AQUA CULTURE
Asia Pacific

JULY/AUGUST 2019
Volume 15 Number 4

MCI (P) 008/10/2018 PPS1699/08/2013(022974)
ISBN 1793 -0561

Responsible & Sustainable Aquaculture

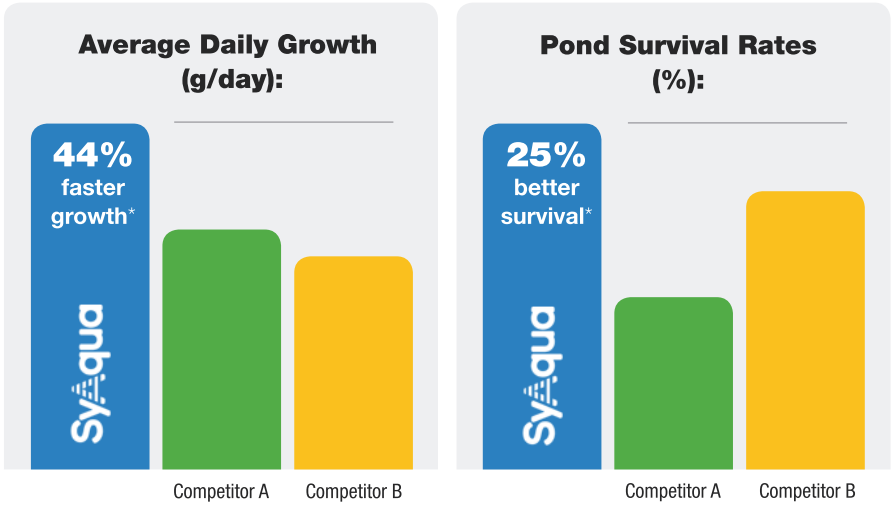
www.aquaasiapac.com

SyAqua

FARMERS LOVE OUR FAST GROWTH AND HIGH YIELD.

SyAqua's advanced breeding technologies achieve a top performing balance of **44% faster growth with 25% increased pond survival:**

- **Fast growth throughout the cycle**
- **High survival, EMS and WSSV resistance**



* Based on actual data from 2016 from 606 ponds in Southeast Asia.

For more information on how **SyAqua** can improve your harvest contact us at **sales@syaqua.com**. For more information visit **www.syaqua.com**

SyAqua

Red tilapia cage culture in Vietnam. Picture by Mavin Aquaculture.

Editor/Publisher
Zuridah Merican, PhD
Tel: +60122053130
Email: zuridah@aquaasiapac.com

Editorial Coordination
Corporate Media Services P L
Tel: +65 6327 8825/6327 8824
Fax: +65 6223 7314
Email: irene@corpmediapl.com
Web: www.corpmediapl.com

Design and Layout
Words Worth Media Management Pte Ltd
Email: sales@wordsworth.com.sg
Web: www.wordsworth.com.sg

AQUA Culture Asia Pacific is published bimonthly by

Aqua Research

Aqua Research Pte Ltd
3 Pickering Street,
#02-36 Nankin Row,
China Square Central,
Singapore 048660
Web: www.aquaasiapac.com
Tel: +65 9151 2420
Fax: +65 6223 7314

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

Subscriptions
Subscribe via the website at www.aquaasiapac.com
Subscriptions can begin at any time.
Subscriptions rate/year (6 issues): Asia SGD 70,
Other zones: SGD 100
Email: subscribe@aquaasiapac.com
Tel: +65 9151 2420
Fax: +65 6223 7314

Aqua Culture Asia Pacific Online
View E-magazine
Download past issues

Volume 15, Number 4 July/August 2019 MCI (P) 008/10/2018 ISBN 1793 -056

From the editor

News

Shrimp Culture

Industry Review

Responsible & Sustainable Aquaculture

Feed Technology

Zuridah Merican

Responsible and Sustainable Aquaculture: No longer a luxury but a necessity

Responsible and Sustainable aquaculture begs the question - does the industry in Asia understand the concept and its importance? Sustainability can be broadly divided into three categories, i.e. economic, environmental and social. The first is fundamental for any business but as the industry develops, the environmental and social importance come into play. Throughout the past decade, the industry has been influenced that this will help suppliers gain market share but is 'Responsible and Sustainable Aquaculture' overemphasised and yet poorly understood in Asia?

It would be interesting to approach this from three different vantage points or series of events that happened within a short span of May to June this year. We start with Seafood Exposition Global in Brussels in May. One could not help but notice exhibitors and companies showcasing their sustainability credentials. Just put on a buyer's hat and see that you have the responsibility to ensure that what you are buying is sourced sustainably to safeguard your company's reputation and that of the retailer's downstream of your supply chain. But this is easier said than done. One could audit every single farm and tick all the right boxes or rely on third party certification bodies. The takeaway message was that the downstream supply chain understood the importance of sustainability and was pushing in the right direction.

The next event was the Seaweb Seafood Summit suitably held in Bangkok as Thailand was slapped with a 'yellow card' for IUU fishing. The Thai government and local companies worked extremely hard to remove this yellow card. The input of Thai Union as a major partner was evident at this event with their SeaChange strategy. Thai Union is now looking at fish meal replacement in shrimp feeds. However, fish meal and fish oil substitution do carry an added cost in the beginning phase of this shift. So, what is the incentive for the farmer who has been brought up to believe that fish meal is the gold standard, to change? While seafood processing plants want to buy from sustainable sources, farmers still need to be convinced.

The following event was the Asia Pacific Aquaculture conference in Chennai, India. In the past 8 years, India's shrimp industry accelerated perhaps too "fast and furious". It did start vannamei shrimp farming very well, with controls on stocking density and effluent treatments systems for discharge water. Today, its sustainability may be questioned as farms face problems with diseases, environment and high costs of production on the east coast. Lower prices since 2018 have crimped margins leading to delayed stocking and farmers preferring to take a temporary break until prices improve. In comparison, Dr Saji Chacko, Onaway Industries, said that the continued crop success in Gujarat is because farms are limited to one crop/year, forcing a break. Sustainability is maintained by the low stocking density and community biosecurity to avoid diseases and which is modified from time to time. Many seafood companies are now focusing on environmental and social sustainability just to stay competitive.

Ignoring responsible and sustainable aquaculture from the beginning would be a huge risk. Arguably, the worst role model here would be pangasius where industry started by prioritising production volumes over sustainability. A recovery from the negative media outbursts and NGO demands is still in the works, today after the WWF emission in 2011. Concurrently its economic sustainability is threatened because it remains at the lowest rung on the white fish ladder and the price to match. Tilapia, in comparison has taken a more planned route. Despite the origin as a cash crop and fish for the masses, certain companies like Regal Springs started out with the mission of environmental and social sustainability, believing that profitability would follow suit. Despite poor reviews of product of Chinese origin, tilapia has earned its place at a much higher rung on the white fish ladder in the US.

A decade ago, sustainability was perceived to be a marketing and differentiating tool, and a luxury but today, it has become a necessity and a passport for export.

CARE FOR GROWTH

INVE IS TAKING ARTEMIA TO THE NEXT LEVEL

Three innovative and groundbreaking technologies are now available in our prime Artemia portfolio.

SEP-*Art*

SEP-*Art*

The reference technology for easy separation.

SMArt

SMArt

A new technology that allows cysts to hatch in the dark.

D-FENSE

D-FENSE

A new built-in protection for the best hatchery biosecurity.

The availability of the product will be different per region, depending on the registrations.

FOR MORE INFORMATION
www.inveaquaculture.com

INVE AQUACULTURE

SHAPING **AQUACULTURE** TOGETHER
A Benchmark Company

Aquaculture for health, wealth and happiness

Some approaches in the diversification and industrialisation of aquaculture in India at APA'19

Over three days, from June 19-21, India was the focus of the global aquaculture industry. It was an opportunity to learn more on the potential and future directions of the Indian industry. Asian-Pacific Aquaculture 2019 (APA'19) was held in Chennai, close to the centres of aquaculture in India in Andhra Pradesh and Tamil Nadu. It was a very successful gathering, with conference and trade show visitors reaching 3,507 from 67 countries. The organiser, Asian-Pacific Chapter of the World Aquaculture Society (WAS-APC) said that there were 74 sessions, including 12 industry sessions.

Dr Felix Sugantham, Tamil Nadu Dr. J. Jayalalithaa Fisheries University, the host for the event, said to *Fishing Chimes*, that it was a 'technical feast for the entire aquaculture fraternity; the participation of the next generation and farmers at the event, demonstrates that there is ample opportunity for India to take aquaculture forward." The trade show had 222 booths, of which 75% trade exhibitors came from outside India. In summarising some achievements and breakthroughs, plenary speaker Shri Tarun Shridhar, Secretary of the Ministry of Livestock, Dairy and Fisheries of India, welcomed more investments into the industry. To accelerate the development of Indian aquaculture, he said that the Indian government will support investment and trade.

Diversifying aquaculture

Today, the tilapia is attracting greater attention in India. At the 12th International Symposium on Tilapia Aquaculture (ISTA12) co-located with APA'19, Atul K Singh, former Director ICAR-DCFR & Emeritus Scientist gave some action points, amongst them, a need for technologies to ensure a strong genetic base and effective management of animal health risks as well as investment and infrastructure development. The goal is to accelerate tilapia production. The aquafeed industry is already ready with sufficient capacity for more production of fish feeds. Tilapia is a global commodity but today, India shares this ambition to increase production with many countries which have already had an earlier start and recently supply has exceeded demand bringing down prices. India's advantage will be to create a large domestic market.

Production of the pangasius fish, introduced into India in 1994, increased to 855,500 tonnes in 2018. The target is a million tonnes by 2025, according to A.B.Ch. Mohan, Seafood Solutions, India in his review on this species in 2018. West Bengal is the main hub of fingerling production supplying 500 million to all the states. Hatcheries and commercial nurseries have been set up in Andhra Pradesh, Chhattisgarh and Odisha. Monoculture and polyculture of the fish use extruded feeds (24 to 32% crude protein) with feed conversion ratios (FCR) of 1:1.3 to 1.46.

"Farms have learnt to produce quality fish but farming and feed segments are challenged by a "boom and bust" cycle. Prices, from INR35/kg in 2006, suddenly dropped to INR16 to 26/kg in 2007 and then peaked to INR54 to 56/kg in 2009 and decreased to INR27/kg in 2010. Farm gate price fluctuated between INR55.6 to 78/kg in 2017 but stabilised at 71.5 to 80/kg in 2018 due to planned stocking and harvesting," added Mohan. While most of the production is sold as chilled whole fish, branded fillet products are being sold to restaurants in cities. Fish meal is produced from offal while pangasius juveniles are also marketed as the "preferred aquarium fish"

"A high value freshwater fish, the snakehead *Channa* spp or better known as striped murrel has a stable live fish price at INR400-500/kg (USD6-8/kg)," said Zhang Taoping, Guangzhou Nutriera Biotechnology Co., Ltd, China. According to Zhang, working with Uno Feeds, they have achieved progress in induced breeding, hatchery technology and development of extruded feeds to commercialise its farming.

Marine fish: open sea vs coastal farms

Relative to major aquaculture producers, India actually lags behind in marine fish farming, despite the first harvest of cage grown Asian seabass *Lates calcarifer* from the open sea cage in Visakhapatnam in 2007. Mohan Joseph Modayil, said that henceforth, this first success demonstrated beyond doubt that there is immense potential in cage culture of marine fish. Species farmed include cobia *Rachycentron canadum*, silver pompano *Trachinotus blochii*, seabass, red snapper, *Lutjanus argentimaculatus*, grouper *Epinephelus coioides* and rock lobsters *Panulirus homarus and P. polyphagus*. Rock lobsters fetched high prices at INR1,200/kg (USD 17.5/kg) but average farm gate prices of finfish ranged from INR120/kg to INR400/kg (USD1.75-5.8/kg). In his opinion, the future for India is not industrial cage culture but organised small-scale coastal farms.

On the contrary, G. Dharani from the National Institute of Ocean Technology (NIOT), India said that it is possible to farm commercially important species in open cage culture systems. NIOT has successfully cultured marine finfishes (cobia, seabass, pompano, milk fish *Chanos chanos*, parrot fish *Scarus ghobban* and rabbit fish *Siganus* spp) in open sea cages in three locations. Among them, cobia showed the best performance with a growth rate of 15.4g/day and an average survival rate of 74%. Notably, the fish attained an average weight of 4kg in 325 days. The farm gate price of the harvested cobia fetched INR 325/kg. Marcell B. Carvalho, Bernaqua, Belgium said that both the cobia and Asian sea bass are promising candidates for aquaculture in India as both tolerate a wide range of temperature and salinity. Whether open sea or coastal cages, the development of a solid marine finfish aquaculture depends on hatchery technology.

APA'19 was opened by Tamil Nadu Governor, Thiru Banwarilal Purohit (centre). On stage, from the right, Dr JK Jena, Program Chair; John Cooksey, WAS; Dr. Felix Sugantham. On the left, Dr Farshad Shishehchian, Co-chair steering Committee.

At the SAP booth, from left, Anil B. Ghanekar, Ecosecure Systems; Aathreya, AquaPro; Dr. G. Ramesh, Wenger India; S.Santhana Krishnan, Marine Technologies; P.K. Senthil Kumar and guest.

Uday Ram Jothy (centre left) and Dr P.E Vijay Anand, USSEC, India (centre right), with Umakanth Ravinuthala, USSEC -ASC Aquaculture Program, USSEC, India and Easwara Prasad.

Prior to APA'19, DSM held a seminar on "Disease Challenges & Nutritional Solutions for Indian Shrimp Production."

From left, Dr Daranee Seguin, DSM, Thailand; Dr Visanu Boonyawiwat, Kasetsart University; Vijay Makhija, ANH APAC, DSM India; Dr Thomas Wilson; S Santhana Krishnan, Marine Technologies, India; and G.V Babu, AquaStar Magazine.

Matching production to markets

During the industry session organised by the Society of Aquaculture Professionals (SAP), Chandrasekar S, past President and General Manager at Grobest India indicated that in 2018, China was the leading importer of shrimp from India, with 200,000 tonnes. Chinese buyers offer better payment terms and a shift to this target market is a possibility in the future. Zhang Taizhuo, Guangzhou Nutriera Biotechnology Co., Ltd, China said, "We have a strong belief that China will be one of the largest importers of Indian shrimp and fish (pangasius and tilapia, seabass and snakehead fish) in the near future. But considering current farming models in India, there are still some aspects we need to overcome to match China's market requirements, such as shrimp size, colour and flavour, and yellow fish meat issues in the pangasius, through functional feeds."

Emphasis on the shrimp sector

India is now the global leader in farmed shrimp production. During the SAP session, Chandrasekar in his presentation on Indian shrimp culture in 2019 and beyond, announced that the production in 2017 was 740,000 tonnes. In 2018, it went marginally down at 738,400 tonnes. A 25% drop in production in 2019 is expected at 540,000 tonnes because of diseases, *Enterocytozoon hepatopenaei* (EHP), Vibriosis, white faeces disease (WFD) and running mortality syndrome (RMS) to white spot virus syndrome (WSSV). While a WSSV outbreak is catastrophic and instantaneous, EHP and *Vibrio* infections have a higher economic impact as the farmers find it difficult to make a decision on the crop. Cost of production is greatly affected by lower survival rates and shrimp harvests often do not meet premium grade. He said specific pathogen resistance (SPR)/ specific pathogen tolerant (SPT) brood stock replacing current practice of using specific pathogen free (SPF) brood stock may be fitting now.

A common goal shared by the various industry sessions at APA'19 was sharing solutions to help shrimp hatcheries and farms achieve successful crops. In the session on emerging challenges in Indian shrimp aquaculture, organised by silver sponsor, Uni-President Vietnam, Dr Baskaran Manimaran highlighted the challenges with diseases and said a holistic approach is required including improved genetic and disease resistant lines of broodstock, production of quality and robust post larvae, usage of balanced diets and feed management and adoption of good management practices. Marketing regulations must be addressed as recent requirements on testing for imports into the US created a panic situation resulting in price drops. He called for the creation of a domestic market, especially with a growing middle class able to afford shrimp products.

D. Ramraj, President, All India Shrimp Hatcheries Association (AISHA) said that the recent slowdown affected the hatchery and feed sectors. As stocking density decreased from 60 post larvae (PL)/m^2 to 30PL/m^2, in March, 3-4 billion of unsold post larvae were destroyed. At the hatchery level, there is the high cost of nauplii due to high cost of brood stock including taxes. Indian hatcheries have imported large numbers of broodstock for the post larvae produced, i.e. 200,000 broostock for 70 billion post larvae. The goal is to improve efficiency; as of today, the total cost of production of post larvae is high at INR250/1,000 PL (USD3.64).

The session on advances in research on shrimp culture organised by gold sponsor Sheng Long Bio-Technology International covered improving efficiency of hatchery operations, disease management and functional feeds. Chen Ming Hsien, Hisenor (Vietnam) Aquatic Breeding Co. Ltd shared his knowledge on standardised hatchery operating procedures and how quality control interventions can be applied during hatchery production of vannamei post larvae.

"It is essential that farmers start with robust post larvae ready for the pond environment," said Ravi Yellanki, CEO, Vaisakhi Bio-Marine Pvt Ltd and SAP president. At its farm along the Tuni coast, Vaisakhi has been developing an open pond nursery. The set up and details on management protocols were presented by Dr V. Surendran. This included transfer to grow-out, critical to the success of adding a nursery phase. There were 24 nursery cycles with a total production of 72 million juveniles. Farmer Saji Chacko, Onaway Industries explained the reasons for the higher rate of success in Gujarat. An important reason is that farms can only have one crop per year and this forces a break cycle. Another reason is the community biosecurity where farmers work together to eradicate a particular disease and to safeguard the shared water resources. Farms also rotate ponds such that in a farm with 100 ponds, only 70 are used to stock shrimp. Saji has calculated that it is more profitable to farm large sized shrimp. His message at the SAP session was to strive to produce larger size, stock at lower density and produce what the processor needs.

Dr Arun Dhar from the University of Arizona's Aquaculture Pathology Laboratory and Dr Loc Tan, ShrimpVet Laboratory, Vietnam provided some remedial measures against a range of diseases, from WFD to early mortality syndrome acute hepatopancreatic necrosis disease (EMS/AHPND). In controlling WFD, Loc said that the protocols include the control of algal blooms, better feed management, application of probiotics, bio-remediation strategies and functional diets. While for AHPND, the strategies used in Vietnam include improving hatchery, nursery and grow out protocols. Loc concluded, "With better adaptation to new farming protocols, it appears that shrimp farming becomes more predictable, explaining the fast increase of Vietnamese shrimp production in recent years."

An important step forward for Streptococcus resistance in tilapia

Benchmark Plc announces the discovery of a significant quantitative trait locus ("QTL") for *Streptococcus iniae* resistance. Streptococcus infections are among the most critical disease challenges in tilapia production and this technological breakthrough presents a significant opportunity for the industry to reduce streptococcus infections and the use of antibiotic treatments.

Benchmark's genomic analysis from controlled disease resistance trials has shown that a significant proportion of the genetic variation for resistance is caused by a small region of DNA – a Quantitative Trait Locus or QTL. Benchmark has made a patent application in relation to its discovery. The QTL identified will be used to select broodstock with high levels of *S.iniae* resistance to produce commercial fry. Currently Benchmark selects broodstock for improved resistance to *Streptococcus agalactiae* using genomic selection, and for resistance to *S. iniae* by marker-assisted selection using the *S. iniae* QTL.

This is the first time that a significant QTL for disease resistance in tilapia has been identified and used for commercial breeding. It represents an important step forward in the genetic improvement of tilapia and in combating its most pressing disease challenges. Benchmark's commercial Spring Tilapia® fry will be available to producers during early 2020.

Malcolm Pye, CEO Benchmark said, "This is a major step forward for the tilapia industry. We have seen first hand how devastating Streptococcus is to the industry and with the introduction of this new technology we can drive significant productively and sustainability improvements for our customers.

(Left) tilapia fingerlings; (Right) tilapia fry

In arriving at this breakthrough our international teams of geneticists have transferred knowledge from our well-established breeding programmes in Atlantic salmon which has shown to be of great benefit to the tilapia industry."

Morten Rye, Genetics Director, Benchmark Genetics added, "This breakthrough in tilapia genetics is the result of many years of investment and commitment to bringing state-of-the-art breeding technology to this important farmed species. Today global tilapia production exceeds 6 million tonnes and we believe that this breakthrough will allow the industry to continue to grow to produce more of this cost effective, high-quality, protein source for humanity. Benchmark's Spring Genetics team is excited to be heralding in a new era in tilapia breeding." www.benchmarkplc.com

Judges announce AIC winners

In June, in Jakarta, Indonesia, judges for the Aquaculture Innovation Challenge (AIC) announced that WeTech, which developed the solar-powered aeration (SUPA) device is the 2019 winner. They receive the chance to participate in the Hatch Blue accelerator programme, adding up to a cash and in-kind prize, worth USD100,000. SUPA increases the amount of dissolved oxygen in the water. Seable, which features an automatic shrimp feeder for hatcheries, has won the USD10,000 cash prize sponsored by the Global Aquaculture Alliance. Both teams will receive a financial package, supporting them to send one representative to the Global Outlook for Aquaculture Leadership (GOAL) 2019 in Chennai, India. Representatives will pitch their innovation, at GOAL, in front of global industry leaders and have the opportunity to network with relevant stakeholders.

WeTech's solar-powered aeration device

Judges believe that the SUPA device has a lot of potential. It is the best mix of social and environmental impact and business development with a great team and knowledge behind it. "I have improved my business model presentation and my distribution model (during the boot camp)," said Kamran Mahmudov. "Before this, I did not know that Indonesian farms are huge, now I know the market and I know the environment and changes we can make to adapt to the Indonesian market? We know that there is room for improvement so I think the accelerator program will help us improve our implementation strategies. We want to come back to Indonesia to do market research."

Seable's automatic shrimp feeder for hatcheries

The judges think that this innovation is a great way to make the first stage of shrimp farming more profitable and believe it targets an important hatchery issue. Agi Erlaut, founder of Seable, convincingly told the story of the challenges faced by hatcheries. www.aquaculturechallenge.com

From left to right Georg Baunach of Hatch, Farid Abbasov of WeTech, Kamran Mahmudov of WeTech, Harris Siagian of Solidaridad Indonesia

SHENG LONG

HAID GROUP

Moving Forward With Sheng Long
Cashing In On Tomorrow

Sheng Long, your professional and trusted aquaculture partner.
We provide the winning combination of high-quality aquafeeds and shrimp larvae along with technical assistance in all aspects for your success.

SHENG LONG BIO-TECH INTERNATIONAL CO., LTD
Block A-05, Duc Hoa 1 Lucky Industrial Park, Hamlet 5,
Duc Hoa Dong Commune, Duc Hoa Dist., Long An Province, Vietnam
Tel: (84-72) 3761358 - 3779741 **Fax:** (84-72) 3761359
Email: sales.shenglong@gmail.com **Website:** http://www.shenglongbt.com

HACCP
ISO 22000:2005
GLOBAL GAP
BAP

Ready-to-use live *Artemia* nauplii supply in India

Along the east coast, vannamei shrimp hatcheries now benefit from a daily supply of fresh, clean and *Vibrio*-free nauplii, relieving them of the anxiety of on-site hatching of *Artemia* cysts.

Notwithstanding the country or region, along the farmed shrimp value chain, a steady supply of good quality post larvae is a major prerequisite. Upstream, in hatcheries, *Artemia* nauplii continue to be a crucial live feed. Traditionally, hatcheries buy dry *Artemia* cysts in cans which have to be hatched, but this hatching procedure is easier said than done.

Among the list of challenges faced by fish and shrimp hatcheries hatching *Artemia* for in-house use include the following:

- Hatcheries need to buy sufficient *Artemia* cyst stocks which can be a drain on cash flow.
- Choosing the right *Artemia* brand to use can be difficult; there are more than 100 brands available in the market with varied hatching percentages.
- Hatching percentage as guaranteed on the label or by the supplier is seldom achieved.
- Some hatching conditions such as light, temperature and aeration are difficult to control and can result in a daily oversupply or shortage of *Artemia* nauplii.
- Separation of live nauplii from the non-hatched cysts and empty shells is a major challenge.
- The *Artemia* nauplii should preferably be hatched as Instar 1 to retain maximum nutrition.
- Bacteria bloom fast during hatching and are difficult to control, often resulting in heavily contaminated *Artemia* nauplii which adversely affect the health of the shrimp and quality of the water in the post larvae tank.

Since 2013, hatcheries in Thailand have the option of using fresh *Artemia* nauplii. In the past year, hatcheries, mainly around Kakinada in Andhra Pradesh and in Lampung, Indonesia have been enjoying the same benefits. In India, the Artemia Nauplii Center is operated by I&V Bio India Pvt Ltd, a joint venture of the Geekay group, a market leader in post larvae production in India and I&V BIO group with its headquarters in Thailand.

Setting a new standard in India

I&V Bio India Pvt Ltd's Artemia Nauplii Center in Vemavaram Village, Thondangi Mandal East Godavari District, Andhra Pradesh is ideally located at the Kakinada/Tuni coast, which is a major hub for vannamei shrimp post larvae production. There are more than 200 hatcheries, from small hatcheries with annual production of 45-50 million post larvae/cycle, medium size hatcheries (75-100 million post larvae/cycle) and large hatchery groups producing 100 million post larvae/cycle. Usually medium size to large hatcheries may have 50-100 tanks producing 1.5 to 2 million post larvae/tank. Hatcheries operate a total of 12 cycles/year with 3-4 sections providing for some operational downtime. To the north, around Visakhapatnam are 25 hatcheries and further south around Ongole are 30 hatcheries where 50-60% are large ones. Going further south along the east coast towards Pondicherry, there are about 25 large hatchery groups. These are current and potential clients for I&V Bio India.

"This facility in Kakinada allows us to reach customers as far south as in Mahabalipuram although the journey takes a very long time. Our first customer was the

Manjunatha group of hatcheries in Ongole. It was their consultant who convinced the group to buy our fresh *Artemia* nauplii, which is free of contamination. They tested post larvae performance in their ponds and 3 months later with good results, were totally convinced of the benefits of using our nauplii. We continue to supply 40 trays/cycle for the hatchery which produces 80 million post larvae/cycle," said Srinidhi, Head-Operations at I&V Bio India.

Geekay Hatcheries is a pioneer in vannamei post larvae production, operating out of Gudur, SPSR, Nellore District, Andhra Pradesh. Back in 2015, Frank Indigne (founder of I&V BIO) together with Y. Krishna Reddy, founder of Geekay Hatcheries agreed to set up this state-of-the-art facility in Kakinada with the same capacity as the Artemia Nauplii Centre in Phang-nga, Thailand. Besides its shrimp post larvae production business, Geekay is also active in the import of aquaculture and aeration equipment from Taiwan and in the development of complete aeration and farming technology.

"We are now producing daily 1,000 trays (800g per tray) *Artemia* nauplii instar 1 (INSTAR*T* 1) in a production facility of 2,000m^2 with a total of 100 hatching tanks of 2,000L each. A second facility next to the existing one is also ready to cope with the increased demand during peak season. Essentially, what we supply in each tray is equivalent to a tin of *Artemia* cysts (usually 425g) with 70% hatching rates," explained Srinidhi. "Our offer is a consistent product which enables the hatcheries to follow strict biosecurity protocols relieving them of the burden of hatching *Artemia* cysts in often sub-optimal conditions."

The team at the center, from the left, Lokesh Kumar, L. Srinidhi, Prapatson from Thailand, D. Kishore Kumar and Suresh, Assiistant Production Manager.

BACTOCELL

LACTIC ACID BACTERIA FOR AQUACULTURE

Believe in what you see

We can see it inside, you will see it from the outside!

BACTOCELL activates and associates with the gut mucosa, which is the key to a true probiotic effect.
If you need to see more, years of research and field applications have provided compiling evidence of BACTOCELL's modes of action and benefits at cellular, animal and farm level.
Discover the world of BACTOCELL, the pioneering probiotic in aquaculture.

Not all products are available in all markets nor all claims allowed in all regions.

LALLEMAND ANIMAL NUTRITION ■ ***SPECIFIC FOR YOUR SUCCESS***
www.lallemandanimalnutrition.com
aqua@lallemand.com

LALLEMAND

The I&V team was active at the Asian-Pacific Aquaculture (APA'19) trade show held in Chennai in June. From left, Y. Krishnan Reddy, founder of Geekay Hatcheries; Sumathi Siddarth Reddy; Y. Kavitha Reddy and Frank Indigne

Vibrio free production

"Our production protocols follow strictly those set up in Thailand by co-founder Luk Van Nieuwenhove. Cysts imported from Russia are processed in the I&V Bio's technology center in Belgium. After processing, the cysts are packed in 12kg bags and exported to India. The regulation in India requires that we send to CIBA (Central Institute of Brackishwater Aquaculture) to test for OIE listed diseases. A health certificate is issued after 7 days. This is an important step as we need to ensure that only disease free *Artemia* cysts are used. Later, in the final tray with fresh *Artemia* nauplii, we need to ensure that the nauplii are *Vibrio* free," said Srinidhi.

This control of *Vibrio* levels is a major priority at the center. "During production, we have recently upgraded our ultra-filtration water treatment systems. We must make sure that the water we use is *Vibrio* free and free of *Enterocytozoon hepatopenaei* (EHP) spores. Another test which is demanded by the Indian government is for antibiotic screening. At our own laboratory daily analyses are performed on *Vibrio*, pathogens for early mortality syndrome/acute hepatopancreatic necrosis disease (EMS/AHPND) and EHP. We also send out samples to a laboratory at the Tamil Nadu University and also to a private laboratory in Chennai," said Kishore Kumar, in charge of production at the center.

During hatching, several parameters need to be checked and a custom-made program monitors and registers each of the hatching steps until harvest. A separate program ensures that nothing will go wrong during the cooling and disinfection procedure.

Logistics is key

Delivery on time is key to the successful operations of this center. Orders for the fresh or frozen nauplii are received the day before and based on these, the production team commences operations. During packing, hygiene procedures are in place, and the quality control team (QC) monitors that 800g of nauplii goes into each tray. Sealed trays are packed in crushed ice and put into cooler boxes for transport.

"Getting logistics correct is crucial to get the trays to our customers. The logistics team carry out deliveries in small trucks and we cannot take any chances of late or non-deliveries," said Lokesh Kumar, Head-Operations.

The distance travelled by the logistics team can range from a few hours for hatcheries around Kakinada to 10 hours and 12 hours to Gudur and Chennai respectively.

Trust leads to success

Today, I&V Bio India has secured trust from leading hatchery players for their ready-to-use nauplii. Aside from the Manjunatha group, the Sapthagiri Hatchery group with 12 hatcheries is another client.

"This trust the hatcheries have in us has led to our successful business," said Y. Kavitha Reddy, Managing Director. "Hatcheries are now willing to buy not only *Vibrio* free fresh nauplii but also nauplii with minimal size variation. We are glad that we could contribute to the hatchery industry in India. Slowly, more hatcheries are realising that this supply of fresh nauplii is an option and that they do not need to worry about hatching percentage and contamination of nauplii."

This production facility of 2,000m² has 100 hatching tanks of 2,000L each

Sealed trays are packed in crushed ice and put into cooler boxes for transport

The next step for the company is to increase capacity. There is already an extension to the existing centre in Kakinada, adding another 100 tanks. Capacity will be increased to 2,000 trays/day. In the pipeline is the establishment of Artemia nauplii centers nearer to hatcheries in Gudur, Chennai and Srikalulam.

Meanwhile, Frank Indigne said, "I&V BIO's goal is to be the preferred supplier of high-tech products, which are easy to use and are delivered daily directly to the end-user. We want to be present in all main farmed shrimp and fish markets world-wide through the establishment of local facilities with local partners. By the end of 2019, the group will have six operational nauplii facilities in Thailand, India, Indonesia, Bangladesh, Vietnam and Ecuador.

In addition, Indigne said that to strengthen the health of shrimp post larvae, I&V BIO enriches the Artemia nauplii with high quality DHA (docosahexanenoic acid) emulsion, algal extracts high in amino acids and carotenoids and followed by ELVAN (a blend of herb extracts, proven for its powerful anti-vibrio effect and its prebiotic properties) to produce (INSTART 2 ENERGY), in a three-step process.

Related article: Commercialising the daily supply of live Artemia nauplii to hatcheries. Aqua Culture Asia Pacific, May/June 2016, pp 12

Hinter

— Your Personal Aquaculture Nutritionist

Hinter's aquafeed premix and additive have been globally used in more than

- 50 aquaculture fish & shellfish species
- 600 aquafeed companies
- 6,000,000 mt of aquafeed products

In addition, our services include integrated solutions for aquafeed company

Hinter

For more information, please visit http://www.hinter.com.cn

Tel：+86-20-82177017 Fax：+86-20-82178865 PC：510530

Guangdong Hinter Biotechnology Group Co., Ltd E-mail: susaquatic@gmail.com

Add: No.56, the 2nd Xingui Road, Guangzhou High-tech Industrial Development Zone, Guangdong Province, P.R. China

Inhibition of *Vibrio* biofilm formation by ginger extracts

The *in vitro* inhibition of *Vibrio* biofilm formation and the protection of shrimp against AHPND when feed is supplemented with a ginger extract

By Chumporn Soowannayan, Sasithorn Boonmee, Sukanya Puckcharoen, Pattanan Yatip, Patoomratana Tuchinda, Bamroong Munyoo and Wing-Keong Ng.

As with most bacteria causing diseases in humans and animals, specific isolates of *Vibrio parahaemolyticus* bacteria are known to colonise and form biofilms on the chitin lining the stomach before releasing toxins that destroy the adjacent hepatopancreas. *V. parahaemolyticus* has been found as the cause of acute hepatopancreatic necrosis disease (AHPND) in penaeid shrimp. An ethanolic extract of ginger (*Zingiber officenale*) was found to inhibit the AHPND bacteria biofilms but not their growth in *vitro*.

When shrimp were fed feeds supplemented with extract of ginger, shrimp survival increased by 40-60% after infection with the AHPND bacteria when compared with the infected shrimp that were fed with normal un-supplemented feed. We suggest that biofilm inhibiting compounds, such as ginger extracts, can be used to treat or to reduce the negative effects of AHPND bacteria instead of the use of harmful antibiotics.

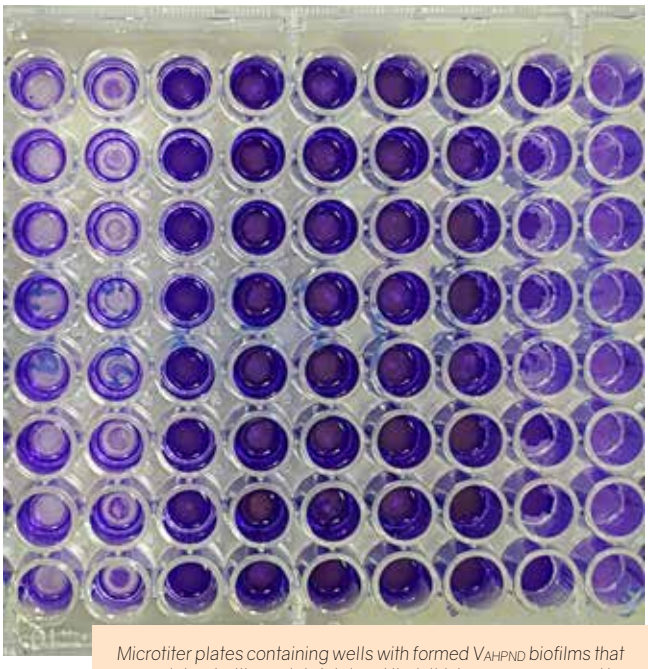
Ginger extracts contain bioactive compounds such as shogaol that was found to inhibit biofilm formation by AHPND-causing Vibrio bacteria

Bacterial biofilms and disease

Biofilm or surface-attached mode is the preferred mode of living of most bacteria. Biofilms are characterised by bacterial cells that are irreversibly attached to a substratum and embedded in a matrix of extracellular polymeric substances. Living in structured biofilm communities allows bacteria to proliferate more rapidly. It has been estimated by the US National Institute of Health that more than 80% of all human and animal bacterial diseases are associated with bacterial biofilms. *Vibrio* bacteria including the isolates that cause AHPND have also been shown to form biofilms in the chitinous cuticular lining of the shrimp forestomach before the bacterial cells produce and release PirA and PirB toxins that destroy the adjacent hepatopancreatic cells that eventually kill the affected shrimp, causing early mortalities.

To prevent or to treat AHPND, several strategies have been used, including the use of antibiotics which in itself is a very problematic practice. The most serious problem with antibiotic use is that it can lead to the development of antibiotic resistant bacteria which is currently the single most important global public health threat. Furthermore, antibiotic usage often leads to rejection or banning of antibiotic contaminated shrimp and shrimp products in the importing countries.

To avoid antibiotic associated problems, we investigated the possibility of using extracts of plant materials that do not kill or inhibit the growth of the pathogenic bacteria but rather inhibit the bacteria biofilm formation in or on their hosts. These plant extracts were initially screened in vitro for their abilities to inhibit *V. parahaemolyticus* 3HP strain (V_{AHPND}) biofilm formation in Mueller Hinton broth (MHB) with 1 v/v glycerol and 1.5% NaCl but not the bacteria planktonic cell growth. From our screening of several plant extracts, we found that the ethanolic extract of ginger was one of the extracts with such properties against V_{AHPND}.



Microtiter plates containing wells with formed V_{AHPND} biofilms that were stained with crystal violet and their thicknesses measured by absorbance readings.

Inhibition of biofilm of AHPND bacteria but not bacterial growth

To prepare ethanolic extract of ginger, dry powder of ginger rhizomes (20g) was first extracted with 95% ethanol (300mL) using a Soxhlet's apparatus set at 78°C for about 14h. The solvent (ethanol) was then removed from the extract obtained using a rotary evaporator set at 42°C resulting in a viscous yellowish-brown material (2.74g). This constituted a yield of 137mg/g (13.7%) of ginger powder.

The concentrated extract obtained was diluted in dimethyl sulfoxide (DMSO) (40mg/mL) and diluted further with sterile distilled water to achieve final concentrations of 20mg/mL and 2mg/mL for use in *Vibrio* cell growth assays, biofilm inhibition assays and feeding experiments. These final diluted preparations (20µL/well) were added to the bacterial culture broth (180µL of bacteria culture prepared from the overnight culture diluted with the same medium

ZEIGLER®

nutrition through innovation

TRACEABILITY

Zeigler diets are carefully tested to ensure they are free from known shrimp pathogens, including White Spot Syndrome Virus (WSSV), Acute Hepatopancreatic Necrosis Syndrome (AHPNS) and Microsporidian (EHP).

Z-ARC
zeigler-aquaculture.research.center

BIOSECURE SOLUTIONS

Managing risks from live and fresh feeds.

DISTRIBUTORS

Bangladesh	China	India	Indonesia	Malaysia	Philippines	Vietnam
Grace Tone Limited	Best Care Bio-Tech Co. Ltd.	Priyanka Enterprises	PT. Lancar Jaya Globalindo	Lantas Resources Sdn Bhd	Feedmix Specialist Inc. II	Vinhthinh Biostadt JSC.
+880-2-885-7165	+86-4008-882-883	+91-99-4964-0666	+62-21-5431-3251	+60-17-247-3640	+63-2-636-1627	+848-3754-2464
shahid.grace@agni.com	mxx_best@hotmail.com	priyankanlr2000@yahoo.co.in	shrimp_jkt@ljglobalindo.com	wtx9406@yahoo.com	www.feedmix.com	www.vinhthinhbiostadt.com

Contact a Zeigler Representative for additional information.

Global Aquaculture Alliance

GLOBALG.A.P. The Global Partnership for Safe and Sustainable Agriculture

Zeigler Bros., Inc. • 400 Gardners Station Road Gardners, PA 17324 • 717-677-6181
www.zeiglerfeed.com
info@zeiglerfeed.com

Product of USA

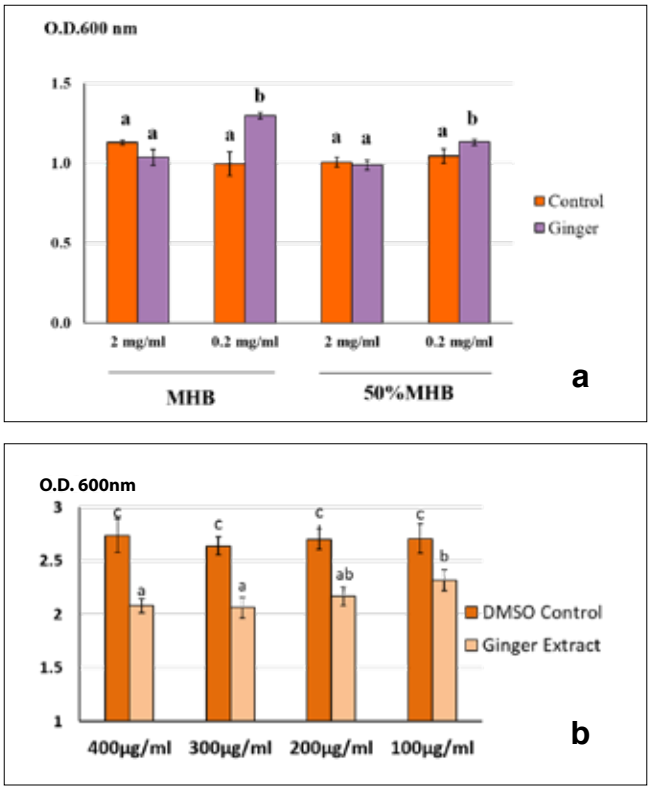


Figure 1. Average optical density readings at 600nm indicative of *Vibrio parahaemolyticus* 3HP planktonic cell growth or growth in broth (a) and biofilm thickness (b). In figure (a), the planktonic cells of the bacteria were grown in half and full-strength MHB medium with and without ginger extract at two different concentrations (2mg/mL and 0.2mg/mL). The extract at the lower concentration (0.2mg/mL) did not inhibit bacterial growth but significantly promoted it when compared to controls. In figure (b), average O.D. reading of crystal violet stained biofilms in the presence and absence of ginger extract at different concentrations and in MHB. The extract significantly ($P<0.05$) inhibited biofilm at all extract concentrations when compared with the controls. Adapted from Soowannayan et al. (2019).

used to culture the bacteria which in this case, MHB medium supplemented with 1.5% sodium chloride and the diluted cells optical density (O.D. at 600 nm) was measured. The culture was diluted to until the O.D. of 0.01 was obtained in microtiter plates in aliquots to achieve final concentrations of 0.2mg ginger extract or 2mg ginger extract.

The biofilm cultures were incubated at 30°C without agitation overnight before the formed biofilms were stained with crystal violet and their thicknesses were measured by absorbance readings at O.D. 600 nm. The higher the reading, the thicker the formed biofilms. A similar experimental set up was also prepared to determine if the extract inhibits V_{AHPND} planktonic cell growth. The bacteria were cultured in uncoated plate using MHB medium with 1.5% NaCl and incubated overnight at 30°C with agitation at 200rpm.

Light absorption at 600nm was used as the cell growth indicator. It was observed that the ginger extract at both of these concentrations were found to significantly inhibit V_{AHPND} biofilm but not the growth of the bacteria so the ginger extract at lower concentrations of 400µg/mL, 300µg/mL, 200µg/mL and 100µg/mL were also tested and all concentrations were found to inhibit the bacteria biofilm formation (Figure 1). For more detailed information on protocols used and results, please refer to Soowannayan et al. (2019) published in Aquaculture 504, pp. 139-147.

Supplemented feed reduced shrimp mortality after V_{AHPND} infection

The ginger extract was then mixed with a commercial post larvae shrimp feed (at two different concentrations; 0.2mg/g and 2mg/g feed) and fed to triplicate groups of whiteleg shrimp, *Penaeus vannamei* for 7 days before the shrimp were challenged by immersion method with V_{AHPND} at 10^5CFU/mL. We continued to feed shrimp with their respective feed while the control shrimp were fed with normal un-supplemented feed for a further 9 days, during which their health and mortalities were observed and compared.

From the results obtained, ginger supplemented feed at 2mg/g or 0.2mg/g concentrations were found to protect whiteleg shrimp against V_{AHPND} infection. The average survival of the ginger extract fed shrimp were found to be 50.0% and 42.5% respectively which are 42.5% and 35 % higher than those of the infected shrimp that were fed un-supplemented feed (7.5% survival). The survival of the unchallenged control group was 92.5% (Figure 2). Histopathological examination of hematoxylin and eosin (H&E)-stained tissues of AHPND isolate 3HP-challenged shrimp showed

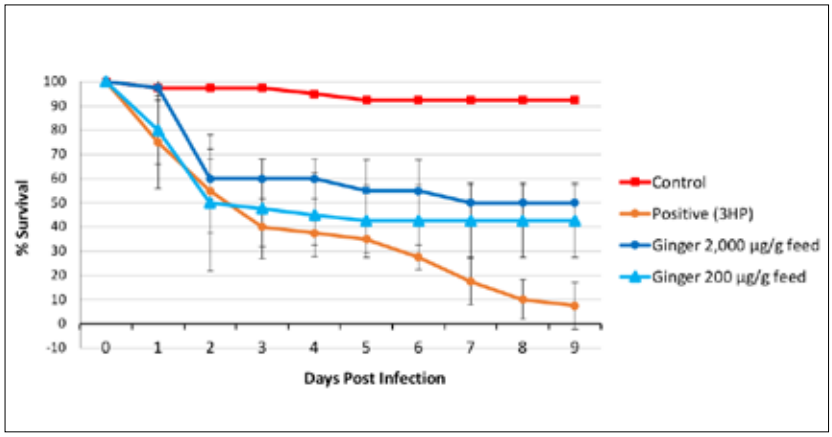


Figure 2. Graph showing cumulative % survival of *Penaeus vannamei* post larvae fed with ginger extract-supplemented feed after challenge with AHPND-causing *Vibrio* bacteria (3HP strain). Adapted from Soowannayan et al. (2019).

less severe AHPND pathologies in infected shrimp that were fed with ginger extract supplemented feeds (Figure 3).

In this study we also found that there was no apparent negative effect of the ginger extract on feed palatability or on shrimp growth. Three potentially bioactive compounds known to occur in ginger extracts (6-gingerol, 8-gingerol, and 6-shogaol) were also tested for efficacy in biofilm inhibition in *vitro*, and 6-shogaol was found to be the most potent. None of these bioactive compounds were found to affect bacterial growth in broth. The results of this study suggested that the use of ginger-based or other feed additives that inhibit biofilm formation may constitute a practical approach to reduce the negative impact of AHPND in shrimp aquaculture.

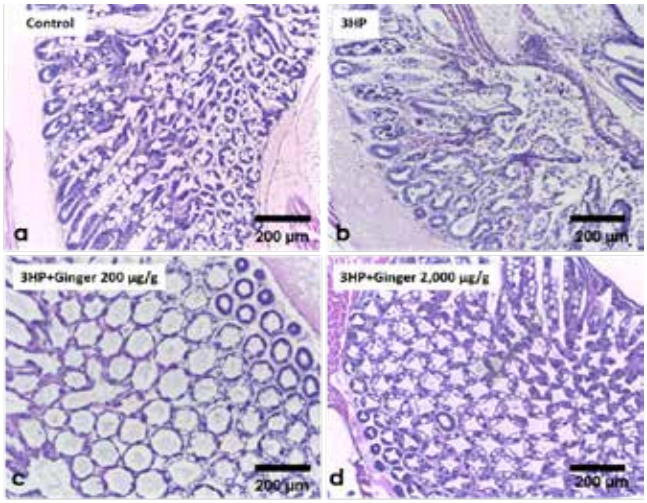


Figure 3. (a) Hepatopancreatic tissue of an unchallenged negative control shrimp showing normal histology; (b) Hepatopancreas of a moribund shrimp from the V_{AHPND} 3HP-challenged group fed un-supplemented feed and showing massive sloughing of tubule epithelial cells pathognomonic for AHPND; (c) Hepatopancreas of a moribund shrimp from the 3HP-challenged group fed with 200µg ginger supplement and showing abnormal collapsed tubule epithelia but no pathognomonic AHPND lesions; (d) Hepatopancreas of a surviving shrimp from the 3HP-challenged group fed with 2000µg ginger supplement and showing normal histology. Adapted from Soowannayan et al. (2019).

Chumporn Soowannayan

Wing-Keong Ng

Chumporn Soowannayan, PhD and **Pattanan Yatip**, MSc are with the Center of Excellence for Shrimp Molecular Biology and Biology (CENTEX Shrimp), Faculty of Science, Mahidol University, Bangkok and National Center for Genetic Engineering and Biotechnology, National Science and Technology Development Agency, Pathumtani, Thailand. Email: chumporn@biotec.or.th

Wing-Keong Ng, PhD is with the Fish Nutrition Laboratory, School of Biological Sciences, Universiti Sains Malaysia, Malaysia and Center of Excellence for Shrimp Molecular Biology and Biology (CENTEX Shrimp), Faculty of Science, Mahidol University, Bangkok, 10400, Thailand. Email: wkng@usm.my

Sasithorn Boonmee and **Sukanya Puckcharoen** are from the Center of Excellence for Shrimp Molecular Biology and Biology (CENTEX Shrimp), Faculty of Science, Mahidol University, Bangkok and Department of Marine Technology, Faculty of Marine Technology, Burapha University, Chanthaburi, Thailand.

Patoomratana Tuchinda, PhD and **Bamroong Munyoo**, PhD are with the Department of Chemistry, Faculty of Science and Excellent Center for Drug Discovery, and Excellent Center for Drug Discovery, Faculty of Science, Mahidol University, Thailand.

Update on Asian tilapia production in 2018/2019

Production rising but with stagnant international demand, producers seek local markets

"Asia leads the world in tilapia production, consumption and exports," said Dr Kevin Fitzsimmons, University of Arizona, USA, as he presented his paper at the 12th International Symposium of Tilapia in Aquaculture (ISTA 12), held in conjunction with Asian-Pacific Aquaculture 2019 (APA'19) in Chennai, India. In his overview on tilapia production and markets in 2019, Fitzsimmons noted that leading players in the global tilapia industry have remained relatively unchanged.

China continues to be the leading producer, consumer and exporter with 1.8 million tonnes per annum. Rapid increases in input costs (land, utilities, feed and labour) amidst stagnant prices have discouraged new production in virtually all the tilapia farming regions in China led by Guangdong, Hainan, Guangxi, Yunnan, and Fujian provinces. As international sales levelled off, domestic demand for value added tilapia products have been increasing.

Fitzsimmons said that, although slow, there has been a steady increase in tilapia farming in the **Philippines** and **Thailand**. Production hovered around 300,000 tonnes in 2016 for the Philippines and 250,000 tonnes in Thailand. Some of the largest hatchery companies are in Thailand, and they export fry to regional farmers. **Bangladesh** is also a large producer at an annual production of 350,000 tonnes but essentially for local consumption. In **Indonesia**, the Ministry of Marine Affairs and Fisheries (MMAF) is encouraging more production; throughout 2015-2018, national production increased by 13%, from 1.084 million tonnes in 2015 to 1.185 million tonnes in 2018. The major tilapia growing provinces are West Java, Sumatra and North Sulawesi (liputan6.com). Fitzsimmons noted that despite the increased production, there has been minimal increases in exports. However, MMAF recognises the economic importance of tilapia farming with regards to employment; Regal Springs Indonesia one of the largest tilapia producers in the world is employing 4,000 workers.

Vietnam, Myanmar and India

These are three countries to watch, according to Fitzsimmons. In **Vietnam**, the government is encouraging the production of more tilapia, thus reducing the reliance on pangasius exports. Ex-farm, black tilapia fetches USD 1-1.6/kg versus USD1.08/kg for the pangasius. In April 2019, the Ministry of Agriculture and Rural Development (MARD) reported that in 2019, there are 30,000 ha of commercial tilapia ponds and 1.2 million m^3 of cages with the majority in the northern areas (Hai Duong, Bac Giang, Bac Ninh, Phu Tho, Hoa Binh, Hanoi) and some Mekong Delta provinces. The target is to increase the farming area to 40,000ha of ponds and 1.8 million cm_3 of cages to produce 400,000 tonnes by 2030. Production in 2018 reached 255,000 tonnes, up 1.1% as compared to that in 2017 (*Vietfish Magazine*, 2019).

There are large players farming tilapia such as Nam Viet (NAVICO) with cage culture in rivers and Mavin Aquaculture (see cover photo) which is targeting 4,000 tonnes in 2019 (*Aqua Culture Asia Pacific*, May/June 2019). Farms prefer red tilapia where there is a large local demand for live fish sold at up to USD2.7/kg ex-farm. Fitzsimmons reported that cage culture in large reservoirs is a significant contributor to national production. Today, virtually all of Vietnam's current production is consumed locally with very small volumes for export.

In **Myanmar**, there have been several starts and stops and the government is pondering on allowing farming in reservoirs and lakes. Production in 2018 was 20,000 tonnes, mostly in polyculture with carps. The monoculture of tilapia in Myanmar has been constrained by the lack of access to quality seed and in 2015, the Worldfish Center sent genetically improved farmed tilapia (GIFT) to be raised into brood stocks by 2017. The US Soybean Export Council (USSEC) has been helping to develop tilapia farming; over three years (2015, 2016 and 2017), it brought delegations of farmers and industry leaders to Vietnam, the Philippines and Indonesia. It conducted training on hatchery technology and on tilapia grow-out, followed by a market seminar linking local and foreign seafood buyers to meet local processors and farmers (worldfish.org; ussec.org).

"Farming the tilapia is gaining traction in **India**. Estimates of production volumes differ; Fitzsimmons reported only 20,000 tonnes in 2018 while a feed supplier in India estimated 60,000 tonnes. Tilapia is farmed in tanks, ponds and cages in reservoirs in Andhra Pradesh, Tamil Nadu, Karnataka and Kerala and West Bengal. Nile, Mozambique and red hybrids are farmed. Juveniles are from government and private hatcheries in Andhra Pradesh as well as from imports as aquarium fish from Bangladesh," reported Fitzsimmons. Tilapia has also been incorporated into polyculture with shrimp.

State governments are working on regulating tilapia farming such as on the development of protocols for the quarantine transfer of fry and juveniles. In general, a recent preference is to farm tilapia over that of carps in India. At this ISTA12 session, Dr Atul K. Singh noted that the Marine Products Export Development Authority (MPEDA) has been focussing on increasing tilapia production over the past few years. It is increasing fry supply with imports of GIFT brood stocks for the nucleus breeding programs of eight private and

state department hatcheries belonging to fish farmer groups like Aresen Bio Tech, Aqua Exports in Andhra Pradesh; Indepesca in Maharastra and CP Aqua (India) in Tamil Nadu (Atul Singh, 2019). Indian reservoirs have good potential for tilapia farming which MPEDA wants to exploit to increase farmed tilapia production. Private fish exporters are planning to invest over INR100 crore (USD15 million) in rearing tilapia in cages in lakes in Maharashtra and Rajasthan in the next four years with technical support from MPEDA's Rajiv Gandhi Centre for Aquaculture (RGCA).

Kevin Fitzsimmons is based in Myanmar and is leading the coastal team for the Myanmar Sustainable Aquaculture Program. At ISTA12, he said, "The best estimate on global production in 2018 was 6.5 million tonnes, which comprised a combination of red hybrids and black tilapia farmed in different systems; from cage farms to rice field culture."

Misinformation on the tilapia

At ISTA12 as well as during World Aquaculture 2019 in February, Fitzsimmons expressed concerns on how tilapia demand and prices in the US, Canada and parts of Western Europe have dropped yearly since 2015. "This drop seems to be completely attributable to several misleading reports posted on the internet with claims that tilapia is worse than bacon for your health. Sites with more accurate and valid information are buried lower in the search results. It is the misleading statement - "worse than bacon" that seems to garner the most attention, even though the claim has been discredited by nearly every nutrition expert, medical doctor and dietician. The comments were included in a technical paper comparing omega 3 to omega 6 fatty acid concentrations in farmed tilapia and other fishes. The first figure in the article shows the omega 3 levels in farmed tilapia to be much higher than many common warmwater wild caught marine species. But a focus on the relatively high ratio of omega 6 to omega 3 led to the spurious comments."

However, despite the weak demand in the most lucrative markets, global production and consumption have continued to rise. Production and consumption have increased in several countries, for example in Indonesia.

Tilapia demand vs supply and forecast

Although a lower consumption volume has been observed in the international tilapia market in past years, demand for frozen fillets continues to capture consumer traction owing to increasing preference for tilapia fillet dishes and lower prices of frozen varieties as compared to fresh tilapia. Some trends on demand/supply for 2018-2019 reported by various organisations are listed below:

The average unit value of frozen Chinese tilapia into the US was USD1.71/kg (CIF) for January-Septembers 2018 which was a small increase from USD1.67/kg in the same period in 2017. This marks a substantial decline from a peak of USD2.22/kg in 2014 (Source: Globefish Highlights January 2019).

A glut of frozen tilapia from China has hurt the fresh fish market in the US. Bob Tate, National Sales Manager for Miami-based Aquabest Seafood LLC said, "You have two categories of consumers — one for frozen fish and usually buys on price and another consumer who does not mind paying more for fresh fish. Retailers still have tilapia at USD5.99-7.99/lb." In today's retail marketplace, variety is key; thriving departments have several items in both tray packs (self-service) and in the full-service case. One thing tilapia has going for it is its convenience. "Tilapia usually takes 8 to 10 minutes to cook, and I think that is a convenience for the consumer." (Source: Supermarket Perimeter)

Chinese tilapia industry witnesses stagnancy in exports amid increasing preference for pangasius

The US remains one of the largest importers of Chinese tilapia. However, according to the Food and Agriculture Organisation of the United Nations (FAO), in the first two quarters of 2017, global tilapia trade witnessed a decline of 6%, attributed to weakening consumer demand, increasing participation of other countries in the global tilapia trade and growing preference for other specialty fishes. A special palate for pangasius was witnessed among seafood consumers worldwide. Led by Vietnam, nearly half of the global supply of pangasius is held by India, Bangladesh, Indonesia, Malaysia, and China.

Tier 3 companies continue to account for over half the tilapia market share

As one of the most popular farmed fish, a huge volume of tilapia for consumption, mostly fresh tilapia is met by domestic production. Especially in the Asian seafood industry, supply chain starts from small fish farmers to big city vendors. China, the world's largest producer of tilapia exports only about 10% of its total tilapia production. In the highly unorganised market, small players continue to leverage opportunities in the domestic tilapia market with their strong local presence and limited regulatory constraints.

Tier 1 and tier 2 players add diversification to target high potential markets

Prominent market players and producers are diversifying their product offerings to target high potential markets in the US and the European Union's 28 countries (EU28). Eco-labelling, low-antibiotic production processes and convenience packaging are some of the differentiated features highlighted in a bid to establish a clear distinction between commoditised and premium tilapia products.

Frozen tilapia fillets remain highly sought after with increasing demand on seafood aisles

The market witnesses dominance of fresh varieties of tilapia whereas exports are mostly towards frozen varieties, as the nature of the fresh commodity is perishable. In addition, increasing palate for this fish has made tilapia one of the most popular fishes consumed in restaurants and seafood aisles. Although a lower consumption volume has been observed in the international tilapia market in past years, demand for frozen fillets continues to capture consumer traction owing to increasing preference for tilapia fillet dishes and lower prices of frozen varieties as compared to fresh tilapia. Source: Fact.MR Oct 2018

Cumin flavoured tilapia from Hainan

Market forecast 2018-2022

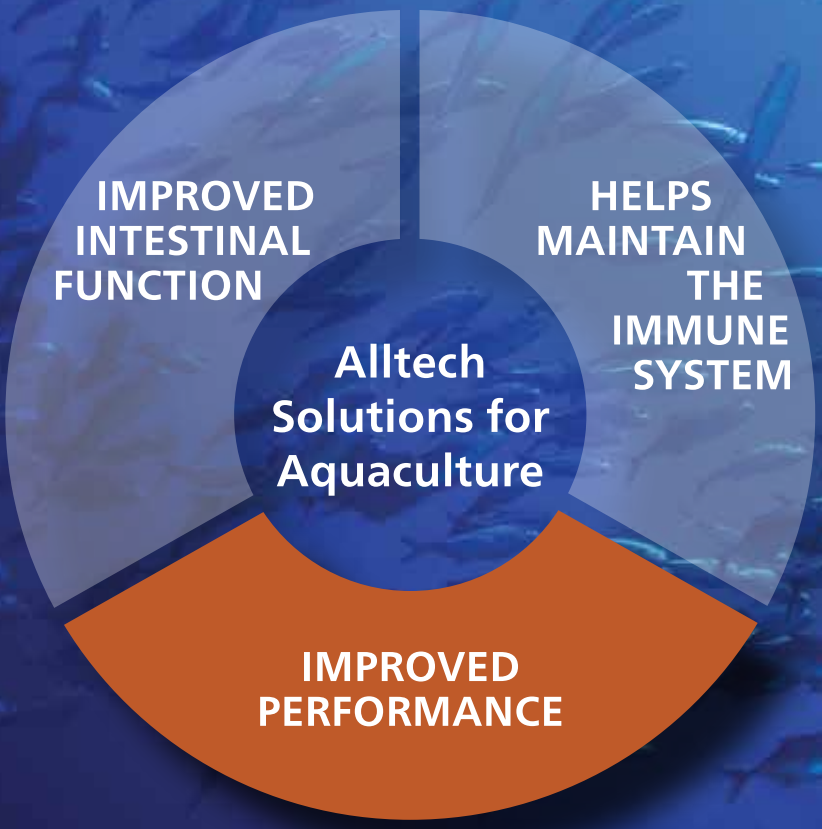
Globefish Highlights (January 2019) expects lower tilapia sales to the US in 2019. The already declining popularity of tilapia in the US is set to take another hit if the proposed current 10% tariff on Chinese origin products is raised to 25% by the Trump Administration (although recent news have indicated a proposed withdrawal). In the expectation of this tariff escalation, trade was strong at the end of 2018. Latin America, Southeast Asia and Africa continue to increase in importance as both producers and consumers of tilapia. However, in its Global Tilapia Market 2018-2022, *Technavio* analysts forecast the global tilapia market to grow at a CAGR of over 5% during the period, according to their latest market research report. Growth prospects in e-commerce is one of the major trends being witnessed in the global tilapia market for 2018-2022. One of the key factors contributing to the growth of the global tilapia market is the growing demand for processed seafood. Canned and frozen tilapia are gaining popularity among consumers because of busy lifestyles and growing demand for ready-to-cook yet healthy products by millennials.

A senior analyst at Technavio for research on food said, "Apart from the growing demand for processed food, new products launches are boosting the growth of the market. New and innovative products, in line with growing consumer demand, characterise the global market. Players launch new products to meet the changing consumer demands and to stay competitive in the market. For instance, in April 2018, Hainan Xiangtai Fishery, a leading tilapia producer in Hainan Province, China, launched an organic pre-cooked range of tilapia products. Similarly, in March 2017, High Liner Foods launched 10 new value-added products through its Sea Cuisine line; the tilapia included, all with better flavours."

References

Vietfish, 2019. www.vietfishmagazine.com/aquaculture/vietnam-aims-reach-400000-tons-tilapia-2030.html
Convenience drives tilapia category growth (May 13, 2019) www.supermarketperimeter.com/articles/3575-article-headline
www.technavio.com/report/global-tilapia-market-analysis-share-2018

What if minerals could offer more with less?



Modern aquaculture production needs a modern approach to mineral supplementation.

The Alltech® Mineral Management Program focuses on organic trace minerals that are better absorbed, stored and utilized by the animal. Modern management of mineral nutrition can be carried out by inclusion at significantly lower levels, while also improving performance. We call this innovation Total Replacement Technology (TRT).

Alltech provides natural nutritional solutions to overcome the challenges in the aquaculture industry for optimal species health, performance and profitability. Email **aquasolutions@alltech.com** today to request an assessment to see how you can achieve a cost effective diet with no compromise on health and performance.

Alltech®

Alltech.com AlltechNaturally @Alltech

Improving the "Taiwan tilapia"

Tilapia accounted for only 20-25% of the aquaculture production in Taiwan in 2018. Not able to compete with cheaper products from China, Taiwan farmers focussed on the genetic improvement of the tilapia and subsequently branded "Taiwan tilapia" are exported to niche markets such as the US. This tradition continues and GaoZheng Tilapia Breeding Company, established in 2011, is now an industry leader producing 50% of the tilapia fry supply in Taiwan.

With further development on the GIFT strain, the GaoZheng Tilapia now dominates in seven areas: fast growth; strong disease resistance; superior taste; excellent body size; environment-tolerant; high fillet yield and robustness during transport. It is Global G.A.P certified.

Covering 16ha, with 44 earthen ponds and 20 cement ponds, the company has not only the product but also the technology for farm management which was being promoted at APA'19. It has developed intelligent farm management systems which include automatic fry harvesting machines, power failure alarms, automatic water quality monitoring systems and cloud data systems. The company ensures all year supply with greenhouse enclosed ponds, and artificial hatchery systems to stabilise production during the non-breeding season.

GaoZheng Tilapia Breeding Company uses RFID for broodstock

At APA'19, Gaozheng chairman Lin Tu-I (left) and Chew Uik Sen (right) with Ministry of Science and Technology Professor Dr. Henry H. Chen

Taiwan Tilapia from GaoZheng Tilapia Breeding Company.

"Taiwan tilapia travels the world with RFID tags for parent fish to have unique numbers to avoid introgression hybridisation and inbreeding depression in breeding processes. We have exported to Malaysia and launched the largest tilapia breeding program in Myanmar."

β-glucans: a natural solution to improving the immune status and survival of fish

A measure of the effectiveness of a yeast cell wall is the ratio between β-glucans and MOS

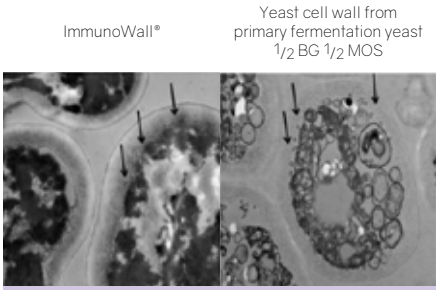
By Liliana Borges and Melina Bonato

Intensive fish and shrimp farms are naturally susceptible to bacterial, fungal, and parasitic infections, particularly when the animals are under stress. For a long time, the most common method for dealing with the occurrence of bacterial infections in aquaculture was the administration of antibiotics. However, aquaculture faces serious problems due to various adverse effects of these drugs, such as accumulation in the animals' tissues and environmental microbiota. Therefore, providing additives that strengthen the immune system might be one of the keys to higher productivity.

ImmunoWall® (ICC Brazil) is derived from purified yeast cell walls of *Saccharomyces cerevisiae*, originating from the sugarcane fermentation process for ethanol production. It is the best natural source of mannan oligosaccharides (MOS) and β-glucans (BG), which are crucial to maintain intestinal health and to improve the immune status, thus ensuring optimal animal performance.

"Given that β-glucans are like the yeast cell wall 'skeleton', it is important to consider the ratio between β-glucans and MOS in order to measure the effectiveness of β-glucans."

The aggressive conditions during the sugar cane fermentation process to obtain ethanol leads the yeast to protect itself and, therefore, to strengthen its cell wall. Given that β-glucans are like the yeast cell wall "skeleton", it is important to consider the ratio between β-glucans and MOS in order to measure the true effectiveness of β-glucans. The higher the β-glucans concentration, the lower the cell wall degradation in the gastrointestinal tract. ImmunoWall® contains around 35% of β-glucans and 20% of MOS, i.e. it has a BG: MOS ratio close to 2: 1, whereas the primary yeast cell walls have a 1: 1 BG: MOS ratio (Figure 1).



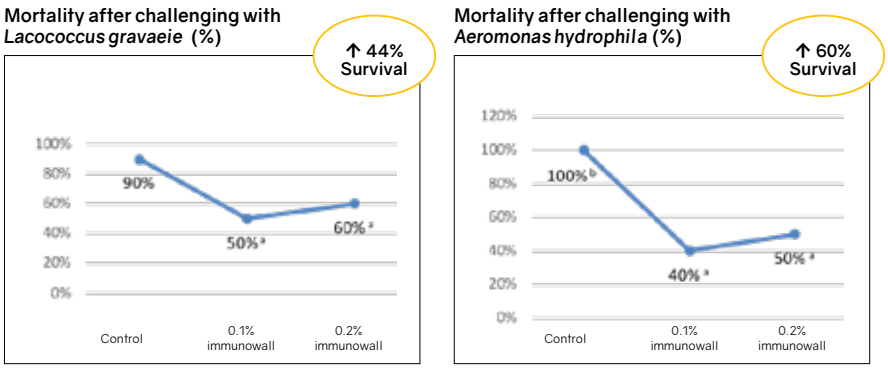
Microscopy structural difference between ImmunoWall and yeast cell wall from primary fermentation. Light microscopy images performed at Electron Microscopy Facility, Cellular & Molecular Medicine, University of California San Diego – 2016.

Figure 1. The difference in β-glucans between ImmunoWall® and the yeast cell wall from primary fermentation.

	Parameters	Control	0.1% Immunowall®	0.2% Immunowall®
Relative immune gene expression determined by quantitative PCR	IL1-β	1 ^{c}	7.5 ^{b} ± 1.1	16 ^{a} ± 1.3
Innate immunity	Phagocytic activity (%)	57 ^{b}	61 ^{a}	70 ^{a}
	Phagocytic index	1.8 ^{b}	1.75 ^{b}	2.5 ^{a}
	Lysozyme activity (µg/mL)	435.8 ^{b}	450.95 ^{a}	464.3 ^{a}

^{ab} *Means with different letters in the same line differ significantly according to a Tukey test (P<0.05)*

Table 1. Relative immune gene expression determined by quantitative PCR, phagocytic activity (%) and index and lysozyme activity of Nile tilapia challenged with *Lactococcus garvaeie* and *Aeromonas hydrophila*.



^{ab} *Means with different letters differ significantly according to a Tukey test (P<0.05).*

Figure 2. Survival of Nile tilapia challenged with *Lactococcus garvaeie* and *Aeromonas hydrophila*.

MOS is known for its ability to agglutinate pathogens. It prevents pathogen colonisation in the gut by offering a binding site to harmful bacteria that possess type 1 fimbriae present in the intestinal tract and is excreted together with the faecal material.

β-glucans are known as immune system modulators or stimulants since when they come into contact with phagocytes, which recognise the β-1,3 and 1,6 bindings, the phagocytes are stimulated and produce cytokines, which will start a chain reaction inducing immunomodulation and improving the response capacity of the innate immune system.

This type of response is especially important in animals in the initial growth phase, reproductive phases, stress periods and during environmental challenges. β-glucans act as prophylactic agents increasing an animal's resistance and minimising further damage (such as a drop in performance or high mortality rates). Intensive animal production is a highly challenging endeavour. Thus, the strengthening of the immunological system can be one of the key steps toward higher productivity.

In a recent study conducted at the Faculty of Veterinary Medicine, Cairo University, Egypt, by Abu-Elala et al., (2018), 270 Nile tilapia, *Oreochromis*

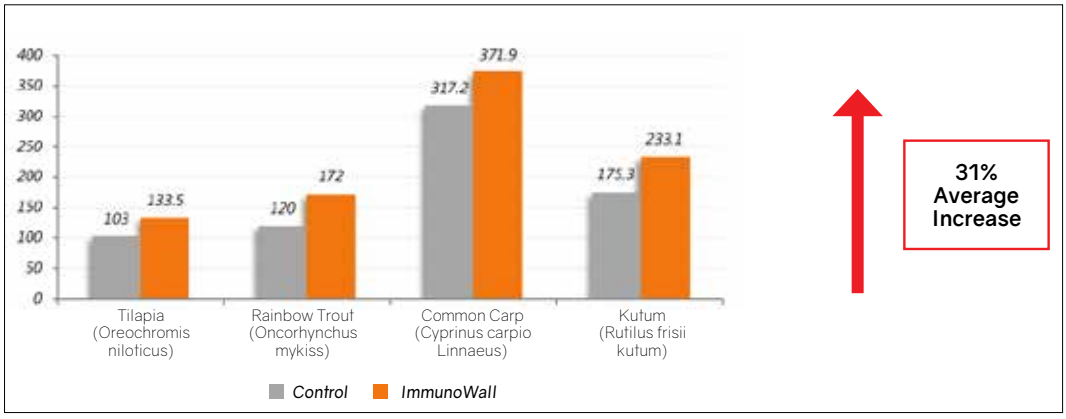


Figure 3. Body weight gain percentage by fish fed with diets containing ImmunoWall®.

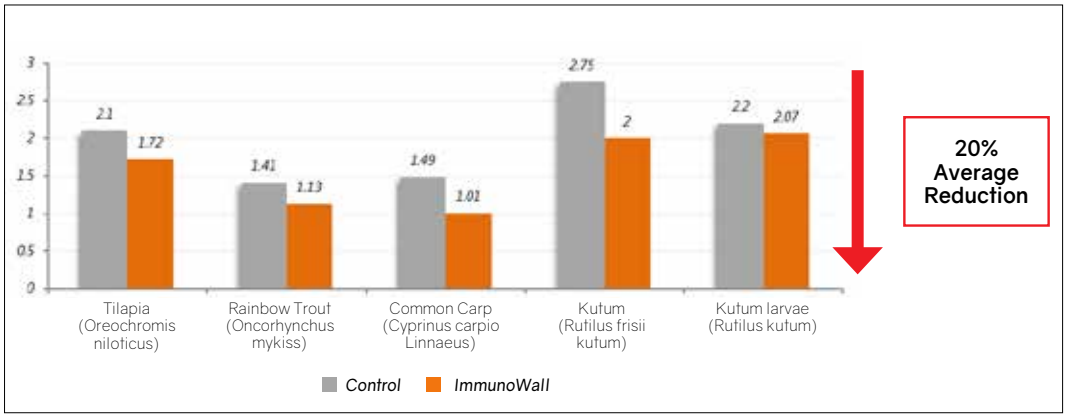


Figure 4. Feed conversion ratio of fish feed with diets containing ImmunoWall®

Source for Figure 3 and 4

Tilapia treatments control and IMW 1g/kg (Abu-Elala et al., 2018); Rainbow trout treatments control and IMW 1g/kg (Department of Fisheries, Faculty of Animal Sciences and Fisheries, Sari Agricultural Science and Natural Resource University (SANRU), Iran, 2014); Common Carp treatments control and IMW1.5g/kg (GH. Ebrahimi et al., 2011): Kutum treatments control and IMW 0.5g/kg (GH. Ebrahimi et al. 2010); Rutilus kutum larvae treatments control and IMW 1g/kg, Caspian Journal of Environmental Sciences, Vol. 13 No.1 pag.99-107, 2015.

niloticus (50.7±0.8g body weight were divided into three experimental groups: control, 0.1% ImmunoWall® and 0.2% ImmunoWall®, with 90 fish in each treatment (three replicates/tank). The performance of fish was measured every 2 weeks over 2 months, and at the end of the trial, 5 fish/replicate were euthanised in order to evaluate the relative expression of immune genes using quantitative PCR, phagocytic activity (%) and index, and lysozyme activity (µg/mL) (Table 1). After 2 months, the fish were challenged with the gram-positive bacteria *Lactococcus gravaeie* and gram-negative *Aeromonas hydrophila* and the mortality rates were observed over 1 week (Figure 2).

These results show that ImmunoWall® was able to improve the immune gene expression response and innate immunity ($P<0.05$), and therefore reduce the mortality rate ($P<0.05$), when the fish were challenged with *Lactococcus gravaeie* and *Aeromonas hydrophila*, compared to the control group.

The improvement in the immune system reflects directly on performance enhancement. Other studies have demonstrated the benefits of ImmunoWall® supplementation in aquaculture on the performance of different species and all have shown an improvement in body weight gain and the feed conversion ratio (Figures 3 and 4).

The improvement in the immune system reflects directly on performance enhancement. Other studies have demonstrated the benefits of ImmunoWall® supplementation in aquaculture on the performance of different species and all have shown an improvement in body weight gain and the feed conversion ratio (Figures 3 and 4).

Intensive animal production is a highly challenging endeavour. Thus, strengthening the immune system can be one of the key steps to higher productivity. The action of β-glucan occurs on the innate immune system, in other words, where the first immune response to pathogen contamination happens. This helps to avoid a higher expenditure of energy during a prolonged inflammation process and mobilise the adaptive immune system faster, thus avoiding losses in production and high mortality rates.

ImmunoWall® can be supplied early to the animals; it modulates and alerts the immune system to many infections or contaminations.

References

Abu-Elala, N. M., Younis N. A., Abubakr, H.O., Ragaa, N. M., Borges and L. L., Bonato, M. A. 2018. Efficacy of dietary Yeast Cell wall supplementation on the nutrition and immune response of Nile tilapia. Egyptian Journal of Aquatic Research. Vol. 44 (4): 333-341.

Amirkolaie, A.K. 2015. Effects of prebiotic on growth performance, intestinal bacteria colonization, and survival rate in Rutilus kutum fry. Caspian Journal of Environmental Sciences. Vol. 13(2): 99-108.

Amirkolaie, A.K, Karimzadeh, S. and Jafary, A. M. 2014. The effects of dietary supplement of ImmunoWall® on growth performance, and visceral and hepatic somatic indices of juvenile rainbow trout, Oncorhynchus mykiss. Department of Fisheries, Faculty of Animal Sciences and Fisheries, Sari Agricultural Science and Natural Resource University (SANRU), Sari, Iran. Unpublished data.

Ebrahimi, G. H., H. Ouraji H, Khalesi, M.K, Sudagar M., Barari A, Zarei Dangesaraki, M., Jani Khalili K.H, 2012. Effects of a prebiotic, Immunogen®, on feed utilization, body composition, immunity and resistance to Aeromonas hydrophila infection in the common carp Cyprinus carpio (Linnaeus) fingerlings, Journal of Animal Physiology and Animal Nutrition. Vol. 96 (4): 591-599.

Ebrahimi, G. H., et al. 2010. Effects of prebiotic supplementation on survival, growth performance and feed utilization of kutum, Rutilus frisii kutum (Kamenskii 1901), fingerlings, Research Journal of Animal Sciences. Vol 4 (6): 125-129.

Liliana Borges, PhD is ICC Brazil's Research and Development Analyst.

Melina Bonato, PhD is R&D Coordinator at ICC Brazil, which is focused on yeast-based products, studying animal nutrition, immune responses, health and performance. She has a Ph.D. in Animal Science
Email: melina.bonato@iccbrazil.com.br

Responsible and sustainable aquaculture

With input from the seafood supply chain, the authors discuss aspects of aquaculture where industry and regulators need to deliver on sustainability in order to attract investments.

By Anton Immink, Dave Little, Dominique Gautier and Manish Kumar

It has been said many times that aquaculture can help to meet the world's growing demand for protein. Value chain actors, politicians and chefs are amongst those emphasising the efficiency of aquatic species in feed conversion and highlighting the health benefits of seafood in the diet. There has also been plenty of debates about how aquaculture can help small-scale farmers, support national food security and boost foreign revenue earnings. Of course, aquaculture has its critics and sceptics, but the growth of the industry over the last decades, the increasing variety of farmed products seen in fresh fish markets and the volumes of farmed fish and shellfish now sold in supermarkets indicate that aquaculture plays a crucial role in the provision of protein for the burgeoning world's population. However, for an industry that is 'here to stay', aquaculture still has many mountains to climb before it can call itself 'sustainable', especially in Asia where it is dominated by numerous, small family-run farms.

> "Many aquaculture sectors especially those dominated by small-scale farmers, ride a fine line between success and failure, particularly when disease strikes or when adverse environmental conditions occur."

Floating cages in China. Courtesy of Jack Morales.

What is being sustainable?

Aquaculture covers a whole range of species, production systems and intensities. Feeding the world with seaweed and bivalves farmed in open seas could be considered to have the least impact on the environment based on life cycle assessments, but would require a lot more of the sea and coasts to be

Small scale shrimp farms in Mamuju, West Sulawesi Indonesia (March 2015). Courtesy of Jack Morales.

managed or production intensified. Moreover, a key issue will be whether people could change their diets and eat more aquatic organisms found lower in the food chain, including carps that have traditionally been farmed using methods with lower environmental impact. Even in China, by far the world's largest producer of various species of carps, wealthier consumers are moving away from this group of fish. Traditionally, carps were produced quite extensively on local, mainly plant-based resources but in recent decades there has been a trend towards the use of formulated feeds, similar to that used in the production of the big four farmed commodities – salmon, shrimp, tilapia and catfish. Improving breeds, feeds and management can enhance efficiency and reduce the adverse impacts in their farming. We can consider sustainability against the classic economic, social and environmental elements.

Economic sustainability cannot be taken for granted, even when it appears that farmers are making money. Many aquaculture sectors especially those dominated by small-scale farmers, ride a fine line between success and failure, particularly when disease strikes or when adverse environmental conditions occur. This has consequences for farm owners, staff, processors, as well as other stakeholders in the neighbourhood. The economic fallout may impact the social dimension of sustainability on a multitude of scales and disrupt environmental sustainability. Recognising that sustainability is a complex concept this article will highlight some issues and solutions that cut across different aspects of sustainability with the aim of supporting improvements in Asian aquaculture that will enable the industry to thrive and remain the aquatic engine to feed the world.

Scale of impact

Current certification standards address environmental and social aspects of aquaculture, and define management practices expected from responsible operators. But they seldom set performance indicators that would measure the broader sustainability.

Responsible farming

Farmers can act responsibly, but still go out of business because of the poor practices of their neighbours that could compromise the sustainability of their activity. Production systems are not (yet) sufficiently isolated from each other to give farmers the confidence

A good crop of quality tilapia from a farmer using data to improve farm management. Credit: China Blue.

Seafresh farm, between a mangrove forest (left) and agricultural land (right) showing advances in technology with greenhouse nurseries, lined ponds, central sludge drain, and water reservoirs. Photo copyright: Seafresh Group.

that they are almost exclusively in control of the risks they may face. Despite strong examples of innovation in more biosecure, contained production systems it will be a while before that level of control is the norm in aquaculture. In the meantime, industry-wide management systems will need to accommodate a wide variety and scale of risks.

Good farm management can be validated through certification to give the market some confidence that a particular supply is contributing to their sustainability goals. But just as Dr Manoj M Sharma commented previously in *Aqua Culture Asia Pacific* (March/April 2019, p8-13) "responsibility must come from all producers and planners/regulators if the industry is to move towards sustainability". The risks and impacts of one farm are minimal, but significant industries connected across landscapes need good management to protect themselves and the resources they rely upon.

Sectorial governance

Without a positive mix of good farm management and good governance in the sector, the industry becomes its own worst enemy, especially in creating significant disease and water quality problems. Production costs can increase for individual farmers and catastrophic industry-wide losses can put many farmers out of business. Dr Andy Shinn has reported at TARS 2016 and in various articles the multi-billion-dollar economic impact of acute hepatopancreatic necrosis disease (APHND) on the Asian shrimp industry. Despite the huge economic losses governments and industries themselves are not investing in coordinated disease management systems or emergency disease response planning. This is a major reason for investors holding back on expansion and for withholding insurance growth to the small-scale farmers in Asian aquaculture.

Data and technology

Many small players in the Asian aquaculture industry still live within a cycle of making enough money from the good crops to cover the next loss. This can limit investments in management approaches and technologies that may help smooth out the boom-and-bust cycles because the investment is seen as adding to costs. In the short term, and without broader adoption of sustainable practices across the industry and wider governance, this is true. A new generation of innovative and industrial farmers and companies are starting to develop new concepts of intensive aquaculture systems based on the use of improved genetic material and biosecurity and to use new technology. Many of these innovative farmers recognise that experience can be mixed with tools to help predict the timing of harvests, increase feed efficiencies and mitigate impending disease problems.

Diagnostic testing at the pond side taking place in Hainan, China. Credit: China Blue.

This longer-term view could increase sustainability, but can also help connect to a new generation of consumers who want more information and assurance on how their food is produced. These tools need data, which can address some of the traceability demands from the market and also start to address the concerns of investors and insurers. Such development could truly transform Asian aquaculture supply to both international and regional markets.

Governance challenges

Changes in regulation will only partially meet the governance challenge; building sector-wide capacity is essential. Putting industry-wide management systems in place helps the long-term profitability of an industry. The *Aqua Culture Asia Pacific* magazine regularly highlights the need for longer-term vision in the industry, for planners and regulators to address cumulative impacts and shared risks (especially disease) and for industry associations to demonstrate leadership and deliver guidance to members on best practices.

Collective efforts of producers in some countries, such as the Ecuadorian shrimp industry, in collaboration with government agencies, seems to be a way forward, not only for improving the sustainability of their industry, but also to gain market trust. These efforts need to be oriented towards responsible production practices, controlled development and management plans, and concerted initiatives to prevent and mitigate the impact of diseases. Even in Europe the success of aquaculture has not just come from clearer regulatory systems enabling investment confidence, but from strong industry associations enforcing good performance from members who form the majority of producers.

Reducing production costs for farmers and meeting increasing market demands are not just about technical solutions. Farmer-led area management systems for coordinated disease control can reduce the costs for individual farmers if everyone follows a few basic practices. Linking this to better data use by farmers can further support greater efficiency gains and enable small- and medium-scale producers to stay in the game (therefore addressing social, economic and environmental sustainability). This would also start to practically address the aspirations for "sustainable intensification" a process that needs careful implementation so as not to be just another buzz word that may cover up the rush to grow production without the required governance.

Some current improvements

There are some positive examples already taking place where farmers, processors, governments, international buyers and NGOs are collaborating to address sustainability more holistically. These include:

- In Surat Thani and Chumpon provinces in Thailand some of the authors here are collaborating with other actors in the SHRImp Project (Shrimp Health Resources Improvement Project) to build a more effective health management system across whole areas of production. The intention is to provide farmers and regulators with an early warning system if productivity drops or if disease problems emerge.
- In Hainan, China the tilapia industry (farmers, processors and international buyers) has created a new association and a local code of good practice to enable farmers across the industry to determine how best they can improve to fulfill international market demands.
- In Indonesia, there are several multi-stakeholder projects underway, (including SI3P, Shrimp Industry Improvement and Investment Program) which work with farmers to increase productivity and build environmental carrying capacity tools to help planners understand how aquaculture – and other activities – may impact the environment. New partners are always welcome.

The future

Asia remains an exciting place to farm seafood and there are lots of innovations and aspirations to make it more truly sustainable. The industry and regulators across the many countries of this aquatic powerhouse need to deliver on sustainability in order to attract new investors and insurers - and keep them interested and reassured. Addressing common risks and challenges through working with neighbours and demonstrating best practices using data will need to be the norm.



Anton Immink is Aquaculture Director at Sustainable Fisheries Partnership, an NGO engaging all levels of the seafood supply chain to support the growth of a sustainable aquaculture sector. He has worked across Asia and Africa on a range of projects over the last 25 years. Email: anton.immink@sustainablefish.org

Dave Little, PhD, is the Chair of Aquatic Resource Development and Research Director of the Institute of Aquaculture, University of Stirling, Scotland. With 40 years professional experience in aquaculture, his main research and educational interests focus around the societal impacts of aquaculture.

Dominique Gautier is Director of Sustainability at Seafresh Group, a producer and distributor of seafood products operating in Asia, Europe and the Americas and investing in improving the sustainability of aquaculture and fisheries. Dominique has 30 years of sector leading experience in aquaculture across Asia, Africa and the Americas.

Manish Kumar is CEO of Fishin'Co, a major supplier of responsibly produced seafood to some of the world's largest retailers. Manish has significant experience of the aquaculture supply chain across Asia and is supporting improvement projects in key sourcing countries, notably China and India.

Some considerations on the sustainability of low fish meal aquafeeds

There is no question that plant meals can effectively replace fish meal when carefully processed to maintain optimal nutritional value.

by Thomas Wilson

The focus on the sustainability of aquaculture production is a relatively recent phenomenon, spurred on initially by several scientific papers, first among which was the *"Effect of aquaculture on world fish supplies"* (Naylor et al. 2000). This paper sought to answer the question "Does aquaculture enhance or diminish the available fish supply?" from an ecological perspective. The concluding assessment of the paper was that feeding carnivorous marine fish (e.g. salmon) required large inputs of wild fish to produce the fish meal in the feeds for those species, but for other lower trophic level fish, such as omnivores and herbivores (like carp and tilapia) that are capable of being grown on feeds without any fish meal at all, there was little impact.

The authors suggested that the aquaculture industry should prioritise four goals:
- increase farming of low trophic level fish;
- reduce fish meal and fish oil in feeds;
- develop integrated farming systems; and
- promote environmentally sound aquaculture practices and resource management.

While there has been no dispute on the basic conclusions of the Naylor et al. paper, the aquafeed industry took exception to some of the fish meal/fish oil utilisation data used to calculate ecological impacts. Naylor et al. (2009) published a follow-up paper entitled "Feeding aquaculture in an era of finite resources" that was well accepted by the aquaculture industry, because it included a number of fish nutritionists among its co-authors, including Ronald W. Hardy, Dominique P. Bureau, and Delbert M. Gatlin among others.

FIFO and FFER ratios

In 2008, Tacon and Metian published a paper, "Global overview of fishmeal and fish oil in industrially compounded aquafeeds: Trends and future prospects", and introduced the concept of the "Fish-In Fish-Out ratio" (FIFO) that has become a mainstream "sustainability" indicator for aquafeeds. At about the same time, retail seafood distributors in the USA and Europe started implementing FIFO maximum levels in their purchasing standards.

Two early examples from the USA are Wegmans Food Markets Shrimp Purchasing Standards (2007), requiring a FIFO ratio for unspecified farmed shrimp of 1:1 or less, and Whole Food Market's Farm Standards for Finfish and Shrimp (2008), which listed their FIFO requirements:
- Shrimp (*Litopenaeus vannamei*): 1:1
- Black tiger shrimp (*Penaeus monodon*): 1.5:1
- Cod: 1:1
- Steelhead/Rainbow Trout 1:1
- Tilapia: 0.25: 1
- Channel Catfish: 0.35:1
- Other finfish and crustaceans: 1:1

FCR	Maximum % Fish meal in feed to obtain a FIFO value = **1**
1.0	21.3%
1.2	17.7%
1.4	15.2%
1.6	13.3%
1.8	13.3%
2.0	11.8%

The initial FIFO model was rejected by the salmon farming sector as being overly simplistic, with critics pointing out that the model did not account for the fact that fish oil was a component of fish meal, and perhaps more importantly, that the FIFO method did not recognise that the salmon industry, as well as supplying fish to the food supply chain, was also a producer of salmon-origin fish meal and fish oil which could be re-utilised in aquaculture feeds for other species. An article by IFFO's Jackson (2009) entitled "Fish In – Fish Out Ratios explained" went into some detail about the mistakes in the original FIFO calculation as proposed by Tacon and Metian.

Representing the argument of the European salmon farming industry, Crampton et al. (2010) published a paper "Demonstration of salmon farming as a net producer of fish protein and oil", and proposed the adoption of the marine protein dependency ratio (MPDR) and marine oil dependency ratio (MODR) methods. The notable difference with the FIFO method is the adjustment of the scores obtained by considering the quantities of proteins and oils available to be recycled from processing by-products from salmon farming, which then makes salmon a net producer of fish protein and fish oil.

Not surprisingly, several aquaculture certification schemes, among them Global Aquaculture Alliance's Best Aquaculture Practices (BAP) certification, and the Aquaculture Stewardship Council (ASC) standards now set maximum FIFO/FFER (feed fish efficiency ratio) ratios in their farming standards. Adoption of FIFO ratios as a requirement for farm certification is a game changer for the aquaculture feed and farming industry in Asia, because for countries with significant farmed seafood exports, the reduction of fish meal is no longer an option; it is a necessity to maintain access to important seafood markets. However, it should be noted that by-product fish meal is generally excluded from the FIFO calculation. BAP farm guidelines (BAP 2017) state, "They shall exclude meal or oil derived from fishery by-products such as trimmings, offal and squid liver powder and aquaculture by-products such as shrimp head meal" (when calculating FIFO).

The IFFO's own program, Global Standard for Responsible Supply (IFFO-RS) started being used with fish meal and fish oil in 2010 and is now recognised by other certification schemes as an important standard because it targets fish meal and fish oil producers rather than the feed industry. It focuses on:
- Responsible sourcing - fish from scientifically managed fisheries, non-IUU (illegal, unreported and unregulated fishing), evidence that governments are taking efforts to protect stocks, habitats and the environment;
- Responsible production - manufacturing according to international feed quality and safety standards, Good manufacturing practice (GMP) certification, segregation of compliant and non-compliant materials; and
- Compliance with international standards- UN FAO, ISO, etc.

According to the IFFO 2017/8 Annual Report, more than 45% of the world's production of marine ingredients is IFFO-RS compliant, and there are now >30 certified producers in Thailand, Vietnam and China.

Fish meal

As aquaculture production around the world continues to increase, greater percentages of the world's limited supplies of fish meal and

COMMITTING TO SUSTAINABLE AND PROFITABLE AQUACULTURE.

RONOZYME®

Our innovative enzyme solutions promote sustainable production by increasing the utilization of nutrients by fish and reducing the amount of waste excreted.
This improves performance and reduces the impact of fish farming on the environment.

DSM

fish oil are being used in aquafeeds. Figure 1 shows estimates of fish meal and fish oil utilisation by aquaculture in 2016. Significant amounts of fish meal made from seafood processing by-products are being used (IFFO estimates by-products now make up about 33% of total fish meal and fish oil production), which will undoubtedly increase in the future. Figure 2 provides an example of product mass flow during the processing of the pangasius in Vietnam, from whole live fish through to exported finished product. It estimates by-product utilisation to make fish meal and fish oil at 14% and 15% of the live fish weight respectively.

Applied to the entire Vietnamese industry, which achieved in excess of 1 million tonnes of production in recent years, fish meal and fish oil quantities would be above 140,000 and 150,000 tonnes, respectively. That amount of fish meal, although not of high quality (typically 56-60% CP, 10% fat, ≥20% ash) could be used at a 5% inclusion rate to produce 2,800 tonnes of feeds for carps or tilapia, which could produce an additional 2,100 tonnes of fish at a feed conversion ratio (FCR) of 1.3. Similar waste streams from seafood processing everywhere can be processed into significant volumes of fish meal and fish oil. The only caveat is that these meals and oils have to be fed to species other than the source species.

> "On the other hand, fish meal made from processing by-products should not be mistaken as being equivalent in quality to fish meals made from whole fish"

The aquafeed industry has been fortunate in having high quality standardised single-species fish meal made from whole fish for several decades, since it supplies amino acids, lipids and other key nutrients in abundance in a highly digestible form. On the other hand, fish meal made from processing by-products should not be mistaken as being equivalent in quality to fish meals made from whole fish. For one thing, by-product raw materials have passed through a processing plant before delivery to the fish meal plant, so is usually less fresh with higher levels of biogenic amines, and has much higher ash and lower protein levels than top quality fish meal because it is made from bones, entrails and trimmings. The difference in composition between fish meal from whole fish and by-product fish meal is that by-product fish meal is harder to use in an effective manner.

Figure 3 shows a graphic representation of the average nutrients found in these different fish meals, and the by-product fish meal is notable for having a very high ash content. High ash fish meal interferes with the uptake of dietary phosphorus and zinc, and in several salmonid species has been shown to induce eye cataracts and blindness due to zinc deficiency.

Animal by-products

The Asian feed industry is also shifting towards greater use of by-product meals from livestock and poultry. The only major producer of processed or rendered animal proteins in Asia is China and it is capable of using the whole volume produced domestically. Other Asian countries depend primarily on imports from the USA, Europe, Australia and New Zealand. The European prohibition on the use of processed animal proteins in feeds after the 1990's bovine spongiform encephalopathy, or BSE scare, inhibited its use at home, so for many years almost all porcine and poultry by-products have been exported overseas, mainly to Asia.

Even though the prohibition on the use of animal proteins in aquafeeds was lifted in 2013, European consumers and retailers are still reluctant to accept them. All of the European salmon feed producers use animal by-products in salmon feed markets that allow them such as in Canada, Australia and Chile. However, any future price increases or supply shocks in the fish meal supply to Europe could open the door for domestic use, and Asia could potentially see supplies drying up. Therefore, Asian feed

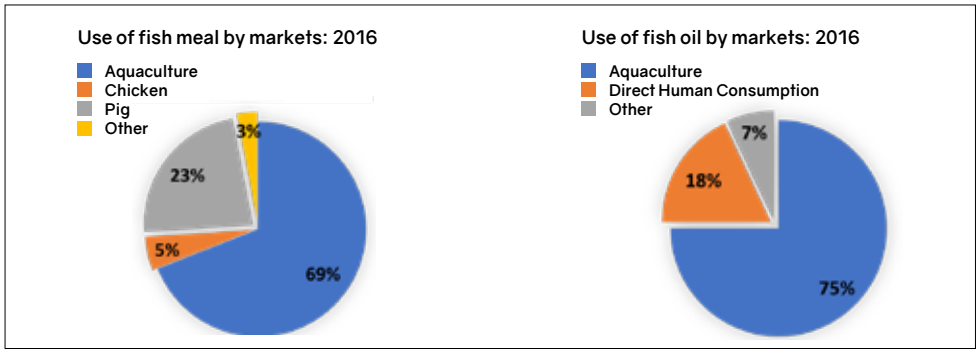


Figure 1. Usage of fish meal and fish oil by market segment in 2016 (FAO and IFFO).

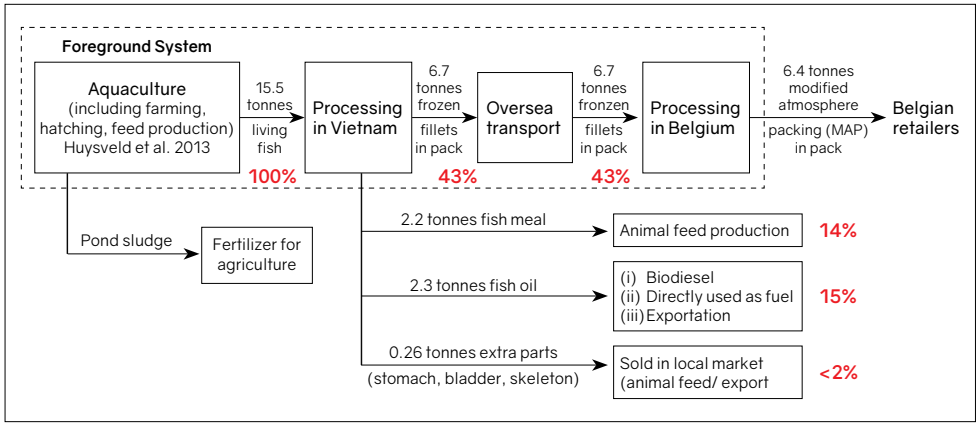


Figure 2. Overview of mass flow of Vietnamese pangasius processing from live whole fish to finished fillets delivered to Belgian retailers, indicating processing by-products and their valorisation (Nhu, 2015). Approximately 28% (4.3 tonnes) of the total weight is not accounted for and is assumed to be moisture lost during fish meal production.

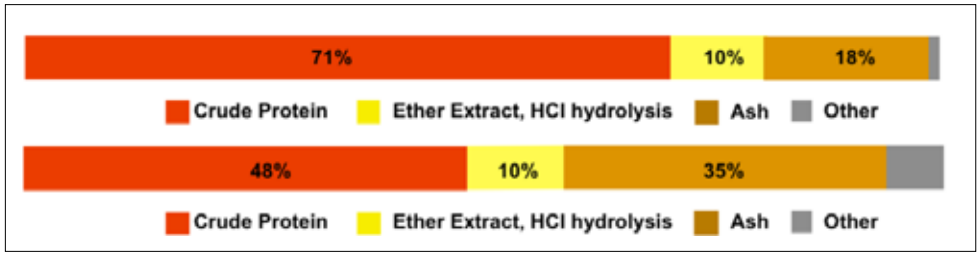


Figure 3. Comparison of protein, fat, ash, and other components in high quality single-species fish meal (top) with a by-product fish meal (bottom). Units shown are averages on a % dry matter basis. Source: www.feedipedia.org/node/208.

producers should consider animal by-products as temporary sources of protein during a transition from fish meal to plant protein alternatives and not rely on them to the exclusion of other alternatives.

Insect meals

Insect protein meals and oils are permitted to be used in aquafeeds in Europe at the beginning of 2017. Since then this industry has received a lot of attention, with investments in production facilities in many Asian countries with access to low cost feed substrates for insects. Numerous experiments with fish and shrimp have shown that insect meals are suitable replacements for fish meal. The key problem, namely inadequate production volumes coupled with high selling prices greater than the perceived value they deliver in feed, will take time to resolve. So for the time being insect meal will not be a mainstream alternative to replace fish meal.

Plant proteins, cereals and grains

Researchers have shown that the apparent digestibility of protein and amino acids in high quality soybean meal and protein concentrates from soy, corn, wheat and rapeseed/canola is often higher than what is found in fish meal. However, soybean meal (SBM) cannot be fed to Atlantic salmon because it contains soy saponins which work in combination with non-starch polysaccharides (raffinose and stachyose) to cause severe gut inflammation (enteritis). Recently, researchers have shown that feeding SBM to common carp, zebrafish, turbot, yellowtail kingfish and Japanese seabass induces gut enteritis, but not when fed to Australian snapper, Atlantic cod, Atlantic halibut or Egyptian sole.

On the other hand, soy protein concentrate (SPC) which has had most of the antagonistic polysaccharides removed during processing and can be fed to Atlantic salmon quite freely, will still induce enteritis when fed to yellowtail kingfish. It is important, then, to conduct feeding experiments to test a candidate aquaculture species for sensitivity to high saponin ingredients (soy, peas, sunflower) and look for intestinal enteritis if no prior research has been done. In Europe recently, researchers have found that feeds containing probiotics or bacterial protein can suppress the development of enteritis and experimentation is ongoing.

Phytic acid, or inositol-6-phosphate (IP6), is found in both SBM, SPC and many other grain products (wheat, rice bran) and oilseed meals. It is considered the most significant anti-nutritional substance in crop-based ingredients, due to phosphorus binding, and its tendency to bind to and precipitate proteins and important trace minerals. In many cases, dehulling seeds and grains removes much of the phytic acid, but in soy, the phytic acid is embedded with the protein, and is difficult to remove by processing. A well-established technology in livestock and poultry feeds, phytase enzyme can be used to degrade phytic acid, and this can be done with ingredient pre-processing, or more commonly, by added heat tolerant enzymes to the feed. Due to high heat over an extended period during manufacturing of shrimp feeds and extruded aquafeed, top coating with phytase enzyme post-pelleting is the preferred application method.

One risk of using plant proteins to replace fish meal comes from the often significantly high variability of nutrients and anti-nutritional factors found with plant crops. Naturally arising from different countries of origin, from soil, climate, seasons, weather conditions, and finally, processing plant design and operation, they are hard to control.

The solution is to use strategies that minimise the consequences of this variability. Glitsøe and Pontopiddan (2014) reported that the origin and processing of nine SBM samples from Argentina, Brazil and the USA had a significant effect on the activity of pancreatic trypsin in poultry, by reducing the efficiency of protein digestion in some samples. The activity of a protease enzyme, Ronozyme® Proact, was equally effective at digesting protein in eight of these nine samples. The ninth sample was found to have proteins that were excessively heat damaged , which explained why the protease did not work. Similar benefits can be expected with fish, although this has not yet been tested. When endogenous trypsin is supported by supplemented protease, protein digestion proceeds faster not only because there are more enzyme molecules actively working at slicing up protein chains, but also because added protease has been shown to digest trypsin inhibitor protein molecules from soy and other ingredients in the stomach, removing them before endogenous trypsin activity can be suppressed by the inhibitors.

Having an adequate dietary supply of available phosphorus (P) is necessary for proper skeletal development and efficient energy metabolism in fish, but it is sometimes difficult to estimate available P from ingredients. Feed performance can be made more consistent with phytase, since with its addition, the phytic acid's anti-nutritional effects are reduced and P availability increases. Since phytase works mainly in the acidic stomach before phytic acid precipitates at higher pH, the rapid gut passage times of many aquatic species might reduce the effective working time of phytase. To counteract this, some users resort to increasing the phytase dosage to 2-3 times the recommended level. Yan et al. (2002) tested a first generation phytase with channel catfish, and found that while a standard enzyme dose (1,000-2,000 U/kg) degraded phytate in the stomach in 6-8 hours, doubling the dose (4,000 – 8,000 U/kg) degraded phytate to equivalent levels in only 2 hours.

In conclusion, if plant ingredients are carefully processed to maintain optimum nutritional value and if they are well characterised with respect to quantities of protein, fat, fibre and ash, with amino acid and lipid profiles known, and if the availability of all essential nutrients has been determined for the species of interest, there is little doubt that they can be used effectively to replace fish meal. It does not matter whether the ingredients are used in feed intended for carnivores, omnivores or herbivores. The methods used to remove or reduce the anti-nutritional components by processing, or with enzymes such as phytase, glucanases or xylanases, result in similar outcomes.

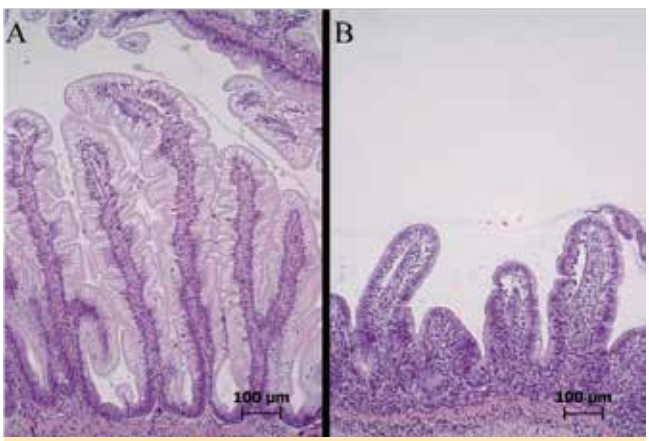


Figure 4. Soybean-meal induced enteritis (right) in Atlantic salmon intestine. A: high fishmeal diet, B: high soy diet.
Source: Sahlmann, 2013 Norwegian School of Veterinary Science

Thomas Wilson, PhD is an Aquaculture Nutrition Consultant based in Bangkok, Thailand, focusing on successful fishmeal replacement. He is also trainer/facilitator in regional training programs in aquaculture nutrition and aquafeed milling for industry in Asia. Email: thomas.wilson@fishnutritionexpert.com

Fishmeal substitution with plant ingredients in shrimp feeds: A sustainability conundrum?

A shift from fishmeal to plant ingredients should not be taken for granted as a sustainable solution to meeting a rapidly expanding shrimp aquaculture industry

By Wesley Malcorps and Björn Kok

Fish meal. Credit: Sadasivam Kaushik

Credit David Mark pixabay.com

Significant amounts of fishmeal are included in shrimp diets, causing a dependency on finite marine resources. Driven by economic incentives, terrestrial plant ingredients are widely viewed as sustainable alternatives. As the relative price of fishmeal increases, feed manufacturers have been decreasing inclusion rates of fishmeal in commercial diets and shifting towards crop-based ingredients such as soy protein concentrate, cereal and wheat gluten.

Substitution of fishmeal by plant ingredients is also considered to be environmentally sustainable, while the nutritional requirements of shrimp may limit the amount of fishmeal substitution. Additionally, substituting fishmeal by plant ingredients would shift resource demand from the oceans onto the land, potentially adding pressure to the land-based food production systems, affecting the environment, biodiversity, and availability and prices of crops.

Current knowledge suggests that aquaculture growth and its increasing demand for plant ingredients in aquafeed could affect agricultural supply and its resources, such as land, freshwater and fertiliser. However, the quantitative impact is relatively unknown.

Aquafeed interactions with marine and terrestrial resources

Aquaculture and capture fisheries are interdependent, as fishmeal and fish oil are used in many aquafeeds. Shrimp feed production uses 31% (approximately 1 million tonnes) of the fishmeal in aquaculture. Global fishmeal production is around 5 million tonnes annually and its future supply may be affected by an increasing demand, climate change, and variability.

Shrimp feed manufacturers have decreased the inclusion of fishmeal from a global range of 19–40% in 2000 to 11–23% in 2014, while the range for fish oil inclusion stabilised (around 0–2%). Future fishmeal inclusion in shrimp feeds is expected to further decline and stabilise at around 6% in 2025. However, total farmed shrimp production is expected to increase to approximately 8.6 million tonnes in 2025.

Plant meal alternatives come at a cost, as agricultural production for aquafeed ingredients (rapeseed/canola, soybean, corn and wheat) required a land area as large as Iceland (~10 million ha) in 2008. Some argue that there is insufficient land available for agricultural expansion, as 4.9 billion ha (which is approximately 40% of the total land surface in 2005) currently occupies 91% of the approximately 5.41 billion ha suitable for agriculture. It is estimated that animal feed crop production occupies around a third of global crop land.

An excessive dependency on plant ingredients for aquaculture could lead to deleterious effects on the environment and indirectly impact human health by altering the nutritional value of aquaculture products. In this respect, our principal objectives were to quantify firstly the resource implications (freshwater, land, nitrogen, phosphorus and wild fish) of soybean meal inclusion to reduce the dependency of marine sources, and secondly examine the inclusion of alternative plant ingredients typically included in modern shrimp feeds, such as rapeseed meal, pea meal protein and corn gluten meal.

Modelling the transition to plant-based ingredients

We modelled the natural resource demands of a transition to plant-based ingredients in shrimp feed formulations. In this study, feed formulation algorithms were used to create unique feed formulations for the two most dominantly produced shrimp species, with intermediate declining steps of 20% fishmeal substitution by plant ingredients, while accounting for the dietary requirements of individual shrimp species. These diets were modelled in combination with a comprehensive multifactorial assessment of marine and terrestrial resource demand for agricultural crop production and processed ingredients.

Feed formulations and scenarios

We estimated the impact of fishmeal substitution with plant ingredients by developing contemporary shrimp feed diets using the feed formulation software FeedSoft™. This software calculates the most cost-efficient feed formulation based on dietary requirement data and global market ingredient prices. Nutrient requirement data of shrimp were obtained from the National Research Council and global ingredient prices were from the International Hammersmith Commodity Index Database. These prices fluctuate; therefore, we selected the commodity prices of September 2018 and converted them to Euros for input into the feed formulation software.

We developed feed formulations for *Litopenaeus vannamei* (whiteleg shrimp) and *Penaeus monodon* (black tiger shrimp). Traditional shrimp feed formulations include between 20% and 30% fishmeal where 30% was commonly applied for *P. monodon*. Fishmeal inclusion differs per species: carnivorous *P. monodon* requires higher protein contents in their diets (36–42%) and *L. vannamei*, 18–35%. Therefore, we set baseline fishmeal inclusions at 20% for *L. vannamei* and 30% for *P. monodon*.

We developed 24 feed formulations for these two species (*L. vannamei* (LV) and *P. monodon* (PM)) and two scenarios: common-plant scenario (LV1, PM1) and alternative-plant scenario (LV2, PM2). Each combination of species and scenarios contained six feed formulations with intermediate steps of 20% fishmeal substitution by plant ingredients. Table 1 is available at https://doi.org/10.3390/su11041212

- The "common-plant scenario" with the lowest possible price used mainly soybean (Glycine soja) meal to substitute fishmeal.
- The "alternative-plant scenario" excluded economic incentives and included alternative plant ingredients suitable for fishmeal substitution based on their nutrient profile. Ingredients were pea protein concentrate, rapeseed meal, corn gluten meal and corn oil.

In order to ensure reliability of the model, we compared prices of our developed feed formulations with indicative prices per tonne of feed in Asia (USD 700–1100), China (USD 450–800), India (USD 844–956), and the Philippines (USD 876–967).

Model simulations and runs

The model ran six feed formulations per species and scenario with intermediate fishmeal substitution by plant ingredients. A shared common data set of multi-factorial resource demand was developed and used per ingredient for each feed formulation to account for the global variety of resource demands by crops and its derived ingredients (Table 1, freshwater, land, nitrogen, phosphorus and fisheries).

The main results in absolute and relative numbers are available in the full text of this paper. In summary, the complete substitution of 20-30% fishmeal could lead to increasing demand for freshwater (up to 63%), land (up to 81%) and phosphorus (up to 83%) while other substitution rates lead to proportionally lower impacts. These findings suggest that even though the production of shrimp feed utilises only a small percentage of the global crop production, the sustainability of substituting fishmeal by plant ingredients should not be taken for granted. For example, Figure 1 shows the relative (%) change in land demand as a result of complete fishmeal substitution with plant ingredients, highlighting one of the trade-offs between marine and terrestrial resources.

The sustainability conundrum of fishmeal substitution

There is a global strategy to find alternatives to fishmeal in shrimp feed formulation. Our results show that although this strategy serves to mitigate marine protein and oil dependency, when used as a sole substitute, it shifts pressure to terrestrial resources. The modelling results show the intensity of the added pressure on freshwater, land and fertiliser, highlighting a shift in pressures in the longer term for using higher inclusions of plant ingredients in aquafeed.

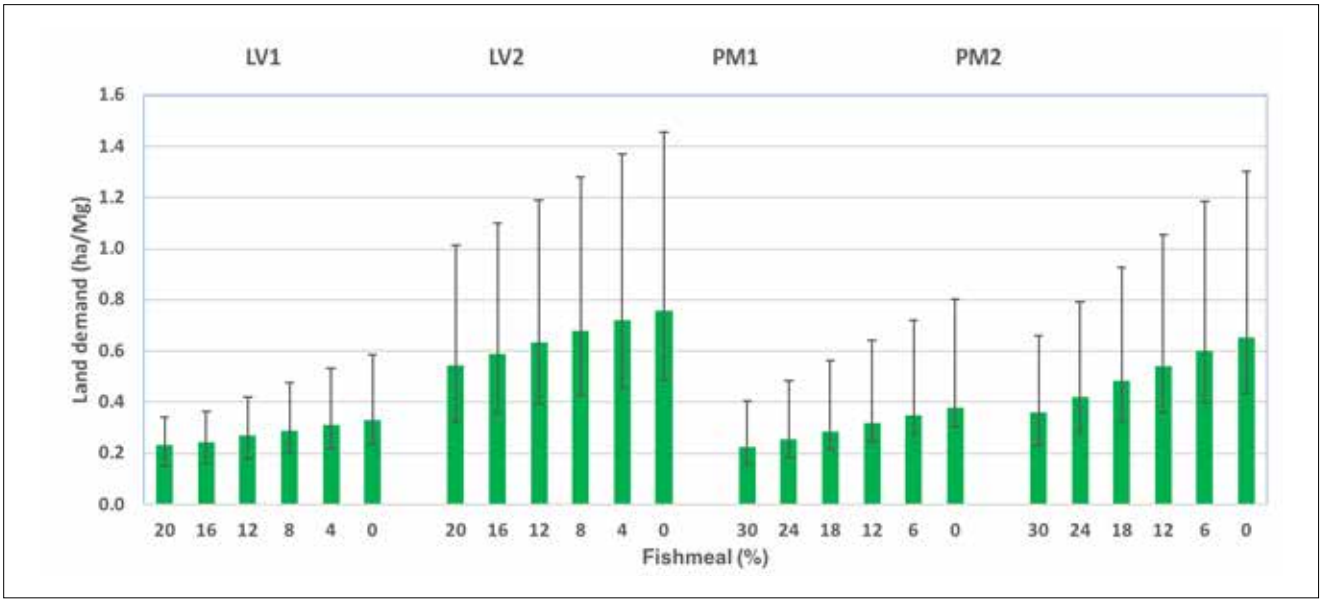


Figure 1. Minimum, mean, and maximum land demand (ha/tonne) for the baselines and five substitution levels in two scenarios and for two species. The y-axis represents the global mean land demand, and the bars indicate the range (min/max) in land demand of a combination of ingredients in the feed formulations.

The large difference in mean land demand between *L. vannamei* and *P. monodon* in both scenarios is caused by the higher inclusions of soybean meal, pea protein concentrate and corn gluten, and their relatively higher land use compared to other aquafeed ingredients (Table 1). Soy production requires more land compared to corn and wheat, while corn gluten meal requires relatively less land (0.2 ha/tonne) compared to rapeseed meal (0.9ha/tonne), which has a higher inclusion (36.7%) in diet LV2 compared to 10.7% in diet PM2, Table 1). It is obvious that land demand is significantly higher in the alternative-plant scenario as a result of the higher inclusion of crops with a relatively higher land demand such as rapeseed, pea and corn compared to soybean and wheat in the common-plant scenario. (Table 1)

A shift from fishmeal to plant ingredients should not be taken for granted as a sustainable solution to meeting a rapidly expanding (shrimp) aquaculture industry.

Conclusions

Our model highlights the need for a paradigm shift in the definition of sustainable shrimp feed by presenting quantitative data on the consequences relating to sea-land linkages as a result of the substitution of fishmeal with terrestrial ingredients based on current resource demands. Our study has clearly demonstrated that complete fishmeal substitution by plant ingredients could lead to an increasing demand for freshwater (up to 63%), land (up to 81%), and phosphorus (up to 83%). These are significant increases, as only a share of 20–30% of the feed is substituted.

This is mainly caused by the inclusion of resource intensive crops and their derived ingredients to meet nutritional requirements, such as soybean meal concentrate, rapeseed meal concentrate, pea protein concentrate and corn gluten meal. A shift from fishmeal to plant ingredients should not be taken for granted as a sustainable solution to meeting a rapidly expanding (shrimp) aquaculture industry. The additional pressure on crucial terrestrial resources inflicted by the rapidly growing aquaculture sector may become more obvious over the next decades.

While the paper is focused on shrimp feeds, the model may be equally applicable to other intensively farmed species (for example, freshwater and marine finfish). However, more data on the origin and resource demand of ingredients are required in order to gain accurate insight into the optimal use of marine and terrestrial resources. This would enable the shrimp farming industry to operate and contribute in a sustainable manner to global food security and the economy, providing the much needed high nutritionally valuable seafood.

Extracted from: The Sustainability Conundrum of Fishmeal Substitution by Plant Ingredients in Shrimp Feeds by Wesley Malcorps, Björn Kok, Mike van't Land, Maarten Fritz, Davy van Doren, Kurt Servin, Paul van der Heijden, Roy Palmer, Neil A. Auchterlonie, Max Rietkerk, Maria J. Santos and Simon J. Davies. Sustainability 2019, 11(4), 1212; https://doi.org/10.3390/su11041212

Wesley Malcorps is a PhD student at the Institute of Aquaculture, University of Stirling, UK. Wesley has an educational background in Water Management (B.WM) /Aquatic Ecotechnology (HZ University of Applied Sciences, Netherlands) and Sustainable Development (MSc at Utrecht University, Netherlands) enforced with experiences in environmental and aquaculture research and international development. He is currently working as a PhD student on "Value Chain and Sustainability Assessments of European Aquaculture Value Chains", as part of the GAIN (Green Aquaculture Intensification in Europe) project funded by European Union Horizon 2020. Email: wesley.malcorps@stir.ac.uk

Björn Kok is a MSc student on Sustainable Development – Energy and Materials,at Utrecht University, Netherlands and research intern at MatureDevelopment BV, Netherlands. His background is in Water Management (B.WM) / Aquatic Ecotechnology from the HZ University of Applied Sciences, Netherlands. He is currently writing his Master thesis on the resource use of aquafeed production and alternative aquafeed ingredients. He has a passion for environmental research and international development. Email: bjorn@maturedevelopment.com

Vision for a more sustainable aquaculture

Karim Kurmaly expounds the sustainability story as algal oil containing EPA and DHA reaches the markets

By Zuridah Merican

In 2018, the aquaculture industry was abuzz with Veramaris coming up with an oil from marine microalgae rich in the essential polyunsaturated omega-3 fatty acids EPA & DHA (docosahexaenoic + eicosapentanenoic fatty acids). Veramaris is a 50:50 joint venture between DSM and Evonik with its headquarters in Delft, Netherlands. Veramaris' CEO, **Karim Kurmaly**, shares one revolutionary vision of how to enable the aquaculture industry to continue growing sustainably using microalgal oil, which will provide the aquafeed industry an alternative to its current reliance on wild-caught fish.

At the sidelines of the recent SeaWeb Seafood Summit 2019 in Bangkok, Kurmaly gave his insights into this joint venture and the strategies to bring the product to market.

It is his background in marine science, aquaculture and an understanding of markets and dynamics which brought Kurmaly to this new role. Kurmaly, with a PhD in microencapsulated diets for marine larvae from Bangor University, Wales, started his career in aquaculture at Trouw International (now part of Nutreco), and later joined Aquastar, a fully integrated shrimp farming business in Songkhla, South Thailand. He then set up the aquaculture research centre in Asia Pacific for Roche Vitamins (Hoffmann-La Roche) which DSM acquired in 2003. Kurmaly continued to spend 10 of 16 years at DSM's Animal Nutrition & Health businesses.

There is also his ability to manage complex relationships, suitable for the 50:50 joint venture. "One of the things that I am able to do is build business teams for the sustainability of the business. This is a joint venture of two very large companies heavily invested in the animal feed industry. DSM brings the biotechnology and algal strains while Evonik has expertise in large-scale industrial fermentation. We are a complementary fit and currently we have three facilities; one in Slovakia, one in South Carolina, USA, and the newest in Nebraska, USA, which opened in July 2019. Today, we have over 45 scientists, from both parties, working on development, scaling-up, etc., allowing us to rapidly come to market."

How did this JV start and is it permanent?

This joint venture's capabilities are limitless; the intention is to build and grow. DSM is a leader in the feed industry with a unique portfolio that runs from the classic vitamins through carotenoids to cutting-edge eubiotics and feed enzymes and Evonik is perhaps the largest in the amino acids space. Both have a vision to move to sustainable ingredients and natural marine algae as it enables our customers and stakeholders to make the changes required to grow while simultaneously helping them begin the journey to reduce their reliance on natural marine resources such as fish oil. Veramaris' primary target is the aqua industry and pet food segment. Species-wise, the current focus is on salmon, sea bass, sea bream, grouper and shrimp.

Our alternative sustainable solution is an algal oil derived from micro-algae, a *Schizochytrium* strain, produced through a very simple, basic biological platform which is highly scalable and sustainable; independent of sunlight. During fermentation, our *Schizochytrium* strain grows exponentially. After a certain period of time, we stop the fermentation and extract the oil with a concentration of over 50% omega-3 EPA & DHA fatty acids. The factory's algal biomass is nutrient dense, so we feed that to local beef cattle, which makes the process waste-free.

The EPA & DHA concentration in our algal oil is more than double that of fish oil, which tends to have between 18-22% EPA & DHA.

Karim Kurmaly became Veramaris CEO in January 2018 after spending 10 of 16 years at DSM's Animal Nutrition & Health businesses.

We are continuing to improve the ability of this strain to convert and produce even more omega-3 fatty acids. Adjusting the environmental conditions during the fermentation process and understanding how the algae is growing exponentially enables you to fine-tune. In 2010, DSM bought Martek Bioscience with the entire library of algal strains so the pipeline of potentially new algal strains and new products from these algal strains is immense. We have only actually touched on 18% of the 6,500 algal strains.

When was the first breakthrough in getting into salmon feeds?

The breakthrough with commercial quantities was in February 2018. We intend to supply 15% of the global demand of omega-3 fatty acids for the salmon industry. The amount of fish oil in the world market is one million tonnes, of which close to 200,000 tonnes is omega-3 oils.

All our customers prefer oil, as it is much easier to handle as a lipid source rather than powder. Furthermore, our algal oil has natural antioxidants. Nutritionists value this concentrated oil where 1% of algal oil can replace 3% of fish oil. For those companies who want to become more sustainable and join the movement to conserve marine biodiversity, they have a very ready-made solution; one tonne of algal oil basically enables them to release 60 tonnes of wild caught fish and meet the United Nations Sustainability Development Goal 14 (conserve and sustainably use the oceans, seas and marine resources for sustainable development).

What are the key benefits for the different stakeholders of the value chain from farmers to consumers?

One reason for the acceptance of this oil is that companies want to mitigate the risk and dependency on finite marine resources. Next, in line with farmers request, they want to reverse the decline of EPA and DHA in their feed. Nutritionists have had to lower their specifications in aquafeed because there has not been enough fish oil available.

There is also growing consumer awareness on the importance of EPA and DHA for heart and brain development amongst Asian shoppers. Seafood, particularly salmon and shrimp, are excellent natural sources of omega-3 fatty acids. Leading retailers who are correctly labelling and messaging this with a "point of purchase" communication plan are allowing consumers to make informed choices. Our consumers survey of 14,000 salmon consumers over several countries (Japan, China, Australia, United Kingdom, United States and France) indicate an awareness on the importance of EPA and DHA and are looking to make informed choices.

Millennials look actively for health and sustainability messages—we have shared this with the retail segment. With farmers and feed millers, we want to help them create and demonstrate value to the entire supply chain, but it requires us to now move from a commodity mindset to understanding the importance of the nutritional value that seafood provides to the consumer. Seafood is not only protein, it is both protein and health.

What's your strategy? You have worked with the retailers to bring it to the consumers rather than work straight with the feed millers.

We do "Value Chain Marketing" where we collaborate across the value chain; feed millers, farmers, processors, retailers and consumers. We engage all parties to ensure "this is a collaborative effort" which requires us all to move to a more sustainable solution and healthier solution for the consumer. So, you've got the healthy food and sustainable element. There is growing scientific literature to be published very soon on the importance of EPA and DHA for fish health.

Soon, through upcoming scientific literature, we will read about gene expression of EPA and DHA in fish and the importance of EPA and DHA on fish welfare and fish health. We want to identify what is in it for the feed miller, farmer and retailer and why at the end, should the consumer purchase the product? For the consumer, the message is clearly sustainability and health. Seafood is a major item for a retailer. Farmers have to satisfy their customers' needs which are the retailers and the consumers. Leading farmers have quickly understood the need to reverse the decline of omega-3s in their feeds for fish and shrimp because frequent consumers of seafood are requiring this, and are willing to pay.

The traditional B2B business of both DSM and Evonik is to go to the feed mill. What we are doing is a paradigm shift and the key success factor is collaboration. Getting this right is not always easy, it can be tough. So, we work a lot with the value chain in Europe and the US and have been connecting salmon farmers from Chile with US retailers.

That is basically our collaborative business model. It is identifying the product, building trust, creating value, being traceable, sorting out the logistics and the supply chain so that the consumer knows then that this salmon, shrimp or sea bass was fed on that algal oil. We also work with processors to identify and label the new products.

What are your ambitions for the Asian market?

We want to identify those front runners in sustainability and those who want to enhance the nutritional value of the product, particularly gearing up to the demands of the millennial generation. In a few years from now, close to USD 31 trillion will be inherited by the millennials who will start making decisions not only on purchase but also on investments. We will help provide food that is much more nutritious that before. For example, over the past seven years, omega-3 levels in salmon have more than halved. As we can help to bring back the salmon brand promise, we can also do the same for shrimp by reversing the omega 3 fatty acids content which has also declined.

We are primarily looking at seafood producers first. There was a recent study which showed that only 8% of the global population meets its daily requirement for omega-3. This is the opportunity for food companies to step into that space and to show that they're creating value; that's what we want to help and work with them on. So, we're talking to several companies and retailers, particularly in Japan, and we want to see whether we can repeat the success we have in Europe.

> "But I cannot underestimate the importance of Chinese consumers because they are so digital, so advanced. They do so much research before they purchase a food item and I would say they are very savvy."
> Karim Kurmaly

From our consumer surveys, particularly in Japan, China, and Korea, there is a growing awareness around the importance of EPA and DHA. I think Japanese retailers will possibly lead the way here. But I cannot underestimate the importance of Chinese consumers because they are so digital, so advanced. They do so much research before they purchase a food item.

This is the whole point of being here in Bangkok, slowly understanding and then tailoring our message and value proposition to Asia. There are Thai customers who want to be the leaders in sustainability, in terms of promoting branded seafood as a nutritional food item. Species-wise in Asia, although sea bass, sea bream, grouper, yellowtail, and shrimp are our predominant species, we hope there may be an opportunity for pangasius.

In Asia, what do you think that you must prove to the feed miller and what do you expect to be your constraints?

We have resolved regulatory and efficacy, which we proved in studies for warm water species. We need to move the conversation from cost to value creation and opportunity. If the value chain is successful, it will benefit the feed miller. If we do not help the feed miller and farmer understand and communicate the value, they will be left with the cost and we will fail.

What are the next milestones?

On July 10, we opened our Blair facility in Nebraska, USA. In fact, our first iso-container left in June. The intention is to enter the pet food sector in a big way.

UV Disinfection in Aquaculture

The increasing demand for fish is changing farming methods and UV disinfection can help

By Duncan Ockendon

Atg Evoqua's WF system aboard the MS Martin Saele.

By permission from AKVA Group, Norway.

In Asia, as with the rest of the world, consumer demand for fish continues to rise. This demand puts increasing pressure on traditional farming methods. Pond and open cage systems occupy large areas and utilise huge volumes of water. This raises questions on the long-term sustainability of this approach, particularly as shared water resources mean that effluent discharges from one farm can pose a significant threat of contamination of another.

Chemical disinfection of wastewater prior to discharge prevents cross contamination but does not address the problem of fish health within the farm. One solution is the use of antibiotics and de-lousing agents such as diflubenzuron and teflubenzuron, to treat disease. However, consumers increasingly demand chemical and antibiotic free products. Disinfection by ultraviolet (UV) irradiation is an effective, chemical-free treatment for both water supply and wastewater discharges, safeguarding brood stock, egg production and fry growth. The process, which acts directly on cell DNA to prevent reproduction, is effective against a wide range of microbes including viruses, bacteria and protozoans. Unlike treatment chemicals, it is impossible for resistant strains to develop.

UV can provide highly efficient disinfection of intake, discharge and recirculating water used during fish transportation. UV treated water protects fish and minimises the need for vaccinations. It increases stock yields as well as prevents the discharge of potential pathogens into open waters. Ultra-compact WF UV units (atg Evoqua, UK) are compact enough to fit into the limited space available on well boats and similar marine vessels.

RAS

Although typically complex, more expensive than open systems, recirculating aquaculture systems (RAS) provide a high level of environmental control and can use as little as 5% of the total tank water volume per day to replace losses from evaporation and cleaning. Temperature and salinity control are simpler. In addition, chemotherapeutical dosing is significantly reduced, efficient and fish health significantly improved because of the high level of biosecurity and disinfection of all intake water.

RAS is a popular choice for hatcheries, but such high intensity rearing has its drawbacks. With such a low water exchange, bacteria are retained in the system for long periods. If not controlled, numbers can double every 20 minutes, and build up in biofilms in pipework which are very difficult to remove.

Some bacteria are desirable, helping to purify the circulating water. These are encouraged to grow on the media in biotreatment filters in a variety of controlled environments. Under aerobic conditions, bacteria such as *Zooglea, Achromobacter, Pseudomonas* and *Flavobacterium* oxidise carbonaceous BOD to carbon dioxide, whilst *Nitrosomas* and *Nitrobacter* convert ammonia into nitrate. If nitrate accumulation becomes a problem, denitrifiers like *Thiobacillus denitrificans*, can convert nitrate to nitrogen gas in anaerobic conditions. However, the recirculating water can also harbour pathogens that cause fish disease, and bacteria-like *Actinomycetes* and *Cyanobacter* which produce compounds causing off-flavours like earthy tasting geosmin.

UV radiation can easily achieve a 4 of 5-log reduction in bacteria count and is completely safe. atg UV Technology has extensive experience in the aquaculture sector and has supplied a number of UV disinfection systems including a 360m^3/h intake disinfection system for a smolt hatchery in Helgeland, an 800m^3/h RAS system for Vartdal Fiskeoppdrett and a 4,000m^3/h system for the well boat MS Saele.

Disinfection by UV satisfies a number of important criteria for the aquaculture sector: it is a highly effective biocide that meets consumer pressure for chemical free production. Equipment is robust enough to meet the challenges of the marine environment. Its low energy consumption also contributes to low operating cost and sustainability.

Duncan Ockendon, a BSc (Hons) in Applied Chemistry graduate is the International Sales Manager at atg Evoqua Technology, UK. He has 15 years experience in the industry.
Email: info@atguv.com

Natural free amino acids influence shrimp behaviour and feed attractiveness

Careful and repeated observations help to understand how shrimp behave toward feeds enriched with natural free amino acids.

By Guillaume Le Reste, Pierrick Kersante, Joël Duperray, Luxsanawadee Soonngam and Orapint Jintasataporn

In a previous article (Aqua Culture Asia Pacific March/April 2018) we described the results obtained when a mix of natural free amino acids (MFAA) was added to feeds distributed in tanks and brackish water ponds in Vietnam. A positive impact was seen with shrimp growth, feed conversion ratio (FCR) and feed consumption.

To better understand how Kera-Stim 50®, a product of poultry keratin hydrolysis rich in free amino acids, can influence shrimp feed intake, a collaboration with Kasetsart University was recently launched. The study was designed to answer two critical questions raised in the previous work: how does MFAA influence shrimp feeding behaviour when included in a feed? Secondly, what is the impact of the mode of application on shrimp behaviour?

Treatment diets

A range of three control diets was formulated with decreasing amounts of fish meal (15%, 7.5% and 0%). Feed formulation (Table 1) and processing was done at Kasetsart University.

Each of the three diets was supplemented with 0.5% of MFAA. The product was added into the ingredient mix prior to pelleting (Mix Group) or coated over the pellet (Coa Group). Post pellet coating was carried out using a hand-held sprayer containing 200mL of water plus 50g of MFAA. It was sprayed onto 10kg of feed. All control feeds were treated in the same way, with application of 200mL of water. The experimental plan included nine treatments (Table 2) and each treatment was replicated four times.

Experimental shrimp

A total of 360 juvenile white shrimp, *Litopenaeus vannamei*, initial body weight (IBW) of 2.5g were divided among 36 aquariums of 100L capacity (10 individuals/aquarium). Each aquarium was filled with brackish water (15ppt salinity).

	FM 15%	FM 7.5%	FM 0%
Fish meal 60%	15	7.5	0
Soy concentrate	13	21.5	30
Soybean meal dehull	16	16	16
Wheat flour Thai	30.13	26.83	23.63
Wheat gluten	10	10	10
Poultry meal	5	5	5
Fish oil	2	2.8	3.5
Soy oil	1	1	1
Lecithin	3.5	3.5	3.5
Premix +Phosphate	4.37	5.87	7.37

Table 1. Feed formulation of three control diets with decreasing levels of fish meal

Fish meal content		FM15%	FM7.5%	FM0%
Control diets		F15-Ctrl	F7.5-Ctrl	F0-Ctrl
Kera-Stim 50®	Coated	F15-AA-Coa	F7.5-AA-Coa	F0-AA-Coa
	Mixed	F15-AA-Mix	F7.5-AA-Mix	F0-AA-Mix

Table 2. Experimental plan with the different feeds and product inclusion levels

Shrimp were fed 3 times/day for 8 weeks. Feed was given using a feeding tray. Daily feed amount distributed was equivalent to 4.5% of biomass (1.5% at each meal).

Once every week the behaviour of shrimp from each aquarium was observed by trained technicians during the second meal of the day. To do so, shrimp were gathered to one end of the aquarium behind a net and a feed tray containing appropriate quantities of feed was plunged at the other end of the aquarium. At this time the separation between animals and the feed was removed and the following parameters were recorded:

- Attractiveness: Time (in seconds) between shrimp release and first pellet attack.
- Global attractiveness: Number of shrimp consuming feed after 15 minutes.
- Feeding stimulant: Amount of feed consumed (g) within an hour.

To estimate the amount of feed consumed within an hour, the remaining pellets were collected, dried and weighed. Observations were performed eight times (once every week).

Individual attractiveness

Results show the positive effect of MFAA on feed attractiveness. Whether mixed with other raw materials or sprayed over pellets, MFAA had positive impacts on all behavioural parameters. As can be seen in Figure 1, the necessary time for the first shrimp to reach the pellets placed in the feed tray is shortened. Firstly, it is noteworthy that this duration increases when the fish meal level decreases for the control group, validating attractive effect of this ingredient for *L. vannamei*.

Whatever the fish meal level in the feed formula, MFAA significantly shortened the approach time. Figure 1 also shows the effect of MFAA application mode. When sprayed over the pellet (AA-Coa groups) the approach time (-41.5% on average for the Coa group) was even shorter than when MFAA was mixed with other raw materials (AA-Mix group).

Global attractiveness

The number of shrimp consuming feed after 15 minutes is another interesting observation made during those 8 weeks. Figure 2 details this parameter for the nine treatments. Even if it was less obvious than for the previous parameter, there was a correlation between fish meal content and global attractiveness of the feed. In all cases, and irrespective of fish meal level, MFAA was able to increase the number of shrimp eating 15 minutes after being released in comparison with the respective controls. In this case, influence of the application mode on shrimp behaviour was not so clear as the AA-Coa group performed better for the FM 15% feed and the AA-Mix gave significantly better results in the two other groups.

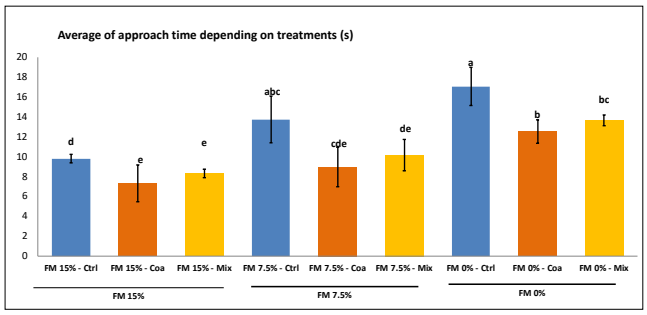


Figure 1. Feed attractiveness depending on fish meal content and treatment

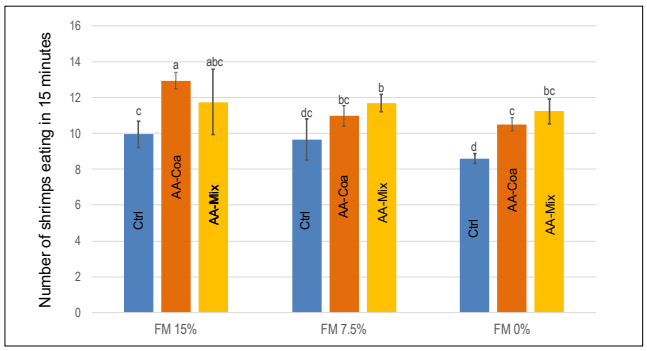


Figure 2. Average cumulative number of shrimp consuming pellets 15 minutes after the separation between feed and shrimp was removed (data are average of observations made in 4 aquariums per treatment for eight weeks).

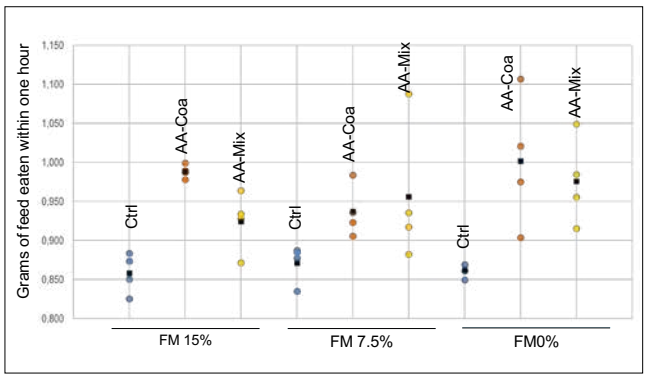


Figure 3. Average quantity of feed consumed within one hour after the separation between feed and shrimp was removed (each dot represents the average consumption for eight weeks in each aquarium; square symbols are average values for the four aquariums).

Feed consumption

Astonishingly, feed consumption after an hour of immersion was not influenced by fish meal levels. This parameter was nevertheless influenced by the use of MFAA either applied on or in the feeds. Figure 3 details the average feed amount consumed in each of the 36 aquariums used for this experiment. The tendency is always the same with an increasing amount of feed eaten by the shrimp fed with AA-Coa feed, followed by the AA-Mix group and the control group.

Discussion

This trial enabled us to understand how MFAA influences shrimp feed intake. Feed attraction parameters clearly underline the product's ability to attract *L. vannamei* shrimp toward feeds. These findings are in line with the available bibliography on amino acid effects and feed palatability (NRC, 2011). Such functionality can reasonably be seen as an efficient way to reduce feed waste as pellets will be eaten in a shorter time.

Another interesting result of this trial is the link made between the addition of MFAA and the amount of feed eaten by the animals. Such an observation underlines another functionality of the product. Taking the behavioural model proposed by Lee & Meyers (1996), MFAA can be considered as a palatant (facilitating the initiation of feeding) and a feeding stimulant (supporting the continuation of feeding).

The third main information provided by this experiment is linked to the influence of the mode of application of MFAA on the feed. Application by coating seems to be more efficient on all behaviour parameters measured during this trial (better individual and global attractiveness and higher feed consumption in all cases). This trend is consistent with the theory that free amino acids act as attractants because of their water solubility and low molecular weight. Soluble compounds and small molecules are better detected by shrimp chemoreceptors. We can then hypothesise that application by coating allows a better MFAA diffusion around pellets than their inclusion in the feed.

Those results have positioned Kera-Stim 50® as an efficient functional ingredient for shrimp feed. Its ability to support feed intake in low fish meal diets is particularly interesting. In the next article, we will demonstrate results on growth and other performance parameters obtained during the same experiment.

References

Lee P.G. and Meyers S.P. Chemoattraction and feeding stimulation in crustaceans. Aquaculture Nutrition. 1996 (2) 157-164.

NRC National Research Council, 2011. Nutrient requirements of fish and shrimp.

Guillaume Le Reste is an independent consultant in aquaculture nutrition based in France. Email: g.lereste@gmail.com

Pierrick Kersante is Application Engineer at Life Sciences, in charge of aquaculture. He is involved in products development, applications and technical support.
Email: pkersante@bcf-lifesciences.com

Joël Duperray is R&D Scientific Support and Applications Manager at BCF Life Sciences. Email: jduperray@bcf-lifesciences.com

Luxsanawadee Soonngam is Business Developer, Aquaculture market Southeast Asia at BCF Life Sciences, working directly with aquafeed mills and farms. Email: lsoonngam@bcf-lifesciences.com

Orapint Jintasataporn is Associate Professor in aquatic animal nutrition and feed technology at the Department of Aquaculture, Faculty of Fisheries at Kasetsart University, Thailand.
Email: ffisora@ku.ac.th

Validating the efficacy of a phytobiotic-based feed additive against white faeces syndrome

Efficacy of preventive strategies was tested in shrimp farms in Malaysia, Indonesia and India.

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

White faeces syndrome (WFS) is considered a major cause of significant crop failures of *Penaeus vannamei* shrimp in Indonesia, Thailand, Vietnam and India. Early disease indications are evidenced by the presence of abundant white faecal strings in feed trays and water surface. The affected shrimp begin to eat less and show loose exoskeleton, distended midgut, pale midgut and hepatopancreas, and dark-coloured gills (Sriurairatana et al. 2014).

Microscopically, the hepatopancreas is characterised by the stripping of microvilli and the midgut appears to be filled with vermiform gregarine-like bodies (Sriurairatana et al. 2014). Production losses due to WFS are generally due to smaller harvest size and decreased survival, with the latter generally reduced by 20-30% but with cumulative mortalities as high as 50% during the summer period (Hou et al. 2018).

Outbreaks are usually associated with increased accumulation of organic matter and plankton blooms in ponds, a result of increasing stocking densities and feeding rates, as well as with increasing pond water temperatures (Mastan 2015; Raveendra et al. 2018). Since shrimp are highly exposed to exchanges of microflora between the pond environment and the digestive system, adverse environmental conditions favouring development of pathogenic organisms in the pond and destabilising the digestive bacterial community can potentially lead to WFS outbreaks (Hou et al. 2018).

Role of pathogenic *Vibrio* spp.

Pathogenic *Vibrio* bacteria along with the microsporidian *Enterocytozoon hepatopenaei* (EHP) have been reported to be associated with WFS. Five species of bacteria namely *Vibrio parahaemolyticus*, *V. fluvialis*, *V. mimicus*, *V. alginolyticus* and *Vibrio* sp. were isolated from the faeces of WFS affected shrimp (Mastan 2015). Among these species *V. parahaemolyticus* and *V. alginolyticus* were dominant in all diseased shrimp samples. *Vibrio parahaemolyticus* is also associated with early mortality syndrome/acute hepatopancreatic necrosis disease (EMS/AHPND). Progression of EMS/AHPND is regulated via bacterial cell-to-cell communication, the so-called quorum sensing, and driven by the production of a toxin that causes the sloughing of the hepatopancreas microvilli (Wang et al. 2011; Lee et al. 2015).

Given the coincidental prevalence of WFS and EMS/AHPND, it has been suggested that the toxin produced by *V. parahaemolyticus* can contribute to the development of WFS (Sriurairatana et al. 2014). EHP spores were also identified in white faeces, with the prevalence of EHP in WFS infected ponds ranging from 16 to 96% (Rajendran et al. 2016; Tang et el. 2016; Ravendraa et al. 2018). EHP does not appear to cause mortality or to be the only agent causing WFS; however, EHP spores ingested via water or faeces will infect the hepatopancreatic microvilli, and will contribute to growth retardation in shrimp and increases the severity of the problem (Ravendraa et al. 2018).

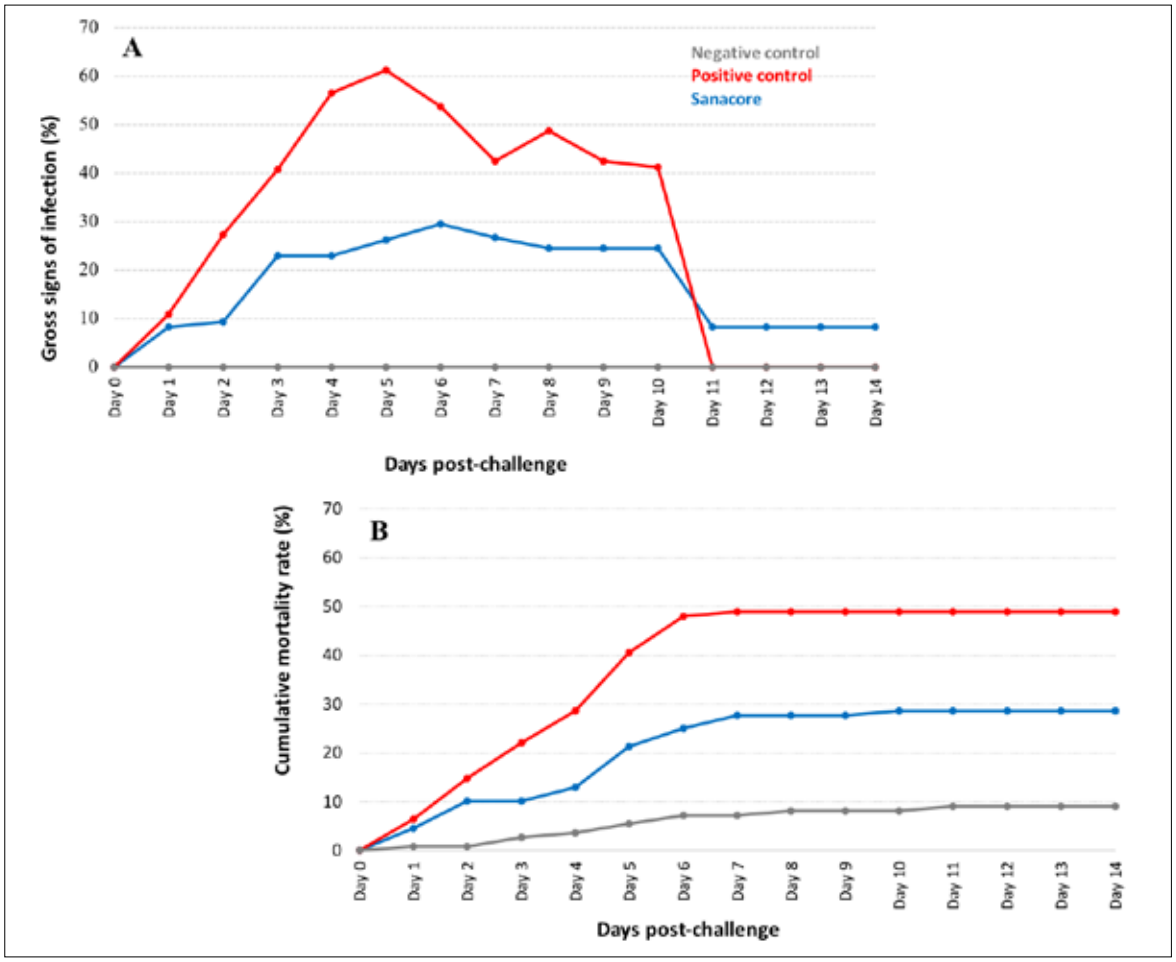


Figure 1. Sanacore supplementation on infection prevalence (A) and cumulative mortality (B) during 14 days post-challenge (n=4). Infection challenge was performed by feeding feed coated with the inoculums of Vibrio sp. (WFD5) to Peneus vannamei. A) At 5-6 days post-challenge, prevalence was reduced by 50-55% by the functional additive. B) At 14 days post-challenge, cumulative mortality was significantly reduced by 41% in relation to positive control. Statistical analysis by one-way ANOVA followed by Duncan test.

Control approaches

A first approach to control WFS is focused on preventive pond management measures such as application of chemical treatments before stocking to kill EHP spores (Sritunyalucksana et al. 2015; Thitamadee et al. 2016; Aldama-Cano et al. 2018), use of filtered water, efficient disposal of organic waste (e.g. shrimp toilets), maintenance of oxygen saturation and alkalinity within optimal levels, water application of probiotics to reduce *Vibrio* spp. populations, reduction of feeding immediately after outbreak detection, and removal of white faecal matter from ponds to avoid re-infection (Tang et al. 2016).

A second approach is to reinforce the prevention strategy via functional nutrition aimed at reducing pathogenic organisms in the digestive tract of shrimp. Indeed, recent evidence suggests a close association between decreased diversity and increased heterogeneity of the digestive bacterial community and WFS (Hou et al. 2018). SANACORE® is a functional feed additive based on a synergetic blend of phytobiotic extracts with a broad antimicrobial spectrum and with capacity to interrupt the quorum sensing communication system of pathogenic bacteria (Coutteau and Goossens, 2014). It can be incorporated into feed during feed manufacturing or via top-coating at the farm; both ways are aimed to deliver an adequate supply of natural antimicrobial activities that has been proven to promote a more diverse and robust microbial community in the digestive tract and therefore to reinforce prevention mechanisms (Robles et al. 2017).

The present article demonstrates the efficacy of this health promoting feed additive under infection challenge conducted under both controlled experimental and field conditions. Results support its use preventive and combined preventive / corrective strategies against WFS.

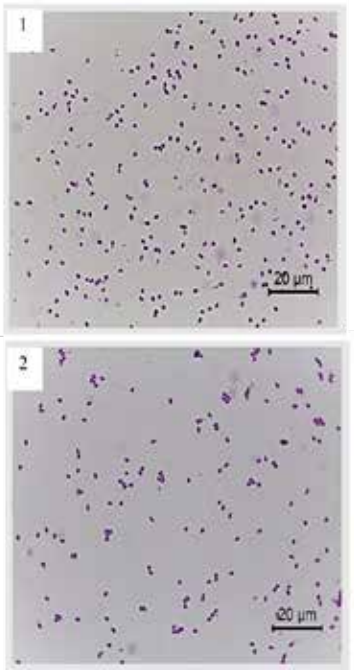
Efficacy of preventive strategies

In recent years, *in vivo* and *in vitro* infection models have been developed to evaluate potential preventive strategies against WFS. ShrimpVet Lab (Vietnam) has developed and standardised an *in vivo* infection model that simulates the natural route of infection of WFS-associated *Vibrio* spp. The model consisted of shrimp *P. vannamei*) 3kg/tonne of feed with control feed and feed supplemented with Sanacore at 3kg/tonne of feed over a duration of 14 days before an infection challenge. During challenge, control feed (positive control) and treated feed (Sanacore) were coated with an inoculum of WFD5 (i.e. a strain of *Vibrio* sp.) and fed for 2 days; a non-infected control group (negative control) was also created.

Infection was confirmed when disruption of moulting and increased mortality at 24 hours post-challenge were observed, and gross signs of infection (e.g. white to yellow faecal strands, distended midgut and pale midgut and hepatopancreas) and mortality were monitored for 14 days. The highest prevalence was detected at 5- and 6-days post-challenge, during which the functional feed additive led to 50-55% reduction relative to the positive control group (Figure 1). Over the 14 days post-challenge, the prevalence and cumulative mortality were reduced by 40% and 41%, respectively (Figure 1).

These results are in line with similar improvements in survival after *in vivo* infection with the EMS/AHPND strain of *V. parahaemolyticus* (Tran et al. 2015). In both cases, the positive effects of this feed additive with a *Vibrio* challenge can be attributed to the combination of the direct bactericide/bacteriostatic properties and quorum sensing inhibition. The minimum inhibitory concentration against *Vibrio* harveyi and *V. parahaemolyticus* has been reported to be between 0.1-0.3%, suggesting in vivo inhibitory activity

A



B

Batch of spores	spores/µl	Germination rate (%)
1	1.05×10^6	61.0 ± 7.6
2	3.25×10^6	80 ± 5.0

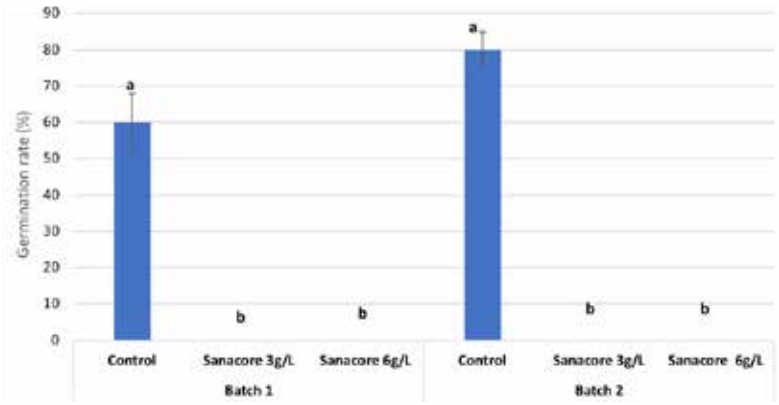


Figure 2. A) Representative views of germinated and non-germinated EHP spores: 1) Germination of the polar tubes from the spores purified from WFS-infected shrimp. 2) Spores that did not germinate. Phloxin B was used as a method to trigger germination as well as to stain the spores and assess germination rates. B) Number of spores in each batch and average percentage of spore germination after 120 min of incubation with Sanacore at two concentrations. Statistical analysis by one-way ANOVA followed by LDS PostHoc. Error bars represent standard deviation.

of the functional additive at low concentrations in the digestive tract. At similar concentrations, interruption of the quorum sensing regulation of *V. parahaemolyticus* has been confirmed in vitro through the depressive effect of the functional additive, on the signaling pathways determining bacterial density and toxin production (unpublished data).

> "Although the in vitro model may not accurately reflect EHP pathogenesis in the gastrointestinal (GI) tract of shrimp, this result certainly suggests a potential reduction of the viability of EHP spores in the GI tract and therefore of the severity of WFS."

Activity of potential inhibitors

Centex Shrimp (Madihol University, Thailand) offers an *in vitro* bioassay to evaluate the activity of potential inhibitors of EHP (Aldama-Cano et al. 2018). Briefly, spores from hepatopancreas from two batches of infected shrimp (*P. vannamei*) were purified and incubated for 120 min with Sanacore at two different concentrations, 3 and 6g/L, equivalent to the dietary inclusion of the additive at 3 and 6kg/tonne of feed. Germination or spore viability was triggered by Phloxin B and assessed under light microscope by the discharge of the polar tube from the interior of the microsporidian (Figure 2A). This discharge seems to be the mechanism to invade host cells and complete the life cycle.

Results showed that while germination rate of EHP spores averaged 70% in the control groups for each batch, the feed additive at both concentrations completely inhibited germination (Figure 2B). Although the in vitro model may not accurately reflect EHP pathogenesis in the gastrointestinal (GI) tract of shrimp, this result certainly suggests a potential reduction of the viability of EHP spores in the GI tract and therefore of the severity of WFS. It must be emphasised that the effect of the phytobiotics on preventing germination and reducing spore infection rates of microsporidian parasites with similar polar extrusion mechanism to EHP has been demonstrated and thus some of these botanicals have been proposed for disease control (Maistrello et al. 2008).

Efficacy at farm level

Further to this, the efficacy of Sanacore against WFS under controlled laboratory conditions has been further validated under field conditions, with focus on its preventive, as well as its combined preventive and corrective applications.

The first trial was conducted in a shrimp farm in Penang, Malaysia where the objective was to evaluate the preventive effects of the functional additive. This farm was historically affected by WFS, EMS and white spot syndrome virus (WSSV). Two ponds were used as control and six ponds were fed feed supplemented with a preventive top-coated dose (1-3kg/tonne of feed) from 1 day of culture (DOC 1) to harvest. All ponds had the same density of 110 post larvae(PL)/m^2. Emergency harvest was required in control ponds at DOC 42 due to the high mortality and growth retardation. In treatment ponds, gross signs of infection were detected at DOC 60, but the outbreak was categorised as mild and production was continued until DOC 129. Overall, application of this feed additive as preventive strategy reduced mortality from 62% to 34% and recovered growth to acceptable levels after 14 days post-outbreak.

A second trial was conducted in a farm located in Subang-Karawang, Indonesia, an area previously affected by WFS and WSSV. This trial evaluated the preventive and corrective effects of Sanacore against WFS under two different supplementation strategies. Each strategy was applied to three ponds, each with a density of 100 PL/m^2 .

In the first strategy, the control feed was supplemented with a corrective top-coated dose (5kg/tonne of feed) and shrimp were fed only during the first 7 days following the detection of an

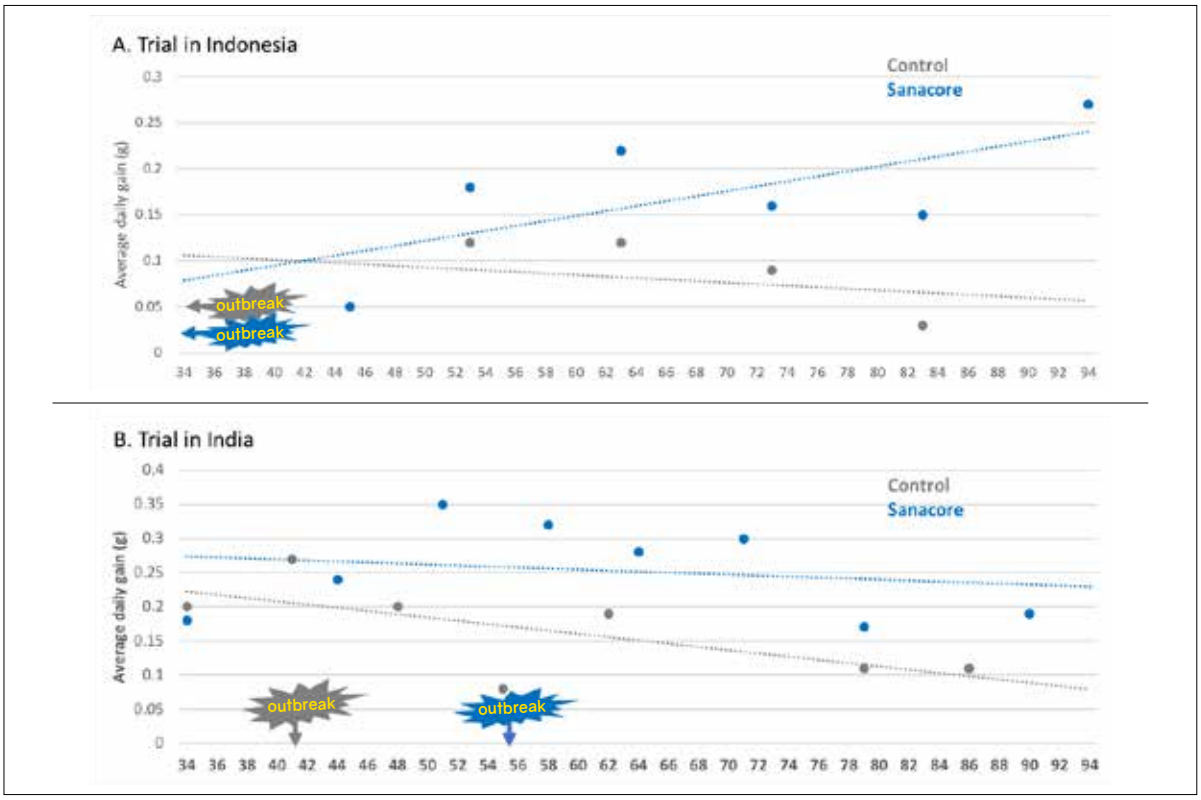


Figure 3. Average daily gain of shrimp in field trials conducted in Indonesia (n=3) (A) and India (n=1) (B), evaluating the effect of supplementing Sanacore. In both trials, the preventive dose of 3-4kg/tonne of feed was boosted with a curative dose (top-coated) of 4-5kg/tonne of feed during approximately 7 days. In Indonesia (A), outbreaks occurred at DOC 23-26. In India (B), outbreaks occurred at DOC 41 and 51 in control and treatment ponds, respectively. The curative dose in the treatment group was applied immediately after outbreak detection in both trials. Trendlines show that daily gain was recovered to acceptable levels or maintained under feed additive supplementation.

outbreak. In the second strategy, the feed was formulated with a preventive dose (3kg/tonne of feed) and shrimp were fed from DOC 20 until harvest. The same treated feed was reinforced with an additional corrective top-coated dose (5kg/tonne of feed) and fed to shrimp exclusively during the first 7 days following outbreak detection (i.e. overall 8kg/tonne of feed).

All ponds received 7 days of the corrective dose after detection of an outbreak at DOC 23-26. Although the corrective strategy eliminated gross signs of infection in all ponds, only the combined preventive/corrective strategy recovered the average daily growth (ADG) to acceptable levels 20 days after the elimination of gross signs of disease (Figure 3A). While the corrective strategy allowed a full harvest at DOC 85, the combined strategy completed harvest at DOC 100 and achieved 25% higher average body weight and over three times more biomass.

A third evaluation was conducted in a farm in Odisha, near Balasore, a region with frequent outbreaks of WFS, WSSV, as well as other diseases (Laxpmappa 2017). In line with the trial in Indonesia, this trial aimed to validate the combined preventive/curative supplementation strategy of a WFS outbreak. Two ponds were stocked with post larvae (PL 10-11) at a density of 65 PL/m^2 at the beginning of September. This time of the year is typically more challenging in this region due to variable climate conditions with high variations in temperature and consequently in salinity.

During the trial, outbreaks occurred at DOC 41 and DOC 51 in control and treatment ponds, respectively. For the treatment pond, Sanacore was top-coated with a preventive dose (4kg/tonne of feed) in three out of four meals before an outbreak (DOC 1-51). After an outbreak and until gross signs of infection disappeared (DOC 52-58), shrimp were fed feeds reinforced with a top-coated corrective dose (4kg/tonne of feed) for two out of four meals and alternated with probiotic supplementation. Then the dose went back to the preventive (5kg/tonne of feed) in three out of four meals until harvest (DOC 59-90).

Besides a delay of about 10 days in the treatment pond, growth depression was observed in the control pond but not in the treatment pond (Figure 3B). The functional feed additive improved survival by 31%, final weight by 35%, and final biomass by 49%. Feed conversion ratio was also improved by 34% and overall production cost by 18%.

Conclusion

WFS is a concurrent problem requiring urgent control. The health prevention strategy must aim to reduce the growth of pathogens in the pond environment while promoting the health status of the shrimp stock. Pond management measures must go hand in hand with nutritional strategies aimed at stabilising the digestive bacterial community. Sanacore delivers in every meal a concentration of phytobiotics proven to inhibit *Vibrio* spp. and EHP isolated from WFS infected shrimp.

This inhibition is consistent with the results obtained under different field conditions and can be attributed to the combination of bactericide/bacteriostatic properties, quorum sensing inhibition and antiparasitic properties. Field data indicate that the application of the corrective dose once the outbreak is detected helps to mitigate gross signs of infection. Field data also show that the combined preventive and corrective strategy can maintain or bring up growth rates and survival to pre-WFS levels.

Waldo G. Nuez Ortín, DVM, PhD, is Lead Scientist Aquaculture at Adisseo/Nutriad. Email: waldo.nuezortin@adisseo.com

Maria Mercè Isern Subich, DVM, Product Manager Aquaculture Health at Adisseo/Nutriad. Email. mariamerce.isern@adisseo.com

Join us at TARS@ 2019 - Asia's Premier Aquaculture Event of the Year!

A UNIQUE PLATFORM FOR INFORMATION EXCHANGE & NETWORKING OPPORTUNITIES

THE AQUACULTURE ROUNDTABLESERIES® 2019

A shared vision for aquaculture in Asia

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

AQUAFEEDS: FIT FOR FUTURE

DIALOGUE
Hard Talk with C-Suite Executives

PARTICIPATE
Interactive Breakout Roundtable Sessions

NETWORK
Connect with Key Aquaculture Players

Limited to 200 Participants.

Register now @ http://tarsaquaculture.com/registration/

AQUAFEEDS: FIT FOR FUTURE

TARS® 2019 **brings together key stakeholders, industry leaders, shrimp and fish nutrition experts to address:**

- State of aquafeed industry in Indonesia, India, Thailand and Vietnam
- Species-specific nutrition along the life cycle
- Replacement of fish meal and fish oil
- Feed management and technologies for disease prevention and health
- Growing the aquafeed business
- R&D to be fit for future

5 PLENARY SESSIONS, 16 PRESENTATIONS

- State of Industry & Challenges
- Nutrient Requirements-based Diets
- New Protein Meals/Oils for Fishmeal/Oil Replacement
- Disease & Health Management
- Technology & Sustainability: Fit for Future

INTERACTIVE BREAKOUT ROUNDTABLE SESSIONS & PANEL DISCUSSIONS

SHRIMP FEEDS

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

FRESHWATER FISH FEEDS

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

MARINE FISH FEEDS

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

Supported by:

Organised by:

AQUA CULTURE Asia Pacific

corporate media The Total Communications Company

For more information, email:
conference@tarsaquaculture.com
or visit www.tarsaquaculture.com
Follow us on

Sponsors:

INVE AQUACULTURE CARE FOR GROWTH A Benchmark Company

DSM BRIGHT SCIENCE. BRIGHTER LIVING.

Corbion

Biomin

BASF We create chemistry

nutriad becomes ADISSEO

BioMar

CALYSTA

Jefo Species-specific additives

veramaris

Phibro ANIMAL HEALTH CORPORATION

SKRETTING a Nutreco company

www.tarsaquaculture.com

Aquaculture versus agriculture & meat production – A paradox

From myth to reality: Sustainable growth of aquaculture requires focused standardised research studies

By Kabir Chowdhury

A recently published paper in the journal Marine Policy, Edwards et al. (2019) discussed the myths, misunderstandings and mantras hindering the growth of aquaculture. They pointed out that after accounting for edible yield, the quantity of aquatic animal-source food available for human consumption was 46 million tonnes, equivalent to only 66% of reported production excluding seaweed.

Edwards et al. (2019) commented that the misreporting of production data can be partially attributed to "Specialized Deafness", competition for resources with other disciplines leading to "Science Spin", and ignorance of the broader food systems.

Being a relatively new field, aquaculture has a large scope for research and development, including identifying species for breeding development, improving feed efficiencies, biosecurity and integration. However, any wrong pretention leads to false assumption, resulting in over-simplified or over-exaggerated data generation and misleading conclusions.

Proper experimental design, accurate collection of data and appropriate statistical analysis are therefore the interconnection of these three distinct elements needed for a successful study. Absence of any one of them increases the chances of faulty conclusion/s.

In this article, I will discuss some basic misunderstandings of the science, wrong perception of the industry as well as misrepresentation of the available data and information to pinpoint the issues that must be rectified for the sustainability of the industry.

Nutrient requirement studies

Designing an experiment is the first critical point where significant errors can happen. A flawed experimental design significantly increases the chances of erroneous conclusions. Nutrient requirement studies often resort to dose-response studies looking at the growth performance, nutrient deposition or genomic expressions.

Several mathematical or statistical models are used to determine nutrient requirement of a species from a dose-response study. Shearer (2000) reviewed several published studies and found serious flaws in the process.

The most commonly used statistical analyses in nutrient requirement studies are broken line analysis, polynomial regression models and the analysis of variance (ANOVA). It is well recognised that broken-line analysis tends to underestimate the requirement.

Shearer (2000) suggested three models to be most suitable for requirement studies after reviewing 32 papers from leading aquaculture journals. These are: five parameter saturation kinetics model (5-SKM), four parameter SKM (4-KM) and quadratic model (2nd order polynomial) (Figure 1).

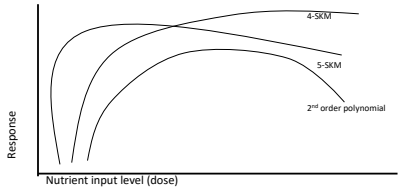


Figure 1. Dose-response curves evaluated by Shearer (2000) using same data (from Shearer 2000)

Nutrient digestibility and bioavailability

Digestion, absorption and deposition are the main metabolic processes, in which, nutrients are released from an ingredient or feed by acidic or enzymatic hydrolysis, absorbed through intestinal epithelium and deposited to form new cells or utilised as energy substrate.

Evaluating the quality of dietary ingredients is an important process in understanding the nutrient availability from a target ingredient. Although economically barring, in vivo digestibility and bioavailability studies are considered to be the most effective to evaluate a new raw material.

Nutrient digestibility

In nutrient digestibility studies, several factors play major roles in determining the accuracy of the findings. Among them, the most important are the faecal collection methods, the equations used to calculate apparent digestibility, the types of indigestible marker used, the ratio between the reference diet and the test ingredient, and finally, the composition of the reference diet.

For example, indirect collection of faeces usually produces values higher than the normal digestibility values because of higher possibility of leaching of the nutrients. On the other hand, direct collection i.e., stripping off digesta from the hindgut may produce lower values than the actual values.

Several indigestible markers have been used in digestibility studies. Among them, most common are chromium oxide (Cr_2O_3), followed by yttrium oxide (Y_2O_3) and titanium oxide (TiO_2). The rate of movement of different markers in the gastro-intestinal tract is different compared to the digesta and can produce strikingly different findings.

In a recent study, digestibility of distiller's dried grains with solubles (DDGS) and cottonseed meal was compared with and without a nutritional supplement, where everything was similar between the two treatments except the ratio of reference and test diets. Changing the ratio from 70:30 to 80:20 produced inconsistent and notable differences in the outcomes (Figure 2).

Bioavailability assay

Bioavailability assays generate more reliable information as they reflect utilisation of nutrients by the animal compared to digestibility assays, which is essentially a measure of nutrient disappearance.

The bioavailability of nutrients in an ingredient available to an animal can be assessed in several ways. These are: nutrient retention or deposition, nutrient retention efficiency, or in the case of amino acid (AA), AA oxidation.

Traditionally, bioavailability is assessed using slope-ratio assay. In these assays, graded nutrient intake levels are created by varying the dietary inclusion level of a particular feed ingredient. The response of fish or shrimp fed the test ingredient related to the intake of the target nutrient is characterised by the slope of the regression, which is then compared to the slope of a reference ingredient. As the values obtained are relative and not absolute values, they are usually referred to as relative bioavailability.

The design of the assay can significantly affect the outcomes and can skew the findings. For example, for a valid linear regression, we need a minimum of three data points and for a polynomial, a minimum of four.

However, to obtain a perfectly linear response, the highest dose or the datapoint should not exceed 80% of the requirement.

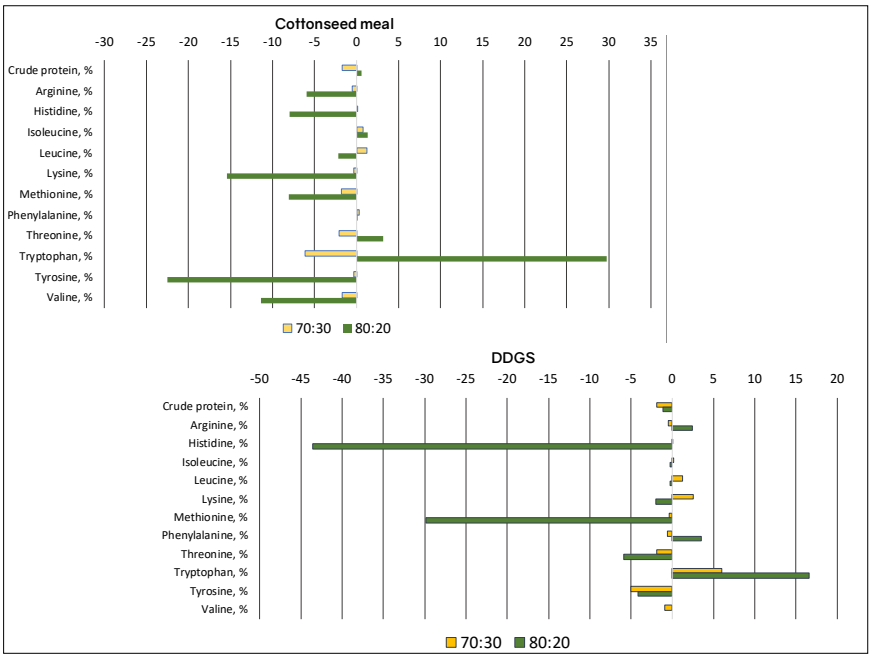


Figure 2. Differences in apparent digestibility coefficients of crude protein and essential amino acids in cottonseed meal and DDGS at two different ratios of reference and test diets

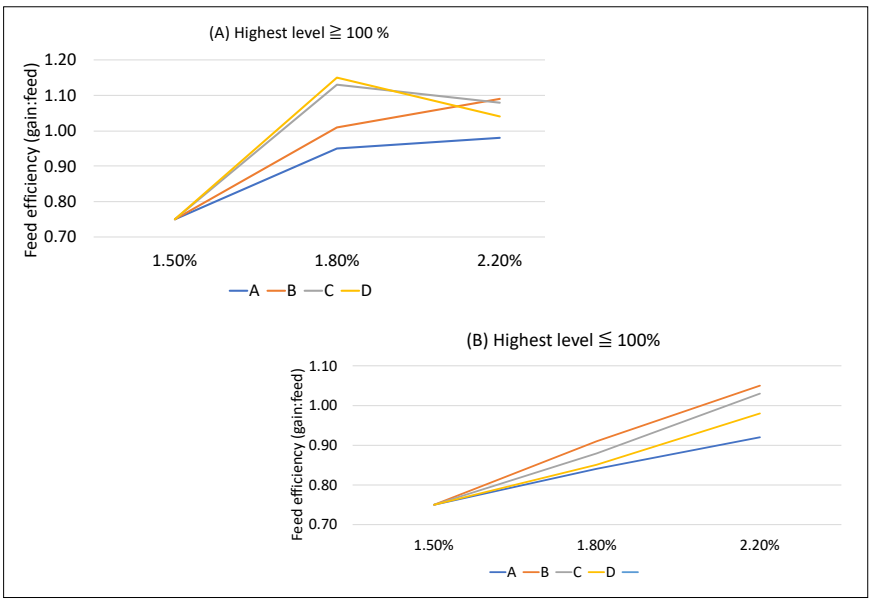


Figure 3. (A)The response is not linear, when the highest data point is over 80% of the requirement; (B)The response is linear at <80% of the requirement.

Figure 3 describes the difficulties to obtain a linear response, when the 3rd data point exceeded the 80% threshold.

Other factors such as the choice of indicator variables may also provide erroneous results. Ideally, indicator variables should be the deposition or retention efficiency of the target nutrients in whole body or in a specific organ.

Summary

This article provided a brief overview of the issues relevant to two major aspects of animal nutrition research: nutritional requirement and ingredient quality assessment. For a sustainable aquaculture growth, we should rely on reliable information and honest interpretation of the information. Well thought-out and properly designed focused research studies should be able to generate reliable information.

Key points to consider are:

- Well thought-out experimental design;
- Appropriate statistical models;
- Consistent faecal collection methods;
- Choice of indigestible marker;
- Proper dose level for a slope-ratio assay relevant to the expected analysis;
- Choice of indicator variables.

M A Kabir Chowdhury, PhD is Global Technical Manager – Aquaculture, Jefo Nutrition Inc., Canada. Email: kchowdhury@jefo.ca

Insect protein takes flight in Asia

With little volatility in price and proven to substitute well for fish meal in marine fish and shrimp, insect meal production is poised to rise as a major aquafeed ingredient

By Martin Zorrilla

The fast growth of the Black Soldier Fly and its ability to eat a broad range of organic waste make the flies ideal for mass production as a novel protein source.

The idea of animals eating insects is not very revolutionary. After all, insects are a natural food source for an enormous number of animal species in the wild. The revolutionary part is integrating insect-based products into our global food supply chain and scaling them up into the right markets. Significant advances have already been made; just this year the International Platform of Insects for Food and Feed (IPIFF) announced that its members had produced 6,000 tonnes of insect protein in 2018. As the industry grows, the Asia Pacific region is well positioned to become a major producer, as well as consumer, of insect protein.

Potential of insect protein in Asia

While most commercial insect protein companies are based in Europe, a growing cohort have chosen to open or move to Asian countries. The Bangkok-based Asian Food and Feed Insect Association (AFFIA) has 12 members producing insects for animal feed, although most are not yet producing in commercial quantities. As the fledgling industry scales up, it may present the region with a way to lower import-dependence as well as production costs.

Over the past decade dependence on imported feed ingredients has grown, reaching up to 75-80% in countries like Vietnam and Malaysia. In 2017, Chinese demand for protein ingredients grew by 7% while its soybean meal production fell by 1.5%. Meanwhile, government-led efforts to incentivise soy and corn production in countries like Indonesia have not succeeded in creating a meaningful domestic supply. Most Asian countries lack the large tracts of farmland required for soybean production, and the region's already depleted fisheries means that fish meal production can only decrease.

> **"..low operating costs in the region will help the nascent sector to grow quickly, which it will need to do to disrupt an industry that produced 1.07 billion tonnes of feed in 2018."**

Insect protein production, on the other hand, is ideally suited for the region. It requires little space, thrives in tropical environments and is not limited by raw materials. Insect farming is carried out in highly controlled systems within factories where one square metre can produce more protein than one hectare of soybean

Range of products from the larvae of the Black Soldier Fly fed on a 100% vegetable diet at Nutrition Technologies in Johor, Malaysia; from meal with 55% crude protein and amino acids profile which includes 3% lysine and 1.95% threonine. The mechanically fat extracted has antimicrobial properties (44.55% lauric acid-C12 and 6.5 % omega-6s).

production. The vertical farming systems are growing increasingly efficient and rely on waste as an input, a readily available raw material that is not subject to extreme price fluctuations. The availability of manufacturing resources and low operating costs in the region will help the nascent sector to grow quickly, which it will need to do to disrupt an industry that produced 1.07 billion tonnes of feed in 2018.

Production methods and safety

Most insect companies are commercialising products from one insect: Black Soldier Fly (*Hermetia illucens*) or BSF. These large innocuous flies do not need to feed as adults, which leads them to accumulate and store proteins and fat in the larval stage. This combined with their fast growth rate and ability to eat a broad range of organic waste make them ideal for mass production as a novel protein source.

Insect farming is carried out in highly controlled systems within factories where one square metre can produce more protein than one hectare of soybean production.

At its factory in Johor, Malaysia, Nutrition Technologies produces a >50% protein meal (Hi. Protein®) from black soldier fly larvae (BSFL). These larvae are reared on factory-grade food waste in a vertical farming system that ensures traceability and product safety. The larvae undergo only 7 days of high-growth rearing after which they are processed into protein meal and oil. The insect manure, also known as, 'frass' is harvested for use as a premium organic compost. Products are sold in Malaysia as well as exported to Korea, Japan and Europe.

Most insect producers, including Nutrition Technologies, follow the regulations created by the European Union (EU 2016/429) which stipulate that insects should only be fed on plant-based substrates or a selection of approved feed ingredients. Risk assessments conducted by the European Commission as well as academic studies have generally found that BSF meals have a low risk profile. Mycotoxins and pesticides do not seem to bioaccumulate in BSF and pathogenic bacteria are reduced or eliminated during feeding. However certain heavy metals have been found to bioaccumulate in insects and processing steps are needed to ensure the microbiological safety of insect products.

Insect production has grown enough that standards are now being modified to apply to their production. Most notably, the GMP organisation now certifies insect production facilities and published an updated Risk Assessment of Insect Protein meals in 2018. On its website, the organisation states: "GMP International supports the use of insects and insect products in feed, provided that the safety is assured."

Sustainability

The environmental sustainability of insect production has been a driving force in the sector's emergence. This is in part because the product could drastically improve aquaculture's environmental image around the world. Multiple studies have shown that BSFL meal outperforms conventional protein feeds on environmental variables like lower CO_2 emissions (1.24 kg CO_2 eq), ecotoxicity and land use. In a 2016 'Life Cycle Assessment' of BSFL proteins, Smetana et al. (2016) concluded that "The production of insect-based protein powder... based on food by-products, is 2-5 times more environmentally beneficial than that of traditional products."

The environmental benefits of insect meal have been used to market specialty animal products in the European Union. In 2018 Feednavigator reported that the insect producer InnovaFeed launched a brand of 'insect-fed fish' in Auchan supermarkets in France. The project collaborators, which include the feed company Skretting, desire to restrict the label 'insect-fed fish' to mean: fish that have at least doubled their weight while on a diet with a minimum of 50% fish meal replaced by insect meal.

These marketing campaigns do seem to speak to, a subset at least, of consumers. Multiple surveys have recorded European willingness to preferentially select food like chicken and fish fed on insects. While consumer attitudes towards sustainability in Asia are not yet on par with those in Europe, much of the farmed aquaculture species are exported to the EU and US, and there is potential for western buyers to positively influence the upstream purchasing of their suppliers. The approach sets a positive example for the feed industry as to how openness about ingredients can be rewarded by an increasingly environmentally aware customer base.

Nutrition and functional benefits

Insect protein meals owe their status as a fish meal replacement to a profile of essential and non-essential amino acids that is very similar to that of fish meal. A typical BSFL meal can contain 3.77% lysine, 0.90% methionine, 0.40% cysteine, and 2.26% threonine on an as sampled basis. In one recent study with Atlantic salmon (*Salmo salar*), Belghit et al. (2018) found that the apparent digestibility coefficient (ADC) of amino acids in BSFL meal to be comparable to that of fish meal and noted in particular the high apparent bioavailability of arginine (ADC of 91%).

Belghit et al. from the Institute of Marine Research in Norway used BSFL meal to replace fish meal in the diets of Atlantic salmon during its seawater phase. They found that the insect meal was able to replace 100% of the fish meal in salmon diets without negative effects. Similar results were reported for the European seabass (*Dicentrarchus labrax*) by Magalhães et al. (2017) where there was no significant impact of up to 45% fish meal replacement.

Large studies on species of high interest to producers in Asia have been less abundant, but nonetheless promising. Cummins et al. (2017) found encouraging results when using BSFL meal as a fish meal replacement in the diets of whiteleg shrimp (*Litopenaeus vannamei*) up to 25%. A 2017 industry-sponsored study at Kasetsart University in Thailand found that insect meal in whiteleg shrimp diets increased weight gain, lowered feed conversion ratios and increased survival when challenged with early mortality syndrome (EMS). The study used mealworm protein to replace fish meal in 5 isonitrogenous diets with varying inclusion rates. When challenged with Vibrio, the treatment with a 50% fish meal replacement had a 90% survival rate compared to 56.7% in the control diet.

The shrimp trial is not alone in showing that insect meals have a positive impact on fish and crustacean health. A study by Terova et al. (2019) from the University of Insubria, Italy found that BSFL meal increased the diversity and richness of gut microbiota in rainbow trout (*Oncorhynchus mykiss*). The authors suggested

that the effects were due to the presence of chitin (a polymer found in insect cuticles) in the insect meal. The study used BSFL meal at 10%, 20% and 30% inclusion rates with no effect on growth performance compared to a control diet with fish meal. Crude protein digestibility was high and ADC above 90% for all treatments.

Pricing

Despite recent increases in the availability of insect protein, it remains difficult for potential consumers to gauge the price point of the products. Prices quoted tend to vary depending on the geography of the company, with higher prices tending to center in Europe, and the targeted market of the producing countries. However, some BSFL producers, including Nutrition Technologies, have already been able to price their products competitively against, or lower than fish meal of an equivalent grade.

In addition to a lower price point, insect meal should exhibit less year-on-year price volatility than products like fish meal. The price stability of insect meal is due to their production in controlled environments which are isolated from weather changes. Waste inputs are readily available and easily interchanged if there are any increases in price. It is our hope that this stability will ultimately lead to less volatile compound feed prices, allowing farmers to plan with greater financial certainty.

With more and more insect producers coming on-line and establishing larger facilities as well as regulations and industry acceptance moving in the right direction, there is a bright future for insect production in the region.

References

Belghit, I, Liland N.S., Gjesdal, P., Biancarosa, I., Menchetti, E., Li, Y., Waagbø R., Krogdahl, A., Lock, E-J, 2018. Black soldier fly larvae meal can replace fish meal in diets of sea-water phase Atlantic salmon (Salmo salar). Aquaculture. 10.1016/j.aquaculture.2018.12.032.

Cummins, V., Rawles, S.D., Thompson, K.R., Velasquez, A., Kobayashi, Y., Hager, J., Webster, C.D., 2017. Evaluation of black soldier fly (Hermetia illucens) larvae meal as partial or total replacement of marine fish meal in practical diets for Pacific white shrimp (Litopenaeus vannamei). Aquaculture. 473. 337-344. 10.1016/j.aquaculture.2017.02.022.

Froehlich, H.E, Sand Jacobsen, N., Essington, T.E., Clavelle, T., Halpern, B.S., 2018. Avoiding the ecological limits of forage fish for fed aquaculture. Nature Sustainability. 1. 10.1038/s41893-018-0077-1.

Koeleman, E., 2017. Insect meal for shrimp: New insights. [online] AllAboutFeed. Available at: https://www.allaboutfeed.net/New-Proteins/Articles/2017/2/Insect-meal-for-shrimp-New-insights-92852E/ [Accessed 30 May 2019].

Magalhães, R., Sánchez-López, A., Silva Leal, R., Martínez-Llorens, S., Oliva-Teles, A., Peres, H., 2017. Black soldier fly (Hermetia illucens) pre-pupae meal as a fish meal replacement in diets for European seabass (Dicentrarchus labrax). Aquaculture. 476. 10.1016/j.aquaculture.2017.04.021.

Mertenat, A., Diener, S., Zurbrügg, C., (2019). Black Soldier Fly biowaste treatment – Assessment of global warming potential. Waste Management, 84, 173-181. doi: 10.1016/j.wasman.2018.11.040

Smetana, S., Palanisamy, M., Mathys, A. Heinz, V., 2016. Sustainability of insect use for feed and food: Life Cycle Assessment perspective. Journal of Cleaner Production. 137. 10.1016/j.jclepro.2016.07.148.

Terova, G., Rimoldi, S., Ascione, C., Gini., E., Ceccotti, C., Gasco, L., 2019. Rainbow trout (Oncorhynchus mykiss) gut microbiota is modulated by insect meal from Hermetia illucens prepupae in the diet. Reviews in Fish Biology and Fisheries. 10.1007/s11160-019-09558-y.

Martin Zorrilla is Chief Technology Officer at Nutrition Technologies since 2017. His role is to oversee the R&D program as the company scales up its pilot factory in Malaysia. Martin leads an interdisciplinary team of scientists that is advancing the field of large-scale insect production. Martin studied agriculture and life science with a focus on entomology at Cornell University, USA. Email: martin@nutrition-technologies.com

Effects of fish meal replacement in the culture of Florida pompano

Growth and physiological conditions of fish fed diets with fish meal replaced with ESBM appeared acceptable but condition of pompano liver was affected with increasing incidence of granulation and inflammation

By Romi Novriadi and D. Allen Davis

Fish meal (FM) is often considered the preferred protein source for aquafeeds because of its high level of essential amino acids and other essential nutrients. To substantially decrease dietary level of fish meal in aquafeeds, plant-protein sources appear to be the most sustainable ingredient. However, deficiency in some amino acids and the presence of anti-nutrients, such as proteinase inhibitors, phytic acid, saponins and anti-vitamins, limit the use of these ingredients which may have detrimental effects on the digestive process and growth of fish.

Studies conducted with Florida pompano *Trachinotus carolinus* indicated that the combination of solvent-extracted soymeal with soy protein concentrate (SPC) were able to reduce the fish meal inclusion rates from 30 to 15% without deleterious effect on growth performance (Quintero et al., 2012). Blending conventional soymeal with advanced soy products is likely to be a viable strategy

Ingredients (g/kg, as is)	Trial 1				Trial 2			
	15% FM	12% FM	9% FM	6% FM	12% FM	6% FM	3% FM	0% FM
Menhaden fish meal[1]	150.0	120.0	90.0	60.0	120.0	60.0	30.0	0.0
Soymeal[2]	466.0	466.0	466.0	466.0	466.0	466.0	466.0	466.0
Enzyme-treated soy (ESBM)[3]	0.0	30.8	61.4	92.1	28.9	89.8	120.1	150.5
Corn protein concentrate[4]	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0
Menhaden fish oil[1]	50.0	52.9	55.8	58.7	50.2	54.7	57.0	59.3
Corn starch[5]	38.5	31.4	24.5	17.5	36.0	23.8	17.3	11.3
Whole wheat[5]	180.0	180.0	180.0	180.0	180.0	180.0	180.0	180.0
Trace mineral premix[6]	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Vitamin premix[7]	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Choline chloride[5]	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Stay C 35%[8]	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
CaP-dibasic[5]	15.0	18.0	21.0	24.0	18.0	24.0	27.5	30.5
Lecithin (soy commercial)[9]	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Methionine[5]	0.0	0.2	0.4	0.6	5.2	5.6	5.8	5.9
Taurine[5]	5.0	5.2	5.4	5.6	0.2	0.6	0.8	1.0
Proximate analyses (g/kg, as is)								
Phosphorus	13.2	12.0	12.3	12.5	11.0	10.8	10.8	10.9
Crude protein	398.2	385.0	395.0	413.2	417.2	418.8	431.6	425.0
Moisture	64.1	96.1	80.9	81.7	75.9	77.8	60.7	63.9
Crude Fat	96.9	82.4	84.8	82.9	96.3	80.8	87.3	87.4
Crude fibre	28.9	25.5	26.5	28.8	28.2	28.2	29.7	31.8
Ash	78.6	75.6	71.3	69.3	71.8	67.3	67.0	65.0

[1]Omega Protein Inc., Huston TX, USA [2]De-hulled Solvent Extracted Soymeal, Bunge Limited, Decatur, AL, USA
[3]Nutrivance™, Midwest Ag Enterprises, Marshall, MN, USA [4]Empyreal 75™ Cargill Corn Milling, Cargill, Inc., Blair, NE, USA

Table 1. Composition (g/kg as is) of diets containing various levels of enzyme-treated soy (ESBM) used in both growth trial

to improve the nutritional value of plant-based diet. However, continued reduction in fish meal levels below 15% will likely reduce the growth performance of this species.

Novel products, such as enzyme-treated soybean meal (ESBM) provide an opportunity to enhance the nutritional quality of plant-based diets for pompano. In the present study we analysed the effect of partial and complete replacement of fish meal with various inclusion levels of ESBM on growth performance, proximate composition of the whole body, amino acid profile, serum and enzyme activities, and histomorphological condition of liver and distal intestine of Florida pompano.

Two trials were conducted to evaluate the efficacy of ESBM to replace the use of fish meal in practical diets for Florida pompano. The reference diet in trial 1 utilised 150g/kg of fish meal, 466.0g/kg defatted soymeal and 80g/kg corn protein concentrate (CPC). Three experimental diets were formulated to include increasing levels of ESBM to reduce fish meal to 120, 90 and 60g/kg (labelled as 12, 9 and 6% FM, Table 1). Diets in trial 2 were formulated based on the results of trial 1. Four experimental diets were produced to include increasing levels (30, 90, 120 and 150g/kg) of ESBM to partially and completely replace fish meal in the diet (Table 1).

Both growth trials were carried out at the Claude Peteet Mariculture Center (CPMC), Gulf Shores, AL, USA. At the start of the trials, 20 fish with average initial weight of 13.05 ± 0.34g for the first trial and 18.45 ± 0.49g for the second trial were stocked into each tank. Each trial consisted of four treatments each with three replicates in a completely randomized design. Fish from all trials were maintained under natural photoperiod for 8-weeks. During the trials, fish were fed 4x/day on a percent body weight basis. Fish were bulk-weighed every other week to monitor growth and adjust feeding rations. During sampling, fish were dipped in chloroquine phosphate (MP Biomedicals, Solon, USA) as a bactericide at 60mg/L followed with a freshwater dip for approximately 1 minute to reduce possibilities of parasitic infection. During both growth trials, water quality was within the acceptable range for Florida pompano.

Diet	Final weight (g)	Weight Gain (%)	Thermal growth coefficient (TGC)	Feed intake (g/fish)	FCR	Survival (%)
Trial 1						
15% FM	70.34[a]	432.73[a]	0.1183[a]	96.39	1.69[a]	98.33
12% FM	70.73[a]	444.13[a]	0.1188[a]	97.07	1.68[a]	100.00
9 % FM	66.33[ab]	411.98[ab]	0.1100[ab]	94.51	1.77[a]	91.67
6 % FM	62.04[b]	376.45[b]	0.1070[b]	90.74	1.86[b]	95.00
PSE[1]	1.6356	12.2549	0.0022	2.0130	0.0401	2.7639
P-value	0.0177	0.0201	0.0206	0.1947	0.0445	0.2272
Trial 2						
12% FM	100.24[a]	442.41	0.1230	138.55[a]	1.70	98.33
6% FM	92.92[ab]	405.65	0.1163	132.80[b]	1.78	100.00
3% FM	91.88[ab]	393.16	0.1145	132.65[b]	1.81	100.00
0% FM	88.08[b]	382.90	0.1118	128.03[b]	1.83	98.33
PSE[1]	2.2011	18.7670	0.0054	1.1389	0.0516	1.1785
P-value	0.0260	0.2056	0.1092	0.0014	0.3644	0.5957
Trial effect	<0.0001	0.3512	0.2208	<0.0001	0.2854	0.0785
Fish meal level effect	<0.0001	0.0006	0.0001	<0.0001	0.0022	0.4483
Trial x fish meal level	0.5426	0.3212	0.1809	0.9762	0.1668	0.1076

Note: 1 PSE = Pooled standard error.

Table 2. Growth performance of juvenile Florida pompano fed experimental diets for 56 days

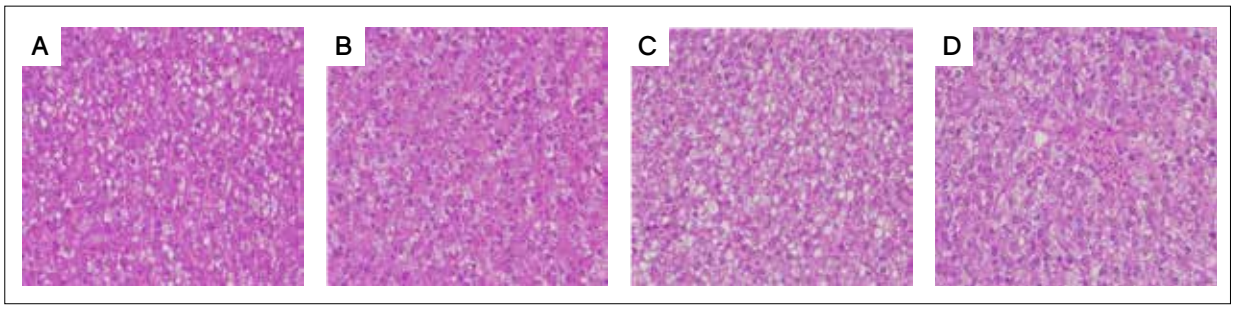


Figure 1. Representative histopathological images of hematoxylin and eosin-stained sections of liver from Florida pompano in trial 1 after 56 days of being fed diets (A) 15% FM, (B) 12% FM, (C) 9% FM, and (D) 6% FM.

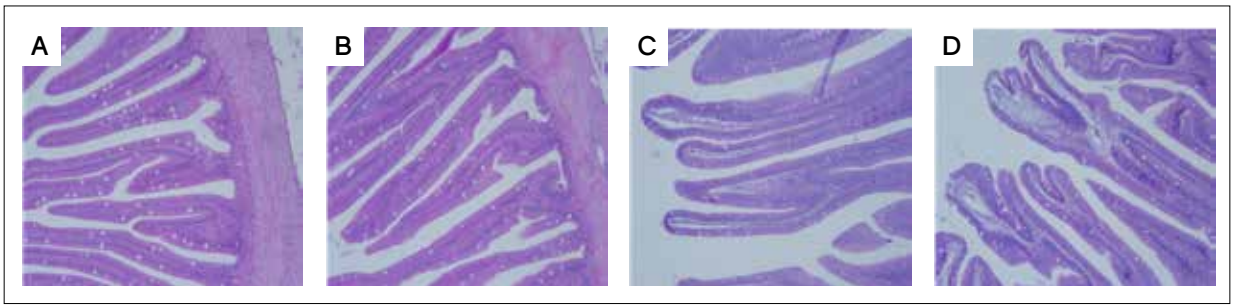


Figure 2. Representative histopathological images of hematoxylin and eosin-stained sections of distal intestine from Florida pompano in trial 1 after 56 d of being fed diets (A) 15%FM, (B) 12%FM, (C) 9%FM, and (D) 6%FM.

At the end of the growth trials, four fish from each tank were randomly sampled and stored at -80°C for body composition analysis. Blood samples were taken from the caudal vein and collected using anticoagulant-free centrifuge tubes. Serum was obtained by centrifugation of blood at 3,000rpm for 10 min and stored at -80°C pending analysis. Serum samples were analysed for total protein, albumin, activities of alkaline phosphatase (ALP), alanine aminotransferase (ALT), aspartate aminotransferase (AST), glucose, cholesterol and bile acid concentrations.

Histological analysis was only carried out in trial 1 and samples were randomly collected after an overnight fast with three fish/treatment tank. Fish were individually dissected to collect the liver and distal intestine. The following parameters were evaluated for distal intestine analysis: the number of goblet cells (GC), level of cellular infiltration (CI) and thickness of the lamina propria within the intestinal folds (WLP). Liver evaluation focused on the presence of hepatocyte vacuolisation, change in nucleus and granulation. Histomorphological images were acquired using a microscope (Olympus BX41, Olympus Optical Co., Ltd., Japan).

Growth performance

For trial 1, survival was over 90% and there were no significant differences in terms of feed intake. However, fish fed the lowest inclusion level of fish meal (6% FM) had a significantly lower final weight, weight gain and thermal growth coefficient. In addition, fish fed the 6% FM diet had the highest feed conversion ratio (FCR, Table 2). For trial 2, there were no significant differences for the above parameters. However, fish fed with completely free-fish meal diet had the lowest final weight compared to other dietary treatment (Table 2). There was reduced growth performance when 15% inclusion level of fish meal was further replaced with soy protein.

For the body composition analysis, there were no significant effects of fish meal replacement on crude protein, fat content, crude fibre, dry matter, moisture and ash content for both trials. No significant effects were observed on the level of total protein in the serum, albumin, glucose, bile acids, ALP, ALT and AST activities. For histological analysis, linear regression modelling suggested severe conditions of pompano liver as indicated by the increasing incidence of granulation and inflammation when fish meal was further replaced by ESBM. A similar condition was also observed in the distal intestine of pompano where the level of cellular infiltration into lamia propria was higher in fish fed with lower level of fish meal. Based on the microscopic observations, there is a tendency toward severe condition as fish meal was further replaced by ESBM (Figure 1 and 2).

An integrated evaluation of novel ingredients by means of growth trial, proximate and amino acid composition of the whole body, serum and enzyme activities in the blood of fish together with microscopical methods for liver and distal intestine tissue analysis provides a comprehensive and reliable assessment of its nutritional effect. In this study, ESBM can be used to reduce the dietary fish meal from 15 to 9g/kg in the development of practical diets for pompano containing 466g/kg of conventional soymeal and together -80g/kg CPC. However, further studies are required to investigate the inclusion effect of ESBM to replace dietary fish meal for a long-term growth duration beyond the current growth trial.

(Extracted from: Novriadi, R., Salze, G., Abebe, A., Hanson, T., & Davis, D. A. (2019). Partial or total replacement of fish meal in the diets of Florida pompano *Trachinotus carolinus*. Aquaculture Research, 50(5), 1527-1538

References

Quintero, H. E., Davis, D. A., & Rhodes, M. A. (2012). Soy protein concentrate as an alternative ingredient in Florida pompano (Trachinotus carolinus) diets. Journal of Applied Aquaculture, 24(3), 247-261. doi:10.1080/10454438.2012.679164

Romi Novriadi is a Senior researcher at the Directorate General of Aquaculture, Ministry of Marine Affairs and Fisheries, Republic of Indonesia. Email: novriadiromi@yahoo.com

D. Allen Davis, PhD is Alumni professor at the School of Fisheries, Aquaculture and Aquatic Sciences, Auburn University, Auburn, AL, US. Email: davisda@auburn.edu

Zhingalala: a shrimp-only seafood restaurant is a boost for local produce in Gujarat

India is now the leading farmed shrimp producer globally with an estimated production of 600,000 tonnes in 2018. However, most of its production is targeted for export, which means producers are at the mercy of demand and supply of the traditional shrimp and China's markets. A recent impact on production was the drop in international prices since April 2018. Creating a domestic market will help absorb some of India's farmed shrimp production.

Manoj Sharma, Managing Director, Mayank Aquaculture has come up with a novel concept "From our Pond to your Plate," to increase domestic consumption of farmed shrimp in India with Zhingalala, the first "Pesco-vegetarian" restaurant in the country. Pesco-vegetarian means a vegetarian diet that includes only seafood and no other meat varieties.

The opening of Zhingalala on June 9 was the culmination of a dream to popularise the domestic consumption of fresh farmed shrimp in India. "I have seen the ups and downs that the sector has faced over the years and feel that I am seasoned enough to take up another challenge. I believe in Mahatma Gandhi's philosophy - be the change that you want to see in the world," said Manoj in an interview with the magazine Aquaculture Spectrum.

Manoj Sharma with his wife Dr Vidya Manoj at the opening of his pesco-vegetarain restuarant.

Mayank Aquaculture Pvt Limited operates farms in seven locations across Gujarat State, covering 200ha. In 2018, the production was 350 tonnes mainly of 30-40 count shrimp. Most of the production is exported to the US and more recently to China. Manoj reckons that it is time that the farming industry takes stock of the situation. "One simple but true fact that we as shrimp farmers need to understand is that worldwide, farmed shrimp production is growing and the International market for shrimp has become very quality conscious and highly competitive.

"We need to produce better quality shrimp at lower cost or produce sizes others do not produce. It is also unlikely that shrimp prices would be higher any time in the near future. In India, farmers struggle to produce even 60 and 50 count shrimp these days. The

minimum cost of production in Gujarat for 80 count is INR 270/kg but the offer price is only INR220/kg. In 2 years', time the situation could get worse. So, we can't wait anymore."

There are many attributes of farmed shrimp which should be exploited to encourage domestic consumption. "We should have messages to convey the health benefits of shrimp and on the high-quality processes in the production chain. Meat protein via aquaculture has less carbon footprint than that from terrestrial animals. It is entirely dependent on exports that is killing the farming sector now."

Manoj added that Gujarat was chosen as it is a very challenging place. "Gujarat is considered to be a state with the highest number of vegetarians. Eating meat or seafood was taboo here. Nobody here knows how to clean or how to cook shrimp and what the goodness or nutritive qualities/values of the shrimp are. With this restaurant, we will encourage people to come and try out farm-fresh seafood prepared to their taste; we hope to make them love the taste and then try to prepare shrimp dishes themselves at their homes and to make it a part of their daily cuisine."

The chief guest at the opening ceremony, Rani Kumudini, IAS, National Fisheries Development Board (NFDB) CEO was proud to see a shrimp farmer coming forward to initiate this new concept of a Pesco-vegetarian restaurant, defying statistics that Indians are vegetarians and do not eat prawns etc. "While the poultry sector got together to promote egg and chicken consumption, in aquaculture we do not feel that we have done enough to educate the public on the benefits of farm- raised seafood and its advantage over other meat forms. This initiative by Manoj Sharma is most creditable and a dream come true for the entire sector".

Today in India, there is no domestic market. The entire sector is focussing on just exporting the produce and grossly neglecting the potential of a local domestic market. Manoj said that his concept of a "Pesco-vegetarian" restaurant came from two simple facts. "India has the capability and resources to produce more shrimp. Assuming 50% of the 1.3 billion population are non-vegetarian and consume a kilogram of shrimp per year, then local demand will rise tremendously. An increased demand would mean a more stable market. The local market demand is 70-100 count shrimp at around INR300-350/kg."

Zingalala will serve the choicest vegetarian food along with shrimp. Initially, it will start with fresh shrimp from Mayank Aquaculture's BAP certified farms and later include other farm-raised fish varieties. The restaurant has tied up with Swiggy and Zomato for online sales and food deliveries.

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

DEPARTMENT OF FISHERIES

NACA
Network of Aquaculture Centres in Asia-Pacific (NACA)

สมาคมกุ้งไทย
Thai Shrimp Association

Supported by:

China Aquatic Products Processing and Marketing Alliance (CAPPMA)

In collaboration with:

INFOPESCA

Media Partner:

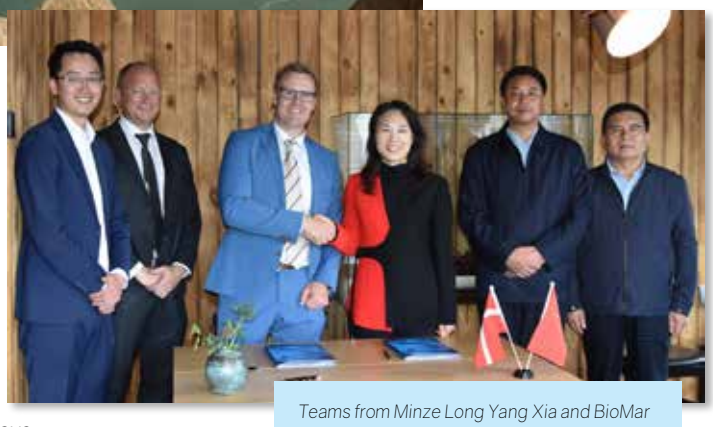
AQUA CULTURE

Sponsors:

I&V BIO

Working together to reduce the environmental footprint in China

In June, a Chinese delegation led by Yan Jinhai, the Vice Governor of The People's Government of Qinghai Province, gathered to witness the signing of a cooperation agreement between **BioMar** and Minze Long Yang Xia, the largest trout farmer in China, to supply high performance fish feed with almost half the environmental footprint compared to local Chinese feed. This took place at BioMar's headquarters in Brande Denmark.



Teams from Minze Long Yang Xia and BioMar

Over the last two years, the BioMar BioFarm teams of China and Denmark have been collaborating closely with Long Yang Xia on technical onsite trials that consider the daily conditions of the water and the fish. The ideal recipe solution that was discovered considered the parameters of growth performance and fish welfare while limiting the discharge of nitrogen and phosphorous into the local ecosystem.

"Our extensive knowledge on nutritional requirements of trout as well as a strict selection of raw materials according to their characteristics and contribution to sustainability impacts, have together made it possible to discover an optimal feed recipe and feeding strategy. Through the onsite trials we have been able to demonstrate a better total performance", said Carlos Diaz, CEO, BioMar Group.

Creating a low impact feed recipe by varying the ingredients plays a crucial role in reducing a farmer's overall environmental footprint. That is because aquaculture feed traditionally is responsible for up to 80% of the environment impact of farming fish due to the feed ingredients and production operations accounting for most of the mass energy flows in the value chain.

The Chinese government is rolling out a new guideline to accelerate green development of its aquaculture industry, which outlines a set of policies to reduce fish farmers' overall environmental footprint and promote transformation of the industry. www.biomar.com

USD 30 million investment to expand production of sustainable single-cell protein

In June, leading alternative protein producer **Calysta** announced a USD30 million investment from **BP Ventures** to support a worldwide rollout of Calysta's FeedKind® protein, which can help improve global food security, one of the greatest challenges facing the world today. The investment will help Calysta expand production of its sustainable single-cell protein, which is produced through a proprietary, commercially validated gas fermentation process using naturally occurring, non-GM microbes with the unique ability to use methane as their energy source. Through extensive customer trials around the world, FeedKind protein has been demonstrated to be an effective, safe and nutritious feed ingredient.

"Welcoming BP as a partner is a tremendous step forward for FeedKind protein and the best indicator yet that Calysta's solution to food insecurity in a resource-constrained world can and will achieve global scale," said Alan Shaw, PhD, Calysta President and CEO.

"The problems facing our food production supply chains have never been clearer, with increasing evidence that land and water scarcity are key challenges to meeting future demand for protein. FeedKind makes more from less, producing feed for livestock, fish and pets while making smarter use of our resources. We look forward to working closely with BP as we prepare to deliver this product to the world. Calysta will benefit from BP's operational excellence and focus on safety when deploying multiple production plants."

The investment agreement will also see BP and Calysta establish a strategic partnership around gas and power supply. Meghan Sharp, Managing Director, BP Ventures added: "We are really excited to be working with the team at Calysta, bringing them into the BP Ventures family as we seek new commercial opportunities for our gas business. Their technology complements our core business while providing opportunities for sustainable products for tomorrow."

Calysta's patented, state-of-the-art fermentation process uses no arable land and very little water, and does not compete with the human food chain, meaning more food can be produced with less resources. In aquaculture, Calysta's initial market opportunity, FeedKind is seen as a key enabler for growth by reducing reliance on conventional sources of proteins.

FeedKind is already being produced from the company's Market Introduction Facility (MIF) in Teesside, England to support market development activities with leading animal nutrition companies around the world. www.calysta.com/www.bp.com

Vision for the next 35 years and a new era

INVE Aquaculture – Benchmark Advanced Nutrition recently celebrated 35 years' service to global aquaculture. It pioneered development of early feeding including *Artemia* which has driven the growth of marine shrimp and fish hatcheries globally. Today it has achieved 24% market share in the global shrimp and marine fish hatchery nutrition segment and is present in more than 70 countries.

At a series of events held around the world to mark the milestone anniversary, leaders of the company mapped out their vision for the future, which will largely focus on developing holistic solutions for sustainably improving fry quality and using microbial management and other health solutions to overcome disease outbreaks.

CEO, Philippe Léger, commented, "Innovation is how we started and in this fast-growing industry, innovation in partnership with our customers is the way to keep driving sustainable growth in the industry, and to stay ahead of the competition". During the celebrations, Léger announced that he will hand over his role as Managing Director of Benchmark's Advanced Nutrition and CEO of INVE Aquaculture to Athene Blakeman who joined Benchmark in 2014 as Group Legal Counsel.

Turning 65, Philippe has decided to work part-time supporting the development and execution of Benchmark's key strategic initiatives. He will continue to play an integral role in the future growth and development of Benchmark. Léger added," During my time as CEO I have had the privilege of working with truly talented, innovative and inspiring people across the global aquaculture industry.

"I am thrilled Athene is taking on my responsibilities as CEO. She is a highly intelligent, respected and ambitious leader. I have every confidence she will continue to build on our achievements throughout the next phase of growth and I look forward to working with her as I continue to lead the Benchmark Strategy Execution and Business Growth team supporting the Groups' key strategic priorities and new business developments."

Philippe has worked at INVE since it was established in 1983 after he signed up to do a PhD with Patrick Sorgeloos (known as the 'Father of Artemia'), University of Ghent, Belgium. Since then, Philippe has played a fundamental role in the development, growth and impact of INVE's products, people and services. He is recognised across the global aquaculture industry for his creative ability and industry leadership.

Athene joined Benchmark in 2014 as Group Legal Counsel and has gained in-depth knowledge and insight across the group, being a member of Benchmark's Plc and Operations Boards, as well as each of the divisional boards, including Advanced Nutrition. Athene said, "The success Philippe has building INVE Aquaculture into the company it is today is testament to his dedication, drive and passion for aquaculture. I look forward to working closely with him and our teams across the business in the coming months to ensure the smoothest possible transition for our customers and partners".

Two technological innovations for *Artemia* cysts

A fundamental part of INVE Aquaculture's success has always been the company's vision not to market *Artemia* as a simple commodity, but to improve the cysts with patented technologies and to simplify their optimal use. A reliable supply of consistently high-quality cysts is vital for any hatchery to achieve performant and robust juvenile production. The aim of its *Artemia* innovations is always towards maximizing output, biosecurity and efficiency in fish and shrimp hatchery operations.

The patented SEP-*Art* technology provides a coating on the cysts, adding a new and unique feature to the shell: complete separation of the nauplii from the shell by means of a set of passive magnets. The result is a suspension of pure, clean and active nauplii, without shell material of any kind and without the use of bleach or other harmful substances.

As a culmination of long-standing efforts in revolutionising the sourcing, characterisation, enrichment and ease-of-use of *Artemia* cysts, INVE Aquaculture, has announced two additions to its set of *Artemia* technologies.

SMArt (Sensitivity Modified *Artemia*) is a new technology that allows the cysts to hatch in the dark, avoiding decreased hatching performance due to lower light exposure. One of the main concerns in achieving a consistent *Artemia* output is the cysts' sensitivity to external factors such as light, temperature and storage.

D-FENSE is a new built-in protection for the best hatchery biosecurity. It is an additional process to the *Artemia* cysts, forming a specific coating that suppresses the growth of bacteria such as *Vibrio* spp during hatching. This important bacterial reduction results in better larval survival, and reduced contamination risks.

By simplifying the process of harvesting high quality *Artemia* nauplii, all these innovations again represent major milestones in improving hatchery performance, rationalising manpower and resources and increasing the sustainability and environmental impact of the industry. The availability of the product will be different per region, depending on the registrations. www.inveaquaculture.com

Opening of USD 200 million facility for EPA & DHA omega-3 algal oil

In July 10, **Veramaris** opened its Blair, Nebraska facility for EPA and DHA omega-3 algal oil to support sustainable growth in aquaculture. The zero-waste facility in Blair, Nebraska, USA was completed in May. The next step is ramping up for full production. Veramaris' production capacity is equivalent to 1.2 million tonnes of wild-catch fish. This will meet around 15% of the entire salmon farming industry's annual demand for EPA and DHA – providing a significant contribution to conserving the biodiversity in our oceans and reducing pressure on marine wild catch fisheries.

Veramaris runs its innovative USD 200 million facility with proprietary technology. The intellectual property behind the production technology, the algae strain *Schizochytrium* spp and the downstream processes are all strongly protected by patents. This unique natural marine algae is rich in both EPA and DHA and together with the technology to cultivate it at a very large scale, is a breakthrough that expands the future supply of healthy seafood without impacting ocean resources. The levels of EPA and DHA omega-3 in farmed salmon have declined significantly over the past ten years. Veramaris' algal oil contains twice as much EPA and DHA as fish oil, so it can reverse the decline and support the salmon brand-promise for healthy nutrition. This is also good news for the health and robustness of the salmon itself.

Due to its state-of-the-art fermentation process, the Veramaris algal oil is free from sea-borne contaminants and unique for its pristine quality 365 days a year. The full traceability of the raw materials used and the transparent production process provide peace of mind for the consumer. Consumer research data (Veramaris Market Data 2016 & 2018) show that omega-3 fatty acids are very important for salmon consumers in all the surveyed countries, including the US, UK and France. Consumers care about healthy and sustainably raised seafood and frequent buyers of salmon are even more aware of the current state of the oceans.

Located in Delft, the Netherlands, Veramaris is a 50:50 joint venture of DSM and Evonik to produce the omega-3 fatty acids EPA and DHA from natural marine algae. www.veramaris.com

Scaling up RAS for sustainable land-based farming globally

An illustration of the facility to be built in Japan

Gitte M Christensen (right) and Shai Silbermann

AquaMaof Aquaculture Technologies is the developer of a world leading sustainable cost-efficient land-based indoor aquaculture technology. Thirty years ago, two brothers working in a kibbutz and involved in fish production discovered issues with increasing efficiency of their fish production. They brought over RAS (Recirculating Aquaculture System) technologies and further developed these systems. Today, the company, with over 30 years of global experience, enables the intensive production of seafood in ways that are nature-friendly and financially beneficial. It has been in the US for the past 10 years and 50 locations globally. In Asia, it is present since 2016.

"Smart fish farming is the future and this is with RAS. I do see opportunity for intensification and expansion of aquaculture if we continue to farm in open systems in cages or open ponds while bridging the gap in demand and supply of seafood with RAS technology," said Shai Silbermann, vice president Marketing and Sales at the large AquaMaof stand during the Seafood Expo Global, held in Brussels, Belgium. This is the 5th time AquaMaof is present at SEG's hall 3 dedicated to farming and processing technology.

The clients are worldwide but particularly in salmon production. In Norway, where AquaMaof is a major player in the RAS technology which has become a standard in smolt production, such as at Grieg Seafood NL. In 2018, AquaMaof reported success with the Pure Salmon salmon hatchery, smolt, and market-size Atlantic salmon RAS near Warsaw. The facility has seen great success since operations began in 2016. "I believe that we are one of a few companies in the world that has successfully developed a technology to produce salmon in RAS over the whole cycle, from smolt to 5-6kg which extends over 2 years." In seafoodsource.com, David Hazut, CEO said, "The investment in Poland will serve two main purposes. First we are operating this facility as a R&D centre, collecting valuable information and analysing it, for further innovation in the RAS area. Secondly, it serves as a training facility for our customers' staff."

AquaMaof is a 50% partner in Pure Salmon's 1st facility in Poland. The company promotes RAS as disruptive, non-invasive, land-based aquaculture method that will reshape the fish farming into a sustainable industry. It provides turnkey setups and support production while experimenting with advanced technologies, such as artificial intelligence in aquaculture (AI) software, tracking and monitoring over the whole production cycle. "What we do is provide technology for facilities to generate profits in the long term. As part of the DNA of the company, we create long term relationships to make sure the facilities are financially and operationally successful," said Silbermann.

In 2018, Pure Salmon launched a USD162 million mega-project to create "Soul of Japan," a state-of-the-art RAS salmon farm that will be the largest ever built in Asia, and one of the largest globally. The 137,000m^2 farm will produce up to 10,000 tonnes of Atlantic salmon/year and will be fully operational from 2021 (fareasternagriculture.com). Pure salmon is also 100% owned by equity 8F Asset Management Pte. Ltd., a global asset management firm focused on impact investing in RAS farming.

AquaMaof has plans to enter new markets especially in China, Thailand, Vietnam and India. "In particular, we see a large potential in deploying RAS technologies. We are also focussed on the scaling up of production. We just cannot manage with small production volumes; less than 1,000 tonnes is a no no in terms of getting returns on investment (depending on species). Before 3,000 tonnes was huge but today, we look at 10,000 tonnes facilities," added Silbermann who also discussed some possible species for farming using RAS. "We have been working with the kingfish in Chile, *Seriola lelandi* and grouper in Asia. "We are very familiar with the tilapia and can develop systems for any conditions- freshwater, marine, cold water and various salinities."

Pure Salmon will use AquaMaof RAS technology in its land-based farms, a proven and scalable method of aquaculture. There are planned rollouts of large-scale facilities of 10,000 tonnes or 20,000 tonnes production per annum in the US, Europe, China and around the world (fareasternagriculture.com). In addition, all Pure Salmon land-based sites will be fully integrated with on-site hatcheries, grow-out systems and processing facilities, delivering a clean, healthy and fresher salmon for local consumption, reducing wastage and limiting its carbon footprint.

In terms of assuring buyers that fish produced using RAS systems have equally good taste as traditionally farmed fish, the company carries out taste panel tests. Feeds meeting specifications for RAS farming is critical and Gitte M Christensen, regional sales manager-Scandinavia, formerly with feed company BioMar, assured that this is a priority for AquaMaof. It works closely with nutritionists to develop the right feeds to match the RAS technology used. www.aquamaof.com

Three years of the GGN label aquaculture

The panel in 2019 comprised, from right, Leon Mol, Board member GlobalGAP, Gorka Azkona Saez, Kristian Moeller, Mark Nijhof, Marie-Claude Quentin, and Remko Oosterveld, GlobalGAP/GGN.

In May 8, during Seafood Expo Global 2019, in Brussels, Belgium, the global certification program, GLOBALG.A.P. held a news conference to announce the progress over three years for the GGN label aquaculture. Aquaculture products that come from farms with GlobalGAP certification can be labelled with the GGN consumer logo with the GlobalGAP Number (GGN). This is a 13-digit identification number that identifies all participants in the production and supply chain under its certification.

More than 137 aquaculture products are now available with the GGN logo. They are connected to 82 farm profiles and supplied by 34 GGN licensees from nine countries. The GGN consumer label for certified aquaculture is now available in nine countries.

Certified aquaculture worldwide

With the GGN printed on the product packaging, consumers can learn more about the farms that have produced the labelled products at www.ggn.org – the consumer portal for GlobalGAP certified aquaculture. The website also explains what good aquaculture practices are and how the certified farms implement them. This direct line between the consumer and the original producer forms the basis of a chain of trust in food production.

According to Kristian Moeller, CEO GlobalGAP, "Certification for aquaculture covered 2.2 million tonnes of production and is dominated by the salmon at 69.89% and white leg shrimp at 13%. This includes group certification which is very important and demonstrate trust."

Learnings

The progress with the adoption of the GGN consumer label shows the high demand, positive feed back as well as its recognition. In terms of traceability, one important lesson during previous years was the need for a consumer-friendly portal to allow traceability from the final product back to the farm. This has resulted in an overhaul of the existing GGN consumer portal, with faster and better readability and functionality as well as a modern design. The portal will be up and running in the summer of 2019.

A standard must provide a realistic promise by developing criteria based on facts which are practical and auditable. At the same time, the certification process must be simple in order to enable cost effective scalability while avoiding duplication. There is a clear emphasis on reducing food safety risks as well as increasing animal welfare. A growing number of retailers around the world is interested in not only clearly communicating and simplifying their purchasing policies but also wishes to limit the number of labels in order to avoid confusion among consumers.

Certified aquaculture at seafood counters

In 2018, EROSKI became the first retailer in Spain to pass the GlobalGAP chain of custody audit to sell certified aquaculture products. This guarantees that the fish on sale at its seafood counters has been farmed in a safe and responsible way. Some 361 seafood counters in Eroski stores now sell gilthead seabream, meagre, European seabass, and turbot labelled with the GGN aquaculture logo.

Representing Eroski, Gorka Azkona Saez said that in June 2018, the company worked with GlobalGAP to introduced GGN Label for certified aquaculture at its seafood counters. "Out of 1,700 tonnes of products, 699 tonnes are certified under CGN. The benefits for the company have been a choice from a range of supplies for seabass, seabream, salmon and turbot. The advantage for the company has been the strong standard for food safety."

Eroski is the first distribution group of the cooperative type in Spain. It has a business network of 1,651 stores, including supermarkets, hypermarkets and cash & carry as well as petrol stations, optical shops, travel agencies and sports shops. It has more than six million customer members and more than 33,800 cooperative members, workers, and franchisees

The criteria for the GlobalGAP standard include an analysis of the environmental impact, regular food safety and water quality checks, and verification of product traceability and the proper utilisation of waters. The standard also ensures adequate feed consumption, an improved use of fishing resources, measures to prevent escapes and thus limit the spread of invasive species, the implementation of animal welfare measures, the guaranteeing of proper working conditions, and the introduction of quality management systems.

GFSI benchmarking

The Global Food Safety Initiative (GFSI) is a non-profit industry organisation and the vision is safe food for consumers, everywhere. GFSI brings together key actors in the food industry to collaboratively drive continuous improvement in food safety management systems around the world. Marie-Claude Quentin, Senior Technical Manager said, "GFSI does a lot of harmonising and raising the standards of food safety certification programs, capacity building for the industry and its suppliers with step by step guidance. With public and private partnerships, it coordinates events on food safety." GFSI benchmarking is broadly based on *Codex Alimentarius*, a common acceptance of good food safety requirements.

In February 2019, GFSI announced that the GlobalGAP IFA Standard has achieved recognition against version 7.1 of the GFSI benchmarking requirements. Moeller said, "GlobalGAP was founded 23 years ago, based on the belief that every generation has the right to safe food. We follow the principles of transparency, credibility and harmonisation. Benchmarking is an important tool, and therefore we actively seek continuous GFSI recognition, as significant markets value this harmonisation effort".

For GFSI, the opportunity to continue working with certificate program owners towards the harmonisation around the world is highly valued; it is one of the strategic tools to ensure safe food for consumers everywhere. GlobalGAP was first recognised in 2012 and has maintained its commitment to the GFSI recognition program ever since. GFSI was therefore particularly pleased to receive GlobalGap's re-benchmarking application.

The aquaculture standard

Mark Nijhof, Vice-Chairman of the GlobalGAP Technical Committee- Aquaculture briefly explained some pre-farm gate aspects of the standards. The standard follows the guidelines of four organisations: GFSI for food safety; OIE (World Organisation for Animal Health) for animal welfare; GSSI (Global Sustainable Seafood Initiative) on environmental care and GRASP (GlobalGAP Risk Assessment on Social Practice) for worker safety & social compliance.

With regards to compound feeds, aquaculture producers are required to source the compound feed used at the farming and hatchery levels from reliable suppliers. In hatcheries and farms, the standard applies to a variety of fish, crustaceans and molluscs and extends to all hatchery-based farmed species as well as the passive collection of seedstock in the planktonic phase. It covers the entire production chain, from broodstock, seedstock and feed suppliers to farming, harvesting and processing. The GlobalGAP chain of custody standard gives aquaculture producers a high level of transparency and integrity by identifying the status of the product throughout the entire production and supply chain, from farm to retailer. (www.globalgap.org/aquaculture)

EVTA at the forum on Vietnam seafood

At Seafood Expo Global 2019, members from Vietnam's seafood industry were actively promoting their products for the European market. This year's exhibition included 25 booths from Vietnam, some were within the Vietnam pavilion. In 2018, Vietnam exported 275,800 tonnes of seafood to the EU, earning USD1.4 billion, making it the second biggest seafood supplier to the EU. Vietnam's seafood exports worldwide reached USD8.8 billion, the highest to date.

Vietnam's Ministry of Agriculture and Rural Development (MARD) took advantage of the presence of exhibitors, seafood buyers and producers as well the media to inform on steps taken to assure quality seafood exports to the EU. The forum was held on May 7. Key speakers came from the Embassy of Vietnam in Belgium, MARD and Vietnam Association of Seafood Exporters and Producers (VASEP). VASEP also collaborated with the Directorate of Fisheries (D-Fish) and the southernmost province of Ca Mau to hold a seminar on pangasius fish and Vietnamese shrimp.

The Deputy Minister of Agriculture and Rural Development Phung Duc Tien expects tariffs cuts with the introduction of the EU-Vietnam Free Trade Agreement (EVTA) to raise Vietnam's export turnover to the EU. Currently, some 90% of seafood face tariffs. According to VASEP, tariffs on frozen shrimp will fall from 20% to zero as soon as the agreement comes into effect. The tariffs for other shrimp products are reduced according to the 3-5-year roadmap, while processed shrimp products will have a seven-year tariff reduction schedule, excluding canned tuna and fish balls with a tariff quota of 11,500 tonnes each. VASEP forecasted that Vietnam's shrimp exports to the EU to increase by 4-6% in 2019. According to vietnamnews.vn, the EU mainly imports frozen raw shrimp and processed shrimp from Vietnam under the Generalised System of Preferences (GSP) tariffs at 4.2% and 7%, respectively. With these tariffs, Vietnam has had an advantage over Thailand and China, who are not entitled to the EU's GSP tariffs.

At the forum on "Vietnam Fishery Products - Cooperation Prospect" during Seafood Expo Global 2019 in Brussels, Belgium

In his discussion on quality inspections, Tien said that the government's role is to oversee and carry out inspections. Based on government decrees, the seafood processor is responsible for food safety and quality. The National Agro-Forestry-Fisheries Quality Assurance Department (NAFIQAD) does inspections and imposes penalties for any offences. It is the competent authority for imports into the EU. Along the supply chain, there are inspections on aquaculture health by the Department of Animal Health and of farms, hatcheries and GAP applications by D-Fish. In terms of monitoring programs for aquaculture production, firstly there is the use of harmful substances and chemical residues involving 166 aquaculture areas in 37 provinces and 9 species and covering 45 tests criteria. Secondly, is monitoring of shellfish production areas involving 13 species. In addition, the ministry is emphasising strictly on certifications. For wild caught fish, Tien said that efforts are ongoing to address the IUU (illegal, unreported and unregulated) regulations.

GOAL
CHENNAI, INDIA 2019
OCTOBER 21-24

For its 20th edition, the GOAL conference descends on Chennai to take on aquaculture's key challenges and opportunities. GOAL 2019 will be held at the Leela Palace in Chennai from October 21 to 24.

It is also the 20th edition of GOAL as well as the 10th time that GOAL has been held in Asia. It has been a long time coming. For the first time in its 19-year history, the Global Aquaculture Alliance's annual Global Outlook for Aquaculture Leadership (GOAL) conference will be held in India. As the world's leading shrimp exporter, surpassing 600,000 tonnes in 2018, India is an aquaculture hotbed, an ideal location for an event that takes on aquaculture's key challenges and opportunities.

Each GOAL takes on a personality of its own, shaped by provenance. Changing host countries each year gives the conference a certain relevance and agility that would be more difficult to attain if it were always held in the same country.

In recent years, disease management has been at the forefront, particularly with the spread of early mortality syndrome (EMS) throughout Asia's shrimp-farming sector. Naturally, EMS which first surfaced in China in 2009, was the main topic at GOAL 2012 in Bangkok, Thailand and again at GOAL 2014 in Ho Chi Minh City, Vietnam.

However, since then, with EMS under control and no other disease rising to the severity of EMS, the conversation has shifted from disease management to the need for marketing. Disease will always be a concern in aquaculture, but the oversupply of shrimp that currently exists globally due to rapid production growth in countries like India and Ecuador has taken over the conversation.

As such, this year's GOAL program will focus on consumer demand and market place acceptance for shrimp, addressing key questions such as:

- How do we get a unified marketing approach for shrimp off the ground for the North American market?
- How do we build confidence in Asia's shrimp-farming practices in the European market?
- How do we grow shrimp consumption domestically in India, where the crustacean is not a staple of the local cuisine?
- How do we get out ahead of emerging issues such as antimicrobial resistance in humans?

Other topics that will be addressed at the conference include area management/capacity building/smallholder engagement, social responsibility, aquafeed sustainability and climate change. As always, presentations on production data and analysis on all major aquaculture species, delivered by GOAL veterans James Anderson and Ragnar Tveteras will start off the conference, setting the tone for the next three days of discussions.

Aquaculture is a rapidly growing sector where change is fast and often disruptive. As an event organiser, you need to ensure that your conference is evolving as rapidly as your industry is. You need to immerse yourself in the discussion and be part of the solution yourself, not just facilitate the discussion, cross your fingers and hope for the best.

GOAL 2019 will be held at the Leela Palace in Chennai

Echoing GAA President and Co-founder George Chamberlain, some issues are simply too broad for a single entity to face alone. A different approach is needed to identify and manage emerging issues. This is what GOAL has always aspired to be - a pre-competitive space where stakeholders throughout the seafood value chain can gain valuable knowledge and develop strategic relationships that keep them ahead of emerging issues and allow them to create their own future.

The first GOAL in Singapore in 2001 — then known as the Global Shrimp Outlook for Leadership (GSOL) — was no different. What has not changed with GOAL from year to year is the need to stay ahead of the curve. At press time, the GOAL 2019 program was in the latter stages of development. The structure of the three-day conference will be familiar, featuring a plenary in the morning and breakouts in the afternoon.

Introducing a Farmer's Day

However, this year, with the assistance of the Society of Aquaculture Professionals (SAP), we will be introducing a "Farmer's Day" where part of the program will be webcast to four locations throughout India (Vijayawada, Balasore, Surat and Pondicherry) so farm and hatchery managers and technicians can access the content. There will be greater emphasis on the breakouts so issues can be discussed in greater detail in a workshop-type atmosphere. In addition, to SAP, partnerships with associations such as the Seafood Exporters Association of India (SEAI) and organizations like Netherlands-based Aqua-Spark and Seafood Trade Intelligence Portal (STIP) and India's Aquaconnect will ensure that the most relevant and timely content possible are delivered.

For regular updates on the program as well information on registration, refer to the GOAL webpage. (https://www.aquaculturealliance.org/goal/).

Breakthrough in diets for bluefin tuna

A new diet aimed at helping tuna farmers avoid the biosecurity risks and sustainability issues associated with baitfish diets has been launched by **Skretting**. Now available in Japan, MaGro is a soft extruded feed for bluefin tuna that has been created using patented production technology. The arrival of the breakthrough is ideally timed for Japan's tuna farmers, who are seeing rising consumer demand for Japanese bluefin in domestic markets and further afield, including Asia and North America.

MaGro is the result of more than 20 years of dedicated R&D at Skretting to establish a viable alternative to baitfish feeding protocols. During that time, Skretting evaluated several feed types – everything from wet mashes to a wide variety sausage formats and these appraisals led to the finding that a soft extruded diet was by far the best option for tuna farming moving forward. The resulting, ground-breaking diet takes the specific nutritional needs of bluefin into consideration and delivers it in a form that the fish want to consume.

Clear advantages

With a texture that is much softer than the pellets tailored for other fish farming sectors, this feed still has a much lower water content than baitfish. As such, it offers a much better feed conversion ratio (FCR). The formulation is also very consistent, comprising fully-traceable ingredients, whereas the nutritional profile of baitfish can fluctuate dramatically depending on the species of baitfish used, when and where it was caught, and the storage system used.

Furthermore, the practical, easy-to-use format of MaGro means that farmers can utilise semi-automatic "canon" feeding systems, which also support much more efficient, cost- effective production. Such user-friendly systems contribute to feed and manpower savings, while also diminishing water pollution.

"MaGro is a sophisticated diet that offers many clear advantages over baitfish. On average, farmers only need to use one-third of the volume to achieve the same or better growth performance. At the same time, being a soft extruded pellet, it is not only digestible for the fish, it's also much easier and cleaner to handle, and a lot more cost-effective to transport," said Chris van Bussel, Global Product Group Manager Marine Species at Skretting.

The new concept was developed by the Skretting Aquaculture Research Centre (ARC). This global unit led a number of experimental trials spanning the different growth stages of the fish. These trials, conducted in Australia, Japan, United States and Mediterranean Europe, found that the tuna fed with MaGro consistently demonstrated equal or improved growth compared with those on baitfish diets.

It was also evidenced that with MaGro, the tuna continued to maintain their feeding regime during the colder months of the year, overcoming the so-called "winter dip" that has historically slowed the growth of farmed tuna. www.skretting.com

---

New partnership in Bangkok

International trade show organisers behind VIV and VICTAM are combining their events in Thailand. The Animal Feed and Grain Industries Show VICTAM Asia in March 2020 and the VIV Health & Nutrition Asia Trade Fair and Forum planned for January 2020 will now be co-located at Bangkok's BITEC on March 24-26 2020 as VICTAM Asia and Animal Health & Nutrition.

"Presenting the shows as parallel platforms at the same time within the same venue is a great way to bring together two strong brands for the Asia market, in an integrated format so that the visitor experiences them as a single event," said Sebas van den Ende, General Manager of VICTAM International b.v. Heiko M. Stutzinger, Director VIV worldwide and Managing Director VNU Exhibitions Asia-Pacific, said, "Our own activities in Asia have gained significantly in importance over the past few years and we view the partnership for the March 2020 Bangkok event as a major next step in better serving the region."

Feed technology now with added ingredients

Stutzinger added the feed ingredients and additives segment is a fast-growing category within the feed to food supply chain. VIV's own perspective sees animal health alongside nutrition as twin pillars supporting the further sustainable growth of the production in Asia of meat, eggs, fish and milk."

Van den Ende expects that the combined event will attract more visitors as well as having a larger footprint with exhibits and conferences on health and nutrition side by side with the displays and seminars on feed manufacturing technology. "VICTAM is formally constituted in The Netherlands with the status of a not-for-profit Foundation to do good for the animal feed industry. The agreement to put VICTAM Asia 2020 together with VIV Health & Nutrition Asia fits that objective because we believe the industry will be happy about it.

"Almost 20 years ago in Europe, VICTAM and VIV events was combined at the last minute due to an animal disease crisis. The market at the time reacted well to that combination with no negative comments. I think we will see a similarly positive industry response to amalgamating our Bangkok shows in 2020."

VICTAM Asia and Animal Health & Nutrition, by VICTAM and VIV, will be marketed jointly by VICTAM's and VIV's sales teams. Pre-registration to attend will be available shortly through a newly created website.

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

THE NATIONAL CONFERENCE & EXPOSITION OF

U.S. Aquaculture Society — A Chapter of the World Aquaculture Society

NATIONAL Aquaculture ASSOCIATION

Aquaculture Suppliers Association

PREMIER SPONSORS

DAR PRO INGREDIENTS

BLUE AQUA®

KEMIN

Tyson INGREDIENT SOLUTIONS

ZEIGLER nutrition through innovation

Associate Sponsors:

AFIA, Aquaculture Committee • American Tilapia Association • American Veterinary Medical Association
Aquacultural Engineering Society • Aquaculture Association of Canada • Catfish Farmers of America
Global Aquaculture Alliance • International Association of Aquaculture Economics and Management

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

Asian launch of an innovative and intensive shrimp farming concept

ADM Animal Nutrition, part of Archer Daniels Midland Company (NYSE: ADM) announced the launch of BIOSIPEC in Asia, a comprehensive solution for intensive shrimp production based on innovative techniques involving feeding, biosecurity, water treatment, aeration system and digitisation, at the Asian-Pacific Aquaculture 2019 held in Chennai, India. Visitors at their booth had an opportunity to discover this single model through a virtual reality movie.

Inside the demonstration nursery in South Vietnam.

Biosipec was initially developed by ADM in Vietnam after observing the characteristics of vannamei shrimp farming, the associated risks (particularly relating to the environment and diseases), as well as sustainability issues. The solution helps to reduce farming risks and environmental impacts and maximizes profitability for shrimp farmers. To showcase the different innovations and provide training to farmers, a demonstration unit was set-up in ADM's Aqua R&D centre in Southern Vietnam two years ago.

To achieve high growth and survival results, BIOSIPEC applies innovative technologies:

- Water treatment to improve biosecurity and prevent disease outbreaks
- Special aeration system to reduce energy cost and optimize water aeration
- Specifically, formulated feed for improved growth and stable water quality

"In 2018, the vannamei shrimp production and exports increased throughout Asia, particularly in India, Vietnam, Indonesia and the Philippines. Further growth is forecast in the coming years, according to the World Aquaculture Society" said Marc Campet, Aquaculture Manager, ADM Animal Nutrition, Asia. "To achieve successful farming results, the choice of feed, water quality, biosecurity and technique all play an important role in shrimp quality and productivity. With Biosipec, we can produce shrimp successfully, differently and sustainably. Our demonstration farm is available for shrimp farmers to discover the different technologies used and provides training to aquaculture professionals," added Campet.

Throughout Biosipec's commercialisation, ADM will be providing training on the use of technology, processes and best-practices to shrimp farmers. This new project reinforces the company's commitment towards the development of aquaculture in Asia.

"Biosipec is an exclusive concept that ADM has designed for its customers in Asia. We are very proud to have developed this solution combining all of ADM Animal Nutrition's know-how. This concept has been developed to answer a market need identified by our teams; it will support the evolution and consolidation of the shrimp aquaculture industry in Asia," said Pierre Domps, Director Marketing and Commercial Development, ADM Animal Nutrition, Asia. www.adm.com

Marc Campet (second left) and Pierre Domps (left) with the ADM team in India and Sekar, Chief Technician, Sapthagiri Aqua (middle).

BMR Group Chairman B. Masthan Rao (centre) with his team of researchers, technicians and hatchery managers together with other participants.

AE2019 welcomes Women in Aquaculture event

A seminar looking at ways to ensure greater gender diversity at all levels of the aquaculture sector is scheduled to take place in Berlin on 9 October, as part of this year's Aquaculture Europe (AE2019) conference.

Jointly organised by the European Aquaculture Society (EAS) and The Fish Site, the Women in Aquaculture seminar will offer first hand insights into how women can overcome perceived gender-related obstacles and build thriving careers right across the aquaculture sector.

"Many promising young researchers and many of the top aquaculture executives from Europe and beyond will be in Berlin for the annual EAS conference and this special session aims to help companies engage with proactive strategies for building diverse workplaces," explains Alistair Lane, Executive Director of EAS.

The one-hour event will be co-chaired by Nofima's Synnøve Helland, who is a board member of EATIP and leader of the Gender Panel of EURASTIP, and Rob Fletcher, senior editor at The Fish Site – which has been responsible for a number of women in aquaculture initiatives over the course of the last year.

"The Fish Site ran a series of articles on women in aquaculture during 2018 – both to tell the stories of women's achievements in the sector, and to help attract talented people. The series has had nearly 40,000 visitors, with reader's eager to find out why these women chose aquaculture, how their careers have progressed and how their hard-won insights can help others succeed. We hope this seminar will help to build on this success," explains Rob.

The event will include a panel discussion featuring prominent figures from academia and the aquaculture industry, who will discuss key issues related to the benefits of diversity in the workforce and ways to ensure that aquaculture organisations pursue recruitment policies that allow talented people, regardless of gender, to succeed.

The seminar will also include a Q&A and an insight into an innovative mentoring programme which has been established to help fast-track ambitious and talented women to the top of the sector. More details of the event will be released in the coming months.

---

aquaculture europe 19

This year, Aquaculture Europe will be held in Berlin, Germany from October 7-10. The Aquaculture Europe events are all about communication with the sector. The AE event is a focal point for meetings of European associations, satellite workshops of EU projects and other events. AE2019 will feature a special international trade exhibition, where German and international companies will present their latest products and services. Since 2014, EAS has teamed up with the European Aquaculture Technology and Innovation Platform (EATiP) to organise a special one-day event of panel discussions focussing on relevant and timely issues for the sector. The EAS thematic groups will also organise special sessions and/or workshops within AE2019. Other industry panels will take place around the trade exhibition, and technical tours will be organised.

Networking for students

A special forum will be arranged for students attending AE2019 to enable networking and exchange of ideas. The forum will have a dedicated programme and include a special student reception. Students receive the full registration package plus the student reception. To qualify for the student rate, a copy of a student I.D. is required.

Innovation Forum and Tours

EAS will offer a unique opportunity for entrepreneurs, investors, farmers, supply and service companies and scientists to join a full day programme. During that day, entrepreneurs with new innovative start-ups or ideas will be given the opportunity to pitch their business models to an audience representing the global aquaculture sector. This event will offer a unique opportunity to interact with key investors and decision makers in the industry. There will be time for networking and one to one meetings with interested parties. Updates on keynote speakers and program will be available here: www.aquaeas.eu/uncategorised/448-aquaculture-europe-innovation-forum

AE2019 Local Organising Committee has announced pre and post conference tours.

On Sunday, **October 6** , there will be a visit to a state-of-the-art, **semi-commercial RAS research** infrastructure for the reproduction and production of pikeperch (*Sander lucioperca*), operated by the Institute of Fisheries of LFA.

On Friday, **October 11**, the excursion will be to two outstanding hotspots for **Aquaponics in Berlin**, one urban aquaponic producer (ECF Farm) and one of the leading research institutions in this field (IGB Berlin). This will give a first-hand impression of a commercial RAS-aquaponic production system for tilapia and basil plants and you can take a close look at the research facilities and infrastructures that were used i.e. for the renowned INAPRO FP7 project. More details: www.aquaeas.eu/uncategorised/447-ae2019-tours

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**

August 14-15
TARS 2019: Aquafeeds
Bali, Indonesia
www.tarsaquaculture.com

August 25-30
26th Annual Practical Short Course on Aquaculture Feed Extrusion, Nutrition and Feed Management
Texas A&M, USA
https://perdc.tamu.edu/extrusion/

August 29-31
Vietfish 2019
Ho Chi Minh City
http://vietfish.com.vn

August 28-30
14th Shanghai International Fisheries and Seafood Exhibition
Shanghai, China
https://www.worldseafoodshanghai.com

September 3-5
Seafood Expo Asia
Wanchai, Hong Kong
www.seafoodexpo.com/asia/

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

October 7-10
Aquaculture Europe
Berlin, Germany
www.aquaeas.eu

October 21-24
Global Outlook for Aquaculture Leadership (GOAL)
Chennai, India
www.aquaculturealliance.org/goal/

November 5-8
LARVI 2019
Bangkok, Thailand
https://www.ugent.be/bw/asae/en/research/aquaculture

November 12-14
INFOFISH World Shrimp Trade Conference and Exposition
Bangkok, Thailand
www.shrimp.infofish.org

November 15-18
Giant Prawn 2019
Shanghai, China
www.giantprawn.org

November 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

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

aquaculture europe 19

OUR FUTURE
GROWING from WATER

BERLIN, GERMANY
OCTOBER 7-10

For more info
on the CONFERENCE
ae2019@aquaeas.eu
www.aquaeas.eu

For more info
on TRADESHOW & SPONSORSHIP
MarEvent
mario@marevent.com
www.marevent.com




BioMar
Gold Sponsor

#AE19BER

eas
www.aquaeas.eu

UNI MAX - MAXIMUM PROFIT AQUACULTURE PROGRAM

With almost 20 years' experience in the field of aquaculture feed, prawn larvae, water treatment, aquatic health products and pond solutions, we are a pioneer in prawn feed manufacturing and today, one of the world's leading aquaculture feed suppliers.

We would like to introduce our "Uni-Max program" - the best solution for aquaculture to help our Asian farmers achieve the highest profits.

UNI-PRESIDENT VIETNAM CO., LTD

No. 16-18-20, DT 743 Road, Song Than II Industrial Zone, Di An Ward, Di An Town, Binh Duong Province, Vietnam.
Tel: +84 - 274 - 3790811
Fax: +84 - 274 - 3790819
Website: www.uni-president.com.vn
Email: aquafeed@upvn.com.vn

AQUATIC BRANDS OF UNI-PRESIDENT VIETNAM CO., LTD