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Volume 13 Number 4

AQUA CULTURE

Asia Pacific

Partnership to mitigate shrimp diseases

Super-intensive indoor shrimp production in Vietnam

Science and technology for sustainable seafood

Optimal DP:DE for red drum

Trending tilapia in Asia

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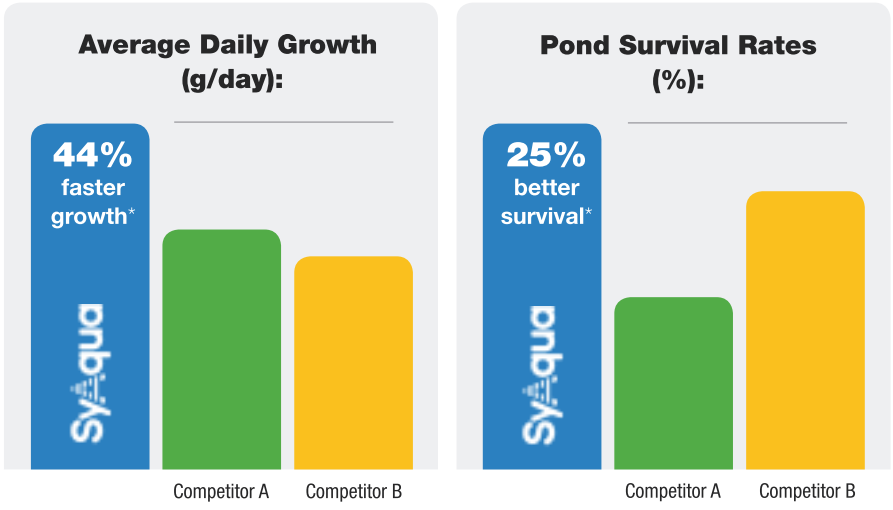

* Based on actual data from 2016 from 606 ponds in Southeast Asia.

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Tilapia in Malaysia, picture credit. Abdullah Abdul Rahim, UPM, Malaysia

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

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

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

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Aqua Research

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

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Singapore 339944

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Zuridah Merican

China - the new premium seafood market

SIAL (Salon International de l'alimentation or Global Food Marketplace) China, held in May 2017 in Shanghai offered an insight into the premium seafood market for the increasing affluent middle class in China. SIAL had a small seafood section and unlike many seafood expositions where one finds thousands of Chinese producers and exporters, the exhibitors here were nearly all international companies and the buyers – Chinese.

This is the China that we seldom see – not just a market to the world but a premium market. We all remember how in seafood, China has been promoting itself as the market to the world and factory to the world with its large reprocessing industry. China, the birthplace of aquaculture, used to be the largest producer and exporter of shrimp and tilapia in the world. This should come as no surprise. All this has changed since the start of the current decade. In 2012, China became a net importer of shrimp. So, what has prompted this change?

Shanghai with its 28 million population provides a good insight into the tier one cities of the nation. There is the pull factor contributed by the large middle class who demand for premium seafood products. Consumers are so discerning that they want branded and imported products prepacked. When it comes to food, provenance and traceability create a differentiation in the market. The push factor has been numerous food scandals that China is infamous for. Those with purchasing power are looking for imported and trusted food products. Imported seafood have to be better than locally produced items.

Certain countries have learnt to market to China – Australia with premium Harvey Beef; Norway with its salmon and now it has Norwegian arctic cod. If there are lessons for the aquaculture industry, the only 3 words to remember are 'Premium, Premium and Premium'. The following words will also help – Certification, Responsible, Safety and Traceability. This is what the China Aquatic Products Processing and Marketing Alliance (CAPPMA) is targeting; Best Aquaculture Practices (BAP) and Aquaculture Stewardship Council (ASC) for its producers to gain access to global markets. At the same time, it is encouraging imports to have similar certification, although at the moment, these are not requirements yet. The model should not challenge the local Chinese product which aims for the high volume low priced segment. China is not a homogenous market so it requires matching the product to the segment or niche. However, it would be wrong to assume that the size of the niche is small.

Asian aquaculture producers have always looked towards the traditional markets of the US, European Union and Japan which are saturated and show low growth potential. But are Asian aquaculture producers ready to capitalise on the China market? Sadly, the answer tends to be more of a 'NO'. Whether it is shrimp or marine fish, Asia has not been able to market to one of its own countries. In shrimp, Ecuador has gained a good reputation for quality, traceability and consistent supply while Vietnam continues to be tainted by glazing, and Thailand focuses on the US and EU. India is aiming for lower prices when it should be improving its post-harvest handling and processing. In marine fish, all the countries bordering the South China Sea are focusing only on the niche live fish markets. Unfortunately, they neither have a fresh chilled product nor a frozen product which can compete with the salmon and high end white fish fillet segments. Singapore may be leading the charge here by leveraging on its reputation as a developed economy.

In the next decade, China will grow as a market for international aquaculture products. The improving purchasing power of the middle class and the strength of the Chinese Yuan will increase the pull factor. When will we cater to this market?

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High volume export focus for the Malaysian marine fish industry

Expansion in production offshore will require a change to a market-led model for international markets.

In May 2017, US Soybean Export Council (USSEC) conducted a series of marine fish marketing workshops on the "Development of a Sustainable, High Volume, Export-Focused Marine Fish Aquaculture Sector in Southeast Asia" in Indonesia, Malaysia, Philippines and Vietnam. USSEC's Southeast Asia (SEA) team, comprising Lukas Manomaitis, Aquaculture Programme Lead Technical Consultant – SEA, Pamudi, Technical Consultant, Aquaculture – Indonesia, and Hsiang Pin Lan, USSEC Asia Marine Specialist, Aquaculture – SEA, invited representatives from local governments, industry associations, international buyers, certification programmes and exporters to discuss how the Southeast Asian marine fish aquaculture industry can target international, extra-regional export markets.

Working with the Marine Fish Farmers Association of Malaysia (MFFAM), the workshop in Kuala Lumpur discussed the issues facing the country's marine fish aquaculture industry and constraints in its industrialisation. To fulfill demands from local and regional markets, Malaysian farms currently culture up to 10 species of marine fish. Increasing production means that the sector will need to reduce a dependence on the chilled and live fish markets and target the international export markets where consistency in volumes and standard product forms are critical.

Manomaitis explained USSEC's role for this workshop series. "There are both immediate and medium to long term opportunities for those interested in industrial marine fish production. The basis of any rapid expansion of the marine fish sector has to be the market. There are opportunities with offshore fish farming but this has technical and investment needs. There is no doubt that the industry can produce more but without market driven production, large volumes will most likely lead to price crashes. The primary goal is to identify target markets. The aim is to inform, educate, and discuss important topics as the Southeast Asian marine fish aquaculture industry starts to develop large scale production."

Current situation

Mohamed Razali Mohamed, CEO, Aquagrow Corporation Sdn. Bhd, representing MFFAM, gave his take on the industry in Malaysia. "Most farmers in Malaysia focus on exports of live grouper to Hong Kong via 20-40 well boats which collect the live fish directly from the cages. Some 70% of the fish sold are re-exported to China, going up as far north as Beijing. We have stiff competition from farms in Taiwan and Vietnam while within China, Hainan is the major supplier of groupers. In addition, supplies come from farms in Natuna and Anambas Islands using wild caught seedstock. Very small-scale farms often do better than mid-size farms moving up the production ladder, as they do not have the high overheads of the latter.

"However, production efficiency and profitability is most optimal when farms reach very large sizes, complete with hatchery, nursery, and grow-out facilities. Unfortunately, we have less than 10 farms that have reached large sizes of 1,000 cages or more. Amongst our small group of 1,984 marine fish farmers, we already have lost 20 farms last year, mostly mid-size farms that are too big to be efficient and yet too small to be profitable."

Nevertheless, the industry has been increasing production; it reached 64,000 tonnes valued at MYR 1.5 billion (USD 280 million) in 2016, surpassing the marine shrimp, the leading aquaculture commodity for Malaysia for several years. The industry is still based on traditional wooden floating cages in near shore areas. The major sites are the west coast of Peninsular Malaysia where the average sea depths are 5 to 7 m with low water quality. Cage depths are about 3 m. While the Asian seabass was a major species, in recent years there is more production of the snappers, which recorded 38% of the total volume in 2016. Various groupers accounted for 17% of production.

Razali added, "The industry realises that culture conditions are better further out at sea. In the south, many farms are finding it difficult to survive with poor water quality conditions. We know that the current 30% survival rate during the grow-out is not sustainable in the long term and that moving further out will help. However, we will then need to use more solid cages to withstand the stronger winds and waves."

A sustainable marine fish business

Goh Cheng Liang, Founder and Executive Chairman of the integrated GST Group discussed how producers in Malaysia can link up to the processing and export industry. GST supplies to both domestic and international markets. Annual production is 1,500 tonnes, mainly of the Asian seabass or barramundi. Live fish is exported to Hong Kong whilst vacuum packed snapper, grouper, pompano and barramundi are sent to other markets in Europe. "GST has eco-friendly methods to combat disease outbreaks but our aim is to improve survival to more than the current 65%. One major challenge for us as well as for many other farms in Malaysia is the high reliance on foreign labour. Feed prices are also rising and since getting the right commercial pellets is very important, by the end of 2017, we will have our own feed mill to supply our farms and third party farms.

"Good Aquaculture Practices (GAP) ensure business sustainability and contribute to company reputation and credibility. This is critical in marketing and business development especially when you target western export markets. GAPs also assist in the reduction of wastages through low mortality rates, optimum feed use and less disease outbreaks. For a smooth development of the industry, producers need to follow GAPs, qualify for certification and invest in intensive farming methods," said Goh.

"The basis of any rapid expansion of the marine fish sector has to be the market.."
- Lukas Manomaitis

"We know that the current 30% survival rate during the grow-out is not sustainable in the long term.."
- Mohamed Razali Mohamed

From left, GST's Goh Siew Chin, Warawut Sophanowong, 88 Feedmill, Thailand, Goh Cheng Liang, Dr Isidor Yu, GlobalGAP, Korea, Ng Chee Kiat, MFFAM, Hsiang Pin Lan and Azhar Mond Yusof, GST.

GST has MYGAP, the Malaysian government standard for aquaculture. It is approved for export to the EU and has "Friend of The Sea" certification. GST is also working with the Aquaculture Initiative Platform (AIP) for certification under the Aquaculture Stewardship Council (ASC) standards.

Right product forms

"Sustainable seafood is not an option but a requirement," said Matt Brooker, Director of Business Development, Fishin' Company, a US seafood importer established in 2002. Brooker with more than seven years of experience working in the retail markets in the UK and US, described trends in farmed seafood, requirements to enter the US markets and opportunities for producers in Southeast Asia. "Today, almost 60% of seafood products imported into the US is from aquaculture. The demand is for certified and sustainable products. In the case of the barramundi, there is a potential to export to the US, provided it is the right product form and sustainably farmed. There are already examples of marketable farmed marine fish such as the cobia from Open Blue (Panama) and from Vietnam. US customers are quite accustomed to the groupers and it will be easy to enter the US seafood market.

"Food safety in seafood is very important and nowadays may override the price. In the case of sustainability, the consumer wants to know that you are doing well for the environment. The next major trend in seafood requirements is full traceability. Buyers want to know every piece of information regarding the product (hatchery name, feed mill, cage number, fish meal source). In the US, Global Aquaculture Alliance's Best Aquaculture Practices (BAP) is the preferred certification. Retailers also have custom audits. Customers also have expectations from the fish they are eating; high protein, overall health benefits, not destructive to the environment and not abusive to the people producing them."

With regard to product forms, the primary criteria are boneless fillets, mild flavour which will pair well with various seasonings, medium to firm texture which will allow cooking in different ways, looks that are familiar to current fish in the markets. In terms of product forms, it should be individual quick frozen or vacuum packed.

Brooker added that an important criteria is the volume potential. Volume can be anywhere from one to 5 or more FCL/month but volume consistency is most important. Smaller stores may require one container every 3 months. "If you say that you can do 2 per month, then that is the expectation. If this is not met, then problems can occur. Being out of product is not an option, as the job of the buyer is to ensure consistency."

His challenge to the industry present at the workshop was to continue to develop aquaculture species and products that meet all required standards for food safety, sustainability, social compliance and traceability. It was also to provide consistent assured supply and pricing to US customers.

Tilapia Lake Virus (TiLV)

Win Surachetpong

At the MSD session on tilapia health during World Aquaculture 2017 conference and trade show, held from June 27-30 in Cape Town, South Africa, Dr Win Surachetpong, assistant professor at the Faculty of Veterinary Medicine, Kasetsart University, Bangkok, described the investigations of unusual mortality in open cage culture in the rivers of central and western of Thailand. The mortality in Nile and red tilapia occurred within 2 weeks with clinical signs of loss of appetite, skin erosion, redness, pale body, eye and scale protrusion and abdominal swelling.

Since 2015 to 2016, among the investigation of 32 outbreaks of mortality of Nile and red tilapia, 22 were positive for TiLV. With these results, Thailand was added to the list of affected countries in 2017. Taiwan also reported some TiLV outbreaks during June 2017 which were however contained in one area. Surachetpong illustrated the clinical signs of moribund fish and how farmers can determine that the outbreaks are linked to TiLV infection. Finally, he added that biosecurity, farm management and vaccine development are important steps to limit the spread of this emerging virus.

Two related scientific articles have been published. Win Surachetpong, Taveesak Janetanakit, Nutthawan Nonthabenjawan, Puntanat Tattiyapong, Kwanrawee Sirikanchana, Alongkorn Amonsin 2017. Outbreaks of Tilapia Lake Virus Infection, Thailand, 2015–2016. Emerging Infectious Diseases., Vol 23, No. 6, June 2017, pages 1031-1033. https://dx.doi.org/10.3201/eid2306.161278

Puntanat Tattiyapong, Worawan Dachavichitlead and Win Surachetpong 2017. Experimental infection of Tilapia Lake Virus (TiLV) in Nile tilapia (*Oreochromis niloticus*) and red tilapia (*Oreochromis* spp.). Veterinary Microbiology, Volume 207, August 2017, Pages 170–177.

FAO issues global alert

Tilapia Lake Virus (TiLV) has now been reported in five countries; Colombia, Ecuador, Egypt, Israel and Thailand. While the pathogen poses no public health concern, it can decimate infected populations. Tilapia producing countries need to be vigilant, and should follow aquatic animal-health code protocols of the World Organisation for Animal Health (OIE) when trading tilapia. They should initiate an active surveillance program to determine the presence or absence of TiLV, the geographic extent of the infection and identify risk factors that may help contain it. Countries are encouraged also to launch public information campaigns to advise aquaculturists - many of them smallholders - of TiLV's clinical signs and the economic and social risks it poses and the need to flag large-scale mortalities to biosecurity authorities.

The outbreak should be treated with concern and countries importing tilapia should take appropriate risk-management measures - intensifying diagnostics testing, enforcing health certificates, deploying quarantine measures and developing contingency plans - according to the alert released in May by FAO's Global Information and Early Warnings System (GIEWS).

Currently, active TiLV surveillance is being conducted in China, India, Indonesia and it is planned to start in the Philippines. In Israel, an epidemiological retrospective survey is expected to determine factors influencing low survival rates and overall mortalities. In addition, a private company is currently working on the development of live attenuated vaccine for TiLV. It is not currently known whether the disease can be transmitted via frozen tilapia products, but "it is likely that TiLV may have a wider distribution than is known today and its threat to tilapia farming at the global level is significant," GIEWS said in its alert.

FAO will continue to monitor TiLV, work with governments and development partners and search for resources that can be explored in order to assist FAO member countries to deal with TiLV, as requested and as necessary.

There are many knowledge gaps linked to TiLV. More research is required to determine whether TiLV is carried by non-tilapia species and other organisms such as piscivorous birds and mammals, and whether it can be transmitted through frozen tilapia products. The disease shows highly variable mortality, with outbreaks in Thailand triggering the deaths of up to 90% stocks. Infected fish often show loss of appetite, slow movements, dermal lesions and ulcers, ocular abnormalities, and opacity of lens. As a reliable diagnostic test for TiLV is available, it should be applied to rule out TiLV as the causal agent of unexplained mortalities.

TiLV belongs to the *Orthomyxoviridae* family of viruses, which is also the same family as infectious salmon anaemia virus. The latter has wrought great damage on the salmon farming industry.

In May, The Network of Aquaculture Centres in Asia-Pacific (NACA) released a TiLV Disease Advisory and the World Organisation for Animal Health (OIE) released a Disease Card. The WorldFish Center also released a Factsheet: TiLV: what to know and do.

Responsible fish meal supplies in SE Asia

The Global Aquaculture Alliance (GAA) and IFFO, the Marine Ingredients Organisation, have joined forces and funding on a project to improve the understanding of the fisheries of Southeast Asia supplying raw material for fish meal production. The study will look at the issues from the perspective of social, economic and environmental sustainability with the aim of identifying where improvements can be prioritised and targeted to enable increasingly responsible supplies of fish meal. This will support change in fisheries management in the region, driving the adoption of certification in the supply chain, which will ultimately support the development of best practice in aquaculture.

"Although the raw material supply for fish meal production globally comes in the main from well-managed fisheries and byproduct, it is recognised that there are some environmental and social challenges with the sourcing of raw material in Southeast Asia. As demand for responsibly produced fish meal in this region is increasing, IFFO welcomes the opportunity to work with the GAA in addressing where the constraints to responsible production lie, and look at how these may be addressed to promote change in the region" noted Andrew Mallison, IFFO's Director General.

End users of aquaculture are increasingly recognising the need to ensure fish is produced responsibly. The development of certification standards for aquaculture and aqua feeds has placed additional emphasis on the importance of sourcing responsibly-produced feed ingredients. If aquaculture facilities are to be able to meet the market demands, then improvements need to be made in this region in order to fill the gap between available, certifiable, fish feed inputs and demand.

The focus of effort will be on the countries of Thailand and Vietnam given their importance in fish meal and fish oil manufacture and supply. A knowledge base will be established covering issues, actors, data pertaining to economic, environmental and social sustainability through the supply chain, allowing for the identification of priorities and recommendations for further work.

"It is critical to understand where to target improvement efforts and how best to support the region in meeting the increasing demand for fish meal inputs. Both the welfare of the fisheries and the associated communities, as well as the development of responsible aquaculture to meet global demand, relies upon truly sustainable supplies – this is the juxta position between wild and farmed seafood," said Melanie Siggs, Director of Strategic Engagement, GAA. More information at www.iffo.net

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Managing hepatopancreatic microsporidiosis and white spot disease in the Philippines

By Maria Abegail G. Apostol-Albaladejo and Roselyn D. Usero

Documentation and mitigation measures demonstrate a time-tested model of government-private sector partnership.

In the Philippines, documented disease cases in shrimp farming are still primarily white spot disease (WSD) and acute hepatopancreatic necrosis disease (AHPND). Cases of hepatopancreatic microsporidiosis (HPM) caused by the newly emerging pathogen *Enterocytozoon hepatopenaei* (EHP), a tiny fungus related spore that is "very resistant to the environment and to chlorination" (McIntosh, 2015), were detected in the second quarter of 2016 and in the first quarter of 2017 by polymerase chain reaction (PCR) method (IQPlus).

EHP was first detected in apparently healthy marketable size *Penaeus vannamei* collected from a grow-out pond in Cebu in June 2016. In January 2017, shrimp manifesting the typical signs of HPM including slow growth with a significantly high variation in size at harvest was observed in an intensive shrimp farm in Sagay, Negros Occidental.

This article presents some hands-on disease prevention and control strategies against mixed infections caused by EHP and white spot virus (WSV) applied by a shrimp farmer in Sagay. The presence of EHP spores was observed through the use of light microscopy (data not shown).

The situation

The Negros Prawn Producers Cooperative (NPPC) recently documented the disease incidences in one of the intensive white shrimp *Penaeus vannamei* farms in Sagay. NPPC expressed the fear of EHP and WSV mixed infections but believed that the outbreaks can be managed. This is the first HPM case documented on the island. The exercise was spearheaded by the Department of Agriculture-Bureau of Fisheries and Aquatic Resources (DA-BFAR).

Spread of EHP in the Philippines, January 2016-March 2017, locations marked with red stars

The shrimp farm at Sagay, Negros Occidental, Philippines at the time it was hit with EHP and WSV.

The farm reported WSD in the latter part of 2013 which was still manageable resulting in a marginal yield with average body weights (ABW) ranging from 16 to 24 g. Since then, all the crops were healthy with no incidence of disease. The best crop was documented in 2016. The farm has been using commercial pelleted feeds since 2013. It obtains post larvae from only one hatchery.

In general, at the farm, the culture period averages 120 days and there are 1.5 to 2 crop cycles/year. Disinfection is through chlorination of the pond bottom during pond preparation and the water used for stocking. Additives for phytoplankton growth, probiotics, vitamin and immune enhancers are used both in pond water and feeds. Based on crop performance records, the inclusion of the probiotic, vitamins and an immune enhancer into its farming protocol since December 2013 were cost efficient inputs resulting in higher production. No disease occurrence was reported in the past 3 years.

The site characteristics include calcareous clay loam soil with low organic matter, pH ranging from 7.9-8.6 and available iron content. The main water source is a deep well with 12-15 ppt salinity. Biosecurity is stringent. Practically, no water is sourced from the river to rule out possible disease carriers outside the farm's perimeter. The farm practices an entirely closed system.

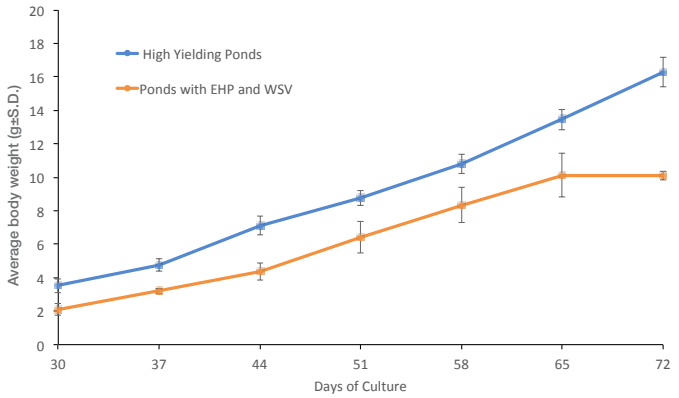

Figure 1. Average body weight (ABW, g ± SD) of shrimp collected from four ponds in the first quarter of 2017

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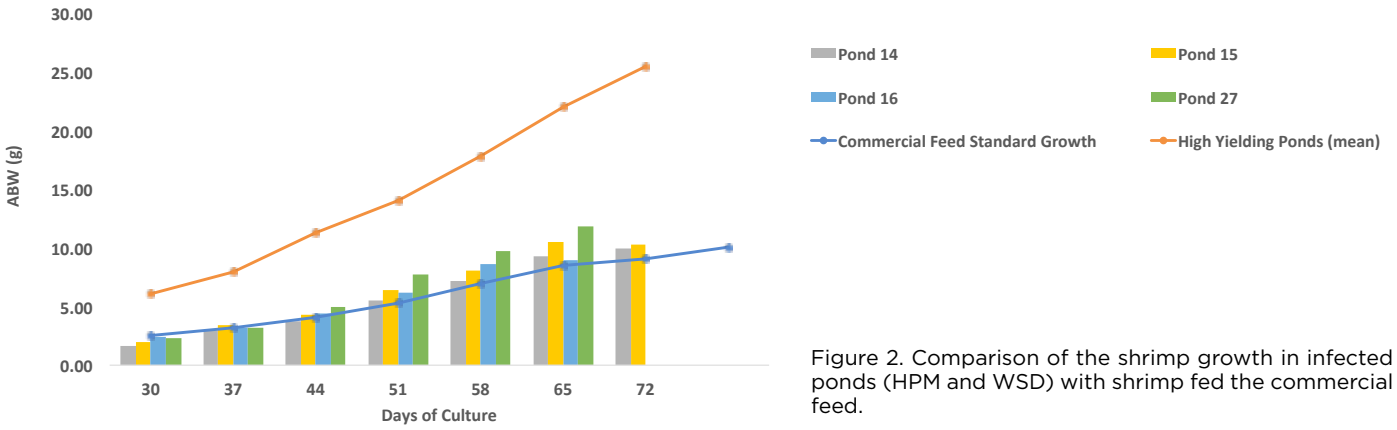

Figure 2. Comparison of the shrimp growth in infected ponds (HPM and WSD) with shrimp fed the commercial feed.

Tracking diseases

Four ponds stocked on January 7 and 13, 2017 were diagnosed EHP and WSV positive at 19 and 25 days of culture (DOC). The post larvae came from two tanks in a government accredited hatchery situated on the same island. Despite the mixed infection, the farm did not abandon the crop and continued to culture until harvestable sizes starting from 10 g. Shrimp were monitored weekly for growth, degree of infection and response to the management strategy implemented.

The results of PCR analyses on shrimp collected at DOC 19 from ponds 14, 15, 16 and 27 showed light WSV and EHP infections. Shrimp analysed at DOC 39 from ponds 15 and 16 were positive for WSV. However, WSV was not detected in the samples taken from ponds 14 and 27 at DOC 39. At DOC 39, only pond 16 was negative for EHP; the other three ponds showed positive EHP results. At DOC 60, only pond 27 manifested negative results for WSV, the other three ponds were positive for WSV. All four ponds were EHP positive at DOC 60 (Table 1).

The average body weight (ABW) of shrimp in the four ponds with mixed infections (HPM and WSD) were significantly lower compared to shrimp ABW of 21 ponds of the same farm during the last crop. The graph showed that shrimp in ponds with disease outbreaks still had higher ABW as compared to the standard ABW of shrimp fed CP feeds at DOC 51 until harvest.

Disease mitigation

Water quality was rigorously checked and timely measures taken to correct parameters that strayed from the optimum values. Feed supplements to boost the resistance of shrimp were added to every meal instead of the twice a day routinely applied during the previous crop. Addition of water was done once to twice a week at a maximum of 10 cm per pumping to replenish water loss due to evaporation or seepage. Probiotics were added regularly to the water. The shrimp were harvested at DOC 60-67.

The ponds at the Sagay farm with mixed WSD and HPM infections were ponds 14, 15, 16 and 27. Ponds 14, 15 and 16 were situated adjacent to each other, while pond 27 was a few ponds away. The ponds have an average area of 0.63 ha and average DOC of 63.25. Details are given in Table 2.

The disease management strategies applied in the four ponds infected with WSD and HPM were as follows:

- Prevention and minimal stress by carefully monitoring water quality daily. Intervention was immediate in case of adverse changes;
- The salinity range was kept at a low range of 12-15 ppt;
- Probiotic, vitamins and immune enhancers were continuously applied daily from day 1 until the day of harvest;
- Probiotics were applied weekly to pond water;
- WSV and EHP in shrimp and in the water were monitored weekly with PCR and timely feedback provided to the farm manager;
- There was regular communication between the owner and the farm team. There was an open exchange between them for timely intervention, when needed;
- Selection of dedicated staff who are responsive to any factor/s which can affect the crop and lastly,
- Soil analyses for WSD and HPM infections were carried out after harvest and prior to pond preparation. Specific details are given in Table 3.

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Table 1. Ponds with mixed infections of WSD and HPM.

Pond Number	Days of culture (DOC)	Results		
		WSV	EMS AHPND	EHP
16	19	(+) light	ND	(+)
	39	(+) light	ND	(-)
	60	(+)	ND	(+)
27	19	(+) light	ND	(+)
	39	ND	ND	(+)
	60	(+)	ND	(+)
14	19	(+) light	ND	(+)
	39	ND	ND	(+)
	60	ND	ND	(+)
15	19	(+) light	ND	(+)
	39	(+) light	ND	(+)
	60	(+)	ND	(+)

Table 2. The harvest results in ponds at Sagay farm with mixed infections of HPM and WSD for the period from January 7 to March 17 2017.

HPM and WSD infected ponds	Area (ha)	DOC	Date of Harvest	ABW (g)	Biomass (kg)	FCR	Survival (%)
Pond 14	0.66	63	3/17/2017	10.00	7,469.95	1.47	106.27
Pond 15	0.66	67	3/16/2017	10.26	7,717.18	1.44	105.94
Pond 16	0.59	60	3/13/2017	8.90	5,230.50	1.38	96.39
Pond 27	0.59	63	3/16/2017	11.85	5,817.80	1.28	92.66
Mean	**0.63**	**63.25**		**10.25**	**6,558.86**	**1.39**	**100.32**
Total	**26,235.43**						
AWB-Average body weight at harvest; DOC- Days of culture; FCR-Feed conversion ratio							

Table 3. Disease management strategies applied in the four ponds with mixed infections of HPM and WSD at Sagay Farm.

Management Strategies	Description
Prevention of further stress or minimize stress	Prevent drastic changes in water quality parameters (morning and afternoon pH difference should be less than 0.5, un-ionized ammonia less than 0.1 ppm, nitrite less than 0.1 ppm, adequate aeration to provide enough oxygen, adequate calcium and magnesium ions, bicarbonate alkalinity greater than 100 ppm, optimum water level—greater than 100 cm, preferably total Vibrio count less than 1,000 CFU/mL majority of which are yellow colonies)
Low salinity	Salinity range of 12-15 ppt
Extended use of probiotics, vitamins and immune enhancer in feeds	Daily application on feed 30 minutes prior to feeding from day 1until harvest
Use of probiotics in water	Weekly application from the first week until harvest
Laboratory analysis of the shrimp and water	Molecular detection using IQ Plus kit at least once a week and timely feedback on the results to farm management
Effective communication between the owner and farm team	Open information exchange among management and technical staff
Dedicated and responsive farm staff	Well-trained on farm biosecurity and trustworthy personnel
Soil analysis after harvest prior to pond preparation	EHP, pH, bacterial profile (Vibrio), organic matter content, available iron

Both water and soil quality were maintained at optimal levels as shown in Table 4. The relatively high survival despite the documented incidence of EHP and light positive (+) WSV infection in the four ponds stocked last January 2017 proved that the management strategy adopted in the farm was sustainable and marginally successful.

Farm performance and sustainability are constantly at stake with new emerging diseases. The success of managing or dealing with mixed infections will definitely improve the understanding of shrimp farmers on diseases. To raise awareness among the shrimp producers, technical meetings are jointly conducted by the DA-BFAR and the NPPC. This is one way of sustaining shrimp production.

The NPPC shrimp growers' cooperative has been in existence since 1984 in Negros Island, and has become the "voice" of the industry in the island. It is also a significant prime mover of the

Shrimp harvest at farm with HPM and WSD.

Dialogue among the members of the NPPC and the National Coordinator of the National Shrimp Production Program of BFAR

Philippine Shrimp Industry, Inc. (PHILSHIRMP). Together with DA-BFAR, a model government-private sector partnership was conceived which is time-tested amidst crisis and challenges throughout the decades in shrimp farming.

Table 4. Optimum range of water and soil quality parameters recommended for *P. vannamei* culture measured at Sagay farm

Water quality parameters measured	Optimum range of water parameters maintained in the farm
Dissolved oxygen	Greater than 4 ppm
Bacterial profile Total *Vibrio* Count Green *Vibrio* colonies Yellow *Vibrio* colonies *V. harveyi* *V. parahaemolyticus*	 <1.0 x 10^3 CFU/mL <40% >60 % not detected at 10^1 not detected at 10^1
Bicarbonate alkalinity	> 100 ppm
Calcium ions Magnesium ions	> 300 ppm > 900 ppm
Nitrite	< 0.1 ppm
pH	7.5-8.5 but morning and afternoon difference should be less than 0.5
Salinity	12-15 ppt
Temperature	28-32°C
Transparency	>20 ppm
Un-ionized ammonia	< 0.1 ppm
Water level	>100 cm

The 11th Philippine Shrimp Congress will be held on November 16-18, 2017 in Bacolod City, Negros Occidental. It is organised by BFAR and PHILSHRIMP.
Email: robmdg@yahoo.com/r.usero@yahoo.com/ mariaabegail11@yahoo.com

Roselyn Usero

Maria Abegail Apostol-Albaladejo

Maria Abegail Apostol-Albaladejo is a Supervising Aquaculturist and the focal person for shrimp. She is the National Coordinator of the National Shrimp Production Program of the Bureau of Fisheries and Aquatic Resources (BFAR). Her experience in aquaculture spans 31 years, 19 of them on the shrimp industry at BFAR. Email: mariaabegail11@yahoo.com

Roselyn Usero is the Laboratory Head, Negros Prawn Producers Cooperative (NPPC), Negros Occidental. She has 27 years of experience in laboratory operations for shrimp culture and environmental monitoring. Email: r.usero@yahoo.com

Producing post larvae for low saline shrimp culture in India

By Menaga Meenakshisundaram and S. Felix

To achieve high survival rates during acclimation in waters to as low as 1 ppt, the process should begin after PL15 while keeping to a constant temperature.

The farming of marine shrimp in inland areas initially started in Thailand in the late 1990s. Underground saline water was used by some shrimp farmers to culture *Penaeus monodon* in 1989 in the north-eastern part of Thailand. The culture was carried out in pond water with salinities ranging from 5-8 ppt. In inland shrimp aquaculture with salinities lower than 10 ppt, diseases caused by the luminescent bacteria (*Vibrio harveyi*) and white spot syndrome virus (WSSV), which result in serious problems in production associated with coastal shrimp saltwater aquaculture, are practically absent or are attenuated (Limsuwan, 2001).

In hatcheries in Thailand, the acclimation is carried out for shrimp post larvae (PL15 to PL20) in brackish water of 5-9 ppt, prior to stocking in production ponds (Lin, 2001). Effluents from small shrimp ponds are released into the surrounding water bodies. However, the effluents after treatment, are reused in mid and large-sized ponds. To avoid or minimise salt contamination on the adjacent land and water, walls were constructed around ponds (Intriago, 2002). The Thailand government banned inland shrimp farming in 1998 because of the concern of potential salinity contamination on land and water used for plant crops.

In the US, inland shrimp farming is practised in Texas, Florida, Arizona and Alabama by using underground saline water with salinity ranging from 0.7-16 ppt (Boyd, 2001). There, inland shrimp farming represents 16% (192- 200 ha) of the total marine shrimp culture industry (1,200 ha). In Alabama, from 1999 to 2000, fish farmers culturing channel catfish (*Ictalurus punctatus*), initiated shrimp aquaculture with well water where salinity fluctuated from 2 to 6 ppt. For about 50 years the culture of channel catfish has been carried out using ground water (Boyd 2001). An environmental assessment conducted on the activity in Alabama revealed that there was no negative effect on the environment. Boyd (2001) added that the reason was due to a reliance on best management practices, such as ponds confined with walls, clay soils with low filtration, no removal of sediments from the pond bottoms and drainage of ponds not more than twice every 15 years.

Low saline (< 5 ppt) shrimp farming trial at the Advanced Research Farm Facility, Chennai, Tamil Nadu.

Inland shrimp farming in Tamil Nadu

In the north of Tamil Nadu, inland shrimp farming of Pacific white shrimp, *Penaeus vannamei*, in low salinity waters started in 1994, the year when WSSV outbreaks were severe. This new culture activity was considered a good alternative to mitigate the impact caused by the WSSV. It made sense, financially and environmentally, because of the low investment required. The system used is more intensive as compared to the conventional shrimp aquaculture developed in mangrove and coastal zones of Tamil Nadu.

The size range of production units of inland shrimp farming is from 0.1 to 10 ha. The type of culture ranges from intermediate stocking with 20-30 post larvae (PL 12-15)/m^2 to extensive or high stocking with 60 PL/m^2. Yields fluctuate from 900 to 6,400 kg/ha (Intriago, 2002). However, inland shrimp farmers and agricultural farmers differ in their views on whether inland shrimp farming can cause negative effects on agricultural crops, other land uses and ground water quality.

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Inland saline (3 ppt) shrimp farm at Kattur, Tamil Nadu

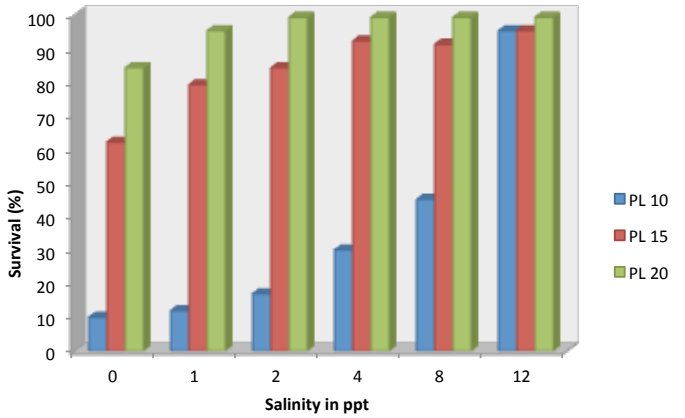


Figure 1. Survival % of post larvae of white shrimp after 48 hr at various salinities

Salinity tolerance test

Shrimp farmers generally purchase post larvae from commercial hatcheries and stock them in ponds during the warm summer months. Post larvae are transported at a relatively young age (PL6-10) in water with salinity above 20 ppt. Inland farmers using low salinity well water must acclimate the post larvae to pond water salinities before stocking them into their ponds. Thus hatcheries acclimatise the post larvae by gradually reducing the salinity. However, post larvae cannot tolerate large salinity fluctuations and their ability to acclimate to low salinities depends on their age. Although understanding acclimation tolerances of post larvae is critical to the aquaculture industry, there is little information in the literature.

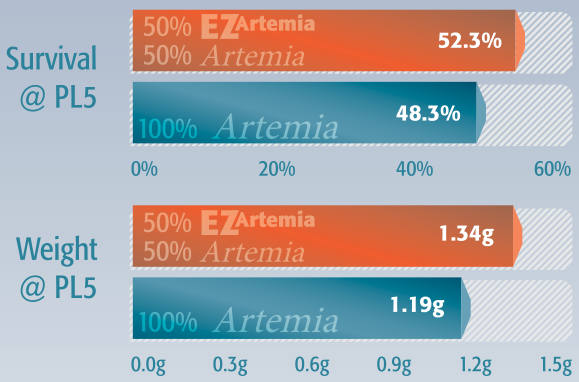
A series of experiments designed to help farmers and researchers better understand the response of various ages of post larvae to low salinities were conducted at the Aqua Nova Hatcheries Pvt. Ltd, Chennai. The species studied was the white shrimp. The experiments were designed to determine the influence of post larvae age and salinity endpoint on 48 hr survival of shrimp.

Three age classes of white shrimp post larvae (PL10, PL15 and PL20) were acclimated over an 8 hr period from a salinity of 26 ppt to treatment endpoint salinities of 0, 1, 2, 4, 8 and 12 ppt. The results are illustrated in Figure 1. Survival of the post larvae in different salinities was compared with the survival of the control maintained at 26 ppt for every age group.

Shrimp farmers started constructing shrimp acclimation and nursery systems within their farms. These systems are being used to refine on-site acclimation and nursery techniques, and for demonstration purposes. Post larvae of the white shrimp were more tolerant to low salinity as compared to black tiger shrimp *P. monodon*. Post larvae PL10 had good survival down to a salinity of 4 ppt, but lower salinities resulted in very poor survival at this post larvae stage. However, older post larvae (PL15 and PL20) can be successfully acclimated to salinities as low as 1 ppt, clearly indicating that the older the post larvae the better it is in handling the stress of a low salinity environment.

In summary, white shrimp post larvae tolerate lower salinities, and acclimate to low salinities at a younger age. Consequently, based on current research results and observations on commercial farms, it is recommended that older post larvae should be acclimated in nursery phase prior to grow out culture.

From this study, we concluded that the salinity acclimation process should begin before PL15, and care should be taken to maintain relatively constant temperatures (range 28-32°C) during this period. After acclimation the post larvae should be nursed for 25 to 30 days. The advantages are that the nursery phase acts as a transition phase for post larvae to recover from acclimation and transport stress. As the shrimp are reared at high density during the nursery stage, compensatory growth will be seen when they are stocked at a lower density in grow-out ponds.



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Penaeus vannamei post larvae of 20 days acclimated to 3 ppt salinity

The nursery phase also acts as a quarantine phase where the risk of disease transfers is minimised. Older post larvae tolerate stress better during acclimation. Furthermore, we have noticed that a uniformity in size can be achieved prior to stocking in grow out ponds. Lastly, post larvae can be purchased and stocked earlier in the season based on the availability.

Different inland well-waters vary in their ionic composition, and therefore some will be more suitable than others for shrimp culture. With appropriate water, proper acclimation, and good nursing techniques, along with standard management practices, shrimp culture in inland saline waters will continue to develop in many states. In addition to its contribution to the national shrimp production, inland farming of the white shrimp provides a functional use of underutilised land resources and creates rural jobs in farming communities.

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Menaga Meenakshisundaram

S.Felix

Menaga Meenakshisundaram is currently doing her Ph.D in aquaculture. Email: mena.fishcos@gmail.com

Dr S. Felix is Vice Chancellor of Tamil Nadu Fisheries University, India

Zero water exchange super-intensive indoor shrimp production

By Manuel Poulain

The story of collaboration at Viet-UC, Vietnam; intensive large-scale farming at higher densities for increased harvest volumes and cleaner shrimp.

Viet-UC runs one of the largest shrimp hatchery operations in the world, at present producing around 15 billion post larvae per year. The group's production capacity is around 40 billion post larvae per year distributed over seven hatchery premises. Furthermore, it is the only hatchery in Vietnam licensed to operate a breeding and genetics program.

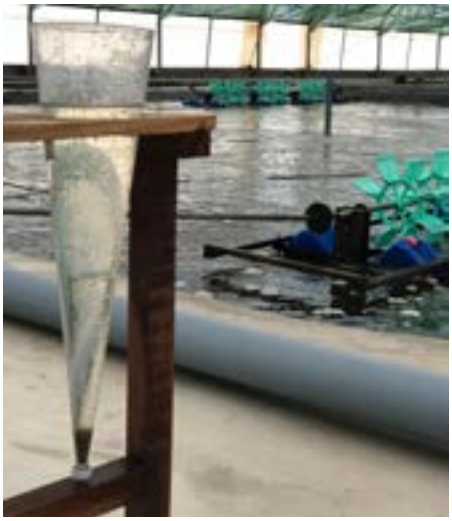
Since 2015, the company has been working on the expansion of its operation to shrimp grow-out. This grow-out system is highly intensive and is conducted in ponds of 500 m^2 each. Today Viet-UC utilises about 600 ha of land in two sites in Central Vietnam (Binh Dinh and Quang Ninh Provinces) and operates its shrimp grow-out facilities in two other sites in Bac Lieu Province, Mekong Delta (50 and 315 ha). By 2020, Viet-UC grow-out operations are expected to cover 1,000 ha, with around 550 greenhouses or 10,000 ponds.

An intensive approach

Viet-UC's approach to intensive large-scale farming already results in higher densities, increased harvest volumes and better and cleaner shrimp. The company wants to show that with adequate investment and better management, intensive farming systems can result in better products, higher market prices and an improved image for Vietnam's shrimp products. Sharing this same philosophy, INVE Aquaculture is working closely with the hatchery and farm management to optimise its operations and protocols. The grow-out expansion strategy of the company will be carried out completely in indoor production systems, with a sustainable yield and zero water exchange protocols.

Globally, every year for the past 30 years, the risk of disease outbreaks has increased; for the past 15 years, drastic increases in bacterial related diseases have devastated many farms. The investment in indoor facilities will provide better biosecurity than outdoor ponds by substantially reducing environmental contamination. But indoor protection should be considered only as a first step; indeed indoor farming will not reach its full biosecurity potential as long as water is exchanged in the ponds. After post larvae, contaminated water remains the vector of highest risk in shrimp farming. To reach the highest level of biosecurity for indoor farming, it is essential to control the

Paddle wheels in a grow-out greenhouse



Biofloc flask

production of shrimp with no water exchange from stocking through to harvesting.

INVE is supporting Viet-UC with continuous on-site assistance by a technical support team that includes shrimp culture experts with an accumulated experience of more than 185 years. It has today a complete portfolio of products specifically developed to support shrimp grow-out production.

Approach and general setup

Since mid-2015, the team has completed several commercial-scale production runs. These were designed to introduce the high density zero water exchange protocols, together with the use of the grow-out product portfolio. The know-how transfer introduced by the INVE team met Viet-UC's production requirements and performed well under local conditions, resulting in a simple, easily replicable production system, which is indispensable for the multiple expansions planned by the company's grow-out program.

As of today, a total of five full-scale production cycles have been conducted over a total of 100 production ponds. The first couple of trials were designed to secure the farming targets using zero water exchange protocols, first experimentally and then commercially. Following these successes, several runs to increase farming outputs with higher stocking densities were conducted. This article summarises the output, explaining the approach and its results.

All of the grow-out production were carried out in 500 m^2 fully lined ponds, which are 1.2 m deep. The aeration system comprised 2.5 cm (1") aero-tube diffusers and air was supplied by root blowers. Two long-arm paddle wheels were installed to use as back-up in case of failure of any air blower.

The water used was previously disinfected and treated to ensure the removal of pathogens. All ponds were stocked with the selected genetic lines of post larvae (PL 10) supplied by inhouse hatcheries. High quality shrimp feed (40% crude protein) was used. Feed was distributed manually up to 1 g size crumbles; then pellets were distributed via the use of automatic spinner feeders positioned in the centre of the ponds over a 24-hour period.

The main principle of the zero water exchange protocol is based on bacterial competitive exclusion, via the use of the selected probiotic bacteria. Also, it should be noted that shade cloth was installed over the ponds to minimise competition and deviation of the physico-chemical parameters due to the phytoplankton population.

Trials baseline protocol

Prior to stocking, all the materials and pond surfaces were disinfected with a solution of Sanocare®PUR, to ensure the complete removal of possible pathogens, including bacterial biofilms. After the first pond was filled, no water was added or exchanged into the tanks for the entire period of the crop.

During production, two products were used as inoculum of beneficially selected bacteria, or probiotics: the Sanolife®PRO-W for water conditioning, and Sanolife®PRO-2, used as feed coating to act at the level of the shrimp gut bacterial ecology.

Both products include a combination of bacteria, with multiple targets:

- Bacterial competitive exclusion for space against *Vibrio* sp. in the water and biofilm colonisation of pond surfaces and gut internal membranes,
- Bacterial competitive exclusion for food source of *Vibrio* sp. via the reduction of organic waste production,
- Bacterial competitive exclusion for food source of *Vibrio* sp. via an improved control of multitrophic nitrification bio-reactions

The optimisation and control of the multitrophic nitrification processes remain until today the major limitation to the development of zero water exchange protocols around the globe. Indeed, production systems of this kind, commonly referred to as biofloc production systems, use mainly the heterotrophic nitrification bacterial processes, working with a carbon:nitrogen (C:N) ratio via the addition of external carbon sources, such as molasses, to the ponds. This nitrification pathway alone is not sufficient to digest all the nitrogen involved in a shrimp pond with zero water exchange. Ammonia spikes, followed by nitrite spikes often impact the overall productivity of such systems.

In addition, within the specific protocol, special focus is brought to the first month of farming, when the pond ecology is developing. During this time, a high quality nursery feed supplement (Sano®S-PAK) is used for the first feeding of each day. S-PAK also includes a complete range of selected immunostimulants to stimulate the shrimp defense against environmental stress (such as high density stocking).

Subsequently, the immunostimulants present in the nursery feed supplement are given to the post larvae in the form of the supplement Sano®TOP S, which is coated onto the feed.

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Results of commercial trials

Figure 1 shows the average growth obtained during the different trials, for different stocking density. Figure 2 presents the evolution of the average nitrogen concentrations, for NH_3-N and NO_2-N, during the trials.

At 250 PL/m² the shrimp reached an average size of 20 g in 90 days; at 500 PL/m² the shrimp reached an average size of 20 g in 100 days; at 700 PL/m² 2 the shrimp reached 17 g in 100 days.

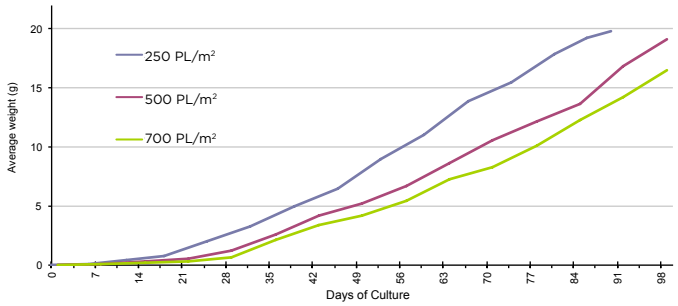

Figure 1. Shrimp growth at different stocking density in three trials

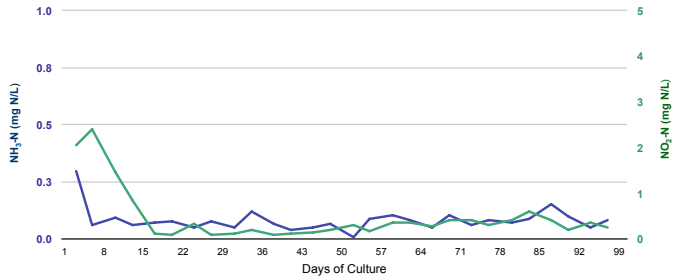

Figure 2. Average nitrogen concentrations, for NH_3-N and NO_2-N, during the trials.

We can observe a complete control of the nitrogen concentrations throughout the farming process. NH_3-N is maintained below a concentration of 0.5 ppm (or mg N/L), and NO_2-N below a concentration of 2 ppm. The maximum concentrations of both are observed during the first two weeks of culture, as the pond ecology develops and adapts to the shrimp culture system. It confirms the special attention that farmers need to give to the ponds during the first month of culture. The use of superior quality feed at early grow-out stages enables the shrimp to feed less. This is essential to optimise this part of the multitrophic digestion.

This nitrogen control removes completely the need for water exchange and bottom siphoning, which improves considerably the biosecurity of the production system while lowering the production cost at the same time. The lower power consumption is mainly due to the absence of water pumping for water exchange. Costs are further reduced as less manpower is needed, since bottom siphoning, pump operation and maintenance are not needed.

With a stocking density of 250 PL/m², the farming process results in the production of 20 g shrimp in approximately 90 days, with a survival rate of 75% and a resulting feed conversion ratio (FCR) of 1.3. Considering the complete absence of water renewal, and the indoor production system, the impact of environmental variables caused by meteorological events is greatly reduced, resulting in optimal consistency of the results shown above for the different experimental and commercial trials.

On the other hand, the control of the water quality, via the control of nitrogen accumulation and the use of high quality probiotics and immunostimulants, greatly reduces the environmental stress on the animals. The direct consequence of the good quality control is a reduction in the size variation at harvest.

View of grow-out greenhouse

To date, the optimal economic output of the protocols applied at Viet-UC resulted from a stocking density of 250 PL/m^2. The stocking of 200% more post larvae, in comparison with 500 PL/m^2 resulted in a productivity increase of only 150%. With higher stocking density, i.e. increasing 280% to 700 PL/m^2, productivity increase was 165%. The growth, survival and FCR differences among the different stocking densities are minimal (<5%); there is lower economic return on the investment, even with increased productivities. Higher stocking densities will result in the increase in both the post larvae and feed costs, and longer production time.

What's next ?

This collaboration have achieved the expected targets for the indoor environment, without the requirement of any new water introduction to the production cycle from stocking to harvest. This substantially reduces the risk of contamination, gives optimum biosecurity, and secures a less risky investment. This culture system also results in lower size variation, and highly consistent shrimp quality.

Viet UC's grow-out expansion includes the complete integration of all shrimp culture aspects. The company has already completed a state-of-the-art feed mill, and is working on the construction of the processing plant. Its development program also includes social projects to help small farmers in Vietnam achieve more consistent production, via the use of its genetically selected post larvae, high quality and improved feed, and technology transfer that includes on-site support. INVE will continue to assist the company in these developments, with the shared goal of making shrimp farming a more sustainable activity than what it is today.

The approach is increased volumes and better and cleaner shrimp.

Manuel Poulain is with INVE Aquaculture since 2015 His role is to help farmers throughout Asia improve output and consistency of their productivity based on his 20 years of extensive experience in shrimp hatchery and farm operations. During the last 10 years, he has managed the establishment of the first commercially successful indoor zero water exchange biofloc shrimp farm in Spain.

Email: m.poulain@inveaquaculture.com

At the heart of sustainable food from aquaculture

By Zuridah Merican

The fast-growing aquaculture industry in Asia can achieve sustainable production via the interphase of science and technology, says Malcolm Pye, CEO Benchmark Group.

At the end of the 1990s, inspired by demands from major retailers in the UK, three friends decided to set a new benchmark for sustainable food production. They also saw that the interphase between science and technology and food production was lacking in the food industry. Benchmark, formed in June 2000, had its initial focus on the sustainable production of terrestrial animal food but since 2003, steadily increased its focus on aquaculture. Today, Benchmark Holdings, led by CEO **Malcolm Pye**, stands tall as a market leader in the supply of applied biotechnology and knowledge transfer in agriculture and aquaculture businesses.

"I was working in a large agri-foods business while veterinarian Ruth Layton and agriculturalist, Roland Bonney advised several large retailers and processors. We saw that at the heart of the development of a sustainable food industry, there should be a tremendous connection between academic scientific development and the development of the industry. This was

> **"...where there are challenges and problems which require more than one tool, we set out to find the tools.." - Malcolm Pye**

lacking in agriculture and especially so in aquaculture. We saw the opportunity to draw the process together," said Malcolm, in a telephone interview in May.

Together the vision was to build a profitable business based on the growing need to create a sustainable and ethical future for global food production and set a new benchmark for sustainable living. Malcolm has over 30 years' experience in breeding and genetics, sales and strategic M&A that has led the company's growth and diversification. Co-founders, Ruth Layton and Roland Bonney are now Head of Sustainability Science and COO, respectively.

"We grew the business, over the ensuing 18-19 years, sometimes by acquisition and sometimes organic growth, at a 50:50 ratio. We grew 30% per annum. We are a technology business for food. As early as 2000, we saw that this interface of science and technology was particularly missing in aquaculture. We see aquaculture as the fastest growing Industry and a key area for the development of sustainable production."

Making a difference

Malcolm attributed several reasons that pulled Benchmark's entry into aquaculture. "In the early 1990s, we could already see the tremendous growth in the salmon, shrimp, tilapia and catfish aquaculture industries and that they were technology hungry. Some of our customers in food processing and retail foods started to ask us to be involved as we were working with them on supply chain standards and codes of practice. They wanted us to help them understand the quality of production in shrimp and salmon aquaculture. We felt that we should be involved."

The starting point into aquaculture came with the acquisition of FishVet Group (FVG) in 2003. FVG was at that time a European veterinary group focused on aquatic health. "FVG gave us the tools to enter aquaculture and we grew from animal health to genetics and advanced nutrition in aquaculture."

Today, aquaculture is prominent in the company's business activities and 90% of its turnover in 2016 is derived from its aquaculture business. Benchmark has several companies involved in aquaculture; along the supply chain, from genetics, health, feed and nutrition to the environment. In 2013, as the company was growing rapidly, it was listed as a public company. This gave it the financial resources for future growth.

Then with the acquisition of INVE Aquaculture in 2015, Benchmark became a global leader in applied aquaculture biotechnology. It now employs 900 people in 70 countries. Today, it operates in every aquaculture market globally and working with the major commodities: salmon, tilapia, shrimp, seabass and bream, *Seriola* and turbot.

Business of linking sustainability science

"We see animal health, breeding and genetics and development of sustainable practices and advanced nutrition as interrelated components of biology," said Malcolm. "At the very early stage, when we started to work across these disciplines and grow the business, where there were challenges and problems which requires more than one tool, we set out to find the tools. Very often R&D is not bound to just one of these disciplines. We try to understand the basic processes driving the situation and we

bring together the tools to address them to create progress. We also need the capability to use all the tools available to us."

The example is the sea lice, a major problem in the salmon industry. Today, there is no single tool to resolve the problem. Benchmark is using genetics (increasing resistance to sea lice attachment), cleaner fish such as lump fish (as biological control to eat the lice away), medicines to treat the salmon and ultimately vaccine development.

"Across our business, we have a number of work streams ongoing to solve this problem; the vaccines and genetics work are interrelated. This is what makes Benchmark different. The idea is to bring together the component parts to develop a holistic solution," said Malcolm.

Acquisitions and organic growth

Malcolm described Benchmark's aquaculture business as follows. At the core of its breeding and genetics program are SalmoBreed and Icelandic StofnFiskur, acquired in 2014 and making Benchmark the second largest producer of salmon eggs worldwide. The acquisition of Akvaforsk and American-based Spring Genetics in 2015, moved the group into the fast-growing tilapia genetics and breeding sector.

The current excitement is with the acquisition of Genética Spring, acquired in 2016, giving Benchmark fast growing and specific pathogen free (SPR) vannamei shrimp for global markets. The latter two acquisitions allow it to cross sell tilapia and shrimp brood stock alongside INVE Aquaculture's early nutrition products globally. INVE Aquaculture, the global leader in advanced nutrition and health solutions acquired in 2015, completes Benchmark's toolbox of the full life cycle strategy from eggs to market size fish and shellfish. The acquisition of Belgium-based TomAlgae in 2015, a producer of freeze-dried microalgae, gives it significant opportunities to explore the capability of algae as a method of carrying vaccines and health products for aquaculture.

In animal health, SalmoBreed together with FVG is addressing the sea lice problem with cleaner fish production. Through organic growth, FVG now has a global network of diagnostic and veterinary services to help farmers prevent and manage disease outbreaks, improve efficiency and farm profitability. Benchmark's knowledge services encompasses 5m Publishing, acquired in 2003 which has grown its online and print portfolio to new markets. Together with FAI and Improve International, it works on training, transfer of knowledge and engaging with food retailers to improve the sustainability of production.

"In the pipeline are oral vaccines to combat diseases in young fish and delivery of vaccines with feeds. We need to put all these demands together and need a lot of science to do this. We depend on biotechnology to find innovative ways in vaccine development and in cell culture. The major areas of such biotechnology applications are both in INVE and TomAlgae. Here we are looking at live feeds for oral vaccines, probiotics and immunostimulants for early larval stages."

Competitive edge

According to Malcolm, competitors for its subsidiaries are from large and well-established genetics and vaccines developers and various small local companies. "Disease challenges are major constraints and core to success is shrimp/fish health. We feel we have put the company to take a lead in the development of aquaculture biotechnology to make a real difference to the industry."

Strong future in Asian aquaculture

"The challenge with disease is a global issue but is more evident in Asia as it is a large producer. In the future, we see changes such as our SPR shrimp which we are now taking to market and the development of advanced nutritional tools as we need to replace the use of antibiotics," said Malcolm.

Picture credit: Benchmark Group

"The emergence of regulatory structure is important for many governments in Asia but sometimes these do not help the industry. We want to help regulators develop standards to protect the industry and help the industry to resolve problems. Sustainable sourcing is key to drive sustainability. Part of this is the sourcing of raw materials and how farms operate.

"I am an optimist. The industry in Asia has developed leadership positions in many species and the people are entrepreneurial but problems are slowing down progress. In a way, we have an advantage as we grew up together with the salmon industry, technically the most developed aquaculture industry. We have seen how the industry took up the technical challenge and how it benefitted tremendously. In Asia, we are not far off, as the shrimp industry is going the same way. I can see that shrimp genetics can make a significant difference in the next 2-3 years," added Malcolm.

Fair solutions

On the need for solutions, affordable for industry in Asia, the approach by Benchmark is to target solutions which are "good value" and deliver much more value than the cost invested by the farmer. Malcolm explained. "When we have disease such as nodavirus and streptococcus in tilapia and early mortality syndrome in shrimp, the key is cost effectiveness. We are working on a new model for vaccine production at a lower cost and more effective than those in the market for the core diseases affecting the pangasius or tilapia. A lot of work is managing the cost side of these products when they come to market such that farmers will make the investment to improve performance. Solutions for low margin products need to remain cost effective."

Final words

On synergies

"We can use our various component parts - genetics, nutrition and health, as route to market or develop products which combine technologies. In our road map, we have the structure that we want. Now together, we have the tools and are working on products in our pipeline."

On acquisitions

"We have been acquiring companies to increase our capabilities. We have never been a private equity. We will continue to grow to create success and drive improvements."

On the tagline "starting with food production"

"Our view is that the food industry is the largest polluter and consumer of water and if we want to make sustainability happen, we need to start with the food industry."

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China and Southeast Asian tilapia in 2016

By Kevin Fitzsimmons

Shift to value added tilapia products for local markets in China to replacing the pangasius in Vietnam.

Asia continues to lead the world in tilapia production, consumption, and exports. **China** continues to be the world's largest producer (1.8 million tonnes), consumer and exporter, but the growth in recent years has been fairly minimal. Rapidly increasing input costs (land, utilities, labour etc) and stagnant prices have discouraged new production in virtually all of the tilapia farming regions in China. As international sales have leveled off, domestic demand for processed tilapia has been growing. Urban consumers have become frequent buyers of tilapia fillets and other value added products. As such, value added tilapia will continue to become a more important sector for tilapia processing in China, as urbanization continues and more working women in the population.

Indonesia has been reporting large increases in production but only minimal increases in exports. Private sector and government reports for tilapia production for 2015 and 2016 were slightly under and slightly over 1.11 million tonnes, respectively. This production is widely dispersed across the country with many production systems. Cage culture in natural and man-made lakes accounts for a significant fraction of production and virtually all of the exported tilapia. Farms using traditional "tambak" ponds, integrated fish and rice, and polyculture with shrimp are all significant sources of tilapia sold into domestic markets. PT Aqua Farm Nusantara, part of Regal Springs, the world's largest tilapia producer and processor has cut back production volumes with the worldwide decline in prices. Tilapia is compensating for the decline in shrimp production at PT CP Prima's farms but production is mainly for local markets.

Tilapia is synonymous with the **Philippine** aquaculture industry. Increases has been steady in tilapia farming in recent years. Farms produced over 300,000 tonnes in 2016. Domestic markets account for virtually all the consumption of Filipino tilapia, with minimal exports. Production is widely distributed across the islands, but Luzon certainly accounts for the greatest volume of production and consumption. Pond culture and cage culture account for most of the tilapia farmed in the Philippines. Polyculture with shrimp was pioneered in the Philippines and contributes a significant fraction of production. Value added forms are common in Filipino groceries and many processing plants provide fillets, frozen forms, smoked fish and other tilapia products.

Thailand has also seen slow but steady growth in tilapia production in recent years. Annual production was around 250,000 tonnes in 2015 and 2016. Some of the world's largest tilapia hatcheries are in Thailand. Their role in the development of improved strains including Chitrilada, TabTim, and other red skinned strains are notable. The recent confirmation of the presence of the tilapia lake virus is a serious concern for future production levels if it continues to spread. The diversity of the Thai tilapia sector may provide some protection from the type of devastation seen with the EMS-AHPND (early mortality syndrome – acute hepatopancreatic necrosis disease) in the shrimp industry in Thailand. Production of tilapia is widespread across the country with farms using ponds, cages, brackish and freshwater as well as rice paddy and shrimp pond polycultures.

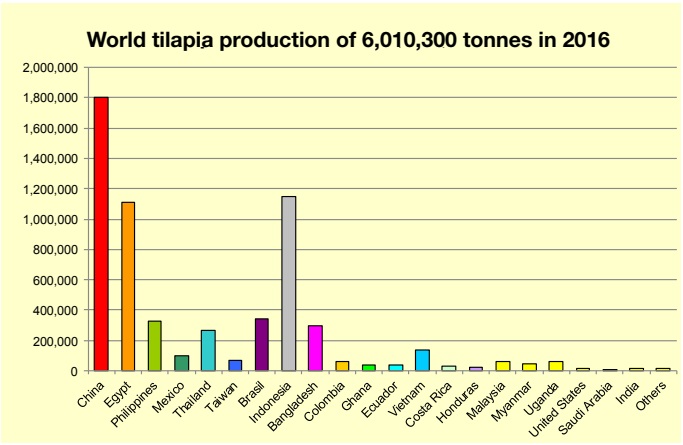
The government of **Vietnam** has begun a concerted effort to vastly increase tilapia production across the country. This is an effort to diversify from an over reliance on the pangasius export markets as well as add another healthy item for Vietnamese consumers. The target is to double production from the current annual production of about 140,000 tonnes by 2020. This will require more investment beyond the relatively slow and steady growth of the last ten years. Tilapia are reared and consumed throughout the country from the north near the Chinese border to the very south of the Mekong Delta. Red tilapia are popular, especially in brackish water where they are often reared in polyculture with marine shrimp. At the moment, virtually all of Vietnam's tilapia are marketed locally with very little export. Conversion of pangasius processing lines has been suggested as a way to reduce over-capacity and jump start the processing of tilapia.

Malaysia has seen uneven growth in the tilapia sector. The government has encouraged aquaculture through the development of designated "parks" as well as directed investments. Current production is around 60,000 tonnes per annum, with a large amount coming from large cage farms in several reservoirs. Most of the production is in peninsular Malaysia, although there are plans for large farms in East Malaysian on Borneo Island. Most of the production goes into domestic markets with very little being exported.

Myanmar is another country with virtually no exports of the 45,000 tonnes harvested per year. The majority of tilapia are produced in polyculture ponds where they are cultured along with Indian major carps and Chinese carps. These ponds are also likely to have the pangasius, pacu, and a mix of native cyprinids. The government is supporting increased tilapia production and has worked with WorldFish to introduce GIFT tilapia. Private growers have also imported tilapia fry from Thailand in past years, but have become leery of further imports over concerns of tilapia lake virus.

Drop in demand

While Asian demand has continued to grow in recent years, tilapia demand and prices in the US, Canada and parts of Western Europe have dropped in 2015, 2016, and early 2017. This drop seems to be completely attributed to several misleading reports posted on the internet. Google and Yahoo searches for tilapia have several of the sites in their top results, with claims that "tilapia is worse



Intensive culture of red tilapia in cement lined ponds in Malaysia

Fillet and whole red tilapia alongside pangasius at the annual Vietfish exhibition

than bacon" for your health. Sites with more accurate and valid information are buried lower in the search results. It is the lead heading of "tilapia is worse than bacon" that seems to engender the most attention, even though the claim has been discredited by nearly every nutrition expert, medical doctor and dietician. The comments were included in a technical paper comparing omega-3 to omega-6 fatty acid concentrations in farmed tilapia and other fishes. The first figure in the article shows the measured omega-3 levels in farmed tilapia to actually be much higher than many common warm water wild-caught marine species. But a focus on the relatively high ratio of omega-6 to omega-3 led to the spurious comments.

While the drop in demand seems to be greatest in English speaking countries, questions on quality have arisen from many countries. Despite this drop in demand, global production and consumption have continued to rise.

Kevin Fitzsimmons, Ph.D is Professor, Extension Specialist & Research Scientist at University of Arizona Tucson, Arizona. Email: kevfitz@ag.arizona.edu

Tilapia, a fish able to meet the challenges of the future

By Eric Roderick

Spotlight on tilapia from the Indian sub-continent, Middle East and Africa as well as current and future challenges.

According to a recent FAO report, global per capita fish consumption has risen to over 20kg/yr for the first time due in particular to the steady increase in aquaculture's contribution to global fish availability. With an increasing world population coupled with a rising demand in fish consumption as the health benefits of fish are widely promoted, there needs to be greater availability of fish. Farmed tilapia is still the main candidate to supply this growing shortfall. World Bank produced a report "Fish to 2030" which predicts that 62% of food fish will come from aquaculture by 2030 with the fastest supply growth coming from tilapia, carp and catfish. Global tilapia production is expected to reach almost 8 million tonnes by 2030.

Harvesting tilapia in Egypt

Increases in tilapia production is now coming from new countries entering into the industry such as India, Pakistan, Myanmar, as well as many of the Middle East countries. At the same time, established producers like Vietnam, Indonesia and Malaysia are also expanding their production, to meet this rising demand. The Indian subcontinent is where tilapia is now marking its mark.The **Bangladesh** government's goal is total self-sufficiency within 2 years (see box).

In **India**, the government is now heavily promoting tilapia as a viable alternative to carp culture, and is working with WorldFish on the GIFT and Fishgen on the YY male technology. The Marine Products Export Development Agency (MPEDA) through the Rajiv Gandhi Centre for Aquaculture (RGCA) and its various tilapia hatcheries is now distributing tilapia fry to many farmers throughout India. There is very strong demand from farmers keen to move away from the native carps and also from new entrants and investors keen to get involved in a rapidly expanding industry, hoping to replicate the success in Bangladesh.

Pakistan is just starting to promote tilapia, again as an alternative to the native carps, and several new breeding programs have been set up, again using both GIFT and Fishgen's YY male technology. The fish is well received there and culture is expanding rapidly. Pakistan's total annual fish production is 0.953 million tonnes including 0.667 million tonnes from marine capture fisheries and 0.285 million tonnes from inland waters including aquaculture. The reason behind the low production is the existence of traditional green water aquaculture systems, under-exploitation of public water bodies (rivers, lakes, dams/reservoirs, coastal waters, estuaries) and lack of trained manpower, low availability of good quality commercial aqua feed and quality seed production in hatcheries, diseases monitoring and control, and almost no intensive aquaculture Inland aquaculture is growing due to increased intensification and increased cultivation area.

Pakistan's per capita fish consumption is very low at around 2 kg compared to the world average of around 20 kg, so there is a need to increase awareness about the benefits of fish as a very healthy food to bring about a big increase in its production and consumption in Pakistan. In the "Feeding Pakistan" project, USSEC (US Soybean Export Council) is advising local farmers of the benefits of using pelleted feed. There has been very successful dissemination of the GMT (Genetically Male Tilapia) by the

Tilapia gaining traction in Bangladesh

Bangladesh has been a true success story in tilapia farming. The country has increased its production at a tremendous rate in recent years. In 2002, the production was under 10,000 tonnes and by 2016, reliable estimates are for more than 300,000 tonnes essentially all for domestic markets. This is even more remarkable considering that the yields of other aquaculture species have not been hindered by the rapid increase. Tilapia have been grown in polyculture systems, or in new ponds and cages that have not displaced the other farmed fishes and crustaceans. While most tilapia are sold as whole fish on ice in domestic markets, some processing to value added forms are beginning to be seen in local groceries. Three companies are planning to process and export fillet.

Hatcheries produce quality fry and fingerlings for local farmers as well as and for export. Broodstock used include GIFT tilapia from Worldfish, AIT and Namsai, Thailand and from the Philippines. The red tilapia is not popular in Bangladesh. There are more than 50 feed mills producing feeds for the tilapia and other freshwater fish. FIAB (Feed Industries Association of Bangladesh) reported a production of 1.2 million tonnes of fish feeds (mash, sinking and extruded). There are also imports of small size extruded feeds (0.5 mm,0.8 mm,1.0 mm sizes) as well as floating feeds from India and Vietnam. Both pelleted and extruded floating feeds are used in tilapia farming. (Information provided by Kevin Fitzsimmons and Mohamed Tarique Sarker, Fish Tech, Bangladesh).

University of Veterinary and Animal Sciences (UVAS) in Lahore to local farmers for evaluation, and a new YY supermale hatchery has been set up at UVAS. In February 2017 an International Fisheries Symposium was held in Lahore was very well attended with many of the presentations relating to tilapia farming.

The **Middle East** is a latecomer to aquaculture, but rising food security issues and increasing importation costs are focusing many Middle East countries to invest heavily in aquaculture. The Middle East is currently importing 1.8 million tonnes of seafood and with per capita consumption rising, aquaculture is seen as a solution. High imported feed costs, and low seed availability and limited local technical skills are the main obstacles to be addressed. With the shortage of water, many high tech RAS and aquaponics projects are under construction throughout the region. Several government funded research centres are also under construction or operational, such as the Qatar Aquaculture Research Centre (costing a reported USD63 million) and also in Oman, a new aquaculture centre offers training courses and carries out research on local and imported species.

In Africa, **Egypt** with a production of 1.17 million tonnes in 2015 is by far the main aquaculture producer and the third globally after China and Indonesia. Historically there has been very limited production from all the other African countries, but aquaculture investment, both local and foreign) is driving a major expansion in the industry. In **South Africa** the Tilapia Aquaculture Association of Southern Africa (TAASA) is helping to drive the expansion. Lack of good quality feed and high quality fry have been major limiting factors in Africa's expansion, but new confidence in the region has led to Aller Aqua building a new tilapia feed mill in Zambia and to expand its factories in Egypt. It has already signed an agreement with Yalelo, which is proposing significant expansion of its Zambian cage farm operations in Lake Kariba up to 30,000 tonnes/year. Lake Harvest is also based on the Zimbabwean side of Lake Kariba. There is also a new feed factory in Nairobi, Kenya developed in partnership with Nutreco and Dutch funding, which is producing 5,000 tonnes/year to supply local tilapia farmers in the region. This combined with the news that Alltech has purchased Coppens, the Dutch feed supplier with strong links to Africa, shows that confidence in the continent is improving.

Current and future challenges

Tilapia Lake Virus

A major new challenge to the tilapia industry is the Tilapia Lake Virus (TiLV) sweeping through many countries from Ecuador to Egypt to Israel. Locally known as "Summer Mortality" in Egypt, 37% of Egyptian farms were affected in 2015. All the main tilapia producing countries are monitoring the spread of the TiLV closely with some countries reporting mortalities of up to 90%. During an MSD sponsored session at World Aquaculture 2017, Dr Win Surachetpong, Kasetsart University reported on outbreaks in Thailand, the latest country to report TiLV (see page 5). There is some evidence that certain genetic strains of tilapia are resistant. Ferguson et al. (2014) noted that one strain of tilapia (genetically male tilapia) incurred a significantly lower level of mortality (10-20%) compared with other strains.

Increasing omega-3 fatty acids in fillet

One of the main drawbacks of tilapia is the low levels of omega-3 fatty acids whilst consumers are encouraged to eat fish high in omega-3. This issue likely to be addressed in the near future with exciting new research from Cargill using omega-3 rich canola added to the feed. Not only will this reduce our global dependence on fish oils high in omega-3 but could be a very cost effective way of boosting omega-3 levels in mainstream commodity fish such as tilapia. Another big story that has enormous repercussions for the aquaculture industry is the "Feed Kind" protein produced by Calysta in collaboration with Cargill and many other investors. This product is 71% crude protein which seems suited as a very cost effective fish meal alterative. These new feed ingredients combined with huge research on microalgae (DSM and Evonik are leading the field) as sources of many essential feed ingredients especially omega-3 fatty acids bode very well for feed suppliers and consumers. An exciting feed development discussed at the recent World Aquaculture 2017 conference is another algae based product developed and marketed by MegaTech, a Swiss based company which can supply a complete fish feed with very high protein levels coupled with high concentrations of omega-3 oils.

Genetics

An interesting trend is the consolidation amongst the fish genetics companies and in tilapia, the recent purchase of Genomar by AquaGen (EW group) is significant. EW has recently also acquired Aquabel a large Brazilian tilapia breeding and distribution company. Genomar, with headquarters in Oslo, Norway, with its main tilapia breeding centre based at Central

Marketing premium tilapia fillet at SIAL 2017, Shanghai

Luzon State University in the Philippines has been working on tilapia genetics for many years and its Genomar Supreme Tilapia (GST) is well known in the industry. It will be interesting to follow developments particularly in Brazil, another rapidly expanding tilapia production country, with huge benefits in terms of water resources, climate and domestic demand for fish.

Eric Roderick is with Fishgen Limited, based in Swansea, Wales, UK. The company developed the YY male technology and markets broodstocks globally. Email: eeroderick@aol.com

Increasing the salt tolerance of Mozambique tilapia through selection supported by genomic methods

In land-scarce Singapore and amidst diminishing global freshwater supply, there is a need to develop fish strains that are fast-growing at increased salinity conditions. Mozambique tilapia (*Oreochromis mossambicus*) being one of the most salt-tolerant tilapia species, would be a promising candidate, but it would require selection to develop it into a commercially viable marine aquaculture species.

Temasek Life Sciences Laboratory (TLL) in collaboration with Marine Aquaculture Centre of the Agri-Food and Veterinary Authority of Singapore (MAC-AVA) started a selection project in 2011 to produce tilapia lines with increased salt tolerance. The founder population contained wild and farmed Mozambique tilapia individuals collected from different locations of the southern African regions. The goal of the project is to develop faster-growing tilapia lines that tolerate brackish or possibly even full seawater. This would make tilapia culture accessible for fish farms located along Singaporean and regional coastlines. They would also help to meet Singapore's future demand for affordable seafood.

Our selection program focuses on improving the growth rate of the Mozambique tilapia in water with increased salinity (25 ppt). The selection starts with mass crossing in freshwater ponds (as fertilization is hindered in seawater) followed by growing out the fingerlings at a research facility with continuous flow-through system containing seawater. So far, we have performed the selection through three generations (F2-F4). Based on the average body weight (ABW) at 3 months post hatching (mph) we have achieved an increase of approximately 10% per generation. Currently, the ABW of F4 individuals at 3 mph is about 33g with initial stocking density of 700-800 fingerlings/tonne of seawater. Although this is a substantial improvement in growth rate, there is still room for catching up with the Nile tilapia, which achieves about 50g ABW at 3 mph (Bentsen et al. 2012).

Using a set of proprietary indicators in the genome (microsatellites markers) developed at TLL, we are able to perform paternity tests for the selected offspring. This data can be used to ensure genetic diversity is maintained and loss of rare alleles is minimized, hence enabling mass crossing instead of pairwise crossing of brooders. To further enhance our R&D capability we have produced several genomic resources (e.g. genetic linkage maps) and recently completed a draft assembly of the Mozambique tilapia genome and transcriptome. These will allow for advanced selection supported by genomic tools in the near future.

Information from László Orbán, Ph.D. Senior Principal Investigator & Professor (adjunct) Reproductive Genomics Group Temasek Life Sciences Laboratory.

Reference available on request

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Enhancement of production performance and fish quality of red drum

By Alexandre Bédier, Vincent Bernier, Jérémie Chanut, Emmanuel Tessier and Piet Verstraete

What are the optimal digestible protein/digestible energy ratios for growth and fish quality of red drum (*Sciaenops ocellatus*) juveniles and adults up to market size in a recirculated aquaculture system?

Tropical fish generally grow much faster than temperate species and a harvest size of more than 1.5 kg can be obtained in 15-18 months. Therefore, the optimal composition of diets to support these high growth rates is likely to be very different from the traditional marine fish feeds used for temperate species. The need is for feeds capable of supporting high production performance during the whole grow-out period, from 30 g to 300 g for plate size fish, and up to 2.5 kg for fillet size cultured under high temperature conditions without affecting flesh quality. Moreover, little is known on the effects of different feeds on the quality and health of the large fish harvested.

In the case of the red drum, a few nutritional studies have been carried out in order to evaluate the dietary requirements of the species and its tolerance to terrestrial feedstuffs as replacement of fish meal-based proteins. However, most published studies have been done on small-size fish over a short period of time and thus did not cover the whole grow-out period.

The objectives of this two-year experiment were to determine optimal digestible protein/digestible energy ratios for growth, feed conversion ratio (FCR) and fish quality of red drum juveniles and adults up to market size. We formulated, produced and field tested the production performances of 3 diets for grow-out operations of red drum. In phase 1, from 30 g juvenile (88 day post hatch-DPH) to 300g (±200 DPH) for plate size fish and in phase 2, from 300g to 2 kg (± 500 DPH) for fillet size fish. We stress that this study is designed to focus on maximum feed intake rather than cost-effective feed management.

Further to this, we then investigated trace heavy metals bioaccumulation in fish tissues (muscle and liver) and performed sensory analysis to determine the effects of feed formulations on the organoleptic characteristics of farmed red drum (sensory profiles and hedonic testing).

Treatment diets

Three diets were formulated with the same raw materials (steam dried fish meal 65% protein, high HUFA fish oil, soybean meal, full fat soya, corn gluten, wheat, soy lecithin, vitamin and mineral premixes) and similar composition except for the % crude protein and % crude lipid levels, which varied from 48/12 (diet A) to 48/15.5 (diet B) and 44/15.5 (diet C).

Phase 1

During the first phase of the experiment fish were grown from 30g to plate size (300g) in closed recirculating systems. Red drum juveniles originating from the same spawning event from domesticated broodstock were randomly distributed to nine tanks of 2 m^3 capacity, each stocked with 104 fish (there were 3 replicates per test diet). Feeding was done continuously and at maximal feeding rate for all treatments. After 102 days of culture, the fish fed diet A reached an average weight of 262 ± 7.26 g, fish fed diet B reached an average 248 ± 7.00 g and for fish fed diet C, 226 ± 13.74 g. Diet A outperformed the other diets in terms of growth with average specific growth rate (SGR) of 4.51% for diet A, 4.45% for diet B and 3.83% for diet C. FCRs were 1.26 for diet A, 1.34 for diet B and 1.55 for diet C.

Phase 2

For the second phase of the experiment, 36 fish from each treatment in phase 1 were pooled and grown in a closed recirculating system comprising six tanks of 2m^3 until fish from the fastest-growing treatment reached fillet size (2.2 kg). After 542 days of culture, fish fed on diet A reached 2.265 ± 0.438 kg in comparison to 2.025 ± 0.452 kg for fish fed on diet B and 1.263 ± 0.419 kg for fish fed diet C. The average SGRs during the second phase were 0.59% for diet A, 0.63% for diet B and 0.60% for diet C. FCRs were 1.58 for diet A, 1.42 for diet B and 1.68 for diet C.

In both phases, the rearing conditions were:

- Photoperiod (illumination): 24/24h through phase 1; 16/24h during phase 2.
- Feeding frequency: during illumination period.
- Rationing similar to the tank that has the highest feed intake.
- 2 automatic feeders per tank + manual feeding.
- 1 airlift per tank.

Bioaccumulation of heavy metals

To get a clear picture of heavy metal bio-accumulation in large size cultured fish, the levels were measured in fish tissues (liver and flesh) and in the feed.

Additionally, liver condition and hepatosomatic index were evaluated per treatment and the bio-accumulation of five heavy metals (lead, cadmium, arsenic, mercury, and fluoride ions) were monitored in both liver and flesh tissues at the end of each growout phase. Generally, very low heavy metal bioaccumulation was observed in both flesh and liver with values often under the limit of detection.

Sensory evaluation

Finally, fillets from the different treatments were subjected to evaluation of their organoleptic characteristics by a panel of sensory experts. Organoleptic analyses were carried out at the sensory analysis laboratory of IFREMER in Nantes, France. The results revealed that the diet influenced the sensory characteristics of red drum flesh, mainly texture, some smell criteria and global intensity. In fact, differences between diets were significant. Texture might be correlated to size difference and growth rate of fish. Fillets from fish fed diet A obtained the best scores and were most appreciated in the organoleptic evaluation by consumers who had never been exposed to sensory evaluation and also by trained panelists.

Furthermore, in the hedonic tests, consumers showed a significant preference for fish fed diet A over those fed diet C, mainly because of its better texture and taste. The more discerning consumers referred to a “lack of taste” or “savourless” for fish fed diet C as well as “dry, dense and soggy” for texture of fish fed diet C. On the contrary, they showed a great appreciation for fish fed diet A.

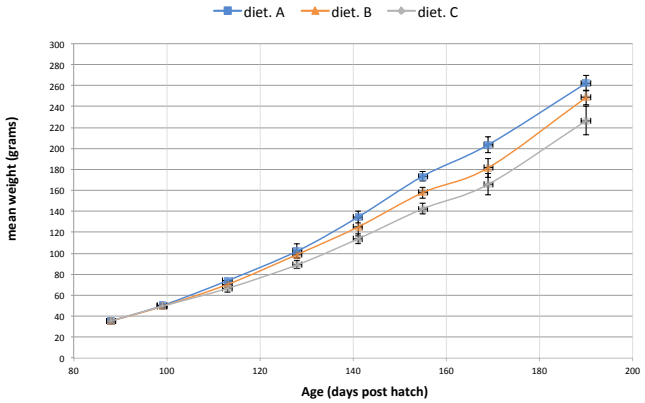

Figure 1. Growth performance (mean weight gain) during phase 1 – plate size grow-out phase (30-300 g)

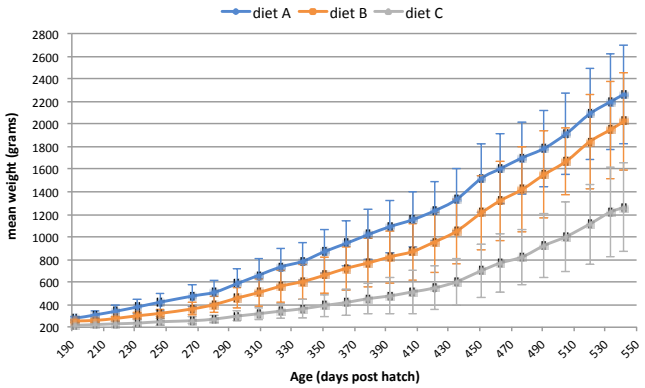

Figure 2. Growth performance (mean weight gain) during phase 2 – Fillet size grow-out phase (300 g -2 kg)


Alexandre Bédier


Vincent Bernier


Jérémie Chanut


Emmauel Tessier


Piet Verstraete

Alexandre Bédier is aquaculture engineer at Nutrima Production, Reunion Island as well as at the Marine Aquaculture Station, Hydrôréunion, and Reunion Island. Email: alexandre.bedier@hydroreunion.re

Vincent Bernier is Manager at the Marine Aquaculture Station, Hydrôréunion, Reunion Island. Email: vincent.bernier@hydroreunion.re

Jérémie Chanut is technician at the Marine Aquaculture Station, Hydrôréunion, Reunion Island. Email: jeremie.chanut@hydroreunion.re

Emmauel Tessier is Scientific Director at the Marine aquaculture station, Hydrôréunion, Reunion Island. Email: emmanuel.tessier@hydroreunion.re

Piet Verstraete is an independant consultant and General Manager of Nutrima Production, Reunion Island. Email: piet@4cmanagement.be

A phytogenic to improve resistance of aquatic farmed species against pathogenic agents

By Stephane Frouel, Clarisse Techer and Frederic Jozwiak

Results from laboratory trials in France and Thailand as well as field trials in Vietnam indicate a promising prophylactic or therapeutic application during certain critical disease outbreaks, subject to specific conditions.

Today, the challenge faced by the aquaculture industry is to maximize yield production to meet supply demands. One approach to reach this objective is to adopt a super intensive production system However, super intensive systems may ultimately lead to diseases outbreaks, introduction and spread of new pathogens. This pathogenic pressure significantly impacts the economics of farming. One solution has been the use of antibiotics to combat disease outbreaks but the massive use of chemicals in aquaculture nowadays raises public health concerns with antibiotic resistance and adverse effects on the environment.

Active research is ongoing to explore alternatives to antibiotic treatments. This article reports on research to evaluate the potential of a natural phytogenic based on specifically selected plant extracts (commercial name "A-Live", MiXscience, France) to control a broad spectrum of pathogens in aquaculture systems, first at a laboratory scale, followed with field trials. The antimicrobial effects of the phytogenic was investigated both *in vitro* and *in vivo*.

Evaluation of potential

In vitro, minimal inhibitory concentration (MIC) and minimal bactericidal concentration (MBC), of the product, respectively, were determined using microdilution methods against a wide range of pathogens from seawater and freshwater aquaculture systems. The MICs were compared to natural extracts known to have high antimicrobial potential such as citral, isolated from citrus oil, eugenol, from clove oil and carvacrol, from oregano and thyme oils. Finally, in order to evaluate the real potential of this product as an antibiotic alternative, MIC and MBC were compared to common antibiotics used in aquaculture (oxytetracycline, erythromycin and enrofloxacin).

Based on these preliminary studies, the product was then applied in challenge trials where the targeted species were either freshwater fish or marine shrimp.

Laboratory to farm trials

The *in vivo* laboratory scale trials for Nile tilapia *Oreochromis niloticus* were carried out in indoor 100 L tanks (Ictyopharma, France). Here an independent recirculation system was used where each system was equipped with a mechanical filter and a bio-filter as well as degasing columns and ultra violet lamps. Temperature, salinity, and oxygen levels were kept within the following range: temperature 27-29 °C, salinity 0 ppt and oxygen 5-7 ppm.

Tilapia juveniles of approximately 15 ± 0.4 g were used. Before challenge, fish were fed for a period of 28 days with the experimental diets (with the phytogenic dose of 1 kg/tonne of feed). After 28 days, experimental infection was performed by immersion. The immersion was performed in static conditions in the rearing tanks of the animals. A fixed volume of an overnight *Streptococcus agalactiae* culture at approximately $1x10^9$ CFU/mL was added to each rearing tank. The fish remained in the static condition with air supply for 1 hour after which the water recirculation was turned back on. After exposure, fish remained fed with the experimental diets (with the phytogenic dose of 1 kg/tonne of feed) during a 21-day observation period post challenge.

A similar protocol was used for the white shrimp *Litopenaeus vannamei* held in indoor 115 L glass aquaria in the Prince of Songkla University, Thailand. Each aquarium was aerated continuously. Water was exchanged at 20% every day. Temperature, salinity, and oxygen levels were kept within the following range: temperature 27-28 °C, salinity 25 ppt and oxygen 5-6 ppm.

Shrimp post larvae (PL5 with average body weight of 0.88 g ± 0.003) were used for the feeding trial. Before challenge, shrimp post larvae were fed for a period of 21 days with the experimental diets (with the phytogenic dose of 1 kg/tonne of feed). After 21 days, shrimp post larvae were exposed to *Vibrio parahaemolyticus* responsible for early mortality syndrome (EMS) in some of the experimental tanks and white spot syndrome virus (WSSV) in other tanks. For bacterial challenge, a suspension of *Vibrio parahaemolyticus* was prepared from a 18-24 hours culture and was adjusted to reach a final concentration of approximately 10^6 CFU/mL of culture water.

For viral challenge, a WSSV suspension at the LD50 concentration previously determined was applied. After exposure, shrimp post larvae continued to be fed with the experimental diets (with the phytogenic dose of 1 kg/tonne of feed) during a 14-day observation period post challenge.

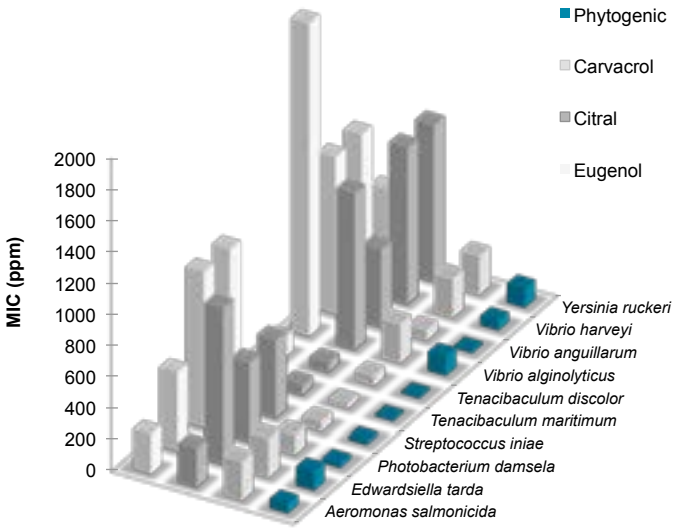

Figure 1. Minimal inhibitory concentration (MIC, ppm) of experimental phytogenic against aquatic pathogens and compared with equivalent products

Table 1. Minimal Inhibitory Concentration (MIC, ppm) and Minimal Bactericidal Concentration (MBC, ppm) of experimental phytogenic against aquatic pathogens and a comparison against selected antibiotics

	Phytogenic		Antibiotics					
			oxytetracycline		erythromycin		enrofloxacin	
Aquatic pathogens	MIC	MBC	MIC	MBC	MIC	MBC	MIC	MBC
Aeromonas salmonicida	**75**	**75**	>300	>300	9	12	9	12
Streptococcus iniae	**19**	**19**	12	12	3	3	5	5
Vibrio anguillarum	**25**	**25**	19	19	50	50	6	6
Vibrio harveyi	**100**	**100**	37	37	50	50	6	6
Vibrio parahaemolyticus	**50**	**50**	12	12	19	25	3	3

Finally, the effect of the phytogenic was tested under commercial farm conditions for both species in farms in Vietnam. The phytogenic was applied temporarily at a disease control dose of 4 kg/tonne of feed during 14 days in tilapia farmed in outdoor cages after the emergence of a streptococcal infection. It was applied at the same dose for a duration of 35 days in shrimp farmed in outdoor ponds after the appearance of vibriosis.

A wide spectrum action

In vitro results indicated that this feed additive showed a wide spectrum bactericidal action since it exhibited high efficiency against both gram positive and gram negative bacteria (Table 1). Moreover, it showed the strongest antimicrobial activity compared to equivalent competitor products. The experimental phytogenic presented the lowest MIC from 16 to 125 ppm whereas it was from 32 to 250 ppm for carvacrol, from 64 to 1,000 ppm for citral and from 64 to 2000 ppm for eugenol (Figure 1). It also demonstrated the minimal inhibitory and bactericidal concentrations from 19 to 150 ppm and in the same order of magnitude (less than 1 log unit) for the phytogenic and the tested antibiotics. These results demonstrated the potential of the phytogenic as efficient antibiotics alternative (Table 1).

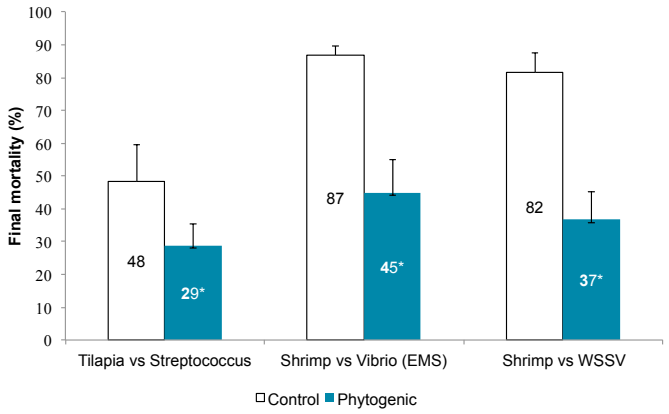

Figure 2. Final mortality (%) observed in different challenge trials under controlled conditions - Phytogenic applied at 1 kg/tonne of feed in tilapia and shrimp *ANOVA p <0.05

In vivo, during the research trials, there was a significant reduction of mortality (ANOVA p<0.05) regardless of farmed species and associated pathogens (bacteria or virus) as indicated in Figure 2. Antimicrobial effect of the phytogenic was confirmed under farming conditions where it significantly supported resistance of tilapia and shrimp (ANOVA p <0.05) when challenged with *Streptococcus spp.* and *Vibrio spp.* respectively (Figure 3).

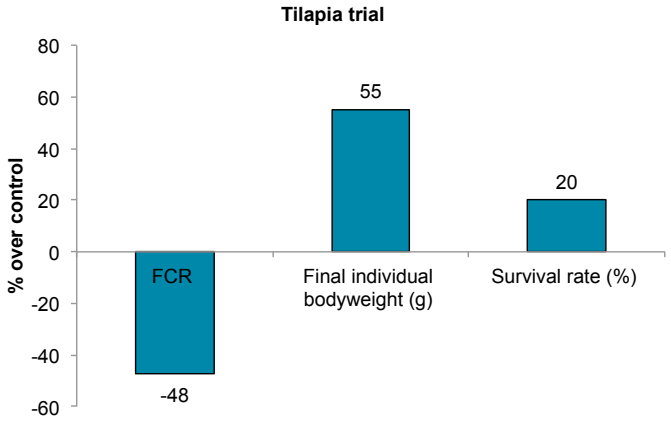

Figure 3A. Final growth performance parameters in Nile tilapia trial under farming conditions expressed as % over control - Phytogenic applied at 4 kg/tonne of feed. FCR-feed conversion ratio.

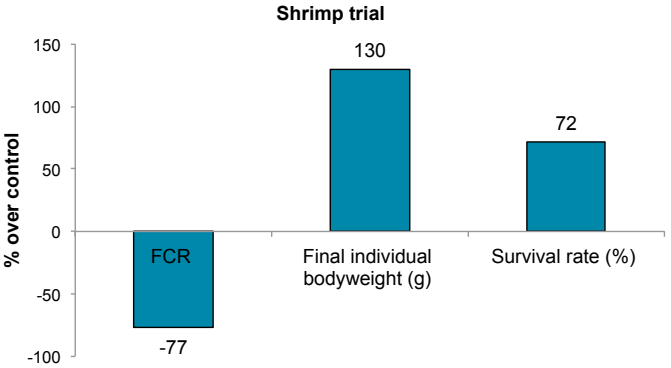

Figure 3B. Final growth performance parameters in white shrimp trial under farming conditions expressed as % over control - Phytogenic applied at 4 kg/tonne of feed. FCR- feed conversion ratio.

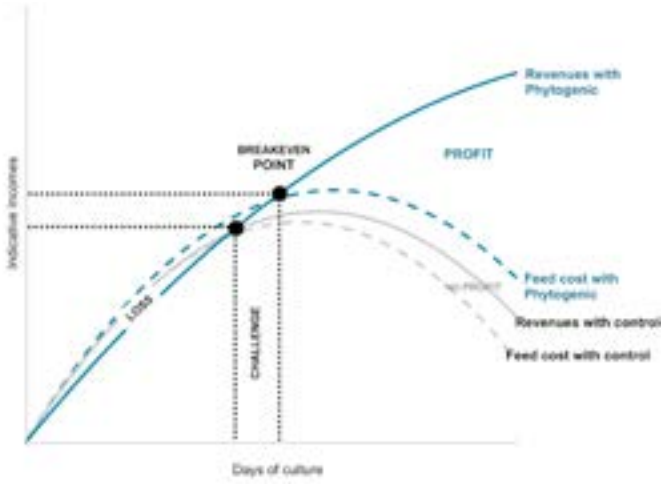

Figure 4. Profit Loss assessment diagram of the phytogenic applied under challenged conditions (data based on the Nile tilapia trial in Vietnam)

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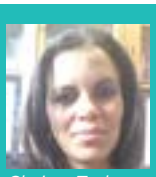
In terms of economics, under non optimal conditions and a few days after a disease outbreak, growth performance would be highly depressed. The incomes from sales of the harvest may not compensate for feed cost and the farmer would lose money. The application of the phytogenic helped to provide a good profit by maintaining significant increase in survival (20% more in fish and 72% more in shrimp) and thus a higher harvested biomass. In contrast, the harvest revenue from the control ponds did not increase and there were losses due to feed costs. This process is explained in the didactic breakeven point diagram based on the tilapia trial conducted in a fish farm in Vietnam (Figure 4).

We concluded that this new feed additive provides efficient control against a variety of pathogens and could be considered as a holistic and natural way of reducing the use of antibiotics in aquaculture systems. Trial data also showed the efficacy of the functional additive to counterbalance disease outbreaks and to maintain a reliable growth performance and farm profit. Moreover, this new phytogenic can be applied in a wide range of conditions either continuously as a prophylactic agent or during certain critical periods as a therapeutic agent. The optimal duration of application is at least 14 days before any known critical period or after the first appearance of disease symptoms.

Stephane Frouel



Clarisse Techer

Frederic Jozwiak

Dr Stephane Frouel is aquaculture specialist and is responsible for aquaculture project management including feed additives assays and worldwide trials. Email: stephane.frouel@mixscience.eu

Dr Clarisse Techer is microbiology specialist and is responsible for microbiology and new bioactives projects. Email: clarisse.techer@mixscience.eu

Frederic Jozwiak is aquaculture expert, responsible for the management of aquaculture products as well as providing technical support worldwide. Email: frederic.jozwiak@mixscience.eu.

All authors are with MiXscience, Avril group based in Bruz, Bretagne, France

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Dry fish soluble: a smart solution for shrimp diets

By Philippe Sourd and Vincent Fournier

From Argentinian fishing vessels to Asian shrimp farms for higher feed performance.

An appropriate nutritional balance, high digestibility, good pellet quality, and great attractability and palatability are key drivers in shrimp feed performances. Fish and shrimp solubles, squid liver paste, clam meal paste or even krill meal are thus very popular ingredients in Asian shrimp diets.

Depending on raw material quality and freshness, process standardisation and product preservation, those ingredients may be a good source of digestible marine proteins. Fish solubles (also known as stick-water) also improve the pelleting process and have been shown to enhance binding properties. In addition, these specific ingredients have a high content of marine soluble proteins and short peptides (<1000 Da), free amino acids and derivatives. They also have a high concentration of other nitrogen soluble compounds such as TMAO (Trimethylamine-N-oxide), nucleotides, total volatile base nitrogen (TVBN) and taurine. These are all deemed to be highly bioactive in shrimp. These nutrients are attractive and palatable for shrimp and can contribute to some health benefits as well.

Dry fish soluble

Yet, fish solubles can show a few downsides and all cannot be considered as being equivalent. Dry fish soluble (DFS) is an innovative ingredient which stands out as a smarter and more performing solution than liquid solubles, squid or clam ingredients

DFS is an innovative ingredient, produced in Argentina from wild caught Atlantic hake (*Merlucius merlucius*) co-products. This unique ingredient, manufactured with a patented process, has been elaborated and designed to bring new assets to shrimp feed formulators against other conventional ingredients. From quality to application, from standardisation to performance in shrimp, we review this new and original option for shrimp diets.

Freshness

A short (less than 24h after processing) and efficient (less than 1h transport) supply chain is key to delivery of fresh and safe raw materials for processing. A recent raw material survey conducted by Aquativ (Diana Aqua) indicated rather inconsistent freshness amongst batches of fish meal sampled on the market as shown in Figure 1. In contrast, the analyses of 32 batches of DFS showed a highly consistent low biogenic amine content. This is despite the fact that it comes from stick-waters that naturally contains more soluble nitrogen.

Although biogenic amines might interfere with the final shrimp feed performance, they are often a sign of supply chain inconsistency, possibly autolysed proteins or even compromised protein digestibility or bacterial contaminations. Such conditions negatively affect the performance of shrimp feed.

In Figure 2, a series of analyses (n=32) carried out on the Argentinian dried fish soluble (DFS) showed very good and consistent freshness all year long. This is attributed to a highly controlled and optimised supply chain detailed in Figure 3.

A unique nutritional profile

Drying stick-water requires a very specific technology which allows the preservation of protein quality, digestibility, while managing volatile nitrogen, short peptides stickiness, hygroscopic

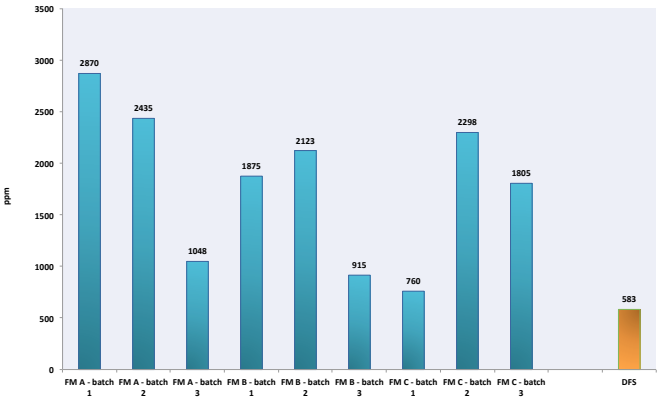

Figure 1. Total biogenic amines (histamine+cadaverine+ putrescine) content in Asian fish meal of various origin and Argentinean dry fish soluble (DFS)

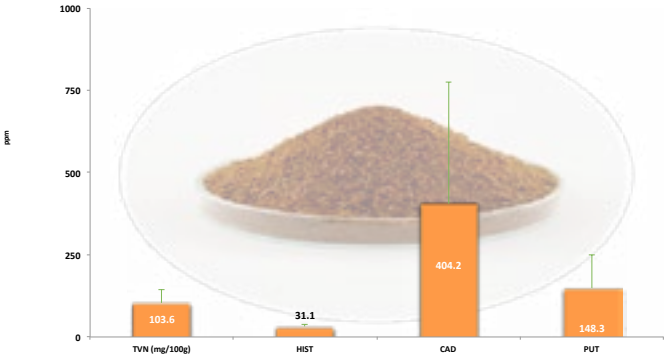

Figure 2. Biogenic amines content in Argentinean dry fish soluble (DFS). Data are mean ±standard deviation of 32 batches. TVN = Total volatile nitrogen; HIST= histamine, CAD=cadaverine and PUT=putrescine.

Figure 3. The supply chain from hake fisheries to DFS manufacturing.

and salt content. A unique patented process yields a very specific profile for Argentinian DFS.

DFS protein content (67%) is higher than liquid solubles (22-45%), krill meal (54-60%) or squid liver paste (28-41%) and is equivalent to prime fish meal (67-70%). Yet, DFS is not a fish meal as protein quality is totally different as shown in Figure 4. DFS shows a very high content of soluble protein and short peptides. This high concentration allows shrimp diet formulators to use a low dose to efficiently incorporate the highly bioavailable marine peptides, free amino acids and other soluble nitrogen compounds into the recipe to enhance shrimp performance.

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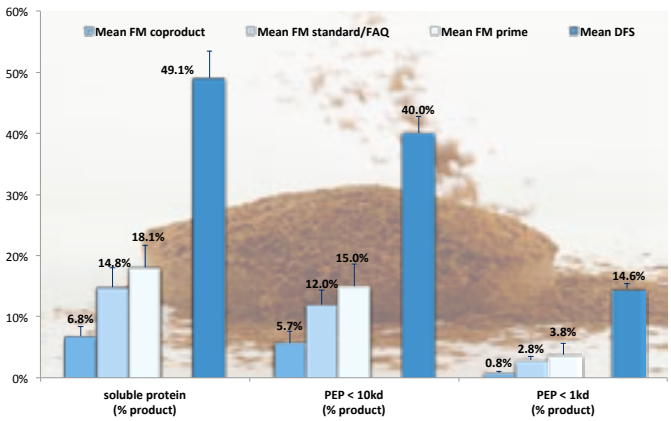


Figure 4. Comparison of protein profiles (% of product) between fish meals of various grades (n=7) and dry fish soluble (DFS, n=10). Note here the consistency of soluble protein content and quality with the short error bars for the DFS product.

Consistent profile with process and raw material standardisation

With another Aquativ survey presented during the TARS 2016 conference, we verified that marine ingredients sometimes show inconsistent soluble protein (and thus peptides) content because of a lack of raw material management and process standardisation. Even the most premium fish meals may show variations. Repeated analysis of super prime anchovy fish meal showed a wide range of 2 to 15% soluble protein depending on batches and origins. In contrast, the special process applied to manufacture DFS has been standardised to a point where each batch displays consistent product quality and protein profile as shown in Figure 4.

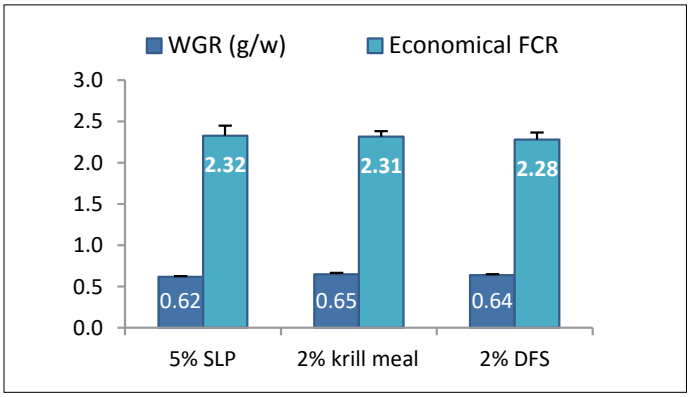
Hake sourced by Agustiner S.A for DFS production.

Superior performance

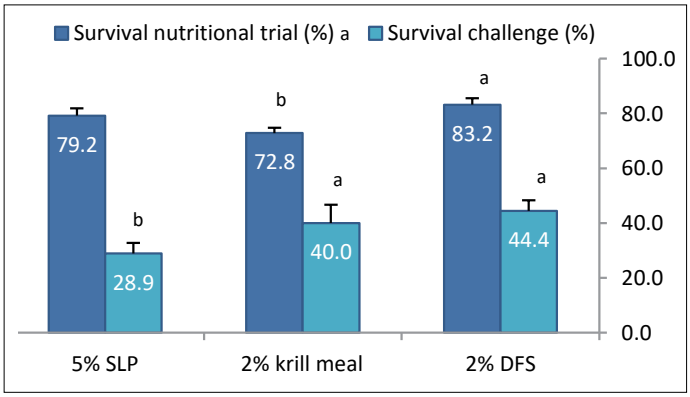
Beside these biochemical comparisons with other marine raw materials, performance benchmarks confirm that DFS delivers a better performance than alternative ingredients.

In a 52-day nutritional trial conducted on white shrimp (*Penaeus vannamei*) at Jeju University, South Korea, 2% DFS were incorporated in a 9% fish meal diet (33% CP, 8% fat). The diet performance was benchmarked against diets containing 5% squid liver powder (SLP) or 2% krill meal. SLP is well known as a shrimp feed booster. The shrimp fed the different diets were then subjected to a bacterial challenge (*Vibrio harveyi*, injection) and survival was followed up for 23 days to assess shrimp disease resistance.

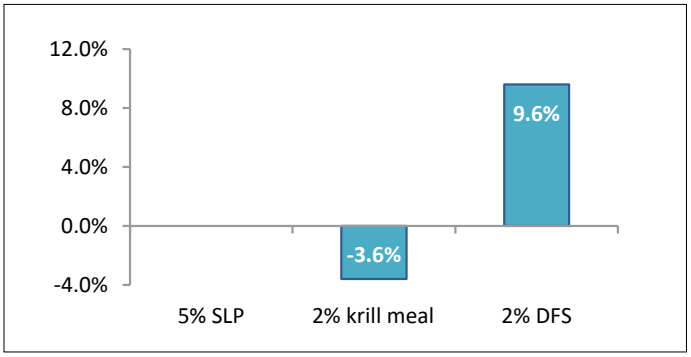
a. Weight and economical FCR



b. Survival % during the nutritional trial and challenges trials



c. Benchmarking against SLP. Gain production/tank (normalise to SLP diet



d. Lysozyme activity (µg/mL serum)

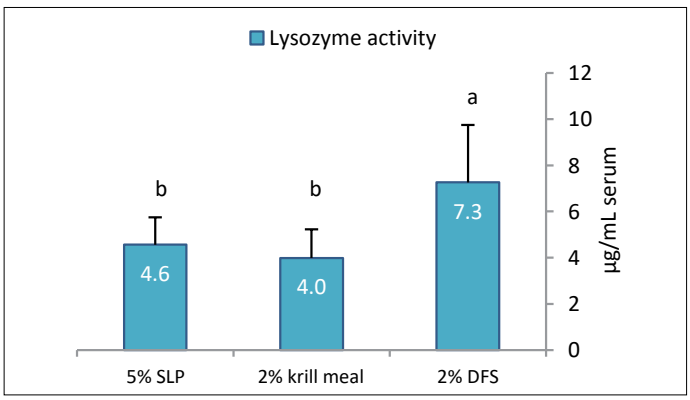


Figure 5. Zootechnical performance of shrimp fed dietary treatments after 52 days of trials. Data are means of 5 replicates/ treatment. When indicated, means with the same letters are not significantly different at P>0.05. Shrimp (initial body weight, 0.25 g and fed 4x daily.)

At the end of the trial, the diet with 2% DFS performed equally well compared to diets containing 5% SLP and 2% krill meal in terms of growth and feed utilisation. This clearly allows cost savings in formulation.

More importantly, shrimp fed the DFS diet showed a significantly better survival than those fed krill meal diet. The health benefit for the shrimp fed DFS diet was then further demonstrated during the challenge trial with a significantly higher survival compared to shrimp fed SLP diet. This came in addition to a noticeable functional effect of DFS on lysozyme activity observed in haemolymph of shrimp fed diet including DFS (Figure 5).

An easy application in the mill

Liquid ingredients are definitely not the favourite among operators of feed mill. Squid paste has been proven to be very labour intensive to use due to its thick and sticky paste form. It is really difficult to handle, pump, transfer and clean. Stick-water is another challenging ingredient to pump and dose in conventional systems. However, the dried and flowable form of DFS allows easy use in silos, making it a preferable solution for feed mills.

Sustainability

To our knowledge, there is no squid derived product certified for its traceability or sustainability in the market. The same applies to Southeast Asian fish solubles. Argentinian DFS is entirely produced from hake co-products. The hake is fished from Food and Agriculture Organization (FAO) Zone 41 and the coproducts generated in filleting lines. DFS is undergoing IFFO RS certification. This traceability commitment is an asset which answers the needs of shrimp feed producers supplying farms with important export markets.

Related article

Sourd, P and Fournier, V., 2016. Marine ingredient standardisation for feed standardisation. Aqua Culture Asia Pacific, Vol 12 (4), July/August, 2016, p44-47.

Philippe Sourd

Vincent Fournier

The authors are with SPF-Aquativ, the aquaculture division of Diana, part of Symrise AG, France.

Dr Philippe Sourd is Global Sales and Technical Director. Email: psourd@diana-aqua.com

Dr Vincent Fournier is R&D Manager. Email: vfournier@diana-aqua.com

Revisiting shrimp nutrition: Organic selenium (hydroxy-selenomethionine)

By Martin Guerin

This is a small and rewarding investment to improve stress resistance and maintain high levels of performance even during challenging conditions.

Diseases and resulting low productivity and high production costs represent the biggest issues in aquaculture in Asia. Diseases are estimated to have cost the global shrimp farming industry over USD 20 billion in lost revenue in the decade from 2005 to 2015 while in Asia, Streptococcus infections of tilapia may have caused losses of 289,000 tonnes in production and USD 480 million in revenue in 2015 (Shinn et al. 2016). In Vietnam, pangasius catfish farming mortality averages 30-40% (7% after stocking, climbing to 30% by mid-culture, and ending near 40% by harvest time), according to Van Hao (2010). This level of loss will not be tolerated in a more mature industry such as the poultry industry.

Stress factors that arise from the stocking process, or from crowding, poor and fluctuating water quality, and degraded pond bottom, are major contributors to disease problems. Poor feed quality, improper feed management and harmful microorganisms also are contributing factors. These lower the immunity of shrimp and fish, and make them more susceptible to pathogens. As in all animals, stress factors tend to accelerate respiration (and therefore energy consumption) of aquatic organisms.

ROS or "reactive oxygen species", such as peroxides, superoxides and other free radicals, are normal by-products of respiration. During stressful periods they are produced and released in larger quantities in the cells with negative consequences such as lipid oxidation in cell membranes, and denaturation of protein and DNA. These phenomena can be collectively described as "oxidative stress". Fortunately, organisms have natural defences including antioxidant enzymes such as glutathione peroxidase (GPx) to capture or break down ROS or eliminate oxidised products. GPx is a selenium dependent enzyme which plays major and critical roles in the defence against oxidative stress, by eliminating peroxides and reducing the oxidised form of glutathione to regenerate its antioxidant properties (Michiels et al. 1994).

Selenium plays a key role in cell metabolism because of its presence in GPx and other metabolically important selenoproteins. It is an essential micro element that must be added to premixes for aqua feeds in trace amounts to ensure optimum antioxidant status, growth, performance and disease resistance. For most aquaculture species, dietary selenium requirements vary between 0.2 and 0.4 ppm (NRC 2011).

In the non-specific immune response mechanisms, the "oxygen burst" consisting of excess ROS produced by shrimp lymphocytes or fish macrophages to kill or harm invading pathogens (Miles et al. , 2001), as well as the ROS produced by invading pathogens to break the host's cell membranes, are two processes that increase the need for these antioxidant enzymes.

Organic selenium

About 10 years ago, commercial aqua feeds started using organic selenium as it had a higher biological value versus traditional inorganic forms such as selenite. Organic selenium has a lower toxicity risk; unlike inorganic selenium, it is present as an amino acid as selenomethionine, which can safely accumulate in selenium-containing proteins. Shrimp feed manufacturers started adding organic selenium to address disease situations after a study had shown better resistance to a viral infection challenge with taura syndrome virus -TSV (Sritunyalucksana et al., 2011) in shrimp fed organic selenium than with those fed selenite or no selenium. However, yeast-derived selenium, the first generation of organic selenium, appeared to be unreliable, because the biological process they are derived from and yields of selenomethionine (63% in average) are variable. All the other selenium forms present in seleno-yeasts are not more bioefficacious than sodium selenite.

Hydroxy-selenomethionine

In recent years, hydroxy-selenomethionine, a 100% pure organic selenium form with high biological value and which is highly stable (significantly more stable than regular selenomethionine) under the harsh high temperature feed production conditions of aqua feeds, and very consistent in content, was introduced to the feed industry. While it is now well accepted in the poultry feed industry for its role in fighting stress and enhancing productive and reproductive performance, the aqua feed industry is only starting to appreciate its benefits. Two recent trials in Asia demonstrated these benefits.

Shrimp trials

In 2016, in Tamil Nadu, India, a commercial-scale trial was conducted in four 750 m^3 plastic-lined shrimp ponds using biofloc technology. The ponds were stocked with *Penaeus vannamei* postlarvae at a density of 262 PL/m^3. Post larvae were fed diets either containing 0.25 ppm selenium in the form of Selisseo® (a commercial form of hydroxy-selenomethionine), selenite, or without any selenium. After 50 days, the shrimp in the two ponds fed the diets containing hydroxy-selenomethionine had 20% and 30% better growth than the ponds fed diets containing selenite or no selenium, respectively (Figure 1). Shrimp fed diets containing the hydroxy-selenomethionine continued growing such that the farmer, at days of culture (DOC) 86, was able to harvest a high biomass (>1.5 tonnes) of shrimp size 15 g. The farmer could only harvest at DOC 107, shrimp from the ponds fed diets with selenite or no selenium, at smaller sizes and lower biomass (Zenagui, 2017, Figure 2).

More recently, a trial conducted at the JingMei University, Fujian Province, China, studied the effect of adding Selisseo® to *P. vannamei* diets formulated with 15% (low) or 30% (high) fish meal (Chunxiao et al., 2017). Juvenile shrimp (0.9 g/juvenile), stocked at 100 PL/m^3 were cultured in 500 L tanks for 8 weeks.

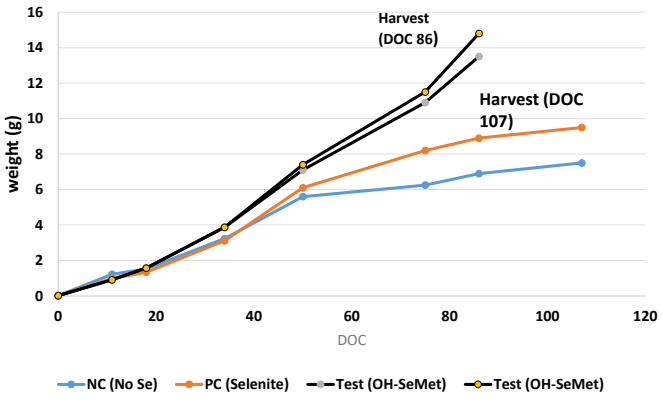


Figure 1. Growth performance of *P. vannamei* fed diets containing OH-SeMet in the pond trial in India

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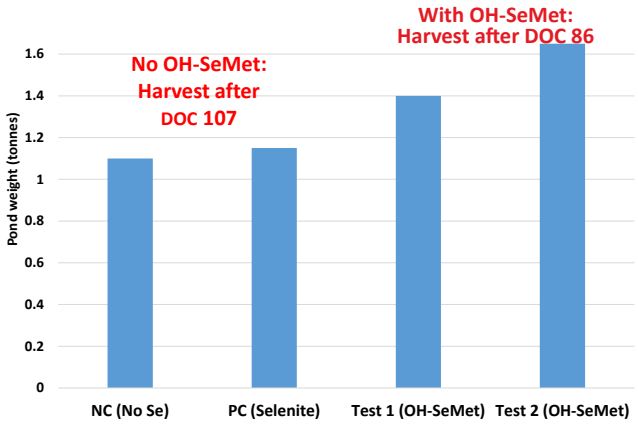

Figure 2. Final production output of ponds in the pond trial in India

The treatment diets contained either 0.3 ppm organic selenium from Selisseo®. The negative control diets contained zero organic selenium. Each dietary treatment was allocated to three tanks stocked with 50 shrimp each (0.9 g/shrimp).

Growth was overall good, and significant improvements in growth and yields were observed in shrimp fed 0.3 ppm organic selenium (Figure 3) in comparison with the negative control. Moreover, feeding organic selenium to the shrimp improved their antioxidant status by significantly increasing levels of antioxidant enzymes Se-GPX and superoxide dismutase. In addition, excess organic selenium was safely deposited in the muscle leading to higher accumulation of organic selenium in the shrimp fed the organic selenium. Growth in shrimp fed the higher level of fish meal and no organic selenium, was significantly faster than in shrimp fed only 15% fish meal. However, supplementation of the hydroxy-selenomethionine helped to improve growth in the lower fish meal inclusion diet and to overcome the growth deficit.

At the end of the 8-week feed trial, the researchers also conducted a stress challenge test by exposing the shrimp fed

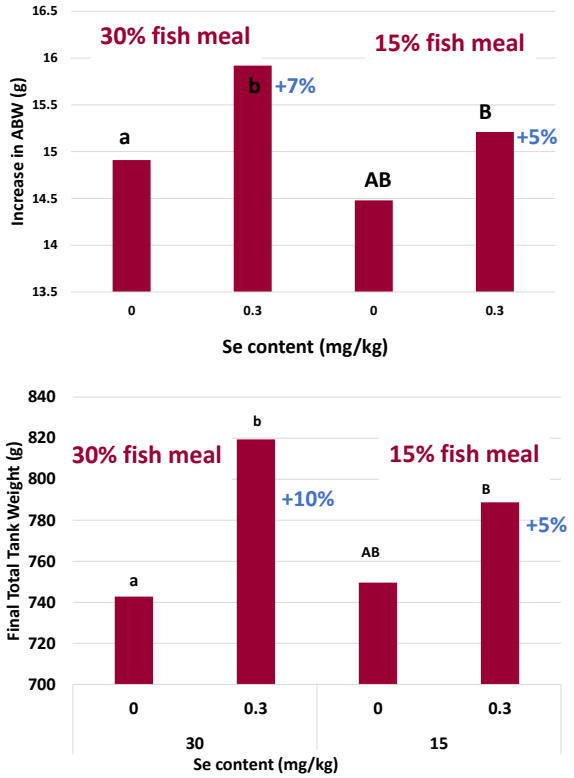

Figure 3. Effect of supplementation of OH-SeMet in low (15%) and high (30%) fish meal diets on growth performance of *P. vannamei* shrimp in a tank trial in China

> **"..results also open new lines of investigation on the protective effect of pure organic selenium which may be useful against stress or disease conditions in commercial farming.."**

the test diets to water with lethal doses of nitrite for 24 hours. Shrimp fed hydroxy-selenomethionine at 0.3 ppm selenium level had significantly higher survival than those fed with diets that did not contain selenium. (Figure 4)

This has important implications for commercial farming. High ammonia (NH_3) levels in pond water leading to elevated levels of nitrite are not uncommon in high density shrimp farming, especially in situations of poor feed management. They can be a trigger factor for disease outbreaks. Organic selenium supplementation is therefore a useful tool to reduce shrimp sensitivity to this stress factor.

These results also open new lines of investigation on the protective effect of pure organic selenium which may be useful against stress or disease conditions in commercial farming.

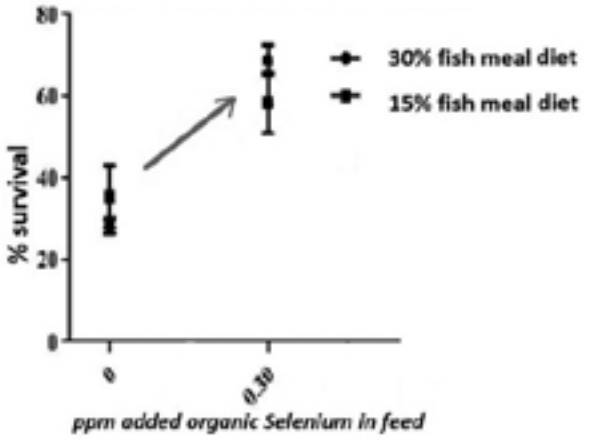

Figure 4. Effect of OH-Se Met supplementation on survival of *P. vannamei* exposed for 24 h to a lethal nitrite concentration in water

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Martin Guerin is a consultant in aqua nutrition based in Kuala Lumpur, Malaysia, with over 25 years experience working for international aquafeed and feed additives companies, mostly in Asia. Email: martin.guerin.aqua@gmail.com

Aflatoxin: A serious immunosuppressant in aquaculture

By Anwar Hasan and Rui A. Gonçalves

Sensitivity to AFB1 leads to biochemical changes and liver damage in the tra catfish aside from lower feed efficiency and reduced daily growth.

Mycotoxins are toxins produced by molds which occur frequently in a variety of feedstuffs, in particular plant based feedstuffs. The use of plant-based feed ingredients and the incorrect storage of grains and compound feeds can contribute to the mycotoxin contamination of aqua feeds. The harmful effects of mycotoxins on most terrestrial farm animals are well documented, while their effects on aquaculture species have been studied less extensively. Recent scientific research indicates that mycotoxins negatively affect fish and shrimp species in terms of health and performance, leading to economic losses for the industry.

Mycotoxicoses (clinical signs of mycotoxins ingestion) are not easily detected. Their effects in animals are diverse, varying from immunosuppression to death in severe cases. The effects of mycotoxins depend on the mycotoxin type, of which there are more than 400, in addition to contamination level, duration of exposure, species, sex, age, general health, immune status, nutritional standing and environmental factors. The latter includes farm management, hygiene and temperature. When an animal is exposed to harmful agents, e.g., pathogenic bacteria, its immune system is stimulated in order to eliminate the foreign organism and to counteract its negative effects. Animals fed mycotoxin-contaminated diets will have a reduced immunity response, as these toxic substances suppress immune system.

How mycotoxins cause immunosuppression

A high occurrence of mycotoxins in aquaculture feeds, suggests that mycotoxins are routinely consumed by fish or shrimp, causing subclinical symptoms that subsequently result in impaired health status, followed by decreased production efficiency.

Evidence suggests that consumption of diets contaminated with mycotoxins suppresses the immune system and decreases disease resistance. This can occur even when animals consume low or moderately contaminated products. As such, the negative effects often pass unnoticed and the economic losses are normally associated with disease outbreak or other causes, rather than with the presence of mycotoxins.

Mycotoxins in shrimp

Most mycotoxins cause impairment of the immune system by inhibiting the synthesis of key proteins associated with the immune function. It has been shown that the total haemocyte,

granulocyte and phenoloxidase activity are reduced in shrimp fed with T-2 toxin and zearalenone.

A negative correlation between the number of haemocytes and dietary concentration of aflatoxin B1 (AFB1) was also reported when feeding shrimp diets up to 2,500 ppb AFB1 during an 8-week period. A biochemical change of the haemolymph by AFB1 was also observed. A decline in the activity of such immuno-competent cells causes a decline in the immune response of shrimp.

Mycotoxins in fish

Fish can also be affected by mycotoxins. Aflatoxins can impact the fish immune system, reducing the production of certain cell components such as C4 complement and lymphokines e.g interleukins, and T lymphocytes. In some species, they may increase the levels of pro-inflammatory cytokine TNF-α significantly in the head kidney.

Apoptosis, necrosis, inflammation and increased number of rodlet cells have been verified in kidney, liver, heart, spleen and brain of fish fed with diets contaminated with fumonisins (10 ppm). At low level contamination (0.5 ppm), fumonisins can increase liver enzyme activity and bilirubin concentration, indicating liver damage, as well as increased creatinine concentration, indicating adverse impact on the kidney.

Tra catfish sensitivity to aflatoxins

The tra catfish, *Pangasius hypophthalmus* is one of the most cultured species in the world. It is known for its resilience to rearing conditions. In one experiment, our aim was to study the effects of AFB1 on tra catfish and the efficacy of Mycofix® Secure (Austria) on counteracting any negative effects provoked by AFB1.

The experiment was conducted in 15 hapas (2 x 1 x 1 m) divided to 5 diet groups containing 0, 50, 250 and 500, ppb AFB1 (µg AFB1/kg diet) each, and one diet group containing 500 ppb AFB1 and Mycofix® secure at 0.15% inclusion level. All the hapas were placed in one earthen pond. One hundred fish (8 g ± 0.2) were bulk weighed and randomly transferred into each hapa.

Growth performance

After 8 weeks, the catfish showed sensitivity towards AFB1. The presence of aflatoxins raised the feed conversion ratio (FCR), resulting in lower feed efficiency and reduced daily growth significantly and average weight gain $P < 0.05$ (Table 1).

The arrangement of experimental system in an earthen pond

Table 1. Effect of AFB1 in tra catfish on weight gain, daily growth and FCR

AFB1 (µg/kg)	Initial weight (g/fish)	Average weight gain (g/fish)	Daily growth rate (%)	FCR
0	7.98±0.13^a	32.6±0.43^a	2.96±0.04^a	1.27±0.02^a
50	7.91±0.04^a	31.2±0.82^b	2.90±0.03^a	1.31±0.04^b
250	7.95±0.20^a	30.7±0.10^b	2.87±0.04^b	1.31±0.02^b
500	7.86±0.17^a	30.3±0.37^b	2.87±0.00^b	1.31±0.02^b

Source: Biomin. Values with different letters are significantly different ($P < 0.05$). values displayed are average ± standard deviation

Liver damage

In fish, certain enzymes can be used as indicators of hepatotoxic effects. One such enzyme is aspartate aminotransferase, or AST which is found in high concentrations in the liver, heart, muscles and kidney. Tissue damage causes the release of AST. Alanine aminotransferase, or ALT, is present primarily in liver cells and is highly associated with hepatic necrosis, or liver damage. Histology of healthy liver cells (Figure 1) is compared with liver cells affected by AFB1 toxicity in figures 2 and 3.

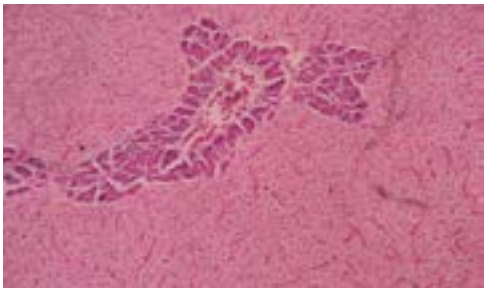

Figure 1. Healthy liver cells are in close proximity to one another (a) and undamaged hepatic artery wall (b) of the control group for 12 weeks (H&E x 100)

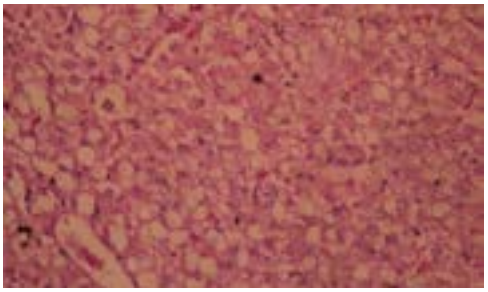

Figure 2. Accumulation of lipid in liver cells (a) affected by AFB1 at 100 ppb for 12 weeks (H&E x 400)

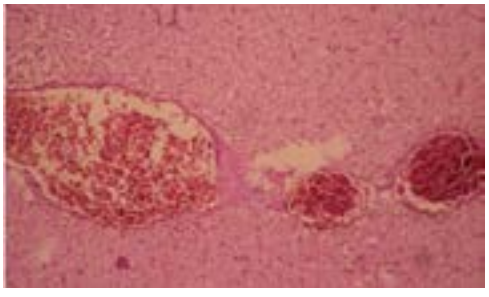

Figure 3. Hepatic artery wall broken (a) and venous congestion (b) produced by AFB1 at 250 ppb for 12 weeks (H&E x 100). H&E = Hematoxylin and eosin stain

After 8 weeks of trial, the activities of AST were significantly higher for animals fed 250 and 500 µg/kg AFB1, compared to the control, indicating liver damage due to AFB1 in diet. ALT showed similar pattern to AST, showing significant increased level for 250 and 500 µg/kg AFB1 in diet (Table 2).

Table 2. Enzymatic activity indicates the effectiveness of treatment in preserving liver tissue.

AFB1 (µg/kg)	AST (UI/L)	ALT (UI/L)
0	402.0±43.9[a]	27.6±5.3[a]
50	436.6±44.0[ab]	31.2±9.0[ab]
250	495.1±47.7[b]	41.8±7.6[b]
500	498.2±35.7[b]	41.4±7.4[b]

Source: Biomin. Values with different letters are significantly different (P < 0.05). values displayed are average ± standard deviation

Counteracting aflatoxins

Binders or adsorbents have been used to neutralise the effects of mycotoxins by preventing their absorption from the animal's digestive tract, in particular for aflatoxin. However, the binder needs to be specific enough towards aflatoxin in order to avoid any possible adsorption of micronutrients, such as trace minerals and vitamins. The results showed that the mycotoxin deactivator Mycofix® Secure could neutralise the negative effects of AFB1 by preventing its absorption from fish digestive tract without impacting performance. The deactivator at 1.5% in the diet improved the catfish immune system as well as growth performance, in some cases even obtaining better results than control group, despite the fact that 500 ppb of AFB1 was present (Table 3).

Table 3. Effect of Mycofix® Secure on performance and enzymatic activity.

	Supplemented AFB1		
	0	500 (µg/kg)	
		Supplemented Mycofix® Secure	
		0	1.5 %
Weight gain (g)	32.6±0.43[a]	30.3±0.37[b]	33.6±0.41[a]
DGR (%)	2.96±0.04[a]	2.87±0.00[a]	2.99±0.04[a]
FCR	1.27±0.02[ab]	1.31±0.02[b]	1.24±0.02[a]
AST (UI/mL)	402.0±43.9[a]	498.2±35.7[b]	404.5±33.6[a]
ALT (UI/mL)	27.7±5.3[a]	41.4±7.5[b]	32.8±3.6[ab]
Erythrocyte (x 10^9 cells/mL	2.96±0.12[a]	2.33±0.20[b]	2.79±0.16[a]
Leukocyte (x 10^6 cells/mL)	2.03±0.03[a]	2.67±0.22[b]	1.95±0.10[a]

Source: Biomin. Values with different letters are significantly different (P < 0.05). values displayed are average ± standard deviation

Different mycotoxins, different strategies

The chemical structure of different mycotoxin varies considerably. As a result, it is impossible to counteract all mycotoxins by using a single strategy.

The flat chemical structure of aflatoxins allows them to be captured between the layers of bentonite, a popular binder material. Once the mycotoxin enters the binder layers, the electric force generated by the atoms of both compounds tightens the bond. The less flat chemical structure of other mycotoxins results in less effective adsorption.

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

Anwar Hasan

Rui A. Gonçalves

Anwar Hasan is Regional Technical Manager – Aquaculture, Biomin based in Indonesia. Email: anwar.hasan@biomin.net

Rui A. Gonçalves, Scientist – Aquaculture at Biomin, Austria.

Natural remedies against vibriosis in shrimp culture

By Niti Chuchird, Arunothai Keetanon, Cristina García-Diez, Álvaro Rodríguez Sánchez-Arévalo and Antonio Martínez

A phytobiotic was able to reduce *Vibrio* counts in intestine and hepatopancreas leading to an increase in survival and better health.

Shrimp farming is growing very fast in recent years, due to the high profit margins which present a good opportunity for those with interest in this sector. In Asia the production of Pacific white shrimp (*Litopenaeus vannamei*) was more than 3 million tonnes in 2015 with a value of USD 14 billion (FAO Statistics, 2015).

Despite the efforts to produce specific pathogen free or SPF post larvae from hatcheries, farmers have to face continuous disease outbreaks along the production cycle. Pathogen free production does not exist as the pond ecosystem environment comes with high levels of bacteria and parasites. Some bacteria are needed for the culture while some are opportunistic. The balance between these pathogens is crucial in shrimp production, especially to avoid growth reduction and high mortalities. Even so, farmers are always exposed to the presence of acute hepatopancreatic necrosis disease/early mortality syndrome (AHPND/EMS), white spot syndrome virus (WSSV), *Enterocytozoon hepatopenaei* (EHP) and white faeces disease (WFS) disease.

Phytotherapy

Phytotherapy provides efficient solutions to the cultured animal helping them to fight against parasites, bacteria and/or fungal pathogens. Preventive strategies together with best management are vital for better profitability and sustainable farm production. The continuous inclusion of phytobiotics in the feed produces healthier animals, with better immune system and growth performance.

An experiment was carried out with the phytobiotic from Liptoaqua-Liptosa, Spain, made with organic acids, plants and essential oils in Kasetsart University for 60 days showed positive results in survival and growth in Pacific white shrimp. The study started with post larvae (PL10) transported from the hatchery and acclimated for 2 days in fiberglass tanks at the Aquaculture Business Research Centre (ABRC) laboratory. Nine fibreglass tanks (500 L) were used in this experiment and shrimp were stocked at a density of 80 shrimp/tank (120 PL/m^2). Salinity during the acclimation period and experiment was maintained at 25 ppt.

The phytobiotic Liptofry shrimp was top dressed on a feed from Charoen Pokphand Thailand (CP) with 36% crude protein, 5% lipids and 4% ash then mixed with fish oil and allowed to dry for 15 minutes. Three experimental groups were prepared with three tanks per group:

- Control group (without Liptofry shrimp);
- Phytobiotic inclusion at 5 kg/tonne; and
- Phytobiotic inclusion at 8 kg/tonne

Growth and survival

Shrimp were fed four times daily to satiation according to standard feeding rate. Water quality parameters such as pH, dissolved oxygen (DO), ammonia and nitrite were measured weekly throughout the experiment period. At the end of the 60 day feeding trial, shrimp from all the groups were weighed. Growth and survival rates of shrimp were statistically compared. Five shrimp from each tank were sampled for total *Vibrio* spp counts in the hepatopancreas and intestine.

Our results showed that shrimp fed with the phytobiotic at the dose of 5 kg/tonne had the highest survival rate of 84.7±1.15%, which was significantly higher than the group fed with phytobiotic at 8 kg/tonne (78.7±1.15%) and the control group (76.7±1.15%) ($P< 0.05$, Figure 1).

Collecting intestine for bacterial check

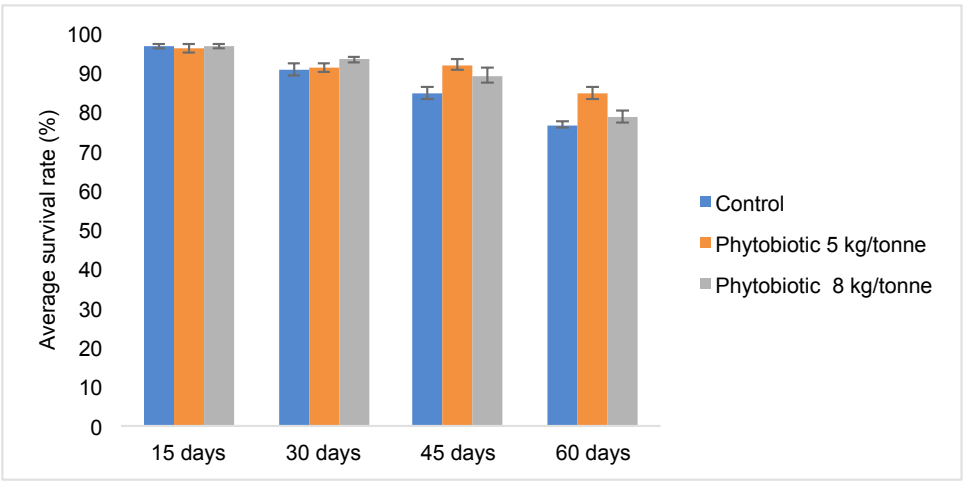

Figure 1. The average survival rate of Pacific white shrimp at 15, 30, 45 and 60 days of feeding with different diets.

The average body weight (ABW) of shrimp is shown in Figure 2 while the food conversion ratio (FCR) of shrimp fed different diets is shown in Table 1. After the 60-day feeding trial, shrimp from the two groups fed with Liptofry shrimp had significantly higher (P<0.05) body weight and FCR compared with the control group.

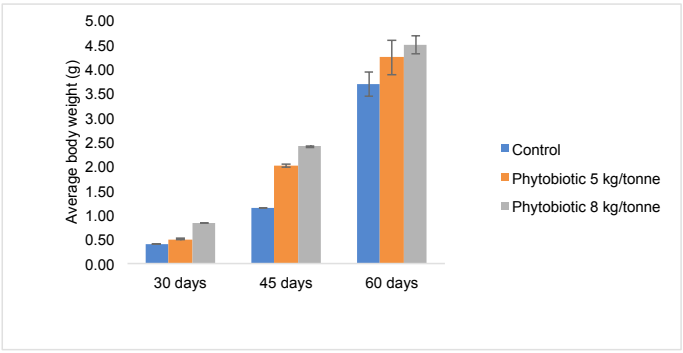

Figure 2. The ABW of Pacific white shrimp at 30, 45 and 60 days of feeding with different diets.

Table 1. The feed conversion ratio (FCR) of Pacific white shrimp after 60 days of feeding with different diets.

Treatment	FCR
Control	1.78±0.14[a]
Phytobiotic 5 kg/tonne	1.40±0.12[b]
Phytobiotic 8 kg/tonne	1.42±0.05[b]
Data are presented as mean ± standard deviation. Means in the same column with different superscript are significantly different from each other (p<0.05).	

Bacteria counts

The average total number of bacteria and *Vibrio* spp. in the intestine of shrimp throughout the study period is shown in Table 2. Shrimp fed with the phytobiotic at the dose of 5 and 8 kg/tonne had significantly (P< 0.05) lower number of total bacteria and *Vibrio* spp compared with the control group over the 30 days until 60 days feeding period.

The average total number of bacteria and *Vibrio* spp. in the hepatopancreas of shrimp is shown in Table 3. Shrimp fed with the phytobiotic at the dose of 5 and 8 kg/tonne had significantly (P< 0.05) lower number of total bacteria and *Vibrio* spp compared with the control group over the 30 days until 60 days feeding period.

Table 2. Bacteria and *Vibrio* spp. in the intestine of Pacific white shrimp.

Treatment	Total number of bacteria (10^4 CFU/g)		Total number of *Vibrio* spp. (10^3 CFU/g)	
	30 days	60 days	30 days	60 days
Control	6.55±0.38[a]	7.56±0.51[a]	4.56±0.19[a]	5.11±0.38[a]
Phytobiotic 5 kg/tonne	5.00±0.33[b]	4.22±0.51[b]	3.89±0.38[b]	3.22±0.51[b]
Phytobiotic 8 kg/tonne	4.22±0.19[b]	4.00±0.67[b]	3.11±0.38[c]	2.89±0.38[b]
Data are presented as mean ± standard deviation. Means in the same column with different superscript are significantly different from each other (p<0.05).				

Table 3. Bacteria and *Vibrio* spp. in the hepatopancreas of Pacific white shrimp.

Treatment	Total number of bacteria (10^3 CFU/g)		Total number of Vibrio spp. (10^2 CFU/g)	
	30 days	60 days	30 days	60 days
Control	8.22±0.19[a]	9.11±0.19[a]	7.22±0.51[a]	8.33±0.33[a]
Phytobiotic 5 kg/tonne	7.44±0.19[b]	6.11±0.38[b]	6.33±0.58[a]	5.11±0.19[b]
Phytobiotic 8 kg/tonne	6.00±0.33[c]	5.44±0.51[b]	5.00±0.58[b]	4.33±0.67[b]

Data are presented as mean ± standard deviation. Means in the same column with different superscript are significantly different from each other ($p<0.05$).

Conclusions

Liptofry shrimp at 5 kg/tonne showed significantly higher survival rate compared with the other treatment groups (10%). Irrespective of dose, the phytobiotic showed significantly higher average body weight and lower feed conversion ratio compared with the control group. At 5 kg/tonne, the phytobiotic improved feed conversion ratio by 27% when compared to the control. The total number of bacteria and *Vibrio* spp. in shrimp fed with the phytobiotic was in all cases, significantly lower than the control group both in the intestine and in the hepatopancreas.

The continuous inclusion of Liptofry shrimp at 5 kg/tonne in the whole cycle can improve significantly the production parameters with reduced Vibriosis outbreaks.


Niti Chuchird


Arunothai Keetanon


Cristina Garcia-Diez


Álvaro Rodriguez Sánchez-Arevalo


Antonio Martinez

Dr Niti Chuchird is Director and **Arunothai Keetanon** is a researcher at the Aquaculture Business Research Centre (ABRC), Faculty of Fisheries, Kasetsart University, Thailand. Email: chuchird@yahoo.com

Cristina Garcia-Diez and **Álvaro Rodriguez Sánchez-Arevalo** are team members of Liptoaqua, the aquaculture department of Liptosa while **Antonio Martinez** is General Manager of Liptosa, Lípidos Toledo S.A. Madrid, Spain. Email: cristina.garcia@liptosa.com

Improved performance of tilapia fed commercial extruded diets supplemented with a protease complex

By Saharat Kuakji, Orapint Jintasataporn, Supornchai Sri-Nhonghang and M. A. Kabir Chowdhury

A full cycle cage trial in Thailand explores the merits of the enzyme to help nutritionists meet their feed performance targets.

The high cost and scarcity of quality protein sources are forcing feed manufacturers and formulators worldwide to use low-cost but poorly characterized alternatives. These alternatives often have imbalanced amino acid profiles, may contain some anti-nutrients, are poor in digestibility, and thus, severely limiting their inclusion in aquaculture feed.

High inclusion of these poor quality raw materials may result in reduced nutrient digestibility, poor performance, and sometimes, extremely poor gastrointestinal health. The quality of these raw materials also varies from region to region, season to season, manufacturer to manufacturer, and even among batches from a single manufacturer. To mitigate these inconsistencies, nutritionists and formulators often resort to irrationally high safety margins for some key amino acids and micro-nutrients to ensure the nutritional requirements of the target species are met.

However, we believe that the quality of these alternative proteins can be improved and the variations in their digestible amino acid profiles reduced by using enzymes, specifically with the use of protease enzymes. Recent studies have shown that proteases not only improve nutrient digestibility and growth performance, they also improve intestinal health, and may provide better immune responses under stress conditions.

Recently, a study was undertaken in Thailand to evaluate the effect of a dietary protease complex (Jefo Nutrition Inc., Canada) on the growth performance of Nile tilapia (*Oreochromis niloticus*) in farm and laboratory conditions.

Experimental protocol

In both trials, fish were fed three commercially manufactured extruded diets produced at a commercial feed mill (Thai Royal Feed Ltd., Thailand). These were;

- Diet 1 – positive control (PC, commercial diet),
- Diet 2 – low digestible protein diet + protease (LDP_PROT), and
- Diet 3 – PC + protease (PC_PROT).

Diet composition

In the LDP_PROT diet, terrestrial animal proteins (poultry byproduct meal and meat and bone meal) were increased by 2.2% by replacing the same amount of marine animal proteins from the PC diet. The protease complex was added to diets 2 and 3 at 175 mg/kg. All diets were formulated to be isoproteic (32.1±0.2% crude protein or CP) and isolipidic (5.3±0.2% crude lipid or CL).

The dietary protease complex used in this study is in a free powder form. It was added to the mixer, after which, the mash went through conditioning, extrusion, pelleting and drying as part of the commercial feed manufacturing process.

The proximate chemical composition of the test diets is given in the Table 1.

Table 1. Proximate chemical composition of the test diets

Proximate chemical composition	Diet 1 PC	Diet 2 LDP_PROT	Diet 3 PC_PROT
Moisture, %	8.3	7.3	7.9
Crude protein, %	32.1	31.9	32.3
Crude lipid, %	5.6	5.2	5.2
Crude fiber, %	3.9	3.8	3.9
Note: PC – positive control, commercial diet; LDP_PROT – low digestible protein diet + protease; PC_PROT – regular diet + protease;			

The farm trial

The farm trial was conducted for 17 weeks at a tilapia farm in Kalasin Province, Thailand. The farm has more than 1,000 cages of 25 m^3 each (2.5 W x 5.0 L x 2.0 D) located in a large reservoir (Lam Pao Dam). Eight cages were selected for the trial where two were for the PC diets, and three cages each for the LOWDP_PROT and PC_PROT diets.

Fish were fed twice daily. Every 28 days, around 50 fish were randomly chosen from each cage for weight gain assessment and subsequently for the adjustment of the feeding rate accordingly. At the end of the trial, all the fish from each of the cages were counted and weighed. Major parameters analysed for the farm trial were weight gain, specific growth rate, feed conversion and protein efficiency ratio.

Sampling fish in the cage farm trial

The 1,000 cage tilapia farm in Kalasin Province, Thailand

The laboratory trial

This was conducted for 8-weeks at the Nutrition and Aquafeed Laboratory, Department of Aquaculture, Faculty of Fisheries, Kasetsart University, Bangkok, Thailand. Fish were acclimated for 2 weeks prior to commencing the trial. A total of 180 fish (average body weight, 25±1.3 g) were randomly allocated to 12 tanks of 500 L each (4 replicates per treatment, 15 fish/tank).

Fish were exposed to natural photoperiod during the trial. Water quality was maintained within the optimal range: temperature was 27-28°C, dissolved oxygen > 5.0 mg/L, and pH > 7.2. During the trial, fish were hand fed three times daily (08:30, 12:30, 16:30) at 3-5% body weight. After 20 minutes of feeding, uneaten feed was removed and recorded. At the end of the trial, the proximal intestine and liver of three fish from each tank were dissected and analysed using an electron microscope.

Statistical analysis

All data were analysed by one-way ANOVA (analysis of variance). The Duncan's multiple range test (DMRT) was conducted to determine the differences between the treatment means. Alphabetical notations were used to mark the differences at significant level of $P < 0.05$.

The findings

In both farm and laboratory conditions, feed intake of the experimental feed was the same as the commercial feed. Growth of experimental fish was also as expected for the specific tilapia strain. Survival of fish was also within the normal range i.e., around 80% and at more than 90% in farm and laboratory trial, respectively.

In the laboratory trial, although all performance parameters of fish fed the protease supplemented diets (PROTs) and those fed the regular diet (PC) were similar ($P>0.05$), the fish fed the PC_PROT diets performed slightly better than the other two diets (LDP_PROT and PC) (Table 2, Figure 2). In the farm trial, fish fed the LDP_PROT and PC_PROT diets performed significantly better than those fed the PC diet ($P<0.05$) (Table 2, Figure 3).

However, the density of villi and the hepatocyte cell count of fish fed the LDP_PROT and PC_PROT diets in the laboratory trial were higher than those fed the PC diet conforming with the findings of the farm trial where the fish fed both protease supplemented treatments performed better than the PC diets (Figure 4).

Table 2. Performance of tilapia in laboratory and farm trials. Data are means±SE

Trial	Treatment*	Weight gain g	SGR	Harvest kg	Survival %	Feed intake g/fish	FCR	PER
Laboratory (8 weeks)	PC	51.0±1.4	1.99±0.08	1.07±0.07	93.3±5.4	73.0±4.4	1.43±0.09	2.16±0.15
	LDP_PROT	49.2±9.1	1.94±0.26	1.01±0.08	91.7±10.0	73.1±5.2	1.51±0.20	2.10±0.31
	PC_PROT	61.5±9.2	2.16±0.17	1.19±0.13	91.7±10.0	74.5±3.9	1.24±0.16	2.53±0.29
Farm (17 weeks)	PC	922±0.6^{c}	3.02±0.02^{b}	359±3.2^{c}	76.0±0.6^{b}	1,474±11.6^{a}	1.56±0.01^{a}	1.83±0.02^{c}
	LDP_PROT	964±0.6^{b}	3.07±0.02^{a}	401±3.2^{b}	81.4±0.6^{a}	1,386±14.2^{b}	1.39±0.01^{b}	2.09±0.01^{b}
	PC_PROT	1064±0.7^{a}	3.12±0.04^{a}	456±3.9^{a}	83.7±0.8^{a}	1,376±11.6^{b}	1.27±0.01^{c}	2.24±0.01^{a}

PC – positive control, regular diet; LDP_PROT – low digestible protein diet + protease; PC_PROT – PC + protease;
SGR – specific growth rate; FCR – feed conversion ratio; PER – protein efficiency ratio.
Different letters in superscript beside Mean ± SE indicate significant differences between treatments *(P<0.05)*.

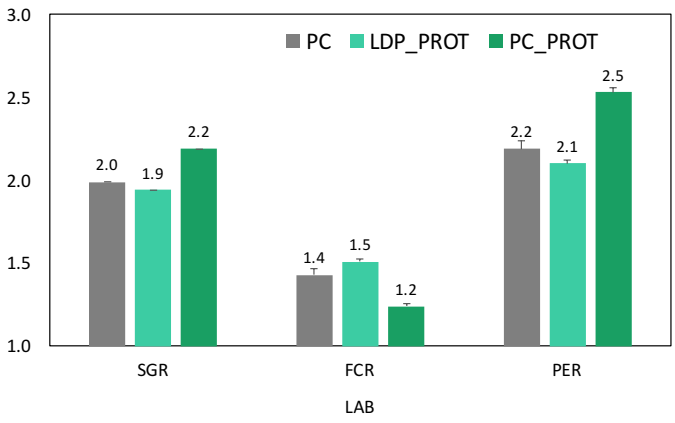

Figure 2. Specific growth rate (SGR), feed conversion ratio (FCR) and protein efficiency ratio (PER) of tilapia fed PC, LDP_PROT and PC_PROT diets in the laboratory trial

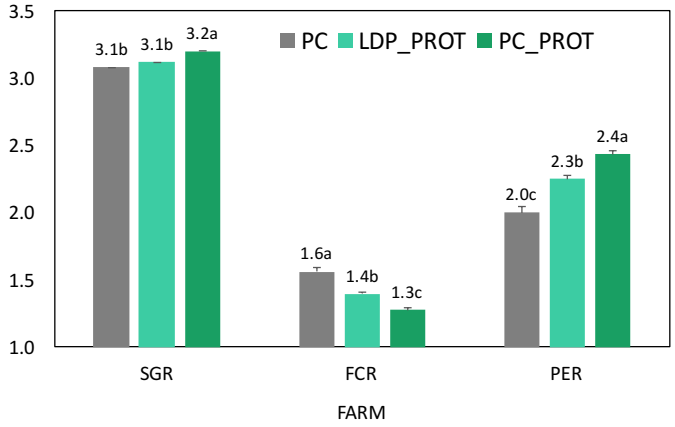

Figure 3. Specific growth rate (SGR), feed conversion ratio (FCR) and protein efficiency ratio (PER) of tilapia fed PC, LDP_PROT and PC_PROT diets in the farm trial

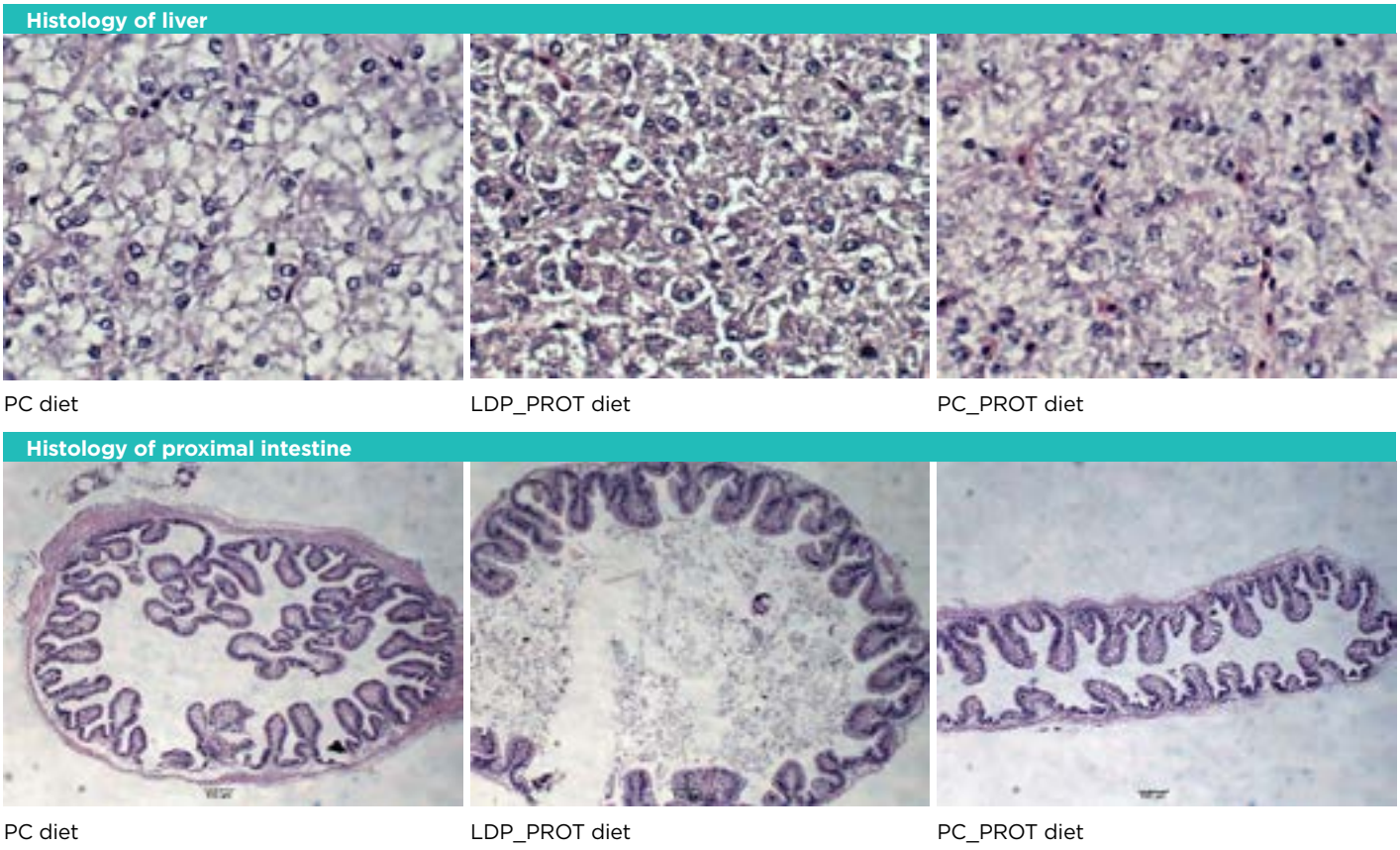

Figure 4. Histology of liver and proximal intestine of fish fed PC, LDP_PROT and PC_PROT diets in laboratory trial

The Final words

This study proved the efficacy of the dietary protease complex in improving growth performance and gut health of this Chitralda strain of Nile tilapia, cultured under both laboratory and farm conditions. A similar improvement in performance of other aquatic animals was observed previously with this protease complex. Those studies were conducted under a variety of environmental conditions and with species ranging from warm tropical water to temperate animals. These studies were with carps, snakehead, salmonids, tilapia, sea bass, sea bream, catfish, shrimp and crabs.

A major objective of most of these studies was to demonstrate similar or better performance in protease supplemented diets where a portion of the most expensive protein source was replaced with less expensive protein sources of poor digestibility.

In this study, the denser villi in the proximal intestine and higher accumulation of nutrients in hepatocytes in tilapia fed the protease supplemented diets indicate better absorption and assimilation of nutrients that eventually resulted in better growth performance. This is more pronounced in the farm trial where fish fed the low digestible protein (LDP_PROT) and regular diets (PC_PROT) supplemented with the protease had significantly higher weight gain and protein efficiency ratio compared to those fed the regular diet (PC).

Moreover, the formulation cost of the low digestible protein diet was much lower than the other diets bringing significant cost savings to the farmer and improving competitiveness of the operation.

Finally, it can be concluded from these findings that the dietary protease complex are beneficial when incorporated in commercially extruded feed. It can also bring significant cost savings (>USD 6/tonne of feed), when used in a low digestible protein diet, and can significantly improve performance of animals. Use of the protease complex could also be considered as an environment friendly choice as it would reduce nitrogenous and other wastes by improving digestibility of nutrients in feed.


Saharat Kuakji


Orapint Jintasataporn


Supornchai Sri-Nhonghang


M. A. Kabir Chowdhury

Saharat Kuakji is with TRF Feed Mills, Thailand

Dr Orapint Jintasataporn is Professor, Faculty of Fisheries, Kasetsert University, Thailand.

Dr Supornchai Sri-Nhonghang is Territory Manager at Jefo Nutrition Inc, Bangkok, Thailand

Dr M. A. Kabir Chowdhury is Global Technical Manager-Aquaculture at Jefo Nutrition, Quebec, Canada. Email: kchowdhury@jefo.ca

At APA 2017 trade show

This year's Asian Pacific Aquaculture 2017, promises a display of products from Malaysia based companies, regional aquafeed manufacturers to global feed additives and aquaculture suppliers. The 150-booth (at press time) trade show will have products in the following categories; aquafeeds (broodstock, larvae and post larvae, grow-out), amino acids, feed additives, artemia, polychaetes, health and diagnostics, genetics, health supplements, aerators and pond equipment, water treatment and analysis and probiotics. Below is a selection of exhibitors confirmed at APA 2017.

APA 2017 will be held from **Tuesday 25 July to Thursday 28 July** at the Putra World Trade Centre, Kuala Lumpur, Malaysia. The trade show hours are as such: **10.00 - 18.30 on 25-26 July 2017; 10.00-16.00 on 28 July 2017**. For more information on the tradeshow, email: mario@marevent.com. For more information on the conference: www.was.org

Showcase from Malaysia and Singapore

Booth No. 44 & 45

THK Sales & Service (M) Sdn Bhd was founded in 2002. It specializes in providing the full range of aquaculture products and services which include autofeeders, paddlewheel aerators, water pumps, HDPE geomembranes, LDPE sheets, submersible pumps and other farm related machinery. THK also provides consultation services such as planning, designing and constructing farm structures to farmers.

www.thk.com.my

New products: At this event, THK will display its new HDPE liner nursery and culture tank system

Show contacts: Tee Hock Koon, Tracy Tee Ghia Hoong, Thee Kim Heng and Tee Hock Keong

Booth No: 7

Lab-Ind Resource (LIR), Malaysia is a leader for aquaculture disease testing (ISO17025:2005). It provides cutting-edge diagnostic tools. Downstream, it offers residue screening and microbiology solutions to the industry and government agencies for food safety compliance. "Our international experience, expertise, end-to-end (integrated) solutions, proven track record are reasons why we are your best partner for pathogen screening , diagnosis and food safety (residue and microbiology)."

Websites: general: www.mylabind.com; laboratory testing: www.mylabind.wixsite.com/labtesting2u

New launch: PCR testing for OIE aquaculture pathogens, affordable end to end solutions of system (lab and mobile) and kits to diagnose TiLV, EHP, EMS.

Show contacts: Dennis Teoh, Leong Mun Chun and Winnie Siow (info@mylabind.com)

Booth No: 133,134

Fishance Bhd is a newly established aquaculture business specialising in indoor hatchery and cage fish farming system. The operations are based in the clean tropical waters off Langkawi Island, Malaysia. Started in August 2016, the company aims to engage in sustainable, clean and green aquaculture. It has the target to be the largest producer of farmed marine fish in Malaysia. It also wants to transform and highlight Langkawi as the first sustainable and successful international grouper species hub in the region. "With the production of 40 tonnes of fish/month, we are planning to grow to 300 tonnes/month farming groupers, red snapper, pompano and barramundi."

www.fishance.com

Technical presentation: Alexey Dorin will present on "Transforming Langkawi into a Grouper Industry hub in Malaysia" at the Malaysian Farmer's day session on Tuesday, 25 July from 11.20 in Room THO A.

Show contact: Alexey Dorin (a.dorin@fishance.com)

Booths No. 154, 155, 156

Aquatic Enterprise Co is an integrated one stop solution centre for aquaculture to meet the nutritional, disease prevention and treatment needs, for both the aquatic animals and environment to optimise production output. The main products are brine shrimp eggs (Artemia), vitamins and enrichment products for rotifer and artemia culture, all kinds of fish/shrimp feed, probiotics and feed additives. "For water treatment, we have products for water disinfection, purification and detoxification. For diseases, we have products to cure and prevent bacteria and parasite infection on fish and shrimp."

Websites: www.shrimpcare.com, www.marinefishculture.com, www.aquatickoi.com

New products: Frozen Free Shell Artemia (Ready to Hatch)

Show contacts: Chris Pui (chris@shrimpcare.com), Lesley Lou (Lesley@marinefishculture.com) for West Malaysia and Chong Mei Mei (chongmeimei@marinefishculture.com) for Sabah

Booth No: 43

Ionix Instruments is a Singapore company founded by pioneers in the analytical instruments industry to specifically meet the growing demands of the Asia Pacific customers. It designs meters (pocket, portable and benchtop) and sensors for measuring pH, ORP, conductivity, TDS, salinity, dissolved oxygen, and turbidity to meet various needs and requirements. "Our mission is to develop and distribute innovative and high quality products which provide great value for money to the discerning user." ***www.ionixinstruments.com***

Product launch: This is the new optical dissolved oxygen meter, an advanced fluorescence based optical sensor with several attributes; no electrode membranes or electrolyte required, low maintenance, simple to use, no warm-up or frequent calibrations required, no oxygen consumption, not flow dependent, no stirring required, fast response and is equipped with electrode calibration cap, which allows easy storage and calibration in water-saturated air. There will be demonstrations of the equipment at the booth.

Show contact: Raymond Chua (raychua@ionixinstruments.com)

HDPE liner nursery and culture tank system by THK Sales & Service (M) Sdn Bhd

International exhibitors

Booth No: 81-82

Nutriad International NV, Belgium, delivers products and services to over 80 countries supported by four application laboratories and five manufacturing facilities (Belgium, Spain, UK, USA, China). Nutriad is an industry leading specialist in the development, manufacture and marketing of animal and aqua feed additives worldwide. Nutriad's business unit aquaculture offers species-specific R&D capabilities, innovative products and nutritional/technological expertise for the aquaculture industry.

Key specialty programs for aquaculture additives are Health with additives supporting the prevention of diseases and parasitic infections; Digestion with species specific digestive/metabolic enhancers to reduce feed cost and improve performance in fish and shrimp and Palatability with palatability enhancers and attractants to replace fishmeal and stimulate appetite.

www.nutriad.com

Products: SANACORE® GM: Natural health promotion by improving gut health and modulation of gut microflora. Well documented, multiple modes of action against bacterial pathogens (including *Vibrio parahaemolyticus*, *Vibrio harveyi*), and quorum sensing inhibition mechanisms. APEX® AQUA: Phytobiotic product with broad-spectrum anti-microbial and anti-parasitic activities. APEX® BRANCHIA C: A synergistic phytogenic compounds with anti-parasitic actions. BACTINIL® AQUA: Natural anti-microbial action using synergistic actions of short and medium chain fatty acids. LIPOGEST: natural emulsifier to boost lipid digestion in fish and shrimp

Technical presentations: Nutriad will sponsor the session on Nutrition and Aquafeeds; subsession: Functional Feeds for Disease Prevention on Thursday, July 27th, 2017 from 8.30-12.20 at the TDI B room.

Show contacts: Allen (Ming-Hsun) Wu (a.wu@nutriad.com); Ho Gim Chong (GC.HO@nutriad.com)

Booth No:65-68

Sheng Long Bio-Tech International Co., Ltd. is an integrated aquaculture company based in Vietnam. It has several feed mills for the manufacturing of various aquafeeds; marine shrimp, freshwater and marine fin fish feeds. It markets aquafeeds to both domestic and global markets. It also has a hatchery producing SPF *L. vannamei* post larvae for the Vietnamese shrimp farming industry. It also supplies animal health products. As an aquaculture total solution services provider, Sheng Long also provides cold storage services.

www.shenglongbt.com

Product launch: Cost-effective prawn feed, fermented feed, probiotics.

Technical presentations: Sheng Long will sponsor the Industry session "The Advanced Research Developments on Shrimp Culture" on Wednesday July 26, 2017.

Show contacts: Ms Nhung and Maple Hung (sales.shenglong@gmail.com)

Booth No: 80

Higashimaru's larval feed for shrimp and fish are the products of more than 40 years of research and development. The feeds are formulated with strictly selected raw materials that contains essential nutrients for their growth and survival. All of Higashimaru feeds are extruded for high stability in culture water.

www.k-higashimaru.co.jp

Products: Higashimaru will be presenting feeds for *P. vannamei* shrimp; ZM-Zoea and ZM- Mysis and for the fish; Sango and Sango Float

Show contact: Yoshi Hirono (Yoshi.hirono@outlook.com)

Booth No: 127 & 128

Uni-President VN Co. Ltd, specialises in the aquatic industry with three feed mills and one hatchery in Vietnam. In addition, our subsidiary, UPVN trading company provides water treatment products, probiotic and aquaculture equipment. To offer the reliability and peace of mind to customers throughout the farming cycle, we have strict quality of each batch and continuously apply the latest research into feed production as well as introduce and support our farmers with new aquaculture technology. At the conference, there will be presentations by experts and staff on feed, probiotics and water treatment.

www.uni-president.com.vn

New products: Probiotics including photosynthesis bacterial PSB brand Uni-Light, *Bacillus* and *Lactobacillus*

Show contacts: Liou Hai Hua (liou@upvn.com.vn), Hung Cheng Yen (yen@upvn.com.vn), Tai Wei Chung (taiweichung@upvn.com.vn) and Ma Chin Tien (chintien@upvn.com.vn).

Booth No. 25

Behn Meyer Malaysia Sdn Bhd, combines the distribution of renowned brands with the development of its own products. Behn Meyer's core business units service a variety of industries, including animal nutrition, food, pharma, fertilizers, rubber and others. For products for the shrimp aquaculture industry, the company offers in shrimp industry, the products include Epizyme AGP-Complete, Epicin D, Epizym-PST, Epilite Z-M-PL, Epicin Ponds and Azomite.

www.behnmeyer.com

New products: Epibal 300, Epibal 500.

Technical presentation: Dr Fernando Castro, Epicore Bionetworks, USA, will present on "Study to determine attractiveness, digestibility, growth conversion, health of post larvae/juvenilies and water quality in nursery systems and comparing Epicore Bionetwork's Epibal 500 & 700 vs post larvae feed mill feed."

Show contact: Benjamin Yeo (benjamin.yeo@behnmeyer.com.my).

Booths 85, 86, 87, 88

Ocialis, is one of the leading fish and shrimp feed brand in Asia with products such as Vanalis and Nutrilis. Ocialis feed is produced from five factories in Southeast Asia. BernAqua is one of the world-wide market leader in the hatchery feed market.

www.ocialis.asia

Show contacts: Pierre Domps (pdomps@asia.neovia-group.com; Thomas Raynaud (thomas@vn.neovia-group.com).

Booth No.37

Daynew Aquatic Sci-Tech Co., Ltd, established in 2002, is a high-tech international enterprise, which integrates R&D, production and marketing of aquatic additives. The key products include functional feed additives and aquatic feed premixes, etc. Daynew has set up advanced enterprise management system and quality control system, obtained the ISO9001 and ISO22000 certification. It has a 3000 m^2 premix production workshop and two full-automatic Buhler production lines constructed strictly following international standards. It markets its product over China and is now expanding to Southeast Asia, South America and Africa.

www.daynew.cc

Products: DayHealth is a liver and intestine protector for animal health. DayWin is a natural growth promoter to reduce feed costs

Show contact: Yongqing Ye (yyongqing@126.com)

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Booth No: 117

Aeration Industries International, the worldwide leader in aeration systems and expertise, offers aquaculturists the premier aeration system for all water quality management needs. The AIRE-O2® Aquaculture Aerator is aquaculture's high performance aspirator aerator. It is a high quality, minimal maintenance unit with proven superior performance for over 43 years.

www.aireo2.com

Show contact: Marcos Kroupa (marcos.kroupa@aireo2.com)

Booth No: 136

Proviron Industries NV, Belgium has an aquaculture product line which combines a range of esterified fatty acids as functional feed ingredients with freeze dried microalgae. Nospot is a feed ingredient for shrimp feeds, improving technical performance (FCR and DWG) and reduces mortality upon WSSV outbreak. Gutyrate is a perfect butyric acid source for fish feeds, increasing but health and technical performance for different species. NannoPrime and IsoPrime are the two micro algae products for hatcheries of marine finfish, crustacean and molluscs.

www.algae.proviron.com

New products: Micro algae, nannochloropsis and isochrysis, freeze dried for marine finfish, crustacean and mollusc hatcheries

Show contact: Tina Rogge (tina.rogge@proviron.com)

Booth: 29, 34

Benchmark Breeding & Genetics is a global leader in aquatic breeding programs. The company is part of UK listed Benchmark Holdings plc. The division is currently running advanced family breeding programs for Nile Tilapia (Spring Genetics), *L. vannamei* shrimp (Genética Spring) and Atlantic Salmon (SalmoBreed/StofnFiskur). The division is also a world leading provider of genetic improvement services from Akvaforsk Genetics in Norway.

www.benchmarkholdings.com

New products: SPR Shrimp, Tilapia with improved streptococcus resistance

Technical presentations: These will be at the by-invitation only tilapia workshop

Show contacts: Birgitte Sorheim (birgitte.sorheim@bmkgenetics.com); Hernan Pizarro (hernan.pizarro@spring-genetics.com); Oscar Hennig (oscar.hennig@bmkgenetics.com), Hideyoshi Segovia (hideyoshi.segovia@spring-genetics.com) and Jorn Thodesen (jorn.thodesen@akvaforskgenetics.com)

Booth No: 137 - 140

Evonik produces and market all five essential amino acids used in advanced animal nutrition as well as probiotics for efficient and sustainable animal production. The company markets innovative products and a comprehensive range of services in analytics, animal nutrition and handling solutions.

www.evonik.com/animal-nutrition

New launch: Evonik's new AMINOTilapia® tool delivers precise recommendations for amino acids to accelerate growth, reduce feed dosage and minimize environmental impact resulting in a cost-efficient and sustainable feed formulation.

Show contacts: Dhanapong Sangsue (dhanapong.sangsue@evonik.com)/Chan Guan Song (guansong.chan@evonik.com)

Technical presentations: "Amino Acid Nutrition in Aquaculture: Application and Trends" on Wednesday, 26 July from 08.30-12.20 at Room TDI B

Booth No: 48

The Center for Aquaculture Technologies, Canada is a full-service contract R&D organisation, focused on the application of biotechnologies to improve productivity, efficiency and sustainability in aquaculture. The research divisions include: Breeding and Genomics, Fish Health and Nutrition, Diagnostics, Genotyping and Molecular Biology. "Our teams and facilities are well positioned to support a diverse range of projects."

www.aquatechcenter.com

New products: Bio Safety Level 3 containment unit, which allows for disease challenge trials with a wide range of pathogens and fish species.

Technical presentation: John Buchanan will have a poster/talk on "Development of a SNP marker panel for parentage, diversity and relatedness analyses in barramundi, *Lates calcarifer*"

Show contact: John Buchanan, jbuchanan@aquatechcenter.com

Booth No: 3, 4, 5

Pentair, USA's mission is to offer symbiotic biological and engineering solutions to support any aquaculture need. This means everything from designing a complete facility to engineering solutions for existing production systems, quality equipment and technical advice.

http://pentairaes.com

New products: PT4 Diffusers are among the most efficient diffusers available, allowing the increase yield while controlling the cost of expensive gases. PT4 Monitoring system offers a host of features suited to the customers' detailed requirements for continuous monitoring and control of water parameters. The RIU3 functions as either a stand-alone field mounted transmitter/controller, or can be daisy chained to create a multi-linked network connection, supporting up to 40 units. Sparus Pumps offer extremely high water flow in a quiet, energy efficient package making them effective in a wide range of aquaculture applications. PR AQUA Heathro 6" Fish Pumps make it easier to move fish and shrimp efficiently and safely. The continuous pumping action keeps fish in the water at all times minimizing damage and increasing output.

Technical presentation: On sustainability by Dr Luca Micciche'

Show contact: Dr. Luca Micciche' (luca.micciche@pentair.com).

Booth No: 38, 39

Phileo Lesaffre Animal Care works at the crossroads of nutrition and health. "We are committed to delivering farmed fish and shrimp health and performance solutions that contribute to food safety and the responsible use of antibiotics. Nothing is more precious than life. That is the philosophy driving Phileo. In every country, our progress is led by the most advanced science as well as practical on-farm experience."

www.phileo-lesaffre.com

New product: Aquasaf

Show contacts: Philippe Tacon (p.tacon@phileo.lesaffre.com); Tanuttha Suyawanish (t.suyawanish@phileo.lesaffre.com) and Otavio Castro (o.castro@phileo.lesaffre.com).

Booth No: 75, 76

Liptosa is a Spanish company specialized in manufacturing of specific phytobiotics and nutraceuticals for animal feed. Liptoaqua is the aquaculture division with a specific portfolio of products focused on health improvement of fish and shrimp.

www.liptoaqua.com

Products: Liptofry is a growth promoter with high antibacterial effect for shrimp post larvae and fish fry. Liptocitro G is an antiparasite against gregarines, myxosporidium and microsporidium in shrimp. Liptocitro MMM is an antiparasite against Trematoda, myxosporidium and microsporidium in fish.

Show contacts: Cristina García Díez (cristina.garcia@liptosa.com); Alvaro Rodríguez ara@liptosa.com

Booth No: 46

Marine Leader Co., Ltd., Thailand supplies feed and frozen feed for broodstock, larval feed, supplements in shrimp and fish rearing. There are also products for nursery systems.

www.marineleader.co.th

New products: Polychaetes, nursing MPL, feed and supplement for nursery system and fish

Show contact: Chatirot Intaraksa (marineleader@hotmail.com)

Booth No: 73, 74

Zeigler Bros., Inc. USA or ZBI is a global leader in the research, formulation and manufacturing of specialised, high quality aquaculture feeds, especially larval stage shrimp products. Founded in 1935, Zeigler is a third generation family owned and operated business located in Pennsylvania, USA.

www.zeiglerfeed.com

New products: Two new probiotics: Rescue, is a natural microbial treatment containing carefully selected strains for controlling Vibrio spp. and other pathogenic bacteria and Remediate, a natural microbial treatment containing carefully selected strains for ammonia reduction and organic waste remediation to improve water quality in aquaculture systems.

Technical presentation: Strategies on the replacement of Artemia nauplii in marine shrimp diets by Peter Van Wyk.

Show contacts: Tim Zeigler(tim.zeigler@zeiglerfeed.com), Chris Stock (chris.stock@zeiglerfeed.com); Peter Van Wyk (peter.vanwyk@zeiglerfeed.com); Ramir Lee (ramir.lee@zeiglerfeed.com); Murthy Chennamsetti (satya.murthy@zeiglerfeed.com) and Cao Khanh Ly (cao.khanhly@zeiglerfeed.com)

Booth No: 83

In-Situ's easy-to-use equipment keeps the hatchery running smoothly, even in harsh conditions. "Our solutions simplify aquaculture management, boosting efficiency through faster, more accurate monitoring. Increase your yields while reducing costs at your growing operation."

www.in-situ.com

Products: The smarTROLL Rugged Dissolved Oxygen Handheld system merges smartphone mobility with a reliable optical RDO sensor. The smarTROLL Multiparameter Handheld system allows instant data collection data on 14 water quality parameters, all from iOS™ or Android™ mobile device.

The RDO PRO-X Probe continuously monitors dissolved oxygen and temperature in ponds, tanks, and raceways. With accuracy up to 30.1 mg/L, it's the most accurate DO probe available for aquaculture management.

The Aqua TROLL 400 is an all-in-one multiparameter aquaculture probe that measures 12 water parameters, designed for aquaculture management and real-time pond water quality reporting.

Show contacts: Alex Hing (ahing@in-situ.com); Kanaiya Naik (knaik@in-situ.com)

New Asia Pacific regional hub in Singapore

Antione Baule, CEO inaugurated the new premises in the presence of Ms. Low Yen Ling, Senior Parliamentary Secretary, Ministry of Trade and Industry and Ministry of Education, and Marc Abensour, Ambassador of France to Singapore.

Lesaffre, a global key player in the yeasts and fermentation industry opened its new Asia Pacific Hub in Singapore in May, bringing its 160 years of expertise closer to their customers in the region.

The new Singapore regional hub houses at the same location as several of its teams in baking, food taste, human health and nutrition, animal care and biotechnology, and will consolidate Lesaffre's various business streams at the forefront of advanced yeast applications and improve collaborative engineering of tailored business solutions in the region. During the opening event, guests were introduced to Lesaffre's full range of capabilities.

The 1,000 m^2 space also houses a Lesaffre Baking Center™ – one of the largest in the world – and a Culinary Center, serving as collaborative spaces for innovation as Asian consumers' palates and nutritional demands rapidly evolve.

"Being at the heart of a region with an important role in the food, biotechnology, human and animal care sectors, fully justify the company's investments in Singapore. As a family-owned group, headquartered in France and operating in Asia Pacific for more than 40 years, Lesaffre is very committed to its new set up in Singapore to better serve its customers in the region" said Antoine Baule, CEO of Lesaffre.

The Singapore hub cements Lesaffre's commitment to its regional customers working with them to meet local demands in a diverse region. The project, an investment of SGD4 million, is expected to create more than 75 jobs by the end of 2018.

Joergen Lundgaard, Managing Director, Asia Pacific, said, "Singapore's capabilities as a high quality, future ready, global food ingredients hub was a key factor in our decision to make it the home of our Asia Pacific regional hub. Lesaffre will continue to invest in local and regional talent, process capabilities and innovative technology to support the robust growth in this important region." More information at www.lesaffre.com

International seminar on health and nutrition

The Olmix Group hosted the Olmix International Seminar on Health and Nutrition in Asia in Guangzhou, China from April 27-28. This year's edition was attended by 120 participants.

Aquaculture is the biggest consumer of fish meal since the 1990's reaching 73% of the world production in 2010 (Fish to 2030, World Bank, 2013). To ensure a sustainable growth, the industry has made tremendous efforts to reduce its dependence on fish meal. In 2000, 2.12 million tonnes of fish meal were used for aquaculture and ten years later only 2.85 million tonnes are used while aquaculture production has more than doubled (IFFO – FAO 2015). Tilapia is a leading aquaculture species. As an omnivorous fish, it requires low or sometimes even no fish meal content in the diets. Also, the feed conversion ratio (FCR) can be optimised as shown by **Professor Nguyen Nhu Tri** from Nong Lam University to produce a more cost efficient meat than beef and thus offer a cheaper protein source to the world.

However, fish meal replacers show some limitations such as the anti-nutritional factors (ANFs) from plant based protein sources, or the heavy nutrient imbalance of the ABPs. Even though information on fish nutrient requirements for most species is very limited, **Dr Mingchun Ren** from the Freshwater Fisheries Research Centre (FFRC) of Chinese Academy of Fishery Sciences, showed that there are many on-going projects to establish these requirements. The focus is on essential amino acid profile (EAA) requirements, especially methionine, lysine and threonine to allow a more accurate fish meal replacement. However, EAAs are not the only consideration when there is reduced or no fish meal in the diet.

Dr Orapint Jintasataporn, Kasetsart University said that fatty acid and mineral profiles should also be considered. She highlighted the fact that knowing the fish nutrient requirements is half of the task. Indeed, the digestibility of the dietary nutrients and micronutrients also needs to be understood. Organic minerals are more bioavailable than inorganic ones but the latter play a more important role in the digestive process as co-factor for the enzymes.

This more specific topic was reviewed by **Maarten Jay Van Schoonhoven**, Olmix Aqua Care Manager. While exogenous enzymes have been used in livestock diets to enhance certain digestive processes for a long time, it has not reached the same success in aquaculture. Initially created for livestock uses, exogenous enzymes have not always shown to be consistently effective in the fish or shrimp's environment (pH, temperature) as shown in the scientific literature. Another reason is the application method of post pellet spraying, that may not be optimum due to potential leaching in water and the extra investment required for its application. Olmix presented the OEA (Olmix Exfoliated Algo-clay) technology that enhances the activity of enzymes by providing co-factors and more surface for enzymes to attach and thereby form a stable structure.

Then ANFs, and especially the mycotoxin risk, commonly underestimated in aquaculture was presented by **Nguyen Thi Ly Luan**, from Olmix Vietnam. With diets sometimes consisting of more than 60% of plant raw materials, the mycotoxin threat is present. This was confirmed by the positive results obtained in aquaculture species with MT.X+ the toxin binder of Olmix. Besides animal performance, mycotoxins can affect animal immunity, leading to potential disease outbreaks.

However, aquaculture is not only about fish meal alone. it is also about the environment and public opinion. Ren said that the Chinese aquaculture industry, mostly oriented towards freshwater fish production with various species of carps, faces land and water shortage, disease outbreaks, etc. This is not the case with only China, but the global aquaculture. **Alexandre Veille**, Aqua Technical Support of Olmix suggested polyculture as a possibility to change public opinion and to produce in a more sustainable way.

Thus, diversification is the key to be more independent from health issues or disease outbreaks, and economic environment that cannot be predicted accurately. Tri also presented on the potential of tilapia to be more than meat production where the skin can be used as leather for shoes, seats and fish oil can be used for human medicine. More information: www.olmix.com

Acquisition of high-end shrimp feed producer

The BioMar Group has announced a strategic entry into the shrimp world. Since 2016 BioMar has been servicing Latin American shrimp farmers from the factory in Costa Rica with focus on sustainability and feed efficiency. With the acquisition of Alimentsa, BioMar will create a solid foothold into Ecuador which is one of the world's leading shrimp producing countries with a volume of more than 450,000 tonnes of shrimp.

"It is our ambition to become a major player within high-end shrimp feed. With the acquisition of Alimentsa we can immediately deliver an attractive value proposition to the shrimp farmers in Latin America and we believe that we in the future - together with Alimentsa and the customers - can develop new product solutions based upon shared interest in innovation, cooperation, sustainability and performance", said Carlos Diaz, CEO, BioMar Group.

The acquisition represents an investment of USD 119 million. BioMar Group estimates that the market will prove to be very attractive with growth rates of 8-12 %. Shrimp production in Ecuador is characterized by optimal conditions that allows up to three production cycles per year. Furthermore, the farming densities in Ecuador are quite low compared to other markets allowing much better and sustainable sanitary conditions. Alimentsa holds a market share around 12-15 %.

"We have during the last years expanded the business significantly. We believe in being 100 % devoted to aquaculture and we have clearly stated that we strive to be innovators dedicated to an efficient and sustainable global aquaculture." More information: www.biomar.com

Site for innovative, new omega-3 fatty acids production

Evonik and Royal DSM will locate the commercial-scale production facility for their omega-3 fatty acids from natural marine algae for animal nutrition in Blair, Nebraska. DSM Nutritional Products and Evonik Nutrition & Care plan to invest around USD 200 million in the facility (USD 100 million by each party over circa 2 years). The initial annual production capacity will meet roughly 15% of the current total annual demand for EPA and DHA by the salmon aquaculture industry. The facility is expected to come on stream in 2019. Both companies announced in March 2017 the start of a joint venture for this purpose. The establishment of the joint venture, to be named Veramaris® and headquartered in The Netherlands, will be finalized subject to regulatory approvals.

Blair, Nebraska, was chosen as it takes advantage of Evonik's decades of operational experience for large-scale biotechnology operations. The company has been operating a facility there for the fermentative production of Biolys® - the amino acid L-lysine - for almost 20 years. As an investor and employer Evonik has built a consistent reputation in the local community. The new plant will be located adjacent to Evonik's current facility on Cargill's site, with established access to the raw materials needed to produce the high value and pure EPA+DHA omega-3 fatty acid oil.

It will, for the first time, allow for the production of omega-3 fatty acids for animal nutrition without using any fish oil from wild caught fish, a finite resource, initial applications will be in salmon aquaculture and pet food.

Evonik's and DSM's highly concentrated algal oil will enable the animal nutrition industry to keep up with the increasing demand for these two essential omega-3 fatty acids without endangering fish stocks, helping to contribute to healthy animal nutrition as well as to the ecological balance and biodiversity of the oceans. More information: www.evonik.com

Genomar Genetics appoints new CEO

Alejandro Tola Alvarez has been appointed as the new Chief Executive Officer of Genomar Genetics, an EW Group company targeting the development and distribution of improved genetics for the rapidly developing tilapia industry. Alvarez comes from a position as Chief Technical Officer and he will be responsible for executing the company´s strategy on innovation, operations and business development, working with the company teams and customers as well as other organizations in EW Group.

"We are very pleased to find a highly qualified internal candidate for the CEO position", says Chairman Odd Magne Rødseth. Alejandro has played a major role in both R&D and commercial development of the most reputable and professional genetic brands in global tilapia aquaculture. He comes with a deep understanding of the tilapia operating environments and the opportunities of modern breeding technologies such as genomics to improve economic and environmental performance of the industry.

Alejandro is educated as Dr. vet. med. and has obtained master's degrees in the areas of aquaculture and business administration. More information, contact odd.magne.rodseth@ew-group.de

First experiences from increased transparency of aquaculture sources and production systems

In April, during Seafood Expo Global in Brussels, leading global certification program, GLOBALG.A.P. reported on the first experiences from increased transparency of aquaculture sources and production systems. One year after introducing the consumer label for fish and seafood from certified aquaculture, 31 farm profiles are now online. They represent ten labeled aquaculture products available on the market. In April, the German retailer GLOBUS introduced the first salmon on ice with the ggn.org label, sourced from The Scottish Salmon Company.

Craig Anderson, Chief Executive, The Scottish Salmon Company said: "Provenance and traceability are of increasing importance to consumers and are paramount to our business. Last year we became the first salmon producer in the UK to secure full GGN licensing, which provides even further reassurance of the premium quality of our Scottish salmon to our customers and consumers. By managing every stage of the production process, from broodstock through freshwater and marine farming to harvesting and packaging, as well as sales and marketing, we can ensure complete supply chain integrity, premium quality and full traceability."

The Scottish Salmon Company is the leading 100% Scotland-based producer of the finest sea loch fresh Scottish salmon. The company employs over 480 people across its 60 sites on the West Coast of Scotland and the Hebrides.

"While GLOBALG.A.P. certification is already a sourcing requirement for our fresh seafood department, the ggn.org label and portal offers our consumers an additional source for information," said Juergen Pauly, seafood buyer at GLOBUS. "Our seafood service team welcomes the additional proof of transparency during talks with consumers at our counters."

Available products with GGN label are listed with pack shots on the www.ggn.org website. New licenses are added every month, building up the pipeline of new products that will be available soon. A special newsletter for parties interested in B2B announces new listings.

"We are very pleased with the first experience and progress of new products introduced with the GGN label," said Kristian Moeller, CEO of GLOBALG.A.P." With our market presence in Germany, we are now ready to start our B2C social media activities to support our partners."

Panelist at the press conference. Kristian Moeller (second left) with from left, Craig Anderson, Jürgen Pauly, GLOBUS Group and Lisa Terese de Jager, DNV GL.

All aquaculture products with the GGN label are certified in accordance with the rules of GLOBALG.A.P. Aquaculture Standards. GGN stands for a thirteen-figure identification number by which all certified participants in the production and supply chain can be recognised. Fish farmers with this number can identify themselves as participants in the independent certification procedure in accordance with the GLOBALG.A.P. Standard. Importers and exporters in the worldwide supply chain are checked to ensure that GLOBALG.A.P. certified goods are suitably distinguished from non-certified goods and that they are correctly marketed as such.

Any visitor to ggn.org can find out who has produced a particular end product and which farm it was bred on. This direct link between the consumer and the original producer forms the basis of a chain of trust in food production. The GGN consumer label is based on the current GLOBALG.A.P. Standard Version 5, which includes a much wider range of species than most comparable standards. The standard covers extensive requirements for food safety, animal welfare, occupational safety and environmental protection. 32 different species of fish and seafood from aquaculture in 29 countries (as of 31 March 2017) are currently certified.

aquaculture europe 17

Cooperation for Growth

October 17-20, 2017
Dubrovnik, Croatia

AE2017 Plenary speakers

AE2017 will have three plenary speakers, one on each day of the three-day conference. AE2017 will feature a special international trade exhibition, where Croatian and international companies will present their latest products and services.

"Is substitution compromising our omega 3 (DHA) position?" - Professor Michael A Crawford, PhD, FRSB, FRCPath, Imperial College, London.

As we look to replace more and more fish meal and fish oil (for sustainability requirements) and replace them with terrestrial plants, the DHA content of farmed fish had also declined. Furthermore, arable land use has reached its limit and in many places the available area is in decline. Meeting the nutritional needs for population growth will require prioritising arable land for high yielding crops for human consumption and not to feed fish, hence the development of marine agriculture is a must.

Michael A Crawford will present on day 1. Wednesday 18 October: 09h00 to 10h00.

Professor Crawford is currently a visiting professor to Imperial College, London and Chief Investigator for a clinical trial on maternal nutrition and pregnancy outcome at the Chelsea and Westminster Hospital Campus. In 1972, he discovered the essentiality of the omega 3 fatty acids to the brain. His evidence was supported by the joint FAO-WHO expert consultations of 1978, 94 and 2010. His resent research points to the supreme importance of the health and nutrition of the mother to the intelligence of the new born child even in the months before conception.

"Large scale RTD facility to take tuna farming forward" – Fernando de la Gándara, Researcher at the IEO (Spanish Institute of Oceanography) and Director of the Murcia Oceanographic Center.

The Atlantic Bluefin tuna is an emblematic species that has fed Mediterranean human populations for centuries. Over the last two decades, its wild stocks have been severely overfished, with high quota limits leading to consequent reduction of the production. In order to satisfy high market demand, it is essential to increase bluefin tuna production coming from sustainable aquaculture where the whole biological life cycle is managed.

The Spanish Institute of Oceanography (IEO) has recently built a land-based large-scale facility (ICRA) for the control of the reproduction of this species, capable of hosting big size breeders. This facility is near the already existing IEO Aquaculture facility in Mazzaron, (Murcia, SE Spain), devoted to the research on Atlantic Bluefin tuna larval rearing and juvenile production.

Fernando de la Gándara will present on day 2. Thursday 19 October: 09h00 to 10h00.

Fernando de la Gándara, born in Barcelona (Spain) in 1958, is graduate and PhD in Biology from the University of Murcia (Spain). Researcher at the IEO (Spanish Institute of Oceanography) and Director of the Murcia Oceanographic Center. An expert on bluefin tuna (Thunnus thynnus) aquaculture and farming research. Over the last 18 years, he has coordinated and participated in more than 20 Spanish and European projects.

"Gene editing. A game changer for aquaculture?" – Anna Wargelius, Institute of Marine Research, Bergen.

Gene editing, using the CRISPR technique has been hailed as a 'major breakthrough' in human medicine, with its 'pros and cons' widely published and discussed over recent years in scientific and general press. But what are the uses of gene editing in plant science and agriculture and how have these benefited production of food crops? What is the potential for aquaculture and what are the main lines of work that are being researched at present? What are the quality/nutritional/market benefits and issues of this technology for aquaculture? What are the ethical questions that we must also consider as we assess if and how best to adopt this as a potential game-changer for aquaculture

Anna Wargelius will present on Friday 20 October at 11h45 to 12h30

Dr Anna Wargelius is a molecular biologist working on aquaculture genetics. She did her Bachelor and Master degrees at the University of Uppsala, Sweden and then a PhD at University of Bergen, Norway, working with zebrafish eye development. She was a post doc at the Institute of Marine Research, Norway working with development, reproduction in both salmon and cod.

She is currently the Group leader of the group of Reproduction and Development of fish at the Institute of Marine Research in Bergen, Norway.

More information: www. www.aquaeas.eu email: ae2017@aquaeas.eu

AE2017 organisers are still accepting abstracts, but please submit them online.

The program grid and program information is now online at the AE2017 page of the EAS website http://aquaeas.eu/39-uncategorised/365-ae2017-sessions with an overview of the sessions.

Aqua Culture Asia Pacific in 2018

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

2017

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**

July 24-27
Asia Pacific Aquaculture 2017
Kuala Lumpur, Malaysia
Web: www.was.org

August 2-4
Aqua Fisheries Cambodia 2017
Phnom Penh
Web: www.myanmar-aquafisheries.com

August 16-17
TARS 2017: Finfish Aquaculture
Bali, Indonesia
Email: conference@tarsaquaculture.com
Web: www.tarsaquaculture.com

August 20-25
24th Annual Practical Short Course on Aquaculture Feed Extrusion, Nutrition and Feed Management
Texas A&M, USA
Email: mnriaz@tamu.edu
Web: http://foodprotein.tamu.edu/extrusion

August 29-31
Vietfish 2017
Ho Chin Minh City, Vietnam
Email: namphuong@vasep.com.vn
Web: www.en.vietfish.com.vn

August 28-September 1
10th Symposium on Diseases in Asian Aquaculture
Bali, Indonesia
Web:www.fhs-afs.net/www.daa10.org

September 27-29
Aqua Fisheries Myanmar 2017
Yangon
Email: marketing.dept@veas.com.vn
Web: www.myanmar-aquafisheries.com

October 17-20
Aquaculture Europe 17
Dubrovnik, Croatia
Email: ae2017@aquaeas.eu
Web: www.aquaeas.eu

October 26-29
The 7 th International Conference of Aquaculture Indonesia 2017 (ICAI 2017)
Solo, Indonesia
Email: icai.mai.ias@gmail.com
Web: icai.aquaculture-mai.org

November 1-2
China Fisheries and Seafood Expo
Qingdao, China
Web: chinaseafoodexpo.com

November 7-10
LAQUA 17
Latin American and Caribbean Aquaculture
Mazatlan, Mexico
Web: www.was.org

November 9-11
Taiwan International Fisheries and Seafood Show 2017 (TIFSS)
Kaohsiung, Taiwan
Email: stenly_yonardi@myexhibition.com.tw
Web: www.taiwanfishery.com

November 16-18
11th Philippine Shrimp Congress
Bacolod City, Negros Occidental.
Email: robmdg@yahoo.com/r.usero@yahoo.com/ mariaabegail11@yahoo.com

2018

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

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THE AQUACULTURE ROUNDTABLESERIES® 2017

A shared vision for aquaculture in Asia

August 16-17 2017, Conrad Bali, Indonesia

Finfish Aquaculture: Strategies for Growth

Growth Strategies for Asia's Finfish Aquaculture

The **Aquaculture Roundtable Series (TARS) 2017** will address *Finfish Aquaculture: Strategies for Growth*. This is the second time this series of roundtables, initiated in 2011 is focusing on the finfish aquaculture industry. The meeting taking place in Bali, Indonesia from August 16-17 will explore the growth potential of Asia's finfish aquaculture industry, with a view towards developing a strategic approach towards market-driven production.

"Asia's finfish producers realise the need to be consumer-friendly fish providers, as the focus is on food safety. The industry must also address several challenges holding back its progress as a trusted and responsible fish supplier, including image and credibility issues," says Dr Zuridah Merican, editor of Aqua Culture Asia Pacific, and chairperson of TARS 2017.

TARS 2017 will start with the plenary session featuring state-of-the-industry and science presentations by invited local and international industry experts. It will be followed by a dialogue with three finfish farmers, group participation at breakout roundtable sessions and a final report session. The two-day meeting aims to promote positive image building and improve relationships and communication among the key players in the finfish sector, namely CEOs, technical managers, integrators, feed producers, farm, hatchery and technologists, investors, seafood marketers, as well as governments, NGOs, scientists and researchers, and other stakeholders.

REGISTRATION IS LIMITED TO 200 PARTICIPANTS.
Pre-registration required. Walk-ins not encouraged.
To register, go to www.tarsaquaculture.com • Email: conference@tarsaquaculture.com

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INTERACTIVE BREAKOUT ROUNDTABLE SESSIONS

"Strategies for Growth"

The plenary presentations sets the tone for the 3 interactive breakout roundtable sessions. Led by a group leader, participants will break into groups of 10 delegates/table to discuss issues and challenges impacting Asia's finfish aquaculture industry; identify opportunities; and recommend strategic approaches towards market-driven production. Leaders from each group will present a summary of the output at the Report Session.

Hard Talk with Finfish Farmers
A dialogue session with hard-hitting questions on farming models, challenges and success to overcome diseases in farms.

See overleaf for program >>>

THE AQUACULTURE ROUNDTABLESERIES® 2017
A shared vision for aquaculture in Asia
August 16-17 2017, Conrad Bali, Indonesia

Finfish Aquaculture: Strategies for Growth

Program

DAY 1: WEDNESDAY, AUGUST 16 2017

0715-0755	**Registration**
0800-0810	**Welcome Remarks**

SESSION 1: STATE OF INDUSTRY AND CHALLENGES

0810-0840	**State of Industry on Finfish Farming in Asia: Development Areas and Reputation Management** **Einar Wathne,** *Cargill Aqua Nutrition, Norway*
0840-0910	**Growing Finfish in Indonesia** **Erwin Suwendi,** *PT Suri Tani Pemuka, Indonesia*
0910-0940	**Challenges in China's Finfish Farming** **Niels Alsted,** *BioMar Group A/S, Denmark*
0940-1010	**Challenges Faced by a Marine Finfish Farming Business** **Laura Khor Li Imm,** *KS Aquaculture Sdn Bhd, Malaysia*
1010-1030	**TEA BREAK**

SESSION 2: NEW REALM OF ASIAN WHITE FISH

1030-1100	**Lessons from the Mediterranean: Strategies with Competition** **Hervé Lucien-Brun,** *Jefo Aquaculture Consultant, France*
1100-1130	**Increasing Value through Technology** **Olivier Decamp,** *INVE Aquaculture, Thailand*
1130-1200	**Moving the Pangasius up the White Fish Ladder** **Jonathan Wilson,** *GODACO, Vietnam*
1200-1240	**Q&A (Sessions 1 & 2)**
1240-1400	**LUNCH**

SESSION 3: PRODUCTION, HEALTH AND ENVIRONMENT

1400-1430	**Palatability Drivers in Fish Diets: From Modes of Actions to Applications for Quantifiable Enhanced Feed and Fish Performances** **Philippe Sourd,** *Diana Aqua – Aquativ, France*
1430-1500	**Parasite Prevention in Fish Farming** **Francisco E. Montero,** *University of Valencia, Spain*
1500-1530	**Responsibility for the Environment Starts with Feed** **Thomas Wilson,** *Aquaculture Nutrition Consultant, Thailand*
1530-1600	**TEA BREAK**

SESSION 4: PERFORMANCE FEEDS & COST EFFICIENCY

1600-1630	**Nutrition, Feed Formulation and the Commercial Field Realities** **Dominique Bureau,** *University of Guelph, Canada*
1630-1700	**Early Weaning with High Performance Larval Feeds** **Luís Conceição,** *SPAROS Lda, Portugal*
1700-1730	**New Tendencies and Challenges in Aquafeed Formulation: Focus on the Mycotoxin Issue** **Michele Muccio,** *BIOMIN Holding GmbH, Austria*
1730-1815	**Q&A (Sessions 3 & 4)**
1830-2030	**COCKTAIL RECEPTION AND END OF DAY 1**

DAY 2: THURSDAY, AUGUST 17 2017

SESSION 5: NEW FRONTIERS IN FINFISH FARMING

0800-0830	**A Future with Fishmeal-Free Diets** **Anant S Bharadwaj,** *Integrated Aquaculture International (iAqua), USA*
0830-0900	**Benchmarking: The Salmon Model** **Bent Pedersen,** *DSM Nutritional Products A/S, Denmark*
0900-0930	**Critical Success Factors for Marine Fish Farming: Kill the Pathogens or Live with Them!** **Alain Michel,** *Aquaculture Consultant, France*
0930-1000	**Q&A SESSION**
1000-1030	**TEA BREAK**

1030-1300	**Interactive Breakout Group Session *(Strategies for Growth)*** Group 1 – Performance & Functional Feeds Group 2 – Marketing, Image & Sustainability Group 3 – Production Efficiency & Industrialisation
1300-1430	**LUNCH**
1430-1530	**Hard Talk with Finfish Farmers** *Hard-hitting questions on farming models, challenges, successes and opportunities*
1530-1700	**Breakout Group Report Session** *(incorporating Tea Break)*
1700-1745	**Q&A and Panel Discussion**
1745-1800	**CLOSING REMARKS AND END OF DAY 2**

Scan this for speakers at TARS 2017