Crystalline products are the result of a drying step after the chemical synthesis of a certain vitamin. Vitamins such as vitamin B1, B6, Niacin, K3 and B12, can be integrated in premixes and feeds in their crystalline form.

Coated

Coated products, such as vitamin C-EC (ascorbic acid coated with ethyl cellulose), improve the stability of the vitamin in storage and in feed processing.

Not all vitamins are created equal

Vitamins for animal feeds are commercially available in different forms and brands. Although manufacturers may claim that their vitamins have similar product forms (i.e., beadlet for vitamin A, spray dried for biotin, adsorbate for vitamin E, etc.), there are, however, stark physical differences in particle size distribution, shape, dustiness and caking or lumping tendencies. These physical characteristics play a key role in vitamin stability in storage and in feed manufacturing. Moreover, these physical traits have an impact on bioavailability, handling properties and homogeneity in premixes and in feeds. Therefore, it is not "what" technologies are being used, but it is "how" technologies are being applied.

These differences become more evident in the manufacture of fish and shrimp feed by extrusion because such a process exposes the vitamins, along with the other ingredients, to heat, moisture, oxygen and pressure. Moreover, exposure to these factors may take longer durations in some of the extrusion "hotspots" aggravating the losses in vitamin activity.

Retention (%)			
Vitamin	**Pelleting, (80°C)**	**Expanding, (100°C)**	**Extruding, (120°C)**
Vitamin A	85-95	70-90	70-90
Vitamin D_3	90-100	80-100	75-100
Vitamin E	90-100	90-100	90-100
Vitamin K_3	70-90	50-70	40-70
Vitamin B1	85-100	70-80	60-80
Vitamin B2	90-100	90-100	90-100
Vitamin B6	90-100	80-90	80-90
Vitamin B12	60-90	50-80	40-80
Niacin	90-100	90-100	90-100
Pantothenic Acid	90-100	80-100	80-100
Folic Acid	70-90	50-70	50-65
Biotin	90-100	70-90	70-90
Vitamin C (phosphrylated)	90-100	90-100	90-100
Source: DSM, 2013.			

Table 3. Retention of formulated vitamins subjected to different processing conditions and stored for three months at room temperature.

Stability

Stability of the vitamins is one of the main concerns when fish and shrimp feeds are processed through extrusion. Table 3 (DSM, 2013) shows that formulation technologies have improved the stability of vitamins compared with the data of non-formulated vitamins in Table 2. For example, non-formulated form of ascorbic acid retains only 20% activity after extrusion. The phosphorylated ascorbic acid, on the other hand, retains 90-100% activity even after extrusion and storing it for three months. In cases where sizeable vitamin losses are expected, quantities on top of the required vitamin levels are added to the premixes and/or feeds (Altemueller & Gadient, 2009).

The stability of various vitamin A products in extruded pet food after feed manufacturing and after six months storage was compared. The DSM cross-linked beadlet vitamin A retained 91% vitamin A activity post extrusion. However, the two other vitamin A products only retained 81% and 73% after extrusion. Following storing these feeds over six months, the DSM cross-linked beadlet vitamin A retained 71% activity while the other two products only had 31% and 33% vitamin A activity.

Homogeneity and particle size distribution

Vitamin particle size distribution affects the homogeneity of the vitamin in premixes and in feeds. The more particles per gram of active ingredient in a product, the better the homogeneity in premixes and in feeds. This was observed when content uniformity in the feed of two vitamin A products were compared. One vitamin A product (Rovimix A1000) has twice as much particles per gram compared with another vitamin A product that has larger particles. The homogeneity, which was measured by coefficient of variation (CV) of the former was 60% better than the latter.

Biotin is one of the vitamins that has low requirement in animals. Biotin recommendations for freshwater fish is 0.5–1.0mg/kg feed (0.5–1.0ppm) and 1.0–2.0mg/kg feed for shrimp (1–2ppm), based on the DSM vitamin supplementation guidelines of 2016. At biotin levels of 100ppb or 0.1mg/kg feed, Rovimix Biotin HP in broiler feed had a CV of 6.1%. This is achieved because of the spray-dried product formulation technology that allows for each particle of the product to contain biotin. In the said form, it is possible to have 40 million particles/g of the product without caking and being dusty. In contrast, other biotin products are hygroscopic and tend to cake up.

Caution should be taken in product formulations where smaller particle size is produced to achieve better homogeneity. Most products with fine particle size are dusty and tend to form lumps and cake. This is observed in various forms of folic acid, biotin, vitamin B1, B6, phosphorylated vitamin C, among others.

Conclusion

Non-formulated vitamins have their own unique critical features. In today's feed production technologies for fish and shrimp feed, stability, flowability and homogeneity are essential considerations to provide the required amount of vitamins to fish and shrimp. Several vitamin formulation technologies add properties to the active vitamin substance to improve its physical and chemical properties and thereby ensuring its proper distribution and retention of the active substance in premix and feed manufacturing for animal use. Thus, this ensures that the required levels of vitamins are in the feed in order to contribute to animal health and performance.

Therefore, it is imperative for fish and shrimp feed producers and farmers to wisely choose appropriate vitamin product forms that can withstand harsh feed processing conditions. This way, they can be assured that the needed nutrients at the right amounts are provided to the animals for growth, development, reproduction, maintenance, and health.

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Alternative fish meal ingredients and engaging consumers

Innovation in Action: SeaWeb 2019 discussed the journey towards incorporating novel ingredients into aquafeeds and how to engage consumers

In the past 17 years, the SeaWeb Seafood Summits had brought together global representatives from the seafood industry with leaders from the conservation community, academia, government and the media to discuss seafood sustainability. Participants transform knowledge into action by shining a spotlight on workable, science-based solutions to the most serious threats facing the marine environment. Produced in partnership by SeaWeb and Diversified Communications, the goal is to define success and advance solutions in sustainable seafood by fostering dialogue and partnerships that lead to a seafood marketplace that is environmentally, socially and economically sustainable.

Chris Haacke (left) and Allan LeBlanc. Photo credit: SeaWeb Seafood Summit.

Future for aquafeeds

The 2018 SeaWeb Seafood Summit featured an exciting panel – "Shaping a Sustainable Future for Aquaculture Feeds". It addressed the fact that aquaculture is the fastest growing food system today and a key part of a secure food future. With this growth, new feed ingredients are required to augment the static supply of fish oil and fish meal that is fed to farmed seafood. Specifically, there is a need for new sources of long-chain omega3 fatty acids and proteins that are scalable and sustainable.

As a follow up, during SeaWeb Seafood Summit 2019, held in Bangkok in June, the next steps were taken to share the journey of Thai Union to act on this challenge to incorporate innovative feed ingredients in their shrimp feed in the Southeast Asia region. The panel, moderated by Ronnie Tan – Aquaculture Consultant, included representatives from Thai Union and two new alternative ingredient providers; Corbion and Calysta.

Thai Union is the largest seafood processor in the world. Thai Union Feedmill produces fish and shrimp feeds. It is the market leader in seabass feeds and one of the leading producers of shrimp feeds. It has been conducting inhouse research to replace fish meal since 2014. Dr Darian McBain is the Global Director of Sustainable Development at Thai Union. McBain leads Thai Union in its endeavour to replace fish meal in shrimp feeds with alternative ingredients.

Corbion produces AlgaPrime™ DHA, a new traceable, sustainable, high-quality source of DHA, which provides flexibility to aquafeed formulators. The microalgae production, powered by renewable energy, has been used in 350,000 tonnes of salmon feeds. Chris Haacke is an international marketing, sales and business management professional who focuses on global development of sustainable aquaculture. Calysta develops and commercialises FeedKind®, a protein produced from natural gas and is an alternative to fish meal in aquafeeds. Allan LeBlanc is Vice President of Marketing at Calysta and is responsible for global market and sales strategy of Calysta nutritional products including prioritisation by geography and species.

As several leading companies in the aquaculture industry work to bring innovation to feed, how do we communicate this to consumers? With responsible sourcing and health top in the mind of seafood consumers, the panel discussed strategies they are using to highlight the story of innovation to consumers.

Palatability and attractability challenges

Alternative protein ingredients face attractability issues when used in aquaculture feeds but we need to differentiate the needs of the animal and that of the farmer. For the shrimp, attractants can be added. When promoting alternative ingredients, it is easier to approach integrators and players in the whole supply chain, rather than single and small-scale farmers. Today, the challenge is that farmers are not asking for alternatives to fish meal, hence the bottleneck arises from the increase in costs versus the benefit. "To go from something farmers are perfectly happy with to an alternative that does not have the same smell according to their quality test or perhaps look like what they are used to, introduces some uncertainty. If the family livelihood depends on the shrimp harvest in the ponds, you are not going to take risk on these alternatives," said McBain. So, while there is a push factor from the feed companies, there must also be a pull effect from consumers, retailers and food service and a controlled supply chain.

"In the replacement of fish meal, Calysta took a systematic approach in the trials starting with tank trials in a US University, then tank trials with a feed company and subsequently pond trials with Thai Union Feedmill. Samples were sent to others such as Chinese feed mills producing shrimp feeds. The conclusion was that although total replacement is possible, an optimal mix of fish meal and FeedKind® worked the best," said LeBlanc. "I think there's a great sustainability story about spreading the existing sustainable resources from wild catch fisheries and getting optimal results from a blend of the two."

Pull factors

The issue of educating farmers to accept replacing fish meal with sustainable ingredients in feeds was raised. Here the panellists noted that everybody has a different role to play. It is at every level: consumers could show a preference for seafood which are more sustainable; markets could do better at promoting such products; the processors could convince farms that what they want to buy are sustainable shrimp or fish; and the feed millers could do better at educating shrimp farmers on "why this is important".

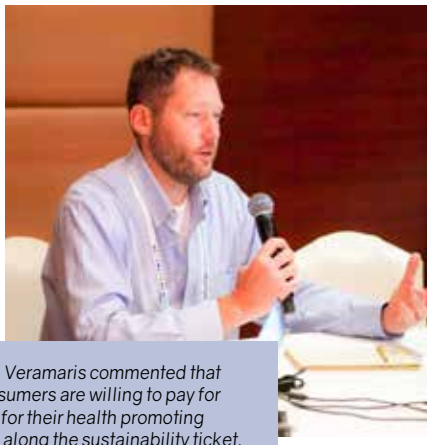
In May, Calysta and Thai Union did upstream marketing of shrimp fed with Calysta's FeedKind to get the pull factor. Big retailers and food service buyers said that they would pay the very small premium, but they also request for traceability in the supply chain. "Not that many retailers or food services are buying from a fully, directly controlled supply chain to the point that the processors can tell the farm exactly what feed they must use. So, we need to at least start on a controlled supply chain," said McBain.

Corbion conducted a survey to find the bottlenecks in utilising alternative feed ingredients. Haacke said, "The big challenges at the start included getting the product approved, conducting culture trials to evaluate the ingredients and making sure that

> "To go from something farmers are perfectly happy with to an alternative that does not have the same smell according to their quality test or perhaps look like what they are used to, introduces some uncertainty," Darian McBain.

Photo credit: SeaWeb Seafood Summit

Moderator Ronnie Tan says that alternative fish meal and fish oil producers do not want to denigrate fish meal and fish oil, so partial replacement is the proposed way forward. Photo credit: SeaWeb Seafood Summit



From the floor, Ian Carr, Veramaris commented that there is a market as consumers are willing to pay for differentiated products for their health promoting properties which brings along the sustainability ticket. But how do we make this happen? Photo credit: SeaWeb Seafood Summit

the farmers are happy with the alternatives. We found we were competing with an established fish meal/fish oil industry". It also had to deal with fluctuating commodity prices. There is always a challenge in cost as these new startups do not have economies of scale. Most importantly, however, is the need to use influencers in social media and chefs. "We engaged a US celebrity chef. We brought him to Chile to have a look at a sustainably algae-fed salmon and we produced a video with the chef highlighting our story. He is an influencer among chefs as well. This is the way we can communicate through social media to draw consumers and bring that message of alternative ingredients to replace fish meal and fish oils."

Adoption and promotion

It was agreed that for the continued growth of aquaculture at 5% CAGR, the industry cannot rely on the stagnating production of 5 million tonnes of fish meal and 1 million tonnes of fish oil alone. The need for alternatives has been established but how do we make this happen? "What can we do to de-risk the adoption of new ingredients as they tend to cost more in the early stages?" Both Corbion and Veramaris, which produces omega 3 fatty acids EPA and DHA from marine microalgae, agreed there needs to be cooperation in the precompetitive period of market adoption and this involves education, marketing, de-risking and getting retailers on board.

The main challenge is that retailers in the supply chain do not get paid extra, so why do the farmers have to pay a higher price for the feed? We need to ask also whether certification should be the way forward as only a small percentage of farmers are certified today. "This will drive cost increases through the supply chain, but again the drive to sustainability in standards does have a cost," said Haacke.

Additionally, the government could also assist by promoting omega-3 fatty acids as a heart healthy product and the public sector takes some ownership. Haacke and LeBlanc noted that the Seafood Nutrition Partnership in the US is a good example which Corbion and Calysta are already working with.

Delivery of the brand promise

Alternative fish meal and fish oil producers do not want to denigrate fish meal and fish oil, so partial replacement is the proposed way forward. A good example is seen in Thai Union's shrimp at the Brussels Seafood show which were fed with FeedKind, traceable tuna by-product meal and fish oil.

However, NGOs would still like to see fish used for human consumption. Currently, it is estimated that 35% of marine proteins ingredients come from by products. A question was raised – "if we say our product is certified sustainable, does it mean that the others are not?" This goes to show the complexity of the messaging process. However, it was agreed that health and sustainability are neither mutually exclusive nor interdependent. The EPA and DHA levels in salmon have halved over the past 10 years due to fish oil substitution by plant oils but as the industry has continued to promote the health benefits of salmon, there is an obligation to deliver on this brand promise - both on sustainability and health.

Information exchange, trade and networking at APA'19

Since 2017, India has become a global leader in farmed shrimp production and at APA'19, it was apparent that to keep up its shrimp production momentum, industry stakeholders need to do more to overcome disease outbreaks and increase productivity. It is also important to maintain the momentum in freshwater fish production which is mainly for the domestic market. The gathering at APA'19 of aquaculture stakeholders in India and from throughout Asia was an opportunity for companies with the latest products, services, instruments and equipment for aquaculture management and all aquaculture related information to encourage sustainable aquaculture practices within the industry. At the trade show, there were 222 booths; 75% were international exhibitors. At the conference several companies conducted sessions focusing on topics of interest to industry in India and the region. Overall, APA'19 held from June 19-21 at the Chennai Trade Center, gathered students, academics, governmental and non-governmental agencies and farmers from India and elsewhere and disseminated a lot of information on today's aquaculture. This report summarises some activities both at the conference and trade show and is a follow-up of an earlier report in issue July/August 2019 (pages 4-6).

Dr Akshaya Panigrahi, CIBA, India (left) with the Wenger team, Dr Ramesh G (India), Marc and Brad Wenger (USA).

Regional and global experts congregated in Chennai over the three days. At the Sheng Long special session on "**Advanced research development on shrimp culture**," Dr Marc Le Groumellec detailed the domestication and selective breeding program for monodon shrimp at Aqualma, Madagascar which now has reached the 16th generation. He stressed that their success in farming is due to good water quality management and technical skills of farmers since SPF monodon shrimp have the same sensitivity to the environment as vannamei shrimp. Investing in nursery systems will reduce risks of diseases. During the SAP session "**Shrimp culture in 2019 and beyond**", Surendran V, Vaisakhi Bio-Marine(P) Ltd, described trials at a pond site nursery in Andhra Pradesh (see page 8-14). In the same session, Robin Pearl, American Penaeid presented on the development of tolerant vannamei stocks which may soon be available in the Indian market. At the Zeigler sponsored session on "**Shrimp hatchery and nursery practices**", Dr Craig Browdy, Zeigler Feeds, USA, discussed the role of hatchery feeds in shrimp health management. "In an increasingly competitive shrimp market, the most profitable farms will be those that understand the value of investing in robust high-quality seed stock, challenging feed providers and hatchery managers to continual improvement of feeding and husbandry practices," said Browdy.

In feed and disease management focused sessions, Dr Thomas Wilson, Thailand, gave a keynote talk on fish nutrition during stress and disease: vitamins and amino acids, at the Evonik sponsored session on "**Health and nutrition for sustainable aquaculture**". His message was: "A consideration of the nutrient composition of aquafeeds with the knowledge that requirements are dynamic rather than static in relation to stress, immune defences and physiological responses to environment. The correct nutrient composition will improve the capability of our farmed animals to adjust, adapt and survive all threats." At Kemin's session on "**Disease management in shrimp culture**," Dr Leong Wee, Malaysia, presented on the current status on the development of sustainable shrimp feeds, and Dr Orapint Jintasataporn, Kasetsart University, Thailand discussed disease challenges and sustainability in shrimp culture. She stressed that in the future, the focus will not only be on shrimp immunity and disease control but also on the selection of disease-resistant animals. Parallel research in immunology and genetics will be essential, and ecological control or improvement will be equally important.

Among the **shrimp broodstock suppliers** at APA'19 was US-based SPD (seaproductsdevelopment.com) with a line of disease tolerant strains which have been exported to more than a dozen countries in Asia, Europe and the Americas. Syaqua (syaqua.com) offers broodstock from multiplication centres in Thailand and Florida, USA, and nauplii and post larvae from SyAqua hatcheries in Indonesia and Thailand. Leading supplier to the Indian and Asian markets, SIS (shrimpimprovementsystems.com) has breeding facilities in Florida and Singapore. Also present was another leading broodstock supplier for Asian hatcheries, Kona Bay Shrimp (konabayshrimp.com).

In-Situ's Kanaiya Naik (left) and Alex Hing (right) with guest, Benjamin Goh, Haixian Impex, Singapore.

China's Tianjin Intra Technologies team of Alice Wang (right) and Nancy Meng.

From left, Mary Ann Solis, Biosolutions International Corp, Constantine C Tanchan and Neil G. Cabigon, Aquatic Phoenix Aquaculture Group, Philippines

At Growel Feeds, from left, Marketing Manager Sandip Ahirrao, CEO P. S. Narendran, Executive Director, M.V.N. Sesha Chary and Technical Manager, Ravikumar Bangarusamy.

Local, regional and international companies promoting **farm equipment** included Thailand's Kasipantarut Co Ltd (kasipantarut.com) which provides aeration systems such as the O2 bubbles aeration hose for hatcheries, ponds and tank systems. In-Situ Inc (in-situ.com) offers water quality flow monitoring instrumentation as well as provides full solutions for quality data via easy integration with telemetry and data services.

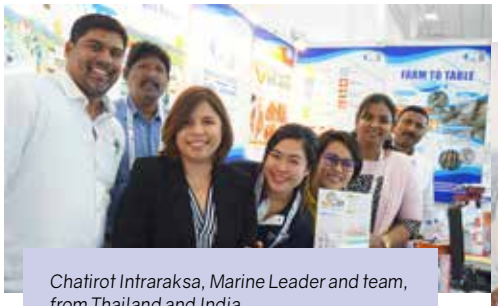
This year, some **new exhibitors** included Singapore-based MJI Universal Pte Ltd (mjiuniversal.com) which markets animal proteins such as poultry by-product meals, porcine meal and bone meal. Solmax (solmax.com), a manufacturer of HDPE geomembrane liners for fish and shrimp farming has acquired GSE Membranes which now makes it a global leader and leading supplier for Asian farms. Tianjin Intra Technologies (intra-feed.com) last exhibited at World Aquaculture in 2018. At this show, the company had irradiated copepods for the larviculture of seabream, halibut and vannamei shrimp. Also new to APA trade shows was MixScience (mixscience.eu). At the conference, the team presented on disease resistance of a new phytogenic on juvenile Nile tilapia.

Marketing **digital aquaculture** solutions was XpertSea (xpertsea.com), a Canadian based developer of smart aquaculture equipment. At this show, it has the new generation of its counter using cameras and machine learning to count, size, weigh and image animals in seconds. India based Eruvaka Technologies Pvt Ltd (eruvaka.com) has developed devices to help farmers remotely monitor ponds for parameters such as dissolved oxygen, aeration and feeding, and make real time decisions.

There was a large group of **local exhibitors** including leading feed producers such as Growel Feeds (growelgroup.com), which markets the tested Nutriva F15, an extruded functional feed against harmful pathogens of vannamei and monodon shrimp and the IB Feeds (ibgroup.co.in), a major producer of extruded fish feeds and pelleted shrimp feed. Poseidon Biotech (poseidonbiotec.com) introduced a new range of products for farms and hatchery operators including a range of auto feeders. Salem Microbes (salemmicrobes.com) is a solution provider to aquaculture in India. It offers a new product which integrates laboratory services linked to best management practices. Equipment providers such as SVS Aqua (svsaqua.com) offers treatment systems for hatcheries and innovative aeration systems. Pranav Plastic Products was marketing air aeration tubes and ceramic diffusers (airoxitube.com). Megaplast (megaplast.in) India is the only company manufacturing 0.5 to 3mm liners in India. Aristogene Biosciences (aristogene.com) has developed natural bacteriophages to selectively and specifically kill *Vibrio harveyi* from culture systems. It also has anti-microbial feed additive for gut health.

Phileo Lesaffre Animal Care team, from left: Yoann Perrault, Otavio Serino Castro, Philippe Tacon and Emerson Kagoo

Dr Sadasivam Kaushik (right), Dr Chandrasekar V. S. (second left) with Jacken Chen,Guangdong Hinter Biotechnology, China (middle) and Asian Institute of Technology, Thailand students, Sayali Prakash Jadhav (second right) and Shrutika Shridhar Sawant (left).



Chatirot Intraraksa, Marine Leader and team, from Thailand and India.

The team from Mixscience, from left, Stéphen Frouel, Thomas Pierrot and Maxime Hugonin.

At Keeton Industries, from left: Luke Keeton, Mike Moore, Ku Bahari (Malaysia) and C. Reddy Noti (India).

Disease challenges and nutritional solutions for Indian shrimp farming

Prior to the start of Asian-Pacific Aquaculture 2019 in Chennai, DSM Nutritional Products conducted a satellite seminar on June 18. The aim was to update aquaculture stakeholders in India on "Disease challenges and nutritional solutions for Indian shrimp farming". Speakers were Dr Thomas Wilson, Aquafeed Nutrition Consultant who presented on "Optimised farmed shrimp health through nutritional solutions" and Dr Visanu Boonyawiwat, Assistant Professor, Faculty of Veterinary Medicine at Kasetsart University, Thailand who discussed disease and health management strategies for Indian shrimp culture.

In opening the seminar, Achyuth Iyengar, Sr Director- Strategy execution APAC DSM, said that DSM is a leader in aquaculture micronutrition. It is focusing on feed formulation and nutrition to enhance immunity and health of aqua species. In addition, it shares its knowledge and technology with farmers to grow their aquaculture business.

Wilson reviewed several nutritional solutions to achieve optimal growth and health, both for *Penaeus vannamei* and *P. monodon*, with a probable need to adjust to a higher nutrient density per kg of feed to match genetic improvements in shrimp growth. Age, growth stage and sexual maturity will also determine the requirements of various nutrients; amino acids, minerals, vitamins and lipids. He said that for optimised nutrition, the amount of digestible dietary lipid in a shrimp diet will need to meet the essential fatty acids (EFA) requirement and lipid derived energy to supplement energy obtained from digestible carbohydrates and proteins. In *P. vannamei*, the requirement is not well defined but it is likely to be 6-8% and EFAs around 0.5% of diets. The recommended level for total phospholipids is 2% of diet but if lecithin is used at 1% diet, total phospholipids can be reduced to 0.4% of diets. In the case of cholesterol, requirement ranges from 0.05 to 0.35%, increasing as supplemental phospholipids decrease.

Optimal health is the equilibrium between environment and pathogens. Various concentrations of astaxanthin have been shown to improve the survival of *P. monodon* in challenging environmental conditions such as high ammonia and low dissolved oxygen and how it combines with vitamin C to overcome salinity shocks. With regards to optimal health. According to Wilson, provided the normal nutritional requirements are met, the best way to support the crustacean immune system is to strengthen the antioxidant defence network to the greatest degree possible. For example, in *P. monodon*, vitamin E works with vitamin C and glutathione to regenerate antioxidant capacity. In *P. vannamei*, astaxanthin at 80mg/kg diet improved survival in a white spot syndrome virus challenge.

Based on experiences in Thailand, Dr Visanu Boonyawiwat presented on some control measures for white spot disease (WSD) outbreaks. He also discussed management of loose shell syndrome (LSS) which is a common occurrence in Indian shrimp farms. With WSD, it is difficult to differentiate between the persistently infected and the disease-free animal. Viral loads in the shrimp with persistent infections can be very low and even real-time or nested PCR (polymerase chain reaction) is not sensitive enough to detect the virus. In Thailand, WSD incidence rate is 5% and post larvae is the major transmission mode. Information from Alday, Pescanova group, indicated that SPF (specific pathogen free) reverse line, a selection of disease-free shrimp from a diseased environment, showed higher survival against WSD, as compared to SPF shrimp.

In describing some control methods for WSD in the hatchery and grow-out ponds, Boonyawiwat said that farms in Southern Thailand used large and fine filters such as 2x4m 100µ filters. According to Boonyawiwat, for the testing of the virus, OIE (The World Organisation for Animal Health) suggested nested PCR but most laboratories use the more accurate real time PCR. Sample size is important and the recommendation is a random 30 post larvae/sample from a batch of 0.5 to one million post larvae to give a 95% confidence limit.

Causes of LSS, according to Boonyawiwat, are mainly related to poor pond and water bottom conditions such as black soil and high concentration of nitrogen-waste in water, chronic low oxygen, algal bloom and high pH. In the case of white faeces disease, the cause is multifactorial; ranging from feed quality to presence of gregarine, microsporidia, *Vibrio* sp and bad pond bottom quality compounded by a secondary *Vibrio* sp infection. "Ultimately, the key to success is community immunity, where every farmer needs to do the same prevention techniques," concluded Boonyawiwat.

Speakers, Thomas Wilson (middle) and Visanu Boonyawiwat (second right) with the DSM Nutritional Products team in India, from the left; Pravin Patil, Dr Vijay Makhija, Achyuth Iyengar and Vilas Autade (right); and Dr Daranee Seguin, DSM Thailand (third right).

Additive strategies for optimising health and digestive performance in aquaculture

A new era for Nutriad/Adisseo Aquaculture was clear at Adisseo's seminar entitled "Innovative strategies for a sustainable blue revolution", held in conjunction with Asian-Pacific Aquaculture (APA'19). It was also the opportunity to introduce the new team and Adisseo's product lines for aquaculture to the sector in Asia, gathered in Chennai, India for the annual conference and trade show held from June 19-21. In 2018, Nutriad was acquired by Adisseo, a global leader in nutritional solutions and additives for animal feeds.

In his welcome to participants, Dr Peter Coutteau, Business Unit Director Aquaculture for Adisseo said that the benefit of being part of the larger Adisseo is the focus on diversification and integration. The aquaculture world is entirely different from the poultry sector and the blue revolution in Asia is exemplified by the farming of the vannamei shrimp. "The strategy for the aquaculture business unit is to develop key markets and India is one of them." Coutteau explained that within Adisseo, aquaculture is positioned in the specialties business unit led by Francois Pellet. "Adisseo's ambition to become a leader in aquaculture is supported by a strong expansion of the technical-commercial aqua team in all key markets and an investment plan for long term R&D".

The integrated Adisseo/Nutriad product portfolio covers all key aspects of additive requirements for aquafeed including programs for health, digestion, palatability, specialty nutrition, and feed quality. During this seminar attended by shrimp and fish farmers as well as aquafeed managers and technicians, Martin Guerin, Regional Technical Manager- Aquaculture APAC/ISC looked at optimising lipid digestion and utilisation in aquafeeds. Guerin introduced categories of lipids and their functions. Lipid digestibility depends on the type of lipids and species. For the latter, the range is 20% to 90%.

"We can improve lipid digestibility with feed additives such as lysophospholipids which form the easily-absorbed micelles. Lysophospholipids reduce the size of the micelles which result in faster absorption at the level of the intestine or hepatopancreas. Lysophospholipid based products find application in fish and shrimp feeds at inclusions between 0.5kg and 1kg/tonne."

Another strategy is bile salts which Guerin explained to be the strongest oil-in-water emulsifier existing in nature with much stronger emulsification power compared to lecithin and even lysophospholipids. Bile salts can replace cholesterol as they have the same structure as the cholesterol molecule. "When we replace fish oil and fish meal, there will be no source of cholesterol and lecithin is usually added into the formulation. In Vietnam, adding bile salts into the regular diet in pangasius feeds reduced visceral fat, improved growth and feed conversion ratio."

Dr Waldo Nuez Ortin, Lead Scientist-Aquaculture presented different strategies for the nutritionist to prevent oxidative stress in fish and shrimp. "Oxidative stress occurs when there is an imbalance between pro-oxidants and antioxidants. There are three levels; breaking down the free radicals, followed by capturing

the free radicals and finally elimination of the oxidised products. Selenium and glutathione are key players in these levels and their antioxidant roles in the optimisation of the immune system and fillet quality are well recognised."

Organic selenium is better absorbed than inorganic selenium. Recent research in different aquatic species shows that supplementation in the form of hydroxyselenomethionine enhances the body pool of selenium, ensuring better antioxidant and immune responses to stress, and improves the shelf life of fish fillet. Methionine is a precursor of glutathione which cannot be supplemented as it is too expensive. Dietary methionine in the form of hydroxymethionine (OH-Met) is better than DL-methionine to create large quantities of glutathione. Supplementation of selenium and methionine in the right form can significantly impact the antioxidant defense mechanisms and therefore these nutrients are key targets of any nutritional strategy to deal with oxidative stress.

In her update from laboratory and field studies to promote health with functional feed additives, Dr Maria Merce Isern, Global Product Manager – Aquaculture Health, said that modulation of the gut microbiota will inhibit the growth of bacterial pathogens and promote beneficial bacteria. She described work using a functional feed additive to improve gut health in tilapia which gives the fish robustness to handle threats from *Streptococcus* and *Francisella* sp. In shrimp, Dr Loc Tran, ShrimpVet Laboratory has developed an infection model which will produce the multifactorial white faeces disease (WFD). Addition of functional feed additives (Sanacore®GM) will reduce prevalence of WFD in this challenge model by 50-55%. In another case, the additive prevented the ejection of the polar tube for EHP infection and resulted in zero germination of the spore.

In Orissa, white spot syndrome virus (WSSV) brought down survival rates from 60-70% to 30-40% at days of culture (DOC30-60). In treatment ponds, functional feed additives not only delayed outbreaks of white spot syndrome virus (WSSV) and WFD but also raised average daily growth and survival.

In closing, Coutteau hoped that the farming as well as the aquafeed community has a better idea on how the company can support their needs. "The demand for specialised feed additives has grown tremendously in the aquaculture industry during the past years. We believe that this trend is here to stay. Producing functional feeds to reduce the impact of diseases and parasites, formulating with less marine ingredients for carnivorous species, maximizing feed efficiency when market price for fish and shrimp is at historically low levels-these are some of the current challenges where the aquafeed industry can benefit from novel additive technology, no doubt!"

The Adisseo Aquaculture team; from left, Dhanunjaya Goud, Regional Manager Aquaculture-ISC; Waldo Nuez Ortin -Lead Scientist Aquaculture; Maria Merce Isern Subich – Product Manager Aquaculture Health; Peter Coutteau- BU Director; Allen Wu, Regional Manager Aquaculture-Asia Pacific; Martin Guerin, Regional Technical Manager Aquaculture ISC/APAC; Claire Xu, Regional Marketing & Communication Manager, Adisseo Asia Pacific Pte Ltd; David Bal, Head of Research Aquaculture Nutrition & Health and Adrian Ng – Regional Director APAC.

Participants at the seminar; Lintang Mutti, PT Dian Natura Agrifarm, Indonesia (left); U.Murali Anand Varma (second left) and K. Sathya Prakash (right), Ananda Enterprises (India) Pvt Ltd; and Ai Tety Nurbaety, PT Suri Tani Pemuka, Indonesia.

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Piyawan Jiravanstit (middle) and Abdel-Fattah El-Sayed, author of the book on Tilapia Culture. Picture by Piyawan

Michele Muccio, Biomin Austria (left) and Balasubramaniam V, Prawn Farmers Federation of India.

Fernando Castro Talero, Epicore BioNetworks, Vietnam (left) at the booth of Nurture Aqua Technology Pvt.Ltd

Gateway innovation to maximise shrimp farm performance and flexibility

Launched globally since summer 2019, Skretting's new grower diet exploits the full growth potential of shrimp, providing proactive farmers with the ability to further enhance their operations. Xpand is a new, innovative feed which enables farmers to make decisions suited to unique operations and environmental factors.

Shrimp farming has become fiercely competitive in recent years. With farmers increasingly seeking new cost efficiencies as well as ways to differentiate their products in the marketplace, Skretting has developed Xpand, a new, superior performance grower diet. The overriding aim behind this new innovation is to provide farms with far greater levels of flexibility. Without taking any shortcuts or unnecessary risks, by feeding their shrimp Xpand, farmers can reduce the associated costs and impacts of farming in exposed water locations by harvesting earlier at the same size; or alternatively, they can choose to produce larger sized shrimp within their usual production schedules.

"Whether it's bigger, more valuable products, or it's reducing the grow-out stage to get shrimp to market faster, Xpand has the potential to be a game-changing solution for many of our customers. Through this heightened flexibility, farmers are now in a position to make the decisions that are best suited to their own unique operations," said Lenaïg Richard Breivik, Global Product Group Manager for Shrimp at Skretting.

Proactive performance

Throughout the past three decades, Skretting ARC has conducted pioneering research into the functionality of the different nutrients in aquaculture feeds. With the knowledge generated, the centre set about developing a new diet tailored to the shrimp sector's unique needs and economic circumstances.

Xpand is the result of four years of R&D, incorporating the investigation and validation of many different ideas. Built upon a thorough understanding of the digestive physiology of shrimp, this development work focused on three pillars:

- Improved growth
- Improved nutrition
- Pond support

Pushing boundaries

The development work for this innovation confirmed that many steps are critical to optimise the digestion of the feed and its conversion into growth. While feeding shrimp with this feed leads to a shorter feed consumption time (time needed to eat a set quantity of feed), Skretting's research also found that shrimp achieved faster gut transit time (time needed to process the ingested feed through the gut). In addition, feed intake is increased while maintaining the feed conversion ratio, which in turn leads to improved growth of the shrimp.

"Essentially, these results illustrated that growth is maximised through improved feed consumption and efficient nutrient absorption," said Richard Breivik.

Furthermore, the level of particles lost from the feed while it is in the water are reduced ahead of it being consumed by the shrimp. This in turn supports water quality in the pond through the production cycle.

Launched in Vietnam

Xpand is initially being launched in Vietnam, and then strategically introduced to other important shrimp farming markets around the world. Its availability will be communicated locally to all Skretting customers and partners.

''We are very confident that Xpand will present a strong alternative to regular shrimp feeds. Shrimp prices have been challenged during these past two years, which has encouraged farmers to look for superior growth performance, as much as for solutions that optimise production costs. Xpand ticks all the right boxes; it's a very important addition to Skretting's shrimp nutrition portfolio," said Marc Le Poul, General Manager of Skretting South Asia.
www.skretting.com

Dr Lenaïg Richard Breivik, Global Product Group Manager for Shrimp at Skretting

New members to regional marketing team

With its rapidly increasing growth and presence in this region, BIOMIN Singapore Pte Ltd is proud to announce its newest team members – Veron Koh and Esther Lim, who have recently been appointed as Regional Marketing Communications Manager and Regional Marketing Associate respectively.

Veron and Esther are tasked with engaging in corporate level communications with the Global Marketing team and leading the implementation of the global marketing strategy of BIOMIN within the region. They will further support the needs of the various BIOMIN Business Units, business partners and customers within the region in order to exceed current market expectations with a particular focus on creating value and increasing awareness and understanding of BIOMIN products and solutions.

Veron Koh
Regional Marketing Communications Manager

Esther Lim
Regional Marketing Associate

Veron graduated from the National University of Ireland, Dublin with a Bachelor of Science (Honours) Degree in Management. Prior joining to BIOMIN, Veron held a regional marketing communications role in various industries such as dental, banking, manufacturing, merchandise and government services. Esther is a graduate from Royal Melbourne Institute of Technology (RMIT) under the Singapore Institute of Management (SIM) with a Bachelor of Business (Marketing).

Their combined experience and knowledge in various aspects of marketing will bring value to the team and help meet an ever-increasing demand for high quality products and services, which will further contribute to the existing success of BIOMIN in the Asia Pacific region.

Esther Lim with the regional and global team at APA'19 in Chennai, India. From left, Anwar Hasan, Technical Sales Manager, Singapore; Michele Muccio and Dr Benedict Standen, Product Managers, Austria and Dr Kumuda Chandra Patra, Business Director, India.

Series A funding to set up Southeast Asia's largest insect protein production facility

Singapore-based agri-food tech company Nutrition Technologies closed a Series A funding round from a consortium of investors led by Openspace Ventures and SEEDS Capital, the investment arm of Enterprise Singapore. The funding will be used to establish the largest high-tech commercial-scale insect protein production facility in Southeast Asia, which can produce over 18,000 tonnes of insect-based feed ingredients and organic fertilisers every year.

This round of investment is the first since SEEDS Capital appointed seven co-investment partners in January 2019 to catalyse over SGD90 million (USD 65 million) worth of investments to develop Singapore-based agri-food tech startups. The latter is supported under Startup SG Equity, a scheme that catalyses private-sector investment for startups through government equity co-investment. Openspace Ventures is one of the co-investors selected based on its investment track record, strong commercialisation resources, networks and familiarity with the agri-food tech startup ecosystem.

The new industrial-scale facility will incorporate Nutrition Technologies' proprietary insect rearing production system to manufacture Hi.Protein® insect meal, its flagship product, as an economical and scalable alternative to competing fish meal products on the market. Nutrition Technologies will also dedicate a significant portion of the funds to continue its cutting-edge black soldier fly genetics and biology research.

"The key to be successful in this sector is being able to produce a consistently high-quality product at an affordable price for feed manufacturers without charging a sustainability premium", said Nick Piggott, Co-Founder and CEO of Nutrition Technologies. "We have achieved this by developing a unique combination of bio-processing steps, which enables us to optimise the nutrient uptake in our insect larvae. Coupled with the low operating costs in Southeast Asia, and the ideal tropical rearing conditions, we're in a very strong position".

Ted Tan, Chairman of SEEDS Capital and Deputy Chief Executive Officer of Enterprise Singapore said, "SEEDS Capital is happy to partner Openspace Ventures in growing a pipeline of innovative agri-food tech startups such as Nutrition Technologies. By innovating the way feed is produced here in Singapore, we are able to enhance food sustainability and safety in the agri-food chain. Such innovative food solutions have high market potential both domestically and across the Asian region. We hope to catalyse more investments in this area as we develop Singapore into a leading urban agriculture and aquaculture hub in Asia."

Moving forward, SEEDS Capital and Enterprise Singapore will continue to work with Nutrition Technologies to connect with industry partners in aquaculture and alternative protein innovation. This will help to further anchor their key activities in Singapore, as well as to support the company's plans to expand its manufacturing operations to Southeast Asia over the next 2 to 3 years. www.nutrition-technologies.com/ https://openspace.vc/ https://www.enterprisesg.gov.sg/

GIANT PRAWN 2019

GLOBAL MEET ON GIANT PRAWNS

Organised by

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15 - 18 November 2019

Shanghai Ocean University

999 Hu Cheng Huan Road

Shanghai 201306, China

The GIANT PRAWN conferences were founded by Michael New, OBE. The first was held in Bangkok in 1980. GIANT PRAWN 2019 is the 5th conference in this series on the farming of *Macrobrachium* spp., jointly organised by AIT, Thailand and SHOU, China.

Themes/Sessions

- 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
- Gender dimensions in giant prawn aquaculture and fisheries

www.giantprawn.org

GIANT PRAWN 2019 will be held at the Shanghai Ocean University (SHOU), 999 Hu Cheng Huan Road Shanghai 201306, China.

15 November 2019
Registration

16 – 17 November 2019
Main Conference

18 November 2019
Farm Tour

Contact :

Krishna R. SALIN, PhD
Asian Institute of Technology, Thailand
Co-Chair

HUANG Xuxiong, PhD
Shanghai Ocean University, China
Co-Chair

Email: **info@giantprawn.org**

SHRIMP 2019 "Modelling for Sustainability" November 12-14, Bangkok, Thailand

The INFOFISH World Shrimp Conference and Exposition 2019 will be held over three days in the bustling city of Bangkok. Over 250 leaders, policymakers, CEOs, investors, researchers and practitioners in the USD10 billion global shrimp industry will assess the industry's sustainability quotient and whether they are indeed moving towards the common goal of environmental and social sustainability at every level. Quite apart from the robust discussions anticipated, the conference and exhibition will be an ideal opportunity for international business and networking.

The conference opening will include a special address by His Excellency Hon. Semi Koroilavesau, Minister for Fisheries, Fiji, followed by the keynote address "Modelling Shrimp Industry towards Sustainability" by Robins McIntosh, Senior Vice President, Charoen Pokphand Foods, Thailand. McIntosh said, "The greatest challenge for the farmer and the shrimp industry of today is the establishment of sustainable practices that reduce the inherent costs while enhancing the reliability of farmed shrimp production. The industry therefore needs to examine itself and its approaches, working towards establishing a sector with more consistent production and employing better practices (including regulations) that would ensure a better future than we could have expected, given our past history".

To date, the confirmed plenary speakers are as follows:

- Dr Somsak Paneetatyasai, President, Thai Shrimp Association;
- Dr Olivier Decamp, Product Manager, Inve Asia Services Ltd, Thailand;
- Dr Cui He, President, China Aquatic Products Processing and Marketing Alliance (CAPPMA), China;
- Johan Suryadarma, Indonesian Fishery Product Processing & Marketing Association (AP5I), Indonesia;
- Jose Camposano, Executive President, National Chamber of Aquaculture, Ecuador;
- Dr Ali Al Shaikihi, Director General, General Directorate of Fisheries and CEO, National Fishery Development Program, Ministry of Environment, Water and Agriculture, Saudi Arabia;
- Dr Manoj M Sharma, Director, Mayank Aquaculture Pvt. Ltd, India;
- Fatima Ferdouse, International Consultant;
- Mike Turenhout, Director for Markets and Resources, Dutch Fish Importers Association (VIV) and Board Member, AIPCE-CEP, The Netherlands;
- Dr Loc H Tran, Founder and Director, ShrimpVet, Vietnam;
- Dr Kallaya Sritunyalucksana, Principal Researcher and Head of Aquatic Animal Health Research Team, National Center for Genetic Engineering and Biotechnology (BIOTEC), National Science and Technology Development Agency (NSTDA), Thailand;
- Dr Jumroensri Thawonsuwan, Aquatic Animal Health Research and Development, Department of Fisheries, Thailand;
- Daniel Gruenberg, Chief Technical Consultant, Infiniseas Co Ltd, Thailand;
- Frank Ping Han Chung, GeneReach Biotechnology Corporation, Taiwan;
- Antonio Bustamante, Manager, Southeast Asia, Biolan;
- Ronnie Tan, Calysta Advisory Board Member and Aquaculture Consultant, Malaysia;
- Dr Derun Yuan, Coordinator, Education and Training Programme, Network of Aquaculture Centres in Asia-Pacific (NACA), Thailand;
- Dr Laurence Massaut, R&D Director, BioMar, Ecuador;

H.E. Semi Koroilavesau, Minister for Fisheries, Fiji

Robins McIntosh, Senior Vice President, Charoen Pokphand Foods, Thailand

- Chelsea Andrews, General Manager – Asia & Pacific, XpertSea, Thailand;
- Roy D Palmer, Executive Director, Association of International Seafood Professionals (AISP).
- Dr Audun Lem, Deputy Director, Fishery and Aquaculture Policy & Resources Division, Fisheries and Aquaculture Department, Food and Agriculture Organization (FAO), Italy;
- Dr Melony Sellars, CEO, Genics Pty Ltd, Australia;
- Nittya Ranjan Biswas, Project Team Leader, Bangladesh Shrimp and Fish Foundation (BSFF);
- Helga Josupeit, Senior Advisor, Marketing INFOPESCA, Uruguay;
- Dr Eduardo M Leano, Coordinator, Aquatic Animal Health Programme, Network of Aquaculture Centres in Asia-Pacific (NACA), Thailand;
- Dr M A Kabir Chowdhury, Global Technical Manager, Aquaculture & Sales Director, South Asia, Jefo Nutrition Inc., Canada; and
- Evelyne Nusalim, Executive Director, Indonesian Food Safety Institute.

Some 20 exhibition booths have been allocated for seafood exporters/importers, processors, equipment suppliers and manufacturers from the Asia-Pacific and beyond. Organisers have announced that Benchmark Group is Platinum sponsor and I&V Bio Co. Ltd., Thailand, is Silver sponsor of the event.

SHRIMP 2019 is jointly organised by INFOFISH, the Department of Fisheries, Thailand, Thai Shrimp Association and Network of Aquaculture Centres in Asia-Pacific (NACA) in collaboration with INFOPESCA. It is supported by CAPPMA. INFOFISH is the leading source of marketing support for fish producers and exporters in the Asia-Pacific. Its activities include bringing buyers and sellers together, publication of current and long-term marketing information and operation of technical advisory and specialised services.

The conference will be held at the JW Marriott Hotel in Bangkok. There will be simultaneous interpretation from English to Mandarin and Spanish at the conference. This opportunity to be part of the biggest global gathering for the shrimp industry in 2019 should not be missed. Programme updates, registration and exhibition details and sponsorship plans are available at www.shrimp.infofish.org. Email: info@infofish.org

www.shrimp.infofish.org

SHRIMP 2019
BANGKOK

INFOFISH WORLD SHRIMP TRADE CONFERENCE AND EXPOSITION

"Modelling for Sustainability"

12 - 14 November 2019

JW Marriott Hotel
Bangkok, Thailand

Jointly Organized by:

INFOFISH

Network of Aquaculture Centres in Asia-Pacific (NACA)

สมาคมกุ้งไทย
Thai Shrimp Association

Supported by:

China Aquatic Products Processing and Marketing Alliance (CAPPMA)

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Latest insights on NIR technology

Global animal nutrition technology company offering pioneering products and technical services to the animal feed industry, AB Vista, recently held the "NIR Academy" seminar in Manila, Philippines, to share the latest developments in NIR technology on feed and raw material application.

Marylan Rivera, Regional Sales Director at AB Vista – Southeast Asia, welcomed delegates from Indonesia and Philippines as well as shared the latest updates on raw material variability in individual markets across Asia. This was followed by a presentation by Chris Piotrowski, Director at Aunir, a division of AB Vista with an-award winning team of chemotricians, who are experts in the application of NIR. Piotrowski shared his perspective on the "Future of NIR", discussing the new developments that have extended NIR applications beyond traditional proximate analysis, to the measurement of parameters such as phytic-P levels.

Dr Natchanok Amornthewaphat, Key Account and Technical Manager at AB Vista – Asia Pacific, presented on "In-Feed Mixability Quality Control and the use of NIR". Amornthewaphat provided the audience with practical examples to demonstrate the importance of feed uniformity – how it will affect the growth of the animals and how can NIR help in determining mixability.

Dr Jae Cheol Kim, Technical Manager, AB Vista – Asia Pacific presented on "Variability of SBM Quality and Effective Quality Control through NIR" to attendees. Kim explained the importance of understanding urease activity and reactive lysine in soybean meal, as well as how AB Vista Feed Quality Service (FQS) provides total solution for soybean meal quality control. Alejandro Criado, Technical Services Manager, AB Vista – Asia Pacific, discussed the topic of "Sample Identification with NIR". He provided insights into how NIR can identify unknown substances and detect spectral differences.

Piotrowski and Criado wrapped up the seminar by providing the latest updates on AB Vista's NIR services and officially launched the latest tool, "INGOT Stat", a data management system which allows users to better manage and analyse NIR data.

"Animal production faces many challenges and improving their margins is one of them, making it more important to ensure that the performance is optimised at every stage of the feed production process," said Rivera.

"NIR services such as the "Feed Quality Service", provided by AB Vista helps our customers maximise their business potential as well as identifying opportunities to improve performance across the entire feed production process," she added.

Following the presentations, guests were invited to watch a "live" NIR demonstration using AB Vista's calibrations to analyse raw material and feed samples. www.ABVista.com/FeedQualityService.

Chris Piotrowski sharing his perspective on the "Future of NIR"

Industry leaders commit to trial winning oil, third quarter results in

The world's largest Atlantic salmon producer, Norway-based Mowi, has committed to test the winning formula from the F3 Fish Oil Challenge, along with China-based Yuehai Feed Group and AlphaFeed.

The free trial for the F3 Challenge winner will be conducted in one of Mowi's open-environment research facilities either in Norway or Scotland and will include Mowi's low and zero fish-oil formulations with the winning fish-oil replacement. Mowi's salmon feeds are genetically modified organism (GMO) and land-animal product free, complying with both European Union (EU) regulations and customer demand. Currently, the inclusion of marine ingredients in their conventional diets is less than 10% of fish meal and around the same low inclusion of fish oil.

"At Mowi we are committed to sustainability and are always looking for more efficient and environmentally friendly ways of producing feed for our salmon," said Laura Martinez Rubio, Research, Development & Technical Manager at Mowi Feed. "It is also important that our salmon gets the healthiest diet possible. At Mowi we want to be at the forefront, and we are therefore excited about testing the winning non-fish oil."

"We are delighted that these big companies have committed to testing the winning fish-free oil," said Kevin Fitzsimmons, F3 Challenge judge and professor at the University of Arizona. "This is an important step forward toward the large-scale adoption and use of alternatives to wild-caught fish in aquaculture feed."

The companies will provide the results of their trials through the F3 Feed Innovation Network (FIN).

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. www.f3challenge.org

AQUAINDIA 2020

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SOCIETY OF AQUACULTURE PROFESSIONALS
Together To Promote Aquaculture
www.aquaprofessional.org

Venue: Hotel Le Meridien, Maradu, Kochi, INDIA

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Registration Fees

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Indian Nationals, Members	Rs.10,000/-	Rs.15,000/-
Indian Nationals, Non Members	Rs.15,000/-	Rs.20,000/-
Overseas Delegates	USD 350	USD 500

For More Details: P.K.Senthil Kumar, Joint Secretary & Coordinator
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Tesco moves forward with sustainable, algal oil-fed salmon rich in omega-3

Salmon farm. Picture credit: Veramaris

British retailer Tesco PLC is updating its salmon standards with the intention of reducing the amount of wild-caught fish that is fed to salmon in aquaculture. Through their new salmon standard, Tesco is encouraging salmon suppliers to incorporate the use of more sustainable feed ingredients like natural marine algal oil rich in omega-3 EPA and DHA.

As the world's third largest retailer, with over 3400 stores worldwide, Tesco's decisions have often helped to influence consumers and other retailers. The introduction of higher salmon standards illustrates the company's ongoing commitment to implementing impactful sustainability measures that help to make healthy sustainable products accessible and affordable to all.

"The development of sustainable aquaculture is essential for the future of humanity's food security. Appropriate species, environment-friendly techniques, and sustainable feed supplies, such as algal oil, are surely the way ahead", says Peter Thomson, United Nations Secretary-General's Special Envoy for the Ocean.

Veramaris strongly applauds Tesco's move to strengthen their sustainability profile in the seafood sector as it sends out a clear signal that sustainability is not tomorrow's issue, but today's. With Veramaris' waste-free algal EPA+DHA omega-3 production facility in Blair, Nebraska, USA up and running, Veramaris is ready to support the seafood industry's increasing efforts for improved sustainability and healthy nutrition with its natural marine algae oil rich in the essential omega-3 EPA and DHA fatty acids.

"Value chain collaboration and a forward-thinking mindset are key to implementing sustainable breakthrough technologies, such as omega-3 EPA & DHA rich algal oil. Tesco sets an example as a prime agent of change, helping to provide consumers with healthy and sustainable choices. We are proud that algal oil rich in both omega 3 EPA & DHA in salmon feed contributes to a sustainable salmon that also supports both brain and heart health of the entire family", said Karim Kurmaly, CEO of Veramaris.

For the consumer, the continuous consumption of seafood creates a lifetime of health benefits. With a daily intake of more than 250mg, omega-3 EPA and DHA support the normal function of heart, eyes and brain. Within Europe, in 2016 alone, almost a quarter of a million (227,000) deaths due to cardio-vascular disease were explained by a diet low in omega-3 fatty acids (Meier et al, 2019). www.veramaris.com

Reference:

Meier, T., Gräfe, K., Senn, F. et al., European Journal of Epidemiology (2019), 34, Cardiovascular mortality attributable to dietary risk factors in 51 countries in the WHO European Region from 1990 to 2016: a systematic analysis of the Global Burden of Disease Study.

Tesco engaging industry

As part of our Little Helps Plan commitment to "lead the industry in addressing the key sustainability challenges in our supply chain", we have been exploring how more algal oil can be incorporated into the diet of fish that we sell, starting with salmon, our most popular species of farmed fish.

We have been working collaboratively with our key salmon suppliers to support them scale up the use of more sustainable feed ingredients, such as omega-3 rich algal oil. Encouragingly, one of our main suppliers in Norway has already started to supply us with some salmon that were partially fed with omega-3 oils from algal oil.

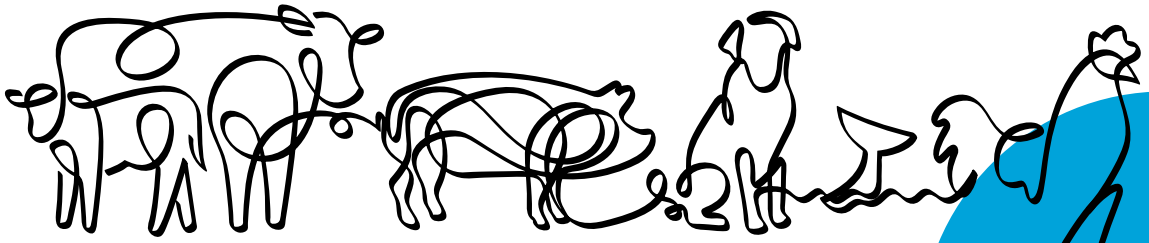
To build on this development, we are in the process of updating our own brand farmed salmon standards with targets to reduce the amount of wild-caught fish that is fed to the salmon we source. While this is a positive step, transitioning the entire aquaculture industry to more sustainable feeds such as algal oil will require the commitment from many businesses and organisations.

The World Wildlife Fund (WWF), the global conservation charity, is supportive of this innovation. Nigel Edwards, CSR Director at Seachill, one of Tesco's fish suppliers, said, "The salmon industry has grown rapidly over the last 30 years, with huge steps forward in feed efficiency and farming technology. But to grow further the industry needs novel sustainable sources of omega-3 oils, which are essential to both fish and human health. Algal oils are a natural solution and we are proud to work with the leading innovative salmon farmers and their partner feed producers to encourage investment in them and increase their use."

Healthy, sustainable products for all

We will continue to work hard with our supply base in addressing the sustainability concerns associated with aquaculture. In this way salmon and other farmed fish can continue to form an important part of an affordable, healthy, sustainable diet in the future.

Extracted from https://www.tescoplc.com/updates/2019/encouraging-sustainable-feeding-practices-in-the-aquaculture-industry/



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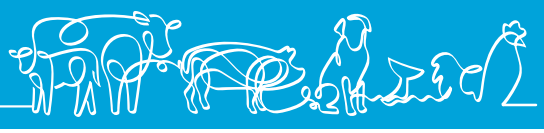

www.victamasia.com www.vivhealthandnutrition.nl

VICTAM CORPORATION vhn

The 9th International Conference of Aquaculture Indonesia (ICAI) 2019 October 4-5, Surabaya

The Indonesian Aquaculture Society (IAS), also known as MAI (Masyarakat Akuakultur Indonesia) will organise the 9th International Conference of Aquaculture Indonesia 2019 (#ICAI 2019) from October 4-5, 2019 in Surabaya. The theme "Toward Sustainable Aquaculture for Happiness and Prosperity" has been chosen to encourage and manifest how sustainable, effective and profitable integrated aquaculture production business can be achieved. This requires commitments and cooperation among aquaculture stakeholders – academics, researchers, practitioners, managers, producers, processors and government representatives," said Professor Rokhmin Dahuri, MAI President.

The conference has 2 sessions of plenary and parallel classes. There will be 5 parallel sessions on •Diseases & Environment •Management & Technology • Feed & Nutrition • Genetics & Breeding; and • Shrimp Farmers Day. Due to limited presentation slots, only selected papers will be for oral presentations. The rest will be as poster presentations. There will be an exhibition. International and regional experts in aquaculture invited to deliver keynote addresses during the conference include;

- Dr Rohana Subasinghe (President Elect, WAS-APC 2018-2020) -Trends in global aquaculture business
- Dr Kartik Baruah (Swedish University of Agricultural Sciences-SLU)-Management of health and disease in farmed shrimp: Holistic strategies, the need of the hour
- Dr Charles Saliba (Founder of Nutri Biotech Services Ltd (NBS) -The beneficial role of cactus extract on the culture of fish
- Dr Nyan Taw, (FAO Projects Consultant -Vietnam & Saudi Arabia)-Current developments in biofloc system for sustainable shrimp farming
- Dr Romi Novriadi (Director-elect, WAS-APC and Senior staff at the Directorate General of Aquaculture, Indonesia)-Effects of fish meal replacement in the culture of Florida pompano

More information: www.icaiconference.org
Email: icai.conferenceoct@gmail.com

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AQUA CULTURE Asia Pacific in 2020

Volume 16 2020						
Number	1	2	3	4	5	6
Month	Jan/Feb	Mar/Apr	May/Jun	Jul/Aug	Sep/Oct	Nov/Dec
Aqua Business *Feature articles and contributions from industry players*	Experiences from industry and opinion articles covering role models, benchmarking, health management, SOPs, social investments, CSR, ancillary services, self-regulation etc					
Issue focus *Recent developments/ spotlight on emerging challenges*	Nursery Phase Developments	Health & Disease Management	Hatchery	Sustainable & Responsible Aquaculture	Demand & Supply Equilibrium	Aquaculture Education
Industry Review *Developments, outlook, demand & supply*	Marine Shrimp	Marine Fish	Aquafeed Production	Tilapia	Aquaculture Start-ups	Catfish & Freshwater Fish
Feeds & Processing Technology *Technical contributions from industry*	Fish meal Replacements/ Feed Enzymes	Feed Additives/ Omega 3 oils	Lipid Nutrition	Health Nutrition	Larval & Nursery Feeds	Processing Technology/ Feed Safety
Production Technology *Technical information along the value chain*	Controlled Systems (hybrid/RAS)	Offshore and Industrialisation	Hatchery Technology	IOT/Innovations	Post-Harvest Technology/ Processing	Organic Aquaculture
Marketing activities	Market and product development, market access, certifications, branding, food safety etc					
NEW Post Harvest Quality & Processing	Technical contributions from industry players on assuring quality at pond site to processing technology					
Company/Product news	News on activities at international, regional and local conferences and trade shows					
Deadlines						
Technical articles	16 Nov 2019	13 Jan	16 Mar	11 May	13 Jul	14 Sep
Advert booking	22 Nov 2019	24 Jan	27 Mar	22 May	24 Jul	25 Sep

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@aquaasiapac.com**

September 26-28
Taiwan International Fisheries and Seafood Show 2019
Kaohsiung
www.taiwanfishery.com

October 4-5
The 9th International Conference of Aquaculture Indonesia (ICAI) 2019
Surabaya
www.icaiconference.org

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/

October 28-30
Ecological intensification: International Conference,
Bogor, Indonesia
www.ecoaquaconference.org

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 18-21
9th International Fisheries Symposium (Asean-Fen IFS 2019)
Kuala Lumpur, Malaysia
www.ifs2019.upm.edu.my

November 19-22
LACQUA19
San José, Costa Rica
www.was.org

November 20-22
12th Philippine Shrimp Congress
Bacolod City
Email: bfarcoshrimp@gmail.com

2020

January 31- February 1
AquaIndia 2020
Kochi, India
www.aquaprofessional.org

February 9-12
Aquaculture America 2020
Hawaii, USA
www.was.org

March 24-26
VICTAM Asia and Animal Health & Nutrition Asia 2020
Bangkok, Thailand
www.victamasia.com
www.vivhealthandnutrition.nl

March 25-27
VietShrimp 2020
Cantho City, Vietnam
www.vietshrimp.net

April 21-23
Seafood Expo Global 2020
Brussels, Belgium
www.seafoodexpo.com

Aquaculture America 2020

Hawai'i Aquaculture:
A Tradition of Navigating with Innovation, Technology and Culture

February 9-12, 2020
Hawaii Convention Center
Honolulu, Hawaii, USA

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Hawaii Aquaculture & Aquaponics Association

Hosted By:
Hawaii Aquaculture & Aquaponics Association

For More Information Contact:

Conference Manager
P.O. Box 2302 | Valley Center, CA 92082 USA
Tel: +1.760.751.5005 | Fax: +1.760.751.5003
Email: worldaqua@was.org | www.was.org

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