NOVEMBER/DECEMBER 2014
Volume 10 Number 6

AQUA CULTURE
Asia Pacific

Sustainable production of high value freshwater fish

New leads to mitigate EMS/AHPND

Biosecurity in aquaculture

Functional hydrolysates in olive flounder

Protein sparing in the tilapia

MCI (P) 014/10/2014 PPS1699/08/2013(022974)

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OUR MISSION

- We strive to be the beacon for the regional aquaculture industry.
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- We strive to be the forum for the development of self-regulation in the Industry.

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From the editor

The year in review – 2014

In the year of the horse, our first editorial started with what this year would bring. This editorial attempts to end the year with highlights of what we have learnt. It covers multiple issues so please bear with the disjointed nature. We all know that demand and supply determine price and shrimp prices have been very good. The first 10 months of 2014 were excellent for shrimp producing countries that were not affected by EMS/AHPND such as India, Indonesia and of course, Ecuador. However, towards the end of October, China which had become an international market suddenly stopped buying. This was evident in the China Fisheries and Seafood Expo in Qingdao (November 5-7) when a stalemate was reached between buyers and sellers. Hardly any transactions were reported. The immediate question is how long will this last?

In the World Aquaculture meeting in Adelaide (WA 2014), there were concerns on the robustness of *P. vannamei* broodstock that have been genetically selected for growth. There is a school of thought that inbreeding is significant in the latest generations and there is a need for the introduction of new genetic material but domesticating new SPF stock will take time. At TARS 2014 in Phuket, one big question raised was whether it was prudent to bring WSSV resistant strains to Asia to increase genetic diversity.

With regards to AHPND, there is a more accurate PCR test in the market today. A theory promulgated is that the specific causative factor is a strain of *Vibrio parahaemolyticus* that has been attacked by a phage which then produces toxins leading to AHPND. While progress has been made, we are far from recognising the epidemiology and are even further from preventive and therapeutic protocols. It is believed that in the short and medium term, the industry must learn to live with EMS, and the consumer with high prices.

Now in its 10th year, Vietnam's pangasius continues to battle the US antidumping duties and changes to the rates. The discontent in Vietnam is that the US is using Indonesia as reference because it is a now major producer of pangasius although all of its production is consumed locally. Nevertheless, producers continue to make efforts to be sustainable and, judging from the increase in ASC certifications year to year, they are succeeding.

We have also seen how targeting the high value but volatile live fish market affected marine fish producers in the region. The clamp down on banquets in China have resulted in low demand and prices which forced grouper producers in Taiwan to divert to freezing and processing. This works well when there is a processing industry for plan B.

While pangasius continues to suffer from poor image and low prices, tilapia has developed a strong market following especially in the US where it is the 4th highest consumed fish by volume. China's tilapia production is concentrated in the south where the growing season starts in March and ends by November. In 2013/2014, China changed its model from producing 1-2 cycles to 2-3 cycles per year. It has been facing high mortality rates during the summer months and hence, growing large fish (1kg) for fillets is unprofitable. China has decided to produce smaller fish (500g) and culture more cycles with the intention of improving profitability.

In terms of feeds, the UK's Guardian special investigation on slavery in fishmeal production has affected Thailand's shrimp exports and image. At the recent SIAL Paris show, the Thai Government came out in full force to support the seafood industry and help the country regain its image as a sustainable producer of quality seafood. In preventing EMS/AHPND, many feed producer are now concentrating on producing functional feeds for shrimp following the footsteps of the salmon industry.

TARS 2014 highlighted the lack of timely data for the industry to plan. It also pointed to a shortcoming with data analysis. All the participants agreed that individual farms have continuously collected data which are only waiting to be analysed. Academic institutions would be of great help here and it dovetails with the needs of the industry. This provides a great opportunity for academia to work with and align itself to the industry.

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Soebjakto Slamet

Aquaculture Indonesia (Indo Aqua) 2014 highlighted the business and food security aspects of the country's aquaculture industry. For this to work well, it requires a synergy of all stakeholders to bring up production as well as value and efficiency of production. The industry reported a total aquatic production (fisheries and aquaculture) increase of 30% during 2009 to 2012. Official data indicated that aquaculture alone contributed 70% (13.7 million tonnes) to the total fish production of 19.4 tonnes in 2012. However, seaweed production dominated at 8.18 million tonnes and fish and shrimp aquaculture at only 5.5 million tonnes only. Fisheries and aquaculture is expected to continue to play a large role in the country's economy.

As 45 million of its 240 million population entered the middle class in 2012 and up to 130 million expected by 2030 (Sudaryono, 2014), supplies of aquaculture products have to increase. This is expected to fuel retail growth. Dr Bayu Krisinamikthi, of the Indonesia Ministry of Trade cited cases such as the growth in retail of 72% in Lampung, a second tier city. In turn, this will require a good supply chain and adequate cold storage facilities. Value adding will reduce imports to meet local demand and this should be the new regime.

Total fish consumption is rising. In 2013, it was 35.6kg/capita/year and is expected to rise to 38kg/capita/year in 2014. In 2010, it was 31 kg/capita/year, of which farmed fish consumption was 9kg/capita/year. The CAGR for the latter was 17% for the years from 2006-2010. Seafood is a major foreign exchange earner for the country at USD 4.2 billion in 2013. Farmed shrimp was exported with a value of USD1.6 million in 2013 (Sudaryono, 2014) to the US, Japan and EU markets. However, growth of exports to these markets is stagnating. In some cases, such as for exports to Germany and France, there has been zero growth. The target is also to market to China, Thailand, Vietnam, Singapore and Taiwan. The ministry is also targeting markets in the Middle East using Dubai as the hub. Recently the Russian market is open for Indonesian products. Shrimp production is expected to continue on its upward trend. Director General of Aquaculture, Ministry of Marine Affairs and Fisheries, Soebjakto Slamet, complemented industry on the progress in shrimp farming which has moved to 15 tonnes/ha from 8 tonnes/ha. Participants at the event applauded when Slamet said that there are no reports of the early mortality syndrome in Indonesia.

Invest in aquaculture

The target aquaculture products in Indonesia are shrimp, seaweed, pangasius catfish and milkfish. The Department of Aquaculture, expects investments in aquaculture to rise by 35% in 2014. It said that the total value of investments both by the government and private sector will reach IDR 30 trillion by the end of 2014. Aquaculture with a high local content is an economy target for the country. Slamet hopes that private sector investments can grow to up to IDR 200 billion until end of 2014. The push is for development in the Riau Islands, East NusaTenggara (http://industri.bisnis.com). However, the call was also to have an integrated supply chain.

Maritime nation

The new government has a strong vision for Indonesia as a 'maritime nation'. In turn, this augers well for the marine fish aquaculture sector. Stakeholders in marine fish aquaculture have been called to provide inputs for the future direction of marine fisheries and aquaculture. The target for marine aquaculture is a production increase of 24% by 2019 (sinarharapan.co). At Indo Aqua, Business director for cultivation, Ministry of Maritime Affairs and Fisheries, Tri Haryanto said that preparations should include infrastructure for the future and a 'maritime' university similar to the Ocean University in China. The Marine Aquaculture Group has participated in drawing up a road map toward achieving this maritime nation goal. Wayan Sudja, Indonesia Mariculture Association (Abilindo) said that the mariculture sector has a potential of 50 million ha of coastal and offshore areas. Offshore aquaculture is a potential growth area but investments have been limited to local players aside from one farm with investments from China. Some of the suggestions include developing broodstock centres, develop vaccines and research on how to increase output. Most of the high value marine fish is exported as live fish and new ideas in marketing such as sashimi grade tiger grouper to Japanese consumers was proposed.

Aquaculture Indonesia 2014 was held in Jakarta from 26-29 August 2014 with technical seminars and concurrent sessions for contributed presentations by academia, government researchers and industry. Local and international aquaculture suppliers and government research centres showcased their products and services at the trade show (see pages 46-48).

Industry and government at Indo Aqua 2014. From left, Legisan Samtafsir, Farm 165, Depot, West Java who cultures Clarias catfish using biofloc technology, Purnomo, PT Matahari Sakti (PT MS) , Dwika Herdikiawan, Department of Aquaculture, Suprato, Shrimp Club Indonesia, Guntur Binaraja and Jaja Subagja, PT MS.

Reference

Agung Sudaryono, 2014. Status of sustainable aquaculture development in Indonesia. Presented at the Sustainable Aquaculture Workshop, National Taiwan Ocean University, Keelung, Taiwan, November 4-10, 2014.

EAS honours aquaculture figures

At the opening session of its Aquaculture Europe 2014 event in Donostia-San Sebastián in Spain on October 14, the European Aquaculture Society (EAS) gave its Honorary Life Membership Award to Michael New and its Distinguished Service Award to Yves Harache, for their long-term contributions to the development of aquaculture and the activities of the Society. AE2014 was attended by almost 1500 participants from 71 countries, making it the biggest Aquaculture Europe event to date.

Honorary Life Membership is the highest EAS award and is given to those persons that have had a marked impact on the development of European aquaculture. The award was presented by incoming President Sachi Kaushik. Sachi introduced the awardee by his contribution towards making everyone aware of the well-recognised role of aquaculture in feeding the masses and his deep involvement in breaking frontiers.

Michael New has been involved with EAS for many years, as a member of the Board and as President of the society. He is also a member of the Editorial board of the EAS journal, Aquaculture International. He has been involved in aquaculture for almost forty five years in both private and public sectors and in many countries throughout the world. He held positions in FAO and UNDP as a staunch promoter of aquaculture. As a convinced European, and recognising the importance of Asian aquaculture development, he initiated projects involving EU knowledge and technology transfer through programmes such as the EU-AADCP, creating links between Europe and Asia through the organisation of training courses, helping to create experimental facilities and making the representatives of developing countries aware of European research and technology in aquaculture. Having been the president of the World Aquaculture Society (WAS) from 1997 to 1998, he was awarded the Honorary Life Membership of WAS in 2002 and subsequently (in 2009) he received the WAS Exemplary Service Gold Medal. He is a member also of the Asian Fisheries Society and an Honorary International Life Member of the China Society of Fisheries.

A major action showing his commitment to the cause of aquaculture was by his founding of the NGO Aquaculture without Frontiers (AwF) in 2003 and recognised globally for its commitment to help and support small farmers and improve their livelihoods (see page 58). Some 15 years ago, Michael New was awarded the Order of the British Empire by Her Majesty Queen Elizabeth II for services to aquaculture in developing countries.

EAS has an award for Distinguished Services that is destined for individuals that have devoted very significant effort and time to the development of EAS and its objectives. The Award for Distinguished Services has only been presented twice in the history of EAS.

The EAS Board decided to give this award for the third time to the eminent scientist, Yves Harache, who experienced and made significant contributions to the development of aquaculture over the last 40 years throughout the globe and from salmon to shrimp. Yves Harache played a major role in the governance of EAS with a total of 16 years on its Board of Directors.

Michael New, OBE, (right) was surprised and delighted to receive the Honorary Life Membership of the European Aquaculture Society at its AE2014 event in Donostia-San Sebastián from incoming EAS President Sachi Kaushik

Recognising Vietnam's aquaculture leaders

During the GOAL 2014 conference, the Global Aquaculture Alliance (GAA) held a special event titled 'Celebrating Leadership in Vietnam's Aquaculture Industry.' The three-hour program was devoted to celebrating the achievements of leaders in Vietnam's aquaculture industry and building awareness of the need to improve responsible aquaculture practices to facilitate market access for small and medium-scale pangasius and shrimp farmers.

The program featured Dr Pham Anh Tuan, Ministry of Agriculture and Rural Development (MARD), Dr Loc H. Tran, Minh Phu AquaMekong Shrimp Vet Laboratory, Dr Le Luu, International Collaborating Centre for Aquaculture and Fisheries Sustainability (ICAFIS), Dang Cong Buu, Integrated Coastal Management Programme (ICMP)/GIZ Vietnam, Dr Flavio Corsin, IDH, Ngo Tien Chuong, WWF Vietnam, Thi Thanh Binh, BAP, Nguyen Hoai Nam, VASEP (Vietnam Association of Seafood Exporters and Producers) and Vo Thi Thu Huong, Vietnam Pangasius Association.

GAA presented Thuan Phuoc Seafood & Trading Corp. with a 'Commitment to Excellence Award' for achieving four-star Best Aquaculture Practices certification. The company is the fifth Vietnamese company and the tenth overall to achieve four-star BAP status, denoting that the company's shrimp processing plants, farms, hatcheries and feed mills are BAP certified. The event sponsors, National Fish & Seafood, Grobest, Minh Phu Seafood Corp., GIZ, Australian Aid, Farmers in Transition Fund and IDH, were also recognised at the event.

News in Brief

Shift in marketing the grouper

Taiwan's grouper market is concentrated entirely in China and Hong Kong. From January to August 2014, Taiwan's farmed grouper export volume to China, including Hong Kong, was 10,964 tonnes, 99.67% of the total export volume of 11,000 tonnes. Only 18 tonnes were exported to Japan, while farmed grouper export volume to the US was negligible. This is the lack of diversification of risk, according to the Taipei Times. China's recent crackdown on luxurious banquets and the increase in China's own domestically farmed grouper, brought down Taiwan's grouper export volume in value, demonstrating a need for a long term marketing plan for the nation's grouper production. The call is for authorities to develop the domestic and overseas markets beyond China. Reports indicated that producers are now looking at freezing and processing of grouper steaks to expand their markets.

Rise in shrimp production in Vietnam

According to the General Directorate of Fisheries, as of 31st October 2014, marine shrimp was farmed in approximately 676,000ha, up 3.6% year on year (vasep.com.vn). The farming area for the black tiger shrimp was 583,000ha and for the vannamei shrimp, 93,000ha, which represents a 46.4% increase, year on year. The total production was 569,000 tonnes, comprising 241,000 tonnes of black tiger shrimp and 328,000 tonnes of vannamei shrimp. By the end of the year, the estimate is a total production of 660,000 tonnes, up 20.4% from 2013, consisting of 400,000 tonnes of vannamei shrimp (45.3% more than in 2013) and 260,000 tonnes of the black tiger shrimp, which remains at the 2013 level. There was a dramatic shift in shrimp farming structure, as farmers switched from farming black tiger shrimp to vannamei shrimp and more intensive farming methods have been applied. The shrimp exports value for 2014 is expected to rise to USD3.8 billion compared to USD2.9 billion in 2013.

Better times for Australian seafood

The industry report, 'Smooth Sailing for Australian Seafood' by agribusiness banking specialist Rabobank, said that the local industry is set to ride the surging wave of global demand. The rapid growth in demand is outstripping supply, with an estimated 30 to 40 million tonnes of additional seafood required globally to meet consumer demand by 2030. Australia is in a 'box seat' to take advantage of this growing demand at the high-value premium end of the global market. Australia's seafood sector is forecast to have a value of AUD 2.5 billion in 2014/15, according to Australian animal proteins analyst Matt Costello, co-author of the report. The main products are the Australian rock lobster, southern bluefin tuna and Tasmanian salmon. In Australia, seafood production is still dominated by wild-catch, accounting for 87% of production in 2012, with aquaculture making up a relatively small, but increasing share of production.

Increase in aquafeed production capacity

In 2015, the total fish feed production capacity in Indonesia is expected to increase by 180,000 tonnes with the operations of three new fish feed plants in Banten, Sumatra, and East Java. This is with an estimated investment cost of USD6 million. In *Bisnis.com*, chairman of the aquafeed division of the Indonesian Livestock Feed Association (GPMT) Denny D. Indradjaja said that each new mill would be able to produce an average of 5,000 tonnes per month. The current installed capacity is 600,000 tonnes of shrimp feed with 70% utilisation. Four years ago, it was only 40%. Since then, shrimp feed consumption has been increasing at 15%-20% per year. The current installed capacity of both pelleted and extruded fish feeds is 2 million with an utilisation rate of 70%-80%. Indradjaja believes this additional capacity is needed because demand for fish continues to grow.

Resumption of exports to Russia

The Russian ban on seafood imports from the European Union countries is benefiting direct exports by Vietnamese seafood exporter. Seafood imports to Russia increased by 150% in January 2014 (with pangasius comprising 44%) before Russia banned imports from seven seafood companies. The ban was lifted by Russia's Veterinary and Phytosanitary Surveillance Service (VPSS), paving the way for Vietnamese seafood exporters to increase exports to Russia. In addition, there will be tariff reduction or elimination under the proposed FTA between the two countries. According to the General Department of Vietnam Customs' statistics, in the first seven months of this year, seafood exports to Russia reached USD36.2 million, an increase of 5.4% compared to the same period in 2014. The Vietnam Association of Seafood Exporters and Processors (VASEP) deputy chairman Nguyen Huu Dung said that tra fish exports to Russia recorded good growth. However, quality did not meet requirements. Therefore, Vietnamese businesses need to pay attention to improving the quality, contributing to enhancing the value chain. Vietnamese businesses also need to focus on diversifying their products (ven.vn)

Certifying small-scale shrimp farms

The National Fish & Seafood, a US based division of Pacific Andes Group, launched a unique project to bring small-scale shrimp farmers closer to BAP certification. The project, which will drive improvements in environmental protection, food security, biosecurity and traceability, was launched at the Global Aquaculture Alliance (GAA) GOAL 2014 conference in Ho Chi Minh City, Vietnam. According to James Baros, Aquaculture and Sustainability coordinator, the company will develop a model that encourages all aquafarmers, especially small farmers, to improve culture methods to comply with rigorous environmental and social standards. This is a win-win for producers and consumers alike. The company is collaborating with GAA and the Sustainable Fisheries Partnership (SFP) and will pilot the first four groups of shrimp farmers; two in India, one in Vietnam and one in Indonesia. It will use the Aquaculture Improvement Projects (AIPs) through SFP to document improvements in practices being made, and support a zonal management approach. The aim is to provide market access for more than 120 small-scale farmers.

Barramundi breakthrough

Barramundi producers in north Queensland are hopeful that a new test to determine which fish produce the strongest offspring will help double Australian production. Researchers from James Cook University in Townsville have developed a way to find out which parents produce the fastest growing fish. In abc.net.au, Dr Jose Domingos said the test involved looking at the cellular growth of young fingerlings. He added that one of the key issues on the differences in growth rate is to do with the parents of origin or the genetics of this fish. Researchers have been able to trace the genes of quicker-growing fish back to their parents, just weeks after the fingerlings were born. Previously, this took year to complete. This breakthrough is important for commercial farmers as it can lead to faster and higher production. Australia imports two-thirds of the barramundi consumed.

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Learning more on EMS and its mitigation

Science is providing new leads on how to mitigate the disease and working together is crucial for industry to sustain production

During the last four years, shrimp farmers in Malaysia and Vietnam and recently in Thailand have been struggling to maintain production amidst early mortality syndrome (EMS), also known as acute hepatopancreatic necrosis disease (AHPND). Some farmers have given up shrimp farming, whilst others have taken crop holidays. For some farmers, polyculture with tilapia gave a temporary respite from EMS infections before the farms succumb to EMS again. There is a general anxiety amongst farm managers of new farms or farms that have been free from the disease.

Malaysia's shrimp farming industry is in a static position. The total production volume in 2014 is expected to remain at 35,000 tonnes. In 2014, the loss in production at established farms is expected to be balanced by production from new farms. However, it is without doubt that EMS and other diseases will continue to play havoc with shrimp farmers. How is the industry handling this disease and how can it mitigate the spread? This was the opening statement made by Abu Bakar Ibrahim, CEO Blue Archipelago, Berhad (BA), the largest integrated shrimp farm in Malaysia, at the second seminar on EMS (EMS2). This seminar which was held in Kuala Lumpur in October, was organised by the Malaysian Society of Marine Science (MSMS) and the Institute of Ocean and Earth Sciences (IOES), University Malaya, Biovalence S/B and BA.

A great deal of research has been done by various regional laboratories over the past one year since the first EMS seminar in 2013. Organisers planned this seminar to update industry players, researchers, academics, government, policy makers as well as other stakeholders on the known body of information within the region and Malaysia. The presentations are by local and regional experts working on EMS. It also included the steps taken by Akazawa Noriaki, general manager of the Agrobest Farm in Malaysia to overcome EMS which continues to affect the farm since 2011. The hope is that as more is known on the causative agent *Vibrio parahaemolyticus*, industry can overcome the disease and move ahead.

A better understanding of EMS

EMS which affects both *Penaeus monodon* and *P. vannamei*, has been observed to cause shrimp mass mortality from as early as PL12 to 40 days of culture (DOC 40) although in some cases, as late as DOC 60. Transmission is both vertical via broodstock and post larvae, and also horizontal from contaminated water bodies. Antibiotics may work for 1-2 cycles and then the pathogen becomes resistant. It occurs in both biofloc and non-biofloc ponds, HDPE lined and unlined earthern ponds. These were stated by Ung Eng Huan, chief technology officer, Biovalence in his presentation on understanding EMS and development of mitigation protocols.

Shrimp with early mortality at DOC20-43. As with this sample, Otta said in India, more than >95% of dead shrimp were infected with WSSV

"Based on the disclosures from the Centre of Excellence for Shrimp Molecular Biology and Biotechnology (Centex Shrimp), Mahidol University, Thailand) on the AP1, AP2 and AP3 primers, Biovalence has developed an AP1/2/3 multiplex PCR that is very economical for use by farms and hatcheries or laboratories with any standard PCR machine. The AP3 primers are accurate to 20 copy numbers. Unfortunately, there are no immunoassay rapid detection kits yet. Some ponds stocked with AP3 +ve post larvae were harvested without mass mortalities showing that if managed well at the pond level, quorum sensing is not reached and the toxin remains unreleased. Nevertheless, AP3 +ve post larvae represents a higher risk level during pond culture," said Ung.

Ung explained that *V. parahaemolyticus* is a facultative anaerobe so it can hide in the pond sediments where oxygen is zero below the top 2mm of the sediment. It can also form biofilms with a resistant matrix protein in its sessile state, and lined ponds should be properly dried in between cycles. The bacteria also have a motile state and the company has now isolated certain secondary metabolites that can kill these pathogens.

Learning more on the bacteria

DNA fingerprinting of the 28 EMS-causing isolates held in the Biovalence library (confirmed by histopathology) was carried out by Prof Thong Kwai Lin at the Laboratory of Biomedical Sciences and Molecular Microbiology, University Malaya. The results showed that 80% of the local strains were closely related to 3HP, the Thai Centex reference strain but that they showed many biochemical differences. Ung also mentioned that all the 28 strains could ferment glucose while Loc Tran, Nong Lam University, Vietnam had mentioned earlier that all his Southeast Asian and Mexican strains could not! As expected, all 28 strains had different virulence levels. This could explain why some EMS outbreaks caused more deaths than others over a shorter period.

"The two key observable damage histologically caused by EMS are blebbing of the hepatopancreal basement membrane observable only by TEM and cell sloughing. Dr Kua Beng Chu, Department of Fisheries Malaysia (DOF), said that hepatopancreatic tubular cells sloughing into the intestine remain the main identification for EMS/AHPND. After sloughing, the cells die and disintegrate and secondary bacteria and later even gregarines colonise the lumen feeding off this rich material."

EMS mitigation

The Centex Shrimp team led by Dr Timothy W. Flegel, Dr Siripong Thitamadee and Dr Kallaya Sritunyalucksana have been at the forefront of research into the causes of EMS/AHPND and later on the bacteria strain. Thitamadee said they are collaborating closely with farmer associations, industry and the Department of Fisheries (DOF).

The collaborators in Taiwan are working on the genomic work relating to two toxin genes, identified previously. In Thailand, industry does not expect better production in 2014 following the 50% drop in production in 2013. There have been new solutions such as imports of brood stocks from Ecuador, improved surveillance on diseases and large scale adoption of probiotics developed by the DOF, Thailand

As early as 2012, when EMS occurred in the Eastern Gulf provinces of Thailand, metagenomics as well as direct bacterial screening were performed to obtain the list of possible pathogenic bacteria (viable isolates and signature sequences) causing EMS/AHPND.

For bacterial toxin study, the candidate toxin genes were obtained from two independent approaches; genomics and proteomics (large-scale study of proteins, particularly their structures and functions). These identified, at least, two toxins that are responsible for causing EMS/AHPND histopathology. We now know the difference in virulence of some *V. parahaemolyticus* strains which range from 73% to 100%. The virulence could be related to chromosome and plasmid toxicity which we have used in developing protocols for AP primers onwards.

"An epidemiological study has been conducted covering 200 preselected ponds. Results are still coming in but from 148 samples, we now have a better understanding of infections in the field. We have found that EMS is not always linked to less than DOC35 mortalities. Some shrimp were infected with microsporidians and most recently, we included the testing for CMNV (covert mortality nodavirus), recently reported in shrimp ponds in China. Some samples showed infections with CMNV where shrimp exhibit similar symptoms such as early mortality."

Further to this, the proteomics study on the toxins showed the culprit proteins to be 50kDA and 17 kDA. According to the reverse gavage tests, by combining and increasing these two proteins, the mortality rate increases. When a proprietary protein adsorber was added, mortality decreased. The next step is to conduct some challenge tests and mix the adsorber into feeds and study the effects.

Soon after the first announcement that *V. parahaemolyticus* was the causative pathogen, the idea of a lysogenic phage transferring a virulence factor was floated. Ung mentioned that genomic analysis carried out by Prof Thong of the University of Malaya yielded integrated bacteriophage elements (proviral DNA) that had zonal occludens toxin (ZOT) sequences. Upon further analysis of the ZOT-related operon (a family of genes working in association with one another), the toxic proteins pirA and pirB were identified which were similar to an independent conclusion reached simultaneously by Centex Shrimp (pers comm). The precedent example of a phage mediated 'weaponisation' is that of motile aeromonad septicaemia in channel catfish in USA.

Ung also said that his group has successfully isolated a lytic phage that can help by killing 50% of all the Malaysian EMS-causing isolates. To ensure that the phage can no longer mutate and lead to more uncertainty, they developed a protocol to separate the phage head from its tail so that the kill occurs only in the first generation. Biovalence has also shown that its N4 probiotic strain kills 93% of all EMS strains within its library.

Phage cum probiotic therapies may be potentially the way forward but there are caveats. Each victory may be only temporary until the pathogen mutates and develops a way to avoid being killed.

Ung therefore concluded that what we can soon expect is the production of an entire pipeline of phage-probiotic combinations that change every month so that the pathogen is not allowed to build up resistance easily.

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Risk assessment

While research is ongoing, the advice to farmers is to carry out monitoring EMS using the AP3 primer. At the NACA website (www.enaca.org), updates on EMS research are available. Thitamadee explained that AP3 primer can be used to check whether broodstock, post larvae, feeds, sediments etc are free from AHPND bacteria.

"We can monitor shrimp during cultivation to be sure they remain free of AHPND bacteria. We can use the method to study toxin production and to test ways to stop or neutralise the production. In the screening of post larvae, enrichment should be carried prior to detection. In the AP3 primer protocol, positive results may not lead to mortality in the ponds as the effects may depend on the bacterial load. Table 1 showed results with tests using the AP2 primer protocol and answer queries on the provenance of *V. parahaemolyticus* strain causing AHPND.

Since September 2011, Dr Kua Beng Chu and the team at the National Fish Health Research Centre, DOF have been carrying out field investigations on EMS/AHPND in Malaysia. Kua said that the definition of EMS/AHPND includes pale hepatopancreas, empty gut, mortality at less than DOC30. Some cases in Malaysia did not fit into these categories. However, all of the cases showed mortality earlier or later than DOC30 with the mixed presence and absence of *V. parahaemolyticus*, as well as presence of hepatopancreas cells in the gut. Sometimes within a pond there is a first wave mortality of EMS/AHPND followed by a second one.

Using common symptoms among the cases, the team found that there was a positive relationship between the presence of hepatopancreas cells with the positive AHPND shrimp and their lower survival rate. Monitoring results on occurrence of EMS/AHPND at the selected farms further confirmed this relationship.

Table 1. Summary of PCR results from AP2 detection with enrichment specimens

Sources	Positive results (no of samples)
Broodstock faeces	50% (44)
Nauplii	30% (14)
Polychaetes	70% (7)
Squid	44% (9)
Artemia	50% (2)
Oysters	0 (3)
Clams	100 (2)
Blood worms	0 (2)

Scoring method

Kua's team subsequently developed a scoring method based on the presence of the hepatopancreas cells in the gut for early detection of EMS/AHPND at farm level. The scoring method was further confirmed with histopathology and PCR method for AHPND. The validation exercise showed that the scoring method can help farmers determine whether their farms have the risk of EMS/AHPND before confirming with the PCR method. When the score is high, the farmer has to decide whether to continue with the crop. Kua quoted some examples.

"In a selected pond at DOC 23, a high score was detected and the farmer was well aware of the risk of EMS/AHPND. However, he decided to underfeed the crop until DOC 59. At that point, the percentage of high score was 70% when first mortality occurred. With the higher risk of having EMS/AHPND, the decision was to harvest the crop at DOC 81 with 83% survival rate. PCR detection for EMS/AHPND for this pond was positive for DOC 23 and DOC 81. In another pond at a different location, a lower score was recorded at DOC 15 and the farmer was also alerted on the risk of EMS/AHPND infection. At DOC30, a higher score was recorded with first mortality and farmer was informed about the higher risk of having EMS/AHPND. However, as shrimp size was smaller in this pond, the farmer decided to continue until DOC78 with the survival rate of 22%.Throughout the culture, shrimp were tested positive with AHPND using PCR method for DOC 15, 30, 50, 65 and 78."

The team also looked at treatment methods. Preliminary trials were conducted on lipid esters to determine whether there is any reduction of positive EMS/AHPND's pathology after the first reported mortality. In general, farmers reported 40-50% of mortality during the first mortality or first wave of infection. Results from laboratory trials were encouraging. The long chain lipid esters were apparently able to reduce the sloughing of epithelial cells from hepatopancreatic tubule of shrimp that showed positive EMS/AHPND's pathology. The lipid esters are food grade and were applied at a dosage of 0.04-0.08%. Field trials will be conducted to further confirm this finding.

Farming amidst EMS

The Agrobest Malaysia farm was one of the earliest farms to report EMS infections. In an update after his presentation in 2013, Akazawa Noriaki said that they continued with efforts to control EMS and conducted various trials. "One of the challenges was the low temperature from late 2013 to January 2014, which was followed by high temperatures in February 2014. Now the production is improving to 10-14 tonnes/ha for the majority of the ponds. However, this has not reached levels prior to EMS.

"We have the advantage of historical sampling data in 2010 which we can use as reference. First of all, during the time when we were farming only monodon shrimp, we have detected multi virus infections. After the EMS we have detected both virus and bacteria infected samples from several farming areas. This was before the farm succumbed to EMS in 2011. I have been able to correlate data with changes in the environment. In my research, I see bacteria and virus everywhere. I often ask whether EMS is caused by *V. parahaemolyticus* only or by other bacteria as well as viruses or even parasites. We need to consider EMS as not only a single infection but a multiple infection.

"The critical parameters are climate, water (water source and pond water) and post larvae. We know that we cannot change climatic factors affecting the region. As regards to pathogens, without full understanding we cannot decide on actions to be taken. From a farm operation point of view, we have a responsibility to minimise impacts to nature. We can only manipulate post larvae quality and pond management. This is our strategy. For the moment, we focus on maintaining survival at 80% where growth may be a bit slow. Next we will then focus on increasing harvest sizes and a shorter culture period.

"My message is that we need to know the status of the farming area, farm and post larvae condition," said Akazawa. He also presented recent sampling data of several farming areas where not only toxic *V. parahaemolyticus* but also several viruses were detected.

Conclusion

"The dire situation in Malaysia is that most farms have at one time or another succumbed to EMS. Almost all farms using AP3 PCR protocol tested post larvae positive. Some farms continuously reportcrop failures from EMS, such as the BA farm in Kerpan," said Abu Bakar, who led the panel discussion. A nationwide census on EMS in shrimp farming was conducted by DOF Malaysia and results are being analysed.

Is there a correlation between EMS and stocking density? Akazawa said that at the Agrobest farm, they tried reducing to

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Ung Eng Huan (right) with speakers, from left, Akazawa Noriaki, SK Otta, Kua Beng Chu and Siripong Thitamadee

60-70 PL/m^2, but this did not work. They have now raised stocking density to 90 PL/m^2. "What is clear is that overfeeding is a bad habit and farmers need to monitor the feed needs of the shrimp," said Akazawa. In India, the stocking density range from less than 40 PL/m^2 to a maximum of 60 PL/m^2. Thitamadee said that in Thailand stocking density can reach 250 PL/m^2, and irrespective of low or high stocking density, farms may get infected.

According to Akazawa, in the early stage of culture, pH and algal blooms cause stress to shrimp. Temperature fluctuation needs to be monitored. Most farms now disinfect incoming water but the elimination of competitors means that *V. parahaemolyticus* will dominate. There should be a mature biota in the ponds after disinfection. This biota should either be a community of balanced bacteria which the farmer desires. This leads to the need for a fully defined bacteria community in biofloc for more controlled culture at high density.

Bacteria biofilm in lined ponds and hatchery tanks could be reservoirs for EMS bacteria. To prevent horizontal transmissions, lined ponds should be dried well and thoroughly. In the case of hatchery tanks, the suggestion was cleaning with acid in older tanks as the effectiveness of cleaning is related to the age of the biofilms. Another strategy is water remediation with probiotics and dosage and application modes will depend on each hatchery or farm. Ung mentioned that 5 ppm of chlorine was sufficient to kill 100% of all the 28 EMS strains in the Biovalence library within only 4 hours of darkness in the laboratory. However, this was in water and biofilm resistance especially on HDPE liners have not yet been tested.

Abu Bakar concluded that, "We have seen progress in understanding the bacteria causing EMS with academia and industry coming together to find solutions. The amount of work was significantly more than that in 2013. The proof of the pudding can only be seen at the farm level. In Malaysia, we are still far from developing concrete measures to mitigate EMS as there is a large variation from pond to pond, farm to farm and region to region. Nevertheless the information provided at this seminar brings us closer to tackling farming challenges and work towards EMS free shrimp farming."

No EMS but vigilance in India

Shrimp production in India continues to be on the upward trend with 72,041 ha of ponds farming the black tiger shrimp and producing 76,978 tonnes in 2013. There are 44,248 ha of ponds farming the vannamei shrimp and production was 250,507 tonnes in 2013. In October 2013, reports surfaced that EMS had occurred in some farms in India. After an extensive surveillance program, these reports were disputed. **Dr Subhendu Kumar Otta**, Central Institute of Brackishwater Aquaculture (CIBA) explained the analysis carried out on samples from shrimp farms in Andhra Pradesh and Tamil Nadu.

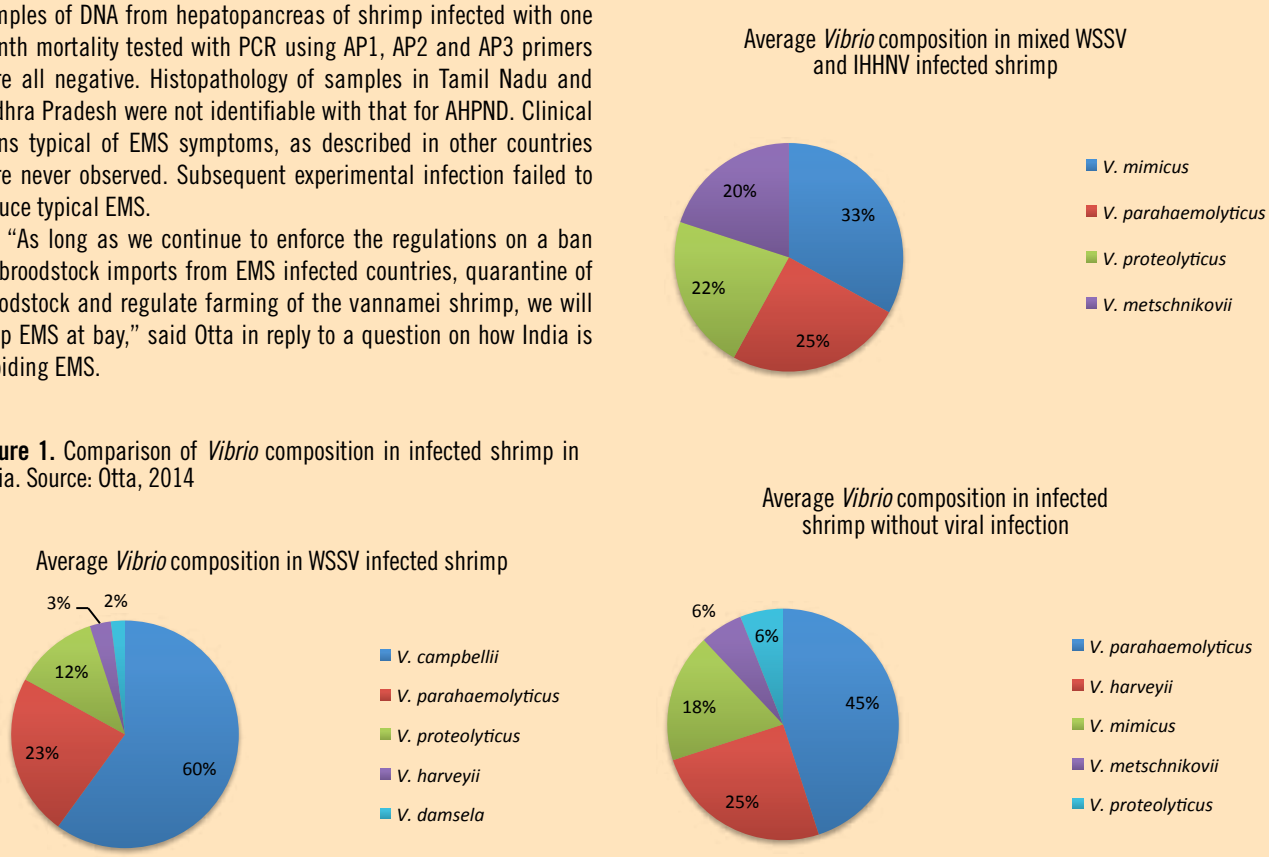
Some of the production problems include early mortality at DOC 20-43 and investigations then showed that in 95% of cases, there was a high load of white spot syndrome virus (WSSV). Otta said that with improper pond preparation, WSSV can remain virulent for 19-21 days in drainable ponds and 35 days in non-drainable ponds. Another disease is running mortality syndrome which is defined as continuous or daily mortality and is a threat to successful harvests. Here shrimp show white patches on the abdomen. CIBA has not determined whether this is due to a new virus but it is widely attributed to poor water quality and pond conditions, such as high levels of hydrogen sulphide and stocking density. Other diseases are white faeces syndrome and black gill disease.

With the pending threat of EMS in India, CIBA took the approach of conducting systematic investigations and a general surveillance on the disease situation in shrimp farming with special reference to EMS/AHPND. In his presentation, Otta said

samples of DNA from hepatopancreas of shrimp infected with one month mortality tested with PCR using AP1, AP2 and AP3 primers were all negative. Histopathology of samples in Tamil Nadu and Andhra Pradesh were not identifiable with that for AHPND. Clinical signs typical of EMS symptoms, as described in other countries were never observed. Subsequent experimental infection failed to induce typical EMS.

"As long as we continue to enforce the regulations on a ban on broodstock imports from EMS infected countries, quarantine of broodstock and regulate farming of the vannamei shrimp, we will keep EMS at bay," said Otta in reply to a question on how India is avoiding EMS.

Figure 1. Comparison of *Vibrio* composition in infected shrimp in India. Source: Otta, 2014



Biosecurity in aquaculture Part II: National considerations

By Leonardo Galli, Don Griffiths, Pikul Jiravanichpaisal, Nattawadee Wattanapongchart, Oranun Wongsrirattanakul, Wimonthip Jarupheng and Andy Shinn

Basics of Biosecurity

Part two shows the steps to establish biosecurity at the national level.

An aquaculture facility, i.e. a hatchery or a farm, can be classified according to their sanitary status, their infrastructure and management level and can then either import aquatic stocks from sites with an equivalent or better score or export to sites with equivalent or lower scores. In each case the movement of aquatic stocks must be in accordance with both local and national regulations.

This is the second, in a series of three articles, focusing on biosecurity in aquaculture. The aim is to provide baseline information for the aquaculture community. In the first article (Aqua Culture Asia Pacific Volume 10 no 4 July/August 2014, pp 41-42), we focused on biosecurity at the international level. In this article, we will now focus on biosecurity at the national level. It is not difficult to define a biosecurity programme for a country; the difficult task is in implementing it. This requires the training of staff, the quality assurance of laboratory facilities and procedures for samples analysis, and the development of robust contingency plans, etc.

Sanitary map for each species

This is prerequisite to establishing the sanitary status of the country for the different diseases. It is not possible to establish a biosecurity programme if there is incomplete information on the current status of particular diseases within a country. The first step should be a monitoring programme, at the national level, to determine the precise sanitary condition of aquatic stocks (ie fish or shrimp) in the country, including both cultured and wild populations of a given species. With this information a sanitary map can be defined for each species, then zones and compartments within this can be established. If the importation of live aquatic organisms is necessary, quarantine stations must be available. These quarantine stations can be either governmental or private but they must conform to governmental regulations.

National biosecurity protocol for aquatic species

Once the sanitary status is known and the zones and compartments have been delimited, then a national biosecurity protocol can be defined. This protocol must establish how a given aquatic organism will enter the country (as in the case of importations) and how the aquatic organisms may be translocated within the country. The aquaculture facilities (hatcheries and farms) can be classified according to their sanitary status, infrastructure, management level, etc, and then assigned to different, nationally defined categories based on their scores.

Assuming that three categories are defined, category A sites might be those with a high level of biosecurity; category B with a medium level of biosecurity; whilst category C sites might be those with very low or no level of biosecurity in place in their establishments. This will generate a unidirectional flow of products, where products coming from category A establishments can go to establishments in any category; products from establishments in category B can go only to establishments in category B and C; and, products emanating from establishments within category C can go only to other facilities within the same category. This can create a natural tendency for improvement with the lower level establishments trying to reach higher categories, thereby improving production systems in general.

It is important to determine the precise sanitary condition of native aquatic stocks before considering imports/exports.

Between hatcheries and farms there is immense variation in infrastructure and system design and although it is not possible to define one precise biosecurity plan that fits all, how biosecurity at the producers' level can be achieved will be discussed in the third article in this series

Requirements for training and laboratories

The implementation of a biosecurity national programme will require numerous conscientious and well trained technicians. Qualified personal should take control of the main access points into the country, inspect hatcheries and farms, maintain surveillance, run laboratory tests, and ensure proficiency, quality assurance and validation etc. The training of technicians, locally or abroad, is a very important component of the whole process. A Reference Central Laboratory (RCL) should be defined, with the capacity to issue national and international health certificates. This RCL can also certify other regional laboratories located within the host country.

Emergency plan

A clear emergency plan must be in place for each disease in the event of a disease outbreak. Official entities must have legal capacity to execute the emergency plan, without interference from other official institutions. For immediate action when required, it is critical that an organisation chart including positions and personnel requirements, responsibilities and capabilities, is already in place and clearly specified. Likewise, a system of economic compensation to the producer(s) must have been contemplated in advance of a disease episode and in the event that mandatory culling of stock is required to either eradicate the disease threat or to curb further spread.

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Opinion article

Some reasons why Indonesia is free from EMS

By Poh Yong Thong

While farms in the west coast of Peninsular Malaysia have almost ceased operations because of EMS/AHPND, those in nearby Indonesia have been free from this disease. A possible reason is the routine practice of cleaning the pond bottom in most farms in Indonesia.

The author has his own shrimp farm in Malaysia and visited shrimp farms in Thailand. Since early 2011, Poh has been spending much of his time visiting Indonesian shrimp farmers in his capacity as nutritionist and he is responsible for technical services in PT Gold Coin Indonesia.

EMS (early mortality syndrome) or AHPND (acute hepatopancreatic necrotic disease) first manifested itself in south eastern China in 2009, which subsequently spread to Vietnam in 2010, Malaysia in 2011, Thailand in 2012 and Mexico in August 2013. The devastating disease has affected the livelihood of many shrimp farmers and resulted in enormous production loss of more than 23% of the 4 million tonnes annual world farmed shrimp production; this is equivalent to an economic loss of USD 5 billion per annum over the past three years.

In 2013, Dr Lightner's team discovered that AHPND was caused by a certain strain of *Vibrio parahaemolyticus* with virulent genes affecting the hepatopancreas of shrimp. *V. parahaemolyticus* is a fast growing opportunistic pathogenic bacterium that quickly develops a biofilm which is capable of attaching to chitin surfaces. The bacterium can develop a resting form and becomes dormant for long periods in dry condition. Just to give an idea, *Vibrio cholerae* can survive in dry form for up to 60 years!

Victoria Alday-Sanz presented a detailed observation on EMS in her presentation at the Biofloc Technology and Shrimp Diseases Workshop Vietnam in December 2013. Her observations indicated that in both the semi-intensive ponds of Mexico and the intensive ponds of Asia, the pond bottom, whether lined or earthen appeared to be the main risk factor. This is validated by the absence of the disease in shrimp placed in a suspended net not touching the AHPND affected pond bottom. *P. vannamei, P. monodon* and *P. chinensis* are all susceptible to AHPND. This may imply that the risk factor is not inbreeding, as once believed to be. Similar to infectious myonecrosis virus -IMNV, AHPND is more severe at high temperatures. Fasting improves the shrimp health. Fermentation should be avoided in the sludge area. A high dose of 10^8 CFU/ml is needed in challenge experiments to infect the shrimp. There is no mortality in 10^4 CFU/ml challenge.

Figure 1. Very clean pond bottom right after harvest of an Indonesian pond

No reports of EMS in Indonesia

Despite its close proximity to EMS affected Malaysia, Indonesia has remained free of the disease as of today. Based on my experience and in conversation with industry in Malaysia and Indonesia, some of the possible reasons for this situation are discussed below:

First of all, after its very bitter experience of contracting IMNV in 2006, the shrimp farming communities in Indonesia have been very careful about trans-border importation of shrimp. The genetic sequence of the Indonesian IMNV is 99.6% similar to that of the Brazilian IMNV, kept in the GenBank. An Indonesian Ministerial Decree 17/2006 had allowed the drawing up of a National Fish Quarantine regulation to protect the country from further introduction of exotic diseases through trans-border movement. The measure has restricted the previously haphazard importation of brood stocks and post larvae.

Figure 2. Ponds in Malaysia. Picture on the left shows a small mountain of sludge accumulated in the centre. Picture on the right, shows pond washing. Note the black sludge.

Secondly, Indonesian farms have very hygienic pond bottoms (Figure 1). In comparison, accumulated sludge is common in Malaysian ponds (Figure 2). More than 90% of the ponds in Indonesia have central discharge systems. Sludge from dead plankton, shrimp faeces and uneaten feed accumulated in the centre of a pond can easily and regularly be discharged to the outlet canal by simply pulling up the vertical pipes placed on an elbow. The frequency of discharge can be up to 5 or 6 times a day (Figure 3)

While EMS affected countries such as China, Vietnam, Thailand, Malaysia and Mexico are yet to recover from the disease, the construction of new shrimp ponds are sprouting all over Indonesia. It is estimated that about 15% of new ponds are being constructed.

Figure 3. Various designs of the central drainage systems in Indonesia

Disc type of central discharge in a Sumbawa pond in Indonesia

Radial type of central discharge in a Central Java pond

Tools used by many farms in Sumbawa to allow the diver to breathe while siphoning remaining sludge on the pond bottom

The practice of ensuring pond bottom hygiene in Indonesia has certainly set it aside from its neighbours.

The incorporation of a shallow sump in the pond centre plus the PVC pipes may cost an addition of USD 1,500 to USD 3,000 depending on the types of central discharge system. However, a prerequisite is that the outlet must be separated from the inlet. There may be an additional of 4 man-hours of siphoning per week after 30 days of culture (DOC30). The investment is negligible compared to the benefits!

Why other countries are not doing what Indonesia is doing?

Intensive shrimp farming has a short history and is barely 20 years old. It is hence still very much an art. A lot of culture practices are being learnt and copied. Industry is still in the lower end of the learning curve. Some creative farmers in Indonesia began to incorporate a central discharge and the good experience was copied by neighbouring farmers. The idea caught on. Mass media and presentations at national meetings have also played an important role in knowledge dissemination.

Summary

Accumulated sludge in the pond bottom is a great liability to the pond water quality. The sludge not only consumes a large portion of oxygen, it ferments, and produces heat and the excessive nutrients together with the warmth from fermentation allows pathogenic bacteria to proliferate. Feed particles either dropped or swept to these areas will be contaminated by the bacteria and end up being eaten by the shrimp. Indonesia has until now been free of AHPND. Its EMS/AHPND-free status is not a coincidence. The clean pond bottom helps! To test this hypothesis, perhaps research institutions can study the virulence of *V. parahaemolyticus* population in a sludge laden pond compared to that of a sludge deficient pond?

Biofloc technology in shrimp aquaculture

By Nyan Taw

Insights into its development and how it contributes to sustainable aquaculture at WA2014

The biofloc session at World Aquaculture (WA 2014) in Adelaide, Australia was quite cosy with only five presentations which covered essential and practical aspects of the technology. The presentations gave the following perspectives: (i) general review and status of the technology, (ii) intensive system with excellent performance in small shrimp farm in Bali, (iii) semi-intensive farm shrimp *Litopenaeus vannamei* performance in earthen ponds in Myanmar (iv) application of biofloc technology in *Litopenaeus stylirostris* broodstock production performance and (v) biofloc technology as a possible solution in preventing shrimp diseases.

The biofloc system, a very recent technology, seems to be a very promising system for stable and sustainable aquatic production as it is a self-nitrification process within fish or shrimp culture ponds with zero water exchange (Avnimelech Y., et al 2012). The biofloc, which is suspended in the water column, consists of macroaggregates comprising diatoms, macroalgae, faecal pellets, exoskeletons, remains of dead organisms, bacteria, and invertebrates. Presently, several major universities and private companies are researching on its use as a single-cell protein source for aquafeeds.

In a biofloc system, algae first develops, a transition with foam formation then brown biofloc develops. This may take a few weeks depending on shrimp/fish biomass in the pond water. Transition from algae to biofloc is fast with tilapia and longer with shrimp. The application of biofloc technology for shrimp culture in commercial scale and in large ponds is simple yet in a way complex biochemically. Basic conventional procedures, depending on location and situation of the farm, need to be followed. The procedure needs to be adjusted with changes in culture water environment and shrimp condition such as health and growth.

The technology was successfully commercialised in Malaysia (Taw et al 2011 & 2012). A simple system using conventional autotrophic algae base as semi-biofloc has been successfully operated in Malaysia (Taw et. al 2013) and Myanmar (Taw and Tun, 2013). The system has also been applied in super-intensive raceways production as high as over 10 kg/m^2 (Moss, 2006: Samocha 2009,). Chime (2012) applied the technology in shrimp broodstock production where the performance was significantly better. The technology is now applied for other species of shrimp such as *Penaeus monodon* (Smith 2008) and freshwater prawn *Macrobrachium* in India.

For an optimised, sustainable commercial biofloc shrimp culture, HDPE- or concrete-lined ponds are basic requirements. High stocking densities of 130-150 post larvae (PL)/m^2 and high aeration rates of 28-32 hp/ha are also essential for expected production over 20 tonnes /ha. Energy efficiency is 680 kg/hp and can be as high as 1,000 kg/hp in partial harvest. Paddlewheel aerators placed in ponds keep dissolved-oxygen levels high, suspend biofloc and guide sludge toward the pond centre. The sludge can then be siphoned out periodically when needed. It has been applied with success in commercial shrimp farming in Indonesia achieving a production of nearly 50 tonnes/ha in small ponds (R&D) and over 20 tonnes/ha from commercial ponds with feed conversion ratio (FCR) of between 0.98 and 1.3 (Kopot & Taw 2004; Taw 2005, Taw, et al 2008 & Taw, 2010).

Semi biofloc ponds in Bali

Surijo Setio described a small family-owned shrimp farm located in Bali at Kubu which raises specific pathogen-free *L. vannamei* in ponds that apply basic biofloc technology with zero water exchange. Ample aeration and well-controlled dissolved oxygen maintain good water quality in the culture environment. The farm has produced 45-55 tonnes/cycle since 2009 in a stable and sustainable way without white spot syndrome virus-WSSV and infectious myonecrosis virus-IMNV outbreaks from a total of two hectares of 12 small concrete lined ponds.

In Myanmar, a trial using semi-biofloc technology in earthen ponds, implemented successfully at Kyauktan shrimp farming zone was presented by Soe Tun. The farm located only over an hour's drive from Yangon has three modules, each comprising three culture and one reservoir ponds with very tight biosecurity. In three modules (nine culture ponds), semi-biofloc technology was applied according to the protocols developed by Taw (2012a, b & 2013). The stocking was done in March 2013. Specific pathogen free (SPF) post larvae were imported from Thailand. Locally produced shrimp feed was used for the trials. The target set was to harvest 5 tonnes/pond (8 tonnes/ha) of small size shrimp (10-14 g) with feed conversion ratio (FCR) of 1.3. The performance was better than the target.

Emilie Cardona made a presentation on the effects of broodstock rearing systems: clear water versus biofloc on reproductive performance and quality of larvae of shrimp *L. stylirostris*. The study confirmed the significant benefits of the biofloc system on reproductive performances of the shrimp *L. stylirostris*. Broodstock survival rate was much better from biofloc compared to clear water with respective mortalities of 20.2% and 47.4%. The number of eggs spawned was twice more in biofloc treatment compared to clear water treatment. Furthermore she showed, for the first time, the influence of the broodstock rearing conditions on the quality of their larvae.

Diseases and bioflocs

Biofloc technology is a possible solution to sustainable shrimp culture industry. Large shrimp farms which initiated biofloc technology in Sumatra, Indonesia from late 2002 to 2007 had not experienced any WSSV outbreaks (Taw, 2010). The Arca Biru shrimp farm (part of Blue Archipelago Berhad) faced serious outbreaks from WSSV before adopting the biosecure modular systems. After the introduction of the biosecure and biofloc systems, although viral incidents were common in other farms in the vicinity, the operation in Arca Biru shrimp farm was a success without viral outbreaks (Taw et al 2011). A large-scale integrated shrimp aquaculture park (iSHARP) project started by Blue Archipelago Berhad in Malaysia in 2009 to farm, *L. vannamei*, on 1,000 ha of land in Terengganu state also uses the biofloc system. The first stocking was initiated in October 2011 using semi-blofloc system. A total of 144 ponds were in operation since mid-November 2012. However, in mid 2014 incidents of suspected EMS were recorded in five ponds. Infection was prevented from spreading to other ponds, most probably due to the biosecure modular and semi-biofloc operation systems applied at the farm.

Kim, et al. (2014) studied the effects of bioflocs on growth and immune activity of *L. vannamei* postlarvae and found that the dense microbial population associated with the bioflocs induces a permanent trigger towards the development and maintenance of the shrimp immune system. The bioflocs thus build up a defence mechanism in the shrimp population.

Recent studies revealed that more than 2,000 bacterial species were found in well-developed biofloc water. Bioflocs may enhance immune activity, based on mRNA expression of six immune-related genes. ProPO1, proPO2, PPAE, ran, mas and SP1 (In-Kwon Jang, 2013).

In December, 2013 a workshop on biofloc technology and shrimp diseases was conducted in Ho Chi Min City where the role of biofloc was discussed. Julie Eskahari et al. (2013)* reported that the application of biofloc brings about beneficial effects in disease control and management in shrimp culture. Wasielesky et al. (2013)* showed that biofloc and biosecurity can be successful in preventing WSSV in Laguna in southern Brazil. Taw (2013)* presented on possible use of biofloc system as biosecurity in preventing diseases in shrimp culture (Table 1). It is widely acknowledged that biofloc technology can help prevent the occurrence of aquaculture diseases.

Table1. *Biofloc as biosecurity measures*

	BIOFLOC SYSTEM	BIOSECURITY
1.	Zero water exchange (topping up only for water loss due to siphoning & evaporation)	Low risk of virus entering culture ponds through water source – modular system
2.	Use treated water only – through reservoirs	Modular system with reservoirs
3.	Aeration full 22-24 hours in accordance with pond carrying capacity (full or semi-biofloc) to have biofloc suspended in pond water.	Stable dissolved oxygen (DO). Healthier shrimp
4.	Phytoplankton (algae) bloom and crash non-existent as biofloc does not need to depend on sun light for photosynthesis.	Stable environment. Low stress for shrimp – healthier shrimp
5.	Stable culture environment – Dissolve oxygen and pH	Stable environment. Low stress for shrimp – healthier shrimp
6.	Extra natural live feed – biofloc with unicellular protein (protein 30-50%)	Extra nutritious natural feed
7.	More than 2,000 bacteria species were found in well developed biofloc water	Possible probiotic affect
8.	Biofloc contains six immune related genes	May enhance immune activity in shrimp

Surijo Setio

Soe Tun

Figure 1. Semi-biofloc ponds in Malaysia

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Fish meal replacement in diets with functional hydrolysates for the olive flounder

By Sanaz Khosravi, Mikaël Herault, Vincent Fournier and Kyeong-Jun Lee

Functional hydrolysates in fish meal replacement diet offset adverse effects on fish zootechnical and immune performances

Replacement of fish meal (FM) by alternative protein sources has long been of interest and will increasingly be important for the development of highly efficient aquafeeds aimed at conserving marine resources as well as to enhance aquaculture performances. FM replacement by plant proteins is currently limited by reduced zootechnical performances, especially when dealing with carnivorous fish species. Even though nutritionally balanced, plant based diets may result in dietary stress depressing fish immune defenses or intestinal health.

There have been several studies demonstrating the benefits resulting from the dietary supplementation of marine protein hydrolysates (MPH) in fish. Bui et al. (2014) and Khosravi et al. (in press) demonstrated higher growth rates, better feed assimilations and enhanced immune functions resulting from the supplementation of MPH in red seabream and olive flounder diets respectively. Another study (Robert et al., 2014) linked MPH benefits to the bioactive peptides naturally encrypted in marine co-products native proteins and released through enzymatic hydrolysis. These bioactive peptides may show antioxidative, antimicrobial, immune modulating, hormone like, anti-stress or palatability attributes.

In light of this, a feeding trial was carried out on the olive flounder *Paralichthys olivaceus*, one of the most important marine fish species farmed in Korea, Japan and China. The aim was to investigate the feasibility of a 50% FM dietary replacement by soy protein concentrate (SPC) and MPH. At the end of the feeding period, zootechnical performances, immune functions and resistance of fish to a bacterial challenge were analysed.

Experimental trials

A high fish meal diet (HFM) was regarded as a positive control and a 50% FM substituted diet was formulated with soy protein concentrate as a low fish meal diet (LFM). Three other experimental diets were prepared by partial replacement of FM in the LFM diet with shrimp hydrolysate powder (SH), tilapia hydrolysate powder (TH) and krill hydrolysate powder (KH) provided by Aquativ, France (Table 1).

Hatchery-reared olive flounder juveniles (15.1 g) were randomly distributed into polyvinyl circular tanks (Figure 1) at a density of 35 fish per tank. Triplicate groups of fish were fed one of the experimental diets for 11 weeks. At the end of the feeding trial, fish were bulk weighed. Blood and gut were sampled from three fish from each tank for analyses of innate immune parameters (Figure 2) and gut morphology. Following blood sampling, 12 fish per tank were randomly captured and intraperitoneally injected with *Edwardsiella tarda* suspension (2×10^3 CFU/ml, Figure 3). The bacterium, highly pathogenic to flatfish species, was provided by the Department of Aquatic Biomedical Sciences, Jeju National University. Injected fish were distributed into 60 L plastic tanks and their behaviour and mortality were monitored and recorded for 17 days.

Table 1: Composition (% of dry matter) and proximate profile (% of product) of experimental diets.

Treatments Diets	HFM	LFM	SH	TH	KH
White fish meal	55.00	27.5	24.16	24.11	24.08
Soy Protein concentrate	5.00	22.00	22.00	22.00	22.00
Corn gluten meal	5.00	10.00	10.00	10.00	10.00
SH	0.00	0.00	3.34	0.00	0.00
TH	0.00	0.00	0.00	2.88	0.00
KH	0.00	0.00	0.00	0.00	3.12
Others	35.00	40.5	40.5	40.1	40.8
Dry matter	91.00	89.9	89.6	89.9	91.3
Crude protein	51.00	50.8	51.00	50.7	51.00
Crude fat	14.2	13.8	13.2	13.5	13.9
Ash	9.7	7.1	7.00	6.7	7.2
Indicative costs (USD/tonne)	2,473	2,070	2,112	2,084	2,130

SH - shrimp hydrolysate, TH - tuna hydrolysate, KH - krill hydrolysate

Figure 1,2 & 3. Clockwise, feeding trial, fish blood sampling and immune assays.

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Zootechnical performances

Dietary FM substitution negatively impacted fish growth rate, mainly due to lower feed and protein assimilation. As a result, apparent digestibility coefficient for crude protein in the LFM treatment was significantly lower than values observed for other diet groups. On the contrary, LFM diets with the inclusion of hydrolysates (SH, TH, KH) resulted in growth performances similar to the HFM group while FCR and PER were even better for supplemented diets. MPH therefore had a positive impact on feed digestibility and assimilation.

Table 2: Zootechnical performances of fish fed the experimental diets for 11 weeks.

Treatments Diets	HFM	LFM	SH	TH	KH
Final Body Weight (g)	120.65 ±0.61^{a}	98.55 ±6.85^{b}	116.73 ±6.13^{a}	119.60 ±3.43^{a}	127.17 ±8.06^{a}
Specific Growth Rate (SGR, %/d)	2.89 ±0.01^{a}	2.60 ±0.09^{b}	2.84 ±0.08^{a}	2.88 ±0.04^{a}	2.96 ±0.08^{a}
Relative daily feed Intake (g/kg of ABW/d)	22.51 ±0.35	22.25 ±0.52	21.26 ±0.38	20.93 ±0.45	20.54 ±0.56
Feed Conversion Ratio (FCR)	1.07 ±0.02^{ab}	1.12 ±0.04^{a}	1.01 ±0.02^{bc}	0.98 ±0.03^{c}	0.95 ±0.03^{c}
Protein Efficiency Ratio (PER)	1.83 ±0.03^{bc}	1.76 ±0.06^{c}	1.94 ±0.04^{ab}	2.01 ±0.05^{ab}	2.06 ±0.07^{a}
Crude protein apparent digestibility coefficient (%)	94.47 ±0.35^{a}	88.03 ±1.08^{b}	93.17 ±1.09^{a}	94.70 ±0.58^{a}	94.23 ±0.33^{a}
Survival (%)	85.71 ±2.02	90.48 ±1.17	92.38 ±4.21	93.33 ±3.09	92.38 ±3.09

SH - shrimp hydrolysate, TH - tuna hydrolysate, KH - krill hydrolysate

Better intestinal health

As illustrated in Table 3 and Figures 4, 5 and 6, fish intestine morphometry was significantly impacted by experimental diets. Dietary FM substitution resulted in reduced intestinal diameter, villi length, enterocyte height and number of goblet cells. These findings may be related to a moderate intestinal inflammation, and as a consequence, a lower capacity of nutrient absorption. Beside feed acceptance, chronic enteritis is another issue commonly associated to dietary FM replacement by plant proteins in carnivorous fish. This study reveals that when LFM diets were supplemented with MPH, intestinal inflammation was greatly reduced, especially in fish receiving KH diet. A better intestinal health may explain, to a certain extent, the improved zootechnical performances observed in fish fed MPH supplemented diets.

A higher resistance to bacterial challenge

At the end of the challenge test, the LFM group had the lowest survival rate (11.1%) and significantly differed from that of fish fed KH diet ($p<0.01$, Kaplan Meier). All the fish fed MPH supplemented diets showed an improved resistance to the bacterial challenge when compared to fish fed LFM diet, or to a lesser extent, fish fed HFM diet (Figure 7).

Figure 4,5 & 6. Villi details of intestinal sections of fish fed HFM, LFM and KH diets respectively.

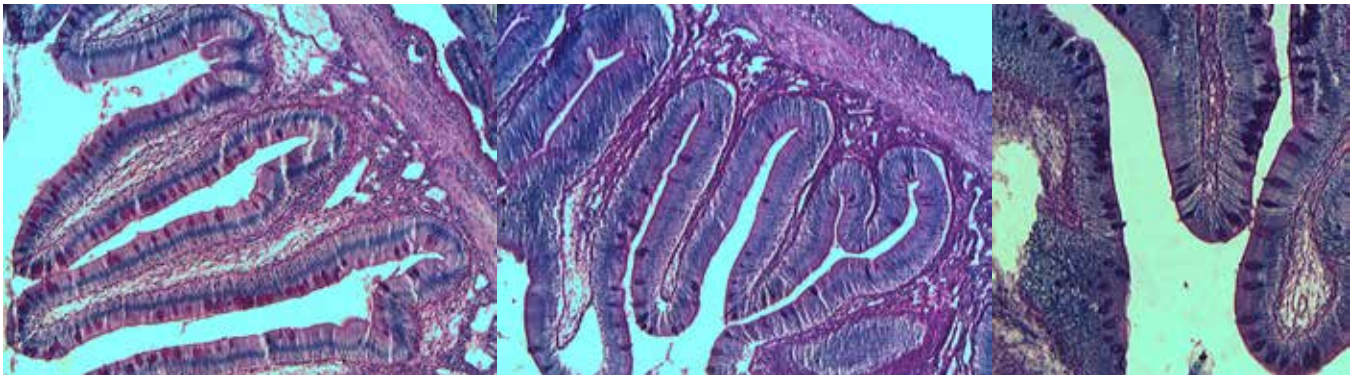

Figure 2. Survival rate kinetics of olive flounder during a challenge with *E. tarda* (2×10^3 CFU/ml)

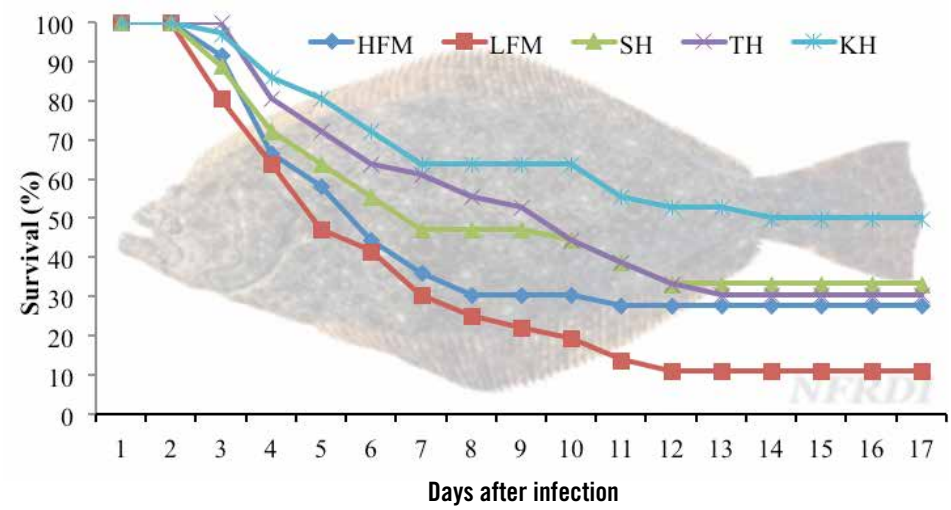

Table 3: Morphometry of intestines sampled from fish fed experimental diets.

Treatments Diets	HFM	LFM	SH	TH	KH
Intestinal diameter (µm)	2835.2 ±52.7^{a}	2569.9 ±51.1^{c}	2753.2 ±67.4^{ab}	2514.9 ±50.7^{cd}	2766.3 ±44.8^{ab}
Villi Length (µm)	505.0 ±7.7^{a}	398.0 ±7.2^{c}	507.8 ±8.7^{a}	501.9 ±8.2^{a}	502.3 ±5.4^{a}
Enterocyte height (µm)	39.1 ±0.5^{a}	30.4 ±0.5^{c}	36.4 ±0.4^{b}	35.8 ±0.6^{b}	36.3 ±0.4^{b}
Goblet cells	1324.3 ±49.0^{ab}	935.0 ±62.3^{c}	1235.3 ±31.0^{b}	1223.3 ±43.5^{b}	1392.3 ±40.9^{a}
SH - shrimp hydrolysate, TH - tuna hydrolysate, KH - krill hydrolysate					

Improved immune functions

Innate immunity was significantly enhanced in fish fed diets containing the MPH (Table 4). Significantly higher NBT activity was observed in fish fed TH and KH diets, as well as total immunoglobulin level in fish fed SH and KH diets, compared to fish fed LFM diet. All the groups fed dietary hydrolysates showed significantly higher lysozyme activity than the LFM fed fish. SOD activity was significantly enhanced in fish fed the SH diet compared to fish fed either HFM or LFM diets. This suggests that replacing FM to a large extent does not compromise fish health as long as MPH are added to the diet.

Table 4: Zootechnical performances of fish fed the experimental diets for 11 weeks.

Treatments Diets	HFM	LFM	SH	TH	KH
NBT- Nitro blue tetrazolium activity (absorbance)	0.71 ±0.1^{ab}	0.69 ±0.0^{b}	0.75 ±0.0^{ab}	0.80 ±0.1^{a}	0.80 ±0.0^{a}
Ig-Immunoglobulin (mgmL^{-1})	21.7 ±1.1^{ab}	18.5 ±0.8^{b}	23.2 ±0.6^{a}	21.9 ±1.6^{ab}	24.6 ±2.7^{a}
Lysozyme activity (µgmL^{-1})	24.5 ±2.2^{ab}	21.2 ±1.6^{b}	28.1 ±1.2^{a}	26.4 ±1.3^{a}	27.3 ±1.1^{a}
MPO-Myeloperoxidase level (absorbance)	1.95 ±0.3	1.98 ±0.1	2.08 ±0.1	2.08 ±0.2	2.26 ±0.2
Antiprotease (% inhibition)	32.0 ±2.4	32.4 ±2.6	33.4 ±3.6	33.3 ±1.9	35.8 ±0.3
SOD-Superoxide dismutase (% inhibition)	67.5 ±3.3^{b}	67.7 ±1.7^{b}	78.7 ±3.7^{a}	75.2 ±2.7^{ab}	72.1 ±3.6^{ab}
GPx-Glutathione peroxidase activity (nmol min^{-1} mL^{-1})	16.7 ±0.4	14.6 ±0.6	15.4 ±0.6	16.8 ±0.8	15.8 ±1.6
SH - shrimp hydrolysate, TH - tuna hydrolysate, KH - krill hydrolysate					

Conclusion

Results of this study showed positive effects of the supplementation of hydrolysate products in low fish meal diets for the olive flounder. The improvements in growth performance, feed utilisation, crude protein apparent digestibility, intestinal morphology, innate immunity and disease resistance by these ingredients are most likely due to the presence of biologically active, low molecular weight compounds. All these compounds are concentrated and rendered highly bio-available through a controlled hydrolysis process. Moreover, the results of this study clearly showed that soy protein concentrate can successfully replace 50% of protein in fish meal in diets for olive flounder provided the tested marine protein hydrolysates are included at low levels (3% on dry matter basis).

Among the examined products, krill hydrolysate seemed to be the most effective dietary supplement for juvenile olive flounder while other functional hydrolysates sustained fish performances in all aspects despite the high inclusion rate of plant proteins. Further studies are currently in progress to determine the optimum supplementation levels in low fish meal diets for this species.

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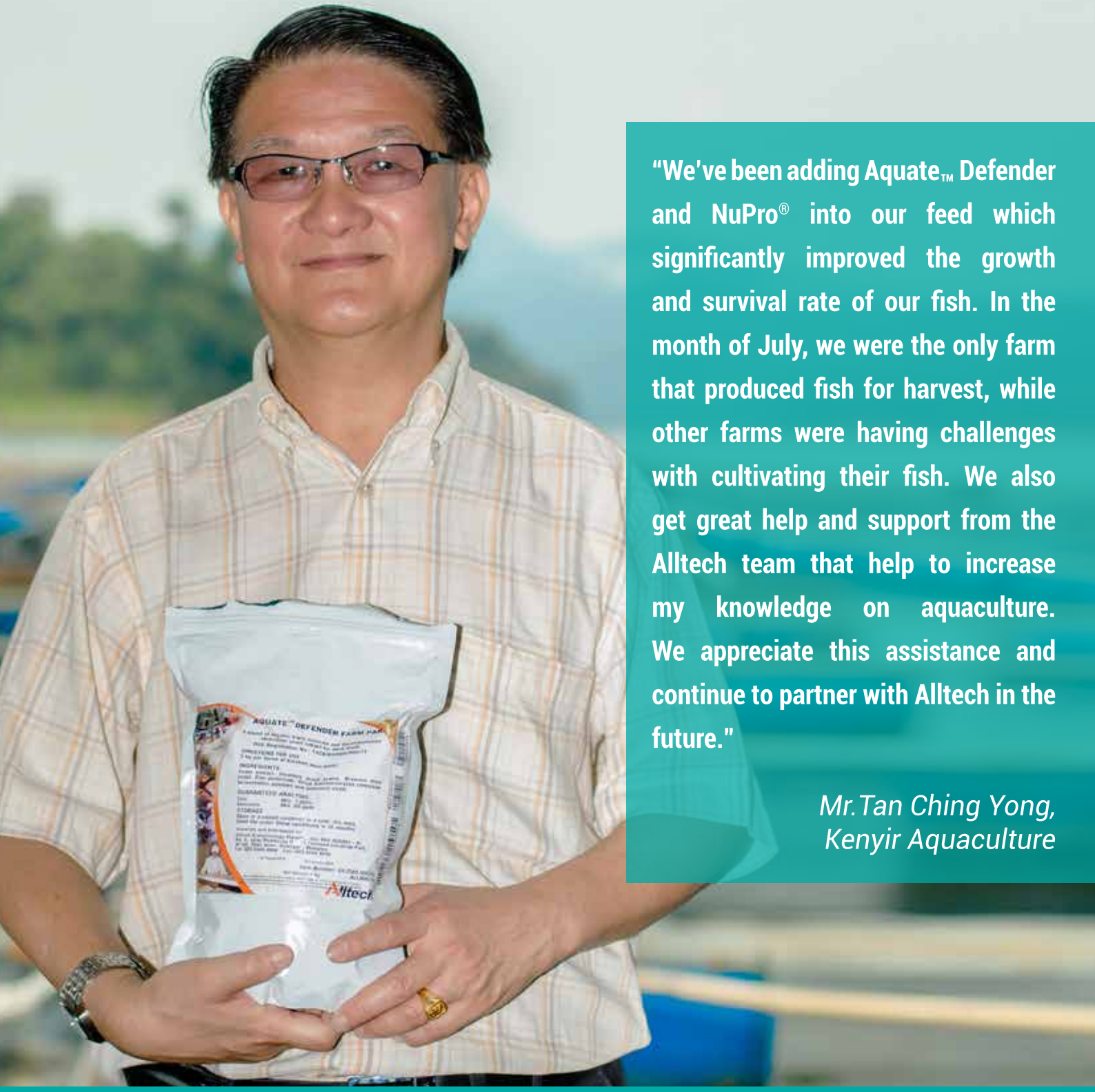

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Protein sparing in tilapia through digestive/metabolic enhancement

By Yu-Hung Lin and Allen Ming-Hsun Wu

The dietary protein level can be reduced by 2% in tilapia diets by adding a digestive/metabolic enhancer

Tilapia production has witnessed an expansion throughout the world and a further increase inproduction is anticipated in the future. As the industry expands and technology development continues, traditional extensive culture of tilapia is being replaced by semi-intensive and intensive production systems. With an increase in stocking rates, the amount of natural food available in the production system becomes insufficient to feed an increased number of stocked fish and the culture will need to be supplemented with artificial feeds. In semi-intensive and intensive culture systems, artificial feed is the most expensive cost item, often ranging from 30% to 60% of the total variable expenses, depending on the intensity of the culture operation. Thus, the use of least-cost, nutritionally balanced diets and good feeding management are two of the most important requisites for successful fish production.

Traditionally, dietary non-protein energy sources, such as carbohydrates or lipids have been demonstrated to spare protein for tilapia (Shiau, 2002). However, the common carbohydrate sources normally have low digestibility due to the high fibre content, whereas high lipid used in the diet causes fatty fish. Therefore, feed additives which can improve nutrient utilisation have a potential to promote protein sparing in tilapia and reduce the feed cost per kg of fish and/or fillet produced. Previous work has revealed the potential of synergistic blends of digestive phytobiotics, natural emulsifying agents and co-factors of fat digestion to improve feed efficiency and growth and to reduce visceral depositions in Nile tilapia under laboratory (Ceulemans et al., 2009) as well as field conditions (Sampaio Gonçalves et al., 2012).

The present study was conducted to investigate the use of a feed additive with digestive/metabolic enhancing action to reduce dietary protein level in tilapia without affecting performance and final product quality. During this trial, a wide range of parameters were evaluated, including fish performance, filleting yield, metabolic indicators, lipid utilisation and intestinal morphology.

Growth trial

Experimental diets (formulation and composition are shown in Table 1) were designed by the National Pingtung University of Science and Technology (NPUST) and is based on a common feed formulation for tilapia in Taiwan. The feeds were extruded by the Tungkang Biotech Research Centre (Pingtung, Taiwan). The feed additive with digestive/metabolic enhancing properties consisted of Aquagest® OMF (Nutriad International, Belgium). Experimental diets consisted of a control diet with 28% crude protein and 7% lipid without Aquagest® OMF (control diet 28/7) and a test diet with 2% less crude protein (26%) and with the feed additive added (0.3% Aquagest® OMF) and 7% lipid, (diet LOPRO 26/7+AG).

Male hybrid tilapia *Oreochromis niloticus* × *O. aureus* were supplied from the local farm in Tainan, Taiwan. All the fish were reared at the '88 platform' test farm facility in Changjhih, Pingtung. Upon arrival, they were acclimated to farm conditions for 2 months in a cement pond (dimensions of 5mX 5mx0.75 m high) and fed commercial tilapia diet (Hanaqua Tech Inc., Taiwan). The conditions during the acclimation period were similar to those at the initiation of the experiment. Three cement ponds were used for the feeding trial. Each pond was divided into two parts by a nylon net. Forty-five tilapia with average initial weight of approximately 175g were randomly stocked into each pond. Fish were reared in a flow-through system with underground freshwater. Around 80% of the water in the system was changed every three weeks.

Table 1: Diet formulation and proximate composition (%).

	Treatment diets	
Ingredients	Control 28/7	LOPRO 26/7+AG
Local fish meal	10.88	10.85
Meat and bone meal	2.18	2.17
Soybean meal	13.06	8.77
Rapeseed meal	8.71	8.68
Wheat meal	10.88	10.85
Wheat flour	10.88	10.85
Coconut meal	8.71	8.68
Whole fat rice bran	10.88	10.85
Corn DDGS	19.59	19.53
Salt	0.70	0.69
Local fish oil	2.61	2.60
DCP	0.44	0.43
Premix	0.44	0.43
Choline	0.04	0.04
Oyster shell powder	-	4.34
Aquagest OMF	-	0.30
Proximate composition (dry matter basis)		
Moisture	8.7	8.3
Crude protein	27.8	26.1
Crude fat	7.4	7.4
Ash	8.2	10.4

Fish were fed with a ration comprising 2-2.5% of their body weight per day. This amount was close to the maximal daily ration for tilapia. The daily ration was divided into two equal meals fed at 08:00 and 15:00 h and fish were hand-fed. Fish were weighed once every 3 weeks by students from NPUST, to monitor growth performance and adjustment of feeding rations. Fish were fed the test diets for an 18-week period from July 28 till November 30, 2013. Water temperature was recorded every day. Other water quality parameters, including ammonium and nitrite concentrates were determined every week by NPUST.

At the end of the feeding trial, body length and weight of tilapia were recorded. Weight gain (WG, as measured by the percentage of body weight gain), feed efficiency (FE), protein efficiency ratio (PER), protein retention, condition factor and hepatosomatic index were calculated. Five fish were sampled randomly. Liver, blood and

Table 2: Growth performance of tilapia fed different diets for 18 weeks.

	Control 28/7	LOPRO 26/7+AG	% change vs control	statistics
Survival (%)	93.3±2.2	96.3±2.6	+3.2%	n.s.
Initial wt (g)	177.3±1.8	174.7±2.1	-1.5%	n.s.
Final wt (g)	469.6±13.2	482.0±12.1	+2.6%	n.s.
Daily weight gain (g/d)	2.32±0.11	2.44±0.03	+5.2%	n.s.
Feed intake (g/fish)	860.5±21.6	840.3±17.0	-2.4%	n.s.
FCR	2.95±0.20[a]	2.74±0.04[b]	-7.1%	P>0.05
PER	1.22±0.08[a]	1.40±0.02[b]	+14.8%	P>0.05
Protein retention (%)	27.70±1.73[a]	29.72±0.04[b]	+7.3%	P>0.05

Different superscripts within rows indicate significant (P>0.05) differences between different dietary treatments. n.s.; non significant difference (P>0.05). Values are means ± SD from three groups of fish (n=3) with 45 fish per group. FCR: food conversion ratio; PER: protein efficiency ratio

Cement tanks for the trials

muscle samples were collected and stored in -20 °C until analysis. The midgut samples were analysed by histological assay. Blood was examined for haematological parameters, including red blood cell count, haematocrit and haemoglobin concentration and plasma triglyceride concentrations. Proximate composition of muscle was also measured. A metabolic enzyme, Glucose-6-phosphate dehydrogenase (G6PDH), was measured. G6PDH is involved in a metabolic pathway that supplies energy to the cells (pentose phosphate pathway) which is important for liver lipogenesis (biosynthesis of fatty acids). Although not related to the fat content in the body, G6PDH is indirectly involved in the utilisation of energy derived from carbohydrates and protein. Thirty fish were transferred to Hung-Yi Frozen Food Factory (Pingtung, Taiwan, Fig. 1) to determine the fillet yield (%) and visceral fat (%).

Table 3: Hepatosomatic index (HSI), condition factor (CF), visceral fat content and filleting yield of tilapia fed different diets for 18 weeks.

	Control 28/7	LOPRO 26/7+AG	% change vs control	Statistics
HSI (%)	3.30 ±0.74	3.09 ±0.26	-6.4%	n.s.
CF	1.88 ±0.14	2.02 ±0.04	+7.4%	n.s.
Visceral fat (%)	6.31 ±1.81	5.83 ±1.62	-7.6%	n.s.
Filleting Yield (with skin)	41.46 ±0.17	41.91 ±0.40	+1.1%	n.s.
Filleting Yield (without skin)	34.82 ±0.14	35.20 ±0.34	+1.1%	n.s.
Values are means ± SD from three groups of fish (n=3) with 5 fish per group. n.s.; non significant differences (P>0.05)				

Multiple effects of the supplementation

Growth performances of tilapia fed different diets are shown in Table 2. Fish fed LOPRO 26/7+AG, grew faster (daily weight gain 5.2% higher) than fish fed the control diet, although these differences were not significantly different. FCR, protein efficiency ratio (PER) and protein retention were significantly better in tilapia fed the LOPRO 26/7+AG-diet compared to the control diet (showing -7.1%, +14.8% and +7.3%, respectively, change versus control). These results clearly indicated that the supplementation of the feed additive had a positive effect on protein utilisation and growth of tilapia, resulting in an effective protein sparing effect.

Visceral fat (Table 3) and plasma triglyceride concentrations (Table 4) in fish fed LOPRO 26/7+AG, showed -7.1% and -14.0% reduction compared to the control group. This indicates that the feed additive ingested by tilapia can enhance lipid utilisation and decrease the metabolism of protein to energy. In addition, hepatic glucose-6-phosphate dehydrogenase (G6PDH) activity was higher in the LOPRO 26/7+AG group compared to control fish (Table 4). This enzyme is involved in the pentose phosphate pathway to generate the coenzyme NADPH for metabolism. High performance of G6PDH generally indicates high activity of fatty acid synthesis derived from carbohydrate. In the present study, enhanced G6PDH activity indicated a higher rate of carbohydrate utilisation in fish fed the feed additive.

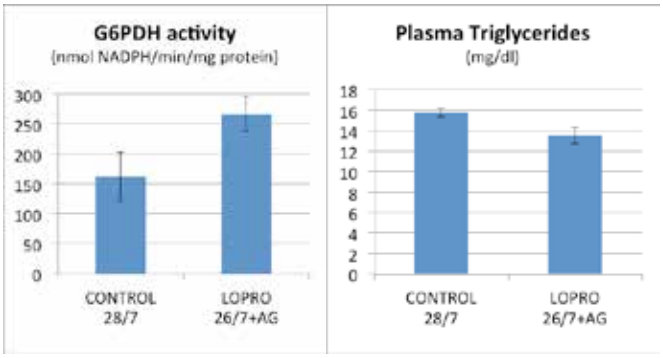
The improvement of nutrient utilisation was also reflected in the filleting yield. Tilapia fed LOPRO 26/7+AG showed 1.1% higher filleting yield (Table 3) compared to control fish.

The authors, Dr Yu-Hung Lin (left) and Allen (Ming-Hsun) Wu (second right) with participants in this study, from right: Neil Shih, Zekent Tam and Peter Chiang

Table 4: Haematological parameters of tilapia fed different diets for 18 weeks.

	Control 28/7	LOPRO 26/7+AG	% change vs control	Statistics
White blood cell (10^3/µl)	235.23 ±10.83	236.46 ±12.24		n.s.
Red blood cell (10^6/µl)	2.55 ±0.08	2.50 ±0.24		n.s.
Haematocrit (%)	33.09 ±2.29	31.61 ±3.02		n.s.
Haemoglobin (mg/dl)	10.12 ±0.56	10.64 ±0.82		n.s.
Hepatic G6PDH (nmol NADPH/min/mg protein)	163 ±40[a]	267 ±29[b]	+63%	P>0.05
Plasma triglyceride (mg/dl)	15.73 ±0.40[a]	13.53 ±0.80[b]	-14.0%	P>0.05
Values are means ± SD from three groups of fish (n=3) with 5 fish per group. n.s.; non significant differences (P>0.05)				

Figure 1: Glucose-6-phosphate dehydrogenase (G6PDH) activity and plasma triglyceride level in Tilapia fed two different feeds.



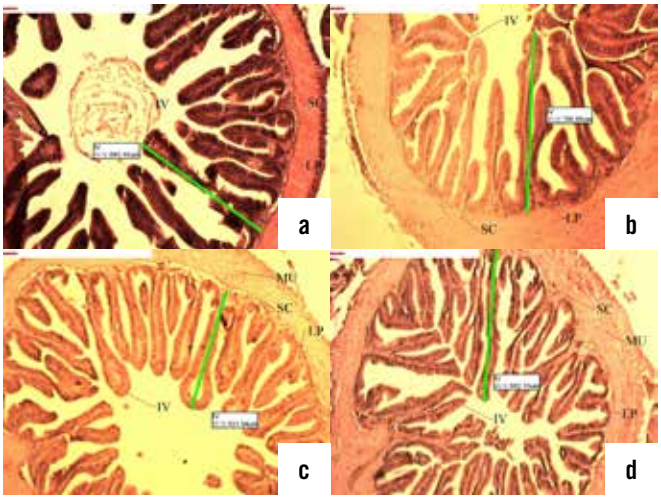
Haematological parameters, including WBC, RBC, Hct and Hb, were not affected by the dietary treatments (Table 4). These results suggest that in the present trial, the general health status of tilapia was not influenced by the changes in dietary protein levels or the supplementation of the feed additive. The histological evaluation of midgut from all treatments (Fig. 2) showed slight atrophy in fish fed diets without Aquagest® OMF compared with fish fed diets with Aquagest® OMF.

In all experimental diets, many plant ingredients were used, such as soybean meal, rapeseed meal, wheat meal, wheat flour, coconut meal, rice bran and corn DDGS. Anti-nutritional factors in plant ingredients can cause intestinal enteritis in fish. So damage to the villi was commonly found in fish fed plant-based diet. In the present study, the villi integrity in fish fed diets supplemented with Aquagest® OMF was better than that in fish fed diets without the feed additive.

Conclusion

The present study demonstrated that the dietary protein level can be reduced in tilapia by supplementing with a feed additive capable of enhancing nutrient utilisation. Tilapia fed 2% less protein and supplemented with a digestive/metabolic enhancer, showed better performance in terms of growth, FCR, PER, protein retention and filleting yield compared to control fish. Furthermore, fish fed the enhanced low protein diet showed lower levels of visceral fat and

Figure 2: Images of the histomorphological changes (40X) with light filter of midgut in fish fed different diets for 18 weeks. a-b, CONTROL 28/7; c-d, LOPRO 26/7+AG. IV, intestinal villus; LP, lamina propria, SC, stratum compactum; MU, muscularis.



plasma triglycerides, but enhanced G6PDH activity, which indicated effects on lipid and carbohydrate metabolism. The metabolic effects can explain the release of non-protein energy, which in turn results in protein sparing and more effective utilisation of protein for muscle growth. Increased nutrient utilisation efficiency is key to achieving more cost-efficient feeds.

Acknowledgement

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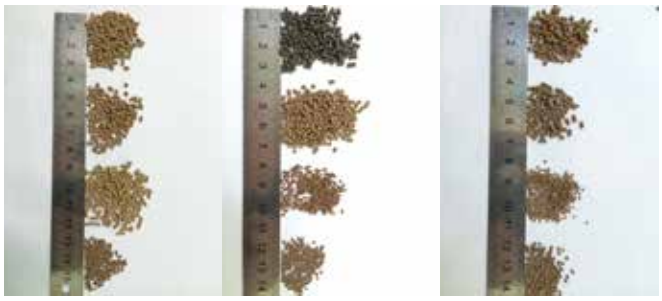
Options to pellet top-class shrimp feed

By Ju Peng, Dong Qiufen, Zhang Song and Yang Yong

Using a commonly-used pelletiser, it is possible to produce shrimp feed with good appearance and efficiency with adjustments to formulation, raw materials, conditioning and pelleting

In the recent years, there has been a widespread culture of white leg shrimp *Penaeus vannamei* in Asia, namely China, Thailand, Indonesia, Vietnam as well as India, an emerging player in the industry. The volume of production from these countries accounted for more than 80% of global productivity in 2012. Consequently, the volume of shrimp feed used is tremendous, estimated at 3 million tonnes per year. However, in some areas, what we see is that feed processing technology and efficiency do not match the huge production, especially in the emerging production areas. Here it is easy to find shrimp feed with high dust levels, poor attractability and water stability, and non-uniform pellet size. These do not meet the physiological needs of shrimp.

Figure 1. Some popular shrimp feed, from left, India, Philippines and Vietnam



Good quality shrimp feed usually is dust-free, with good appearances, such as uniform length and colour, no fractured area, reasonable hardness and durability, as well as good water stability, attractability and digestibility. Water stability is an essential factor for evaluating the quality of shrimp feed, as pellet with poor water stability may pollute the shrimp farm and increase feed conversion ratio (FCR) , hence resulting in a higher production cost and farming risk.

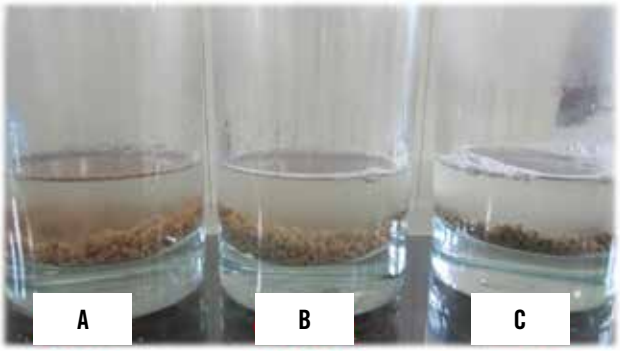
Figure 2 shows results of a trial to compare water stability among three shrimp feed samples. Two samples are from Indonesia (A and B) which we compared with feed produced with support from a Hinter (Guangzhou Hinter Biotechnology Co., Ltd) co-operator using Hinter's technology support in China (feed C). Hinter is the largest producer and supplier of aquafeed premixes in China. It mainly delivers a whole range of practical solutions for aquafeed mills to help them produce high quality aquafeeds.

The need for efficient feeds is even more critical when we consider that operating costs are increasing while shrimp prices decline leading to lower profit margins. Farmers are distressed with high FCR. This also impacts feed millers, not to mention the daily increasing cost and power consumption of feed machinery.

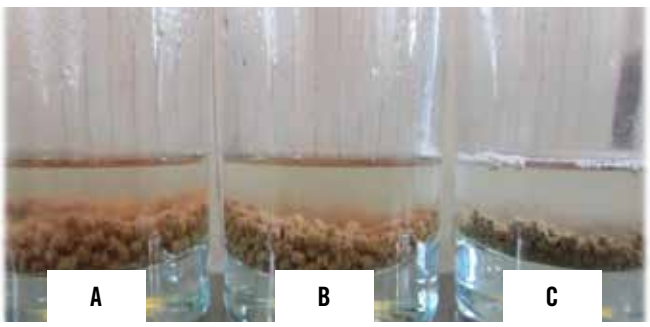
Two conventional choices have been presented to the industry for years to solve the problem of poor quality shrimp feed. One solution is to revise the process flow and migrate to a brand new state-of-the-art extruder or pelletiser. On the other hand, some nutritionists and formulators prefer to increase the use of binder, starch material and attractant. Can either way or both ways solve the problem of poor quality pellets efficiently? The answer is obviously not as it will incur extra costs and raise processing and raw material costs.

Figure 2. Comparison of water stability of feed pellets. A&B are samples from Indonesia and C was produced in China using Hinter's technology

Water stability after an hour



Water stability after two hours



An economic and practical solution

Is it impossible to produce high quality shrimp feed without investing too much on equipment and adding excessively low cost performance raw materials such as starch and binder? After long-term and intensive technical research with numerous practical trials, the technical team from Hinter can now present solutions on how to produce shrimp feed with good appearance and efficiency with commonly-used pelletiser.

Among some of our many successes is a shrimp feed mill in Southeast Asia which has shown rapid and remarkable progress with Hinter's support. With a small adjustment to certain equipment such as the conditioner, Hinter's established technology was able to reduce the amount of common wheat flour (not high gluten flour) to as low as 20%, and without adding any binding additives was able to produce market-oriented good-looking and water stable pellets.

The key factors determining pellet quality

It is not difficult to see the difference in pellet quality from pre-adjustment to post-adjustment of equipment. Some machine operators may advise increasing the compression ratio of pellet die as their first choice to improve pellet quality. However, we at Hinter know that excessively high pellet hardness caused by increasing compression ratio does not mean a quality pellet. Hard pellets are known to reduce productivity as well.

It is essential to know the factors that determine pellet quality in terms of shrimp feed processing. The weightage affecting pellet quality for each component is: feed formula and raw material, 40%, post-ground raw material size and conditioning, 20% each. Around 15% of feed quality is decided by the pelleting process, while the remaining 5% will be determined in the cooling and drying process

Feed formula and raw material

Generally it is accepted that a formula with too much fibre or fat may affect shrimp feed quality considerably through an increase of powder ratio and decrease in water stability. However, many formulators also insist that the feed appearance could be improved by increasing the dosage of starch and binder, even when this means higher cost and indigestion in shrimp due to excessive binder inclusion. Some also make use of wheat gluten to improve shrimp feed quality despite the high price of wheat gluten and poor cost performance of unit protein compared to animal protein source such as fish meal. In addition, it has been proven through a number of feed trials that better growth performance can be achieved with feed using the common and more affordable wheat flour and high protein fish meal rather than wheat gluten.

Post-grinding raw material size

The ground raw materials before pelleting ought to fully pass through a 60 mesh standard screen, and 95% through a 80 mesh standard screen, when ultra-fine grinding is adopted. Otherwise, the steam in the conditioner will not be able to penetrate the particles due to oversized diameter, resulting in poor pelleting and feed quality.

Conditioning

The common knowledge is that during conditioning, heat and water exchange occur between steam and materials. When steam is cooled, it releases 'latent heat'. At the critical points of steam and water, the condensation of saturated steam is an instantaneous process, while the overheated steam still needs 2 to 3 minutes for self-cooling. It has to cool down from the overheated temperature to the critical point for steam-water

disengagement. However, raw material retention time is so short that there is insufficient time to absorb heat and water.

Condensing 1% of saturated steam will cause a material temperature rise of around 15ºC (theoretical value: 18.5ºC). Thus assuming that the temperature of dry materials is 30ºC, after absorbing 3% of steam, the material temperature will increase up to 75ºC. The conditioning temperature for common fish feed is from 85ºC to 95ºC, while for shrimp feed it is 95ºC to 105ºC.

The conditioning time, affected by factors such as volume of conditioner (length and diameter), conditioner paddle angle, rotating speed of shaft and filling rate of materials, is usually referred to as actual retention time of materials inside the conditioner. The conditioning time generally for fish feed is around 40 to 60 seconds, while for shrimp feed it is better to extend the conditioning to 120 to 180 seconds. In the case of steam pressure, the right steam pressure before pressure release may be 0.7 to 1.0 MPa. However, after pressure release, the pressure should be reduced to 0.15 to 0.4 MPa for better conditioning.

Pelleting

In pelleting, die and roller specifications are important to achieve high quality feed. The die and roller selection should match the feed formula. Besides the materials, die hole size, structure and compression ratio need to be considered. There are 3 main materials for the die: carbon constructional steel, alloy constructional steel and stainless steel. With regard to compression ratio, it is 11 to 16 for fish feed and, 20 to 29 for shrimp feed. The proper clearance between roller and die (roller gap) is 0.1 to 0.3 mm. In the case of formulas using ingredients which are easy to process the clearance should be a little larger.

Cooling and drying

Aquatic feed, especially shrimp feed, need to be stabilised for 10 to 30 minutes at 95ºC to100ºC after pelleting. Air volume for cooling and cooling time also should be well controlled. Meanwhile, the right measures should be taken to avoid uneven cooling, excessively high cooling air volume and too fast cooling speeds. Excessively high cooling air volume and too short cooling time will result in different moisture content at the surface and core of pellets resulting in broken and mouldy pellets.

Conclusion

In this article, we demonstrate the possibility of producing top-class shrimp feed using simple equipment. As long as we choose the right raw materials, design formula to suit the pelleting equipment, grind raw materials into suitable particle size and ensure good conditioning and pelletising as well as cooling and post-ripening, we can spend remarkably less to produce higher quality shrimp feed.

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Freshwater prawn farming in reservoirs Telangana, India

By B. Laxmappa

Reservoirs, or man-made lakes, are created primarily for irrigation, power generation and other water resource development purposes. These water bodies have become the prime inland fisheries resource of India due to many reasons: development of reservoir fisheries also brings with it many economic and social advantages; reservoirs form an important source for increasing fish and prawn production along with irrigation; and reservoir fisheries play a significant role in providing the livelihood opportunities to many rural fishers. Although India has vast freshwater resources, they are not fully exploited except in a limited scale for carp culture. Freshwater prawn culture and fish culture technology have become popular for use in large number of tanks and ponds. However, most reservoirs are underutilised for this purpose in the country.

India is the second largest contributor of freshwater prawns to the world market. All farmed freshwater prawns today belong to the genus *Macrobrachium*. Until 2000, the only species farmed was the giant river prawn (scampi) *Macrobrachium rosenbergii*. Since then, China has begun farming the oriental river prawn *Macrobrachium nipponense* in large quantities, and India farms a small amount of monsoon river prawn *Macrobrachium malcolmsonii*. Freshwater prawn culture has attracted more attention in recent years due to its export potential and increasing demand as luxury protein. *M. rosenbergii* is preferred because of its higher tolerance to a wider range of temperatures.

Telangana is the recently formed state situated on the Deccan Plateau, located in the central stretch of the eastern seaboard of the Indian Peninsula covering 114,840 square kilometers. The region is drained by two major rivers, with about 79% of the Godavari River catchment area and about 69% of the Krishna River catchment area located in Telangana; however, most of the land is arid. Telangana is also drained by several minor rivers such as the Bhima, the Manjeera and the Musi. Many of the reservoirs in Telangana state are stocked with farmed fish to enhance production. Culture trials of freshwater prawn have been carried out successfully in a couple of reservoirs in Mahabubnagar and Khammam districts.

Prawn seed stocking in reservoirs

Fishermen of the concerned reservoirs regularly stock wild freshwater prawn juveniles from the Godavari River in Andhra Pradesh every year in the months of July to August. The prawns grow until February after which they start harvesting the prawn until June. This is an additional source of income aside from the regular reservoir fishery in the state.

Production trends

Freshwater prawn production in India that includes farming and wild capture of the giant freshwater prawn, *M.rosenbergii* and the monsoon river prawn, *M. malcolmsonii* has increased steadily since 1999. Production levels of up to 750-1,500 kg prawn/ha/8 months are achieved in tanks and ponds under monoculture systems. Furthermore, it is a compatible species for polyculture alongside Indian major carps and Chinese carps, where production levels of 300- 400 kg prawn in ponds and 50-83 kg prawn/ha/ 8 months in reservoirs can be achieved.

There is no uniform growth in freshwater prawn and the harvest sizes range from 40 g to 110 g each. In a harvest, about 60% comprise individuals of less than 50 g and 40% of individuals more than 50 g. Every year this percentage varies by ±10%. This is due to seed quality and quantity of stocking in the reservoirs. Prawn production trends over the last ten years in three important reservoirs (Ramanpad, Koilsagar and Palair) are shown in Table 1.

Table 1: Prawn production trends of 3 reservoirs in Telangana state of India

Year	Ramanpad Reservoir (300 ha)		Koilsagar Reservoir (1036 ha)		Palair Reservoir (1748 ha)	
	Production (kg)	Production/ha (kg)	Production (kg)	Production/ha (kg)	Production (kg)	Production/ha (kg)
2004-05	12,320	40.39	26,400	25.48	87,650	50.14
2005-06	15,600	51.15	23,600	22.78	92,180	52.73
2006-07	16,180	53.05	19,500	10.82	124,620	71.29
2007-08	15,950	52.30	21,700	20.94	136,380	78.02
2008-09	13,340	43.74	18,250	17.61	141,560	80.98
2009-10	14,150	46.39	17,450	16.84	143,940	82.34
2010-11	12,600	41.31	16,300	17.73	137,500	78.66
2011-12	14,750	48.36	10,250	9.89	145,780	83.40
2012-13	13,230	44.10	12,160	11.74	142,410	81.47
2013-14	11,960	39.87	9,680	9.34	139,530	79.82

Summary

Freshwater prawn culture now occupies a significant position in inland aquaculture practices. The practice of culturing prawn in ponds/tanks and reservoirs is flourishing because farming in these water bodies is proving to be a better practice compared to capture fisheries in lakes, rivers, canals or streams or estuaries in India. The reservoirs in the various states of India offer immense potential for freshwater prawn culture and there is a possibility to increase the prawn production from the Indian reservoirs.

The global market for scampi is expanding with attractive prices and thus there is scope for an expansion of scampi production and export. About 4 million ha of impounded freshwater bodies in the various states of India offer the potential for freshwater prawn culture. Although aquaculture production of the giant freshwater prawn, *M. rosenbergii* in India has shown a phenomenal increase in recent years, the major bottleneck for the further expansion of prawn culture is the lack of adequate supply of prawn post-larvae for stocking. Large-scale seed production under controlled conditions for year-round supply is extremely important. The technologies of large-scale seed production and grow-out culture have led to increased attention from farmers and entrepreneurs for diversification of culture practices.

Still, there are vast opportunities to increase productivity from the reservoirs. Timely and quality fish and prawn seed stocking is required to augment production levels. Moreover a sound marketing system will also fetch higher incomes which will further improve the socio-economic status of fishermen.

Acknowledgements

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Passion to niche marketing the 'empurau'

By Zuridah Merican

From hobby to sustainable production of this high value fish complete with selective breeding in eight years

Bill Lu Thian Tack with a 10kg fish

The 'empurau' is the local name in Sarawak for *Tor tambroides*, a species of the freshwater mahseer fish native to Southeast Asia. Sarawak, on Borneo Island is the largest state in Malaysia and is well known for its massive riverine systems. The fish is endemic to Sarawak. For **Bill Lu Thian Tack**, managing director of LTT Aquaculture Sdn Bhd, what started as a hobby has developed into a commercial business-breeding and grow-out of the fish, exported live to China and regional markets. LTT's tanks and earthen ponds are spread over a 17 ha land area. It is the largest farm in the country dedicated to this fish.

This all started in 2006, when Lu was given some fry by the Indigenous Fisheries Research & Production Centre (IFRPC) in Tarat, Serian, Sarawak. His intention was just to grow the fish as a hobby whilst he continued with his business of medical supplies. Eight years ago, Lu left the latter business. Today, he is recognised as a dedicated aquaculture entrepreneur. All this is because of his love for the fish.

"There are several varieties of the fish, but the taste of the white 'empurau' is the best. This makes it the 'king of the river' and is highly sought after, despite the high price. It is now the most expensive freshwater fish or most likely, the most expensive fish in Malaysia. The current ex-farm price is MYR800/kg (USD 240/kg). Rightly so, as it takes about 3 years for the fish to reach a marketable size of 1.5kg. I believe that the unique taste of the fish is attributed to keeping to the diet of the fish in the wild – the 'engkabang' fruit or illipenut which is only found along some river banks in Sarawak.

"Marketing is niche to the high end markets. My biggest market is China especially Beijing, Shanghai and Guangzhou. Until the recent crackdown on banquets, we transported live fish daily, using a special packing technology which keeps the fish in a hibernation stage for 24 hours. Unfortunately, we do not have direct flights to these cities in China but we have been managing well as the total journey takes between 10 to 12 hours.

"The fish fits perfectly with the intention of successful entrepreneurs to feast clients. I gave this a brand image by calling it the 'emperor fish', a play of words with 'empurau'. Chinese diners appreciate the flesh texture of the fish-soft texture and aroma especially when the fish is steamed," added Lu

"I have been marketing to the China market for the last 3 years, through Hong Kong. We also deliver to West Malaysia, Brunei, Macau and Singapore. The casino restaurant market is an important one. This year, I have achieved a breakthrough as the first company to market live 'empurau' direct into Guangzhou, south China after getting approval from relevant authorities."

The mahseer is also endemic to India, Myanmar, Nepal, Thailand and Indonesia. In India, research centres breed the fish (same genus but different species) for restocking into reservoirs. There are some private hatcheries and grow-out facilities in North India (K.R. Salin, pers. comm.). In Indonesia, farming using wild seed stock is common in Sumatra by small scale farmers. In Nepal, the challenge to farming the golden mahseer is the long culture period and low demand.

In West Malaysia, the mahseer fish is called 'kelah', distinguishable by the presence of a red tail. Mahseer sold in restaurants are farmed or wild caught. Hatchery breeding was achieved in 2009 and from then on, interest in its farming, albeit often on a small scale with farms dedicating only 1-2 ponds for its grow-out. The pull factor is the high price and marketing for high end restaurants. In the 1980s, the price for the 'empurau' was only MYR 140/kg (USD 42/kg) when the demand was lower and limited to local communities. Since then, its popularity has transcended communities, consumer groups and geographical regions. Today, restaurants charge around MYR1000/kg (USD300/kg) for the fish.

Four month old fingerlings

One year fish in an aquarium

Passion to sustainable farming

Early in this project, Lu realised that depending on wild broodstock will not sustain his business in the long term. In 2009, he started to amass fish from various parts of Sarawak as founder stock for his domestication and selective breeding program. The fish came from clear running waters of rivers in Kapit, Belaga, and Limbang. However, now the rivers are no longer clear as before, said Lu.

"I have one fish weighing 20kg which is 30 years old, determined by a local university by the fish scale aging method. The family based selective breeding program has produced the 4th generation which is now used for my fry production and grow-out. Although there are various variations to the mahseer, from white, red, blue, green and yellow, I focus only on the white variety and with my feeding regime to produce the best flesh quality. The fish tastes good because of the fat level which is better in large-size fish of at least 1.5kg."

In 2012, Lu obtained a grant from the Ministry of Science, Technology & Innovation (MOSTI) to further expand the breeding program. He now tags each broodstock with a microchip implant to identify the fish. Lu monitors the weight and length on a six month basis. Information is uploaded into a database and retrieved when he is embarking on his breeding work. Broodstock are fed a special diet, produced in collaboration with a local feed company. The formula is proprietary information and all Lu will divulge is that it is a very high protein diet.

Broodstock are usually 5 years or older weighing 3 kg. In the wild, the spawning season is linked to the monsoon rains. At LTT, Lu conducts spawning once every 4-6 months and usually using the ratio of 2:1 (male: female) but may increase this to 3:1 depending on the number of eggs ranging from 500-2000. At LTT, HCG is injected to initiate spawning. Eggs hatch into larvae in 3 days but this can take up to 7 days at lower temperatures.

"Survival rates are low at 50%,"said Lu. "Hatchlings proceed to fry and to fingerling development. At this stage, survival is good at 80-90%."

A long culture period

The business focuses on grow-out of the 'empurau' for live fish sale but LTT also sells some fingerlings to local farmers. These cost MYR10 (USD3) per inch. A 6 inch (15cm) fish would take just less than a year to produce. Larval and fingerling rearing to 6-inch fingerlings are in indoor tanks. The stocking density is 4,000 fish/600sq feet (55m^2). After a year, fish is transferred to ponds of one acre (0.4ha) each. The following year, all the fish from one pond are transferred to large tanks for reconditioning prior to harvesting. The water source for the ponds and tanks is rain water which is recycled through a biological filter and treated with ozone. Water parameters are maintained at less than 24ºC but more than 18ºC. pH is kept at 5.6-8.5.

The fish grows slowly. Growth is only up to 8 inches (20cm) or 300-400g in the first year and the growth rate increases exponentially in year 2 and 3 in the farm culture condition. Fish is fed with a diet containing the illipenut, *Shorea macrophylla*, which Lu has collected as the tree bears fruit once in five years. The feed is extruded on-farm comprising raw fish, vitamin C, fish oil, smoked illipenut and flour.

"Commercial feeds do not work with this fish. The fish will have an off flavour. I do not know the reason for the effect of the illipenut on the flesh as there is no research done on this yet. I have enough supplies of this main ingredient," said Lu.

Survival is high at 90% from the juvenile to marketable size. There are eight earthen ponds and more than 100 concrete and fibreglass tanks of various sizes for the different stages of culture. Ponds are cleaned after harvesting and tanks sterilised every six months. According to Lu. "I attribute this to our hygienic practices here at the farm. Being involved in a medical industry, we continue to practise this."

Lu has developed this farm into a long term and sustainable business enterprise. Lu's takeaway message is, ***"Farming of this fish is a passion. First, I had to wait for 3 years for the first harvest followed by marketing. I had to do this myself. The flavour of the fish and the demand from markets are rewards for all this hard work."***

Acknowledgement

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Smoked illipenut

Sustain:Ability in animal production

The World Nutrition Forum emphasises the importance of sustainability in food production as global consumption will peak in 50 years' time

At the aqua breakout session, from left, Lukas Manomaitis USSEC, Thailand, participant, Ali Husin Bismi Farms, India, Teddy Njoto, PT Matahari Sakti, Indonesia, Steven Luong, Viet Au, Vietnam and Pedro Encarnacao Biomin, Singapore.

At the World Nutrition Forum (WNF), Biomin's CEO Americas, Michael Eder quoted Hans Carl von Carlowitz, a 17th century accountant and tax collector who phrased sustainability development as one that 'meets the needs of the present without compromising the ability of future generations to meet their own needs'. The theme of this 6th WNF was 'Sustain:Ability' and for Biomin, this means economic and environment sustainability and social responsibility.

WNF is Biomin's biennial event for the animal nutrition industry. This year's forum held from 15-18 October in Munich, Germany, was attended by 800 participants from 86 countries. Jorgen Randers, a professor at the Norwegian Business School and one of the authors of the much debated book 'Limits to Growth' model in 1972, opened the forum on 16 October with latest views on the state of world affairs as detailed in his 2012 publication '2052 - A Global Forecast for the Next Forty Years'.

Randers divided the world into 5 regions; US, China, OECD less US (ie old industrial world-EU, Japan, Canada, Australia and New Zealand), BRISE (Brazil, Russia, India, South Africa and 10 largest emerging economies) and rest of world (140 countries). He predicted a world heading in the direction of declining population and GDP growth, a shrinking global middle class, widening rich-poor gap, and potential climate catastrophe.

What does this mean for global food? Randers said that global consumption will rise by 60% by 2052; most of the growth will be in emerging economies, demand for high quality will explode and chicken will win over red meat and fish. China's consumption will grow but it will come from local sources in line with a self-sufficiency goal. All additional fish will come from aquaculture because of its carbon footprint but environmental issues will limit its growth. According to Randers, "The world is less sustainable today as when he started work. Dramatic change is needed if we want to move in the direction of sustainability."

Marty Matlock of the University of Akansas showed how sustainability is connected. "It is about continuous improvement and building resilience in the system through key performance indicators or KPIs. When technology and culture collide, technologies will always prevail. Cultures that do not adapt will fade away."

In intensifying agricultural production, the framework for sustainability that supports continuous improvement includes three stages; defining, measuring and implementing. In an enterprise, definition of sustainability is often overlooked. Animal producers must clearly understand the scope of their sustainability strategy. Defining KPIs (upstream and downstream) is prerequisite to developing goals and the strategy. Matlock added, "We are never ever sustainable, you just become more sustainable."

The opening address on 17 October was a thought-provoking presentation on managing complexity. Citing varied literature on organisational complexity, Biomin founder Erich Erber shared how organisations could master this trend by fostering a culture of empowerment and trust, leading by KPIs, and creating an environment where honest feedback is encouraged and heeded. Quoting Confucius who said, "Life is simple but we insist on making it complicated", Erber added, "delegation and trust is a must and KPIs should be meaningful to strategy and execution. Feedback should be immediate and honest."

The mycotoxins session chaired by Gerd Schatzmayr saw some of the top researchers in mycotoxins research presenting topics on different mycotoxin determination methods, effects of mycotoxins on gut integrity and the immune system, and new insights on the trichothecene deoxynivalenol or DON.

In the future agenda session, Jason Clay, World Wild Life Fund, USA, talked on 'feeding 9 billion -- how to maintain the planet'. He said that the biggest threat is how to produce food. "We have to be strategic. What we think is sustainable today is not going to be sustainable tomorrow. The issue is not what to think, but how to think."

"The need is for more efficient production and intensification is key. The choice is deciding which systems will double productivity. By 2050, available food should double but should consumers choose 'sustainable' foods or should all production be sustainable. This is moving sustainability from niche to norm.

In the species break-out sessions, speakers from each of the four livestock sectors (swine, poultry, ruminants and aqua) shared how the use of technology, more efficient feed formulation, healthy profits and environmental issues determine the future sustainability of animal production.

Aqua breakout sessions

At the aqua breakout session on 'Is sustainability profitable?, from left; Albert Tacon, Catarina Martins, Dominique Bureau and Ram Bhujel

The aqua breakout program was led by Goncalo Santos, product manager for aquaculture, Biomin. It comprised 8 presentations in two sessions: Sustainability:profitability? and sustaining the future with innovations.

Dr Albert Tacon, Aquatic Farms, USA in a presentation on 'Aquaculture: securing the future' gave an overview of global aquaculture production. Production was 90 million tonnes in 2012 and valued at USD 144 billion. The rate of growth of aquaculture was 8.1% per year in comparison to 0.6% for total capture fisheries and 2.6% for terrestrial meat production for the period 1970-2012. However, in China, farmed aquatic meat production was the second most important meat after pork in 2012.

"In comparison with feeds for livestock, aqua feed production is small but grew 10.3% during the period from 1995-2012 to 39.6 million tonnes and is expected to increase by 5.4% to 87 million tonnes by 2025. There is no doubt that fish meal is more than just protein, but the replacement of fish meal and fish oil is a necessity. Some species such as tilapia and carps do not need fish meal. Even for high value marine fish, fish oil and fish meal is not irreplaceable,"said Tacon.

On Asian aquaculture and sustainability, **Dr Ram Bhujel**, Asia Institute of Technology, Thailand said that from an environmental aspect, polyculture in ponds for non-fed and fed carps is a sustainable production method. The same applies to tilapia in cages in lakes but a concern on future sustainability is when there are too many cages in a water body.

"Controlled production is with ponds and tank culture but the latter is not common in Asia. In the case of the pangasius, high production volumes are economically sustainable but environmental impact needs to be studied. The question mark is now with shrimp farming as the early mortality syndrome has brought down production since 2009 but solutions to overcome the disease are not available."

Optimisation of aqua feeds

Dr Dominique Bureau, University of Guelph, Canada focused on feeds and sustainability. He said, "Contrary to what many environmental NGOs want us to believe, feeds is no longer about fishmeal but about using the variety of resources. Formulators assemble these into a pellet, a value-added product which meets the specific requirements of fish or shrimp. Fish meal is a strategic ingredient and cost effective but sustainability is not only about fish meal but about using all available resources in a wise way."

Bureau added that it is important that we increase efforts for a systematic characterisation of ingredients. Large aquaculture companies are investing in this but in the public domain, there is little information. "We need to increase building up information on requirements across life stages and weight range of the major aquaculture species. I propose using nutrition models as tools to address these. We need to invest time to characterise feed ingredients; chemically and focus on the individual nutrients or components (which the animal needs) as well as the bioavailability of these nutrients. *In vitro* approaches to do these will be increasingly important. We also need to learn on feed additives to address some limitations of feed ingredients. Fine-tuning feed formulations using certain processing techniques and feed additives can go a long way to reduce waste output. This has been effective in the salmon industry and we should be able to do these with the tilapia, pangasius and shrimp."

Is sustainability profitable?

Catarina Martins, Marine Harvest ASA Norway discussed 'why sustainability is a game changer in salmon farming'. The company is a leading and global seafood company with production in six countries totalling 343,800 tonnes in 2013. The group strategy is to think and grow in a sustainable way. With full control of the supply chain, the vision is to lead the blue revolution; provide quality and safe seafood in an environmentally friendly way for the generations to come.

According to Martins, environmental responsibility in salmon farming is important for Marine Harvest. Some of the initiatives towards more sustainable production of salmon include: FCR of 1.2 and 1/3 the carbon footprint as compared to wild salmon; reduction of carbon footprint by 5% with recirculation aquaculture systems in one business unit; lowering energy with R&D to improve logistics; significantly decreasing escapees; managing sea lice and sustainable feeds and nutrition. The target is zero escapees as well as communicating on the positive side of the industry.

On corporate governance, Martins said, "Sustainability is key for industry reputation, long term business success, investor confidence and shared value. A good step is when CEOs think of sustainability in a holistic way, bring this across the whole company and endorse global initiatives such as the Global Sustainability Initiative (GSI). GSI members produce 70% of the global salmon output and the aim is to change the industry towards sustainability, transparency and cooperation. Marine Harvest sees this as raising the bar in the salmon industry as its works towards Aquaculture Stewardship Council (ASC) certification.".

Discussing sustaining the future with innovations, from left; Peter Bossier, Adel El-Mowafi, Lisa Elliot and Pedro Encarnacao.

Shrimp and shrimp feed producer Ali Husin, Bismi Farms, India (left) with Dr Kumuda Chandra Patra, Biomin India.

Host microbial interactions

Based on research at Ghent University in Belgium, **Dr Peter Bossier** explained host microbial interactions and intra- and inter kingdom signalling for larviculture. Quorum sensing by which bacteria communicate by producing extracellular signal molecules is important in aquaculture.

"We know that there are three types of structurally different quorum sensing signal molecules in a lot of *Vibrios*. Virulent factors are produced *in vitro* in response to quorum sensing. At Ghent, we study this with gnotobiotic *Artemia* (controlled microbial community composition) and demonstrated that Vibrio is pathogenic to *Artemia*. By using mutants it could be demonstrated that in Artemia one of the three quorum sensing molecules is not needed for Vibrio virulence. Wild type *V.harveyi* is pathogenic and reduces also survival of *Macrobrachium* larvae. By using the same set of mutants it could be demonstrated that in Vibrio-*Macrobrachium* interactions, a different subset of quorum sensing molecules is important for infection.This showed that in *Vibrio* the usage of quorum sensing molecules is depending on the host.

Bossier said that the interruption of quorum sensing, called quorum quenching, by compounds which interfere with signal detection and signal transduction can be a strategy to control negative microbial interactions. Results of studies with furanones from macroalgae, cinnamaldehyde and thiophenones were discussed.

Bacteriophage therapy

Bacteriophage or phage are a group of antibacterial agents which are viral in nature. They are highly specific and can only infect bacterial cells with cells receptors that match that of the phage. **Dr Lisa Elliott**, AusPhage, Australia discussed work to control specific pathogenic or problematic bacteria diseases. Elliott explained how phage therapy works and provided some examples in aquaculture.

"It has been tested in Australia against luminescencent vibriosis in a marine hatchery. We isolated 17 virulent *V. harveyi* and prepared several phage cocktails. One case study of phage therapy was for *Aeromonas hydrophilia* in a redclaw crayfish hatchery in Australia causing 90% stock mortality. We developed a phage cocktail from isolates which was then used daily for 3 months. The result was 90% survival and consistent reduction in the biofilm in incubators.

"In Vietnam, we are helping industry overcome acute hepatopancreatic necrosis disease (AHPND). With groups in Vietnam, we developed 15 different bacterial phages for 114 *Vibrio parahaemolyticus* isolates from various regions and from moribund shrimp. When we used these in laboratory trials, the effect was an 80% reduction in *V. parahaemolyticus* biomass.

Elliott assured that phage therapy is safe, applicable and sustainable in aquaculture. Infectivity of bacteriophage is specific to the bacteria. Phages do not have the mechanism to infect eukaryotes. The host bacteria has no undesirable genes and there are no toxicity side effects. Application methods can be through feed.

Functional feeds

According to **Dr Adel El-Mowafi**, EWOS Innovations, Norway (the R&D body of Ewos, a global feed manufacturer), there is growing acceptance of functional feeds in commercial farming arising from technical data in peer reviewed literature.

The list of functional ingredients is long but El Mowafi focussed on nucleotides, prebiotics and immunostimulants to support good gut health for better growth performance. Nucleotides are in demand in cases of immune challenges. Prebiotics are important during the freshwater stages and essential for host microbiota. Mannan oligosaccharides (MOS),galacto-oligosaccharides (GOS) and fructo-oligosaccharides (FOS) are essential for gut and liver health.

"Health feeds are divided into three areas: support, clinical and synergestic. Support feeds are needed during periods of health challenges or stress. Clinical feeds have anti-inflammatory functions which may include increased amounts of micro ingredients. We avoid immunostimulants at this time which can actually bring about negative effects. Sealice is the biggest challenge to the salmon industry and parasite attachment is host specific. With plant extracts, we have managed to reduce the attachment of the parasite by 30-40% only. In sealice management, we will need an integrated solution such as using functional feeds and rotating medicinal feeds etc," added El Mowafi.

NutriEconomics in aquaculture

This is a concept developed by Biomin incorporating 3 pillars; nutritional growth model, economics and environmental responsibility. **Dr Pedro Encarnacao**, Biomin Singapore said, "Economics is used to show 'how we can maximise profit and not only on how to maximise growth'. We need to have the maximum margins. In aquaculture, we constantly look at reducing costs. But should we look at costs of feeds or at reducing the cost in producing a kilo of fish? Reducing the cost of feeding ($/kg fish produced) is the most effective way. Nevertheless, in lower value fish species, we see an increase in FCR but in terms of revenue, the lower cost feeds can give a lower production cost. However, we need to look at the time taken to reach market size and the impact of waste.

Aquaculture in terms of carbon footprint is much lower when compared to livestock culture. The major environmental impact of aquaculture is water eutrophication and damage to ecosystems. Feed is the ultimate source of waste and control waste discharge is the responsibility of the industry.

"Biomin uses the holistic approach to develop its additives which impact on growth. In one example with the pangasius catfish in Vietnam, we used phytogenic additives to improve feed efficiency. We improved growth rate and produced the best white fillet. We managed to reduce the cost of production and improve profitability. By improving feed efficiency, we reduced discharge of total waste by 57 tonnes/ha. The Life Cycle Assessment (LCA) showed that by using our phytogenic product (PEP-MGE) the carbon footprint of farming the pangasius was reduced by 82 g of CO_2 per kg of fish produced.

Anwar Hasan, Biomin (left) with Johannis Go, PT Panca Patriot Prima (middle) and Nasril Surbakti, PT Charoen Pokphand Indonesia.

Growth, Asia and aquaculture

The Biomin team, from left, Christian Seiwald, (chairman of the Executive Board, Erber Group), Michael Eder (CEO, Americas), Andreas Kern, Erich Erber (founder of Biomin), Martin Bednar (CEO, Europe, Middle East and Africa), Jan Vanbrabant (Asia Pacific) and Franz Waxenecker, (director Development Department).

At the press conference, the Biomin team highlighted its growth key areas which encompass mycotoxins and advancement into Asia and its aqua markets. Andreas Kern, director of the ERBER AG Executive Board and CEO of Biomin Holding said Biomin will focus on the key areas for future growth and sharpen its strategic focus and concentrate on two core competencies -- mycotoxin risk management and gut performance.

"Last year we achieved EU registrations for Mycofix® Secure and BIOMIN® BBSH 797 and this year the EU authorisation for FUMzyme® . These important milestones confirm once again the safety and efficacy of the company's mycotoxin biotransformation solutions and signal a significant breakthrough in mycotoxin research for us. On the gut performance side, we succeeded in the registration of our poultry probiotic, PoultryStar in the EU."

Forthcoming are the global launch of Biotronic® Top3 and the completed integration of Digestarom® in the Biomin product portfolio, which will further strengthen the company's position in the area of gut performance. The extension of research facilities in Tulln will further ensure a continuous stream of innovation to fuel product pipelines for years to come and to develop services. Biomin will be closer to its customers in the Asian and Latin America markets with production facilities in Wuxi, China and Panama, respectively.

Growth in Asia

According to Jan Vanbrabant, CEO Asia Pacific, the current trend to move away from AGPs in Asia, fits into the gut performance strategy. "We are seeing a big move, not just for export production but also in production for local markets as consumers increase pressure on health and safety. This has boosted the growth of our phytogenics product-line (Digestarom®), along with acidifiers (Biotronic® Top3) and probiotics (PoultryStar®). The Mycotoxin Risk Management program continues to contribute to our regional growth. Mycotoxin contamination is a recurring problem in Asia.

To support this growth trajectory, Biomin is expanding its presence in the market with more sales and technical experts to support our customers in dealing with current challenges and using its application concepts successfully. In 2014, new business units were set up in Myanmar, New Zealand and Japan."

Aquaculture

Vanbrabant added that Biomin is increasing its presence in the growing aquaculture market. "We recently invested in an aqua research centre in Vietnam, to be opened soon. We have dedicated aquaculture teams and experts in several countries. Product-wise we have dedicated probiotics, feed additives and pond treatments."

On the side-lines of WNF, Pedro Encarnação, director Business Development-Aquaculture at Biomin Singapore, discussed further Biomin's role in dealing with some issues in aquaculture markets. In the shrimp markets, naturally, EMS is of concern and Biomin is working on developing solutions for this disease.

"At Biomin, we are working on understanding the *vibrio* strain and isolates of *V. parahaemolyticus* and conducting R&D on solutions," said Encarnação. "It is too early yet but when we know that we have an effective solution, will we then go to the market. Nevertheless, we already see that our probiotics and phytogenics feed additives can inhibit the bacteria. But these are not the silver bullets and there should be an integrated and holistic approach. We support farmers who focus on water and pond management. We know that the gastrointestinal tract (GI) is involved and we should be able to use feed additives to reduce the impact of the *Vibrio* in the gut. In the nursery stage, probiotics can be used at higher concentration and clients have reported lower mortality."

On developments in the aqua markets, Encarnação said that Thailand is their largest market with a large dedicated team working closely with farmers. "In Thailand we go direct to the farms. We are also focussing on the market in Vietnam and are working with large farms. For countries like Malaysia, India and Indonesia we work mainly with distributors, but still giving technical support to farmers. Product-wise the focus is on feed additives and for that we work closely with the largest aqua feed producers in the region. One area that is getting more attention from our clients is our achievement on having conducted a LCA assessment and obtained the ISO 14040 and in Vietnam, some companies have now asked us to help them to achieve this too.

"In line with our theme at the aqua session, to be profitable and sustainable, aqua has to look at nutrition, to maximise profit, but at the same time consider the environmental impact. This is efficiency. The problem is the short term vision of most farms in aquaculture. The salmon industry is the most sustainable and profitable and is a model to follow. In Asia, the potential of some species such as the pangasius in Vietnam, is fantastic if we do this right. We can still produce 400 tonnes/ha of pangasius but need to reduce FCR which in turn will reduce the waste output in ponds and impact on the environment. Better pond conditions will reduce occurrences of diseases and the need for antibiotics. In industry, we need to raise the bar; increasing efficiency rather than focus just on cutting costs. Recent cases show how antibiotic residues is damaging the industry in Asia."

Moving aquaculture in Indonesia

Indonesia Aquaculture is the biennial meeting of researchers and industry organised by the Department of Aquaculture, Ministry of Marine Affairs and Fisheries. The 2014 edition was held in Jakarta over 4 days in August 2014. The event was started in 2006. This year the theme was 'Aquaculture for Business and Food security'. The plenary session consisted of panel discussions on investing in aquaculture in Indonesia and also the preparation for the ASEAN economic community in 2015 (see page 4). The conference consisted of presentations in 6 concurrent sessions; shrimp, seaweed and marine fish, milkfish, ornamentals and catfish and other freshwater fish. At the trade show, government research and provincial centres, promoted recent developments (see boxes).

In marine fish research, a presentation was on the use of *Caulerpa* sp as biofilters in sedimentation tanks to prevent parasite infestations of grouper brood stock. Researcher Ramelan said that this resulted in a reduction in the infestation rate of *Calligus sp* and *Hirudinea sp.* Romi Novriadi and KB Haw, looked at immunostimulatory effects of a herbal bioconditioner (AquaHerb) on tiger grouper juveniles against *Vibrio parahaemolyticus* infections. Their results indicated that the prophylactic approach is an effective alternative to using antibiotics. The use of a cocktail of vaccines to increase the immunity of groupers against some diseases is not common. In their work, Evri Noerbaeti and team applied double vaccines comprising IridoV (AquaVac) and Vibrio Caprivac-L (Caprifarmindo) to juvenile humpback groupers via an intra-peritoneal injection. Survival after 3 months following booster injections gave better survival at 86% versus 76% in the control.

The farming of the pangasius *Pangasius hypophthalmus* is increasing in Indonesia but farmers often complain of high production costs (COP) because of high prices for commercial feeds (IDR 6,800/kg or USD0.6/kg) whilst farm gate prices are IDR 13,000/kg (USD 1.06/kg). At a COP of IDR 9,520/kg (USD0.78/kg) with commercial feeds at a feed conversion ratio (FCR) of 1.4, profit margins are small. Fish nutritionist, Ediwarman and his team at JFADC have developed a 28-30% feed with local raw materials such as trash and salted fish, coconut and copra meal and rice bran. This lowers the feed cost to only IDR 4,500 (USD0.36/kg). At an FCR of 1.54, the production cost is only IDR6,900/kg (USD0.56/kg) There is an interest in farming saline tilapia in brackishwater ponds and at the Aquaculture Business Centre, Karawang, Jawa, Wawan Cahyono Ashuri and team are working on a technology package for this fish in 10-25 ppt ponds. They started with 8g fish and used commercial floating pellets with 28-32% crude protein. Fish grew to 330g after 150 days and survival was 85%. COP was IDR 15,580/kg (USD1.28/kg) and ex-farm price was IDR18,000/kg (USD1.5/kg).

Ediwarman (right) with Wawan Cahyono Ashuri

Indigenous species development

Farmers in Sumatra benefit from the R&D at Jambi Freshwater Aquaculture Development Centre (JFADC) in Jambi province. These are domesticated broodstock and seed stock such as that for pangasius, tilapia and *Clarias* sp. All of these are local species which have been domesticated and undergone some genetic selection. The centre has a capacity to produce 22 million of one day old larvae and 1 million of 1.5 to 2.5 inch (3.8cm to 6.3cm) fry. These are sent to local seed and extension centres for farmers to purchase or for free distribution. It also distributes broodstock to centres in Riau to encourage industrial farming of the pangasius.

Since 2008, the centre in Jambi is leading in the genetic improvement of the pangasius to avoid a decrease in seed stock quality. In the case of the pangasius, the domestication and genetic improvement work was with 7 founders stocks since 2009 which included the local *Pangasius jambal* and *P. hypophthalmus* from Vietnam as well as some other stocks from various provinces in Indonesia. The result of mass selection was a genetic gain of 12.9% at the F1 generation. For the next generation, scientists target 30% increase in growth.

"Our current work on disease focus on vaccines for bacterial disease. This is a general vaccine based on local isolates from the culture area. These are now mass produced by Sanbe Farma. Broodstock are vaccinated via injection. Fry is vaccination with immersion at 21 days. The second vaccination is also via immersion before stocking into grow-out ponds and the third vaccination is provided orally in feed 2 months after stocking when the fish is 70-100g," said Mimid Abdul Hamid, head of JFADC. JFADC also researches on other economically important freshwater fish; broodstock development of the tilapia, seed production of the mad carp *Leptobarbus hoevenii*; domestication and seed production of the giant gourami *Osphronemus goramy*; KHV (kio herpes virus) resistant strains of the Majalaya carp and mass production of broodstock and seed of the walking catfish.

Mimid Abdul Hamid

Diversification to new shrimp

The shrimp has a sharp rostrum which poses difficulties in transportation

Researchers in the Ujung Batee field station are looking at domesticating a new species of shrimp which they call 'udeung pisang' or translated 'banana shrimp'. According to the team led by Abidin Nur, the marine shrimp is indigenous to Aceh waters and was discovered before 2004. They have not given it a scientific name although it has been identified as a Penaeid shrimp. Juvenile shrimp shows bluish green colouration but adult shrimp are darker. It differs from the black tiger shrimp *Penaeus monodon* in rostrum and telson features.

They believe that the shrimp has a potential for farming as it has almost the same taste as the black tiger shrimp. Their farm trials show that the shrimp can be cultured at a stocking density of 40 post larvae (PL)/m^2 and production was 6 tonnes/ha. Feed conversion ratio was 1.5 and the harvest size after four months culture from PL10-12 was 30-40pcs/kg. The shrimp can be farmed well at lower salinity of 25 ppt or less.

On why there is this interest to seek an alternative species to the black tiger shrimp, Nur said that farmers' experiences with the black tiger shrimp have been quite disappointing, especially in terms of the disease resistance of the seed stock from wild broodstock.

"In hatchery production which we started at the end of 2013, we specify the condition that post larvae must be white spot virus syndrome-WSSV negative. From August to February, wild broodstocks are available. The peak season is November and December. In maturation, we feed the broodstock with squid, the most preferable diet. We also feed with cultured organic terrestrial worms *Lumbricus sp* and mussels," added Nur.

Faisal (left) and Abidin Nur (right) with Purnomo, PT Matahari Sakti

Progress in development of VN1 and VN2

At the booth, Made Suastika Jaya (right) and I. Nengah Gde Sugestya

Since 2001, Indonesia has been importing specific pathogen free (SPF) vannamei shrimp brood stocks from Hawaii and Florida, USA for its hatcheries. Although, the expansion in vannamei shrimp production was attributed to these imports, in 2003 shrimp stakeholders expressed concern on this total dependence on imported broodstocks. For an industry targeted to increase annual shrimp production, this practice is not sustainable. With a proliferation of hatcheries using pond reared broodstock, a particular threat to industry is the vertical spread of diseases by contaminated broodstocks and nation-wide disease outbreaks. In 2009, the Department of Aquaculture, Ministry of Marine Affairs and Fisheries started a national shrimp program called Vaname Nusantara 1 (VN1) to produce fast growing shrimp broodstock of uniform size and free from the white spot syndrome virus (WSSV), infectious myonecrosis (IMNV), taura syndrome virus (TSV) and infectious hypodermal and hematopoietic necrosis virus (IHHNV).

The initial work began in 2009 at the Research Centre in Situbondo. Another nucleus and multiplication centre was officially launched in 2010 in Karangasem, Bali. At their booth, I. Nengah Gde Sugestya and Made Suastika Jaya, head of the Broodstock Centre for Shrimp and Mollusc in Karangasem, Bali, explained the progress to date on the VN1 program. VN1 was developed using nine founder stocks from local and imported sources.

"The aim of the project is also to reduce the imports of specific pathogen free (SPF) vannamei broodstock. Together, the two centres have a capacity to produce a maximum of 300,000 pieces of brood stock. The specifications are that female broodstock are more than 40g and 18cm long and males are more than 35g and 17cm long. They can be used for 5 months. These locally developed brood stocks are adapted to local conditions.

"The centre grows the shrimp for 7 months for sale of broodstock to local hatcheries at USD2-3 each. In comparison, costs of imported broodstock have been increasing from USD45 each to USD 65, recently. We have produced 27,000 pieces in 2013. These were sold to hatcheries in Lampung, Kalimantan, Makassar and Bali. Our production target in Bali alone in 2014 is 40,000 pieces. The use of local broodstock will reduce cost of post larvae. Currently FI post larvae from imported broodstock costs USD3/1000PL whilst post larvae from local brood stock costs USD1/1000PL."

With regards to performances, Made said that in a comparison of growth performance of VN1 post larvae versus FI post larvae in farmer ponds showed that the latter grew faster by 25-40% but these were more susceptible to diseases. Tests showed that the VN1 broodstock is free from WSSV, IMNV, TSV and IHHNV. VN1 post larvae showed better resistance to diseases. However, farmers seemed to be happy with disease free post larvae, added Made.

"We have done some benchmarking on the performance of VN1 post larvae against those produced by some commercial producers of SPF vannamei broodstock in Indonesia. The number of nauplii/female was lower for VN1 broodstock when compared to other locally developed broodstock such as Global Gen and imported broodstock. Survival from nauplii to PL10-12 was lower at 40% for VN1 as opposed to 50% for imported broodstock. Broodstock maturation rate is lower. In ponds, VN1 post larvae survival rate was comparable to FI post larvae but the shrimp size variation was larger with VN1 post larvae. This means that we need to further develop our broodstock. We are doing this under the next program, Vaname Nusantara 2 (VN2) where the selection is family based as compared to VN1 which is on mass selection. A further development will be to use molecular markers in our breeding work," said Made.

In a discussion on the performance of locally produced vannamei shrimp (Global Gen, VN1 and VN2) in Trobos Aqua (2014), industry experts said that industry standards should have a minimum maturation rate of 10%. The number of nauplii should be 150-180,000 nauplii/female. In comparison, maturation rate of VN1 broodstock is 8-10% with only 120,000 nauplii/female. Kona Bay broodstocks produce 250,000 nauplii/female. In the VN2 program, the target is to minimise differences with F1 broodstocks. Research has progressed well such that VN2 post larvae is comparable in growth performance to F1 post larvae. Growth rate is 10% higher than VN1 post larvae and the size variation has been reduced. The two centres expect to release VN2 broodstock to farmers in 2015. (Trobos Aqua, edition 15 July-14 August 2014, strength of vannamei broodstock, local versus imported, pp16-18).

At the Tequisa booth, Darjono Johanes (second right) and guests. On display was an underwater camera called the Deep Trekker, which can go down to 75m deep. It also measures water depth and current direction. Images are displayed on a video screen. Tequisa also distributes feeds for larval fish until 300g fish from Marubeni, Japan and a nanobubbles aeration equipment.

Entry into Asia for premium seafood producers

East Asia's insatiable appetite for seafood moves a step up in Hong Kong

In its fifth year in Hong Kong, Seafood Expo Asia (formerly known as the Asian Seafood Exposition) continues to capitalise on Asia's booming seafood market. This year, there were more than 200 exhibitors and 8,600 visitors from 66 countries.

According to the exhibition's organisers, Diversified Communications, the strong attendance at this year's exposition serves as a testament to the optimistic outlook for the Asian seafood marketplace which Global Industry Analysts, Inc. (GIA) predicts will expand at a steady compound annual growth rate of 4.4% through to 2018.

Information from the Hong Kong Tourism Board indicates that 30-40% of fish and aquaculture products imported to the territory are immediately re-exported to countries including the US, Vietnam, Taiwan and mainland China. With a population of over 7 million, the average person in Hong Kong consumes over 70 kg/year of seafood, according to FAO. This makes the territory the second highest seafood consumer in Asia. Almost 95% of the seafood consumed in Hong Kong is imported primarily from Japan, mainland China, Australia and the US, according to Global Trade Atlas data.

Panel on sustainability

The panel comprising Professor Yvonne Sadovy, University of Hong Kong , Dr Mohamed Shainee, Minister for Fisheries and Agriculture of the Maldives, Yuming Feng of the Zhangzidao Group Co, China, Rick Robins, Chesapeake Bay Packing and David Krebs, Ariel Seafoods, discussed how to put this sustainability issue into practice. In the demand vis-à-vis sustainability relationship, the biggest issue is price. In fisheries, when volumes from sustainable fishing go down, prices will increase. In China, food safety was a main priority in the early years of production and now it is sustainability. Consumers now need a high level of transparency and information on country of origin. Sustainability systems need some controls by government. However, governments may not have adequate resources to do so. Notwithstanding these, third party audits are essential.

Entry to Asia's market

This was a seminar to explain to potential investors the advantages of Hong Kong as a seafood hub. Andrew Davis, Invest Hong Kong said that 20% of imports for the food and beverage (F&B) sector in Hong Kong comprise seafood, and 25% of the seafood produced in Japan is exported to Hong Kong and then 20% of this is in turn re-exported. The fast growth in seafood demand is because of changing lifestyles in Hong Kong as well as in greater China. The demand is for quality seafood, sustainably sourced and organic seafood. Therefore, there has been a rise in the number of speciality shops. Setting up a seafood business is fast and easy in Hong Kong; a company licence takes a week, no licence is required for a seafood trading business but a health form is required. Invest Hong Kong will assist with service providers required by new companies. Hong Kong is also the springboard for mainland China seafood companies to go global.

Products from around the world

Hong Kong with some 14,000 food establishments and restaurants is an attractive market for premium products. Participation at the Seafood Asia Expo included country pavilions such as Malaysia under the umbrella of the Fisheries Development Authority; Singapore under Seafood Industries Association Singapore (SIAS) and Taiwan under the Taiwan Frozen Seafood Association.

The Malaysia booth comprised both seafood processors, exporters and integrated shrimp producers such as Asia Aquaculture and Blue Archipelago. The Fisheries Development Authority is the government agency responsible for seafood marketing in Malaysia. The Singapore pavilion had some leading horeca supplies in Singapore and the region. This is the second time that the group is exhibiting at this show and next will be the China Fisheries and Seafood Expo in Qingdao. SIAS was set up in 1988 with the assistance of the Agri-Food and Veterinary Authority of Singapore (AVA) to represent and develop the seafood processing, manufacturing and trading companies in Singapore. Its role is to encourage members to penetrate overseas markets. According

The SIAS team and guest, from left, Belinda Lee, Jurong Cold Storage is 2nd vice president, Kenneth Chia, The Seafood Company Pte Ltd is treasurer, William Tan, Hock Lian Huat Foodstuff Industry Pte Ltd is 1st vice president,and Jasmine Keh

Visitors from the Philippines, Constantine Tanchan and team from Choobi Choobi Flavors Corp, Cebu.

At the Malaysia pavilion. Ong Hock San (second left), Fleet Quality Group with the team from Asia Aquaculture Malaysia, from left, Law Eng Hee, Yip Kam Toh, Chang Swe Ming and Benedict Tan

At Lee Fish booth, Tho Ching Ching, GST group (left) and guest, Catherine Lee, Blue Archipelago, Malaysia

to Kenneth Chia, treasurer of the association, "The seafood business is very competitive and the main product for the Singapore local market is pangasius catfish (marketed as dory) from Vietnam which has 30-35% market share. We assist our members with trips to source seafood. In Singapore, the latest development is ASC (Aquaculture Stewardship Council) and its consumer facing logo."

Lee Fish markets seafood from fishing and aquaculture. It is recognised as a leader in the industry and is a source of premium quality chilled seafood. At Lee Fish, the sustainability criteria for aquaculture and fisheries products are met by the Friend of the Sea certification. It also markets sea bass and snappers produced by the leading Malaysia cage culture company, GST.

A focus of Taiwanese exhibitors was marketing the grouper. Despite competition from local producers in mainland China, grouper and cobia production continue to rise. The Taiwan hatchery industry can supply more than 100 species of fish fry to the region. It also continues to develop breeding technology for several new species. Hai Yu Enterprises is a leading supplier of feeds and culture technology to the region and it has diversified to fish production (see box). Tekho Marine Biotech (TMBIO) farms groupers in Chigu, Tainan City and in concrete tanks in Pintung County, both in south Taiwan. It integrates the breeding to brand marketing of various groupers - giant, tiger, giant hybrids and brown marble, as well as green and leopard coral trout. Esther Material Technology Co Ltd has a line of nano health care products which are substitutes for antibiotics. The company is going global with these products for Japan, Germany and USA. Aqua farmers in Taiwan and China are using these products. The unique characteristic of the product is its activity in seawater conditions.

Sea bass and bream

There was a strong presence of global producers of these two species fish. R&O France markets organic European sea bass *Dicentrachus labrax* and sea bream from Greece *Sparus aurata* (see box). Kefalonia Fisheries, Greece produces organic sea bass and sea bream, certified by Naturland and EU organic. It was the first farm to offer organic sea bass and sea bream to global markets in 2009. Also from Greece was the Andromeda Aquaculture Group with farms in Greece, Spain and Albania. It exports 70% of fresh fish production to Europe. Nireus Aquaculture farms these fish in Greece, Spain and Turkey. Both Dias Aquaculture and Selonda Aquaculture have an annual production of 20,000 tonnes of sea bass, bream and meagre. Currently, their main markets are the respective domestic markets and other parts of Europe. According to the Greek Union of small and medium fish farming companies, the major advantage of fish from these producers is the observance of strict controls in all stages of production and distribution, application of high quality standards and specialised workforce. Closer to Asia is the Ferme Marine de Mahebourg in Mauritius, which farms the European sea bass in offshore cages. The market size is 800 g and production is certified by Friend of the Sea (FOS) for sustainable aquaculture.

Seafood Expo Asia in 2015 will be held from 8-10 September in Wanchai, Hong Kong

Making a mark with premium shrimp

In September, it was the second consecutive Seafood Asia Expo for Singapore's Jurong Cold Storage (JCS). The company is an icon in the premium seafood business in Singapore with a 20-year history. At this show, the team expected to make headway in marketing the full range of its IQF, semi IQF and block frozen shrimp, from head on shell on (HOSO) to other product forms, and from sizes 16-20/lb and sizes 100-200/lb. The company has also exhibited at the Dubai Seafood show, but attends as a trade visitor at other shows world-wide.

Its main markets are Australia and the Middle East for frozen shrimp. JCS farms the shrimp in Kalimantan, Indonesia ,where it has an integrated shrimp processing plant and is a wholesale distributor of shrimp and other seafood from Vietnam and Indonesia. In Singapore, the company is expanding with an 11,000 m^2 cold storage facility scheduled to be completed in 2016.

Production in Kalimantan is mainly vannamei shrimp with small quantities of black tiger shrimp. The 300ha farm with 450 ponds was started 10 years ago by Lee Weng Wah. It is fully integrated with a hatchery producing 40 million post larvae/month. Annual production is 3,000 tonnes of shrimp. The processing plant handles 10 tonnes of shrimp per day.

Jason Ng at the JCS booth

According to Jason Ng, marketing executive, "We have full control of the supply chain. The processing plant is only two hours away from the grow-out farm. We also have our own vessels to send the shrimp direct to Singapore. Our uniqueness is the sweet taste of the shrimp farmed in an area with pristine water quality and away from other aquaculture activities."

Madagascan organic shrimp and Corthin Gulf sea bass

This is the first time for R&O at Seafood Asia Expo. From left, Toufic Bitar and Leila Royer

R&O is a seafood gastronomy specialist since 1924, marketing 40,000 tonnes of seafood annually. At the Seafood Asia Expo, Leila Royer, in charge of marketing and communication and Toufic Bitar, in charge of export sales department, said that the company is targeting the premium seafood market in Hong Kong and China, particularly with OSO® organic Madagascan shrimp, and OSO® organic sea bass and sea bream from cage culture in Greece. With Reynaud Polar Circle Salmon and the French Oyster La Perle Blanche, these are the core sustainable seafood products which R&O offers to premium customers.

The OSO shrimp farm in Madagascar only farms *Penaeus monodon* shrimp and these are 100% organic certified under the strict EU regulation. Shrimp harvest sizes are usually large from 30-40/kg to size 60-80/kg. Larger sizes are 20-30/kg said Royer. The specifications for organic production include farming at stocking density of 8 post larvae/m^2, using 100% organic certified feed. Production is integrated with a hatchery and domestication centre cum processing plant which is only 30 minutes away from the 10 ha of ponds. Most of the shrimp are sent to France as frozen and are thereafter 'cooked daily' on demand. Some volumes have entered Japan in the high end food service sector.

"OSO is a pioneer in the EU organic shrimp farming sector with its initial certification granted by France in 2006. OSO shrimp is for the niche and premium markets", said Royer. "Over the years, we have built this up to become top in taste, pleasure and price. It is highly demanded by the high end gourmet markets and Michelin star restaurants in France, but also available at Marks and Spencer in the UK.

"The organic shrimp market is unique. Prices in conventional shrimp markets fluctuate weekly but in this niche market, prices are more stable in a 6-month period. Generally, demand for it increases when prices increases for conventional shrimp."

The organic sea bass and sea bream are farmed in cages in the Gulf of Corinth, Greece. The fish is produced in net pens and annual production is 400 tonnes of size 400-600g fish. The farm gets its supply of organic fry from its integrated hatchery. Some farming traits are fast currents and clear water, low stocking density and welfare friendly practices. Feeding is monitored for low fat fish. Feeds contain non-GMO ingredients as well as no terrestrial animal meals. Product quality attributes are white and firmer flesh after cooking with fine and delicate texture.

"We are here to find out more about doing business in Hong Kong and the mainland. This is an interesting place to market premium products and we can supply when required," said Royer. "Our next target is the Middle East market."

Premium grouper and other fish from Taiwan

Jeffrey Liu (left) and Burhan Irawan, CV Surya Nusantara Sejati, Indonesia

Hai Yu Enterprises has been in the aquaculture industry since 1968. It was one of the pioneering companies with micro particulate feeds for shrimp farming in the 1980s. At the Seafood Asia Expo, the focus was on marketing its supreme TT™ (Trusty and Tasty) quality seafood.

"The total solution is to help farmers to increase harvests and provide high quality seafood," said Jeffrey Liu, general manager. Recently the company achieved a breakthrough in the genetic selection and breeding of the Murray cod *Maccullochella peelii*, a freshwater fish, indigenous to Australia. Taiwan farmers can now farm the fish which markets at USD40/kg. Cultured in brackish water ponds, the fish has better flesh texture as compared to farming in freshwater ponds. Another breakthrough is the development of the original barramundi fish *Lates calcarifer* as opposed to the Asian sea bass. The market size is 800g to one kg.

Hai Yu's product range also includes the high quality brackish water red tilapia and 'king of tilapia'. The latter is black tilapia farmed in seawater or brackish water from saline fingerlings. Its farm price is TWD 100/kg (USD3.3/kg).Cobia is another fish harvested at 1-2 kg and from 4-6 kg for fillet and loin.

"What is important is to get prime quality. In the case of the leopard trout, we developed the culture and feeding protocol to get the right red colouration. The fish is marketed at TWD2000/kg (USD 66/kg) and it is the second most expensive fish after the Napoleon grouper," stated Liu. "Hai Yu co-operates with clients in farming the fish. They use our feeds and we do the marketing for domestic and exports markets such as the Middle East, Europe, Japan and Russia. The fish are delivered as frozen and live to markets in Hong Kong and mainland China. To Russia and Europe, we deliver fresh chilled fish using a proprietary technology, gutted and in a special box. The temperature is lowered with dry ice or gel ice. This keeps the fish fresh up to 36 hours. This new technology was developed in 2014.

"In live fish transportation, I use the NINS (negative ion nozzle system) for aeration of live transport in tanks deployed on vehicles in mainland China. This has been used since 2012."

Liu elaborated on the food safety issue in Taiwan. "Recently, there is concern on the quality of food products. We ensure that our products fulfil the 5N criteria: No antibiotics, toxicants, chemicals, pesticides and radioactive contaminants. This means that the testing involves almost 437 parameters. The government has encouraged the traceability system and farmers to have certification. By marketing these unique fish and also ensuring that our products stand out, we managed to secure the premium seafood market."

A distribution partnership in India for shrimp larval diets

Since August this year, aqua feed producer BioMar, is working with Devee Biologicals Pvt Ltd to distribute BioMar's LARVIVA shrimp feed range in India.

"The Indian shrimp production has, in the shadow of the early mortality syndrome (EMS) outbreak, exploded in the last years. India is fast becoming one of the leading shrimp producers in the world and the demand for shrimp post larvae is very high. BioMar has experienced a growing demand for high performance larval diets for shrimp. We believe that BioMar's LARVIVA shrimp feed range is suited to support the growing production trend in India," said Kostas Ntomalis, responsible for sales and technical support for the hatchery feed segment at BioMar.

Ntomalis points to the importance of co-operating with a local distributor that can secure a good distribution network and that aims at making farming sustainable, economically viable and environment friendly through innovative integrated solutions.

Devee Biologicals Pvt Ltd is a highly respected and well connected manufacturer and distributor of aquaculture, poultry, and veterinary health care products across India, with a mission to provide the highest quality products, said Ntomalis. "Hatcheries that I visited in India confirmed their good connection with Devee Biologicals and they reported a main point, the excellent customers' service offered by the company. India is a great country with excellent know-how in shrimp production and we are very satisfied to work together in supporting the effort to produce excellent quality shrimp seedstock."

U Dushyant Kumar, managing director, Devee Biologicals with Kostas Ntomalis, responsible for sales and technical support for the hatchery feed segment at BioMar.

A new bio-technology R&D facility

AQUAFARM location in Oban, Scotland

Lallemand has acquired the marine bio-technology business, intellectual property and laboratory assets of Aquapharm Bio-Discovery Limited in December 2013. Aquapharm, founded in 2000 and based at the European Centre for Marine Technology in Oban, Scotland has built up a library of over 10,000 marine microorganisms harvested worldwide from unique marine habitats representing the biodiversity of the oceans. Using the patented SeaRch™ technology, Aquapharm has the expertise and R&D laboratory facilities to screen and identify new bacterial strains and novel classes of compounds for use in aquaculture.

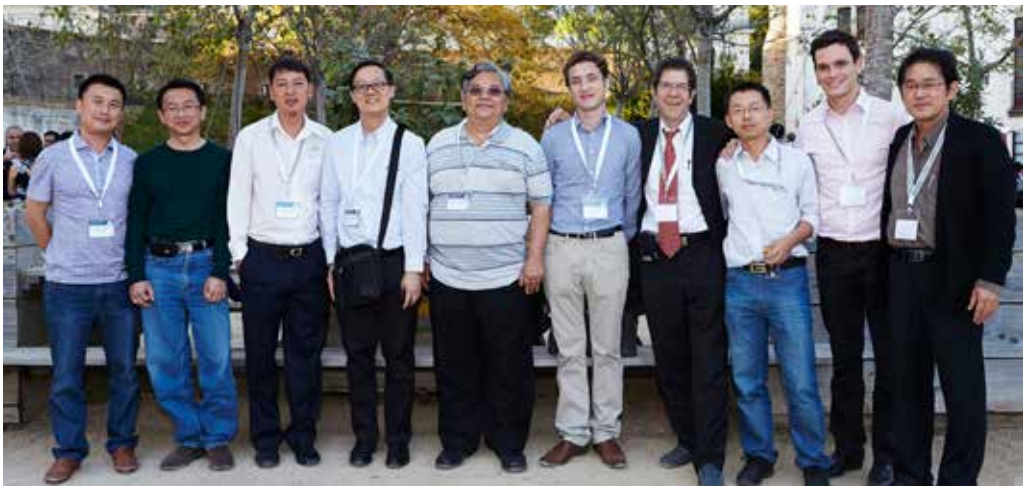
Commenting on the acquisition, Yannig Le Treut, general manager Lallemand Animal Nutrition said, "Aquapharm's unique library of over 10,000 marine organisms and its expertise in screening these microorganisms deepen our R&D capabilities. We work closely with a number of Scottish universities and our strategic partners worldwide to develop new microbial solutions to the challenges facing aquaculture producers and the aqua feed industry. The Aquapharm library and R&D platform is used to screen marine microorganisms for potential use in all Lallemand businesses. We also make the Library and R&D facilities available for use by our strategic business partners and by third party organisations seeking novel marine derived organisms and actives. This acquisition also offers an R&D presence located close to some of the world's leading marine research organisations".

Mathieu Castex, R&D director Lallemand Animal Nutrition (LAN) added, "The access to additional screening capacities and skills has been an important asset to support our Innovation strategy. Specifically, we use the screening capacities of the Aquapharm platform in order to select new candidates from the Lallemand collection now enriched with the Aquapharm library. The LAN R&D team has already launched several screening programs fitting with our strategy to optimise the health and the nutritional performance of animals through the control of microbial ecosystems. We also work actively on bioremediation applied to aquaculture. Thanks to the Aquapharm expertise, the work initiated over the last 6 months has already led to the selection or confirmation of some promising candidates that we are already testing in the field."

Some of the research areas concerns the selection of microorganisms having specific properties for bioremediation of aquaculture ponds in tropical areas, the selection of microorganisms with specific competition exclusion properties in various environmental conditions as well as the selection of microorganisms or bioactive fractions derived from them to address some of the main challenges of the modern aquaculture industry (ectoparasite management in fish, early mortality syndrome prevention in shrimp etc).

More information: Email: aqua@lallemand.com (Stephane Ralite, Aquaculture product manager).

Marine algae boost efficiency and safety in animal production



Some of the participants from Asia at the Breizh Algae Tour 2014. (From left) Peter Fang (Olmix China), Chew Yew Chai (Progress Animal Nutrition, Malaysia), Trinh Quang Thanh, (Olmix Asia Pacific), Suphol Phantuma-o-phas and Dr Chawalit Orachunwong from Charoen Pokphand Foods Public (CPF), Thailand, David Cherel (Olmix China), Alain Reocreux (Olmix France), a participant from Olmix China, Thomas Guillaume (Olmix Thailand) and Monthai Wanichnatee (Daika Thai).

Essential elements extracted from marine algae have been proven to improve animal production efficiently through better hygiene, health and nutrient utilisation. This was addressed at the Breizh Algae Tour 2014, held by Olmix in Nantes, France. It was attended by more than 500 participants from over 25 countries.

"Algae offer an exceptional untapped potential. Molecules extracted from algae represent a new source of innovation for biotechnology," said Hervé Balusson, Olmix's CEO.

In conjunction with the tour, Olmix also held its annual technical conference, 'Algae and Nutrition: A New Approach to Health'. Renowned researchers presented their latest findings on the gut and its wide ranging functions critical to the health and well-being of both humans and animals.

"While today priority is still given to chemistry, particularly antibiotics, we know now that algae extracts can have a favourable influence on our digestive ecosystem, act on the microbiota, and stimulate both our enteric nervous system and the myriad of receptors of the immune system lining the intestinal wall.

"This new knowledge opens up very encouraging prospects which make algae a new avenue for approaching health through nutrition," said Professor Bernard Kloareg, director of research CNRS 8227 and director of the Biologic Station of Roscoff UPMC, Roscoff, France.

For years, Olmix extracts essential elements from algae and turns them into different products for improving hygiene in animal production, binding mycotoxins in feed, and enhancing digestive and immune systems of animals.

Hervé Balusson, Olmix's CEO

Based mainly on 'Ulvans', sulfated polysaccharides found in green algae of the genus *Ulva,* are unique elements that are not found in terrestrial plants and therefore more efficient in improving health and growth performance of the animals. Utilisation of algae is also sustainable because algae can be harvested sustainably from natural populations, which grow without the need of fresh water, fertilizers and pesticides.

Seaweed extract to boost feed efficiency

With the knowledge that profitability in animal production depends on feed efficiency, Olmix has launched a new product based on seaweed extracts to boost the use of feed by animals. This is MFeed+, a unique association of clay particles and different seaweed extracts. MFeed+ acts as a matrix for enzymatic reactions to occur. It is the meeting point of enzymes and feed in the intestine. Besides, MFeed+ also provides many diverse metallic ions, sometimes absent in the feed. These metallic ions are cofactors required for the activation of several enzymes.

"By optimising the efficacy of enzymes in the intestine, MFeed+ increases the use of the feed," said Marie Gallissot, technical supervisor at Olmix. "Since more nutrients are used for growth, less undigested feed reaches the large intestine, contributing to the maintenance of the gut microflora balance and the integrity of the gut wall."

Gallissot was speaking at the workshop session of the tour. Besides attending the lecture session, participants were divided into small groups to take part in different workshops to gain hands-on experiences on how algae contributes to agriculture, animal health and human health.

Marie Gallissot

Energy efficient low to medium head pumps

Pentair Aquatic Eco-Systems, Inc. introduces the new L3-PLUS Series™ and H3-PLUS Series™ Pumps. These pumps were engineered using best-in-class technology. The proprietary impeller design delivers a higher level of precision concentricity for increased efficiency. The proprietary hydraulic isolator smooths the water flow inside the volute, raising the efficiency even higher. A rugged plastic construction delivers durable pumps at an affordable price. Pentair said that the L3-PLUS, ultra-dependable and energy efficient pumps, are an excellent choice for applications that require maximum flow rates at low head. They are also perfectly suited for ponds, water features, fountains and aquaculture. The H3-PLUS is an excellent choice for any application that requires maximum flow rates at medium head.

L3-Plus Series™ and H3-Plus Series™ features include:

- Freshwater and saltwater compatible, 316SS internal fasteners, EPDM/stainless mechanical seal.
- Hydraulic isolator separates priming water from pumping water for faster priming, more turbulent-free flow and increased efficiency.
- H3-PLUS models feature Aquaculture-duty, totally-enclosed-fan-cooled (TEFC) motor with anodized aluminum construction.
- Union connectors included for connecting directly to 2.5” or 3” plumbing.
- Diamond seals made of oxidation-resistant, self-retaining EPDM rubber for increased durability and tighter seal.
- Extra-large, robust basket with smooth surface for easy debris removal.
- Easy-carry handle; easily removable, ergonomic lock ring; and see-through lid for easy basket inspection.

New premium efficiency pump

The aquaculture-duty Verus™ pump provides extraordinary electrical and hydraulic efficiency that delivers premium performance and low electrical costs. Their impellers are manufactured for true breakthrough performance, allowing for lower loads and longer motor life. A non-corrosive, thermoplastic construction equipped with saltwater-rated stainless steel internal fasteners and a highly robust mechanical seal make this the ideal pump for commercial aquaculture and other heavy-duty applications. Thanks to its light overall weight for its size; one-man installation is possible.

Available in ratings with flow rates up to 800 gpm, and from 3 to 15 hp. Verus pumps are equipped with continuous-duty, NEMA-rated premium efficiency motors. The new Verus 3-phase pumps with TEFC motors feature heavy-duty sealed bearings and an ultra-strong aluminum fan for superior cooling. The TEFC models are an ideal choice for installations prone to coastal elements and harsh environments. The Verus pump is available with or without a modular strainer pot, for maximum flexibility in a wide range of field applications. One-year warranty. UL778 listed. Not certified for use in swimming pool applications.

The standard features are;

- New TEFC motor available in three-phase only.
- Closed-coupled for quiet operation and stable flow rate.
- Self-priming when equipped with optional strainer pot.
- ANSI-certified flange port design: 6” suction and 4” discharge. (Flange kit sold separately)
- Closed impeller for long life and durability

(More information: www.PentairAES.com)

H3-PLUS Series™ Pumps

VREKT-20-AQ

Appointments

New group CEO

The BioMar board has appointed VP Carlos Diaz as new Group CEO, and he will take over the seat from Torben Svejgard sometime towards the end of the year.

Torben Svejgard, who has been Group CEO in BioMar since 2008, has resigned from his position in order to focus on a career as a full-time board member.

Torben Svejgard says about his decision: "My 6 years with BioMar has been fantastic. Aquaculture is an exciting industry and BioMar is a wonderful company with wonderful and smart people. It has thus been a very difficult decision for me to resign, but this is the right time for me to withdraw from the executive life and seek a new career path as a non-executive."

Chairman of the board, Jens Bjerg Sorensen, says: "First I want to thank Torben for his contribution to BioMar's development over the past 6 years. His successor Carlos has been with BioMar since 2000 and after a strong career in the Chilean organisation he has during the last years broadened his responsibility area successfully, so he today has responsibility for the two Regions Americas and Continental Europe and on top of that he is the overall responsible for business development. I and the board are thus confident that we in Carlos have a strong Group CEO, who can lead the company towards new heights."

Carlos Diaz is 45 years old, has a background as a veterinarian and holds an MBA with specialisation in marketing and commercial management. Before BioMar he has been working in the aquaculture industry in some Chilean companies, as well as in the pharmaceutical industry.

Commenting his appointment Carlos Diaz says: " I am pleased and happy to take this new professional challenge in my career and contribute to consolidate and grow BioMar as a global leader in fish feed. I am sure that with all the good people in the company we can continue making a difference and creating value for our customers, employees and shareholders".

Appointments

Chief innovation officer

Global animal health and nutrition leader Alltech has appointed vice president **Aidan Connolly** as chief innovation officer, connected to the company's global research department. Working closely with Dr Karl Dawson, vice president and chief scientific officer, Connolly will be involved with Alltech's innovation pipeline and lead the commercialisation of the company's research programmes.

In his new role, Connolly will put together a team within the company's research department that will primarily focus on developing innovative, nutrition-based technologies. Their new product development will capitalise on the insights gained through the company's considerable investment in nutrigenomics, the science of how diet affects gene expression.

"Giving a rapid and effective response, backed up by cutting-edge scientific research, to the market's changing needs, has always been one of Alltech's biggest strengths. It is all about how these technologies are implemented to the market," said Connolly.

Connolly brings a strong commercial background to Alltech's research team. He graduated from University College Dublin with a master's degree in international marketing. He has been with Alltech for nearly 25 years; initially in Ireland, and then in France, Brazil and the United States. From 2002 until 2008, Connolly held the position of vice president of Europe and was most recently based in Washington, DC, as vice president of corporate accounts.

Today, Connolly is an adjunct professor of marketing at University College Dublin and a professor of agribusiness at the China Agricultural University in Beijing. He is also an executive board member of the International Feed Industry Federation (IFIF), the International Food and Agribusiness Management Association (IFAMA), the National Chicken Council, the National Turkey Federation, and a former board member of the European Union Association of Specialty Feed Ingredients and their Mixtures (FEFANA).

"As Alltech is moving forward to become a USD4 billion company in the next 4-5 years, it is crucial that the company's research and technical teams work hand-in-hand with sales and marketing. With Aidan joining our group, we will be even more strongly placed to support the industry with science-based nutritional solutions," said Dawson.

Based at Alltech's Centre for nutrigenomics and applied animal nutrition at Alltech's corporate headquarters near Lexington, Kentucky, Connolly will also maintain his current responsibilities as vice president, corporate accounts at Alltech. Connolly is well-known as the architect of Alltech's annual global feed survey, which assesses global feed tonnage in more than 130 countries.

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8th Aquafeed Horizons

June 9, 2015, Cologne, Germany

The 8th in the series of Aquafeed Horizons conferences will focus on aquafeed processing. The impact of processing on feed ingredients and nutrient quality, aquafeed processing considerations when using novel ingredients and new aquafeed processing technology will be among the topics discussed in a full day of presentations by some of the world's leading aquafeed specialists from industry and research organizations such as the Norwegian University of Life Sciences.

This popular conference brings together aquaculture feed industry professionals from around the world. The 2014 conference took place April 8, 2014 in Bangkok, Thailand. More than 140 delegates from aquafeed companies and other industry stakeholders enjoyed presentations from world-class speakers on aquafeed technology and formulation options.

Aquafeed Horizons 2015 will take place at Koelnmesse, Cologne, Germany, along-side VICTAM/FIAAP/GRAPAS 2015, the world's largest feed and grain exhibitions. This creates a must attend event for anyone concerned with staying abreast of feed production developments. 2015 is the 50th anniversary of Victam and visitors can expect a number of special events, adding even more value to the experience. Aquafeed Horizons 2015 will be held on June 9, 2015. Early registration is strongly advised. The 2015 conference is sponsored by Andritz, Buhler and Wenger Manufacturing.

More information: www.feedconferences.com.

1st AquaForum

26 May 2015, Jeju Island, Korea

The World Aquaculture Society has announce the 1st AquaForum during a World Aquaculture event. This will be at the International conference and trade show on Aquaculture, World Aquaculture 2015, Jeju, Korea. This newly organised AquaForum will be to enhance industry participation and to benefit industry professionals during the WA15 conference and exhibition.

Targeted towards Asian farmers, suppliers, and other industry professionals, activities at the aquaforum will include specific topical industry sessions, facilitated workshops, round table discussions, simultaneous translations, designated meeting spaces, farm tours, etc. The focus of the 1st AquaForum is targeted towards the most important industry issues affecting key Asia Pacific aquaculture producing countries. It is a true Industry forum whereby timely topical and regionally relevant sessions are tailored to enhance industrial representation and participation.

On May 26, the first AquaForum on the first day of World Aquaculture 2015 will comprise of several industry sessions plus time for facilitated and simultaneous translated panel discussions. Top professionals will be invited to attend the panel discussions. Each industry session will focus upon a specific, timely and industrially important aquaculture topic in the region, targeted towards industry professionals, farmers, and suppliers. This forum is free of charge. However, the participants have to register in advance to reserve seat and entrance badge. The badge also allows entrance to the WA15 exhibition. WA15 AquaForum topics are: Shrimp Health; Shrimp Production Systems; Shrimp Nutrition; Fish Nutrition; Fish Health and Fish Production Systems

More info: info@marevent.com (English) or le.hue2008@gmail.com (Chinese).

Aquaculture for Healthy People, Planet and Profit

Jeju Island, Korea
May 26-30, 2015

This is the annual international conference & exposition of the World Aquaculture Society, Asian-Pacific Chapter, WAS and Korean Chapter, WAS. Aside from the technical conference and tradeshow, World Aquaculture 2015 will have a special Farmer's Day with the latest in practical knowledge for aquaculture producers. More information: www.was.org

What to look forward to in Aqua Culture Asia Pacific in 2015

Our editorial calendar reflects the new and existing issues in aquaculture in Asia Pacific which we see as most relevant to the industry. We will continue to present trends and update you with technologies to help the aquaculture industry in Asia Pacific move to the next level.

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Industry Review *Trends and outlook, demand & supply*	Marine Shrimp	Tilapia	Aqua Feed Production	Catfish	Marine fish	Freshwater Fish/Prawn
Feeds & Processing Technology *Technical contributions from feed industry*	Functional Feeds Hatchery/Nursery Feeds	Fishmeal & Fish Oil Replacements & Novel Feed Ingredients	Extrusion & Processing Technology	Feed Enzymes, Additives & Probiotics	Feed Safety & Hygiene Processing & Environment	Nutrition & Formulation
Production Technology *Technical information and ideas*	Blue Revolution/ New Culture Technologies	Disease Biotechnology	Recirculation Aquaculture Systems	Sustainable & Responsible Aquaculture	Genetics in Fish/ Shrimp	Aeration Technology & Waste Removal
Aqua business Feature articles	Experiences from industry and opinion article covering role models, benchmarking, health management, SOPs, social investments, CSR, ancillary services etc					
Markets	Developments in markets (live fish, product development, market access, certifications, branding, food safety etc)					
Company/Product news	News from industry including local and regional trade shows					
Deadlines for Technical articles	**December 2, 2014**	**January 26**	**March 30**	**June 1**	**July 27**	**September 28**
Deadlines Advert bookings	**December 10, 2014**	**February 2**	**April 6**	**June 8**	**August 3**	**October 5**
Show Issue & Distribution at these events as well as local and regional meetings ****Show preview***	**Aquaculture America 2015** February 19-22 New Orleans, USA ***Aquatic Asia/VIV Asia** March 11-13 Bangkok, Thailand	**Global Seafood Expo 2015** April 21-23 Brussels, Belgium	***World Aquaculture 2015** May 26-30 Jeju, Korea	**The Aquaculture RoundTable Series (TARS 2015)** August 19-20 **Vietfish 2015** August 24-26 Ho Chi Minh City, Vietnam	**20th China Seafood & Fisheries Exposition 2015** November China (TBA) **10th Philshrimp Congress,** General Santos (TBA)	

Feeds and Pet Food Extrusion 25th Annual Practical Short Course

February 1-6, 2015

A one week practical short course on Feeds & Pet Food Extrusion will be presented from February 1 to 6, 2015 at Texas A&M University by staff, industry representatives, and consultants. The program will cover information on designing new feed mills and selecting conveying, drying, grinding, conditioning and feed mixing equipment. Current practices for production of pet foods, preparing full-fat soy meal; recycling fisheries by-products, raw animal products and secondary resources; extrusion of floating, sinking, and high fat feeds; spraying and coating fats, digests and preservatives; use of encapsulated ingredients and preparation of premixes and least cost formulation are reviewed. Practical demonstration of pet food, vacuum coating, and several others are demonstrated on four major types of extruders - (dry, interrupted flights, single and twin screw), using various shaping dies. Reservations are accepted on a first-come basis.

More information: Dr Mian N. Riaz, director, Food Protein R& D Center, Head - Extrusion Technology Program, Graduate Faculty, Nutrition and Food Science Department. Email: mnriaz@tamu.edu; http://foodprotein.tamu.edu; http://foodprotein.tamu.edu/extrusion

2014 - 2015

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

November 24-28
9th Symposium on Diseases in Asian Aquaculture (DAA9)
Ho Chi Minh City, Vietnam
Web: www.fhs-afs.net

December 1-2
Aquafeed Europe 2014
Ghent, Belgium
Web: www.smartshortcourses.com

February 1-6
2015 Feeds and Pet Food Extrusion
Texas A&M, USA
Email: mnriaz@tamu.edu; http://foodprotein.tamu.edu; http://foodprotein.tamu.edu/extrusion

February 2-3
Aquafeed Latin America:
Guayaquil, Ecuador
Web: www.smartshortcourses.com

February 19-22
Aquaculture America
New Orleans, USA
Email: mario@marevent.com
(Mario Stael for trade show)
Web: www.was.org

February 20-22
Aqua Aquaria India 2015
Vijayawada, India
Email: mpeda@mpeda.nic.in
Web: www.aquaaquaria.com

February 20-22
Shrimp 2015
Vijayawada, India
Email: info@infofish.org
Web: www.infofish.org

March 11-13
VIV Asia 2014/Aquatic Asia
Bangkok, Thailand
Web: www.vivasia.nl

March 17-19
International Conference on Marine Science & Aquaculture (ICOMSA 2015)
Kota Kinabalu, Malaysia
Email: icomsa@ums.edu.my
Web:www.ums.edu.my/ipmb/icomsa

April 2-4
Tilapia 2015
Kuala Lumpur, Malaysia
Email: info@infofish.org
Web: www.infofish.org

April 5-6
Middle East Aquaculture Forum
Dubai, UAE
Email:info@meaf.ae
Web: www.meaf.ae

April 21-23
Seafood Expo Global
Brussels, Belgium
Web:www.seafoodexpo.com/global

May 26-30
World Aquaculture 2015
Jeju Island, Korea
Email: mario@marevent.com
(Mario Stael for trade show)
Web: www.was.org

May 27-29
World Aquaculture Aquaforum 2015
Jeju, Korea
mail: mario@marevent.com
Web: www.was.org

June 9
8th Aquafeed Horizons
Cologne, Germany
Web: www.feedconferences.com

June 9 – 11
FIAAP VICTAM GRAPAS International 2015
Cologne, Germany
Email: patriciaheimgartner@victam.com.
Web: www.victam.com

August 19-20
The Aquaculture RoundTable Series (TARS 2015)
Hanoi, Vietnam
Email: conference@tarsaquaculture.com
Web: www.tarsaquaculture.com

August 24-26
Vietfish 2015
Ho Chi Minh City, Vietnam
Email: quocthanh@vasep.com.vn/
tienloc@vasep.com.vn
Web: www.vietfish.com.vn

World Aquaculture 2015

Aquaculture for Healthy People, Planet and Profit

www.was.org

WORLD AQUACULTURE Society

WA2015 - Jeju Island Korea

May 26-30, 2015

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