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AQUA CULTURE

Asia Pacific

The Marine Shrimp Industry in 2017

Living with the white spot virus in Negros

A millennial's view on shrimp disease

Fusarium Mycotoxins in Aquafeeds

Functional Hydrolysates

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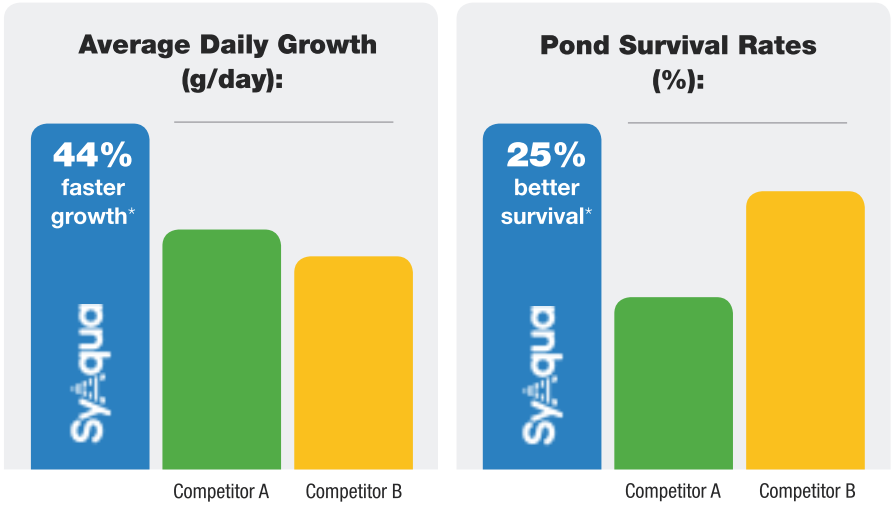

* Based on actual data from 2016 from 606 ponds in Southeast Asia.

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View of ponds at the Calumangan farm in Negros with the active Mount Kanlaon in the background (Picture by Ong Si Mon)

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The year ahead – where are the weakest links and opportunities?

Zuridah Merican

In the history of agriculture, revolutions have occurred around developments in seed, feed, disease mitigation and environment control. The Asian aquaculture industry is in dire need of these revolutions. So in 2018, where should be our focus be? The industry should focus on the weakest links recognising that these are species specific.

In the marine shrimp industry, disease ranging from the acronyms of WSSV, AHPND, EHP to WFD are placing a roadblock not only on expansion but on current farming practices today. In 2018, the long road towards finding any therapy will continue. Shrimp have a primitive immune system, so this is not an easy task. Furthermore, a disease-challenged shrimp is not going to consume feed, the desired delivery system for a therapy. Prevention is still the best option and the industry must learn to control the trigger points for disease. It needs to use science not empirical solutions to understand the uniqueness of each pond ecosystem. Why is Ecuador's *P. vannamei* model performing so well when Asia's is not? Is it the difference in the loading on the carrying capacities of each system? If the Asian model is to succeed, it must look closer at environmental control especially in the nursery phase or the first 30 days after stocking so as to strengthen the animal.

In marine fish, both disease and genetics are the weakest links. For certain high value species like groupers, the industry can live with 30% survival due to high prices but this model is its own worst enemy as complacency sets in. There is little regard for biosecurity or vaccination as this model stumbles along. The research community needs to give industry solutions to combat NNV and Iridovirus. The barramundi segment has an inherent competitive edge as an identified single species with economies of scale. However, genetics and seed supply are still weak links. Genetics can contribute to high growth strains which also has added benefits of shortening the farming cycle which reduces risk and improves cash flow.

The freshwater fish industry faces a different challenge altogether – here the weakest link is image and marketing. In Vietnam, stakeholders in the pangasius segment and government must invest in market promotions and communications to respond quickly to negative publicity. Any bad apple will ruin the image of the fish and the chances of moving up the value ladder, and finally derail any potential price increase. Today, the low prices of the end product do not allow sufficient margin for any segment of the supply chain to invest in genetics, feed or vaccination for disease mitigation. The tilapia segment is over-reliant on the US market which is currently experiencing a down cycle where supply exceeds demand. The market in Europe for tilapia has hardly been tapped.

The market is defined by demand and supply. Asian aquaculture tends to be so focused on supply that it forgets about demand. Emerging markets are slowly creeping up on the traditional markets of Japan, US and Europe. China has been a net importer of shrimp for the past few years and has transformed into a major market for any seafood (this term includes freshwater fish). Vietnam's pangasius seems to making good inroads into China. In 2018, industry needs to follow the 'people and their wallets.' In other words, the population and their purchasing power. India with its 1.3 billion population is forecast to overtake China in 2022 as the most populous country. India, which previously exported nearly 100% of their shrimp is now looking at a growing domestic consumption in its equivalent tier one cities of Bombay, Delhi and Chennai. Mexico, with a population of 123 million people, is an emerging market for tilapia, a traditional fish for its population. Although Mexico's high valued fresh chilled tilapia is exported to neighbouring US, it still imports frozen Chinese tilapia to meet local demand.

Goldman Sachs predicts global growth will reach 4% in 2018, buoyed by synchronised expansion across developed and emerging markets. Let us take the opportunity to ride the wave and not remain content with mediocrity.

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Philippines shrimp: A unified direction for production and growth

There is optimism to increase production with higher consumer demand and an active processing segment.

The Philippines shrimp industry is seeing some changes. Production is increasing. Official figures from the Philippine Statistics Authority, 2016 indicated 59,655 tonnes in 2016. Most of the growth in production was from central Luzon and northern Mindanao. The Bureau of Fisheries and Aquatic Resources (BFAR) also targets a 2% annual increase in production until 2022 under the agency's HIPON program (see page 6). Prices are higher and stable, PHP 165/kg as compared to PHP 130/kg for 10g shrimp in 2016. Demand from the domestic market is increasing. The processing segment is more active than was reported in 2015. In 2016, exports of frozen shrimp rose to 6,333 tonnes valued at USD42 million (EMB, 2017). However, costs of energy and logistics are much higher here than in other countries in Southeast Asia and the next step is to increase production efficiency to remain competitive.

The theme for this 11th National Shrimp Congress and 58-booth Trade Show held in Bacolod City, Negros Occidental from November 16-18, 2017 was "Sustainable shrimp industry: Unified direction towards production and growth". The event was attended by 1,250 participants. There were 29 presentations in the conference covering a range of topics along the supply chain to guide industry towards higher production efficiency and growth.

While projecting growth, Roberto A Gatuslao, President, Philippines Shrimp Industry Inc (PhilShrimp) described the industry's woes, "Sometimes we get lucky in our farms and sometimes not, but we try to do our best. On post-harvest, we want to improve conditions and satisfy market demands. The vision is to grow together and to have a better outlook for the small-scale farmers carrying out extensive shrimp culture with lower operational costs. Our intention with this congress is to inspire participants to do better."

Commodore Marfenio Y Tan, Chairman, San Andres Fishing Industry Inc. (SAFII) which operates farms in Saragani, Mindanao, under the San Andres Aquaculture Corporation, clearly expressed the desires of the industry. He has been in shrimp farming for the past 38 years and has learnt the hard way developing farms. Shrimp farming has grown as a commercial business, created employment and is supporting ancillary businesses such as packaging etc. However, the local market is small and to date, there has been little incentive to be competitive. The industry needs to improve to grow regionally as well as internationally, just like Vietnam. "Technology is at our doorstep. We can use nursery and probiotics to improve production. We need to be proactive with disease prevention and need help in forecasting markets. We need to ensure importation of broodstocks as the industry grows. The private sector is ready to work with the government."

PhilShrimp Officers, from left; Christopher Co, Vice President Visayas, Constantine Tanchan, Director Visayas; Roger E Rivera, Vice President, Mindanao and Ramon Alegre, Director for Hatchery group.

Industry updates

According to BFAR, there were 510 registered shrimp farms for farming either the vannamei or monodon shrimp in 2016. Most of the newer farms are in Mindanao with the established farms in the Visayas. There are 29 accredited hatcheries producing vannamei post larvae using imported specific pathogen free (SPF) broodstocks, mainly from the US. Marginal farmers carrying out extensive farming, stocking 1-5 PL/m^2 usually depend on lower cost post larvae produced by backyard hatcheries using pond reared broodstock. These post larvae (PL8-10) costs as low as 8 centavos each (USD 1.60/1,000 PL) in comparison to 25 centavos each (USD 5/1,000 PL10) from the accredited hatcheries. Both BFAR and NPPC recommend PL12 for stocking. Since 2013, in an effort to prevent the entry of early mortality syndrome (EMS) and other shrimp diseases, BFAR banned imports of live shrimp from Southeast Asian countries and also China.

"Quite common features in grow-out ponds are liners and shrimp toilets. In fact, some farms break cycle to install shrimp toilets. Stocking density varies depending on carrying capacity. The range is from as low as 80 PL/m^2 to 200 PL/m^2 to produce 30-40 tonnes/ha in lined ponds. Farms usually have three partial harvests with the first harvest after the second to third month to produce 15-18g shrimp and some continue until shrimp reach 40g.

"During the cold season (November to February), small farms either continue farming shrimp, polyculture shrimp with tilapia or farm only tilapia. Large farms can afford to break cycle. Prices are high from November to April. Today, we also see that differences in shrimp prices for domestic and export markets narrowing," said Chris Mitchum Ganancial, Bayer, Philippines.

At the Biosolutions booth, sitting, Mary Ann C. Solis, Sales Director, Biosolutions International Corp (left) and Emelyn Bravo, Bacolod, Philippines. Standing, Alexandre Veille, Olmix, Jakarta, Indonesia (left) and Dr Dean Akiyama, Consultant, Feedmix. Veille presented on immunomodulation as feed additives and Akiyama on technical constraints for the shrimp farming industry.

Ryan Alegre, Dobe Hatcheries (second left) and team.

White spot syndrome virus (WSSV) is the major disease threat with both the monodon and vannamei shrimp affected. There are reports on outbreaks of early mortality syndrome (EMS) and *Enterocytozoon hepatopenaei* (EHP), but industry players say that the impact of the latter is less compared to that of WSSV. However, WSSV may occur singly or in combinations with EMS or EHP. In her presentation during this Congress, Roselyn Usero, from the NPPC laboratory, reported widespread outbreaks in region 1 (Ilocos) for all three diseases for the January-September 2017 period while EMS was more prominent in region 8 (Eastern Visayas).

Reviving monodon shrimp farming

Monodon shrimp hatcheries still depend on wild broodstock for post larvae production. Although monodon shrimp are being farmed by both large and small farms, the majority are marginal farmers. In aquaculture, the Department of Science and Technology (DOST) has a program to help small and medium sized entrepreneurs. During this Congress, the Southeast Asian Fisheries Development Center/Aquaculture (SEAFDEC/AQD) held an evening session to discuss with industry stakeholders its plan to return to monodon shrimp farming with the "Oplan Balik Sugpo" program.

Dr Leobert de la Pena reviewed the status of monodon farming and Dan Baliao, AQD chief described the program on domestication and breeding of the species starting with the local wild stock. The aim is the production of SPF broodstock and disease-free post larvae. Past experiences with domestication and the development of breeding programs for the shrimp in Hawaii and Thailand, indicate that it will take several years before SPF broodstock will be available for industry in the Philippines. Recognizing the long process, high investments as well as the high prevalence of WSSV in wild stocks, industry stakeholders countered the local wild stock breeding plan with suggestions of introducing SPF *P. monodon* broodstock from Thai and Hawaii breeding programs.

PhilShrimp director for Luzon, German D Cruz (left) and Vice President Luzon, Jake Lorenzo S Vergara.

Success stories and polyculture

Farmer Conde Mascado in Brgy Dahican, Mati City, Davao Oriental recounted how he started as a small marginal farmer, with a 0.5 ha pond stocking 20,000 post larvae (4 PL/m^2) in 2012. He suffered for over a year with WSSV. Subsequently with help attributed to the technical assistance provided by Charoen Pokphand Foods Philippines Corporation and support from BFAR, his group slowly built up their shrimp farming business into intensive farms. The group now has 64 farmers with a total culture area of 100 ha. They formed the Dahican Shrimp Association. Mascado alone has an 18-man team at his farm and others in the vicinity now enjoy better livelihoods from shrimp farming.

Erwin D. Enriquez of TDNRC Aquafarm detailed practices in traditional extensive systems in Hagonoy, Bulacan. Milkfish is the major commodity and shrimp is added for additional income. Initially, milkfish and vannamei shrimp are stocked in separate ponds for 1-3 weeks. From the second week, milkfish and shrimp are released to grow-out ponds at the same time. Stocking density of shrimp is 5-7 juveniles/m^2, days of culture for shrimp is 75-90 for sizes 12-30g. Partial harvesting of shrimp starts after 2.5 months or when shrimp reaches 12g. Shrimp yields are 150-250kg/ha and there are 3 cycles/year, providing a profit margin of 40%. In polyculture with tilapia in Pampanga, Philip Naguit said that tilapia serves as the major commodity and vannamei as an additional income, with a profit margin of 70%.

Related article: Living with the white spot virus in Negros, pages 8-13.

Pangasius: High ex-farm prices and more exports to China in 2017

Ex-farm prices for the pangasius in the Mekong Delta, Vietnam have been rising since May 2017. It reached VND28,000-29,000/kg (USD1.23-1.27/kg) in December 2017. This is the highest level in several years, according to the Seafood Farming and Export Association in An Giang province. Farmers could profit around VND5,000-7,000/kg, reported *sggpnews.org.vn.* Vietnam Association of Seafood Exporters and Producers (VASEP) reported that exports of pangasius fillet reached USD 1.8 billion in 2017.

As of September 2017, while sales to the US and the EU were down, Vietnam increased its exports to China by 42%. Shipments to this market recorded continuous growth, showing the shift of many pangasius exporters to the China market. Exports to the US were down 9.9%. In the preliminary decision of POR13, the US Department of Commerce announced a tariff of USD2.39/kg, 3 times higher than in POR12. In the EU, exports were down as pangasius competed with whitefish products. In September 2017, Vietnam's pangasius exports to Brazil were up 103.3% over the same period last year; exports to Mexico, Colombia and Saudi Arabia rose by 22.6%, 1.4% and 4% respectively.

Guangdong Evergreen begins tilapia farming in Egypt

Zhanjiang-based Guangdong Evergreen, a market leader in aquafeed production in China, and the government of Egypt have set up an aquaculture complex in the Ghalyoun Lake Industrial Park. This is an integrated project for tilapia and shrimp farming, feed production and processing. During the China Fisheries and Seafood Expo in November 2017, Leo Xie, general manager of Evergreen gave some details on the project covering 1230 ha to *undercurrentnews.com.* The feed mill has a capacity of 120,000 tonnes/year of fish feed and 60,000 tonnes/year of shrimp feed. The lake farming has 100 x 20 m diameter cages. Evergreen has also built a hatchery for both fish and shrimp. Founded in 1998, the Evergreen group is a large-scale private enterprise focusing on farming, aquatic product processing and real estate development. With dozens of subsidiaries in Guangdong, Guangxi, Hainan and Fujian, it has been listed as one of the top 500 private companies in China.

FDA shrimp entry lines refusals in 2017

In its January post, the Southern Shrimp Alliance (SSA) reported on the import refusals by US FDA (Food and Drug Administration) throughout 2017. In December 2017, FDA refused a shrimp entry line for shrimp contaminated with veterinary drug residues from Myanmar. The FDA reported refusing just 55 entry lines of shrimp for reasons related to banned antibiotics. This is the lowest total number of shrimp entry line refusals for banned antibiotics reported since 2012. The SSA commented that other major shrimp importing nations continued to report significant detections of banned antibiotics in shrimp imports, particularly from India and Vietnam. The European Union has mandated that one out of every two shrimp shipments from India be tested for banned antibiotics.

However, the FDA's reporting in 2017 implies that significantly less testing of shrimp shipments were conducted in 2017 compared to prior years. It added that a significant portion (27.3%) of the total shrimp entry line refusals in 2017 can be traced to a single company and its affiliate. In 2017, the FDA's reporting indicates that the issue of banned antibiotics in shrimp continues to be concentrated in only a small number of nations; 85.5% (47 of 55) of all such shrimp entry line refusals last year came from just three countries: 19 were of shrimp imported from China (including Hong Kong), 16 were of shrimp imported from Vietnam, and 12 were of shrimp imported from India.

HIPON
Hipon Iangat ang ProduksyON

In English, "Hipon langat ang Produksyon" means an increase in shrimp production. "Hipon" is a Filipino word for shrimp. During this congress, Abegail A Albaladejo, focal person for shrimp culture at BFAR outlined the roadmap until 2022, developed with consultation of industry players. The cautious target is to increase shrimp production annually by 2%. This program is fully supported by BFAR Director and Undersecretary for Fisheries Commodore Eduardo B Gongona PCG (Ret). At its board meeting following the congress, PhilShrimp endorsed the implementation of the HIPON Program.

Roselyn d. Usero (right) and Abegail A Albaladejo launched the manual on "Fry Quality Assessment Criteria for Shrimp Culture in the Philippines" at this congress.

The main aim of this program is to train more shrimp grow-out farm technicians at shrimp schools established within BFAR facilities. Several other strategies and recommendations such as promotion of science based culture in extensive farms; implementation of good aquaculture practices and, broodstock multiplication centre and exploration of alternative energy sources, hopefully, will be implemented with the next 5 years.

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Living with the white spot virus in Negros

By Zuridah Merican

At the Calumangan farm, mitigation efforts against WSSV outbreaks are clean post larvae, biosecurity measures, optimal water quality, disease monitoring and carrying capacity.

Among the many potential diseases feared by shrimp farmers in the Philippines, it is none other than the white spot virus. The virus is ubiquitous in the two farms belonging to major aqua feed producer, Hoc Po Feeds Corporation in Calumangan, Negros Occidental and in Balibago, Calatagan, Batangas, Luzon. In fact, the Calumangan farm was abandoned by its previous owner because of losses from white spot syndrome virus (WSSV). Hoc Po took over the farm in 2010 and developed 26 culture ponds in the 34 ha site. The farm will be adding 10 more ponds in the near future.

Since 2010 to date, shrimp were positive with white spot virus which have been successfully mitigated. Other than in 2013 and 2014, where there were emergency harvests, successful harvests have been achieved consistently. The key success factors are clean post larvae; biosecurity; regular monitoring of water quality, *vibrio* and white spot virus; and an understanding of each pond carrying capacity.

The Calumangan farm has one primary 2.3 ha reservoir used for water storage and two secondary reservoirs and treatment ponds. Four culture ponds are HDPE lined and are deeper at 1.2 -1.4m as compared to 1.0-1.2m deep earthen ponds. Pond sizes are generally around 4,000-7,000 m^2. Water is pumped from a nearby river during high tide and stored in the primary reservoir.

In the Philippines, the Bureau of Fisheries and Aquatic Resources (BFAR), the authority in charge of aquaculture development in the country issues licenses for shrimp farming. Hoc Po Feed Corporation has a license to farm both vannamei and monodon shrimp, but to prevent interspecies transfer of diseases BFAR's regulations discourage a single farm from farming both species. Thus, only vannamei shrimp is cultured in this farm.

In pond preparation, ploughing is carried out, at least three times to a maximum of five times. Buffalos are used in this process. (Picture by Simon Ong)

Planning for harvests

The Philippines shrimp market is unique. In the Manila market, the offer price for 10g shrimp is extremely high at PHP300/kg, and supply is dominated by farms in Luzon. The price remains unchanged for 12g shrimp. Supply of the larger size shrimp such as 15-19g comes from farms on other islands, like the Calumangan farm. Therefore, production planning at this farm must take into account this demand as well as plan for the shortest culture duration, the shorter the better to reduce risks of disease and pond carrying capacity.

"Our target is an average daily growth (ADG) of 0.25g which means that we can get 15g shrimp before 70 days of culture (DOC). Buyers in Bacolod will not buy smaller shrimp unless they need to fill up a container. Taking into consideration pond carrying capacity, we actually start our partial harvesting at 15g or 10 tonnes per ha, whichever comes first. Although there is demand for larger 19-25g shrimp which we can also produce, we prefer to harvest at smaller sizes. In the subsequent one or two partial harvest, we can get larger shrimp," said Hearty A. Magbanua, Branch Manager, Hoc Po Feeds Corporation.

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The management team and visitors at the farm's office. Simon Ong (centre) and Hearty A. Magbanua (front right). From right, farmer Andrew Baldwin, Mindanao; Hernan G. Lim, President, Hoc Po Feeds Corp; Otto Tsai, General Manager, Quadlink Technology, Taiwan; and Mike Lim, Manager, Jacinto Candido, Farm Technician and Hilario Callos, Consulant from Southern Milling Corp, Philippines.

"We sell our harvests to buyers who most likely send these to markets in Manila as Luzon producers cannot supply this size. We are lucky as prices have been very stable. This year, prices have not gone below PHP 165/kg base 10g. Three years ago, prices were low as PHP 130/kg base 10g. We sold our last harvest of 15g shrimp for PHP240/kg base 10g (PHP260/kg for 15g shrimp). This is good as our cost of production ranges from PHP 159/kg when conditions are ideal to PHP180/kg during the rainy season." (Editor's note: Prices rose to PHP270/kg for 15g in December).

Carrying capacity

Currently, the stocking density depends on pond conditions. It is 80-90 PL/m^2 for earthen ponds and 90 -100 PL/m^2 for the lined ponds. In the Philippines, energy costs are high. It is apparently twice the energy cost in Malaysia. As a result, the farm does not run paddlewheels throughout the day. Aeration is now 350 kg shrimp/hp at night and only 500 kg/hp during the day. The plan is to increase aeration with blowers.

"We need to understand carrying capacity of each pond well. Each pond has its own attributes and so we cannot assume that carrying capacity is standard. After 2 years, one can easily estimate the carrying capacity of each pond at a farm. Sometimes, even by increasing aeration, we see that we cannot adjust a pond carrying capacity. Our strategy is to start partial harvesting as planned or when we have suboptimal water quality readings (ammonia, nitrite, nitrate, phosphate, alkalinity and hardness of calcium and magnesium etc) and when we see that shrimp are stressed. We analyse water quality parameters twice a week," said Simon Ong, a managing director of HP Multi-Lines Inc., a subsidiary company of Hoc Po, marketing allied products, probiotics and immunostimulants. Ong is also a consultant, advising the management team on disease prevention and mitigation.

"Partial harvesting is also the way to manage carrying capacity. In the earthen ponds, the carrying capacity is less at 5 tonnes/ha whereas it is double (10 tonnes/ha) in lined ponds."

Step by step monitoring

The reason for very close monitoring is to be ready to preempt adverse conditions triggering a WSSV outbreak. Post larvae (PL 12) supplied by a certified hatchery, is checked by a BFAR laboratory in Cebu. Post larvae are also sent for second testing at the Negros Prawn Producers Cooperative (NPPC). In pond preparation, ploughing is carried out at least three times to a maximum of five times. This process will take 9-15 days depending on the number of ploughs used. After each plough, soil samples are sent to the farm laboratory to measure *Vibrio* populations.

Lined pond with digital monitoring devices to continuously monitors temperature, pH, oxidation-reduction potential (ORP), dissolved oxygen and salinity.

Daily the sludge is pumped into these large tubs and transported out of the farm to mangrove areas for disposal.

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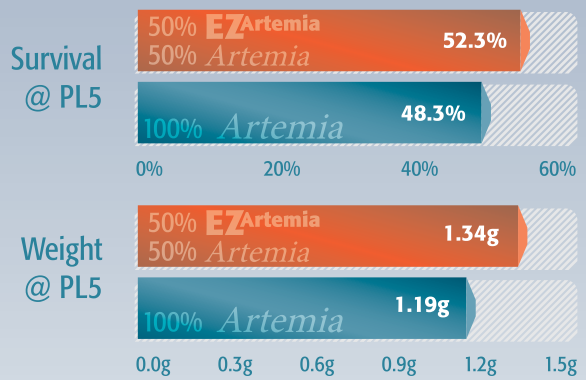

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"Once the *Vibrio* level is less than 50 CFU/g at the third plough we stop. If the *Vibrio* population is more than this amount, we will then add probiotics (HPML) after the third plough.

"We are very fortunate that here the volcanic soil pH is 8-9, and we actually do not need to add lime. The hydrogen sulphide is also low, contrary to ponds located in mangrove areas. That is why earthen ponds are more suitable for us. We filter incoming water and chlorinate (70% chlorine). The downside for this farm is the large range of salinity — from 18 ppt to 5 ppt when it rains for a week. We experience this 5 ppt salinity when we had the eye of the typhoon passing us recently. This means that there can be no water exchange for the first 45 days of the culture cycle," said Ong.

"To automate water quality monitoring, we are now testing a digital monitoring system, each separately in an earthen and lined ponds. Taiwan's Quadlink technology, powered by solar cell continuously monitors temperature, pH, oxidation-reduction potential (ORP), dissolved oxygen and salinity. It then sends the measured data to the cloud via the internet. Our limitation is however, the poor wifi connection. You will be surprised on the importance of ORP readings in shrimp farming and how it signals stressful conditions," added Ong.

The earthen ponds at the farm are all originally equipped with a central drainage system, where sludge will flow out with gravity. Today, the sludge is pumped into large drums daily. These are then transported out of the farm for disposal.

Harvest of ~15g (Picture by Simon Ong)

Biosecurity

In charge of farm infrastructure and marketing, Hearty has gone all out to ensure that the farm biosecurity is maintained at all times. At the farm entrance is a shower area, specifically for the part-time harvesting team of seven to shower before entering the ponds for the partial harvesting process. Usually, there will be three partial harvests for each pond. Hearty has also set up a harvest station close to the entrance. Buyers' lorries are not permitted to enter the farm at all. Within the farm, groups of ponds are fenced off and only pond aides for the particular area are allowed to enter the area.

Ong described the steps in the mitigation and PCR diagnosis of the white spot virus after stocking. "In the first 15 days after stocking, we will add the immunostimulant with anti-viral properties, Beta Defense Plus to the feed. After 15 days, we test the shrimp. This is to determine if there has been a transfer of the virus from the hatchery. Throughout the farming cycle, every 15 days, we send shrimp samples for PCR test for the virus. We also use the Pockit PCR system (GeneReach, Taiwan) for quick results but confirm with PCR tests at the NPPC laboratory. If the virus is detected, we immediately use Beta Defense Plus and mitigation protocol to counter the white spot virus. We then send another sample for testing after a week. Otherwise, we just continue with Beta Defense.

"When we look back at how we have been challenged by white spot virus since 2010, we are glad that we now have a solution. We have managed to reverse the positive results to negative ones. The regularity of PCR test may cost money but we only needed to do four tests if the cycle is 90 days. Imagine the consequence of not testing and faced with an outbreak."

Key performance indicators for Calumangan farm

- ADG: 0.25g
- Harvest size: ~15g <DOC70
- Survival rate: 80% from PL 12 to 15g
- Number of cycles/year: 2
- Feed cost/kg of shrimp: PHP56/kg of shrimp at FCR 1.3 and 15 g shrimp over DOC90

Improving shrimp resistance to diseases through early detection and immuno-response enhancement

During the conference, Simon Ong, representing GS Biotech, Malaysia and HPML looked back at some experiences in handling diseases at Hoc Po farms as well as at other farms. He discussed some trials with disease mitigation of the white spot virus syndrome, occurring singly or co-infection with white faeces disease in farms, using Beta Defense Plus.

Ong said that white spot is a major threat while the emerging ones are *Enterocytozoon hepatopenaei* (EHP), which also occurs together with WSSV. "White spot virus can cause the primary infection followed by *Vibrio* or vice versa. Contrary to our experiences, where yellow colonies are not toxic like the green colonies, we consider both as harmful. This came about from our experiences in dealing with luminous shrimp disease during the days of farming the monodon shrimp. Filipino farmers understand and know how to control *Vibrio harveyi*, the causative pathogen for the luminous disease. Thus today, they continue to apply the same protocols in combating other *Vibrio* sp including *V. parahaemolyticus*, the cause of EMS/AHPND."

Ong showed PCR test results demonstrating the efficacy of Beta Defense and Beta Defense Plus in mitigating several disease situations. "I have used these facilities to detect suspected pathogens as well as confirm negative results after we have implemented some strategies. PCR test results are negative for the virus. Shrimp survival was 100%.

"For the Negros Occidental farmers the cooperative NPPC provides testing services and in Iloilo, there is SEAFDEC-AQD which also offers its services. In 2016, BFAR offered free tests as they wanted farmers to schedule testing every 15 days. Today, almost all farms follow a strict protocol of testing every 15 days."

What is clear, continued Ong is that, "We must not let the immune system be interrupted. The white spot virus will block the immune system. What Beta Defense does is to induce the prophenoloxidase (PPO), the immune protein and Beta Defense plus is to block the virus entering the host. There is actually no killing of the virus."

A millennial's view on shrimp disease management

By Zuridah Merican

Vietnam's disease diagnostics and research lab start-up aims to change the value chain from art to science.

The idea for starting laboratory services for the shrimp aquaculture industry in Vietnam came about during the early mortality syndrome/acute hepatopancreatic necrosis (EMS/AHPND) era in Vietnam and the region. Dr Tran Huu Loc known simply as Dr Loc, was part of the team instrumental in identifying *Vibrio parahaemolyticus* as the causative agent for EMS or AHPND in 2013. At that time, he was a PhD student at the University of Arizona, Shrimp Pathology Laboratory (UAZ-APL) working under Dr Donald Lightner.

With this background and training, Loc decided on his return to Vietnam to continue his academic and research career at Nong Lam University as Assistant Professor, Department of Aquaculture Pathology, College of Fisheries. In 2014, he founded ShrimpVet Laboratory to provide laboratory services to the industry in Vietnam. Working with Minh Phu, a leading shrimp farming and processing company, gave him a good start both in terms of facilities and a base to provide diagnostic services and carry out R&D. That is the reason why the lab, located in Binh Duong, north of Ho Chi Minh City, is also refered as "Minh Phu AquaMekong Laboratory. Listed Minh Phu has more than 1,000 ponds at its major farm in the Mekong Delta and has liaison with many contract farmers supplying both vannamei and monodon shrimp raw material for processing.

"Vietnam's shrimp farming is growing extremely fast but is saddled with disease challenges. Unfortunately, this has also encouraged farmers to use antibiotics to settle some woes with disease, whether bacterial, viral or microsporidian pathogens. We also have a lack of vertical integration in the industry," said Loc.

"Overall, I see a lot of work to be done for the industry here in Vietnam. There is lack of technical services and disease prevention/interventions. We lack good and reliable diagnostic services as well as good education for farmers, who are mostly small scale. I want to change the industry; move away from low efficiency and bad practices and strengthen technical support. I may not have the silver bullet but at least I can effect some change in the value chain - from broodstock to post larvae production to farming."

In 2015, the laboratory expanded to the shrimp hatchery area in Ninh Thuan province. This brought the team closer to industry in the central region. It also started production of clean post larvae (PL12) from a small hatchery, producing 30 million PL12/month) for the first phase. In the second phase, starting in 2018, it will produce 120 million PL12/month. Its post larvae clients have free access to the laboratory's diagnostic services.

Today, ShrimpVet has a team of 65 researchers working on shrimp diagnostics through to shrimp technology and farming. They carry out trials and disease challenge tests. "In Binh Duong, we have a wet laboratory, a specific pathogen free (SPF) facility, a nursery facility, and diagnostic centre. The SPF facility handles disease-free shrimp for research. SPF shrimp is a critical part of any of our research."

SPF (left) & WSSV-infected (right) shrimp (Picture courtesy of ShrimpVet Laboratory)

Diagnostics services and disease challenges

"Our customers can send their samples for analysis. Located in Vietnam and with access to *Vibrio parahaemolyticus* (VP_{AHPND}), the laboratory can use bioassay challenge models for several shrimp diseases; from EMS/AHPND, *Enterocytozoon hepatopenaei* (EHP), taura syndrome virus (TSV), white spot syndrome virus (WSSV), infectious myonecrosis virus (IMNV), yellow head virus (YHV), infectious hypodermal and hematopoietic necrosis virus (IHHNV) to *Vibrio* sp. to evaluate resistance in selected families and for testing feed additives such as probiotics, prebiotics, etc." The services are not limited to shrimp as it has done assays for fish diseases too (*Streptococcus* sp., Iridovirus, *Flavobacterium columnare*, etc.).

In terms of facilities, the laboratory in Binh Duong has several PCR (polymerase chain reaction) platforms/methods including on-site PCR (pockit), conventional PCR (thermal cycler, quantitative) and Real-time PCR. Pockit assays is a fast diagnostic method, applied in the field for quick diagnosis and for screening most of the dangerous diseases infected in fresh and brackish water aquatic animals. ShrimpVet is the only lab in Vietnam to participate in the annual Inter-laboratory Calibration- Ring test for shrimp pathogens.

"In disease detection, essentially, we either do field visits or send to the farmers the sampling protocol by email and based on the purpose for the diagnosis, we may ask for live samples. Farmers use the network of bus services to deliver samples to us. We are glad that we have this effective way to receive samples quickly and we email or phone the results," said Loc.

Tracking EHP and WFD

The EHP microsporidian is an emerging pathogen affecting shrimp farming in Vietnam and other parts of Asia. ShrimpVet has been working in collaboration with National Cheng Kung University, Taiwan on EHP as well as white faeces disease (WFD). They presented results of the research at the Asian Pacific Aquaculture 2017 shrimp industry session. There are no distinctive gross signs in EHP infected shrimp and the only indication for the farmer is retarded growth. WFD infected shrimp show floating white feacal strands on feeding trays and whitish to golden brown gut. Loc also described WFD histology in gut and hepatopancreas of affected shrimp. Histology of EHP just showed spores in lysed cells and in gut lumen. In a series of challenge tests, the research group confirmed that WFD is a bacterial disease affecting the gastrointestinal track of shrimp.

In the case of EHP, Loc said that even if the broodstock is EHP clean, during maturation over 4-5 months, there are risk factors such blood worms, oysters, squid etc being infected and fed to the broodstock. "Within these 4 months, I have seen 60-70% of broodstock contaminated. In one month, 20-30%. This goes on along the chain; nauplii to post larvae and in the grow-out, the microsporidian will multiply. I know that we can avoid such contamination by using frozen feeds. But the question is how available are these feeds. Imported live feeds cost more."

The solution is to inactivate the pathogen in the maturation facility and to routinely check for the pathogen at the nauplii stage. At this stage we can reduce the risks of infection by collecting eggs, followed by washing and disinfection. Next is ensuring post larvae biosecurity and checking with real time PCR whether post larvae are infected. Next, according to Loc, is the check for infections in the pond sediments.

In 2014 when Loc was tracking EHP, he then advised farms on what should be the steps to take, such as preventing contamination along the value chain, from algae to post larvae before stocking in ponds. "Nobody listened as farmers did not want to take any risks. I then added a small prototype hatchery in Ninh Thuan to explain the work required to monitor the microsporidian. Then many large companies picked up the information. They adapted and modified for their facilities. At least I know that ShrimpVet is making a contribution."

> **"In the end, I do not want aquaculture to be so unpredictable, I want to bring it closer to a science.." - Loc Tran**

Wish for industry

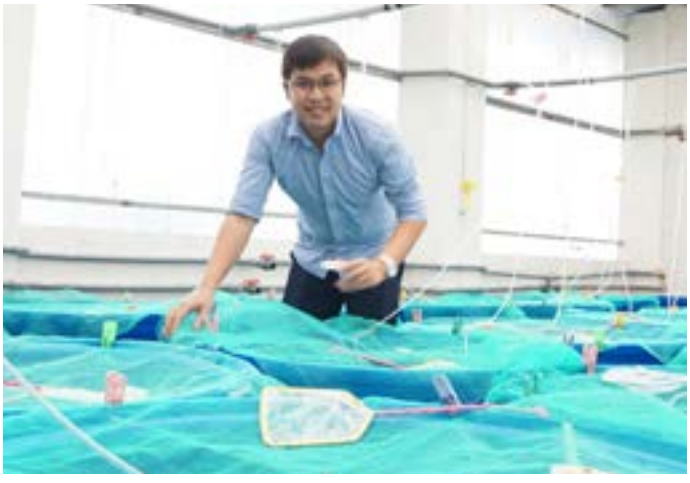
In 2017, to fulfill two objectives – quick diagnostics and then assisting industry with innovations through the total value chain – Loc set up a 6 ha farm which allows him to try out some ideas on improving farming technology and protocols. He wants to carry out more field trials at different stages or over the whole cycle of shrimp farming and then demonstrate through models. "If we do this right, have higher efficiency, we will be less dependent on antibiotics and have traceability."

Loc Tran (right) with his team

The farm will have square ponds for running trials. Water filtration and treatment is an important feature of this farm. "I want to show solutions along the value chain. I want to show that we start with good algae for better larval culture through to technology without the use of antibiotics. I want to contradict some practices such as at less than 30 days, the pond system is very immature and is building up *Vibrios* populations. I relate this to why having tilapia in ponds works to prevent disease. *Vibrios* in clean water will collapse if starved of organic matter. This is the concept of pond conditioning. Having a nursery phase with stronger shrimp is a way forward. I believe EMS and WFD can affect 1-2g shrimp too. Perhaps feeding with nutrient dense diets (albeit expensive) diets will strengthen shrimp during this phase.

"When post larvae performance is good, we then combine this with good farming protocols and new innovations in feeds. With the latter, I mean working with genetics to find the feed additives which will bring out the best of a particular stock." Loc is keen to start some training programmes. "I expect these programmes to be popular with the feed industry. Perhaps they can give vouchers to their clients to attend these courses. "In the end, I do not want aquaculture to be so unpredictable, I want to bring it closer to a science," said Loc.

During his pitch at the recent Aquaculture Innovation Competition Vietnam, Loc explained his future plans for ShrimpVet. "We want to expand in several directions which will require funding support. The market potential for services in disease management is there. Our goal is to expand our research capacity three-fold with more on-site services. The plan is to have 8-10 field centres. We need to expand the team to provide services such as shortening the time to diagnose diseases to assist innovation. We need to shorten the time from innovation to field application and farmer acceptance of successful ideas and provide independent training of farmers on the science of aquaculture."



Wet Lab Manager Phuc N Hoang with tanks for feed trials.

In charge of the histology laboratory, Vy Van uses histology as a general diagnostic method to detect presence of pathogens or abnormal changes in the cell structure screen. Histopathology method is used for diagnosis and screening viral diseases in shrimp (WSSV, MBV, HPV, IMNV, etc.), lesions of EMS /AHPND, microsporidian (EHP).

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Marine shrimp in Asia: A round-up in 2017

By Zuridah Merican

The industry moved at three speeds: the fast and furious, recovery and decline.

Over the last 5 years, we have seen the varied growth in the farming of the marine shrimp in Asia which is a consequence of the supply and demand gap created as industry in some countries suffer from the "crisis situation" of early mortality syndrome/acute hepatopancreatic necrosis disease (EMS/AHPND) and other emerging diseases. Production trends in 2017 can be summarized into several industry scenarios: expansion and conversion, led by India, Vietnam, Indonesia and to a small extent, the Philippines; recovery in Thailand and decline in Malaysia and China.

In 2017, India's industry was 'fast and furious' to fill the supply gap left by Thailand. There was the opening of new areas for vannamei shrimp farming in India as well as in Indonesia. While Thailand banned marine shrimp farming in freshwater areas, there are reports on the conversion of fish ponds to farm vannamei shrimp in India. The Philippines, the latecomer to vannamei shrimp farming, also expanded with less monodon shrimp and new farming areas (see pages 4-5 and 8-12). Hitting the brick wall in vannamei shrimp farming, many Malaysian farmers returned to farm the monodon shrimp. China's production continued to decline. To produce all year round, some indoor recirculation water systems were developed.

The production estimates in Table 1, sourced from industry, showed that in 2017, India, Vietnam and the Philippines produced more vannamei shrimp as compared to 2016.

Overall, Asian shrimp producers benefited from the much higher and stable local prices in 2017. It was as high as PHP300/kg (USD5.9/kg) in Luzon, Philippines for size 100/kg shrimp, MYR23.50/kg (USD5.9/kg) for size 70/kg in West Malaysia, as high as THB217/kg (USD6.7/kg) for size 60/kg in Thailand, and VND125,000/kg (USD5.5/kg) for size 70/kg in Vietnam. The preference was to sell locally, when possible, as offer prices by processors were generally lower. In India an emerging domestic market absorbed almost 70,000 tonnes of small shrimp at INR250/kg (USD3.9/kg) for size 100/kg.

This review looks at the significant developments along the supply chain. The information is based on feedback from industry stakeholders and news reports.

Broodstock and hatchery

In 2017, hatcheries in Asia continued to depend mainly on Shrimp Improvement Systems (SIS) and Kona Bay for their supply of specific pathogen free (SPF) broodstocks. In Thailand, Charoen Pokphand (CP), markets post larvae with very fast growth, with average daily growth (ADG) of 0.36g. SyAqua, with nucleus breeding and multiplication centres in Thailand also provides post larvae for industry in Thailand and sells broodstocks to several countries including Malaysia, Vietnam and China. In Indonesia, Prima Gen and Global Gen produce post larvae using SPF broodstocks from their own breeding lines.

Wary of EMS, industry in India and the Philippines continued to hold back the import of CP broodstocks. In India, the Coastal Aquaculture Authority (CAA) issues permits for imports of broodstocks. It has allowed imports from only seven suppliers; five in the US, one in Mexico and one in Indonesia. Industry reported that a few licenses for SPF vannamei broodstock suppliers from Thailand have been withdrawn over the last few years due to EMS.

"Here in India, apart from the last approval in 2015 to allow the import of SPF broodstocks from Indonesia's Global Gen, there have been no new approvals. However, there is a big, continuing debate for almost a year on whether to allow CP to bring their broodstocks from their facility located in the Pacific Island of Guam. Industry stakeholders are strongly objecting to this introduction," said S. Santhana Krishnan, Maritech, Tamil Nadu, India.

Table 1. Range of industry estimates on farmed shrimp production in 2017 in selected countries

Country	Total production estimates in tonnes 2017e
China	550,000-700,000
India[1]	430,000-620,000
Thailand	305,000
Vietnam[2]	415,000-600,000
Indonesia[3]	260,000-390,000
Philippines[4]	65,000-75,000
Malaysia[5]	32,000-35,000
Bangladesh[6]	55,000 -60,000
Total	2,107,000-2,785,000

[1] includes 20,000 tonnes of monodon shrimp
[2] comprise 60-70% vannamei shrimp
[3] includes 30,000 tonnes of monodon shrimp
[4] includes 5,000 tonnes of monodon shrimp
[5] includes 9,600 tonnes of monodon shrimp
[6] 50,000 tonnes of monodon shrimp and rest, other shrimp species

In 2017, China imported all of its SPF broodstock requirements from providers in Asia, Latin America and US ie. SIS, Kona Bay, Primo Broodstock, Blue Genetics, Molokai Sea Farms, Syaqua and Global Gen. CP Thailand stopped exporting broodstocks to China at the end of 2016, according to local media and reported by *seafoodnews.com*. Industry in China then initiated several collaborative plans such as that between Guangdong Jinhaijiao

SPF (left) & WFD infected (right) shrimp (picture courtesy of ShrimpVet)

and Grimaud Blue Genetics. Early in 2017, Ningbo Techbank acquired Texas-based Primo Broodstock in a deal described by Chinese media as the "first time China's industry has gained control over its own shrimp broodstock resources", according to a report in *undercurrentnews.com*.

In Vietnam, farmers said that post larvae from the Viet Uc group are fast growers. In 2017, Viet Uc was the industry leader with a 15% share of Vietnam's 70 billion post larvae market. It also announced a joint cooperation with the government on a breeding program for vannamei shrimp. The aim is to be self-sufficient and to supply 500,000 to 600,000 broodstocks by 2020. Viet Uc has an annual production capacity of 50 billion post larvae in seven facilities (*en.vietnamplus.vn*).

In South America, many farms have their own breeding programs to produce specific pathogen resistant and tolerant (SPR/SPT) broodstocks. Here in Asia, there has been little interest to do the same or use such broodstocks. Some farms in Malaysia and Thailand are using post larvae from SPT/SPR broodstocks. In Vietnam, some farmers have indicated interest in SPR/SPT broodstocks. "With intensive farming systems, where production costs are already high, I do not expect many farmers to use these post larvae. Such post larvae with lower ADG will further increase costs," said Loc Tran, ShrimpVet Lab, Vietnam.

Post larvae quality

Intensive farmers have been more judicious on post larvae quality and generally demand information on the source of SPF broodstocks. However, even with the same source of broodstocks, farmers do not take any risks and farms know which hatchery will provide the best post larvae for their needs. In Thailand, high quality post larvae is *de rigueur* from hatcheries. CP is the leader in the supply of high quality post larvae in Thailand, which is bundled with feed supply. According to industry feedback, Chinese farmers have been too focused on price such that hatcheries supply post larvae with no guarantee on quality and without any compensation on poor performances. In India, the increasing demand on high quality post larvae forced hatcheries to inform customers on the source of their broodstocks. Consequently, the use of pond reared broodstocks decreased, according to an industry source.

In Indonesia, intensive farmers are happy with the quality of post larvae produced. Farmers are confident on the quality when they buy post larvae from the leading hatchery groups which guard closely their reputation for supply of disease-free and high quality post larvae. They monitor and conduct PCR tests on stocks along the production chain and a final PCR test at PL6-7 prior to delivery of PL9. The common size of post larvae sold was slightly larger in 2017, from 8.5mm to 9.5mm. Several recent developments among the medium size and backyard hatcheries were reported. In cases of observed slow growth of zoea, operators opted for total washout instead of selecting the good batches. In quality assessment, they are giving more attention to *Vibrio* levels, relating age to post larvae length and providing post larvae scoring and PCR test results.

Zoea-2 syndrome continued to be a major threat in post larvae culture. In Vietnam, one producer said that survival rate from nauplii to PL10 improved to 45-50%. It was 8% with zoea-2 syndrome. Many in India attributed zoea-2 syndrome to some batches of imported broodstock. Little effort has been made to find a way or technology to overcome problems or even attempt improvements in post larvae production. "It does seem that there is a bandwagon approach to produce volumes and sell in the market to meet the huge demand. CAA has issued closure notices to many shrimp hatcheries in Andhra Pradesh State for not complying with registration and regulatory requirements. This is a good sign for the shrimp farmers that their source of post larvae comes from registered hatcheries who are serious players in the entire production chain," said Santhana.

Prices

In Vietnam, the price range is VND120/PL (USD5,284/million PL) to as low as VND90/PL (USD3,962/million PL) with the higher price for post larvae sold by the two leading hatchery groups Viet Uc and CP Vietnam and the lowest by small hatcheries. Industry

reported that prices increased every 3-4 months. "Although quality was the top criterion in the purchase of post larvae, often there were promotions from different hatcheries and farmers will take the best offer," said Jeff Jie-Cheng Chuang, Sheng Long Bio-Tech International, Vietnam. However, in 2017, ShrimpVet Laboratory sold PL12. "It is most profitable to sell PL10 but small post larvae may not be able to withstand the harsh environment at stocking. We encourage farms to stock at PL12, even though our production and transportation cost increased by 20%," said Loc Tran. In Indonesia, the average price in Indonesian rupiah did not change since 2016 but with a lower exchange rate, USD prices declined.

In India, large fluctuations in post larvae prices were related to supply, demand and location. "For example, in Tamil Nadu, the lowest price in the month of June to August was around INR150/1,000 PL (USD2,350/million PL) in the Kakinada area. Hatcheries from Chennai to the Pondicherry coast maintained the same price INR300-350/1,000 PLs (USD4,680-USD5,450/million PL). One exception was the sudden increase in the demand for post larvae for the second half of November as many hatcheries shut down for maintenance but the rainy season was almost over. Prices rose to INR400/1,000 PLs (USD6,250/million PL)," said Santhana.

Nursery phase

In 2017, CP Vietnam promoted the two-stage culture practice using their fast-growing post larvae. This was successful in the first and second quarter of 2017. The nursery concept was also introduced in Malaysia and Thailand, 2 years ago, according to Hea Kok Wei, Star Feedmills, Malaysia. "The uptake was better in Thailand and Vietnam. In this system, we stocked post larvae at a density of 1,500 to 2,000 PL/m^2 which are then grown to 2-3g juveniles over 30 days. The juveniles were stocked into ponds at a regular density of 80-100 juveniles/m^2."

In general, farms and hatcheries still find including a nursery phase very problematic. One issue cited by industry in Vietnam is the large size variation and difficulties with juvenile transfer. The same problem deterred hatcheries from selling large post larvae. In India, there are many trials, stocking at high density in open pond nurseries mainly in Andhra Pradesh and with a few in the Tamil Nadu area. Farms have also set up in-house nurseries and larval feed producer, Zeigler Feeds will start testing out nursery culture in the Philippines," said Ramir Lee, Zeigler Feeds. Industry in Indonesia expressed no interest in a nursery phase.

Working with several farms and hatcheries in the Mekong Delta, Manuel Poulain, Inve Aquaculture commented on the situation in Vietnam. "In Vietnam, farmers prefer 'large' nursery ponds, from 300m^2 to 1,500m^2, to grow juveniles to more than 0.3-0.5g preferably, stocking from 1 to 5 PL/L. They use high concentrations of probiotics, and high quality feed supplements with reduced water exchange, mainly for biosecurity reasons against EMS." Poulain added that results were very promising, which motivated others to follow. "This may be contrary to the common practice in many parts of Asia, where when nursery systems are developed, stocking tend to be more intensive (over 10 PL/L, up to 40-50 PL/L), done in a shorter time and in smaller tanks with high water exchange. Happa net nurseries, where there is a net inside a grow-out pond is also popular in some places."

Manoj Sharma (second left) with a harvest at Mayank Aquaculture in Gujarat, India.

Managing diseases

In 2017, white spot syndrome virus (WSSV) affected farms across Asia but with varying impact. It was reported as very serious in farms in Malaysia towards the end of 2017 and similarly in India and Indonesia. In the Philippines, WSSV is the main threat and co-occurrence with EHP or EMS was reported at the 11th Philshrimp Congress in November 2017. EMS/AHPND was reported as less virulent in Vietnam, possibly because farmers have learnt how to manage it with probiotics, water quality management and biosecurity. In Malaysia and Thailand, while EMS was more controllable, the microsporidian *Enterocytozoon hepatopenaei* (EHP) was the major threat, more so because shrimp growth was slow. "The cost of production (COP) as compared to that of 2010/2011 has increased by 50% for 14g shrimp," said industry in Malaysia.

In Indonesia, white faeces disease (WFD) was still a problem and infectious myonecrosis virus (IMNV) seemed to be more virulent than 5 years ago with faster and higher mortality. It could be associated with the generally cold weather in 2017. EHP infections resulted in severe growth retardation in the vannamei shrimp. Anwar Hasan, Biomin Asia, said, "With WFD, in many cases, we do not see the strings of white faeces. WSSV was particularly damaging in 2017 with the rains. In many cases, the impact of diseases was localized. In north of Java, WSSV was the major disease, but in the south, IMNV was the main threat."

In 2017, industry in India said that the main disease threats continued to be WSSV and WFD. There were reports of EMS and EHP but with limited damage. "There is a continuing need to focus on best management practices to avoid or minimize the impacts of these diseases," said Santhana. "WSSV outbreaks result in many small sized shrimp harvests, as small as 5g to 15g. We are fortunate that there was a demand for small shrimp."

Recovery

If it were not for the floods occurring in the last quarter of 2017, **Thailand** would have increased its production to 365,000 tonnes. With a loss of 60,000 tonnes, the production remained at 305,000 tonnes. While Thailand is losing to its competitors in Asia in terms of volume, industry in Thailand is proud of the increase in productivity. "That is why this it termed as a recovery. Culture is more efficient and profitable. Most farms are getting three cycles with 15 tonnes/ha/crop. If you use these averages, you need only 7,000 ha of ponds. This is the result of the crisis with EMS and Thai farms in general have become very efficient and profitable," said Robins McIntosh, during his presentation at the Philshrimp Congress in November 2017. In 2018, the industry expects improvements to continue.

It was estimated that the total area of culture ponds was reduced greatly following the start of the EMS outbreaks at the end of 2012. It is now less than 10,000 ha as compared to 35,000 ha in 2011. Farms have reduced culture ponds and dedicated more ponds for water reservoir, treatment and sedimentation.

"Whether operating small or large farms, farmers and technicians in Thailand have their own style to work within the carrying capacity of the ponds, water resources and individual technical capability. Even though some farmers have little technical background, they are managing well as they now understand the science of farming. This is the way forward as expansion of land area for shrimp farming is not possible. In fact, the government has prohibited the use of freshwater areas for vannamei shrimp farming," said Soraphat Panakorn, Novozymes Biologicals, Thailand. Producers in Thailand, traditionally strong in small and medium sizes, were growing shrimp longer to bigger sizes (size 50/kg).

"we now have large and very successful farms with high volume production as well as small farms that can also do the same."
- Soraphat Panakorn

"We now have highly efficient farmers producing for example 120 tonnes/year in 5 rai (0.8 ha) of ponds, (extrapolated to 150 tonnes/ha/year). Then, we have large farms of 30-40 ha and small farms of 2 ha producing only 6-8 tonnes/ha/crop. At the extreme end, there are farms of 10 ha preferring to adopt low stocking density of 40-50 PL/m^2 and producing only 4-5 tonnes/ha/crop. In summary, we now have large and very successful farms with high volume production as well as small farms that can also do the same. Survival rates of 80-95% are expected " added Panakorn.

"This clearly shows the way forward, not more ponds, but more efficiency. If averages went to 3.5 cycles at 20 tonnes/ha/crop, then Thailand should be able to increase production," concluded McIntosh.

India

Estimates of total production in 2017 ranged from 430,000 to 550,000 tonnes. According to industry in India, vannamei shrimp production increased 8-10% since 2016. Andhra Pradesh contributed 70% of this production, Gujarat, 10% and Tamil Nadu, less than 8%. An estimated 20,000 tonnes of monodon shrimp were produced in 2017, mainly from West Bengal. Thus, while China's production dips, India's production moved up. In 2018, industry expects more production.

Production came from expansion within existing culture areas, conversion of monodon farming to vannamei shrimp, more crops/year, and new farming areas in Andhra Pradesh, Orissa, and even Kanakarta. Stocking density depended on location; within Andhra Pradesh, this ranged from 10-30 PL/m^2 in East and West Godavari districts, and to 30-60 PL/m^2 in Ongole and Nellore areas. In Tamil Nadu, the range was 20-60 PL/m^2 and in Orissa, it was 20-40 PL/m^2. Survival rates ranged from 50-85% and were predominantly influenced by outbreaks of either EHP or WFD or both. The production cycle starts in January/February with the first partial harvest in April. In the third quarter of 2017, with hatcheries offering post larvae at discounted prices, some farmers continued to stock.

Marketing shrimp at the Indonesian booth during Seafood Expo Global 2017

"The major harvest size from February to April is 8-12g shrimp from April to August or September, we produce 25-30g shrimp and September to November back to smaller 12-20g shrimp. The harvest size is also influenced by raw material price. The general trend among farmers in Andhra Pradesh is to plan for the harvest of 20g shrimp in less than 100 days at the maximum stocking density of 60 PL/m^2. But disease outbreaks mainly WSSV also determine harvest sizes," said Santhana.

"Our industry has grown so big without caution or mitigation measures for any disease outbreaks..."
- S. Santana Krishnan

In 2017, Gujarat contributed 50,000 tonnes to national production. Farmers in Gujarat are recognized as the ones with the best productivity. For several years, they have targeted the large size shrimp market of 30-40g (size >25/kg). "Nowadays it is difficult to grow large shrimp. In 2010, we could easily reach that size in 100 days but now we will need 160 days. Today, in 100 days, we can only manage size 50/kg. Thus, farmers here now stock at 40-50 PL/m^2 and harvest 7-8 tonnes/ha. Harvest is size 35-40/kg with 70-75% survival. With this comes increases in cost of production. Our average FCR is 1.5 for this size and fuel cost INR37-45/kg," said Dr Manoj Sharma, Mayank Aquaculture in Gujarat.

A new demand for small size shrimp (size 80-120/kg) is fueling production. "As producers, we are happy that there is domestic demand in the major towns, from Mumbai to Surat, here in Gujarat. Although the price (USD3.5/kg) is close to the cost of production and our profit margins are small, it is much better than selling for export. Some 90% of Gujarat's production is going to the domestic market. Soon, I will be harvesting 150 tonnes for this market. Our shrimp is becoming popular. Shrimp is now a good choice as it is close to the price of chicken at INR220/kg!" added Manoj.

With regards to costs of production, EHP which results in slow growth and high FCR (sometimes even more than 3) has a significant impact on the production cost of shrimp. Labour cost continued to rise, currently at 7.5% of production cost as compared to 4.5-5% previously.

Future outlook

Santhana had this message for the industry, "Our industry has grown so big without caution or mitigation measures for any disease outbreaks. The good news is that our farming model is still predominately lower stocking density compared with regional vannamei producers. In expanding, there has to be some understanding between stakeholders. Farmers believe processors should buy what they produce. Whereas farmers should approach processors on what size they need or what the market demands. This will bring some discipline to the industry. We also have many health care products in the market, mostly unregulated, although dominated by many quality and reputed Indian producers and imported suppliers. Our biggest threats in 2017 were reports on detection of antibiotic residues in shrimp consignments to the European Union. However, we are positive that in 2018, with more investments for new feed mills and additional farming areas, production will increase."

Although Manoj predicted that India should be able to produce 550,000 tonnes in 2018, because of contributions from Gujarat, Orissa and Maharashtra, he has the following concerns on the environment. "My major concern is the growth pattern of shrimp in older areas versus newly developed areas. In older ponds, we cannot attain the desired shrimp sizes in a given time and this affects profitability. I also noticed that with age of pond and culture density, creeks are severely affected by the accumulation of organic loads. This has an adverse impact on our water sources. We remove the sludge from the ponds to reduce the impact on the shrimp but then we discharge the sludge into our shared water resources. We should direct our attention not only to the carrying capacity of our ponds but also on these common resources."

Vietnam

More shrimp was produced in 2017 as compared to 2016. Monodon shrimp comprised 30-40% of the production and these were from semi-intensive and extensive farms. As the government policy is to increase the production of the vannamei shrimp, this will be at the expense of areas used for the monodon shrimp. In 2018, industry expects further increases in the production at 10-15% but less monodon shrimp production. However, as Vietnam's farmers are very price sensitive, a less than 'acceptable price', may mean that they might stop or delay operations.

There are several reasons for the high shrimp output in Vietnam. Industry stakeholders reported that Vietnamese farmers have been coping well in overcoming EMS/AHPND, with good management practices, use of probiotics to improve water conditions, and higher water exchange. In 2017, pond side shrimp prices were relatively high and stable. Farmers in the north and central region had the opportunity to sell directly to Chinese buyers with cash payments. This may continue as China's demand is increasing at 14% per year according to Dr Pham Anh Tuan, Vietnam Fisheries Association, at Vietfish 2017.

The changes have been in the culture systems. "Most of the farms in the south have lowered stocking density to 50-80 PL/m^2, while farms in the central region, with lined ponds, have kept to the higher density, from 150 to 300 PL/m^2. Survival rates are high at 60-80%," said Chuang. In the north, pond salinity is 20 ppt. These ponds produce small shrimp (size 70-120/kg) in 80 days of culture. In the south, farmers produce size 50-80/kg in 70-80 days. Here, the salinity is low; ranging from 5-6 ppt to 2-3 ppt.

Hai-Hua Liou, Uni-President Vietnam said that in the north at high stocking density, farms use feed formulated for the monodon shrimp while in the south, farmers use the lower density feed formulated for the vannamei shrimp. Only when farmers in the south detected slow growth (presumably because of EHP) do they use the booster feed for the monodon shrimp.

During Vietfish 2017, leading shrimp producer and processor, Minh Phu's CEO Le Van Quang estimated a large increase in production for 2018. He indicated that his farm was achieving more than 90% success with the 3 Cs protocols (clean post larvae, clean water, clean pond) and partial harvesting. Minh Phu has been applying this practice for the past 3 years with very good yields but it requires a high investment in pond reconstruction. His aim is to help local farmers improve production and reduce the risk factor with shrimp farming. However, in Vietnam, there are concerns on the adverse impacts on the environment due to the frequent untreated effluent discharge .

"Technology is being applied widely in Vietnam, such as the use of IoT in water quality management and functional diets for disease control..."
- Loc Tran

"I think the industry has made some progress, especially with disease control. Farmers are paying more attention on biosecurity, post larvae quality and better pond management. Technology is being applied widely in Vietnam, such as the use of IoT (internet of things) in water quality management and functional diets for disease control. The industry is moving towards more control and more automation," said Loc Tran.

Indonesia

The estimated vannamei shrimp production remained the same as 2016 at around 225,000 tonnes to 360,000 tonnes. The estimate was 30,000 tonnes of monodon shrimp which came from traditional farms as well as the large farms in Kalimantan on Borneo Island. In 2017, there was further consolidation at Indonesia's largest farming entity, CP Prima, and production may increase in 2018. Some ponds were stocked at a low density, 20-50 PL/m^2. While several new farms in the south and west of Sumatra, west and south Sulawesi and in Madura contributed to this production in 2017, some farms also stopped production because of the extreme weather in 2017. Productivity was low in mid-2017. The outlook for 2018 indicated a rise of 8-10% in vannamei shrimp production.

In terms of culture practices, there were small changes such as farms reducing stocking density to target faster shrimp growth. The range in stocking density for intensive farms was 120-250 PL/m^2. According to industry players, intensive systems contribute 75% to the production. Super-intensive farms comprise small units and may account for only 5% of production. Stocking density ranges from 400-500 PL/m^2. "Production was generally of shrimp size 50/kg within 90-100 days and larger shrimp of size 30-40/kg in 110 days. Survival rates were 70-90% for the shorter cycle and 70-80% for the longer cycle. We also have a lot of farmers who stocked at 180-250 PL/m^2 and traditional farmers stocking at only 30-60 PL/m^2. Those with new ponds in sandy soil which are HDPE lined stocked at more than 200 PL/m^2. Closed system culture is used with limited water exchange and farms use probiotics to maintain water quality," said Anwar. In terms of rising costs of production, industry listed staff costs, especially for the highly skilled technicians. With a weaker Indonesian rupiah, cost for probiotics and other supplies increased.

"The prospect for increasing production in 2018 is still very promising especially with good prices, just as in 2017. We need the government to support shrimp farming and drive more investments. In 2018, I would still expect that industry will continue to combat disease such as WFD, IMNV and WSSV in the vannamei shrimp. Outbreaks are likely, but our farmers have been learning on how to manage diseases. With new techniques and technology, they are constantly trying to apply, among others, probiotics, additional aeration, automatic feeders and various types of additives," said Rudi Purnomo, PT Matahari Sakti.

Philippines

The estimate in table 1 is 60,000 tonnes of vannamei shrimp in 2017. In 2018, there is optimism that production will increase (see page 4-5). Chris Mitchum Ganancial, Bayer Philippines gave additional information on trends in the industry. "Stocking in grow-out ponds started in late March 2017 onwards. It worked well as farm gate prices were high from December 2016 to April 2017 (Figure 1). Prices were strong again from October to December 2017. When partial harvesting began in May, farm gate prices dropped until the end of September. The low supply with decreasing harvest in the southern parts of the country in November in the Visayas areas raised prices for 15 -20g shrimp in October 2017. The cost of production was around 180/kg which gave farmers an acceptable profit of PHP80-100/kg."

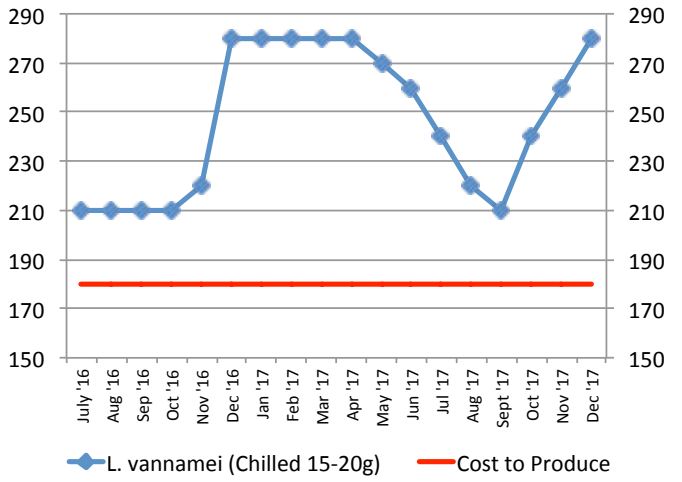

Figure 1. Market prices in 2017. Prices were for farms in Visayas and Mindanao. Farms in Luzon sold shrimp at prices higher by PHP30-40/kg for chilled shrimp (which was the cost of airfreight from farms in Visayas to Manila). The premium for Luzon farmers for live shrimp was PHP70-90/kg.

Acknowledgements
We thank all those mentioned in this review as well as many in the industry who have willingly assisted with information and inputs but wished to remain anonymous. This review would not have been possible without their participation.

Next issue: A discussion on return to monodon shrimp in Malaysia and the position of monodon shrimp in Asian aquaculture.

Promotion of novel ingredients as fish oil replacements: F3 contest and a Feed Innovation Network

By Kevin Fitzsimmons

Fish meal and fish oil have long been staple ingredients of most aquatic feeds as sources of protein and lipids. However, as fish meal and oils have rapidly increased in price, many alternatives are being considered. Some of the alternatives, such as soybean and meat and bone meals, are widely accepted and have become basic ingredients.

More recently several new technologies have developed that are providing a variety of novel ingredients. Bioreactors for the production of bacteria, algae, and yeast are providing a variety of proteins and lipids. Production of methanotrophs, bacteria-fed methane as their primary nutrient, is one of the promising products with amino acid profiles similar to fish meal. Several species of algae are now being produced in bioreactors, tanks and ponds for aquafeeds. Both the protein and lipid components are proving to be valuable. *Saccharomyces* and other yeasts/fungi have also proven to be valuable bioreactor-friendly producers.

Insect meals derived from the larvae of the black soldier fly and mealworm beetle are also gaining market share. The larvae have been tested in aquaculture diets for many years, but the recent development of factory-scale production has lowered the price of the larvae meals to be competitive with fish meal. Lipids generated from the process of converting the insect larvae fed on seafood processing wastes to dry meal and oil are also gaining interest as an oil source.

Feed Innovation Challenge

Recently, a series of technology-driven contests were initiated to encourage feed companies and farms to give more consideration to the use of novel ingredients. The first prize of USD 200,100 was awarded to Evergreen Feeds of Guangdong, China, which sold the most fish meal free aqua feeds in an 18-month period ending in September 2017. The second prize will award USD 100,000 to the company which makes and sells the most alternative oil source capable of replacing fish oil in aqua feeds.

The next step in the F3 effort is to develop a Feed Innovation Network (FIN) that will link a series of laboratories and training centers that will demonstrate novel ingredients in practical feeds and educate feed mills, formulators and farmers regarding the pros and cons of various novel ingredients and feeds. The initial

centers in Myanmar, Vietnam and China will be linked to the Fish Technology Center in the US, which will provide technical information on ingredients, while the Asian centers will be able to prepare demonstration diets for various species and test them on-site or with farmer partners. The ability to explain the costs and benefits of these F3 diets will be a primary goal of the FIN Centers.

An additional goal of the F3 effort is to encourage consumers to consider seafood produced without the use of fish meal or fish oil as the environmental equivalent of free-range chicken or grass-fed beef. Preserving more forage fish in the environment will benefit many marine predators, reduce the price increases that have slowed the growth of the aquaculture industry and further dissuade those who have committed illegal, unreported and unregulated (IUU) fishing and egregious human rights abuses while fishing for these forage fishes in various parts of the world. More information: www. f3challenge.org

Dr Kevin Fitzsimmons is Professor at the University of Arizona. The University of Arizona together with University of Massachusetts Boston, Anthropocene Institute, World Bank and SynBioBeta are sponsors of the F3 Challenge. Email: f3fishfreefeed@gmail.com

Resources behind an environment-friendly and effective aquafeed

By OddGeir Oddsen

With the human being well placed on top of the food pyramid, and a fast-growing population, it is about time we find out where we can obtain enough proteins to avoid a global dilemma. Today, an estimated 2 billion people suffer from malnutrition due to lack of micronutrients. Furthermore, in emerging economies, the demand for animal protein is growing explosively, partly due to rising incomes and urbanisation.

Limited oceans

The sea has long been designated as an increasingly important resource for food, but even in the vast oceans the marine resources are limiting. Large parts of the fish currently caught in the world's oceans are used in fish farming.

Back in 2011, more than 90% of our global fish stocks were overexploited. This kind of overfishing takes an enormous toll on marine ecosystems, and so the world is relying more and more on farmed seafood.

Started with research

High quality proteins will be hard to come by in the years to come. Sea Farms Nutrition, a company located in the United Kingdom was established in 2013 by a group of researchers and business people, the company supplies specialised feed to a variety of species produced in aquaculture farms. Much of this goes to Asia and Central America. Sea Farms Nutrition has also developed its own hatchery feed, and the demand for such specialty foods is increasing.

The enterprise actually began as a research project among several participants from different stakeholders as feed supplier, worm farmer, aquaculture specialist and seafood suppliers. The shared vision was no less than to provide a new solution. Today the goal is to create innovative feed formulations for aquaculture production, without the dependency on fish ingredients.

Proteins have to be obtained from somewhere. Trying to feed the world using land-based animal proteins will have dire consequences. In addition to deforestation, greenhouse gas emissions and waste, industrial animal farming on a large scale leads to soil degradation on an unsustainable scale. Therefore, a large part of our food supply needs to come from aquaculture.

> "We need to start thinking about consuming and producing proteins sustainably"

Please credit illustrator: Fredrik Kleppe

Worms – an emerging source of proteins

Sea Farms Nutrition has focused on farmed polychaetes, also known as bristle worms. Farmed polychaetes are an effective way of producing edible proteins that can form a foundation for high quality aquaculture feed. My partners and I hope that we can provide an exceptional effective feed, and help the aquaculture industry to bring better food to consumers.

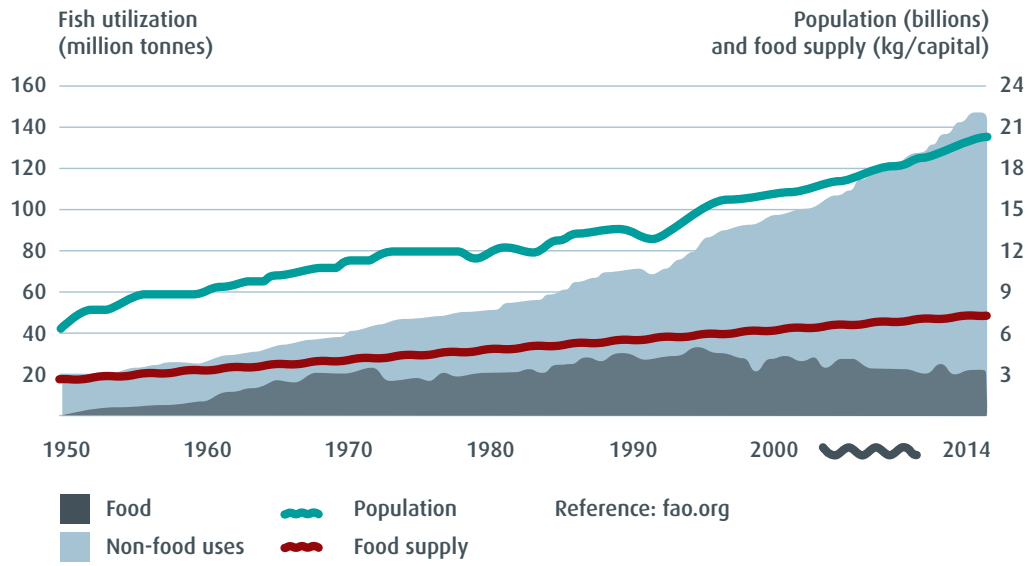

Figure 1. World fish utilization and supply

Holt & Paulsen

The future of feed planning is PRO

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The clear message is that "we need to start thinking about consuming and producing proteins sustainably." The development of sustainable animal feed, both on land and under water, represents a giant leap in the right direction. One of the key elements in this area is the conversion of different waste materials into proteins. A very efficient way of doing this is by using worms; more specifically polychaetes. Polychaetes contain nutritious, versatile proteins that can form a solid foundation for high quality aquaculture feed.

From waste to value

Polychaetes convert a wide range of nutrients into protein, which again allows the company to convert nutrient sources that would normally be considered waste, into valuable protein sources. However, the group was not satisfied just with turning polychaetes into a high quality aquaculture feed. It was determined to use polychaetes to quite simply create the best and most effective aquaculture feed in the world. Sea Farms Nutrition are currently working on research that will increase the production of worms.

From bio-secure ponds

The company obtains its farmed polychaetes from biosecure ponds in The Netherland. The rationale guiding Sea Farms Nutrition was – and still is – quite simple: the future of aquaculture needs to be sustainable. Sustainable aquaculture in turn needs to rely on environment-friendly feed. And feeds made from polychaetes is an environment-friendly and effective alternative solution.

Great nutritional benefits

There are a number of advantages to using farmed polychaetes as feed in aquaculture. Perhaps the most important is that farmed polychaetes have as good a nutritional value as traditional feed from fish. In addition they also contain important amino acids, peptides and other functional molecules that are not found in the same amounts in traditional fish feed.

More growth

This feed is more protein-efficient and allows species such as shrimp to grow faster and healthier, giving less emissions to the environment. Tests done with rainbow trout showed that after 12 weeks, the weight gain is 14% higher with farmed polychaetes added into the feed than without it. In addition worms and feed have been tested for parasites, bacteria and viruses. This ensures a disease-free feed.

Better tasting food

The taste of seafood is also important. According to a professional taste panel, species fed with farmed polychaetes also taste fresher and better. Last but not least, the use of farmed polychaetes makes the entire value chain of a modern aquaculture more sustainable.

OddGeir Oddsen, CEO, Sea Farms Nutrition is leading ProChaete's efforts to make a better and more sustainable feed for aqua culture.

(Photo credit: Tord F Paulsen).

Fusarium mycotoxins: A main threat to Southeast Asian aquaculture

by Rui Gonçalves

A discussion on some erroneous concepts and where we are today in understanding mycotoxin threats to production.

In a recent publication in World Mycotoxin Journal, BIOMIN experts, led by the author, revealed the most recent conclusions of their survey study on plant-based meals and finished feeds in Southeast Asian aquaculture. The authors acknowledged that awareness on mycotoxin related issues in the aquaculture industry is growing, as manufacturers and producers realize the importance of mycotoxins, beyond aflatoxin (AF), and their potential to impact production. However, there are still some erroneous concepts within the aquaculture industry. Thus, it is very important to identify current doubts and address them.

Figure 1. *Fusarium* ear rot in corn, is the most common fungal disease on corn ears, caused by *Fusarium verticillioides* and several other *Fusarium* species. Infection can occur under a wide range of environmental conditions.

Some wrong concepts or misinformation

One of the main concepts deeply entrenched across aquaculture is that the majority of mycotoxin issues are the result of poor storage conditions leading to aflatoxin contamination. Consequently, these wrong assumptions bring consequences where aquaculture professionals seek solutions for mycotoxin management as adsorption, the most common approach to deal with aflatoxins, but this is not a feasible strategy to tackle *Fusarium* mycotoxins. However, it remains true that poor storage

Figure 1. *Fusarium verticillioides* colony. *F. verticillioides* is well known for its capacity to produce DON and FUM.

conditions can lead to the growth of *Aspergillus* spp. and *Penicillium* spp., which can ultimately lead to the production of aflatoxins and ochratoxin A (OTA). The present observations show that most of the mycotoxins found in finished feeds come from raw materials used to produce feeds.

Mycotoxin contamination in previous years

In previous assessments of mycotoxin contamination in the aquaculture sector (Gonçalves et al. 2016 and 2017), we found that in Southeast Asian samples, soybean meal, wheat, wheat bran, maize, corn gluten meal, rapeseed/canola meal and rice bran were mostly contaminated with *Fusarium* mycotoxins (ZEN, DON and FUM). The only exception was cottonseed meal which was mainly contaminated by AF together with other *Fusarium* toxins (ZEN and DON) in considerable amounts. Finished feed samples were also mainly contaminated by *Fusarium* mycotoxins, reflecting the use of plant meals.

Processing conditions do not affect mycotoxins

An observation that relatively high levels of *Fusarium* mycotoxins are found in the feeds, confirms that mycotoxin contamination found in these finished feeds is mostly related to the plant-based raw materials used in their formulation. *Fusarium* fungi are generally an issue in the field rather than in storage. This reinforces the reminder that mycotoxins commonly occurring in plant materials are not destroyed during most processing operations. On the contrary, processing affects mycotoxin distribution and concentrates mycotoxins into fractions that are commonly used as animal feed (plant by-products such as corn gluten meal, DDGS, etc).

The fate of mycotoxins in feedstuffs is variable and is affected by several factors such as the type of mycotoxins, the level and extent of fungal contamination, and the complexity of the cereal processing technology. As a result, the use of mold inhibitors does not guarantee that feed is free of mycotoxins, as they are also produced in crops and not destroyed during processing. However, mold inhibitors do prevent the production of storage mycotoxins such as AF and OTA.

Objectives for 2016 aqua samples

The contamination of aquafeeds and plant-based feedstuffs with mycotoxins (for aquaculture use) is, in general, often neglected. At Biomin we want to fully understand and better manage mycotoxin risks in aquaculture. Therefore, the objective of this work was to analyse the risk of mycotoxin contamination in conventional plant ingredients used for aquafeeds (as was done in the past). However, we have also started to analyse the by-products of these commodities, which are beginning to be used in aqua feed formulations due to their lower price and availability. Particular attention was also given to local non-conventional meals and aquaculture by-products such as shrimp head meal, sun dried fishmeal and others. Besides the most common mycotoxins (AF, ZEN, FUM and DON), we extended our goal to analyse 18 mycotoxins per sample in order to understand the occurrence of masked and alternative metabolites of mycotoxins in these aquaculture feedstuffs. Additionally, we also analysed finished feeds for fish and shrimp. Due to the increasing globalization of trade, and the incorporation of imported raw materials into aqua feeds, the mycotoxin contamination of locally produced commodities was compared to the same imported commodities.

What was found in 2016

During a one-year period (January 2016 – December 2016), 175 samples of different plant proteins, aquaculture/fishery by-products and finished aquaculture feeds, were analysed. Samples were tested for: aflatoxins (AF; AFB1, AFB2, AFG1 and AFG2); zearalenone (ZEN); Type B trichothecenes (deoxynivalenol (DON); Nivalenol (NIV); 3-Acetyldeoxynivalenol (3-AcDON); 15-Acetyldeoxynivalenol (15-AcDON) and fusarenon X-glucoside (FUX)); fumonisins (FUM; FB1, FB2 and FB3); Type A trichothecenes (T-2; HT-2; Diacetoxyscirpenol (DAS) and neosolaniol (NEO)) and ochratoxin A (OTA). All samples were sourced in Southeast Asia.

Only 4% of the analysed samples were free of detectable mycotoxins. Eight percent of the samples had one mycotoxin and 88% were contaminated with more than one mycotoxin. The current work showed a similarity to previous studies, that mycotoxin occurrence in plant meals, and consequently in finished feeds, is quite variable. It also confirmed that AF is not the main mycotoxin in aquafeeds. Mycotoxin occurrences in fish and shrimp feeds in the present samples were higher than reported in the previous studies for the same region. In samples of shrimp feed with DON detected, the mean average DON level was 882 μg/kg with a maximum level of 2,287 μg/kg. These values are within the reported sensitivity levels of white leg shrimp *Litopenaeus vannamei*.

Mycotoxins in atypical ingredients

Shrimp head meal and fish meal produced by grinding sun-dried fish, while not typical products to be analysed for the presence of mycotoxin are also known to contain mycotoxins (Fegan and Spring, 2007; Biomin survey data; data not published). Theoretically, these ingredients might include mycotoxins such as AF and OTA, as they are produced by molds for example *Aspergillus* spp. and *Penicillium* spp. which can occur in poor storage conditions. However, the samples analysed in the present study contained FB1 and FB2 which are toxins produced by *Fusarium* molds and are generally related to field contamination of crops rather than storage. Interestingly, Fegan and Spring (2007) also reported several marine derived samples from fish meal and shrimp meal contaminated with mycotoxins produced by *Fusarium* spp. It is known that *Fusarium* species namely *F. oxysporum* and *F. solani*, are opportunistic pathogens for fish and shrimp (Hatai et al., 1986; Lightner, 1996; Ostland et al., 1987; Souheil et al., 1999). However, the ability of these fungi strains to produce toxins is not known and this hypothesis cannot be totally rejected. The authors also believe the possibility for FUM contamination through bioaccumulation. Recently, Michelin

et al. (2017) showed that the lambari fish *Astyanax altiparanae* fed more than 50 μg of AFB1 per kg of feed, presented AFB1 in muscle after 120 days in similar levels as in the feed. FB clearance kinetics of fish and shrimp is not known. This is something that should be further researched.

How to fight *Fusarium*?

Fusarium mycotoxins are a broad class of compounds with different chemical structures, physical and toxicological properties. Due to this great diversity, different detoxification strategies are required to deal with this complex group of compounds. Adsorption is the most common approach to deal with mycotoxins and many products using this strategy are available in the market. However, as proven by several studies (Veikiru et al. 2015; Hahn et al. 2015; Fruhauf et al. 2011), adsorption is not a feasible strategy to tackle *Fusarium* mycotoxins, as it is only effective towards aflatoxins and, to a lesser extent, ochratoxins. The reason relates to the flat chemical structure of these mycotoxins that allows them to be captured between the layers of bentonite, a popular binder material. Once the mycotoxin enters the binder layers, the electric force generated by the atoms of both compounds tightens the bond. The less flat chemical structure of other mycotoxins such as DON or ZEN results in less effective adsorption.

Some governmental authorities, particularly the European Commission (EU) have recognized this issue. This is the reason why only aflatoxin binding claims are allowed in Europe. The state-of-the-art technology for mycotoxin deactivation uses enzymatic deactivation or biotransformation that provides a specific, effective and irreversible degradation of mycotoxins. Biomin is the only company to date that has feed additives legally recognized and registered in the EU for their ability to safely and effectively counteract mycotoxins.

A beginning in mycotoxin management in aquaculture

Drawing firm conclusions on the impact of mycotoxins in aquaculture is still difficult and more research is still needed. However, even with the scant literature and the knowledge already created around this topic, it is clear that mycotoxin levels found in finished feeds might negatively affect growth performance of fish/shrimp, feed efficiency and make animals more susceptible to diseases. The recently published manuscript (DOI 10.3920/WMJ2017.2239) presents some limitations (limited number of samples and short period of sample collection). However, for the very first time we can inform the aquaculture sector on the presence of mycotoxins in locality-specific and aquaculture-specific plant materials, and we encourage frequent monitoring of these plant meals for the presence of mycotoxins. A more extensive study, with a longer sampling period and larger number of samples is being implemented currently in order to support the preliminary data collected and presented in this article.

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Functional hydrolysates: sustainable ingredients to support development of the next generation of aquafeeds

By Paul Seguin, Mikael Herault, Kyeong-Jun Lee and Tanatchaporn Utairungsee

An overview of marine functional hydrolysate performances for different targeted benefits; from digestibility, superior health benefits, palatability to overall feed performance.

Sustainable innovations are driving the development of the aquaculture industry and especially that of aquatic feed formulation. The 30-year old trend to reduce fish meal (FM) inclusion in formulas has led manufacturers to find new alternatives to marine raw materials. Research on the optimization and efficiency of these new raw materials needs to be carried out: determination of their origin (traceability), characteristics (physical and biochemical properties), performances (palatability, digestibility) and manufacturing process are key parameters.

By-products resulting from seafood and food processing are valuable sources of raw materials as long as freshness and supply chain consistency are guaranteed: tuna, tilapia, squid, shrimp, whitefish as well as chicken bases are among the most common sources. If meal process is today dominating the valorisation of such seafood co-products, the hydrolysis process can be considered as a better alternative to generate new functionalities to finished products: functional hydrolysates.

Functional hydrolysates are made from enzymatic hydrolysis of the raw material proteins. The high level of control applied by Diana Aqua during the hydrolysis process ensures the production of standardized products with consistent performances from batch to batch over time.

This 'new generation' of functional ingredients shows multiple benefits for aquafeed manufacturers: enhancement of feed performances, replacement of raw materials showing unpredictable quality, development of specific feed segments and the guarantee of traceability for farmers and processors.

Thorough characterization of functional hydrolysates brings crucial information to assess their performance and standardization levels. Such product performances are intimately linked to their peptide profile where quantification of peptide sizes and diversity are essential for predicting the responses of animals fed feed with functional hydrolysates. Any change in the peptide profile could lead to deviation in product performances, either in terms of digestibility, bioactivity or palatability.

With more than 10 years of experience, Diana Aqua has performed hundreds of trials for developing and analysing many types of functional hydrolysates, assessing their performances in different species and under different testing conditions. The following data will give an overview of marine functional hydrolysate performances for different targeted benefits (higher growth rates through higher feed intakes or assimilation and digestibility, higher resistance to infectious challenges and resulting survival rates among others).

Superior health performances in white shrimp

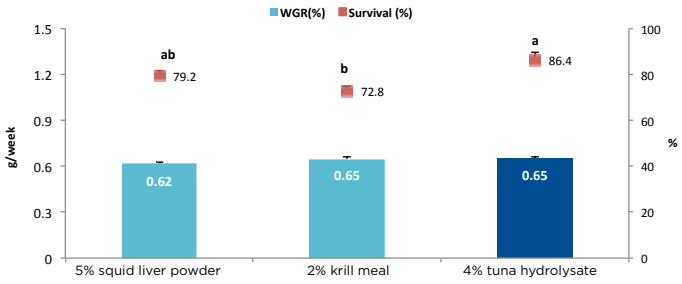
A trial conducted in Jeju University (South-Korea) was performed in 2016 to evaluate the the effect of supplementing tuna hydrolysate, a highly standardized functional hydrolysate produced in Thailand, on feed performances for the shrimp *Litopenaeus vannamei*. The feed containing 3.6% tuna hydrolysate was benchmarked against common marine ingredients: squid liver powder and krill meal. There were 5 replicates/treatment. Tests were conducted in 120 L aquarium holding 25 shrimp/aquarium of initial body weight of 0.25g and fed 4 meals/day. The trial duration was 52 days.

Table 1. Formulation and proximate composition of experimental diets

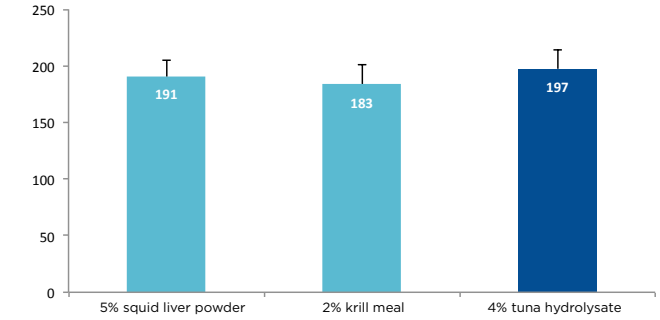
Ingredients	Squid liver powder diet	Krill meal diet	Tuna hydrolysate diet
Tuna meal (55% CP)	8.91	8.90	8.68
Squid liver powder	**4.55**	**0.00**	**0.00**
Krill meal	**0.00**	**1.82**	**0.00**
Tuna hydrolysate	**0.00**	**0.00**	**3.55**
Wheat gluten	4.61	4.60	4.49
Soybean meal	46.08	48.14	48.36
Wheat flour	16.75	16.74	16.33
Starch	6.88	6.91	6.05
Soybean oil	1.82	1.82	1.77
Fish oil	2.17	2.80	2.72
Lecithin	0.91	0.91	0.89
Mineral mix1	1.82	1.82	1.77
Vitamin mix2	0.91	0.91	0.89
Cholesterol	0.04	0.07	0.07
Choline chloride	0.91	0.91	0.89
Monocalcium phosphate	2.73	2.73	2.66
Guar gum	0.91	0.91	0.89
Proximate composition			
DM (%)	92.76	92.97	93.19
CP (%)	32.91	33.57	33.64
CF (%)	8.01	8.66	7.89
Ash (%)	6.15	6.07	6.39
Ileal digestibility (%)	94.06	95.48	95.02
Raw energy (Kcal/g)	4.36	4.43	4.42
CP/DM	35.48	36.11	36.10
Raw energy (Kcal/g)/DM	4.70	4.76	4.74

The results showed a better survival (Figure 1a) in shrimp fed 4% tuna hydrolysate compared to 2% krill meal and 5% squid liver powder, (respectively +18% and +9%). Total feed intake (Figure 1b) and final biomass (Figure 1c) were correlated to this higher survival rate result (+21 and +17% respectively) while tuna hydrolysate improved significantly feed utilization, in terms of feed conversion ratio (FCR) (Figure 1d) compared to benchmarked ingredients. No significant differences were observed for weekly growth rates (WGR).

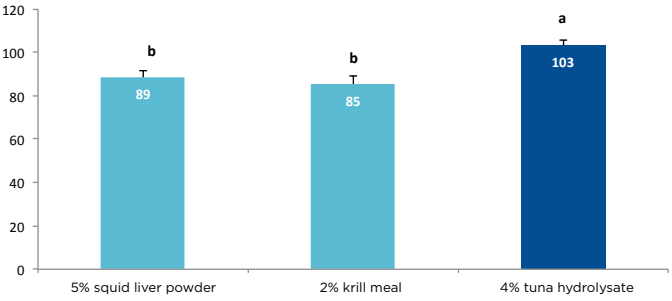
a) Weekly growth rate (WGR, g/week) and survival (%)



b) Total feed intake (g)



c) Production (g/tank)



d) Economical FCR

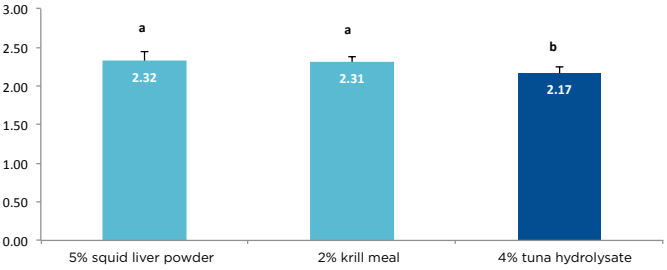


Figure 1. Growth performance of shrimp fed dietary treatments at the end of the trial

Health benefits of tuna and squid hydrolysates

In 2016, another trial was conducted at the SyAqua facilities in Bangkok, Thailand, to study the health benefits of the dietary inclusion of a mix of tuna and squid hydrolysates in shrimp (TSH, produced in Thailand).

A total of 1,000 specific pathogen free (SPF) shrimp *L. vannamei*, of average weight 2g were reared following the usual larval and nursery practices. Following shrimp acclimation to experimental facilities, the trial consisted a 4-week dietary conditioning with experimental diets before the start of a bacterial challenge with *Vibrio parahaemolyticus* infection and monitoring mortalities for 1 week.

A commercial diet (Table 2) was optimized through the supplementation of 3% of tuna-squid hydrolysate (Table 3). Experimental diet specifications matched shrimp nutritional requirements and feeds showed the same levels of macro-nutrients. As a positive control, a high dosage of vitamin C was applied in commercial diet as an immunostimulant.

Table 2. Commercial diet formulation & protein composition

Formulation of commercial diet	% total protein	% feed
Marine protein	23.89	9.5
Animal protein	11.2	4.5
Plant protein	55.71	22.2
Other	9.2	3.7

Table 3. Feed composition and analysis

Feed (NIR)	COM diet	COM / 3% Tuna-Squid hydrolysate	COM / 5% vit C
DM (%)	90.56	90.47	90.11
CP (%)	39.91	39.76	39.56
CF (%)	8.87	9.02	8.93
Ash (%)	9.15	9.36	9.3
In vitro ileal digestibility (%)	87.73	87.85	87.98
Energy (Kcal/g)	4.29	4.3	4.28

Even though this trial was not dedicated to measure growth performances (only one replicate per dietary group), it showed that the addition of 3% inclusion of tuna-squid hydrolysate on a commercial feed improved growth rate after 4 weeks (Figure 2).

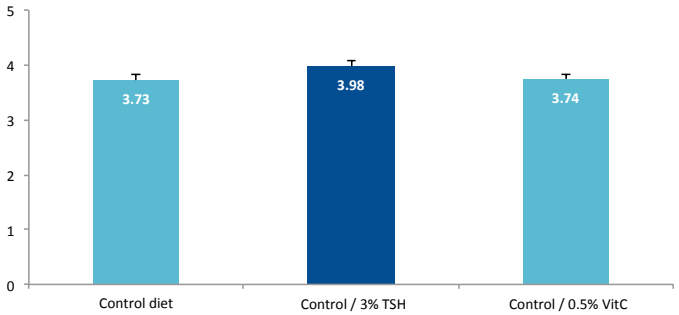


Figure 2. Average final body weight (g) of shrimp after a 4-week dietary conditioning

For the bacterial challenge, a *Vibrio parahaemolyticus* AHPND (acute hepatopancreatic necrosis disease) strain was used. Fifteen shrimp/tank were immersed for 15 minutes in a 2 L bacteria bathing tank and then placed into a 60 L aquarium. There were six replicates for each diet (plus one for non-infected shrimp). Two successive immersions were carried out to increase the bacteria challenge (between 10^6 and 10^7 CFU/mL). Bacteria count in rearing water before and after the experiment was recorded. Shrimp survival was followed for 1 week (Figure 3). Detection of AHPND was performed by using AP4 primer based on the method of Dangtip et al. (2015).

During the AHPND challenge, shrimp fed the tuna-squid hydrolysate diet showed significantly higher survival rate than those fed the non-supplemented commercial diet. Furthermore, no significant difference in shrimp survival rates was recorded compared to the vitamin C diet, considered here as a functional feed additive (Lee and Shiau, 2002).

The health improvement was explained by the high level of low molecular weight peptides supplied by functional hydrolysates. The enzymatic hydrolysis of the marine raw material resulting in the production of bioactive peptides has been found to exhibit numerous bioactivities associated with antimicrobial and antioxidant properties (Kim and Wijesekara, 2010; Chung et al., 2015).

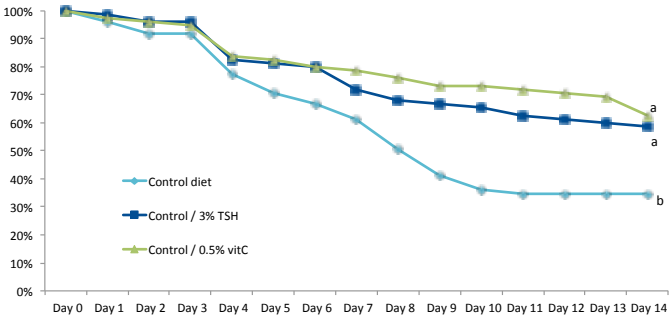


Figure 3. Shrimp survival rates during an EMS/AHPND challenge by immersion

Recovering high feed performances

Marine fish feeds require high fish meal levels to support their palatability and nutritional requirements. However, variable supply and quality, unsustainability issues and volatile prices of fish meal have led to the development of new cost-effective alternative sources of protein. In fish meal substitution strategy, consisting of a blend of different alternative protein sources, amino acid profiles and essential micronutrients must be adjusted to overcome the nutrient limitations of a single protein source (Pratoomyot et al. 2011). However, even if all the nutritional requirements are met when formulating low fish meal feeds, there could be some adverse side effects on feed intake (palatability) and fish health status (enteritis for instance). A major challenge faced by feed formulators is how to recover high feed performances when replacing fish meal in feeds for marine fish.

The study below was designed to evaluate the nutritional benefits of a shrimp hydrolysate (SH) in red seabream (*Pagrus major*) fed a low fish meal diet. In the facilities at Jeju University, 8.5g fish were stocked for this 15-week trial in 150 L tanks. Thirty fish were stocked per tank and there were three replicates/treatment diet. Fish were fed three diets: positive and negative control diets containing 40% fish meal (40%FM) and 25% fish meal (25% FM) respectively, and a diet containing 20% fish meal and 5% squid hydrolysate ((20% FM+5% SH), Table 4). Fish were fed ad libitum 2 times per day.

At the end of this feeding trial, diet 20% FM+5% SH, performed significantly better than the 25% FM diet and even better than the 40% FM diet. The strategy of fish meal substitution through shrimp hydrolysate supplementation showed a significant beneficial effect on fish growth performances and feed utilization even at low inclusion levels (Figure 4). In this specific case of fish meal replacement, the shrimp hydrolysate helped to improve palatability of low fish meal feeds as well as feed protein digestibility. Shrimp hydrolysate has also shown to have beneficial effects on gut health and immunity of fish (Bui et al., 2014; Khosravi et al., 2015 and unpublished results).

Conclusions

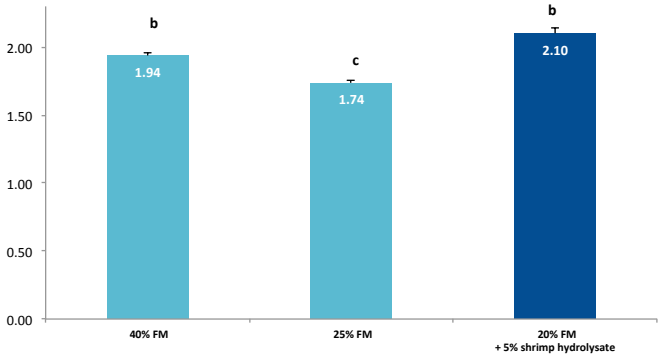
The multiple constraints in the aquaculture market all along the supply chain compel raw materials suppliers, feed manufacturers and aquafarmers to perpetually innovate by developing more performing and cost effective feeds. The results presented in this article provide convincing evidence that functional hydrolysates can bring valuable benefits to the farmers as well as to the feed manufacturers, under different testing conditions, species and applications.

In addition to well known palatability and nutritional benefits, our results also demonstrate undeniable health benefits related to the use of functional hydrolysates. An additional benefit of functional hydrolysates is their ability to improve the physical feed quality, thanks to binding properties linked to their important concentrations of highly soluble peptides.

Table 4. Feed formula and proximal composition of experimental diets (SH: shimp hydrolysate)

Ingredients (%)	40% FM	25% FM	20% FM + 5% SH
Fish meal	40.00	25.00	20.20
Shrimp hydrolysate	0.00	0.00	5.00
Soy protein concentrate	9.00	21.00	21.00
Corn gluten meal	8.00	8.00	8.00
Wheat flour	30.50	29.80	29.60
Squid liver oil	4.00	5.50	5.50
Soybean oil	4.00	4.00	4.00
Mineral Mix	1.00	1.00	1.00
Vitamin Mix	1.00	1.00	1.00
Starch	2.00	1.50	1.50
Choline chloride	0.50	0.50	0.50
L-Lysine	0.00	0.50	0.50
L-Methionine	0.00	0.20	0.20
Taurine	0.00	0.50	0.50
Di-calcium phosphate	0.00	1.50	1.50
Proximate composition			
DM (%)	93.27	93.14	92.8
CP (DUMAS) (%)	43.71	44.31	43.7
CF (%)	11.92	12.18	12.81
Ash (%)	7.75	7.37	7.09
Raw energy (Kcal/g)	4.77	4.78	4.76

a) Specific growth rate (%)



b) Feed conversion ratio (FCR) and apparent digestibility coefficients of protein (ADCp)

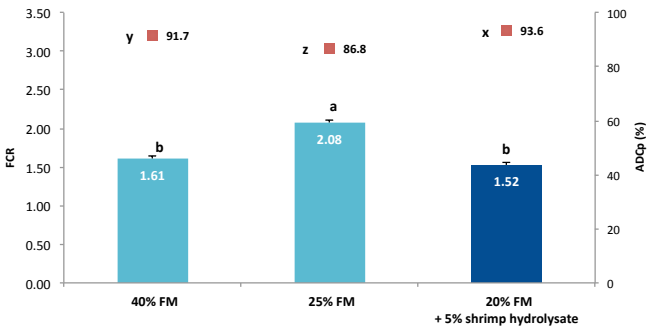


Figure 4. Specific growth rate, FCR and apparent protein digestibilty in the trial with red seabream *Pagrus major* fed a low fish meal diet supplemented with squid hydrolysate

All these benefits, which are associated with the dietary utilization of functional hydrolysates, offer nutritionists and formulators more solutions and flexibility to establish stable formulations and thus, limit the risk of variations in animal performances resulting from one feed production batch to another. However, there is one important prerequisite to derive the maximum value of functional hydrolysates: product standardization must be controlled and guaranteed, as it will be the peptide profile of hydrolysate which will drive its performances.

Last but not least, the sustainable and increasing conversion of by-products from seafood processing plants into high value and standardized marine ingredients dedicated to the aquafeed industry allows full transparency and traceability in the value chain. Certification processes (BAP, IFFO, etc.) provide further guarantee to the quality of these products.

References are available on request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Nutritional value of aquafeeds in intensive aquaculture

Increasing farm productivity and reducing environmental effects of intensive land based aquaculture come with better farm practices and upgrading the nutritional value of aquafeeds.

The 23rd DSM Asia Pacific Aquaculture Conference 2017 was held in two locations: Ho Chi Minh City, Vietnam on 15 November and Bangkok, Thailand on 17 November. This year, the focus was intensive aquaculture and alongside this, using technology and science to increase the nutritional value of feeds and their management. This report covers the meeting in Ho Chi Minh City.

"Each year, we review recent advances and future trends in warm water aquaculture to demonstrate our strong commitment to grow the industry in Asia. Aquaculture is expected to be the main source of fish supply for the growing global population. This production comes with a lot of pressure, on land, water and energy. As producers we need to balance between our livelihood, health and environment. There are lots of advances occurring in genomics, big data, sophisticated culture systems, etc. By 2050, we can expect the aquaculture sector to be bigger than swine and poultry.

"There have been new advances in feed technology to increase the availability of raw materials. There are also new raw materials for the feed industry such as insect meal. Our company itself, is producing DHA (docosahexanenoic acid) from algae as an alternative to fish oil. We are always reminded that we need to play a role to protect the environment and fish stocks. Thus, we need to learn how to use technology and science to utilize nutrients in aquafeeds wisely," said Dr Fidelus Fru, Director of Marketing and Nutritional Solutions, DSM Nutritional Products, Asia Pacific, Singapore.

For this year's conference, DSM's aquaculture team invited experts to discuss shrimp and fish farming practices, various issues with feeds and feed management and on nutrient requirements and utilization. There was also a presentation on Asia's seafood supply chain, prompted by consumers' demands for sustainable practices, fish health and welfare compliance for aquaculture in Asia.

The feed factor in farming

Vietnam-based **Dr Nguyen Duy Hoa**, Technical Director, Southeast Asia Empyreal Products, Cargill Inc. focused on the feed factor in his presentation on key factors for intensive aquaculture: production, feed, farming and the consumer. "When we look at different shrimp culture practices, in Asia and Latin America, we see a correlation with protein content of feeds. In Asia, we culture shrimp at various stocking densities. Here in Vietnam, farmers stock at 250-300 vannamei shrimp post larvae (PL)/m^2 in the lined ponds producing 40-70 tonnes/ha with feeds of 42-40% crude protein (CP). The average stocking density in the earthen ponds is 80-100 PL/m^2 producing 15-25 tonnes/ha also using feeds of 42-40% CP.

Fidelus Fru (right) with the DSM team and participants. From left, Lee Low and Liew Kok Wah, Dindings Soya Multi Feeds, Malaysia; Liew Chiow-Yen, DSM, Malaysia; Chee Wei Ling, Dindings Soya Multi Feeds, Malaysia; Dr Anita Yong and Thien Fui Yin, University Malaysia Sabah; Dr Fuci Guo, DSM Singapore and Tan Seow Pheng, DSM Malaysia.

There is no doubt that feed is a key factor in intensive shrimp farming here in Asia. Hoa added, "Within Asia, we have some variables with feed use. In India, although stocking density of vannamei shrimp is only 30-60 PL/m², 36-35% CP feeds are used in comparison with Vietnam where farmers stock at 80-100 PL/m² using feeds with much higher protein (42-40% CP). Farmers in Vietnam achieve 20g shrimp in 80 days of culture (DOC) whereas in India even with lower stocking density, farmers achieve 20g shrimp in 110-130 days. If we compare with the situation in Ecuador, we have stocking at 10-20 PL/m² and growth to 20g in 90-115 days with 36-28% CP feeds. This implies that for intensive shrimp farming, we need high density nutrients to achieve targets."

Another scenario happening in Vietnam is the use of high density feeds to shorten the culture period, improve feed conversion ratios (FCR) to 1.1-1.2 and thus feed costs. Some vannamei shrimp farmers use the higher density monodon shrimp feeds when stocking density is high. In contrast, some monodon shrimp farmers stocking below 15 PL/m² use vannamei shrimp feeds with lower CP content and take advantage of pond natural productivity. Another instance is the use of monodon shrimp super-growth feeds (46% protein) for vannamei shrimp farming when shrimp prices are high. In the case of tilapia, starter diets (with higher protein levels) have been used until 100g fish instead of up to 30g fish.

> **"..higher intensive culture requires feeds of higher nutrient density and quality." - Nguyen Duy Hoa**

Hoa presented results of a monodon super-growth feed with 46% CP fed to vannamei shrimp since DOC46 as compared to shrimp fed on a standard vanamei feed throughout the 90-day cycle. Although feed cost/kg shrimp was higher for the super-growth feed group, the net income was 14% higher for this group. High protein feeds to improve shrimp performances will provide more chances for highly digestible protein ingredients in the formula as well as other "natural" key nutrients normally present with high quality protein ingredients, such as cholesterol, EPA/DHA, minerals, etc. He also discussed the important roles of micronutrients to shrimp heath performances, especially vitamin E and nucleotides for shrimp and fish health.

"In summary, intensive culture requires feeds of higher nutrient density and quality. However, specific species requires specific key nutrients for their growth and health. It is also important for feed formulators to understand what is happening at the farm level and that using high-density feed not only provides more protein but also gives more room for high quality ingredients, and inherent key nutrients. But at the same time, non-nutrient values such as physical attributes of the pellets are important considerations when formulating diets for intensive aquaculture."

In his presentation, Hoa also discussed successful feeding methods in intensive aquaculture as well as consumers' perspectives on intensive aquaculture. Environmental pollution, antibiotic and chemical residues in products are some issues drawing negative perceptions from consumers. There are differences in consumer perspectives between those in Asia and in the West on the use of pigments in feeds.

Dr Haifeng Mi (second right) with Anne Lawrence Huillery, Thetis Aquaculture Support, Vietnam (middle) who presented on Asian seafood supply chain and consumers' demands: focus on farmed seafood in Southeast Asia; Dr Fuci Guo, DSM Singapore (second left) and Wu Jian Yong, The Mau Production Co Ltd, Vietnam (right).

Approaches to health management

In this presentation on Health Management through Nutrition, **Dr Mi Haifeng**, Director at Tongwei Aqua Research Institute, China looked back at the rapid development of aquaculture in China. Tongwei is one of the largest aquafeed producers in China with 70 feed mills with a total volume of 2.3 million tonnes per year. It had a large share of China's aqua feed market of 19.6 million tonnes in 2016.

Growth of aquaculture in China was attributed to the intensification of farming. However, with the higher stocking density and water pollution, disease outbreaks are common. "How can we improve fish and shrimp immunity and their ability to resist diseases and at the same time reduce dependence on chemicals and antibiotics?" asked Mi.

The situation with water resources, important for aquaculture, is not good. Mi said that in 2008 the water quality in the seven major rivers was already moderately polluted. Eutrophication of lakes is high and major lakes are seriously polluted. "In the next 5 years, there is a government target to reduce pollution in the seven biggest rivers. Intensive aquaculture is already banned in rivers and lakes."

Mi added, "Because of diseases we lost one million tonnes of shrimp. Disease is everywhere, in tilapia, carp and shrimp farming. In shrimp, survival is less than 10%. Genetically, fish are getting weaker as there has been too much inbreeding and focus on fast growing strains, and little on robustness and better immunity." Some symptoms are intestinal haemorrhages, and redness of liver and gall bladder in fish. In shrimp, there is early mortality syndrome with yellow and whitish hepatopancreas.

From left; Dr Richard Smullen, Ridley Aqua-Feeds, Australia who presented on Feed management: Diets for intensive production-updates on challenges and recommendations; Dr Allen Davies, University of Auburn, USA; Vorapong Pattrakulchai, Cargill, Vietnam and Nguyen Duy Hoa

Nutritional interventions

"We can mitigate these diseases with dietary supplements," said Mi. As the Chinese love live fish, the condition of the fish is important. "We need healthy fish not only during farming but also during live transport so that the fish can withstand stress and do not have gut damage. Sixty percent of carps have gut lesions. In June and July, farmers overfeed leading to such lesions."

Barriers preventing infections lie with a balance of gut microbes and gut mucosa integrity. Mi discussed several options on how to maintain this balance and have good gut health. "As China has to continue to do intensive aquaculture, there is pressure to develop better diets. Too much fat will affect gut health and create problems. At Tongwei, we looked at different fatty acid compositions of diet and effects on the fish. Unfortunately, although at Tongwei, we extrude most of our feeds, there is a lot of pelleted feed marketed with high levels of carbohydrates. This situation leads to fatty liver and increases susceptibility to bacterial infections."

Research showed that insufficient fat in diets causes slow growth in blunt-snout bream but 15% excessive fat leads to fatty liver and damage of mitochondria (Li et al 2012; Lu et al, 2014). The fat source is also important. Lard, which contains high levels of saturated fats, causes high fat deposits in liver and pancreas (Gao Yanling et al, 2009).

> **"We need to understand further, at the molecular level, the interactions between nutrition immunity and disease resistance.."**
> **- Mi Haifeng**

Mi discussed the health benefits of amino acids, arginine and threonine, vitamin C and B6 as well as trace minerals for animal health. Essential oils from Chinese herbs, emodin and curcumin have been shown to have health benefits. "Supplementing 30-60mg/kg of emodin powder improved immunity and stress resistance in blunt-snout bream with high survival during an *Aeromonas* challenge. Curcumin powder added at 60mg/kg feed improved non-specific immunity in the same fish (Zhang et al. 2014; Xia et al. 2015). Enzymes, organic acids, probiotics and functional peptides also have health benefits. Tongwei is working on the enzymes; phytase, xylanase and protease. As China has strict rules on the use of antibiotics, we need to research on replacements," said Mi.

Jorge Dias (right) and Bent Pedersen, DSM Denmark

Huynh Man Khoi (left) and Peter Robson, DSM, Vietnam with participants My Dung, Proconco Cantho (second right) and Ngoc Hau, ACC, Vietnam

As for the future Mi said, "We need to understand further, at the molecular level, the interactions between nutrition immunity and disease resistance, as well as how nutrients and feed additives regulate the accumulation of hazardous substances and how nutrients work as anti-stressors."

Increasing the value of feed ingredients with enzymes

Dr Jorge Dias, Sparos LDA, Portugal, discussed how enzymes work and the rationale for inclusion. "Over the last few years, aquaculture feeds have evolved towards an optimization of nutrient supply. Biologically, we seek to adequately cover the nutritional requirements of species, taking into account different developmental stages, environmental farming conditions and the promotion of well-being and functionalities (e.g. immune status). Economically, aquafeeds are formulated with least-cost principles based on market availability of ingredients and technology constraints, but not guaranteeing a low environmental impact with a high nutrient digestibility, optimal metabolism and low-impact on water quality."

Grain and oilseed by-products are good sources of protein and energy for aquafeeds. However, high dietary inclusion levels of plant proteins generally depress fish growth and feed efficiency. This poor growth performance commonly found in fish fed plant-protein rich diets is generally related to the lower biological value (essential amino acid imbalance, impaired phosphorus availability, presence of anti-nutritional factors, higher carbohydrate fraction) of the plant-protein sources."

Supplemental feed enzymes are powerful tools to improve the supply of nutrients and enhance digestibility. The opportunities are to break down anti-nutritional factors (ANFs) or specific bonds present in raw materials and hence to improve bioavailability of nutrients (energy, protein, amino acids, phosphorus, other trace elements) "But ultimately, it depends on the enzymes and type of raw materials and the solutions we are looking for," added Dias.

Enzymes are already used in the processing of hydrolysates and soy protein concentrates. However, high potential exists for the use of enzymes as a supplemental additive in complete aqua feeds to enhance digestibility directly by its action on proteins and phosphorus, and indirectly by the reduction of ANFs to liberate nutrients. Dias discussed work conducted at Sparos with some enzymes, using tilapia as an example of beneficial effects of supplemental enzymes on warm water fish.

Xylanase

This carbohydrate-degrading enzyme works on non-starch polysaccharides (NSPs). Beneficial effects of xylanase (or cocktails of NSP-degrading enzymes) has been shown in warm-water fish fed low grade or unprocessed vegetable ingredients. "To guarantee a beneficial effect, we need to know in detail the type of NSPs that we are targeting in the feed. Different dietary NSP profiles may require different enzyme solutions," said Dias.

The beneficial effect of xylanase (Ronozyme WX, DSM Nutritional Products) was described in a trial with Nile tilapia. The enzyme was top coated in low fish meal (5%) and high fish meal (10%) extruded diets. "Xylanase supplementation significantly increased weight gain, specific growth rate, protein efficiency ratio and retention of protein and energy in a dose dependent way. At 10% fishmeal level, beneficial effects were achieved at 100 FXU/kg supplemental dose, while at 5% fish meal level, beneficial effects were generally found at 200 FXU/kg dose".

Proteases

These are relatively recent enzymes. Efficacy seems ingredient-dependent. In trout, protease supplementation had a moderate effect on digestibility of sunflower and rapeseed-based diets, while it improved nutrient digestibility in a soybean-based diet (Dalsgaard et al. 2012).

"Our 12-week trial on the tilapia using top-coated protease (Ronozyme ProAct, DSM Nutritional Products), compared protein digestibility, FCR and final body weight with low fish meal diet (26%) versus higher fish meal diet (28%). Protease supplementation at 600mg/kg allowed a successful 2% reduction of crude protein level. The magnitude of effects was associated dietary crude protein level, with limiting protein supply enhancing the nutrient releasing role of protease."

Phytase

This is the most well studied enzyme in fish. Fish lack phytase, an enzyme that hydrolyses phytate to release phosphorus. Phytate is a powerful anti-nutritional factor (ANF) with detrimental effects also on the absorption of other minerals and protein. "Trials with Ronozyme HiPhos (DSM Nutritional Products) at three doses, top coated in extruded feeds demonstrated that the percentage of phosphorus released is related to the dosage of phytase supplementation. However, knowing phosphorus digestibility is important but to gain further flexibility in formulation, it is key to know the phosphorus release value of phytase, and preferably on an individual raw material basis." The efficacy of phytase is

also related to raw materials. Therefore, it is suggested that feed formulators have to decide on the level of phytase based on the raw materials.

"Today, efficacy has to be substantiated by improvements on whole-body phosphorus retention and bone phosphorus content. In Europe, EFSA (the EU agency on food safety) is demanding information on this," added Dias.

Cocktail of enzymes

Dias explained the effects of a multifactorial tilapia trial using two mixes of phytase, xylanase and protease, all from DSM. The enzymes were applied post-extrusion by top coating onto 0% fish meal and 4% fish meal diets. "Overall, we found significant effects with blending them together, not only on protein and phosphorus digestibility, but also on weight gain, FCR and nutrient retention at the whole-body level. The effect was also significant for the 0% fishmeal diet."

> **"..just like an enzyme that requires a specific substrate, we should clearly define our target,.." Jorge Dias**

The message was, "Feed enzymes are valuable tools to upgrade the nutritional value of plant-based ingredients used in aqua feeds. They contribute towards a greater flexibility of ingredient use by feed formulators, a reduction of the environmental impact associated with feeding and a higher economical profitability to feed mills. But, just like an enzyme that requires a specific substrate, we should clearly define our target, and fine tune it in terms of fish species and formulation specificities. It will take time and knowledge, but it will surely pay off."

Feeding for improved productivity and reduced environmental impacts

As the aquaculture industry matures, we need to start paying increasing attention to environmental sustainability of aquaculture enterprises while not forgetting about their sustainability. Professor **Dominique P. Bureau**, Fish Nutrition Research Laboratory of the Department of Animal Biosciences, University of Guelph said that as feed millers improve feed quality and FCRs, they consequently reduce waste output associated with the feed. The next step is to go to the field with farmers to improve productivity and profitability of the farm.

Dominique P. Bureau and Nguyen Duy Hoa

Measurement is the first step

"You can only improve something you can actually measure. Many of us go to the farms as the last step but I propose this as a key step." To illustrate this point, Bureau showed some data collected over 2 years, covering a long and risky cycle at five commercial and one experimental freshwater rainbow trout cage farms in Lake Huron, Ontario, Canada. The measurements over 2 years included biological feed conversion ratio (BFCR), defined as the feed served per fish: average weight gain per fish. "In analysing data from farms, there were tremendous variability from farm to farm. Feed and the strain of fish used were the same and so the variation is associated with farm management and other factors. These ranged from sampling errors to environmental and production issues influencing BFCR. We also initiate a 'clean-up' process to improve data collection and then use statistics to tease out outliers.

> **"..look at curated field data and identify achievable 'targets', as opposed to ad hoc ones. - Dominique P. Bureau"**

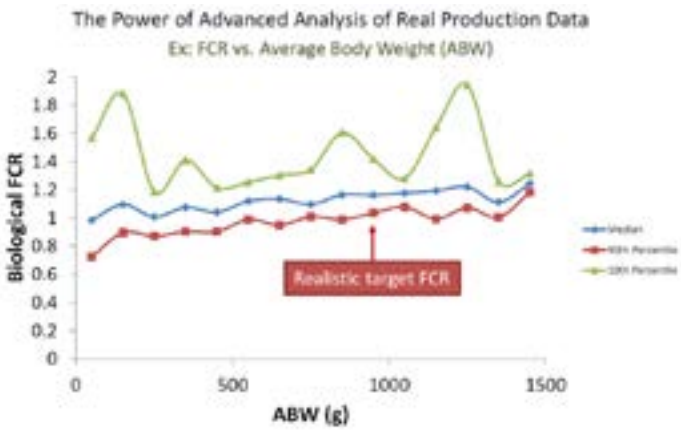
"Advanced statistical analysis of the data is a way to look at highly variable field data and identify achievable 'targets', as opposed to ad hoc ones. In the figure, we show that advanced analysis of field data can show realistic FCR targets at 90th percentile. Measuring is a first step to understand problems with farms and see how well we are doing. How many efforts has there been at objectively looking at farm performances in Asia? A few but clearly not enough."

Sustainability effect

Environmental sustainability is important for many different aquaculture operations but depending on the production environment, these need to pay attention to different types of waste outputs. In the case of freshwater fish culture operations, solid wastes, notably solid organic wastes, and phosphorus waste discharges are most critical for environmental sustainability. In the case of marine fish culture, it will also be solid wastes in addition to nitrogenous wastes. The focus to minimize wastes will differ as a function of operations.

"A major issue of solid waste such as sludge is that it accumulates at the bottom of pond, bays and lakes and create areas that are anoxic and too high in ammonia and other compounds to sustain life However, a small amount of waste into the environment can be highly beneficial and stimulate the growth of natural food. In a Canadian study on a model cage fish culture operations, researchers found that waste was settling directly under the cage. The negative impacts were localized and the global environmental impacts of the fish farm were overall very positive for the wild fish populations due to the increase availability of natural food. "We always talk on the negative aspects of aquaculture but not on the positive impacts," added Bureau.

We can predict the solid waste output of a farm from a simple nutritional budget. If we know the digestibility of the feed and how much is retained by the animal, we can easily predict waste outputs. However, predicting environmental impacts of aquaculture operations is really difficult and will be very different for different types of operations.



Improving feed quality

How can we minimize waste output? "Simply by making high density feed, we can improve on feed conversion ratios and reduce the waste output. We can reduce solid waste by 50%; in the mid-1980s, the solid waste output was 0.28kg/kg rainbow trout produced but in 2000s, it declined to about 0.17kg. The first step is to get rid of indigestible matter. In a farm in China, run by farmer cum professor Wang Yan, the transition from feeding raw fish to pelleted feeds to a marine fish species reduced total nitogen wastes/tonne of fish produced from 91kg to 45kg.

"A major issue here in Asia is formulating feeds for different species, culture systems and market demand (economy feeds etc). But formulators need to think more in terms of waste output which is an emerging issue. They should no longer focus on specification only but move to digestible nutrient basis; FCR is higher with low density feeds and lower (better) with higher digestible nutrient density feeds. "

Marketing different feed grades based on feed quality and feed costs is common in Asia. "Actually, on a cost basis (feed cost per kg of fish), these feeds are equal as the FCR is higher with lower quality feed. However, in terms of waste output, they are not equal. The higher quality/higher cost feed will have a much lower waste output. We can easily formulate tilapia feeds to optimize the reduction of waste output, as has been done with the trout."

Bureau had the following messages with regard to reducing environmental impacts:

Formulation for fish of different sizes: If the same formulation is used for fish of different sizes, there can be tremendous impact on the environment, such as phosphorus output. Feeds should be reformulated for fish size, while respecting certain risk margins. Further reduction of environmental impact is by selecting raw materials or supplementing with enzymes.

Ingredient selection: Understand ingredients and not just simply fat/protein etc and develop solutions.

Fibre and faecal cohesiveness: To target lower waste output, the focus should be on dietary fibre. For example, feeds with soybean meal and enzyme cocktail are less cohesive, more easily breakable with higher faecal material waste.

Feeding management

How feed is used is as important as the formulation and processing. "At the farm level, there are factors affecting feed utilization such as health issues, water pollution etc. Feed millers will need to tease out what impacts feed utilization. They need to develop tools and training programs to make farmers more efficient. Identify the conditions impacting FCR and start making adaptations," said Bureau.

The recommendation is to use models to make sense of data collected. "These are available and we can run simulation of situations. Adaptable and scientifically developed feeding charts will also help. In the industry, many are using different feeding charts. We developed Wittaya Aqua (*Wit in Aquaculture Production and Feeding Management*) for easy access to farm and feed manufacturer and as more information is added, we can increase its robustness. The aim is to help improve efficiency, sustainability and long-term profitability of aquaculture operations. As we gather more information, it will improve the answers for 'what if' situations."

Models could be valuable for improving productive efficiency of aquaculture operations. Information from the laboratory and field can be used to construct models which can help to identify areas of improvement for production. However, Bureau warned not to blindly believe output from models or field data.

Applications of a single cell protein in the culture of whiteleg shrimp

By Allan LeBlanc and Josh Silverman

A total fishmeal replacement in whiteleg shrimp diets demonstrated improved growth and survival of shrimp at low inclusion levels.

Originally developed in Norway for the Atlantic salmon industry, there is a new and promising high-protein feed ingredient for marine shrimp. FeedKind Aqua protein (Calysta, USA) has a similar amino acid profile to fishmeal, is highly digestible, and can be incorporated into diets across all life stages. Table 1 shows the proximate, chemical and essential amino acids (EAA) composition of FeedKind *Aqua* protein and comparison with Peruvian Super Prime fishmeal (min. 68% crude protein).

FeedKind *Aqua* is a non-GMO (genetically modified organism) single cell protein produced via natural fermentation from a state-of-the-art production facility. Beginning 2019, the product will be available year round, independent of weather events, and thus is able to protect the feed supply chain from volatility and risk.

This single cell protein is also traceable from factory to plate. Containing a unique elemental profile that persists in the feed and the final product, shrimp fed this product can be differentiated from shrimp fed on other diets. A simple test can guarantee that the shrimp in the freezer at the local grocer is the same one that came out of the pond. It has been approved for use in a wide range of fish and livestock in multiple regulatory jurisdictions around the world.

Nutritional value

To assess the beneficial effects of FeedKind protein in shrimp, a trial with the Pacific whiteleg shrimp *Litopenaeus vannamei* was conducted in partnership with Texas A&M University-Corpus Christi and Auburn University using material from Calysta's market introduction facility in the UK. Growth response and survival in juvenile shrimp fed graded levels of the protein was evaluated relative to a fishmeal-containing reference diet.

Nutritionally complete diets were prepared at Texas A&M AgriLife Research and compared in an indoor, 8-week growth trial, at the E.W. Shell Fisheries Research Station, Auburn University, Alabama. Juvenile shrimp of approximately 0.1g average weight were stocked at a density of 10 juveniles/80L tank. Each treatment had either five or six replicates; altogether there was a total of 39 treatment tanks. Treatment tanks were connected to a recirculating aquaculture system to maintain water quality conditions .

Table 1. Proximate and chemical comparison of FeedKind *Aqua* protein and comparison of essential amino acids (EAA) composition with Peruvian Super Prime fishmeal (min. 68% crude protein).

Proximate composition (Typical values, as-is basis)		EAA (g/kg)		
	FeedKind *Aqua* protein		FeedKind *Aqua* protein	Peruvian Super Prime fishmeal
Crude Protein	71%	Arginine	42	37
Crude Fat	8%	Cystine	4	7
Ash	9%	Methionine	18	20
Crude fiber	<1%	Histidine	15	20
N-free extract	7%	Isoleucine	30	28
Moisture	5%	Leucine	50	52
Gross energy (MJ/kg)	22.1	Lysine	39	54
		Phenylalanine	29	27
Fatty acids (% of total)		Tyrosine	22	22
C14:0	6	Threonine	30	29
C16:0	54	Tryptophan	12	8
C16:1	35	Valine	39	35
Others	5			
		Histamine	<10 ppm	<500 ppm
		Antioxidants	None	<150 ppm Ethoxyquin

Shrimp were fed six different treatment diets including a control diet, which is based on a feed conversation ratio (FCR) of 1.8:1, with a doubling of weight every week until week five. The feeding rate was modified depending on the visual observation on consumption. Feeds comprised a basal control diet of 15% fishmeal and five diets of increasing concentrations of FeedKind protein to replace fishmeal, at 1.5%, 3.8%, 7.5%, 11.3%, and 15% of total feed. Diets also included krill meal and squid muscle meal as marine attractants that were kept constant in all diets. The average weight of shrimp at the termination of the experiment was 8-10g.

Better survival

The mean survival of all the diets was 93.5% over the 8-week period, indicating that the experimental conditions were adequate for shrimp growth. Survival rates varied from 84% for the control diet to 97% for the diet with 100% fishmeal replacement. The exception was the 3.8% group, showing significant ($p<0.05$) improvement relative to the control (Figure 1). This improvement in survival demonstrates that FeedKind protein is well-tolerated in shrimp relative to fishmeal and can improve the health of the animals under research conditions. Additional farm-scale trials will be conducted to assess the magnitude of this benefit at commercial scale.

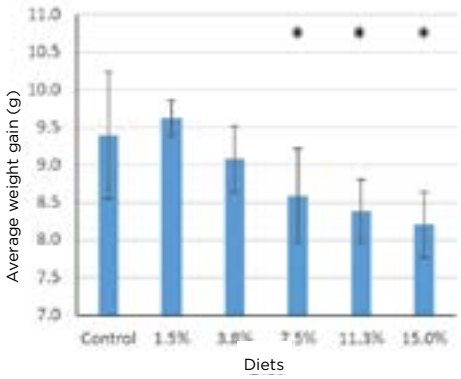


Figure 1. Average weight gain (g) of shrimp fed diets with increasing levels of FeedKind *Aqua* to replace fish meal

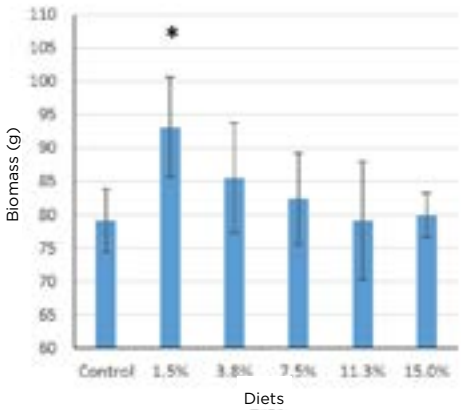


Figure 2. Average biomass per tank (g) of shrimp fed diets with increasing levels of FeedKind *Aqua* to replace fish meal

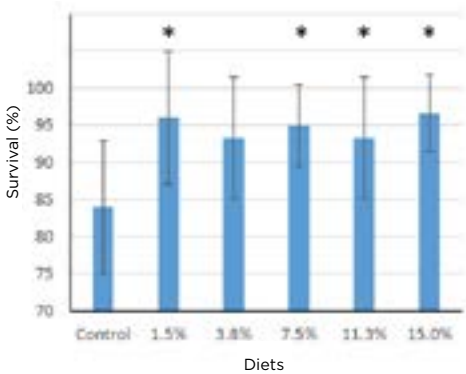


Figure 3. Survival rates (%) of shrimp fed diets with increasing levels of FeedKind *Aqua* to replace fish meal

Total biomass

The inclusion of this single cell protein resulted in significant ($p<0.05$) increases in aggregate shrimp weight in the 1.5% and 3.8% diet groups (Figure 2). The largest increase was a total biomass/tank improvement from 80g/tank up to 93g/tank in the 1.5% protein diet, representing an 18% increase in total productivity. Shrimp fed the treatment diet with no fishmeal performed equally well, as compared to the control, indicating that a 100% replacement of fishmeal with FeedKind can be achieved without a loss of productivity.

Weight gain

The average weight gain was also assessed (Figure 3). Unfortunately, the significant differences in survival among the groups complicated the interpretation of this parameter. The 7.5%, 11.3%, and 15% FeedKind diets all showed a significant decrease in average shrimp weight relative to the control. This is likely due to the fact that the feed amounts were held constant for all tanks, even though there were more live shrimp in the test diet tanks than the control tanks. Therefore, it is likely that individual shrimp in the control diet tanks were able to grow larger due to having more food available. In the control tanks, an inverse correlation was observed between survival and average weight gain in individual shrimp, thus supporting this hypothesis.

The data from this trial show that this single cell protein can successfully replace fishmeal in diets for whiteleg shrimp. The improved growth and survival of shrimp with low levels of this protein inclusion indicate that performance of these diets may even be superior to fishmeal under certain conditions. Additionally, as a reliable and traceable feed ingredient, FeedKind protein stands to dramatically improve consumer confidence in the supply chain.

Acknowledgement

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Choosing the right phosphorus source for shrimp

By Sjo Zwart and Emilie Willems

Feed phosphates with a high total and digestible phosphorus have an economic and environmental advantage.

Phosphorus (P) is an essential element for growth and metabolism of shrimp. Together with calcium (Ca), phosphorus is important for the formation of the exoskeleton. It is also a part of the soft tissues such as muscles, nerves and blood cells. Phosphorus is also an important component of nucleic acids, phospholipids, ATP (Adenosine triphosphate) or coenzymes.

It is necessary to have sufficiently high phosphorus levels in the feed to avoid deficiencies. Contrary to other minerals such as calcium, magnesium (Mg) or potassium (K), which are abundantly present in sea and brackish water, phosphorus has to be supplemented in the feed. These minerals are important for osmotic regulation and for molting. A supply below requirement will result in lower productivity of shrimp.

Today, diets are changing, with more plant protein sources being used to replace fish meal. As plant proteins contain a low level of total phosphorus and digestible phosphorus, inorganic feed phosphates must be added in the diet. With an emphasis on phosphorus, Aliphos, a company which specializes in mineral nutrition has developed a special feed phosphate for use in fish and shrimp nutrition. Windmill® Aquaphos is a highly soluble feed phosphate containing 26% of phosphorus but does not contain calcium. It has showed a high and proven phosphorus availability (aP) of 90% in aquatic species.

Phosphorus and calcium interaction in shrimp nutrition

Feed phosphorus digestibility depends on dietary calcium. A high level of dietary calcium impacts negatively phosphorus digestibility. This negative effect of dietary calcium on phosphorus availability is explained by the formation of indigestible Ca-phosphate salts in the intestinal track. Therefore, if an additional supply of phosphorus is needed, it is advised to use a Ca-free feed phosphate.

A study carried out by Cheng et al. (2006) demonstrated the adverse effect of dietary calcium on phosphorus availability. In the absence of supplemental calcium, a level of 0.77% available phosphorus in the feed was adequate for optimal growth of juvenile whiteleg shrimp *Litopenaeus vannamei*. However, in the presence of 1% supplemental calcium in the feed, the level of available phosphorus in the feed has to be increased to 1.22% to reach the same growth performance. A supplementation of 2% calcium to the basal diets resulted in a significant reduction in growth.

In 2017, Aliphos performed a trial to compare the efficacy of various feed phosphate sources on the growth performance, phosphorus retention and digestibility in whiteleg shrimp. The trial was organized in collaboration with SPAROS I&D (Portugal) in the experimental facility of RIASEARCH (Ovar, Portugal). Three treatment diets containing the following feed phosphates were tested against a control (diet NC).

- Windmill® Aquaphos (Diet WA)
- Monocalcium phosphate, MCP (Diet MCP)
- Monopotassium phosphate, MKP (Diet MKP)

Experimental details

Shrimp were kept in a recirculation aquaculture system (RAS) in seawater (salinity 20 ppt). Shrimp were fed manually 4 times per day. Feeds were formulated to contain levels of phosphorus of 0.58% in the negative control (NC) and 0.85% in the experimental diets. No calcium was added in the form of $CaCO_3$; only calcium from the feed materials was present in the experimental feeds. Five replicate groups of 25 shrimp, with a mean initial body weight (IBW) of 1.67 ± 0.22g were fed the experimental diets over a duration of 54 days.

In addition to growth performances, two other criteria were used to measure the efficacy of the phosphate sources: phosphorus digestibility and retention.

Table 1. Composition of the diets

Composition	Control (NC)	MCP	MKP	WA (Windmill Aquaphos)
Dry matter, %	97.74	94.52	94.55	94.69
Crude protein, %	36.22	36.09	36.16	36.45
Crude fat, %	6.15	6.11	6.10	6.15
Total P, %	0.58	0.84	0.85	0.85
Ca, %	0.41	0.62	0.39	0.40
Energy, KJ/g DM	17.67	17.64	17.66	17.64

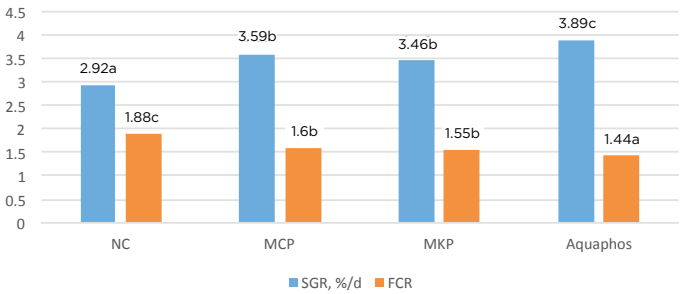


Figure 1. Growth performance of shrimp when fed different diets for 54 days($p<0.001$)

Performance results

Specific growth rate (SGR %/d) of shrimp fed the NC diet was significantly lower than all the other diets. Shrimp fed Windmill® Aquaphos (Diet WA) showed a significantly higher SGR than all other diets (Figure. 1). FCR of diet WA was significantly lower than MKP, MCP and NC. During the entire trial, the survival rate ranged between 97.6 and 99.2%.

Nutrient retention

The body composition (protein, phosphorus and calcium) was significantly affected by the various dietary treatments. The retention of phosphorus (expressed as % of intake) was significantly higher for Diet WA as compared with other treatment diets (Figure 2).

Shrimp fed the diets containing phosphates without calcium (Aquaphos and MKP) showed calcium retention values higher than 100%, suggesting absorption from the surrounding water. The diet containing MCP resulted in a significantly lower retention of calcium. In other words, it was not necessary to add calcium via the feed. There was even a negative effect on nutrient retention, i.e. more particularly retention of phosphorus.

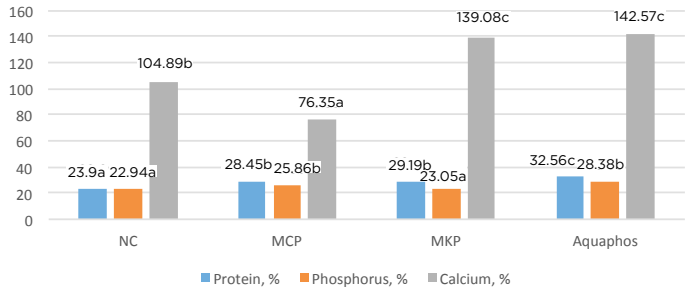


Figure 2. Retention of nutrients in whole body from the complete diets (p<0.001)

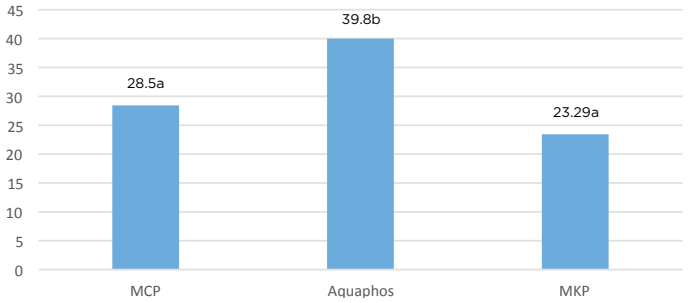


Figure 3. Phosphorus retention of the phosphates, % (p<0.001)

Retention of phosphorus from the feed phosphates was also calculated based on the body composition (Figure 3) and the negative control. Again Windmill® Aquaphos showed the highest value. These values were lower than the P-retention generally found in fish, but with shrimp P-retention was impacted by molting periods during the trial.

Apparent digestibility

In the digestibility trial, larger shrimp were used (average weight 9g). Collection of faecal matter was through siphoning. An indigestible marker (Yttrium oxide) was added to the feed to measure digestibility. Phosphorus digestibility in the complete diet was significantly higher for the WA diet as compared to the other treatments. Calcium digestibility of the diet containing MCP was significantly lower than the other diets (Figure 4). This suggested that the requirement for calcium was met with calcium absorbed from the surrounding water.

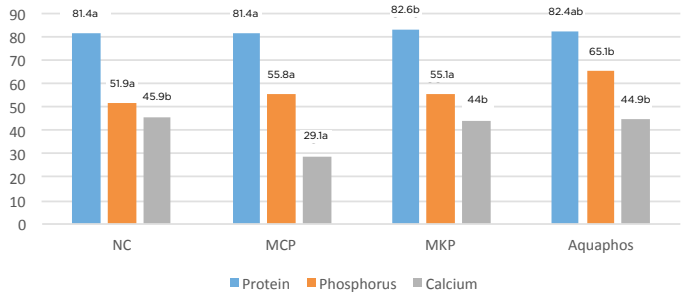


Figure 4. Apparent digestibility of protein, phosphorus and calcium from the complete diets (p<0.001)

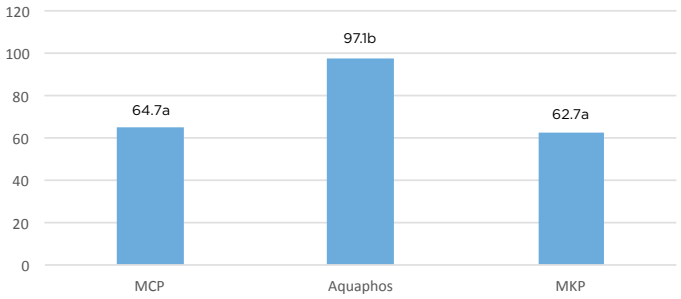
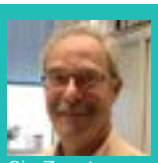


Figure 5. Apparent digestibility coefficients of the phosphates, %

Windmill® Aquaphos presented a significantly higher phosphorus digestibility than in the case of MKP and MCP: 97.1% vs 60.7 and 62.7% respectively (Figure 5).

Conclusion

Feed phosphates with high total and digestible phosphorus such as in Windmill® Aquaphos offers economic advantages, because less phosphate is used in the feed for the same digestible phosphorus level. Furthermore, eutrophication of water is related with the phosphorus level. As this product showed higher P-retention than monocalcium and monopotassium phosphate, it means also that less phosphorus enters the water and thus less likelihood of eutrophication.


Sjo Zwart


Emilie Willems

Sjo Zwart is currently working for Aliphos, part of Ecophos. Sjo has been responsible, amongst others, for the trial work within Aliphos into the biological value of its feed phosphates for different animal species.

Emilie Willems is an agriculture engineer specialising in animal science. Previously, Emilie worked for FAO and travelled in Africa to work as farm manager. In Aliphos, Emilie's role is in technical and marketing support. Email: emilie.willems@aliphos.com

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Voluntary certification and marketing the pangasius

It is not only certification alone, but coupled with communication that brings the desired results in marketing pangasius.

In Vietnam, producers and processors have been applying for various certifications as a means to increase market access for their seafood products. Particularly for farmed seafood and more so for the pangasius, producers consider it important to be certified to the standards set by both internationally renowned and private certifications, alongside the publicly developed VietGAP. The latter is now a mandatory requirement in Vietnam. During Vietfish 2017, representatives from leading certification organisations participated in the VASEP organised seminar on voluntary certifications: How to get 'visas' for seafood imports and experts. Their presentations to the audience comprising mainly seafood processors gave information on standards developed by third party certification bodies and their attributes.

Indeed certification is important for market access, but it does not solve all the issues pertaining to the marketing of fish. There is a need for the industry to better engage with the media to promote the fish and counter the frequent adverse reporting on the pangasius.

According to FAO (2011), private standards and related certification schemes are becoming significant features of international fish trade and marketing. Their use is also becoming more common in the efforts to ensure food safety, quality and environmental sustainability in the growing aquaculture industry. Private standards are now a key mechanism for large-scale retailers and commercial brand owners wishing to translate requirements – both product and process specifications – to other parts of the supply chain. This is especially important as supply chains become more vertically integrated. Certification also facilitates traceability, standardization of products from a range of international suppliers, and transparency of production processes.

"The latest research shows that 72% of consumers in 21 surveyed countries rate sustainability more highly than price and brand. Some 62% of consumers believe that independent labelling increases trust," said Huynh Quoc Tinh, Food Practice Lead, WWF-Vietnam. However, Tinh asked, "Do voluntary certifications and labelling really promote sustainability for the aquaculture sector? This depends on standard requirements, management mechanism and transparency."

Trends in certification

In Vietnam, the common voluntary certifications for aquaculture include Friend of the Sea (FOS), Fairtrade, Aquaculture Stewardship council (ASC), GlobalGAP, Best Aquaculture Practices (BAP) and Naturland for organic certification. An update on voluntary certifications in Vietnam presented at the seminar indicated the following: 76 GlobalGAP certified up to April 2016; 50 BAP/GAA certified and 31 under assessment up to August 2017; 85 ASC certified and 13 in assessment up to June 2017; 6 Naturland certified up to June 2017 and 8 FOS certified up to July 2017. In the case of VietGAP, Vietnam's National Standard on Good Aquaculture Practices, which was introduced in 2014, up to August 2017, there were 291 VietGAP certificates issued to around 350 producers. This is because the Ministry of Agriculture and Rural Development (MARD) certifies for individual, group and multi sites.

VietGAP

The aim of this certification is to regulate the principles and requirements to be applied in aquaculture for food safety, environmental integrity, aquatic animal welfare, safety and benefit of the workforce, and traceability, according to Bang Tam, MARD in her presentation. "The supply chain for the monodon and vannamei shrimp in Vietnam indicated that 87.8% and 85.2% of production, respectively are exported. In the case of the pangasius supply chain, producers are small scale and 80% of processing plants have farms to supply 60-70% of their raw material needs. Thus, VietGap fits into the need to have control on production at the farmer level and fits into the requirement for sustainable development. At the consumer level, there is the need for certified products."

VietGap is meant to instill transparency and traceability of producers while raising awareness on market needs. To date, Bang reported VietGAP has certified a total of 291 facilities covering a total area of 2,300 ha. These comprise 51 shrimp farms (633 ha) and 195 pangasius catfish farms (1,332 ha).

However, despite all efforts, with expenditure of considerable resources (personnel, finance etc), Bang said, "The industry continues to face adverse reporting by media. Producers do not benefit from higher prices and consumers do not wish to pay more for safe products. There is however, a realisation that VietGAP is a long-term program to ensure the quality of seafood products of Vietnam, and gradually build brands based on quality. Changing

Speakers from left, Bang Tam, Huynh Quoc Tinh, Nguyen Thi Thanh Binh, Valeska Weymann and Esther Luiten, Aquaculture Stewardship Council.

The 10-year old OFCO is a leading provider of services on seafood inspection in Vietnam; offering inspection, market intelligence and advice. Founder Jean-Charles Diener is active in the development of worldwide communication with regards to sustainability of pangasius aquaculture.

production practices now, will gradually change the image of Vietnam's seafood products in future."

Exploring some issues

Nguyen Thi Thanh Binh, Vietnam country coordinator for BAP looked at issues of concern along the supply chain. "With aquafeed, issues of concern to retailers are linked to the slave labour, food safety and responsible use of fish meal. There is the use of banned chemicals where we are lacking on food safety and social responsibility at the processing plant. The market still grapples with unsustainable developments warnings. BAP always focuses on several issues such as: food safety, social responsibility, environmental responsibility, animal health and welfare, and traceability. While covering all these areas in depth, we are certainly giving a special focus to social issues.

"Within markets, each buyer and retailer has his or her own vision on seafood and certification helps to complete this vision. Many retailers only buy certified products that meet their definition. Even e-commerce platforms request certified products that they define. Recently, BAP is the only seafood-specific certification program approved by Walmart, the top retailer in the US, for monitoring supplier social compliance."

Binh added that that there is now a total of 139 BAP certified facilities including processing plants, farms, hatcheries and feed mills in Vietnam and 1,671 certified facilities worldwide through August 2017.

Invest in communication

Valeska Weymann, GlobaGAP said that there is a lot of work in the certification process with regards to verification and compliance. The effort lies with the farmers, feed mills and hatcheries. Unfortunately, Vietnam's farmed seafood industry previously faced adverse reports from the media. "We did have the case of the WWF film 'The Pangasius lie'. This demonstrates that all efforts can be lost in minutes through massive media which avoids the good news, and spotlights on the bad. There are also other cases like the ethoxyquin issue." She added that unfortunately, the media did not bring up factual information such that the farm was certified. "Whether a farm is certified by private or local certification program, we need to invest in communication."

This brings up the crucial need for transparency which comes with certification. Weymann described how this is shown with the GlobalGAP certification process. GlobalGAP has the GGN number which links online to all the information on a product; stages where the product is covered by certification, feed source and countries of destination.

There is the collaboration between GlobalGAP and VietGAP which was started in May 2016. The new version 5 of GlobalGAP has been compared in detail with VietGAP standard version2. "This is going to the other end of just communication; it is working at the government level to initiate change."

Feed supply to ensure quality raw material

The 30-year old Co May group is well entrenched in Vietnam's agriculture industry. It is also a major rice exporter in South Vietnam and operates its own rice mill. It started aquafeed production in 2004 with 3 extruders producing 20 tonnes/hour of floating feeds for the pangasius. In 2015, with a crowded pangasius feed market, AAP reported that Co May was moving against the tide by installing a new fish feed line in the plant in Dong Thap Province. At Vietfish 2017, company representatives gave some updates on the fish feed production and the scenario in farming and marketing of the pangasius.

Firstly, there has been further expansion in its feed production to 200 tonnes/day, bringing production for the pangasius fish, just behind leaders, Proconco and Viet Thang. In 2016, it set up Co May Import & Export Company or Co May Imexco. It is an investment in the processing of the pangasius and export of seafood. It also has an important role; seeking potential

Co May's Nguyen Truong Giang (centre, left) and Nguyen Thi Kim Phung (right) with Nguyen Thi Minh Huong (centre, right) and Nguyen Quoc Viet, Behn Meyer Vietnam Co Ltd.

markets aside from current ones such as South America, Middle East, Australia, EU, China, Malaysia, Philippines, Singapore and Thailand. CoMay already exports a range of pangasius products to more than 30 countries. Its leading markets are in South America, totaling 40%.

At present, the company is not involved in any farming activity, preferring to produce feed for the open market and buying back harvests. "We supply feeds to farmers and buy back fish for processing. In this way, we can ensure that the raw materials we use for further processing meets our specifications," said Nguyen Truong Giang, Vice Director, Co May Imexco. "One hurdle for the industry today is the quality of fingerlings and the government is working to help farmers with strong fingerlings." However, in the future, it might consider leasing land to build new farms. "In this way we have full control of the supply chain," added Giang.

In the last three years, farming of the pangasius has been rather unstable; low prices usually resulted in farms stopping operations and resuming when prices picked up. For example, at the end of 2016, with better prices, farms reinvested in farming. "In 2014-2015, we observed fast growth in this industry while in 2016, volumes were lower. The challenges for the industry, according to Nguyen Thi Kim Phung, Deputy, Marketing Department, Co May Imexco, is the generally higher feed conversion ratios, from 1.5 to 1.8, because of low survival rates due to poor water quality. "Some farmers overcome these poor conditions with probiotics which also help in reducing disease outbreaks. Our farmers have reported FCRs of around 1.5 during the grow-out stage from 25 g fish to 800g to 1kg fish. Feeds costs are around VND14,000 to VND16,000/kg (USD 0.6-0.7/kg) and with better farm gate prices of VND 27,000/kg (USD 1.2/kg) in April (which is the highest to date), profit margins are improving for the farmers. Quality says it all."

However, Phung raised a general concern in the industry. Vietnam's pangasius producers and processors continue to face a dilemma with certifications. "Each month retailers and buyers change and demand for new certifications. The FDA checks each consignment of imports of frozen pangasius products." CoMay has a range of certifications; Aquaculture Stewardship Council (ASC), GlobalGAP, VietGAp and will soon apply for Best Aquaculture Practices (BAP). www.comayimexco.com

Matching quality standards of buyers

Cuu Long Fish Joint Stock company or CL-Fish Corp is among the top ten pangasius producers and exporters in Vietnam. It is a pioneer in the farming of the pangasius with a 25-year history. Today, it has a total farming area of 120 ha in An Giang and Long Thap provinces in the Mekong Delta. These farms supply 80,000 tonnes or 80% of raw materials for the processing plant with a 40,000 tonnes/year of finished products. The rest are from contract farmers using feeds from the CL-Fish feed mill.

The CL-Fish feed plant produces 5,000 tonnes/month of feeds for the pangasius. Feeds are for its own farms and for the open market. Farms have Aquaculture Stewardship Council (ASC) and Best Aquaculture Practices (BAP) certifications. "We need to have very strict management protocols at the farms to match the strict quality standard on products as demanded by our buyers. We have full control of farming from fingerlings to harvesting. We are one of the few in Vietnam with 2-star BAP certifications (farm and processing plant). We will be better prepared and expect to improve harvest volumes in 2018," said Nguyen Thi Kim Ngan from the Sales Department at the CL Fish booth during Vietfish 2017, Ho Chi Minh City in August 2017.

The US hypermarket chain, Walmart is a major client. "Walmart's audit team comes to check on our supply chain four times per year. Our fish is called 'swai' in this hypermarket. Mexico is also an important market for us." On marketing to China, Ngan said, "Step by step we are progressing to increase exports into China. We are also interested in selling via an e-commerce platform in China. The Chinese markets also want us to sell in bulk for further repacking."

Nguyen Thi Kim Ngan (right) with her team (Tran Nguyen Quynh and Dang Thi Thanh Qui) at the booth.

Monthly, CL-Fish exports 100-120 containers of pangasius fillet and other products. It counts 70 countries as its markets. It has ASC, BAP, BRC, IFC certifications. "As we export to the Middle East, we also have Halal certification. For products to South America, the requirement includes BAP, BRC and IFS. In 2010, we achieved the Dipao certification for exports to Brazil. ASC is for exports to Europe where we sell small volumes of products. There are also requests for GlobalGAP certified products." She recounted some recent experiences with European markets. "The demand is not increasing but buyers such as those in Spain, Germany and Sweden are demanding products at much lower prices." In the case of the US, Ngan echoed the overall difficulties with exports; regulations which require FDA inspection of each container. www.clfish.com

New streamlined larval shrimp feed line

New microencapsulation production line in Nersac, France. Microencapsulation followed by low temperature drying ensures that essential nutrients such as proteins and vitamins are neither denatured nor destroyed and keeps the living organisms that constitute the probiotic Bactocell® alive.

BioMar has new larval shrimp feeds for the global shrimp hatchery market developed using the latest knowledge from internal and external R&D efforts in both feed processing techniques and larval shrimp nutrition requirements. The goal is for industry to supply strong shrimp larvae with an increased survival potential.

In recent years, the group has built a strong knowledge base within larval feed for shrimp. It has been developing new product solutions based upon extensive research, experience and shared interest with its customers in sustainability, innovation, cooperation and performance.

Jef Peeters, Product Manager for shrimp hatcheries, is proud of the new line of shrimp hatchery products. The investments in a business unit for hatchery products allow for producing high-end physical quality and properties of products and through internal and external R&D efforts our feeds deliver state of the art results.

Peeters is very positive on the company's future development of high-end products for shrimp farming. "After having for some years successfully offered our encapsulated products Larviva ProStart Zoea, Mysis and PL and our extruded and crumbled Larviva Shrimp PL products, it was time to implement the latest knowledge from internal and external R&D efforts in order to be ready to tackle new markets."

"Now, we start feeding our zoea and mysis larvae with Larviva Zoea and Larviva Mysis which are cold processed microencapsulated particles," said Peeters. "This technique ensures that the nutrients are maximally protected and the leaching of the nutrients is reduced to a minimum, offering complete nutrition in each particle during these fragile larval stages."

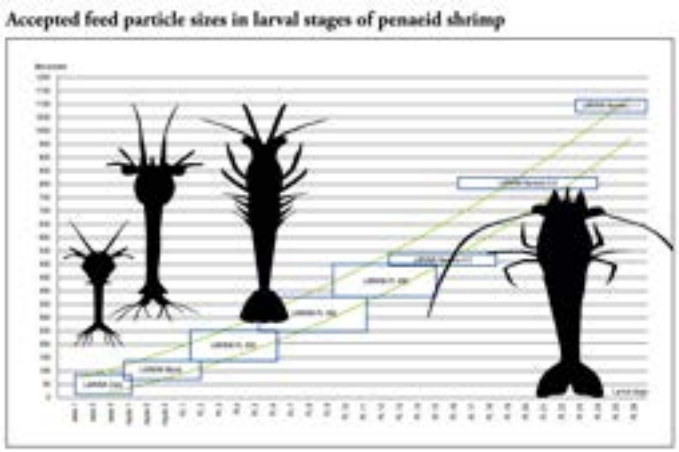
A synergistic anti-*Vibrio* package

Peeters added, "From post larvae (PL) onwards, we switch gently to extruded and crumbled particles. These are Larviva PL 200, Larviva PL 300 and Larviva PL 400. Together these offer a complete nutrition and that are designed with an optimal water-stability in mind."

Furthermore, all BioMar shrimp hatchery products now contain the probiotic Bactocell® and the yeast extract B-WYSETM. "These are products developed together with Lallemand, and that are key in combating Vibrio bacteria synergistically, Bactocell® (a living bacteria) by colonizing the gut and reducing Vibrio concentrations, and B-WYSETM by binding to the *Vibrio* bacteria and rendering them useless."

For nurseries that want to on-grow the larvae for another month, and offer strong animals to the ongrowing farms with an increased survival potential, BioMar now offers mini-pellets that are designed to overbridge the changing digestive system dynamics during the transition of the post-larvae into juveniles. These products also contain the Bactocell® and B-WYSETM synergistic anti-*Vibrio* package and are offered in three sizes: Larviva Nursery in 0.5 mm, 0.8 mm and 1.1 mm pellets.

These new products listed above replace the former shrimp hatchery products. The new streamlined larval shrimp feed line is available to our customers around the world. "We look forward to collecting the feedback from customers as such cooperation is very valuable for further testing and development of our offerings," concluded Peeters. (www.biomar.com)



The figure shows the larval product particle sizes of BioMar's shrimp hatchery products and the larval stages for which they are intended. From PL2 to PL15, it will be high quality cold extruded crumble feeds (PL200-400). Nursery feeds are from PL15 fed on mini pellets until PL25 (0.1, 0.8 and 1.1) and then pellets until PL40.

Related article: BioMar at AE2017, page 56

Artemia Nauplii Center in Kakinada, India

Following the 2013 establishment of the pilot *Artemia* Nauplii Center in Thailand, **I&V-BIO** announced that it has just completed construction of a state of the art facility in Kakinada, India in partnership with the Geekay group. The Indian facility, just like the one in Thailand, will produce 700-800 trays of 800g Instar1 *Artemia* per day. A tray is equivalent to a can of 70% hatching *Artemia* cysts. I&V-BIO is also currently in the process of setting up *Artemia* Nauplii Centers in Indonesia, Vietnam, Bangladesh and Ecuador.

I&V-BIO's key to success is the guarantee to supply customers with daily fresh, clean and disinfected (*Vibrio*-free) products. Separation technology, disinfection and packaging are equally important to produce consistent quantity and quality. Customized programs in combination with trained staff ensure on time delivery 365 days per year. I&V-BIO developed a unique separation technology and quality protocols which ensure the production of *Artemia* nauplii on an industrial scale.

I&V-BIO's INST*ART* 1 is recognised for its pure Instar1 *Artemia* nauplii; no impurities, no damaged animals, no *Vibrio* and offered in a consistent live-paste setting is a new standard in the shrimp industry. The product enables the hatcheries to follow strict biosecurity protocols relieving them of the burden of hatching *Artemia* cysts in often sub-optimal conditions.

To further strengthen the health of shrimp post larvae, I&V-BIO also offers INST*ART* E (Enriched *Artemia* nauplii) to hatcheries, nurseries and grow-out. INST*ART E* is produced in a 3-step enrichment; DHA SELCO from INVE Aquaculture, plant extracts high in amino acids and carotenoids and finally enrichment with ELVAN a blend of herb extracts, proven for its powerful anti-vibrio effect and its prebiotic properties. The company also offers decapsulated cysts (M-BRYO) in a paste form.

The goal of I&V-BIO is to be the preferred supplier of high-tech products, being both easy to use and with daily delivery directly to the end-user. It wants to be present in all main shrimp and fish markets world-wide through the establishment of local facilities with local partners. www.iandv-bio.com

4th Certificate in Aqua Nutrition

July 16-20
Kasetsart University, Thailand

Progressus AgriSchools will organise the Certificate in Aqua Nutrition on 16 – 20 July 2018 at Kasetsart University, Kamphaeng Saen Campus, Thailand. The course provides an excellent overview of current knowledge on aquaculture nutrition in Asia. Special emphasis will be on the important commercial species in Asia, including tilapia, carp, pangasius, Asian seabass and white shrimp.

The course will include a detailed hands-on training on the role of the nutritionist in feed companies and farm performance. The programme covers in detail aqua nutrition including marine and fresh-water fish and shrimp formulations. More importantly, it will explore options available in adjusting formulations.

All Progressus AgriSchools are university-certified courses that are independent, unbiased, set in a university setting and are delivered by university and independent Industry experts. All materials are constantly reviewed and updated to ensure AgriSchools' participants receive the latest industry knowledge, best practices and standards. All participants will be presented with a Certificate of Completion at the end of the AgriSchool from Kasetsart University and Progressus. www.progressus.asia

New production facility in China

BIOMIN has further expanded its capacity to serve clients in the fast-growing Chinese market and internationally with the opening of a production plant in Wuxi, Jiangsu Province, in China. "Biomin is strongly committed to serving clients in China," said Dr Hannes Binder, Managing Director, Biomin. The company has been active in the Chinese market for nearly 20 years, having opened its first production unit in China in 2004.

The latest addition to the firm's global production network encompasses a 5,600m² building featuring offices, a warehouse and laboratory designed to provide both quality control and analytical services for customers. "This investment reflects our high ambitions for the future," added Binder. "We value the opportunity to provide customers with the right mix of innovative, high quality products and cutting-edge services," said Jack An, Managing Director of Biomin China. "With this new Wuxi facility, we intend to support and further develop client relationships," he added.

The facility in Wuxi has two automated acidifier production lines with a total installed capacity of 32,000 tonnes per year, and four packing lines. The configuration will produce five products within the Biotronic product line, a family of enhanced acidifiers. Another automated production line with installed capacity of 32,000 tonnes per year produces the firm's leading mycotoxin-deactivating feed additive, Mycofix. With the new facility coming online, Biomin doubles its global capacity to produce Mycofix. The Wuxi facility also includes a more than 360m² scientific laboratory designed in accordance with feed safety management and testing process rules and requirements. The laboratory fulfills two key functions: quality control of products made on-site and mycotoxin analysis for Biomin customers. www.biomin.net

Inauguration of Qingdao factory

In October, Denmark based **Aller Aqua** group inaugurated its sixth factory, Aller Aqua (Qingdao) Co., Ltd. The inauguration came just a month after the inauguration of the company's Zambian factory.

"Inaugurating 2 factories in 2 months is exceptional", said Hans Erik Bylling, President for Aller Aqua Group. "We have had a few busy years leading up to the inaugurations and now we are finally ready. I am proud of what we have achieved."

Anders C. Bylling is the Managing Director of Aller Aqua Qingdao and son of Hans Erik Bylling. Anders explained that the process of building a factory in China had been long. "We have had some delays along the way, but we reached our goal. Our Chinese team has worked exceptionally hard to have everything ready for the inauguration. It has been a very good day with almost 200 participants for the opening itself, and almost 300 participants to the first International Cold Fish Aquaculture Technology Seminar we organized on October 30."

Aller Aqua chose to establish themselves in China without a Chinese partner. "We chose to establish the factory without a local partner to ensure that we can continue to deliver the products that the customers are familiar with. We have delivered high quality aquafeed to China for the last 20 years, produced under European standards, and we will continue to run the factory like we would in Denmark. We will do this by sourcing the raw materials in Europe, and ensure a highly trained local team which knows how to comply with the European standards."

The factory in China will focus on the growing cold-water species aquaculture industry in China. Thus, it was natural that it held the first International Cold Fish Aquaculture Technology Seminar, hosted by the renowned Heilongjiang River Fisheries Research Institute (HRFRI) of the Chinese Academy of Fishery Science. The program included many interesting speakers from both China and Europe, a visit to Aller Aqua Qingdao and concluded with a shuttle bus to China Fishery Expo.

The father and son team, Hans Erik Bylling and Anders C. Bylling

Aller Aqua Qingdao will have a production capacity of 45,000 tonnes per year. The factory is Aller Aqua's first in Asia and Hans Erik Bylling considers it essential: "The factory will increase our competitiveness in China, with shorter delivery times to key markets." The factory will export to both Korea and Vietnam. www.aller-aqua.com. (Related news, Aller Aqua at AE2017, p 57)

New advanced formula shrimp feed

Neovia Vietnam has officially introduced an advanced formula shrimp feed for the monodon shrimp Monolis and a growth booster line - OC Maxi – after a period of research and improvement. These two products promise good performance in terms of growth and maximizing profit for farmers.

To achieve successful farming, nutrition plays an important part in ensuring shrimp quality and productivity. Understanding that, Neovia is bringing under the Ocialis product range, this shrimp feed with innovative nutritional composition to ensure better growth rate and strengthen immunity. These are synonymous with the needs as well as interests of farmers. They contain ingredients such as astaxanthin and krill meal.

Besides, as with its other shrimp feeds, Monolis and OC Maxi are produced by a modern production line, which ensures high quality as well as traceability; high stability in water that helps reduce loss and limits water pollution. In particular, there are no chemicals, hormones and banned antibiotics in Monolis and OC Maxi; feed consumption rate is low, which helps to increase remarkably the profitability of farmers.

In May 2016, Neovia received the "Best Aquaculture Practices" (BAP) certification. This certification assures customers of the quality of feed from raw materials to the production, storage and preservation of finished products. Neovia is commited to use responsibly sourced fish meal and fish oil so as to protect the sustainability of aquaculture. Monolis has 8 feed types, from starter to 2 growth booster feeds suitable for different stages of shrimp farming.

Le Thanh Tung, Commercial Director of Neovia Vietnam said, "In 2017, Vietnam's shrimp exports are expected to continue to grow positively due to high demand from developed countries. Vietnam has applied effective control on the use of chemicals and antibiotics, which ensures the supply of high quality shrimp to markets. Vietnam has the advantage of an abundant labour force and the technical level is increasing so that we are confident we are able to introduce the best shrimp feeds, and are organising seminars in different provinces to share the experiences of successful shrimp farming and the new modern culture techniques. Hence, farmers are kept up to date with the latest farming knowledge". www.ocialis.asia/www.neovia-group.com

Seminar on functional feed additives in marine fish aquaculture

NUTRIAD, the feed additives producer with its headquarters in Belgium hosted a customer event at Aquaculture Europe 2017 conference and trade show held in Dubrovnik, Croatia from 17-20 October. This event, titled "Functional feed additives in aquaculture: How to add more?" was well received by producers of marine fish, fish feed producers, and a large number of consultants and academic scientists attending from Spain, Portugal, Italy, Greece, Turkey, Norway and Croatia.

"Nutriad has invested considerably and consistently in aquaculture research and service in recent years, building a team of experts with global experience in health and specialty additives for fish and shrimp", said Dr Peter Coutteau, Business Unit Director Aquaculture. "This seminar was aimed at sharing information with our European aquaculture customers, with a specific emphasis on the Mediterranean producers of marine fish. The audience represented well over 50% of the marine fish production in the Mediterranean region, attending either as farmer or feed supplier."

Invited speaker Dr Panos Varvarigos, Veterinarian and Consultant, Greece, provided an overview of the current health challenges and farm management strategies to prevent disease in Mediterranean marine fish. A main challenge is metabolic stress as fish are farmed in intensive conditions. The obvious indicators of health being compromised are with gills and the liver. In addition, toxicity with copper based antifoulants also weakens the fish and the liver reacts to block the copper, added Varvarigos. "Genetically improved fish may have better growth and disease resistance but do our farming conditions allow for this potential? Some deformities that could arise are lack of lateral lines and lack of dorsal fin and gill filaments. As such nutritional programming becomes essential. Promoting fish welfare is like an insurance benefit. Treat them well and we can harvest well. This is also part of the total scheme demanded by consumers." Varvarigos continued to discuss the role of health consultants in marine fish farming and how a holistic approach with feed supplements is essential.

Maria Mercè Isern, DVM, Business Development Manager Aqua Health reviewed global experiences with Nutriad's functional feed additives to promote fish health. She discussed the application of Sanacore®GM in fish such as tilapia infected by myxozoans in Brazil. In Asia, there was a promotional effect on growth with tilapia fed diets with this feed additive. However, she said this is not the silver bullet as farm management needs to be good.

Dr Palenzuela Oswaldo, researcher at CSIC Torre de la Sal, Spain, reported on a recent study which demonstrated the capability of a functional feed additive to reduce the impact of the disease caused by the myxozoan parasite *Enteromyxum leei* on growth and parasite development in gilthead seabream (GSB). There are no vaccines or effective prescription medicines to treat enteromyxosis which also affects tiger puffer, Japanese flounder, Malabar grouper and various breams. The effect of this chronic infection in the GSB is slow growth and eventually death. The use of Sanacore®GM resulted in a delay of anorexia induced by the parasite which in turn made fish growth no longer being significantly affected by the parasitic infestation. Furthermore, a reduction of the prevalence with 60% (qPCR), and reduced parasite intensity and abundance was observed.

Peter Coutteau (left) with presenters and team (from right), Panos Varvarigos, Alexander van Halteren, Maria Mercè Isern, Palenzuela Oswaldo and Sam Ceulemans.

Alexander van Halteren, Business Development Manager Aqua Nutrition, demonstrated how functional feed additives can enhance digestive/metabolic processes in carnivorous fish. He discussed emulsifiers such as lysophospholipids which could improve permeability and allow for faster absorption of nutrients. Bile acids improve the utilisation of fats and fat soluble vitamins. Maria Mercè Isern closed the session with a talk on prevention strategies for monogenean gill parasites and Nutriad's current research programs in this field. Monogenean parasites are currently regarded as one of the main threats by marine fish producers in southern Europe.

At the trade show, Nutriad's booth focused on programs for aquaculture additives that support the prevention of diseases and parasitic infections (Sanacore®, Aquastim®, Apex®, Bactinil® Aqua) and species-specific digestive/metabolic enhancers to reduce feed cost and improve performance in fish and shrimp (Aquagest®, Aqualyso®, Lipogest®).

At the scientific conference, Nutriad co-authored a scientific contribution by Rocio Robles et al. demonstrating that a functional feed additive can reduce the mortality caused by the monogenean parasite *Diplectanum* sp. in European seabass.

Concluding, Nutriad CEO Erik Visser, said, "To address the nutritional, digestion and health needs from different aquaculture species Nutriad has invested in the development of a range of species-specific feed additives that have proven their efficacy across the world, which is coupled with high level technical support from our aqua team. Nutriad continues to be committed to aquaculture as part of a strategic focus going forward." www.nutriad.com

Cooperation for Growth at aquaculture europe 17

The 2017 edition of Aquaculture Europe (AE2017) attracted a total participation of 1,688 from 62 countries. Among the 1,294 full conference delegates, were 255 students. A total of 437 oral and 356 poster presentations were given during the conference. The trade show presented products and services from 92 exhibitors. Three plenary sessions addressed the theme of the event "Cooperation for Growth" and paved the way for the parallel sessions of oral and poster presentations derived from a record submission of 752 abstracts.

DHA in aquaculture

In this first plenary, Professor **Michael A Crawford**, Imperial College, UK, discussed, "Is substitution compromising our omega 3 (DHA) position?" The pivotal role of DHA (docosahexaenoic acid) in brain function may explain its absolute conservation in neural signalling systems over the whole of vertebrate evolution and indeed how learning, memory, recall, etc. works. "As we look to replace more and more fish meal and fish oil to meet sustainability requirements, and replace them with terrestrial plants, the DHA content of farmed fish has also declined. Meeting the nutritional needs for population growth will require prioritising arable land for high yielding crops for human consumption and not to feed fish, hence the development of marine agriculture is a must," said Crawford.

Taking tuna farming forward

The second plenary was on the need for farming of the Atlantic Bluefin tuna (BFT) in the Mediterranean to satisfy high market demand. It is thus essential to its production with sustainable aquaculture where the whole biological life cycle is managed. The presentation on "Large scale research facility to take tuna farming forward" was by **Fernando de la Gándara**, Researcher at the Spanish Institute of Oceanography (IEO) and Director of the Murcia Oceanographic Center. IEO has a land-based large-scale facility (ICRA) for the control of the reproduction of this tuna and can hold large size breeders. This facility is near the IEO Aquaculture facility in Mazzaron, Southeast Spain), devoted to the research on BFT larval rearing and juvenile production. Both these Spanish facilities are models of how research centres of excellence can enhance cooperation to generate new knowledge on performance that can be transferred directly to operators and provide the technical basis needed to take the sector forward.

Gene editing

In the final plenary, **Anna Wargelius**, Institute of Marine Research in Bergen presented on "Gene editing. A game changer for aquaculture?" Gene editing, using the CRISPR technique, could be a potential for aquaculture. Wargelius discussed the lines of work that are being researched at present and on quality, nutritional and market benefits. "What are the ethical questions to consider as we assess if and how best to adopt this as a potential game-changer for aquaculture. The key benefits of gene editing for aquaculture are: precise and faster targeting; breeding is more precise and faster; increasing significantly knowledge regarding traits; lower risk and potentially fewer ethical considerations and we are not introducing or mixing DNA from different species. Potential risks include off target activity which can be solved by sequencing and genetic introgression of farmed fish into wild strains which can be solved by genetic containment. Changes in the nutritional content of the fillet can be evaluated."

The above was extracted from the full report on Ae2017 prepared by session chairs. https://www.aquaeas.eu/images/stories/Meetings/AE2017/AE2017_SUMMARY_REPORT.pdf

Honorary Life Membership award

New EAS Honorary Life Member Sachi Kaushik. Photo courtesy of MisPeces.com

EAS President Bjorn Myrseth presented EAS' highest award, the Honorary Life Membership award to **Dr Sachi Kaushik**. This was for his highly distinguished career and his contribution to the sustainable development of (European) aquaculture.

Myrseth introduced Kaushik as a very well-known name in aquaculture – not only in Europe – but throughout the world. His name is synonymous with the word 'nutrition'. Over a period of 30 years, Kaushik founded and directed the Fish Nutrition Joint research units of the Hydrobiology Station (INRA) at Saint-Pée-sur-Nivelle, France. Many of his PhD and other students have gone on to become respected scientists in this field. He has continuously supported the development of the EAS as well as aquaculture expansion through the FAO, UNDP, World Bank and other organisations. In 2015, he was made an Officer of the "Ordre du Mérite Agricole" by the French government for his services to nutrition and to aquaculture.

Kaushik has published more than 300 papers and given countless presentations, expert consultations, articles and interviews on the issues of replacement of fish meal and fish oil, fish in/fish out ratios, human nutrition. Retired from INRA, Kaushik is now European Research Area chair on ecosystem approaches to sustainable aquaculture development in the eco-aqua initiative based in the University of Las Palmas in Grand Canaria, Spain.

AE2017 Trade show highlights

Joana Amaral (left) and Jef Peeters

BioMar, the Gold Sponsor of AE2017 celebrated 10 years with its BioSustain™ concept, which was started in 2007. Group Sustainability Director Vidar Gundersen discussed the company's sustainability efforts at its booth. "Sustainability has long been in the DNA of BioMar. However, it was the development of BioSustain™ concept that firmly established the company as the forerunner in driving sustainable innovation through collaborative partnerships in the aquaculture industry."

In 2017, BioMar reported below 1 FIFO ratio (Fish-In:Fish-Out) achieved for its raw material usage in 2016 for the first time in its history. New alternative raw materials as well as high prices of fish oil and fishmeal in 2016 made it possible to formulate price competitive, high performance feed with a low FIFO ratio. CEO Carlos Diaz, BioMar Group said, "Although it is unlikely that BioMar will achieve such a good FIFO ratio every year due to ever changing market conditions, this is a major milestone and shows that we are progressing towards an industry where sustainable and high performance alternatives to fish oil and fishmeal are accessible and becoming commercially viable". More information is available in BioMar's Sustainable Report 2016.

During AE 2017, the new hatchery team commented on the work ahead. Jef Peeters, Product Manager, Shrimp Hatcheries, has been in Asia for many years and is confident of penetrating the market in Asia. "We have made a strategic decision to enter the shrimp market. Our Larviva products for shrimp hatcheries and nurseries are selling well in India and Bangladesh. These feeds all come from our factory in Nersac, France. In all, the microencapsulated feeds with neutral buoyancy have good nutritional attributes. We have been conducting trials and benchmarking against competitor products."

Joana Amaral, Product Manager, Marine Fish Hatcheries, will use her experiences in farming seabass and seabream. She said, "The focus is now the industry in the Mediterranean but next we will move to global markets for early feeding of fish. Here in the Med, our first challenge is to develop a technology to replace live feed and arrest the issue of deformities. Getting out of this live feed trap is a big goal. Today, with the Larviva range, feeding starts as early as mouth opening until 1.1 mm size pellets for 2-3g bream. To date, we are working with several marine species, both warm and cold water, namely sea bream, sea bass, turbot, sole, red drum, halibut, cod, *Seriola*, Asian seabass and cleaner fish."

Peeters said, "We do have ambitious goals. The market is very competitive, quality and pricewise. At BioMar, we provide technical support. Essentially, our R&D has been the keystone for these developments in larval feeds. This has been happening before this BU for hatchery feeds came into being."

At the session on Health Control: prevention and treatment of diseases, Dr Daranee Sookying, (left) presented on "Diseases in shrimp culture: How do Asian shrimp farmers survive the threat?" Dr Rutchanee Chotikachinda, presented on "Benefits of antioxidants in improving feed quality and aquatic animal health". Both presenters are with DSM Nutritional Products, Asia Pacific, Thailand.

*A first-time exhibitor to an Aquaculture Europe trade show was Taiwan's **Genereach Biotechnology Corp.** Dr Su Chen (left) and colleague presented iQ+, a coldwater fish disease monitoring system. This is a powerful OIE-certified molecular diagnostic tool combining advanced insulated isothermal PCR (iiPCR) technology with a field deployable platform.*

*The team from Canada based **XpertSea** presented the version 2 of a portable smart device for rapid counting of early-stage aquatic populations. Within Asia, XpertSea has some of the leading hatcheries in Vietnam, Indonesia and India as its customers, said Emilie Robichaud (right), pictured here with the team.*

*Malta based, **AquaBioTech Group** is active in various activities related to aquaculture design, engineering and recirculation aquaculture systems (RAS). It is also active in facilities testing, training and R&D, marine environmental monitoring and site surveys. At the booth, Shane A. Hunter, Technical Director (right) with Kyra Hoevenaars, Senior Aquaculture Consultant – Hatchery Operations detailed some of the more recent projects which included the custom designed RAS at the Alltech Coppens Aqua Centre in Holland to conduct feed trials in both saltwater and freshwater conditions for a variety of species and at temperatures from 6-28°C.*

China is base for entry into Asia's aqua feed market

At the **Aller Aqua** booth, CEO Hans Erik Bylling briefly, described its long history in China and future for its feed business in Asia. "We have been in China, marketing our feeds imported from Europe, for trout, salmon and flatfish such as turbot and sole. A new factory, producing feeds for the trout and salmon, will be our base for our entry into Asia. For a long time, when we exported feeds from Europe to China, we needed an import permit to bring in starter and grow-out feeds. Sales have been good, and these volumes have justified the investment into this new factory. In the north, we sold functional feeds to help farms cope with the production of cold water species. Meanwhile, we still export organic feeds from Europe for customers in Hong Kong and other Asian countries". (see page 52 for news on the launch of Aller Aqua Qingdao).

However, Bylling emphasized that Aller Aqua is not all about cold water species. "We have a considerable experience with warm water species and later we will be producing feeds for the warm water fish such as the tilapia and catfish, as well as for the groupers. The company has excellent formulations to produce fast growing and healthy tilapia. We already have customers in South China and Hainan, currently using our starter feeds."

It has not been smooth sailing in this business of bringing feeds from Europe. "In between these 20 years, in Europe we had the BSE debacle. We could not import feeds into China, but we still needed to keep our contracts with farmers and maintain the links. The new factory has state-of-the-art equipment, and the latest technologies for aqua feed production We have experienced a lot of interest from our Chinese customers. Aquaculture is growing and that we want to grow too, and we are willing to take the opportunities that arise.

Hans Erik Bylling

"Our feeds are competitive, in China as they are in Europe. In China, we will continue with strong R&D support. We will copy what we do in Europe at this feed factory which may mean that we import quality ingredients from Europe. The quality will be under Danish control. Similarly, as we do elsewhere, we will maintain high standards on food and feed safety and produce highly digestible feeds. In the future. we will obtain relevant certifications in all our factories."

Aller Aqua is a family owned feed company, established in 1910. Hans Erik is the third generation in the company, and has been the owner since 1979, taking over from his father, Hans Jorgen Bylling. With the investments Aller Aqua made in 2017, production capacity in the company has doubled.

Seafood marketing and aquaculture innovations in Taiwan

The Third Annual Taiwan International Fisheries and Seafood Show (TIFSS) started with a joint opening ceremony, together with the Taiwan's Agriculture Week in Kaohsiung's Exhibition Centre (KEC) from 9-11 November 2017. Joint organizers, Taiwan External Trade Development Council (TAITRA) and My Exhibition Co Ltd were pleased with the responses to this TIFSS which had 185 exhibitors occupying 354 booths. This year, there were more country pavilions including those from Japan, the Philippines, Thailand, Vietnam and Belize.

There was a one-day international forum which covered aquaculture industry trends in the region and included challenges in Taiwan's aquaculture industry and how to deal with future issues. A panel discussed Internet of things (IOT) in fishery. Exhibitors presented their latest innovations at the 'INNO' stage of breakthroughs which included long distance seawater pumping and power saving improvements from HCP Pump manufacturing. The team from the National Taiwan Ocean University (NTOU) presented on the anti-nervous necrosis virus (NNV) and highlighted four fish type 1 interferons in grouper cell line and larvae. Japan's Aquatic Products Export Council had a tuna deboning and filleting show and the Keelung City Government, a major seafood hub, organized a mouth-watering cooking show.

Biotechnology on NNV and WSSV inhibition

At **NTOU**, the team comprising Drs Pinwen Peter Chiou, Li-Li Chen and Ming-Wei Lu said that particularly, in grouper farming, NNV infects the larval stage followed by iridoviruses. These two viruses can cause 90-100% mortality of a stock.

"We have researched some strategies to target these viruses; to stop their infection and then strengthen the immune system of the grouper larvae. The first stage is using RNA interference technology to prevent the infection of NNV and improve fish larvae survival. In this way, we can effectively inhibit the virus replication in the larval stage. We package the RNAi in lipid for oral delivery in feed," said Chiou. "Overall, we managed to control NNV. Our trials showed that larvae survival rates improved to 50 ~ 75% from less than 10% during NNV outbreak. We are now working for commercial availability with a company."

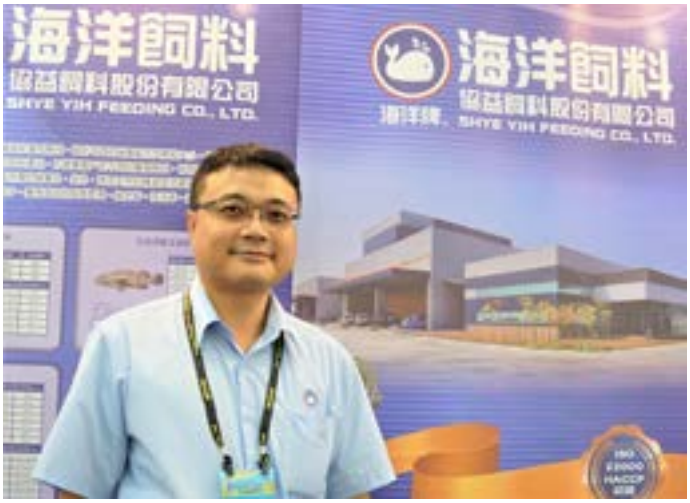
When the fish is bigger, the number two strategy is utilised. This is more conventional, using immune stimulants containing

The National Taiwan Ocean University team, from left, Pinwen Peter Chiou, Li-Li Chen and Ming-Wei Lu

oligodeoxynucleotide (ODN). This stimulates the innate immune system and can boost vaccine efficacy when used as an adjuvant. However, Chiou added, "The interference is species specific. To overcome this, we developed fish specific ODN. We then adapt the oral delivery in lipids to stimulate the immune systems." Regarding shrimp, Chiou added," We have applied a novel technology to inhibit white spot syndrome virus in *Penaeus monodon*. We added the recombinant protein to shrimp feed and deactivate the key step to viral infection. Viral protein binds proteins of the host to start an infection so we develop the anti-viral protein to block this step." www.ntou.edu.tw

Aquafeeds from Taiwan

After increasing its capacity to 10,000 tonnes/month at its new plant, opened in March 2014, **Shye Yih Feeding Co Limited** is now ready to further expand its regional markets. "We can now produce 10,000 tonnes per month. Our company markets 56,000 tonnes of Hai Yang feed to the Taiwanese market each year. We can now offer more volumes of other fish and shrimp feeds for the export market. The Indian market is attractive for us," said Danty Lin, who is in charge of sales. "The factory area is 25,000 m^2 and the whole factory is fully automated with computerized production systems to enhance production efficiency."



Danty Lin of Shye Yih Feeding Co Limited

Eels from Chihfu Fishery Enterprise

CAS frozen fish at Anyong's booth

Marketing Taiwan giant grouper

Johnson Seafood's Taiwan origin size 40/50 vannamei shrimp

Shye Yih is already exporting seabass feeds to farms in Malaysia. Five years ago, it started to export mullet feeds to Korea. The company was founded in 1965 to produce feed ingredients for livestock production. Since 1985, when fish culture took off, it started to produce feeds for the eels, milkfish, tilapia and marine shrimp. With R&D, Shye Yih went on to produce feeds for 10 aquatic species: pelleted and powdered feeds for the eel, and floating and sinking feeds for several high value species such as grouper, seabass, threadfin, milkfish, shrimp and ayu fish. It also has 85% of the feed market in Taiwan for the ayu fish.

The company is also involved in fish farming. It has 40 ha dedicated to the upstream activity: hatchery to produce fry and fingerlings, and grow-out farms for the seabass and tilapia. Eel farming is in Quilin City. Meanwhile, the company invested 30 ha in China to farm eels and soft-shelled turtles. www.oceanfeed.com.tw

Feed probiotics

In issue July/August 2015, AAP featured the story of **Fortune Life Enterprises Co Ltd** which introduced the patented BUIK fermentation system to produce probiotics from recycled wastes. This involves a high temperature fermentation and biodegradation process which breaks down fish protein into small amino acid molecules. Two years later at this third edition of TIFSS, the sons of owner Frank CH Tsai, are now more involved in the business. The company's investments in biotechnology, to produce probiotics and to revive aquaculture has now developed into a new company **Fortune Biotech Co Ltd**. Jerry Tsia handles the business in Thailand while brother Terry is in Taiwan. Fortune was established in 1979, marketing sashimi grade tilapia, yellowfin tuna and grouper. Thus, waste products from their seafood processing business provide them with raw materials for the production of a feed probiotic product Bio Aid. The aim is to reduce byproduct wastes and Terry is also looking at using antibiotic free byproducts from surimi production in Vietnam and India to produce this probiotic. "Unlike *Lactobacillus* which is not heat resistant, our probiotic comprising 50 species of bacteria is heat resistant and can withstand high temperatures during the extrusion process.

At the Fortune Life booth, from right, Jerry Tsai, Shouin Tsai and Terry Tsai

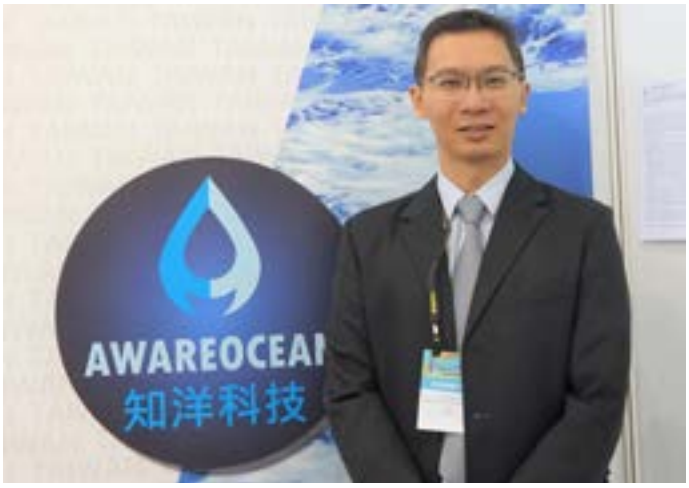
Added to fish and shrimp feed, the product is aimed at targeting optimal health, and benefits include strengthening immunity, improving survival and inhibiting pathogen growth. "We have added the product in feeds for the tilapia, giant grouper and freshwater prawn in Taiwan. The team will be working with marine shrimp farmers to test out the probiotics in vannamei and monodon shrimp farming. Current survival rates are not acceptable and with inclusion of this probiotic in feeds at 4-5% inclusion, at a low temperatures of 10°C, we have seen only 1-2 fish dying. We are now collaborating with a company in China to develop tilapia and shrimp feeds. We should be able to give some good news soon," said Terry. www.fortunelife.com.tw

IOT in marine sector

Awareocean Technology Co is a new company involved in using IOT in monitoring and big data analysis to develop complete solutions for the marine fishery and aquaculture industry . Currently, its market is in Taiwan, but the company is interested in expanding to other markets in Asia. At his booth, Dr Hsiang-Chih Chan, President, said that he started the company recently after more than 16-years in R&D and working on IOT technologies for the marine fishery and aquaculture industry. One development is the Auspice with integrated underwater sensors for sounds, temperatures and pressures. It will record and transmit data.

"The innovation is important; from a research perspective for the government to do remote sensing of the environment and study the food chain. Remote sensing of fish population can save fuel costs and increase output. We can listen to fish and marine populations. We use hydrophones to listen to the noise and then use IOT to integrate hardware and software sonar and acoustics. Data are sent via wifi etc. However, as these require power we also assemble power transmission systems and later we will explore using solar energy."

Another innovation is the Aquaeye, a flashing light to light up underwater. The device uses micro emitting light emitting device which can be customized to 450W and as deep as 15m. In future, there is a possibility of adding a camera to study fish populations in cages. www.awareocean.com



Dr Hsiang-Chih Chan, Awareocean

Edward C.T. Lin at the Johnson Seafood Co Ltd booth

Keeping eel farming alive in Taiwan

Chihfu Fishery Enterprise leads in Taiwan's eel farming industry. It is involved in the whole supply chain for the eel. It has five farms all over Taiwan, some of which are for the farming of tilapia and jade perch. At the show, Crystal Sun, the second generation in this family business said that 7 years ago Chihfu started to farm four species of eels for the different markets: from the Philippines, American, European and Japanese eels. It is also involved in the farming of the tilapia and jade perch. "We import the glass eels and then raise them to marketable sizes. The eels from the Philippines are most suitable for farming here in Taiwan. But as different markets have their own preferences, we are obliged to source glass eels of other species and raise them. Markets in Korea, Japan, China and Taiwan demand black eels. Depending on species, it takes 8 months to 1.5 years to grow the eels to a marketable size of 200g. Soon we will start two farms in China. We prefer China because of the ease in communication. Further expansion will also be in China."

There is a two-phase system in eel culture: an early stage closed system for 6 months and grow-out in ponds to marketable size. There are different specifications depending on markets; more than 250g and no bones, and 250-300g for the Korean market.

The company produces more than 100 tonnes of eels annually and uses 40 tonnes for its processing plant. Products range from live, chilled and value added products where the most popular is teriyaki unagi. www.chihfu.com

Crystal Sun and colleague at Chihfu Fishery booth

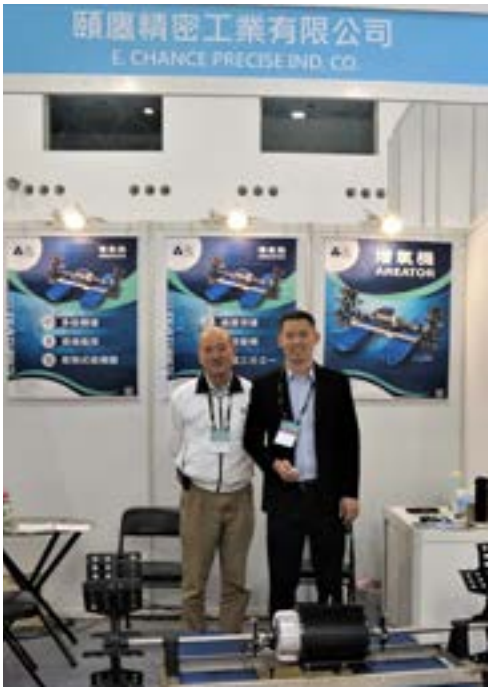
Inroads into cage farming in Asia

Taiwan's **Toford Aquaculture** can be seen in all of Asia with 1,100 cages delivered since 1995. Its markets are Japan, Taiwan, the Philippines, Malaysia and Indonesia. It also has customers in Mexico and Russia. At this show Toford introduced the new skid guard stanchions following the success of the standard double walled neck stanchions. "Another development is the expansion from 20m diameter cages to large 80m diameter cages. Most farms would consider 20m diameter cages as very small these days. We have been making 50-60m diameter cages in recent years and now have the capability to make up to 80m diameter cage. The cages are typhoon ready. Our competitive edge is design flexibility and are not limited by mold, which forces customers to buy standard sizes. We use stanchions constructed and welded from top quality HDPE100 pipes to give superior quality and strength. With regards to markets, we continue to focus on Japan, the Philippines and Indonesia," said Dave Cheng, Project Manager. In Japan, it recently set up four sets of 40m-diameter round cages, three sets of 15x15 m square cages as well as 40m round cages for tuna farming. Regionally, Toford competes with Sunrise in Taiwan and Aquatec in Indonesia. "Most farmers do not realize that the cost of the cage is actually minimal when compared to the value of the fish stock," added Cheng. www.cage-aquaculture.com

Premium seafood

This company is a major seafood buyer, wholesaler and distributor in Taiwan. Based in Kaohsiung with branches in Taipei and Taichung, 30-year old **Johnson Seafood Co Ltd** distributes 70% of its products to hotels and 30% to chains, TV shopping networks and online. E-commerce is fast growing. Products span three areas: live, frozen and fresh seafood. The company with 10,000 tonnes of cold storage capacity, touts itself as a supplier of premium seafood in Taiwan, with products such as spiny lobster from the Caribbean, American lobster and abalone from China. "As a seafood buyer, we prefer to source farmed seafood as sizes are stable and we can demand specific species and sizes. Now 30% of the seafood we purchase is farmed," said Edward C.T Lin, Deputy General Manager. From within Taiwan, Johnson buys size 40/50 vannamei shrimp and sells under its own brand. It also buys local grouper and abalone but local products account for less than 10% of its seafood products. On display at its booth were vannamei and monodon shrimp farmed in Malaysia.

On traceability, Lin said that there is increasing interest from restaurants and governments are also asking for these. www.johnsonseafood.com.tw



The E.chance team, father (P.H Chen) and son (Chen Zhi-Wen) with their silent aerator.

Dave Cheng, Toford Aquaculture

Jacob Lu, Anyong Biotechnology

Cells alive freezing system

Anyong Biotechnology Co Ltd proudly introduced the cutting edge Cells Alive System (CAS) for the freezing of seafood and other food items. "Essentially, the freezing technology at - 50°C keeps cells alive and when defrosted retains freshness, flavour and texture, which are attributes of the original product. CAS uses electromagnetic fields and low frequency waves to prevent large ice crystal formation which destroys food texture," said Jacob Lu, CEO It now has a state of the art processing plant in Mituo, Kaohsiung, with an investment of NTD100 million. Product lines are ISO 22000 and HACCP certified. It provides one stop shopping services from raw material procurement, quality control checks to warehousing and logistics. It also offers professional service for hire in processing in Taiwan and abroad. "Through Anyong Food Safety Centre, we hope to build up a farm-to-table concept which will incorporate production and sale," added Lu. www.anyongfresh.com

A silent aerator

One would be surprised that shrimp is affected by noise and the father and son team at **E.Chance Precision Industrial Co** have been working on a silent aerator. Taichung based E.Chance is a 40-year old company producing propellers. Being an engineer, P.H Chen has been researching on how to bring down the noise level of paddlewheel aerators. Just prior to the show, he developed a prototype which is a DC model with no induction gear. Tested at sea, their prototype has a low noise level at 42 rpm and medium noise at 78 rpm. The highest speed is 108 rpm. The noise level is from 30 to 65 decibels and depend on the depth of the impeller. In general, the noise level achieved is three times less than a conventional aerator. An advantage is that this aerator is made from aluminum alloy and can be guaranteed for 10 years. www.echancetaiwan.com

Hsiang-Pin Lan, Asia Marine Aquaculture Specialist, US Soybean Export Council (USSEC, right) and Dr Hsin Pinyeh, Professor of National Pingtung University of Science & Technology, Aquaculture Department at the Keelung Provincial Booth.

Visitors, from right, Kuek Sian Chai, Uni President (Malaysia), Shu Lin Su, Uni President Enterprises and Dr Hector N.H Lee, La Koto Mfg. Co. Ltd , Taiwan.

In 2018, the Taiwan International Fisheries and Seafood Show (TIFSS) will be held from November 22-24 in Kaohsiung. www.taiwanfishery.com

Opening of first factory in Asia

The ceremony was attended by representatives from the Department of Livestock Production, Binh Duong Province officials, the French Embassy, 300 customers of Olmix -Viphavet from different Asian countries and important livestock producers in Vietnam.

The grand opening ceremony of the first **Olmix** factory in Asia was held in October 2017 at Song Than 2 Industrial Zone, Binh Duong province, Vietnam. The factory will be producing approximately 15,000 tonnes of animal feed additives and nutraceuticals for feed mills and farms per year.

The opening of this new production facility is a milestone on the Olmix Group's road towards a prosperous growth in Asia. It also represents the Olmix Group's commitment to further strengthening the presence and activities in Vietnam and throughout Asia. Starting its production from November 1 2017, the factory will focus on producing new feed additives to be provided to the Asian market, such as mShell (shell and bones quality enhancer) and ASEAD (range of innovative acidifiers). The productions will use innovative ingredients or nucleus produced in France with Olmix unique patented technologies (algae biorefinery, clays and algae associations). www.olmix.com

Asian Pacific Aquaculture 2018
Taipei - Taiwan -April 24-26

Innovation for Aquaculture, Sustainability and Food Safety

APA 18

WORLD AQUACULTURE Society

All info: www.was.org
Conference management: worldaqua@was.org
Trade show & Sponsorship: mario@marevent.com

Acquisition of probiotics expert in the global aquaculture market

Neovia has announced the acquisition of 100% interest in Epicore, a North American company specialised in the manufacture of larval feed and probiotics in the global aquaculture market and, more specifically, shrimp. Through the expertise of the two companies and Neovia's international R&D network, Neovia intends to develop its aquaculture business and offer new natural and sustainable solutions for livestock farming: probiotics.

Epicore, is a recognised player in the global shrimp market. It manufactures feed and probiotics. Founded in 1987, the company's headquarters and its production facility are located in Eastampton, New Jersey. The company has storage space and a key technical centre within its Ecuadorian subsidiary which facilitates the distribution of its products and services in the largest shrimp producing country in the Americas. Epicore has a leading expertise in manufacturing liquid feed for shrimp larvae and a recognised global expertise in the production of probiotics.

Complementary and promising synergies This acquisition will allow the two companies to benefit from numerous synergies worldwide, particularly with regards to R&D and innovation. Neovia's aquaculture business will also benefit from an expanded portfolio of products and services as well as new expertise in the production of probiotics first for aquaculture species and then for the Group's other species. William Long, CEO of Epicore said, "We are delighted to be able to share our expertise in probiotics with a large international group like Neovia. The strength of its R&D expertise and its international innovation network will allow us to develop new applications for the international aquaculture market and other markets together. It is a great opportunity for our company and a new adventure is beginning for all Epicore employees!"

An acquisition that provides a concrete response to the growth of the Asian shrimp market is one of Neovia's main development areas and aquaculture is one of its priority businesses. With Epicore, the Group has additional resources to accelerate its growth in the Asian shrimp industry. Four out of the world's top five shrimp producing countries are located in this region: China, India, Vietnam, and Indonesia. Hubert de Roquefeuil, CEO of Neovia added: "With the acquisition of Epicore, Neovia's aquaculture business will achieve its critical size to accelerate its international development, especially in Asia where we can rely on the Group's presence and our recognised aquaculture expertise in Latin America (Ecuador, Brazil, Mexico) and Vietnam. Epicore has a lot to offer to Neovia and I am pleased to welcome its teams of experts in probiotics to our company which will allow us to complement our portfolio of products and services and offer high-performance and sustainable solutions to farmers all over the world." www.neovia.com

Strategic R&D investment in the shrimp market

Just two months after confirming the acquisition of Ecuadorian feed manufacturer Alimentsa, **BioMar** has announced the establishment of a new trial facility for shrimp. The new investment confirms the previous announcements from BioMar stating that high-performing diets and functional feeds for shrimp will be an important part of BioMar´s portfolio.

"This is a part of our overall expansion strategy. We basically take the required decisions to build a strong, competitive and innovative foothold in the shrimp market. The investment in Ecuador is a tangible outcome of a much greater plan for innovation in BioMar. The global R&D budget will increase by roughly 20% in 2018, which comes on top of a dedicated global set-up for R&D implemented over the last years", said BioMar, CEO Carlos Diaz.

Havard Jorgensen, Global R&D Director elaborates, "We are moving into several new geographies and new species, and this requires an increase in R&D activities. Our global set-up based in Trondheim is complemented with our ATC (Aquaculture Technology Centre) innovation network, which includes ATC Patagonia in Chile, ATC Nordic with facilities in Denmark and Norway as well as now our ATC in Ecuador. Here we will mainly focus on shrimp, strengthening our set-up and allowing a faster take to market".

"We experience that the most innovative feed solutions are generated when local market potential is being met with solid scientific methodology, boosted by in-depth knowledge from aquaculture hotspot across the globe. Ecuador has developed into one of the most important shrimp producing nations and has in many aspects taken alternative roads. This makes it a very interesting hub for product development", added Diaz.

BioMar for some has years been supplying shrimp grower diets from Costa Rica and shrimp larval diets from France to customers around the world. The company will also within a few months launch its shrimp range in China. www,biomar.com

Model of the new ATC in Ecuador

AQUA 2018

The joined meeting of the European Aquaculture Society and World Aquaculture Society

For more info on the TRADESHOW : mario@marevent.com
For more info on the CONFERENCE : www.was.org and www.aquaeas.eu.

Appointments

New Commercial Director for Thailand

Alltech has announced the appointment of Pooyot Prommanee as Commercial Director, Thailand, based in Bangkok. "Thailand has always been a strong and important market for Alltech," said Matt Einarson, Alltech regional director for Thailand, Vietnam and Philippines. "We are delighted to welcome Pooyot to our team. He brings with him a wealth of knowledge and experience making him an exceptional candidate to successfully lead our commercial activities and continue to drive our sales efforts within Thailand."

Prommanee has a BSc degree from King Mongkut's Institute of Technology, Ladkrabang. Prior to joining Alltech, he spent the past 15 years working within the agriculture industry, most recently serving as assistant vice president of key accounts in a farming automation and housing equipment company with responsibilities spanning South Asia and Southeast Asia. "I am very happy to join Alltech," said Prommanee. "I look forward to working closely with our team and helping to grow our customer business across Thailand".

Asia Commercial Director

Dr Jose Nicandro 'Niki' C. Atienza has joined **Olmix Asia** as Commercial Director. With the appointment of Atienza, Olmix Asia reinforces its management with a director that has strong commercial background, supported by his wealth of experience in health and production and in technical and marketing. He will also be consolidating all commercial and strategic activities for Olmix Asia operations in South East Asia, South Korea and Japan and enhance collaborations with key customers in all these countries.

When asked to comment on his new role Atienza said, "At these times, all producers (our customers) aim for better efficiencies and enhanced productivity and Olmix through its current range of products is in the best position to help them achieve that". Hinting a bit on the future he added that "the agility of Olmix in R&D and in investments will further bring value to our key customers and will continue to drive the productivity and efficiency of our swine, poultry and aqua customers, with Olmix sustainable products". Atienza will be reporting to Quang Thanh Trinh, Olmix Asia Director and will continue to be based in Manila in the Philippines.

Aqua Culture Asia Pacific in 2018

Volume 14 2018						
Number	**1 – January/ February**	**2 – March/April**	**3 – May/June**	**4 – July/August**	**5 – September/ October**	**6 – November/ December**
Issue focus *Trending issues and challenges for the next step*	Nursery Technology	Health Management	Sustainable & Responsible Aquaculture	Disease Management	Genetics & Genomics	Integration and supply chain
Industry Review *Trends and outlook, demand & supply*	Marine Shrimp	Marine Fish	Aquafeed Production	Tilapia	Monodon shrimp	Catfish/General Freshwater
Feeds & Processing Technology *Technical contributions from feed industry*	Fish meal Replacements Feed Enzymes	Feed Additives Fish oil replacements/ omega 3 oils	Extrusion & Processing Functional Feeds	Lipids & Minerals Nutrition	Feed Safety and Hygiene	Functional Feeds
Production Technology *Technical information and ideas*	Controlled systems/ RAS	Finfish Industrialisation	Hatchery Technology	SPF/SPR/SPT shrimp	Post-Harvest Technology	Organic Aquaculture
Market and product developments, market access, certifications, branding, food safety etc)	Shrimp	EU	Tilapia	China	USA	Catfish
Aqua business *Feature articles*	Experiences from industry and opinion article covering role models, benchmarking, health management, SOPs, social investments, CSR, ancillary services, self-regulation etc					
Company/Product news	News from industry including local and regional trade shows					
Deadlines for Technical articles	**November 17, 2017**	**January 19**	**March 16**	**May 18**	**July 13**	**September 14**
Deadlines for Advert Booking	**November 24, 2017**	**January 26**	**March 23**	**May 25**	**July 20**	**September 21**
Show Issue & Distribution at these events as well as local and regional meetings ****Show preview***	**Aqua India 2018** Feb 2-3 Chennai, India **Vietnam Aquaculture 2018** March 14-16, Ho Chi Minh City **Victam Asia** March 27-29, Bangkok, Thailand	***Asian Pacific Aquaculture 2018** April 23-26, Taipei, Taiwan **Seafood Expo Global 2018** April 24-26 Brussels, Belgium	**Offshore Mariculture Conference Asia** May 15-17, Singapore	**Aqua 2018** August 25-29 Montpellier, France ***TARS 2018 Shrimp Aquaculture** August 15-16 Chiang Mai, Thailand **Vietfish 2018** August 22-24 Ho Chi Minh City, Vietnam		

Aquafeed Horizons Asia 2018

March 27, 2018
Bangkok, Thailand

Nutritionists, formulators and feed processors in commercial aquafeed companies from the region and beyond come together with researchers and other stake holders from throughout the aquafeed value chain at the Aquafeed Horizons conference series, to discover the latest advances in technology, ingredients and formulation at the industry's international technical conference. Technical presentations at Aquafeed Horizons Asia 2018 will cover extrusion and drying, mycotoxin control, functional feed additives and novel ingredients such as single cell protein and insects.

"We are fortunate to be able to bring in the highest level of expertise to share commercially valuable information with the industry", Suzi Dominy said. "These include David Tze, the CEO of Novo Nutrients, who will talk about the economical replacement of fishmeal with single cell proteins, and Tarique Arsiwalla, the founder, of Protix, which has teamed with Swiss engineering company, Bühler, to produce commercial scale insect protein."

Aquafeed Horizons Asia will take place alongside Victam Asia, the feed, grain and biofuels exhibition taking place at BITEC from March 27-29, 2018. http://feedconferences.com

Program

Welcome and opening remarks by Dr Juadee Pongmaneerat, Thai Dept of Fisheries, Thailand/Meredith Brooks, Associate Editor, Aquafeed.com LLC, Hawaii, USA

Extruded Aquafeed Quality Management; Relationship Between Technology and Extruded Aquafeed Quality - Thomas Ellegaard Mohr, ANDRITZ Feed & Biofuel, Denmark

Aqua Feed Production – How Extrusion Reliability Affects Factory Performance - Rob Strathman, Muyang USA Design & Engineering, USA

Optimizing Design and Operation of the Pre-drying Product Transport Process - Anders Fjeldbo Haubjerg, Graintec A/S; Assistant Professor, University of Southern Denmark, Denmark

Advancements in Micro Aquafeed Extrusion - Ramesh Gangatharan, Wenger Manufacturing Inc., USA

Mycotoxin Challenge in Aquaculture Feeds - Maarten Jay van Schoonhoven, Olmix group, Netherlands

Balancing Nutrient Levels Through the Application of Functional Additives: Survey of Nutrient Levels in Commercial Shrimp Feeds in India - Alexander van Halteren, Nutriad International NV, Belgium

Comparing Novel Single Cell Protein Technologies For Economical Fishmeal Replacement - David Tze, CEO Novo Nutrients, USA

Insects: The Missing Link in Aquaculture - Tarique Arsiwalla, Protix, The Netherlands

Aquafeed Probiotics - Challenges and Opportunities-Benedict Standen PhD, BIOMIN GmbH, Austria

Nucleotides and Bioactive Peptides: Boosting the Functionalities of Aquafeeds - Francisco González, Bioiberica S.A.U., Spain

Immunity - The Next Frontier in Aquaculture Nutrition - Kabir Chowdhury PhD, Jefo Nutrition Inc., Canada

Offshore MARICULTURE Asia2018 Conference

Mercator Media Ltd, producer of the highly regarded Offshore Mariculture Conferences has announced the launch of Offshore Mariculture Asia, which will take place in Singapore from 15-17 May 2018.

Off the coast, deep water and strong current fish farming of fin fish is the main topic of the debut conference, which is set to welcome over 150 international delegates and speakers to the Marina Mandarin Hotel in Singapore. Day 3 of the conference will culminate in a technical visit to a fish farm.

The conference, which is in association the US. Soybean Export Council (USSEC) will offer technical presentations and panel discussions from high level experienced operators, covering topics including hatchery and breeding technology, offshore technology and cages, nutrition, valued added and distribution.

Marianne Rasmussen-Coulling, Events Director at Mercator Media, organiser of the conference said, "At the last European edition of Offshore Mariculture Conference (OMC) in Barcelona, it was highlighted by the Food and Agriculture Organization (FAO) Chairman that Asia is the developing hub in terms of quantity and potential, and it needs to intensify with more fish per cubic metre of water. It is felt that the market in Southeast Asia is now well-primed for large scale/large volume production and is an excellent location for our conference"

Previous European locations of the conference include Malta, Spain, Croatia and Turkey and in March of 2017 OMC launched in Mexico. The debut Asia conference is expected to attract audiences from around the globe and will include Stakeholders in the supply chain ranging from hatchery to production to the value added and distribution of farmed fin fish. www.offshoremariculture.com/asia

2018

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**

February 2-3
AquaIndia 2018
Chennai
Email: contact@aquaprofessional.org/
aquaindia.sap@aquaprofessional.org
www.aquaprofessional.org/

February 19-22
Aquaculture 2018
Las Vegas, USA
www.was.org

March 27-29
Victam Asia 2018
Bangkok, Thailand
www.victam-asia.com

March 27
Aquafeed Horizons Asia 2018
Bangkok, Thailand
www.feedconferences.com

April 19-21
Aquaculture Asia 2018 Expo and Forum
Kuala Lumpur, Malaysia
www.livestockasia.com

April 23-26
Asia Pacific Aquaculture 2018
Taipei, Taiwan
www.was.org

April 24-26
Seafood Expo Global
Brussels, Belgium
www.seafoodexpo.com/global/

April 27-29
Vietshrimp 2018
Bac Lieu, Vietnam
www.vietshrimp.net

May 15 -17
Offshore Mariculture conference Asia
Singapore
www.mercatormedia.com

June 3-7
18 th International Symposium on Fish Nutrition and Feeding (ISFNF)
Las Palmas de Gran Canaria
Canary Island, Spain
www.isfnf2018.com

July 16-20
Certificate in Aqua Nutrition
Bangkok, Thailand
www.progressus.asia

August 15-16
The Aquaculture Roundtable Series (TARS): Shrimp Aquaculture in Asia
Chiang Mai, Thailand
www.tarsaquaculture.com

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• Flakers, extruders • Grain processing systems • Additives

Industry conferences
• The FIAAP Asia Animal Nutrition Conference 2018
• Petfood Forum Asia 2018 • Aquafeed Horizons Asia 2018
• Proagrica Feed Efficiency Conference Asia 2018
• GRAPAS & Global Milling Conference Asia 2018 • GMP+ Seminar

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• Animal Health Products Association • Department of Fisheries
• Ministry of Industry • The Thai Chamber of Commerce
• Thailand Convention and Exhibition Bureau

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