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AQUA CULTURE

Asia Pacific

Industry review: Shrimp production trends in Asia

Managing off-flavour in Thai seabass

A mycotoxin threat to yellow catfish

'Back to Basics' for aqua feeds

Genetic improvement of giant freshwater prawn

Moving aquaculture in Taiwan

MCI (P) 013/10/2016 PPS1699/08/2013(022974)

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Zuridah Merican

The year ahead – opportunities to be had

We do not like to start the new year with a gloomy note, but this is how the strong US dollar may impact our industry. There are pluses and minuses to this development with the dollar's strength. We can expect feed prices to rise as feed ingredients are traded in USD which in turn, will affect our cost of production. The competitiveness of industries in Malaysia, China and the Philippines with weakening Ringgit, Yuan and Peso, will change. A strong US dollar is nothing new to feedmillers. The real game changer is how the industry in each country will adapt along the supply chain in view of this.

On the brighter side, the industry can take advantage of an arbitrage market and at the same time revive the processing industry in most countries, which for several years have found it difficult to survive with high raw material costs and unattractive international prices. It is time for our shrimp, pangasius and tilapia processors to make hay while the sun shines.

In the shrimp farming industry, the biggest worry are outbreaks of the microsporidian *Enterocytozoon hepatopenaei* and white faeces syndrome, common in almost all countries. The challenge for farmers is the slow growth and high consumption of feed leading to massive increases in cost of production. The double jeopardy, as Anwar Hasan of Biomin pointed out in our review of Asia's marine shrimp sector is that after the higher cost of production, an emergency harvest results in smaller shrimp at lower prices. In 2017, we need to learn to effectively manage these two diseases.

In terms of shrimp farming, how can we exert more control over production? In 2017, I imagine that industry will contemplate and analyse nursery systems as a way to 'nip in the bud' some of the farming problems. The merits of a nursery as a controlled production system at the early stage of culture will be to get stronger and bigger post larvae before stocking into 'open' grow-out ponds. This new phase of farming encompassing 30 days allows for more focus, control and the use of more expensive, quality, and also functional feeds. The benefits compared to the costs are significant when one takes into consideration the small quantities of feeds. A more recent issue is using post larvae from specific pathogen resistant/tolerant brood stock. But, we have learnt that our farmers do not want slower growing animals (apparently a characteristic of SPR stocks used in Asia). After all, here in Asia, we are rather spoilt with genetically selected strains of fast growers. Should we follow the path of farms in South America and consider SPR stocks? There is an increasing tendency but we have to ensure that these stocks are specific pathogen free too.

In the past year, the tilapia and pangasius have faced low prices because of oversupply. This is a classic case of two steps forward and one step back, at least with the tilapia. Demand will inevitably pick up and the industry will be on its feet again. While tilapia has jumped to be in the top 4 whitefish consumed in the US, it still has a long way to go in Europe. Indonesia has announced that it is will focus on expanding its production of seabass while Vietnam has a target of 300,000 tonnes of tilapia by 2020. Both will require generic marketing to expand markets although domestic consumption should take up a considerable part of production.

There are many challenges which we expect to address at ***TARS 2017: Finfish Aquaculture-Strategies for Growth***. We see a huge disconnect between demand and supply in Asia and though there are large investments in production, there is little effort in production efficiency, product development and branding. There are opportunities to exploit the health credentials of fish protein. Asia is still behind in ensuring economic sustainability of its farming enterprises. These are steps forward for our finfish stakeholders to discuss in Bali in August.

The sustainability issue continues to be a focus in aquaculture and particularly fish meal replacement in feeds. Although little fish meal is used in tilapia and pangasius feeds, it is still a prerequisite in feeds for the shrimp and marine fish. There are options out there from insect meals to single cell proteins and algal meals. The 'holy grail' will be to replace fishmeal and achieve the same performance without increasing the feed cost. Is this achievable when the replacement protein meals are all benchmarked to the price of fish meal? Would it be interesting for feed companies to have access to a protein meal that has price stability throughout the year? We can expect more developments in 2017, particularly with the strong dollar.

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TIFSS 2016: Taiwan's aquaculture industry leaders, innovators and movers

A selection of the industry leaders at the second Taiwan International Fisheries and Seafood Show.

Taiwan has a long history in aquaculture and a dynamic marine fisheries and seafood industry, contributing NTD 100 billion in 2015 to the national economy. The annual Taiwan International Fisheries and Seafood Show (TIFFS 2016) is a conduit for its technology innovators and developers to demonstrate to the global fisheries and aquaculture industries their strengths. This year's TIFFS in Kaohsiung on the south-western tip of the Island nation, was held from November 9-11. It was hosted by the Taiwan External Trade Development Council (Taitra) and organised by MY Exhibition Co Ltd. TIFFS 2016 comprised exhibitions on fishing equipment and technology, aquaculture, seafood, processing equipment, fisheries and aquaculture services, and marine biotechnology. Exhibitors came from all walks of life – the private sector, local government and academia. The three-day trade show began with an opening ceremony attended by several local and foreign representatives of industry associations in the region. Altogether 212 companies participated in the trade show; foreign countries with trade pavilions included Japan, South Korea, Indonesia, Malaysia and South Pacific island nations. The theme, 'Green Fishery and Resource Sustainability' was to raise awareness on sustainability and environmental friendly fisheries and aquaculture. Concurrent conferences featured innovations and technology advances in Taiwan's fishery industry, trends in aquaculture and aquaponics.

"The fisheries and aquaculture sector in Taiwan is the second largest contributor to the national economy and the aim is to further boost their economic growth. At this event, we showcase achievements of this industry in Taiwan. We also wish to create branding so that products from Taiwan are recognised for their quality," said Peter W-J Huang, Taitra's President and CEO at the opening.

"This 2016 show is 60% larger than our inaugural show in 2015 and with participation from more than 21 countries. It provides the platform for the exchange of information and new business opportunities. We have organised one-to-one meetings for businesses with more than NTD10 million capital."

The Fisheries Agency, Council of Agriculture is responsible for the development of fisheries and aquaculture in Taiwan. Its Director General, Chen Tain-Shou said that last year's TIFFS brought together professional expertise in research institutions, government agencies and academia to understand strengths and weaknesses along the supply chain. "This year, aside from its role in the development of fisheries and aquaculture, the Fisheries Agency introduced the concept of 'environmental consciousness and sustainability'. We have planned sessions on how aquaculture companies can expand and pursue offshore aquaculture since we have limited areas for near-shore aquaculture. Systematic and automated systems that can provide a suitable working environment for young fisheries and aquaculture professionals were also highlighted. After all, the purpose of technology is to give us a better future."

Industry leaders

Business model for cage culture of high value marine fish

Ever Spring Marine Aquaculture is now the largest marine fish farming company in Taiwan. Established in 1999 by Rocky Chen, it now farms cobia *Rachycentron canadum* and pompano *Trachinotus ovatus* in 30 offshore cages of 16-20 m diameter in the south-eastern waters about 1-1.5 km off Pintung, Taiwan. The location takes advantage of the warm Kuroshio Current and avoids the cold winter temperatures. Current production is 800 tonnes per year and there are expansion plans to double production.

The company sells vacuum packed frozen gutted cobia and pompano to markets in Singapore and China. Products have accreditation from Taiwan Good Aquaculture Practices (TGAP). Together with another company, it also markets grouper farmed in ponds.

Leo Huang, Marketing Manager said, "Our competitors for the cobia market are Chinese and Vietnamese producers. Cobia prices have been relatively flat over the years but we have the advantage of high demand for cobia in the domestic market as imports are restricted. Prices are higher in Taiwan. We produce the larger size pompano (>1.2 kg) for the sashimi market.

"Our management strategies focus on achieving high fish survival with good water quality to prevent possible failures. We attribute our success to the professional management of the company as well as to the support and cooperation of local aquaculture organisations. Material of cages are supplied by a local company Sun Rise (see pp57) and we do our own assembly. High survival and equipment such as ocean submerged cages and floating sea cages are necessary for a profitable and sustainable business."

This is the second time that the company is exhibiting at the show and this time, Huang said that Ever Spring is marketing its cage farming technology. This includes the planning, setting and pre operation and consultancy in marine cage farming of high value species.

"Our aim is to work together with investors in countries such as Malaysia and Singapore in the farming of a species such as cobia. We will work together on the whole supply chain, from the beginning (e.g. evaluation of suitable sites in terms of weather patterns, marine environment and marine ecology) to the initial stocking and operation of the farm and then to market. We will look at a suitable farm model in terms of the technology and equipment, and then evaluate the investment feasibility, environmental risks and fish species and plan and set up the farm with work base, equipment, cages etc. Finally, we will help on with processing and export of the fish. In the case of cobia, there is a high demand in the sashimi market in Japan."

In Taiwan, Ever Spring will continue to improve on the supply chain. Currently, it buys about 70-80% of its requirements of fry and fingerlings from local land based hatcheries.

"Currently survival rate for our pompano is 80-90% for 400-500 g fish. However, for cobia, survival rate is 70% for a >5 kg fish and is declining. However, we require a stable quality for the fry and fingerlings. We will expand our hatchery to supply 100% of our needs using our own cobia and pompano brood stock," added Huang. (www.seafarm.com.tw)

Building a reputable fish breeding industry

Taiwan's **Fish Breeding Association** (FBA) is an aquaculture institution. Its mission is to assist hatchery farmers to improve their production facilities and open up marketing channels. Since 1996 it has in many ways influenced the farming success and introduction of new species into the marine fish farming industry in Taiwan and that of the Asian region.

With regard to developments, new species propagated by the association members faced competition from regional producers; hence FBA members need to keep up their reputation as suppliers of quality fry. Since 2012, the hatchery industry in Taiwan has commercialised the breeding of several grouper hybrids following the hybridisation of groupers by Dr Senoo Shigeharu in Malaysia. Some recent popular marine fish are the four finger threadfin which is partially replacing groupers, and short fin pompano, *Trachinotus falcatus* which can tolerate lower temperatures as compared to long finned pompano, *T. blochii*. New snapper hybrids are *Lutianus sebae X L. erythropterus* and *L. erythropterus X L. sebae*. (Kevin N-H, Yu, FBA, 2012).

"Currently, we have >500 members and they represent 40-50% of fish breeders in Taiwan. Some breeders from Hong Kong are also members. FBA also has some grow-out farmers. Our members produce more than 50 million one-month old juveniles and 20 million two-month old fingerlings," said Chi Yuan Liu, General Secretary.

"We have been active in aquaculture trade shows in Asia, where we help our members to develop their business. Some have set up hatcheries outside Taiwan, nearer to grow-out farms. As we face more and more competition from hatcheries in Vietnam, Indonesia, China and Malaysia, we are now looking at new markets in the Middle East.

In Taiwan's aquaculture industry, there is clear specialisation and segmentation; breeding companies with brood stock produce the fry and juveniles and sell these to nurseries to grow to fingerlings. In turn, nurseries sell to grow-out farms. There are companies producing live food and micro feeds for fish larvae. Production systems vary from recirculation aquaculture systems (RAS) for the early stages to fry and juvenile stages in earthen ponds and indoor systems.

"The association is the channel for interaction between the government and producers in Taiwan. We update members on developments through regular seminars. In Taiwan, if we have a technique that works, it will be rapidly adopted." (www.fish.org.tw)

See pages 56-60 for reports on innovators and movers at TIFSS.

Association leaders at their booth, from left, Huang Chia-Fen (Deputy Secretary), Vickie Liang and Powen Yang (Coordinators), Jenny Liu and Chi- Yuan Liu. For this TIFSS, FBA gathered several members to participate and to display products ranging from farmed fish and clams, equipment such as blowers, pumps, RAS systems, aerators to biotechnology products, probiotics and microbial innoculants.

Leo Huang (right) and Edward Hsu, Ever Spring. High survival is necessary for a profitable and sustainable business.

White spot disease in Australia

In January, Biosecurity Australia reported that five properties, owned by four farms, on the Logan River were infected with the white spot disease (WFD). The authorities were unsure of how the shrimp farms in Queensland were infected with WSD. In December, Biosecurity Queensland said that only six wild shrimp from the Logan River have been found to have a 'low level' of white spot virus DNA. Investigations into the viral pathogen's pathway is underway but the emphasis is to contain and eradicate the white spot virus. Affected farmers have ruled out other possible pathways for the disease, such as hatcheries and animal feed. Biosecurity Queensland is treating infected ponds with chlorine and is preparing for disposal and decontamination work.

"The Australian shrimp industry is in crisis mode," said the Australian Prawn Farmers Association executive officer, Helen Jenkins in abc.net.au. She said losing four farms was a huge blow to the industry, with the combined value of about AUD 25 million. In December, only two out of eight aquaculture businesses along the Logan River were affected by the virus. Eight farms near the Logan River, collectively produced 25% of Australia's farmed shrimp, and 40% Australia's farmed tiger shrimp.

Dallas Donovan, operations manager for Seafarms Group, the largest prawn farming operation in Australia with about 160 ha of productive ponds in north Queensland is confident that the white spot disease could be eradicated, and the incursion would not be a blight on the country's highly regarded aquaculture industry. The Federal Department of Agriculture said it has a 'rigorous testing regime in place', which requires every consignment of imported raw frozen prawns to be tested for white spot disease.

Offshore cage farms for Indonesia

The Directorate General of Aquaculture (DJPB) is planning for offshore floating fish cages in three areas: Karimun Java in Central Java, Java's South coast, and Sabang in Aceh. In December 2016, the Director General of Aquaculture, Slamet Soebjakto said that the aim is to utilise the potential of the oceans. Currently only 2% out of a potential 281,000 ha is utilised for aquaculture. Slamet said that off-shore cage farming offers several benefits: increase in fish production, use of modern technology and opportunities for new businesses such as for the nursery grow-out of seabass from 10 g to size 100 g for stocking. He added that an 8-unit offshore cage can produce 568 tonnes of fish from 1.2 million fingerlings. Land based farming would require an area of 290 ha. Project delivery is expected to be in 8 months.

Seabass production in 2015 was 5,082 tonnes. "Three units of offshore cages will contribute 1,600 tonnes to national production. We hope that this project will stimulate the emergence of a flourishing industry that will uphold sustainability." (djpb.kkp.go.id).

Pangasius from Dominican Republic

Value Aquaculture, based in Cabarete, has the approval from the US Department of Agriculture to import siluriformes, or pangasius, into the US. This approval is valid for all pangasius produced in the Dominican Republic. The company is the only pangasius producer in the Republic. Bergen, the owner of Sustainable Seafood Sales in Portland, Maine and a partner in Value Sustainable Aquaculture has set up a joint venture to handle the import and distribution of Value Aquaculture's fish into the U.S.

Bergen told SeafoodSource that products of Value Aquaculture are all natural; they are farmed in clean water from the mountains and that the company is creating jobs in an impoverished area. The five-year-old company was founded by four German nationals. After 3 years of R&D, the company settled on a farming process that uses no antibiotics or growth hormones and has a feed conversion ratio of 1.4 to 1. It has an eight-month growth cycle from hatchling to harvest. The grow out phase began in 2014 and production reached 300 tonnes in 2015. The target is to reach 1,500 tonnes. The company uses a local processing facility to fillet its fish and then packages it specifically for fresh export. The company sells its fish fresh rather than frozen.

In 2014, the US passed a law requiring all imported pangasius to be inspected by USDA, in addition to US FDA inspections. Supporters of this law were accused of protecting the domestic catfish industry from lower priced imports of a similar tasting fish. Value Aquaculture is working with the National Fisheries Institute to get the law repealed. Pangasius from Value Aquaculture is marketed as satchi (another accepted name for the species) as a premium product. It is more expensive than other available pangasius, which comes frozen from Vietnam. The price range (USD 5/kg) for its fillets still compares very favourably with tilapia, barramundi and cobia. Bergen said that their approach is a different price point as it is also a very different product and many have been amazed by the flavour and texture. The pangasius is the sixth most popular species of seafood and third most popular whitefish species in the US, with an annual consumption of 0.74 pounds/capita.

Authorisation of insect proteins in fish feed

In December, the International Platform of Insects for Food and Feed (IPIFF), the European Umbrella Organisation, representing the interests of the insect production sector for food and feed welcomed the 'green light' given by EU Member States on the authorisation of insect proteins as fish feed. The EU Member States representatives endorsed an European Commission proposal which was discussed in a meeting of the EU Standing Committee on Plants, Animals, Food and Feed (SCoPAFF). The proposal is expected to be formally adopted in spring 2017, which means that insect proteins should be effectively authorised for use in fish feed as from 1 July, 2017.

IPIFF President Antoine Hubert said, "The endorsement of this legislation is in our view a major milestone towards the development of the European insect production sector. A recent opinion from the European Food Safety Authority (EFSA) dated 8 October 2015, had concluded that insects fed with plant based materials entail no risks if insect producers comply with best hygiene practices. In the long run, these changes should contribute to alleviate European dependency on protein imports, whilst securing a promising source of protein for EU farmers and customers." (ipiff.org)

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Balancing the pond ecosystem in shrimp farming

By Poh Yong Thong

Poor shrimp farming management disrupts the delicate balance in shrimp pond ecosystems; controlling feed inputs and managing the pond environment are crucial.

One of the biggest problems in shrimp farming management is overfeeding. In their enthusiasm to grow shrimp faster, farmers believe that providing more feed is critical. This seemingly harmless act is actually the cause of many pond water quality and shrimp disease problems.

In the wild, shrimp are generally not densely crowded together; shrimp density is perhaps only 1 shrimp in 5 m^2 area or even lower. However, when we began to domesticate and farm shrimp such as the vannamei shrimp in Asia, we tend to use stocking density as high as 100 post larvae (PL) or more per square metre to maximize returns. We then call this an intensive culture system.

In the shrimp pond, there are microorganisms that keep the pond ecosystem in a balance state. Excess inputs in the form of feed and the resulting wastes (faeces, other metabolic wastes such as ammonia, nitrite, nitrate and carbon dioxide) are being neutralised by the myriad of microorganisms, algae and plants. If at one point in time, there is excess feed in the pond, the limited amount of microorganisms in the pond will not be able to cope with the sudden increase in nutrient inputs, and the excess feed will disintegrate and pollute the water with poisonous pollutants which promote the growth of pathogenic bacteria that are harmful and result in shrimp disease problems and mortality.

The ecosystem in the pond is similar to that in an aquarium as seen here. Overfeeding will pollute the water and kill your shrimp

The ecosystem of a lake

In a lake which is exposed to nutrient overloading from sewage or agriculture fertilisers, algal blooms will occur. The algae will respire at night resulting in severe depletion of dissolved oxygen. The large amount of carbon dioxide produced by the algae at night lowers the pH of the lake water, resulting in the in the release of toxic hydrogen sulphide gas.

On the other hand, during a bright sunny day, algae will photosynthesise and remove huge amounts of carbon dioxide, thus resulting in increased pH levels. High pH is detrimental to many living organisms in the lake because high pH levels of over 8.5 result in the equilibrium of ammonium in the lake

In a commercial shrimp farm, often more than 100 shrimp are crowded into a 1 m^2 area

to be shifted towards the release of a high amount of toxic ammonia. The deleterious depletion of oxygen at night together with the fluctuation in pH levels between night and day, affect the dynamics of hydrogen sulphide and ammonia production resulting in severe damage to the fish and other biota in the lake.

Eutrophication which originates from the Greek word "eutrophia" meaning "well-nourished, is nature's response to the presence of excess nutrients which induces explosive growth of plants and algae, resulting in serious fluctuation of oxygen and pH between day and night, causing the collapse of the aquatic ecosystem.

The high nutrient loading in the lake will also encourage the proliferation of pathogenic bacteria. It is therefore not surprising that a eutrophic body of water carries a high bacterial and fungal load.

The intensive shrimp pond

In a commercial shrimp farm, often more than 100 shrimp are crowded into a 1 m^2 area. This is an unnatural condition. The high number of more than 100 PL/m^2 of shrimp means that the small amount of water and pond bottom relative to the unnaturally high number of shrimp (compared to perhaps 1 shrimp in 5 m^2 in the wild) requires proportionally more than 500 times the amount of feed. Shrimp farmers must be able to manage this excessively high amount of feed properly. The risks are high and striking a balance is difficult. If he or she overfeeds just by a small amount, the overloaded system will result in the microorganisms being unable to neutralise the load of nutrient inputs and the result is eutrophication of the pond.

Dead fish in a eutrophic lake

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Feed management is the key to success in shrimp farming

The pioneer Taiwanese farmers that practise intensive shrimp farming have an adage stating that ' it is better to feed the shrimp to only 80% satiation. This is great wisdom as the ecosystem of an intensive pond culture system is very fragile. Any degree of overfeeding will tilt the system towards an eutrophic condition.

In many farms in Malaysia, Indonesia and Thailand, withholding feeds to shrimp at specific times has produced good results. In most of these farms, feeding stops when the sun goes down. Contrary to the natural biorhythm of the shrimp, no feed is given at night when the dissolved oxygen is low since no photosynthesis takes place. During the day, there may be 4- 5 feedings in an intensive culture system. When shrimp are more than 60 days old, they are not given feed 2 to 3 times in a week depending on the water quality, so as to allow the microorganisms in the pond to catch up on neutralising excess nutrients.

All shrimp farmers are aware of the importance of withholding feeds periodically or even to stop feeding completely, whenever there is water quality or shrimp disease issues in the pond.

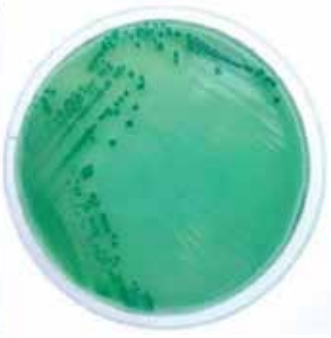
The use of probiotics

In nature, over time, bacteria will establish themselves in sufficient numbers to assimilate the extra nutrients in the culture system. However, where feed quantities are excessive, the system will lose equilibrium in the ecosystem with sudden large nutrient inputs. Timely addition of reputable commercial probiotics can play a role in supplying an array of selected bacteria to assist in mopping up the excess nutrients. Some farms conduct daily pathogenic bacteria analyses and add more probiotics into the ponds which have a higher concentration of pathogenic bacteria. This practice is effective in re-establishing the ecosystem equilibrium.

There are two major groups of *Vibrios* depending on the colour of the colonies formed on TCBS agar plates. The yellow colonies are benign. These are *Vibrio alginolyticus* and *V. fluvialis.* The green colonies are pathogenic. These are *V. parahaemolyticus*, *V. chlorelae*, *V. vulnificus* and *V. mimicus*. When the green colonies dominate, more probiotics have to be administered to the pond water.

It is also good practice to apply proportionally more anaerobic probiotics to the pond at the later stages of shrimp farming to conserve oxygen for the shrimp.

TCBS plate yellow Vibrio colonies



TCBS plate green pathogenic Vibrio colonies

(pictures credit: www.microbiologyinfo.com)

Table 1. Acceptable number of *Vibrio* (CFU/mL)

	Before stocking	30 days of culture	60 days of culture
Pond water	$1x10^2$	$1x10^3$	$1x10^{4-5}$
Shrimp blood		$1x10^2$	$1x10^3$
Gut		$1x10^3$	$1x10^4$
Hepatopancreas		$1x10^3$	$1x10^{4-5}$

Water exchange

Depending on the water exchange regime practised, the shrimp pond ecosystem will fall into one of the three systems below:

- bioflocs system with little or 3 to 5% daily water exchange
- oligotrophic system with more than 30% daily water exchange
- phytoplankton system with intermediate or occasional high water exchange

A biofloc system is difficult to manage and usually yields inconsistent results due to fluctuating sunlight. Its greatest advantage is its ability to produce stable pH. If excessive sunlight can be partially shielded, a biofloc system will be able to produce more consistent results.

The liberal water exchange system will produce an oligotrophic system in which the pond water is relatively devoid of excessive nutrients and hence pathogenic bacteria.

When there is sporadic high water exchange which may be due to occasional availability of water due to high tides, phytoplankton tend to dominate immediately after the excessive water exchange. Due to photosynthesis in the presence of sunlight and respiration at night, the pH in this system tends to have large daily variations, high during intense sunshine and low at night. This pH swing will in turn results in high toxic ammonia at high pH during the day and high toxic hydrogen sulphide at low pH at night. This system is deleterious to shrimp farming.

Central discharge and siphoning

The ecosystem in intensive shrimp culture pond is very vulnerable due to high nutrient input in a small volume of water. Nutrient loading results in the production of excessive ammonia and hydrogen sulphide, resulting in the proliferation of pathogenic bacteria. In order to reduce nutrient loading, measures must be taken to discharge sludge which is formed from faeces, dead plankton and microbes. This can be achieved by the appropriate arrangement of aerators which produces circulation in such a way so as to accumulate the sludge in a designated area. The sludge can be discharged periodically by a discharge system or by siphoning physically. The central discharge channels common in ponds in Indonesia has been described in a previous article (Aqua Culture Asia Pacific, issue May/June 2014, p8-10).

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Asian seabass in Thailand: off-flavour and markets

By Suthi Mahalao, Tavatchai Chidchomsrichantra and Olivier Decamp

Markets consider fish with off flavour as low quality and the solution is planning pond management 10-15 days prior to harvest.

The global production of Asian seabass (*Lates calcarifer*, also called barramundi) was last estimated by FAO at 70,000 tonnes (FAO data, as reported in GOAL 2013). However, recent estimates from the industry can be as high as 180,000 tonnes, with the main producers being Malaysia, Taiwan, Thailand, Indonesia, Vietnam and Australia. In the period 2014-2016, the annual production growth rate has been 8% (GOAL 2015).

In 2015, Thailand is reported to have produced around 50,000 tonnes of Asian seabass, of which 5-6,000 tonnes were exported. In comparison, Thailand produced 400,000 tonnes of inland finfish and less than 20,000 tonnes of costal/marine finfish in 2014 (FAO, State of world fisheries and aquaculture, 2016; Thai Association of Asian Seabass).

Asian seabass aquaculture started three decades ago in Thailand. Production systems are ponds and cages but the trend is towards pond production in central-east and southern Thailand. For farmers, the main benefit of producing fish in ponds is better control of water quality and disease outbreaks. In February 2016, the Thai Marine Fish Farmer Association was established by Suthi Mahalao. This Association (with around 350 members) aims at promoting healthy and quality seafood through marine fish culture. This is achieved through the provision of technical support to farmers and cooperation between government agencies and companies. In order to develop the sustainable production of quality Asian seabass, the Association collects and shares information on the market and on all key issues facing farmers, such as disease and the management of rearing conditions.

Farmgate prices vary with season, supply and contract condition. In July 2016, farmgate price ranged from a high of THB 135/kg (USD 3.8/kg) for 600-800 g live fish to a low of only THB 85/kg (USD 2.4/kg) for large size (1.2 -2 kg fish) chilled fish (Table 1).

Size	Type	Price/kg (THB)
300-400 g	dead	100
400-500 g	dead	100
600-800 g	live	135
600-800 g	dead	125
900-1,200 g	live	125
900-1,200 g	dead	100
1,200-2,000 g	dead	85
2,000-3,000 g	dead	140
3,000-4,000 g	dead	150
>4,000 g	dead	170

Source: The Thai Marine Fish Culture Farmers Association (Exchange rate: one USD=THB 35.6 on 6 December, 2016).

Flavour and smell

Fish flavour and smell are critical factors for consumers, and fish presenting muddy or earthy flavour characteristics are described as tainted or off-flavour, and are perceived as low quality. In addition to the perception from the market, off-flavour problems have additional financial costs. In the US catfish industry, getting rid of off-flavour in fish requires additional processes such as the introduction of the purging process where fish are not fed, thus leading to delayed fish harvest, weight loss, lower feed efficiency and delayed re-stocking dates. The purging process in the US catfish industry has resulted in a loss of an estimated USD 47 million annually (Hanson & Schrader, 2006). The same authors mentioned that the additional cost caused by off-flavours could represent as much as 17% of the total production cost. Off-flavour is caused by the accumulation mainly via the gills of geosmin and 2-methylisoborneol, which are semi-volatile terpenoid chemicals that are produced by cyanobacteria, fungi and actinomycetes.

In Thailand, there is a strong desire to produce high quality fish for the export market, in Australia or Europe. Thailand-based companies also have plans to airfreight high quality fresh Asian seabass fillets to the European Union countries (Intrafish, June 2016).

A critical sales issue

Off-flavour is a critical issue as tainted fish has a limited market. This problem must be solved by the producer prior to the sale of the fish. The procedure is as follows:

Based on the expected farmgate price, farmers contact a broker, who will evaluate the fish at the pond side, for size, shape and flavour. If the first assessment is positive, fish samples are brought back to the laboratory for further evaluation on meat quality, as well as residues of banned antibiotics and chemicals. Processing plants will have their own quality assessment protocols to check the quality of the fish when delivered to the plant. The off-flavor evaluation is done by the farmer before harvesting each pond. Typically, fish are sampled, and kept for 1-2 days without feeding before being sacrificed.

Off-flavour has been found to be highest in the 'belly' cut of the fillet and lowest in the 'tail-cut' and 'shoulder' of the fillet (Percival et al., 2008). It is therefore decided to cut fish abdomen and place them in a sealed HDPE bag. The sealed bag with the fish samples is then boiled before being tested for meat quality and smell. Off-flavour is a critical issue for the export and niche

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The aim of the 350-member Thai Marine Fish Culture Farmers Association is to promote healthy and quality seafood through marine fish culture.

market (for example, Thai Airways catering). This quality market represents 500-600 tonnes per month.

Farmers targeting this high quality market, when faced with off-flavour problems, will take the following steps over a period of 10-15 days:

- Reduce feeding
- Increase aeration to maintain high dissolved oxygen above 5 ppm
- Exchange water every 2-3 days to reduce the density of cyanobacteria
- Apply salt at 200-250 kg/ha for 7-10 days
- Apply Sanolife Nutrilake at 15-20 kg/ha every day for 7-10 days
- Apply Sanolife PRO-W at 300-350 g/ha every 2 days, up to 5 applications.

There are other options to manage off flavours. Copper algicides is one of the options to reduce cyanobacteria populations. However, these are not ideal for off-flavour management as they affect all phytoplankton species, and not only cyanobacteria. The uptake of the chemicals causing earthy smell (geosmin and 2-methylisoborneol) is fast, reaching a plateau within 3 hours, whereas the removal of the same chemicals takes longer, e.g. at least five days (Tucker and Martin, 1991). This implies the need to control phytoplankton composition over a period of time preceding the harvest.

Customer support

As part of their support to their customers, staff of the Thai Marine Fish Culture Farmers Association will visit farms to check the pond water quality and fish status. Before committing on a harvest, fish samples are taken to the Department of Fisheries (DoF) laboratories for analysis (nitrofuran, chloramphenicol, malachite green). Only after receiving positive reports from the laboratory, will the processor be contacted. The Thai Marine Fish Culture Farmers Association will provide a quality certification that the fish is free of off-flavour.

Suthi Mahalao

Dr Olivier Decamp

Tavatchai Chidchomsrichantra

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Shrimp production trends in Asia in 2016

By Zuridah Merican

Growth was mired by inclement weather, drought, rain and disease.

Farmed shrimp production in 2016 mirrored the ongoing challenges faced by shrimp farmers, changing and unfavourable weather conditions and disease outbreaks. Farms in south eastern Thailand and Peninsular Malaysia's east coast started the year well with a mild monsoon and less rain. Shrimp were available for the high demand high price Chinese New Year season in early February. Farms in Gujarat, West Bengal and Odisha in India also had good crops in the early part of the year, but those in Andhra Pradesh and Tamil Nadu which usually contribute almost 71% to the annual shrimp production, faced heavy rain and flooding. Drought and high salinity delayed stocking in Vietnam's Mekong Delta.

In the second half, Vietnam's shrimp farmers in the Mekong Delta recovered production. Then the same farms in the east coast of Peninsular Malaysia succumbed to early mortality syndrome (EMS) or acute hepatopancreatic necrosis (AHPND) at year-end. The new culture system with three reservoir ponds for each production pond lowered production capacity of farms, mainly in Thailand and Malaysia.

Table 1 shows the farmed shrimp production estimates provided by industry in their respective countries. Leading monodon shrimp producers, Philippines, Indonesia and Vietnam reported lower production of this shrimp. According to Mohammed Tarique Sarker, Bangladesh produced 40,000 tonnes of monodon shrimp in 2016. Stocking density depended on farm infrastructure. Intensive systems used specific pathogen free (SPF) post larvae and ponds were stocked at 10-15 PL/m^2. Harvest sizes were 35-50 g/pc. The extensive and traditional ponds were stocking with less than 1 PL/m^2.

In this review on shrimp aquaculture in selected Asian countries, the focus is on significant developments in the hatchery and grow-out segments. This information is based on data provided by selected hatchery operators, farmers and suppliers of feeds, equipment and services.

Living with diseases

The major threat throughout industry in Asia was slow growth because of white faeces syndrome (WFS) and the microsporidian

Cooked vannamei shrimp farmed in Taiwan (left) and monodon shrimp farmed in Malaysia, presented at the Grobest booth during the Taiwan International Fisheries and Seafood Show 2016

The keys to the success at this farm in East Java are the use of sedimentation and treatment reservoirs, paddlewheels to move and aerate water, feeds and right feeding management, probiotics to manage the feed and pond wastes, sludge removal and a good partial harvesting program.

Enterocytozoon hepatopenaei (EHP). In Indonesia, outbreaks of infectious myonecrosis (IMNV) were always imminent. When infected with WFS, shrimp sizes reduced from size 50/kg to 90/kg at harvest as reported in farms in Lampung in Indonesia. In Malaysia, at the Blue Archipelago Farms, Dr Celia R. Lavilla-Pitogo described how they prepared to abort or harvest to hasten pond turn-around instead of waiting for larger shrimp sizes. The decision on what size to harvest also depended on whether the harvested shrimp has a market value (Lavilla-Pitogo, 2016).

White spot syndrome virus (WSSV) continued to be in the background in most shrimp farms, and manifested frequently, particularly during low temperatures, often in the last quarter of the year. Industry in India reported WSSV as the major threat throughout the year, followed by WFS and high *Vibrio* loads. EMS was a major problem in China, Vietnam, Thailand and Malaysia, and added to this, it co-occured with other diseases such as yellow head virus (YHV), WFS and EHP. While farms in Thailand were successful in managing EMS by changing culture practices such as regular sludge removal with the use of shrimp toilet to reduce the impact of the causative *Vibrio parahaemolyticus*, new production losses resulted from EHP and WFS.

Dr Loc Tran, Department of Aquaculture Pathology, College of Fisheries, Nong Lam University, Vietnam and Shrimpvet Laboratory, said, "In Vietnam, the economic losses were mostly from EMS/AHPND, followed by WSSV, EHP and WFS. With EHP, production cost increased by 20%, if a harvest was possible. For WSSV and EMS, it was difficult to calculate particularly with 100% mortality before 50 days after stocking. Prior to 2010, farmers were happy to sell size 100/kg at USD 3.5/kg. But today, they will not stock unless a farm gate price for size 100/kg is more than USD 4.5/kg."

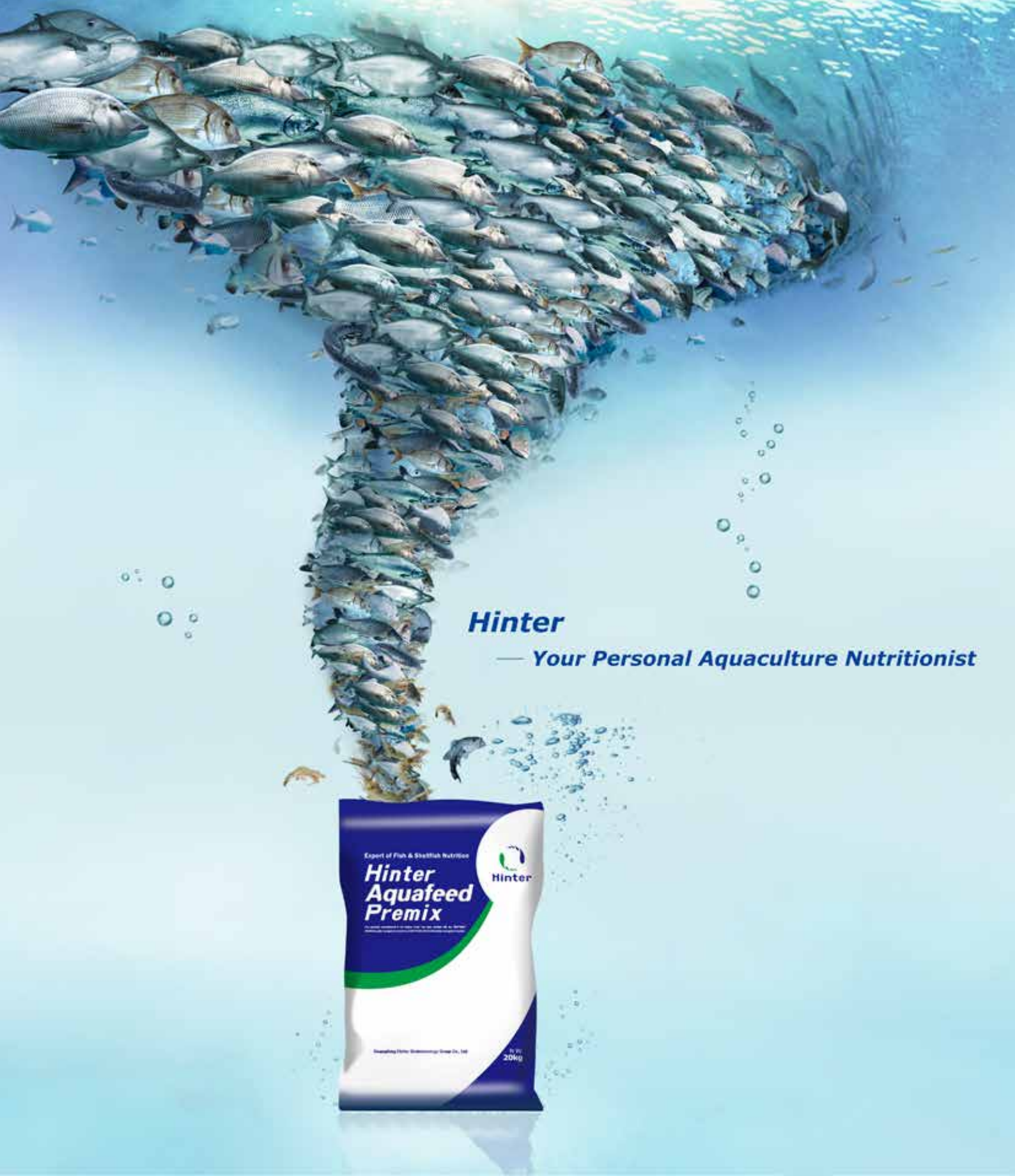
"While EHP was suspected in some cases and the farmers continued with the crop to a marketable size of 100/kg, survival rates were low and feed conversion ratio (FCR) high. We had EHP positive shrimp which continued to grow, some even well, creating doubts on the detection tests. Some farmers were in a dilemma on the next course of action when faced with a positive test result. The question is does EHP infections increase shrimp susceptibility to the omnipresent WSSV pathogen?" posed Jeffrey Lee, Kembang Subur, Malaysia.

Post larvae efficiency index

Robins McIntosh, Charoen Pokphand, Thailand introduced the post larvae efficiency index (PEI) in his presentation on the state of the industry in Asia at TARS 2016. This index can indicate the efficiency of the industry in a country, particularly with disease outbreaks. It is calculated as tonnage produced per million post larvae. For example, he quoted how in 2010, industry in Thailand was very efficient and produced almost 10 tonnes/million post larvae (PL). With EMS outbreaks, this decreased to 3 tonnes/million PL. An improvement to 7 tonnes/million PL would be a signal for recovery, according to McIntosh. In Table 2, based on estimates on hatchery production, we developed the PEI for several countries. In the case of India, we used data presented by Ravikumar Yellanki at TARS 2016 to calculate the PEI for 2015. This was 10.8 tonnes/million PL.

Post larvae quality

Post larvae quality in Thailand is often regarded as the gold standard with survival of 80% under optimal farm conditions. However, farmers questioned whether this quality is only adequate for farming during the early part of the year when conditions are ideal but possibly not when farming conditions are more stressful. Large hatcheries maintain high quality standards to secure clients and maintain their reputation in the industry. A small mistake will then require image rebuilding in the close-knit aquaculture community of each country. The Philippines has a few accredited hatchery operators producing good quality post larvae and the advantage for its industry is that farmers have choices and do not need to opt for post larvae-feed bundling purchases.



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Biosecurity, nutritional protocols, broodstock source and genetics are the essential criteria for success. Integrated operations use quality feed but often companies that sell only post larvae cut costs through feeds and compromise on quality. The production of clean post larvae requires investments for high tech filtration systems, biosecurity and feed protocols while backyard hatcheries cannot justify investing. Table 2 shows how post larvae prices varied depending on source. It also shows common sizes of post larvae used for stocking into grow-out ponds.

Small traditional or extensive farms in Indonesia, India, Vietnam and the Philippines depend on supply of lower price post larvae from backyard hatcheries which cost VND 25-26/PL (USD 1,151/million PL) in Vietnam. In the Philippines, the survival rate for low quality post larvae (costing USD 2,221/million PL) was 10 to 20%.

Intensive farms focus on post larvae quality rather than price, especially after several disease outbreaks. Indonesia's super and supra intensive farms, stocking more than 300 PL/m^2 demand the best quality post larvae. In supplying post larvae, hatcheries in Indonesia give a mortality allowance depending on transportation duration, this extra allowance can be 10% for less than 10 hours. However, during the low stocking season, a hatchery may give an extra allowance without compromising on price. In the Philippines, the mortality allowance is 5-10%. A leading hatchery in the Philippines said that by growing PL 7-8 to PL 13-15, they can overcome stress during transportation and ensure higher survival rates. At the Andalas farm in East Java, management give technicians a 12% variation, to either stock less or more depending on the quality of post larvae, so as not to disrupt the pond carrying capacity.

"In Vietnam, good quality post larvae with no disease, registered survival rates of 70-80% at final harvest. The main criterion for 30% of the farmers is price rather than quality while the rest focus on quality," said Chien Ho Van, Inve Aquaculture, Vietnam. There are many small-scale hatcheries (producing less than 100 million PL/year) and a few large hatcheries producing >1 billion PL/year. Hatcheries compete in the market by offering 30-50% more free post larvae, without compromising prices. Some inconsistencies in size and quality was reported.

In India, although all hatcheries provide 5 to 10% more post larvae, there are regional differences. Dr Manoj Sharma, Mayank Aquaculture in Gujarat, said, "This extra may be common for farms in Andra Pradesh and other farms near hatcheries, but for us in Gujarat we will only count stress free post larvae. We demand this as our post larvae supply comes from the east coast after a minimum travel time of 18 hours."

Soraphat Panakorn, Novozymes Biologicals, Thailand, explained the situation in Thailand, "We used to accept more post larvae than our purchase order. However, today, farmers count the precise numbers of post larvae at the farm gate and only accept the numbers required. This exact number must be post larvae of high quality. Farmers are familiar on how to determine gill and rostrum development relative to PL size, as was explained by Dr Chalor Limsuwan several years ago. However, there may be cases where the farmer has been experiencing poor shrimp survivals in his pond and will then accept more post larvae."

Table 1. Range of estimates by industry on farmed shrimp production in 2016 in selected countries

Country	Total production in tonnes[a]
China	600,000-800,000
India[b]	385,000-430,000
Thailand[c]	260,000-300,000
Vietnam	350,000-420,000
Indonesia	280,000-350,000
Philippines[d]	60,000
Malaysia[e]	35,000-40,000
Bangladesh[f]	40,000
Total	1,910,000-2,440,000

a. Production estimates are for both vannamei and monodon shrimp with the exception of the Philippines and Bangladesh.
b. India- includes monodon shrimp, estimated at 21,000 tonnes (Ravi Yellanki, 2016)
c. Thailand – 300,000 tonnes, Thai Shrimp Association
d. Philippines – data is for vannamei shrimp only
e. Bangladesh, data is monodon shrimp only, source: Mohammed Tarique Sarker, Fishtech Ltd
f. Malaysia, includes monodon shrimp estimated at 5,000 tonnes

Table 2. Post larvae efficiency index and other details in 2016

Country	Estimate on annual post larvae production (million)	Post larvae efficiency index (PEI)	Selling Prices (USD/ million PL)	PL sizes for stocking	PL size after nursery
Penaeus vannamei					
China	500,000	1.6	2,900-4,000	PL8-PL10	3-4cm (small pond nursery)
India	40,000	11.2	5,140-7,350	PL7-PL 12	0.25g
Thailand	40,000	6	2,250-3,930	PL10	1-3g
Vietnam	73,000	5.8	1,150-1,550 (small hatcheries); 4,000-4,900	PL8-PL12; peak season, PL7-PL9; low season -PL16-PL20;	0.8-1.2g; PL20
Indonesia	35,000	11.6	2,900-3,700	9 mm (P9-PL10, intensive); PL 8 (extensive)	2.5 -3g
Malaysia	5,000	6	2,680-3,600	PL10	1-1.5g
Philippines	3,600	16.7	2,222 (small hatcheries) min 3,660 (excluding airfreight)	PL10-13 (intensive); PL5-PL8 (extensive)	
Penaeus monodon					
Bangladesh	3,000	20	12,700 (SPF) 3,810-6,350 (conventional)	PL15-PL16 (13mm - 15mm)	
Malaysia	300	16.7	8,800 (SPF)	PL 8-10	

India

Industry forecasted a marginal increase to 385,000 tonnes in 2016. New culture areas estimated at 30,000 ha of freshwater ponds and conversion of extensive monodon shrimp ponds to farm vannamei shrimp contributed to this production. The 2016 production was higher than the production of 363,000 tonnes in 2015 (Ravi Yellanki, 2016). Throughout 2016, there was a slow recovery from WSSV and particularly in Andhra Pradesh, a lower production was recorded because of slow growth due to WFS and perhaps EHP, present in pond reared brood stock.

"WSSV was the major damper for the industry although we had suspected EHP in some cases. Farmers managed to grow shrimp to marketable size, some at size 100/kg, although at reduced survival rates and increased feed conversion ratios. Some farmers faced a dilemma on whether to harvest the crop or not when faced with the EHP positive shrimp in their ponds. Development of efficient biosecurity and disease management strategies is the need of the hour to manage the co-occurrence of WSSV and EHP," said G. Ramesh, Wenger, India. "There was a drop in stocking density, which now ranged from 20-30 PL/m^2. Smaller farms stocked at 10-15/m^2. Only farmers with very good infrastructures and nurseries stocked above 70 PL/m^2."

"..there is the demonetization of our currency. In our shrimp farming business, though feed is available on credit we deal with cash to pay for labour, fuel and other day to day operational expenses and sometimes receive payment for harvests in cash.."
- G. Ramesh

Dr Hasanuddin Atjo (second left) and some members of the Shrimp Club Indonesia. Atjo developed the supra intensive farming of the vannamei shrimp in small and deep 1000m² ponds in Sulawesi. Stocking density was more than 500 PL/m². Production ponds are integrated with waste water treatment ponds. Picture was taken at the Asian Pacific Aquaculture tradeshow in Surabaya, Indonesia, held in April 2016.

Manoj said that industry in India should move to more sustainable models and adopt better management styles. "In the case of earthen ponds, the farm should target only 7 tonnes/ha. For lined ponds the harvest can go up to 12 tonnes/ha.

"Nurseries can reduce the grow-out period and also provide a compensatory faster growth rate. But the stumbling block is the high initial cost of investment and farmers are still not used to this system. We need dedicated workers and constant care on the postlarvae. At Mayank, we will start our nursery phase in January 2017."

On the outlook for 2017, a production increase in 2017 may occur with contributions from new farms in Gujarat, West Bengal and Odisha, to compensate for anticipated declines in Andhra Pradesh. However, there is a general fear of failure due to WSSV, EHP, slow growth and WFD. "Added to these, there is the demonetization of our currency. In our shrimp farming business, though feed is available on credit we deal with cash to pay for labour, fuel and other day to day operational expenses and sometimes receive payment for harvests in cash. We will need to wait for the next step announcement by the government in 2017 to improve the money flow situation." added Ramesh.

Vietnam

In the Mekong Delta, there was a slow start in 2016 with a drought and water salinity went up to as high as 30 ppt (vietnamnet.vn). Post larvae sales went down as stocking began only in the middle of the second trimester. After this, production went smoothly. The final industry estimate for total shrimp production in 2016 ranged from 350,000 to 420,000 tonnes, with 15-20% being monodon shrimp.

.. "Prior to 2010, farmers were happy to sell size 100/kg at USD 3.5/kg. But today, they will not stock unless a farm gate price for size 100/kg is more than USD 4.5/kg." - Loc Tran

"It may seem that adverse conditions were kept in check and all went well with production in Vietnam in the later part of 2016," said Manuel Poulain, Inve Aquaculture. "In early 2016, diseases impacted the industry tremendously. Crop failures due to EMS and/or EHP outbreaks could have affected 20 to 80% of the ponds. Overall production cost at a farm could have skyrocketed and a successful farmer was one that could achieve an average margin of 30%." Chien added that preventive measures could add 8-18% to the production cost, while disease management could increase the cost by 20-30%.

"Before 2015, farmers stocked at 200-400 PL/m². In 2016, they reduced stocking to 60-70 PL/m² but stocking at 80-70 PL/m² should be ideal. When all went well, the harvest sizes could be size 50/kg in 100 days but in 2016, prices for small shrimp were better, so farmers began to harvest size 70-80/kg."

Poulain added, "There are many pathogens in the vicinity of farms and water quality is going down. Farms need to set-up techniques to reduce water exchanges. Flushing into the environment feed wastes using shrimp toilets or central drains is a non-sustainable practice, if there are no investments in waste water depuration systems. Farms also need to feed less, but quality feed should be used, especially high quality nursery feeds."

China

Estimates on the 2016 production in China, ranged from 650,000 tonnes (McIntosh, 2016) to 800,000 tonnes, by industry. A series of media reports confirmed that China's shrimp was under threat from disease and culture management along the supply chain. Seafoodsource.com detailed reports by the Nanning Evening News that cash shortages arising from failed crops in 2015 and water shortage combined to make 2016 a dismal year for farms in Guangxi. Some producers from Guangdong, the major shrimp production province, have shifted to Guangxi. The demand in China is for better quality post larvae using imported broodstock, as local broodstock suffers from poor reproductive capacity and post larvae showed slow growth and non-uniformity. The Chinese government also has a new mission to ensure a sustainable industry. It wants site evaluation for new farms to ensure better layout and management practices so that land in the farm vicinity do not become unusable after 5 years.

An analysis by undercurrentnews.com showed that South China has the biggest problems with disease in China, reflected by the sales of shrimp size 140-120/kg in markets in South China comprising Guangdong, Guangxi and Hainan province. Together, these provinces produce 65% of annual production where the usual shrimp sizes are 80-100/kg.

Indonesia

In a large archipelago such as Indonesia where shrimp is farmed everywhere, production estimates are difficult to come by. In December 2016, the Chairman of the Shrimp Club Indonesia (SCI), Iwan Sutanto said that he expected production in 2016 at 400,000 tonnes, similar to that in 2015 (Trobos Aqua, December 2016). Others in industry gave estimates ranging from 250,000-350,000 tonnes.

The general opinion is that production losses can be linked to weather conditions but there are other factors such as location and age of farms. In 2016, production was more stable in the

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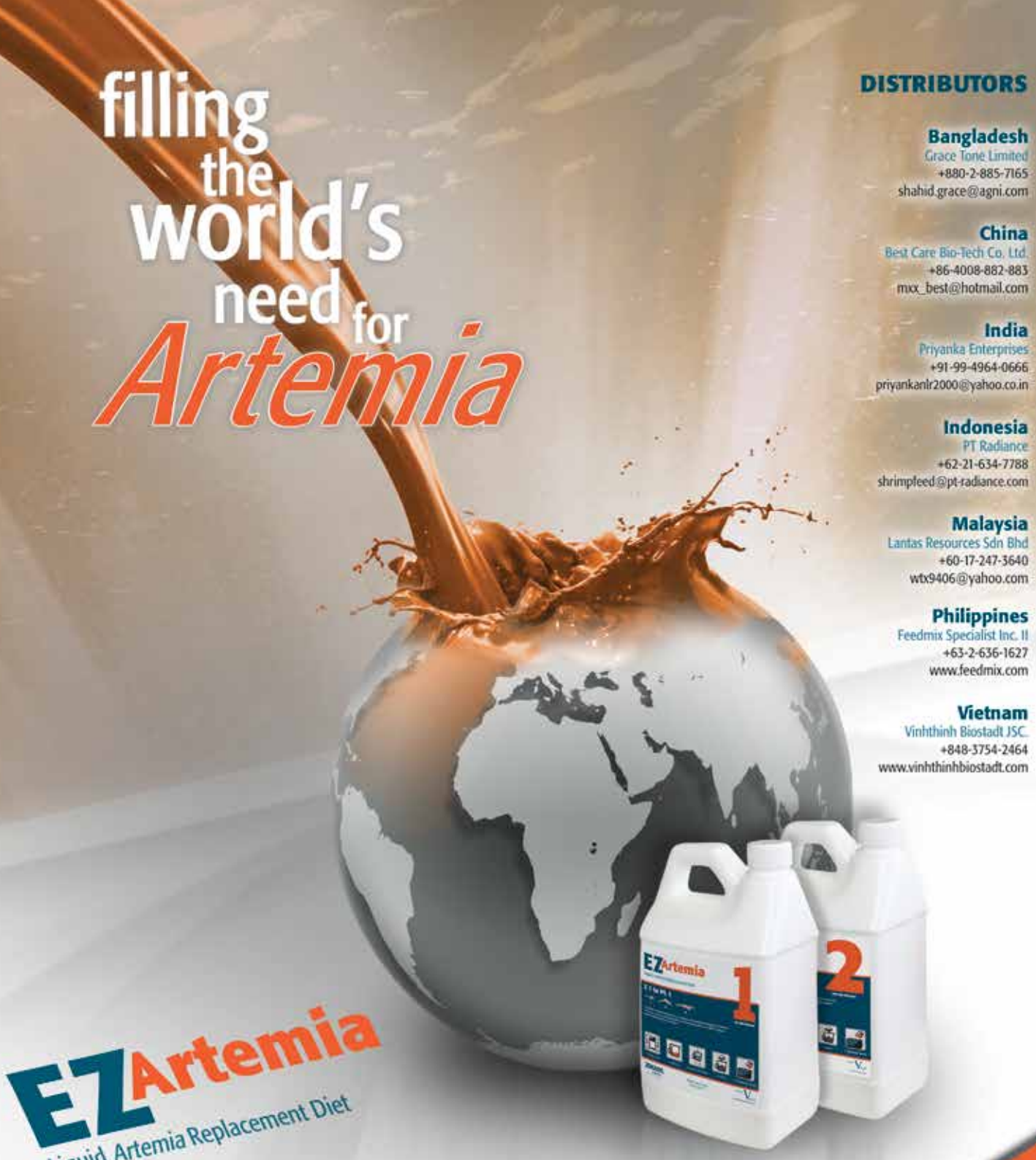

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Ponds at the Bang Go farm in Suratthani, Thailand. "We now have the 3Cs program- first C is clean post larvae. The second and third Cs are clean ponds and clean and clear water," said Dr Surapol Pratuangtum, CEO, Bang Go, during the Hard Talk with Shrimp Farmers at TARS 2016 in August, 2016.

western part of Indonesia as compared to those on Java Island and Bali. Newer farms in Sumbawa and Makassar are also recovering production from outbreaks of WFS which began in late 2014 (villagerspots.com). There was a significant loss in volume with the closure of a large number of ponds in Dipasena in Lampung. Slow growth with WFS and EHP infections had the most impact on production whereas WSSV and IMNV lurked in the shadows.

Intensive and super intensive systems are common in Indonesia. Due mainly to WFS outbreaks, farms had reduced their stocking density, from 400 PL/m^2 down to 300 PL/m^2 or from 200 PL/m^2 to 125 PL/m^2. Those stocking at 80 PL/m^2 had lowered their stocking density to 60 PL/m^2. Harvest sizes ranged from size 30-70/kg.

Anwar Hasan, Biomin, said, "Despite the threats of disease, stocking at 100-170/m^2 is still common. We could see a significant increase in production cost per kg shrimp during an outbreak. WFS increased the cost of production by 30-37%, from an average of USD 3.2/kg mainly because FCR could increase to 2.3 from the usual 1.5 or the acceptable 1.8."

There is optimism on the future in Indonesia, underlined by the sentiment that "Indonesia has so many new potential farming areas, so most farmers in disease prone farming areas will move or expand to new areas and continue to stock at high densities, perhaps as high as 400 PL/m^2 with productivity levels around 60 tonnes/ha."

Thailand

Up to August 2016, farms reported high survivals and successful crops. For 2016, industry leaders initially forecasted production at 300,000 tonnes, 20% higher than that in 2015 (nationmultimedia.com). However, with rain during the latter part of 2016 which cut back production to only 50% of that during the first 8 months of the year, industry revised production numbers. Small sizes (150/kg) produced during this period also brought down the volume.

Aside from the adverse weather effect, there is no doubt that the industry in Thailand is on its recovery phase from EMS/AHPND. Several different techniques are being adopted by farms; some have been successful with the clear water farming technology introduced by Charoen Pokphand (CP).

"However, farms can easily achieve survival rates of 80% when all is well. What is preventing higher production is now slow growth because of white faeces disease and EHP. After two months of culture, 90% of shrimp were only in the 80-100/kg size range. Even size 50-80/kg at 2 months is considered good," said Panakorn.

Philippines

It was a good year for the Philippines' shrimp industry as none of the 14 potential typhoons and cyclones in 2016 made landfall, according to Christopher Co, Oversea Feeds. Total production of the vannamei shrimp was estimated at 60,000 tonnes. There was a decrease in monodon shrimp production but an estimate was not available. This rise in production was supported by active buying by processors. Industry in the Philippines said that this only happens when demand from the local market has been fulfilled. There were reports of localised outbreaks of diseases but none on a widespread level. Problems with EMS were minimal and only during the cold season. Survival rates were good and several large farms reported increased production either due to lining of ponds or expansion of culture areas.

The average stocking was 80 to 120 PL/m^2 and only a few farms stocked at 150 PL/m^2. Depending on the region, partial harvesting was first carried out at 13-14 g shrimp and then at 18 g shrimp. Farms in Negros started partial harvesting at 15 g and the final harvest was 25-30 g shrimp and some continued farming until shrimp reached market size of 35-40 g. The industry measures productivity on a per hectare basis which is 12-15 tonnes/ha per million PL and for those growing larger shrimp, it would be 15-20 tonnes/ha per million PL.

In Malaysia, young farmer Vikraman Krishnamoorthi has been very successful in the farming of the vannamei shrimp. In 2016, stocking density was 183 PL/m² in 0.3 ha ponds and the crop after 105 days was size 46/kg. He uses a brown diatom plankton technology introduced by a local company. Picture by Karunanithi, Yogaa BioShrimp.

Malaysia

A lower production in 2016 at between 35,000 to 40,000 tonnes, was mainly due to EMS which even affected new farms in Sabah. Most of the older farms in the northern and central part of Peninsular Malaysia have not recovered from EMS. Throughout the year EHP was also a major threat. In addition, rains at the end of 2016 resulted in outbreaks of WSSV.

Some farms have begun to look at a nursery phase but the constraint is the high investment cost. Most farms had not changed pond stocking density but on the whole, farmers were stocking less as they had converted production ponds into reservoirs.

While the production of vannamei shrimp had declined, there was a renewed interest to farm monodon shrimp using post larvae from high health broodstock which originated from Madagascar and Hawaii. According to the farmers, monodon shrimp showed less susceptibility to disease. Post larvae were supplied by three hatcheries. Ponds were stocked at 25-40 PL/m².

References are available on request

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Immunostimulants need appropriate dosages and administration time to mitigate AHPND infections in white shrimp

By Loc Tran, Nadège Richard and Philippe Tacon

Yeast parietal fractions act to give resistance to shrimp challenged by AHPND, but this resistance is only possible at appropriate dosages and administration times.

Acute hepato-pancreatic necrosis disease (AHPND) is the major challenge faced by the shrimp industry in Asia for more than 5 years. However, recent improvements in farm management lead to better control of the disease and the shrimp industry is beginning to recover production. Nutrition with specific feed additives, particularly the use of immunostimulants, helps to improve the resistance of shrimp towards this disease infection and is playing a part in the recovery process.

Parietal fractions, isolated from yeast, contain mannan oligosaccharides, beta glucans and chitin components that are potential immunostimulants (Ringo et al 2012) which have been shown to prevent bacterial infections. Moreover, they also have the property to bind bacteria such as *Vibrios* (internal data Phileo Lesaffre, France) and are good candidates as supplements in feeds designed to improve shrimp health. Previous trials both in laboratories and on farm sites (Aqua Culture Asia Pacific, January/February 2016 and March/April 2015) have shown that an optimal dosage of 1 kg/tonne of yeast parietal fraction in feeds gave significant improvements in survival in white shrimp *Penaeus vannamei* infected by AHPND and fed during 2 weeks prior to infection.

The short administration time action of the yeast parietal fraction shows that they have a fast reaction time. However, it would be interesting to know if shortening the administration time would allow the immunostimulant to remain effective against diseases, and if dosages could be modified accordingly. A faster action would be particularly interesting to quickly improve the resistance of shrimp, and help them cope with sudden environment changes, for example at the time of stocking.

A trial was then designed to test increased dosages that were fed for 2 weeks (to confirm previous results) and 1 week (to see the effect of a shorter administration), in order to identify the best combination 'dose-administration duration' for an optimal efficiency against any AHPND infection.

Experimental design

SPF (specific pathogen free) *P. vannamei* utilised in this study were provided by ShrimpVet Lab which uses brood stock from Kona Bay Hawaii. These have been tested for important infectious disease including white spot syndrome virus -WSSV, Taura syndrome virus -TSV, infectious myonecrosis virus –IMNV as well as AHPND using both histopathology and PCR techniques. Larvae culture of the Kona Bay line was done at a strict biosecure ShrimpVet Lab hatchery. Post larvae (PL12) were transferred from hatchery to ShrimpVet Lab wet lab and were grown in strict biosecure conditions for another 45 days to reach 1-2 g.

The experiment was set up as a completely randomised design (CRD) in which, each treatment was randomly assigned to five replicate tanks. The total period of the trial was 25 days, including 1 day of acclimation, 14 days of feed additive administration, followed by 10 days AHPND challenge under the same feeding treatments.

One day prior to the start of the study, all shrimp were transferred to 35 tanks of 120 L each. They were weighed in a group prior to stocking and then, at trial termination for growth rate calculation. Shrimp were fed with treatment diets supplemented with yeast parietal fraction Safmannan® (Phileo Lesaffre, France) for 1 to 2 weeks as described in Table 1. The positive and negative control diets were commercial feeds.

Table 1. Description of the treatments diets used in the study

No.	Treatment	Feed additives dosage	Challenge
1	Treatment T1 (NC)	Commercial feed	None
2	Treatment T2 (PC)	Commercial feed	None
3	Treatment T3	Dose 1 (0.5 g/kg) (2 weeks)	Immersion
4	Treatment T4	Dose 2 (1 g/kg) (2 weeks)	Immersion
5	Treatment T5	Dose 3 (2 g/kg) (2 weeks)	Immersion
6	Treatment T6	Dose 4 (2 g/kg) (1 week)	Immersion
7	Treatment T7	Dose 5 (3 g/kg) (1 week)	Immersion
	NC: Negative control, PC: Positive control uses a commercial shrimp feed (CP Lotus 4000) 1 week: 7 days before challenge, 2 weeks: 14 days before challenge		

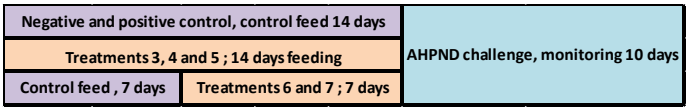

Figure 1. Feeding design of the experiment

Feeds

The test diets were prepared by a cold-extrusion process. The feed additives were mixed with commercial shrimp feed No. 0 (fines, very fine particles), and added with the binder CMC (carboxymethyl cellulose) and moisture before being extruded through a pressurised meat grinder. The spaghetti-like feed strands were dried at 60 °C for 6 hours. The final moisture of the feed did not exceed 11%. Feed strands were broken to size 1.5-2 mm in length for the experiment. The finished pelleted feeds were stored in plastic containers at 4 °C until use.

AHPND challenge

After 14 days of feed additives administration, tanks of treatments T3, T4, T5, T6, T7 and the positive control (T2) were subjected to an immersion challenge. A standard volume of bacterial suspension of a consistently virulent Shrimpvet Lab's strain of *Vibrio parahaemolyticus* was added directly into the challenge tanks to achieve a pathogen density of 5.0 x10^5 CFU/mL which is

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expected to kill 70-80% of shrimp in the positive control within 10 days. The negative control (five tanks in total) was treated with sterile tryptic soy broth with 2% NaCl (TSB+) added into the tanks. Shrimp were fed the same supplemented diets and control groups were fed with a commercial diet without any supplement.

Up to six times per day, tanks were checked and all dead shrimp were removed from the tank and frozen for PCR tests when required. Water quality parameters; dissolved oxygen, pH and temperature were measured every day. Total ammonia concentration, nitrite and alkalinity were measured twice a week. At termination of the challenge study, all live animals were counted as survivors. Before the challenge, there was no significant difference in survival between treatments. There were also no differences in water parameters during the course of the study.

Results were analysed by one-way analysis of variance, followed by Fisher's LSD test to determine significant differences between treatments. Differences were considered significant when $P < 0.05$. Survival data were arc sin transformed for statistical analysis, but only the original values are presented. Results are presented as mean 3 standard error. Those tests were made with the Minitab 17 statistic calculation software.

Histological analysis

All moribund shrimp were sampled for histopathology purposes. The histological sections were analysed by light microscopy for AHPND lesions in the hepatopancreas. Lesions severity was graded according to the G-grading system, from G0 for negative to G4 as the highest severity of AHPND (Lightner, 1996).

Post challenge survival rates

The survival rates of shrimp *P. vannamei* after 10 days post-challenge are given in Figures 2 and 3. The mortalities started from the second day of the challenge test. The clinical signs included shrimp going off feed, empty gut and stomach and pale-atrophied hepatopancreas. The peak mortality happened during the fifth to sixth day post-challenge and shrimp mortality seemed to flatten in the subsequent days. This method of infection seems to kill shrimp in the first 5 days of infection and then shrimp tend to recover.

The negative control (T1) did not show any clinical signs of AHPND and had high final survival rate (93.72 ± 2.4 %). Hence, this indicates that the trial set up was acceptable and no cross-contamination happened to the negative control. All moribund shrimp collected after 10 days of challenge showed lesions ranging from G1 to G3.

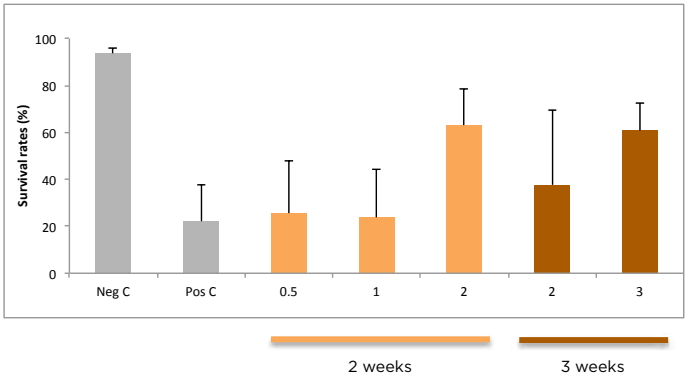

Figure 2. Survival rates of the shrimp among the treatments at day 10 post-challenge (Mean ± SD). Means sharing the same letter do not differ between treatments (Fisher's test, P>0.05). The dosages are expressed in g/kg

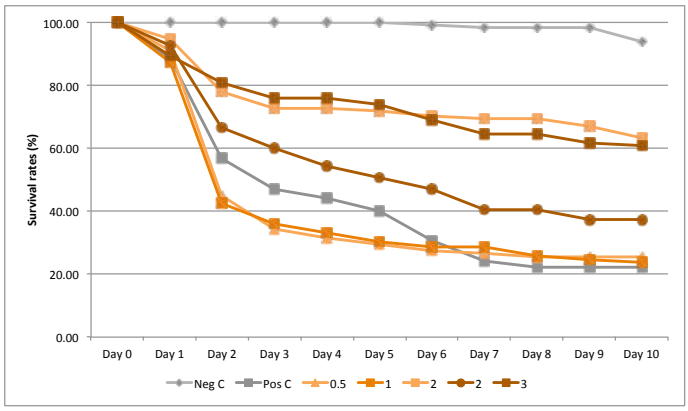

Figure 3. Survival rates of the shrimp among the treatments the during 10 days post-challenge

AHPND resistance

The results show that only two treatments have significantly improved the survival after AHPND challenge. These were treatments T5 (2 g/kg) and T7 (3 g/kg) administered for 2 weeks and 1 week respectively.

This study confirms the beneficial action of yeast parietal fractions Safmannan® on the resistance of shrimp undergoing a challenge by AHPND. However, this resistance can only be obtained by using optimised dosages and administration times. Too low dosages do not give adequate protection at 2 weeks administration; this protection is only attained with a dosage of 2 g/kg. This concentration is nevertheless not efficient if the administration time is reduced, and it is then necessary to increase the concentration of the product (3 g/kg for 1 week administration period).

The treatment with high dosage of Safmannan® could confer protection even though within a short period of administration time. It could be referred to as fast immune response and good binding effect to bacteria. Thereby, the use of yeast parietal fractions at an appropriate dosage could be very beneficial in case of strong pathogen pressure presence in the shrimp pond. It is important to fully understand that the administration time must be carefully set up to the appropriate dosage in relation of the feed intake as a minimum amount of immunostimulant has to be ingested before their action takes place.

The study also highlights that an administration as short as 1 week can give adequate protection. It clearly provides the rules when setting up management practices for disease mitigation.



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The mycotoxin threat to yellow catfish

By Rui A. Gonçalves and Michele Muccio

A new study shows the potential harm and way to protect yellow catfish from aflatoxins. New data reveal that other mycotoxins also pose a threat.

Yellow catfish *Pelteobagrus fulvidraco* is an important commercial freshwater species in China, with promising market potential across China, Japan, South Korea, East and South Asia. Due to its high market value, the yellow catfish farming has increased rapidly in recent years. A new study conducted by BIOMIN in collaboration with researchers in China demonstrated the effectiveness of a registered mycotoxin deactivator in offsetting the negative effects of aflatoxin B1 (AFB1) in yellow catfish.

Mycotoxin an increasingly serious threat to aquaculture

Plant-based ingredients already represent the major dietary protein source used in feeds for lower trophic level fish species. These plant ingredients used in aquaculture are of varying origin and quality and have recently been reported to show the possibility of mycotoxin contamination. Mycotoxins are found mainly in agricultural commodities and are produced at various stages e.g. before or after harvest, during transportation or storage. With the recent trend to replace animal-derived proteins, such as fish meal with plant protein sources, the risk of mycotoxin contamination in aquaculture feeds increases in tandem with the more widespread use of plant materials in these feeds.

Twenty four yellow catfish juveniles weighing 2.02±0.10 g/fish were randomly distributed into 24 net cages (2.0x2.0x2.0 m, Table 1). Fish were hand-fed to apparent satiation with one of the experimental diets prepared to have different concentrations of pure AFB1 with or without the addition of Mycofix® Secure. In analysing the experimental diets, AFB1 levels were found to be higher than the amount added to feed by the researchers—probably due to the natural aflatoxin contamination of ingredients used in the basal diets.

Table 1. Experimental diets

Diets	AFB1 in ppb		Mycofix® (%)
	Added to diet	Analysed on diet	
Without Mycofix®	0	12	0
	200	269	0
	500	648	0
	1000	1186	0
With Mycofix®	0	27	0.2
	200	233	0.2
	500	573	0.2
	1000	1114	0.2
Mycofix® Secure is a product of Biomin, Austria			
Source: Wang et al., 2016			

Weight gain

Greater concentrations of AFB1 in diets were strongly correlated with lower weight gain (Table 2). This negative response was considerably less pronounced when the mycotoxin deactivator was added to the contaminated feed. At 1,000 parts per billion (ppb) of AFB1 in diet, the mycotoxin deactivator improved weight gain by 9.64%.

Feed efficiency

The presence of AFB1 in the diet at levels of 500 ppb or higher led to a significant increase in the feed conversion ratio (FCR), as shown in Table 2. At 1,000 ppb of AFB1 in the diet, the FCR rose by 60%. Catfish fed diets with 500 or 1,000 ppb of AFB1 and Mycofix® Secure had much better feed efficiency (up to 36% improvement) than the control groups.

Survival rate

Survival rates decreased significantly with the increase of AFB1 in diets. At 1,000 ppb of AFB1 in diets, survival fell 22% compared to control treatment. Application of Mycofix® Secure improved survival rates by up to 10.8% (Table 2).

Overall, the researchers found a negative relationship between AFB1 levels in the diet and fish survival, growth performance and feed efficiency. They also identified suppressed immunity parameters in catfish fed AFB1-contaminated feed. Diets containing 1,000 ppb AFB1 were highly toxic to yellow catfish. The registered mycotoxin deactivator decreased the negative impact of AFB1 toxicity on yellow catfish. These results could represent enormous direct revenues for catfish farmers throughout Asia.

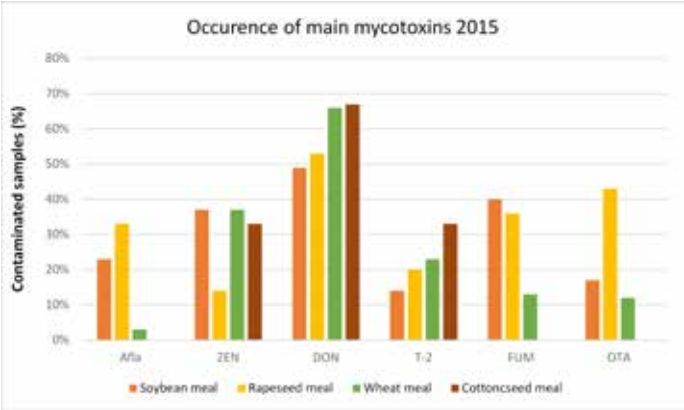
Table 2. Summary of growth parameters during the experimental period

	Diets	WG	SGR(%/day)	FCR
Without Mycofix®	A-0	40.16±1.38^{ab}	3.61	1.36±0.09^{a}
	A-2	40.22±2.98^{ab}	3.65	1.60±0.22^{ab}
	A-5	38.37±0.55^{ab}	3.55	1.72±0.12^{a}
	A-10	32.98±2.44^{c}	3.42	2.18±0.12^{b}
With Mycofix®	A-0M	41.49±1.71^{a}	3.59	1.42±0.07^{a}
	A-2M	40.62±2.40^{ab}	3.65	1.59±0.24^{a}
	A-5M	40.08±0.37^{ab}	3.63	1.53±0.03^{a}
	A-10M	36.06±1.00^{bc}	3.45	1.69±0.10^{ab}

WG (weight gain), SGR (specific growth rate) and FCR (feed conversion ratio). Data are presented as mean ± S.D. Values in the same column with different letters are significantly different ($P < 0.05$).

Aflatoxin not the only threat

Being an omnivorous freshwater fish, yellow catfish have a high probability of consuming mycotoxins in feedstuffs—and not just aflatoxins. A look at the most common ingredients in yellow catfish diets —soybean meal, rapeseed meal, cotton meal and wheat meal— reveals the presence of several other major mycotoxins that can also impair health and performance. Samples of these ingredients were tested as part of the 2015 Biomin mycotoxin survey for the presence of aflatoxins, zearalenone (ZEN), deoxynivalenol (DON), T-2 toxin (T-2), fumonisins (FUM) and ochratoxin A (OTA). As Figure 1 shows, mycotoxin contamination of these commodities is high.



Source: Biomin

Figure 1. Mycotoxin occurrence in yellow catfish diet ingredients

Soybean meal

All main mycotoxins were present in soy samples in percentages that varied from 14% in the case of T-2 toxin to 49% for DON.

Rapeseed meal

For rapeseed meal, DON was found in 33% of the samples, at an average concentration of 820 ppb. OTA was detected in 43% of the samples. Afla, ZEN, T-2 and FUM were all detected in 11%, 41%, 5% and 36% of the samples respectively.

Wheat meal

Regarding wheat meal, the most frequently occurring mycotoxin was DON, detected in 66% of samples at an average concentration of 807 ppb. ZEN was detected in 37% of samples.

Cotton seed meal

Here 335 of the cotton seed meal samples were contaminated by aflatoxins with an average value of 2,038 ppb and maximum value of 16,258 ppb. Fusarium toxins (ZEN and DON) were also found in considerable amounts.

Broad spectrum protection

A number of common molds found in the field produce a variety of harmful mycotoxins that make their way into feeds and impair fish health and performance. Different groups of mycotoxins differ structurally from one another, and therefore require different solutions. A robust mycotoxin risk management program that combines several strategies, or modes of action, to counteract a broad range of different mycotoxins offers better protection for animals and farmers' profits.

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'Back to Basics' for nutritional requirements and aqua feeds

The 2016 edition of the annual DSM Aquaculture Conference Asia Pacific was different from previous years. It was held in two venues: Surabaya, Indonesia, on November 14 which was attended by 71 participants from 3 countries, and Bangkok, Thailand, on November 16, attended by 231 participants from 10 countries. This report covers the conference in Bangkok.

Dr Fidelis Fru, Director of Marketing and Local Solutions, DSM Nutritional Products Asia Pacific, Singapore welcomed the participants. "Aquaculture has to supply healthy protein to an expanding world population. As we are in a demand control business, we should be able to control markets. However, there are many challenges; in raw materials, we compete with livestock feed producers and replacement ingredients for fish meal need to fulfill the health attributes of aqua products."

The 'Back to Basics- Nutritional requirements and aquafeeds' program for this 22nd DSM conference covered reviews on nutrient and energy digestibility, anti-nutritional factors (ANFs) in raw materials and vitamin nutrition of warm water fish and shrimp. Two other areas given focus were health supplements as a strategy to enhance the immunity and resistance to diseases in aquaculture, and enzyme supplementation in aqua feeds.

Dr Dominique P Bureau provided a functional perspective on anti-nutritional factors (ANFs) in his presentation on 'Anti-Nutritional Factors of Significance to the Southeast Asia Aquaculture Feed Industry'. Bureau, Professor of Animal Nutrition and Aquaculture at the University of Guelph (Canada) said that from a feed manufacturer's perspective, ANFs are important considerations that limit the use some economical raw materials.

Dr Fidelis Fru (centre) with participants and staff. From left, Dr Fuci Guo (DSM Nutritional Products Ltd, Singapore), Vilas Autade (DSM Nutritional Products Ltd, India) Mahesh Nekkanti (Devi Sea Foods), Ravi (Sharat Industries Ltd), Mohan Krishna (Devi Sea Foods) and Dr Muthu Ramkrishnan (DSM Nutritional Products Ltd, India)

"Traditionally, ANFs are defined as compounds which interferes with the digestion, absorption and metabolism of a nutrient. However, I would suggest a slightly broader definition that includes all compounds which can have physiological and metabiological impacts on animals. These will then include oil seeds anti-nutritional factors, dietary fibre components, phytic acid and fungal or microbial metabolites/components."

Oil seeds anti-nutritional factors

The range include protease inhibitors, saponins, lectins (agglutinins), oligosaccharides, antigenic compounds, glucosinolates, tannins,

Dr Daranee Sookying, Aquaculture, DSM Nutritional Products Ltd, Thailand (centre) with Dr Orapint Jintasataporn, Kasetsart University (left) and Apirux Kimawanit, TRF Feed Mill Co., Ltd.

Dominique Bureau (centre) with Dr Jowaman Khajarern (right) and Dr Yaomamal, Khon Kaen University, Thailand.

gossypol, phytoestrogens, alkaloids, and cyanogens. Proper thermal processing of oilseeds can bring down ANFs levels so as not to cause deleterious effects. However, over processing, such as excessive heat treatment that aims at reducing heat labile ANFs can instead reduce digestibility of nutrients, such as amino acids.

"The urease test is often use to determine if a soybean meal has been sufficiently but not excessively heat treated. However, recent studies have shown poor correlation between urease level and protein digestibility.

"KOH solubility, another common indicator of soybean meal quality, was found to be a very poor indicator of quality as it was not well related to protein digestibility. We truly need better quality control tests to predict digestibility of protein in soybean meal and other oilseeds. We also need nutritional interventions to improve protein digestibility of less digestible oil seeds and a case can be made for the use of proteases," added Bureau.

Non-infectious gastroenteritis

One hallmark issue related to ANFs of soybean meal is the non-infectious enteritis it causes in salmonid fish species. This enteritis is caused by a combination of heat stable ANFs, such as soya-saponins and oligosaccharides. This enteritis (inflammation of the distal intestine) can affect digestibility of some nutrients and affect permeability of the intestine. This issue is important to salmon feed manufacturers in Europe that screen soybean meal shipments for soya-saponin content and can reject batch of soybean meal with high levels of these ANFs.

There is a lack of systematic investigation of the effects of the different ANFs from oilseeds in the different fish species of commercial importance in Asia. However, it seems likely that some carnivorous fish species cultured in Asia could be affected by these compounds. According to Bureau, a recent study in China, showed that heat stable antigenic proteins had negative effects on the turbot and carp. He recommended that experiments be carried out in Asia to compare the effects of regular versus fermented soybean meal or SPC on gut histology of different fish species.

Nutritional interventions

"This does not mean the we should avoid soybean meal. Fish are able to adjust. There are evidence of nutritional inventions that can reverse some of the negative impacts of oil seed ANFs. Research

Dr Preecha Ekatumasuit, TRF Feed Mill Co. (left) with (from left) Dr Nontawith Areechon, Department of Aquaculture Kasetsart University, Dr Pikul Jiravanichpaisal, Fish Vet Group Asia Ltd and Dr Vanvimon Saksmerprome, Centex Shrimp, Thailand.

in Norway showed that supplementation of the diet with bacteria grown on natural gas or with butyric acid could alleviate the soybean meal-induced enteritis in the salmon. Oil seed ANFs are not always bad. There are studies which showed that, soybean oligosaccharides and other ANFs can could improve disease resistance of fish after a challenge with a pathogen" said Bureau.

Dietary fibre

This is a broad range of compounds encompassing oligosaccharides and polymers. When we buy ingredients, we buy a lot of fibre which actually dilutes the nutritional content of the ingredient. "It is my belief that feed companies are wasting time and dollars measuring crude fibre which is not a very reliable measure of fibre content of feeds and ingredients. Few companies have a true understanding of how much fibre they are actually purchasing. They should move on to measure total dietary fibre cellulose, lignin, hemi cellulose and other poly and oligosaccharides. In addition, different types of fibre have very different effects and thus we should strive for better characterisation of fibre content of ingredients and better determination of the potential effects of different types of fibres."

"In carnivorous fish, insoluble fibre, notably cellulose, in excess of 10-12% can have negative impacts on nutrient intakes of the animals. However, we generally worry more about soluble fibre which have a high capacity to retain water forming a gel in the gastrointestinal tract can increases the viscosity of the digesta which can in turn affect digestion and absorption of nutrients. A number of studies have suggested that different types of soluble fibre components may reduce the digestibility of protein, lipids, minerals, and starch. Research by Glencross et al. (2012) showed how different soluble and insoluble non-starch polysaccharides affect diet digestibility in the rainbow trout."

One type of fibre that feed manufacturers can worry about is lignin since it has been found to have negative affect on digestibility of some nutrients. Lignin is sort of molecular sponge and binds proteins and some nutrients and affect their digestibility.

Phytic acid

Phytate-P is present in plant meals in various concentrations. In his discussion on phytic acids, Bureau said that his group has developed phosphorus digestibility models using meta-analysis of total feeds. These models indicate that tilapia can digest 25% phytate because there are gut bacteria whereas in the carp and trout species, the digestibility of phytate phosphorus was 0%.

"Like lignin, phytic acid is like a molecular sponge, it binds protein and starch and interferes with the digestion and absorption of amino acids. In the presence of small amounts of phytic acids, amino acid digestibility is not affected but higher amounts can result in lower digestibility of certain amino acids, such as histidine and lysine."

Vitamins for nutrition and health

In this review, **Dr Viviane Verlhac Trichet**, Principal Scientist, DSM Nutritional Products, France presented the current knowledge on vitamin requirements of warm water fish and shrimp and their functional properties.

"There are fat-soluble vitamins which are stored in the body while water-soluble vitamins have limited body storage capacity. In general, most vitamins are involved in the metabolic processes and some are excellent antioxidants. Their metabolic functions in fish are similar to land-based animals. However, since fish are not able to produce vitamins themselves, it is essential they are supplied from a dietary source.

"Feed ingredients contain vitamins but usually the contents are variable and they are degraded by processing since vitamins are unstable. With replacement of fish meal with plant meals, feed formulators need to rethink on levels of vitamins such as the B-vitamins. We also need to adapt vitamin requirement levels to metabolic demand, intensive production systems and environmental conditions."

Verlhac Trichet showed that the recommended supply in feeds is derived from the minimum dietary requirements of selected vitamins for growth and the avoidance of deficiency symptoms as published in the NRC (2011). Add-ons are corrections for optimal production, safety supplement, health and well-being of the fish and compensation for losses in feed processing. She highlighted the importance of product types, particle sizes and formulation to guarantee recovery of the vitamins and their efficacy assurance.

Viviane Verlhac Trichet

"Looking beyond nutrition, we need to look at functions such as immune stimulation and meat quality. Since vitamins are so involved in metabolic processes, we need to ensure maximum tissue storage of vitamins to quickly respond to stress and health challenging situations. We also need to consider individual variations as slower feeders also need their supply of vitamins."

Fish health with vitamin C and E

Verlhac Trichet focussed on the antioxidant vitamins C and E, giving examples of their additional effect on health through immune response. She discussed their functions; as single vitamins, Vitamins C and E have their respective roles for the health of the animal and how together they work in synergy.

"As the level of vitamin C increases in the diet, levels in cells will also increase concurrently until it reaches a plateau. The optimal amount is 1,000 (ppm) mg/kg. Vitamin C contributes to maintain the integrity of the immune cells through protection against oxidation. It modulates non-specific immune defenses, leading to an improved resistance to infectious diseases. Fish leucocytes store ascorbic acid in their cytoplasm. Vitamin C also has a wound healing role.

"Vitamin E is stored in the immune cells and its contents are related to dietary supplementation. The vitamin is stored in cell membranes and supports membrane fluidity. In rainbow trout, we showed that vitamin E is correlated with phagocytosis. Vitamin E has the capacity to respond to vaccination (a higher dose providing a higher antibody response) which shows its influence on lymphocyte functions." Verlhac Trichet also showed an example of the positive effect of a high dose of vitamin E (600 ppm versus 150 ppm) in reducing apoptosis of lymphocytes from rainbow trout fed high lipid diet.

"Finally, when we combine the two vitamins at high dietary dose, this results in lower mortality as exampled in the case of a viral infection. The benefit of the combination of the two vitamins is due to the fact that vitamin E is stored in membranes and vitamin C in the cytoplasm of cells and also to the need for vitamin C to regenerate vitamin E," added Verlhac Trichet.

Availability of nutrients

"Nutrient variability is affected by a range of factors, including source and processing, thus being able to understand causes of variability is key to its management," said **Dr Brett Glencross**, Director of Research, Institute of Aquaculture, University of Stirling, Scotland in his presentation on availability of nutrients: amino acids, energy and phosphorus.

Brett Glencross

"We can reduce formulation risk by moving from formulations relying on fish meal as the major ingredient to formulations using different types of alternative ingredients with a lower price volatility and better supply dynamics, but potentially face increased risk associated with nutritional variability. Additionally, some types of alternatives introduce new risks such as anti-nutritional factors (ANFs), contaminants and digestible protein variability,"

Moving beyond fish meal, Glencross reminded the audience that fish and shrimp need nutrients and energy, and not raw materials. "The same amino acids exist in plant and animal protein meals, and energy from protein, fat and starch is not affected by source, whether animal or plant based. However, all raw materials will have issues with variability. Nutritional variability is affected by source and processing among other things. Understanding variability is key to its management."

Assessment of digestibility

Measurements can be made of both apparent digestibility and true digestibility. Apparent digestibility is less complex than true digestibility, which takes into consideration endogenous and microbial contribution of the nutrient lost in the faeces. The former is more suited to the requirements of aquaculture.

"In the evaluation of an ingredient, there should be standardisation of our assessments such as with species, genotypes, digestibility methodology and palatability. Most raw material processing methods influence both composition and nutritional value. For example, the dehulling efficiency of lupin affects the crude protein level and its protein digestibility for the salmon."

There is a range of methodological issues such as the faeces collection methods used and the choice of inert markers, that can affect results. Acclimation and diet composition also affect digestibility values. Rapid analysis of digestibility is possible with Near Infra-Red (NIR) where the digestibility value can be obtained in seconds in lieu of what usually takes months. However, this requires extensive work in developing the appropriate calibrations.

"The feed processing method is also important. To compare digestibility of ingredients for extruded commercial feeds, we should also use the same processing method in the lab studies. All in all, the data demonstrated that there are a range of constraints to be considered to optimise obtaining digestibility information *de novo* and/or reviewing the available data in the public and private domain," said Glencross.

Digestibility data

There is a wide range of ingredients, some new, such as microbial proteins and insect meals and some conventional ingredients such as feather meal. "What drives change is when we start using digestibility data, we start to better understand the qualities of

the raw materials. Each process in the production of animal proteins changes the digestibility value of the product. Recently we have collated data for the sea bass *Lates calcarifer*. It presents all the data on digestibility for the seabass. Data on 9 different digestibility studies on 34 plant protein and 20 animal protein raw materials, 11 plant starch and 3 lipid materials were collated and reported in Glencross et al. (2016). Such data are of great value and can be broadly applied for the seabass."

Glencross presented a study which showed that with an increase in crude protein levels there was an increase in digestible protein; the study also highlighted critical variability that could be seen around some data points. "Something is driving this variation in digestibility and if not unaccounted for it can result in feeds that fail to perform. The data presented also showed how we need to consider amino acid digestibility. Ultimately, the animal needs dietary amino acids which it uses for growth and we should move away from focusing on ingredients to amino acids when formulating feeds. A study by Tram et al, (2008) on *Clarias* catfish and the tilapia gives some useful data for formulating diets based on amino acids. More information is available from the USSEC sponsored International Aquaculture Feed Formulation database (IAFFD)."

In the case of the shrimp, Glencross said that data is not available to determine the digestibility variability in raw materials. He referred to the work of Smith et al (2007) on the digestibility of lupin kernel meals for the monodon shrimp and Yang et al (2009) on digestibility of ingredients and amino acids in selected ingredients for the vannamei shrimp. "We need more data like this to better understand variability and its causes. In Australia, a commercial fish meal-free feed for the monodon shrimp showed growth comparable to that of a standard fish meal feed."

Glencross concluded that, "Analysis of digestibility effects of different raw materials is really very important and if there is a clear understanding of the value of raw materials, almost any raw material can be used for feed formulation. Understanding the drivers affecting variability in digestibility is key to formulation success. Getting this right means that we need not rely on fish meal."

Resolving disease issues with health supplements

During the 2013 edition of this conference, **Dr Yu-Hung Lin**, Associate Professor, National Pingtung University of Science and Technology, Taiwan discussed the available information on the nutrient requirements for optimal growth and health for the grouper and fish. In this 2016 edition, he updated the audience on recent findings on established nutrient levels for optimal growth.

Yu-Hung Lin

"Fish nutritionists often quantify nutrient requirements to maximize the animal's growth but largely ignore the roles of nutrients in disease prevention. Fish/shrimp farmers are interested in developing cost-effective preventive measures to stop or reduce the effects of diseases on their stock. Often in the absence of information on health supplements, farmers tend to use antibiotics excessively as a prophylactic in an attempt to mitigate these challenges."

According to Lin, health supplements used to enhance immune response and resistance to diseases in aquaculture can be categorised as essential and non-essential nutrients. Some of these supplements can also be used to improve intestinal health. With regards to amino acids, arginine at 2.7-3.6% increased lysozyme activity in the golden pompano whereas 2.7% also increased lysozyme activity as well as resistance to *Aeromonas hydrophila* in the yellow catfish.

"Previously, we showed that in the grouper *Epinephelus malabaricus*, dietary lipid deficiency depressed non-specific immune responses of grouper. Enhanced immune responses required that the dietary DHA/EPA ratio be greater than 1, indicating that DHA was superior to EPA in promoting fish health. Usually n-6 fatty acids are considered non-essential as fish can biosynthesise them. However, recent work by Shankar et al, 2016 showed that dietary arachidonic acid at 0.71 to 1.06% could significantly improve growth and immune response in the Japanese eel," said Lin.

Both vitamins C and E are requisites for fish health. However, Lin cautioned that although the tendency of farmers is to increase the amounts of these two vitamins in the diet, high levels of Vitamin E may be toxic to the animal. "Therefore, it is important to evaluate the maximum threshold for vitamin E if we want to include more vitamin E into diets to enhance immune responses," said Lin.

Published work showed that 480 mg/kg of vitamin E is required for growth and immunity for the turbot (Niu et al, 2014) but for the yellow catfish, the amount for immunity rose 1.4 times to 46 mg/kg from the amount of 33 mg/kg required for growth (Lu et al, 2016). Shankar et al (2016) reported that the Japanese eel required up to twice the amount of Vitamin C for immunity compared to growth, from 410 mg/kg to 438-840 mg/kg.

Non-essential nutrients

These are nucleotides, algal extracts, plant products and probiotics. Current interest is with microalgae which can produce highly unsaturated fatty acids, mainly EPA.

"We showed that heat treated macro algal meal *Sargassum cristaefolium* can enhance the immune response and resistance to *Vibrio alginolyticus* in white shrimp (Lin et al., 2016). Li et al (2014) showed that the microalgae *Haematococcus pluvialis* at levels of 0.28-0.56 g/kg in the diet enhanced growth of the yellow croaker, a popular marine fish in China," said Lin.

"In Taiwan, we are concerned with the disposal of agricultural wastes. Research showed that banana peel extract can be used as a bacteriostat and immunostimulant, as well as a physiological regulator for the freshwater prawn," explained Lin.

Gut health

"Recently, intestinal health is becoming an important issue. Plant meal such as soybean meal used to replace fish meal, has been found to cause morphological changes and inflammation of the fish intestine. Nucleotides can be used to repair damage to the gut as well as 1% butyrate or lactate. Some organic acids have the same role. The nutritional strategy is to reduce the risk from the use of soybean meal in feeds," said Lin.

"Soybean meal fermented by *Lactobacillus* spp shows less adverse effects from anti nutritional factors and lower molecule weight of protein. There was less damage to the gut walls in grouper fed diets where fermented soybean replaced 20% fish meal. At 7.5-15% replacement levels, groupers had a better survival rate from *V. alginolyticus* infection."

Use of supplemental enzymes

"As compared with other types of animal protein production, aquaculture faces more demands to attain sustainability. Feed nutritionists have to formulate to demands by retailers and certification programs on what can and cannot be included in fish feeds. A frequent demand is to remove all or at least greatly reduce the use of fish meal in fish feeds," said **Dr Thomas Wilson**, Consultant, DSM Nutritional Products Asia Pacific, Singapore.

In his presentation on supplemental enzymes and fish meal reduction of warm water fish feeds, Wilson showed an example of a tilapia feed in which fish meal inclusion was reduced to 0% from 32% with high percentages of soy or other plant proteins (high in phytic acid). "The consequences of using high levels

Thomas Wilson

of plant proteins are increases in anti-nutritional factors. Phytic acid increases while total and available phosphorus declines, and if not supplemented with phosphorus at full fishmeal replacement, phosphorus and zinc deficiencies will occur. As non-starch polysaccharides (NSP) increase, they interfere with gut viscosity, enzyme activity and nutrient absorption. Saponins increased to nearly 25 g/kg feed. These reduce feed intake because of the bitter taste and increase gut wall permeability."

Using the enzyme phytase reduces the consequences of phytic acid in the feed. The cost benefits of using phytase in lieu of mono or dicalcium phosphate (MCP/DCP) to ensure sufficient phosphorus availability was discussed. More details are available in an article in Aqua Culture Asia Pacific (September/October 2016, p42-45). Wilson added that each new generation of DSM phytase product has improved phosphorus recovery from phytate P compared to the generation before.

"However, phytase cannot withstand the high temperatures during the extrusion process, so must be sprayed on pellets after drying. The cost of adding 2,000 units of liquid phytase will be about USD 1.50/tonne of feed."

Managing other ANFs

"While insoluble NSPs (dietary fibre) do not generally interfere with digestion, high levels in feeds may reduce feed intake due to sensation of fullness of the gut. Soluble NSPs on the other hand, decrease the rate of diffusion of digestive enzymes into the gut lumen, and of digested nutrients to the gut wall, and there is evidence that some soluble NSPs can even bind nutrients and prevent their uptake (lipids, cholesterol, vitamins). As a consequence, using xylanase to improve gut viscosity improves the utilisation of starch, fats, amino acids, minerals and energy. Thus, nutritionists need to pay attention to these ANFs," said Wilson.

In one example with a tilapia feed in Thailand, Wilson showed how the addition of xylanase to a feed with 0% fish meal showed growth improvement of 10% as compared to a diet without its addition. He emphasised, "It is important not to assume higher growth will always occur with use of xylanase enzyme. In my experience, the real benefit of using xylanase in feeds with significant amounts of plant ingredients is the ability to reduce formulation cost without decreasing feed performance."

Improving protein digestibility

Plant ingredients such as soybean and rapeseed meal containing protease inhibitors reduce activity of trypsins, chymotrypsins and other proteases. "Different proteases have different specificity. While trypsin is very specific for arginine and lysine, DSM's protease (ProAct) has specificity for hydrophobic amino acids, and is more aggressive at cutting proteins into shorter peptides than endogenous proteases. Shorter peptides are easier to digest at the gut wall.

"Usually, the composition and processing of plant meals like soybean meal is very variable. Variability in cooking will affect residual protease inhibitor content, and nutrient digestibility. Dietary proteases provide more consistent and uniform digestion and compensate for the variability of ingredients," said Wilson. "It is recommended to use multiple enzymes at the same time. They use the same space and each have their respective functions which are complementary."

"The environmental benefits of using feed enzymes in an aquatic environment are clear; with 41% reduction in tilapia and 35% in catfish ponds in Thailand. Enzymes support absorption and reduces waste excretion. We need to focus on how best we can use plant meals. We cannot turn back but move forward with sustainable ingredients," concluded Wilson.

How can yeast derivatives support aquaculture production?

By Stephane Ralite, Eric Leclercq and Sylvie Roquefeuil

When combined, different yeast fractions exert a synergistic effect on the immune system in fish and shrimp

The intensification of aquaculture production has led to increased pathogen pressure. At a time of growing concern regarding the use of antimicrobials in food producing animals, alternative strategies are sought to promote animal health and performance in a sustainable way. Fish have several natural lines of defenses against external threats including the gut, skin, gill mucosal surfaces, the mucus, epithelial cell layer (mucosal surface) and their associated microflora, and finally the immune system. Based on the natural ability of yeast fractions to help balance the intestinal microflora and stimulate the host natural defenses, a new generation of yeast derivatives has been developed to help support those natural lines of defenses in freshwater and marine species. Trials conducted in fish and shrimp indicate very promising outcomes, in terms of animal performances and economic benefits for the producer.

Three natural lines of defense

- Mucosal surfaces are the first line of defense against bacteria and viruses as well as parasites which are ubiquitous in the aquatic environment. The integrity of the mucosal layer is easily disrupted by a variety of factors such as handling, infections and chemicals exposure.
- The gut epithelium houses a rich and diverse microflora population. Through mechanisms such as competitive exclusion, the microflora is instrumental in keeping undesired pathogens at bay. The digestive microflora balance can be easily disrupted by dietary, physiological and environmental stressors.
- The immune system acts as a third line of defense in the animal.

Developing innovative yeast derivatives

A research program to identify and develop a new generation of yeast fractions with optimal characteristics to help animals face various challenges, was conducted in partnership with renowned research institutes. Cutting-edge techniques such as atomic-force microscopy (AFM) and single-molecule force spectroscopy (SMFS) were used to study yeast fractions . These techniques constitute powerful tools to investigate the forces and motions associated with single molecules. For the first time, we were able to 'visualize' very precisely, the yeast surface topography in terms of pathogen binding potential. It was shown that binding molecules were arranged differently depending on the yeast sample. For certain yeast strains, they are arranged as 'sticky patches' while in others they are scattered along the surface. In terms of functionality, the sticky patches show higher adhesive properties.

This finding clearly shows that, while chemical composition is important, it is not sufficient to account for the functionality of a given yeast fraction. In other words it is not enough to know the percentage of binding molecules on a specific fraction of yeast to address its binding capacity. The distribution of these molecules along the cell wall and the yeast fractions biophysical structure (topography) are very important features and differ between strains. Further it was possible to measure by SMFS the length of the polysaccharide chains, which forms a second characteristic directly linked to the yeast binding capacity; different yeast strains have been shown to have different polysaccharide chain lengths.

Together, these studies demonstrate that yeast cell wall properties are linked to the strain, each strain exhibiting specific structure and functionality in terms of binding properties. Moreover, it was also shown that, for a given strain, binding properties can differ when applying varying production and inactivation processes. Hence, for every selected strain, it is essential to determine the optimal fermentation conditions, as well as the treatment of the live yeast to obtain the yeast fractions (inactivation technique). These specific production parameters cannot be controlled when yeast cell walls are a by-product of fermentation processes. When producing customized yeast cells, the production process for each selected strain is specifically adapted to achieve a yeast derivative with the desired characteristics.

Based on this knowledge and techniques, different yeast strains were screened to select the best candidates for optimal binding of various bacteria *in vitro*, such as different Vibrio species of particular importance in aquaculture. The best strains were selected for their complementary properties (Figure 1). Transposed to *in vivo* settings, such properties indicate a potentials to agglutinate a larger spectrum of undesirable bacteria inside the gut lumen prior to a potential colonization of the gut epithelium.

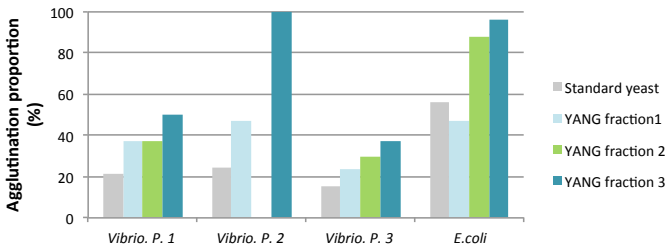

Figure 1. Example of yeast fractions pathogen binding properties (agglutination proportion measured 1 hour after incubation *in vitro*). The yeast fractions 1, 2 and 3 showing much higher levels of agglutination, were selected and formulated together.

Further mechanistic studies also indicated that the different yeast fractions exert, when combined, a synergistic activity on the immune system *in vitro*. A patent has been filed concerning this synergistic immune effect. The selected yeast fractions were combined into a unique formulated solution named YANG (Yeast association new generation); and tested in various aquatic and terrestrial farm animals.

Benefits in shrimp and fish

A trial was conducted with YANG in Vietnam in 2015 on juvenile white shrimps (*Litopenaeus vannamei*) subjected to a

pathogen challenge. YANG supplementation for 3 weeks prior to a controlled EMS/AHPND (*Vibrio parahaemolyticus*) challenge was associated with a 4.6 fold improvement in survival (12% Control; 56.3 YANG – $p<0.05$). In 2016 and in a separate trial under similar conditions, dietary yeast fractions supplementation was also associated with a significant higher end-point survival reaching 49.6 ± 18.5% compared to 16.5 ± 9.8% in the control. These very consistent results at the animal level confirm the *in vitro* agglutination results. They are a clear demonstration of the potential of yeast fractions as an efficient tool in support of good health against one of the most damaging pathologies in aquaculture.

What about the mucus, the first line of defense?

An 8-week trial was conducted in rainbow trout (*Oncorhynchus mykiss*) in 2014 (Plymouth University, UK) to evaluate the effect of the yeast derivative formulation on skin mucus production. In this trial, skin mucus secretion increases with time in the control, indicating on-going recovery toward normal mucus level following transfer into the rearing system. Compared to the control group, a positive effect of supplementation is observed within 4 weeks with a 65% increase in skin mucus level. After 2 months (week 8), skin mucus level was 27% higher than the control group in the yeast supplemented group. By supporting a rapid recovery (under 4 weeks) and high levels of skin mucus quantity, YANG supports a lower risk of secondary infection and physiological disruption following challenging conditions (Figure 2). Results on skin mucus level were in agreement with the up-regulation of a molecular skin biomarker indicative of the immune function and regenerative capacity (wound healing) of the skin mucosal layer.

These results have been demonstrated in several species such as seabass, seabream, trout and salmon. By supporting the skin mucosal barrier, yeast fractions contribute to the resilience and recovery from challenging conditions including parasitic challenges, chemical treatments and mechanical disruptions from handling and transfers.

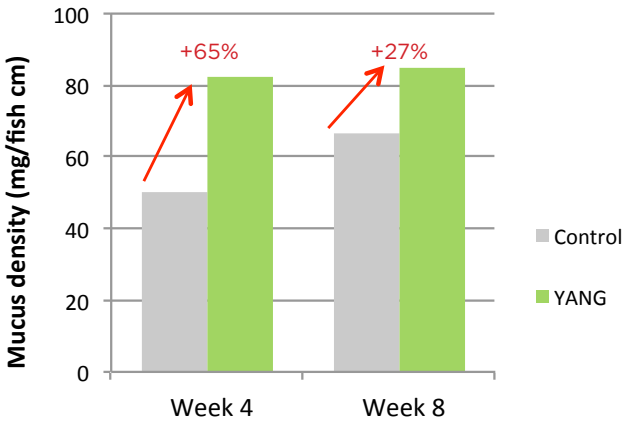

Figure 2. Effect of YANG supplementation on skin mucus quantity in rainbow trout.

In the same trial, YANG was also shown to enhance the microvilli density of intestinal epithelial cells, the second line of defense. A higher surface area of the intestinal brush-border is associated with enhanced gut health, protective barrier function and nutrient absorption.

Similar outcomes were observed in juvenile seabass in conditions of digestive stress (incorporation of high level plant-based raw materials in the diet – 40% soybean meal). Following 10 weeks of YANG supplementation, the density of microvilli of the intestinal cells was increased, and significant differences in the length of microvilli and gut perimeter ratio were also observed. These were associated with improved feed utilization and growth performance. Weight gain (21.6 vs. 18.5 g/fish in control), daily growth rate (1.39% vs. 1.25% in control) and feed conversion ratio (1.45 vs. 1.66 in control) were improved (statistically significant difference for all parameters) with YANG (Plymouth University, UK, 2014). Finally, in the same trial, a strong correlation between dietary YANG supplementation and the intestinal expression of genes involved in the immune response was demonstrated (Figure 3) indicating a positive modulation of the immune system.

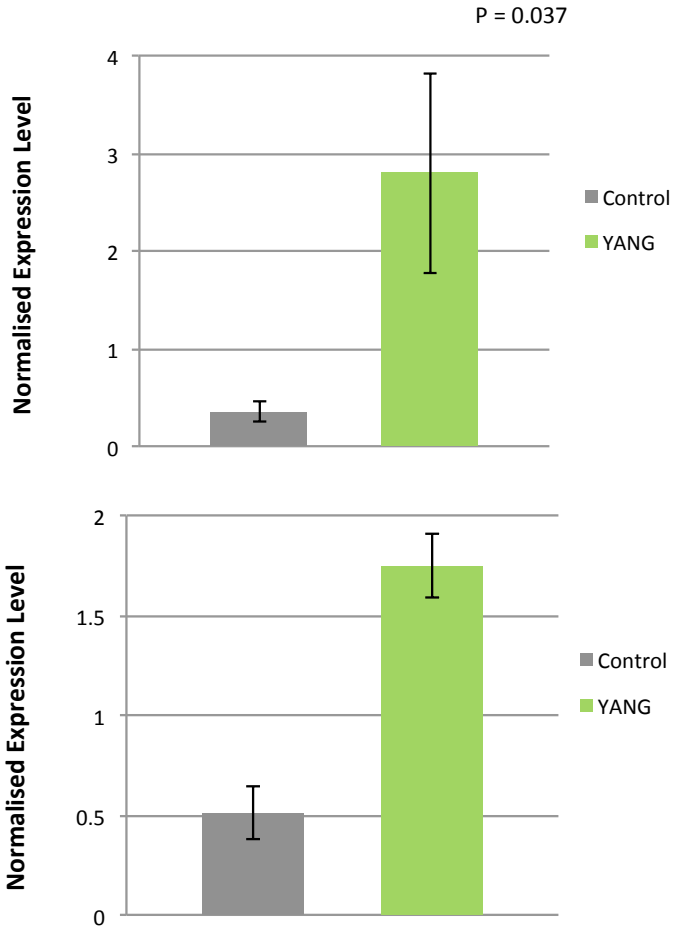

Figure 3. Effect of YANG on interleukin gene expression showing modulation of the immune system (Seabass trial, Plymouth University, UK, 2014).

We conclude that an innovative approach to yeast strain selection and yeast derivative development has led to a new generation of products combining different yeast fractions. These give promising benefits for the natural defenses of aquatic animals.

Stephane Ralite *Eric Leclercq* *Sylvie Roquefeuil*

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Apparent phosphorus digestibility coefficients of inorganic feed phosphates for the tilapia

By Hélène Briand

Phosphorus is an essential mineral in fish feed. It is a key component of hard tissues (bone, exoskeleton, scales, and teeth), DNA and phospholipids. Unlike calcium (Ca), phosphorus content in natural water is low and not absorbable by gills. Thus, phosphorus is mainly supplied in feeds.

Phosphorus deficiency impairs fish metabolisms resulting in reduced growth and poor feed conversion. Various skeletal malformations associated with lower mineralisation of hard tissues are observed at suboptimal phosphorus intake (NRC, 2011). Fish meal can be a source of phosphorus but the partial replacement of fish meal with plant ingredients decreases the phosphorus availability in diets. Indeed, most fish species are not able to digest phytate-P (phosphorus from plant ingredients). Inorganic feed phosphates are a common source of phosphorus in fish feed. Its digestibility is variable, depending on the source and digestive system of the fish. If the digestibility is too low, the phosphorus is released and accumulates in the environment, causing eutrophication of the water body.

Nile tilapia *Oreochromis niloticus* is the most commercially cultured freshwater fish species globally (El-Sayed, 2006). Several studies on phosphorus requirements in Nile tilapia have been reported. Yao et al. (2014) observed optimal performances for

Nile tilapia with 8.6 g/kg of available phosphorus. Nevertheless, only a few studies reported on the digestibility of inorganic feed phosphates. Hua and Bureau (2010) developed a phosphorus digestibility model for the tilapia in which the apparent digestibility coefficient (ADC) of phosphorus was 93% and 62% for a monobasic Ca, sodium (Na) or potassium (K) phosphate and a dibasic Ca phosphate, respectively. The aim of this study was to evaluate the ADC of two feed phosphates, monocalcium phosphates (MCP - 22.7% P) and the dicalcium phosphate (DCP - 18% P) for the tilapia (Table 3). The study was conducted at the Research Institute of Aquaculture (RIA2) in Ho Chi Minh City, Vietnam.

Experimental diets

Three diets were formulated, based on soybean meal (46%) and cassava meal (22.95%), to meet all nutrient requirements for feeding tilapia juveniles (Table 1). These were isonitrogenous and isolipidic. Ca:P was fixed at 0.92 (Table 1). The control diet (CTRL) contained no inorganic feed phosphate (IFP). The first test diet (DCP_{18}) contained 1.8% of DCP18 and the second test diet ($MCP_{22.7}$) contained 1.35% of MCP22.7. Chromic oxide was used as a non-digestible marker to determine phosphorus apparent digestibility by following the wet-digestion method of Furukawa and Tsukahara (1996). The test ingredients, characterised in Table 3, were finely ground before mixing with the other ingredients. The ground mixture was steamed pelleted to 2-3 mm pellets and dried.

Experimental design

A total of 135 fish (body weight 51.6 ± 1.7 g) were randomly allocated to nine faecal collection units of 150 L (fiberglass tank), with 15 fish per tank. There were three replicates for each treatment diet. Fish were fed twice a day to satiation at 3-5% of body weight. After 7 days of acclimation, faeces were collected by siphoning twice a day, after the removal of uneaten feed in the system. The duration of the experiment was 4 weeks.

Table 1. Detailed composition of the experimental diets (% of dry matter)

Composition	Diets		
	CTRL	DCP_{18}	$MCP_{22.7}$
Fish meal, Vietnam 60% (a)	4.00	4.00	4.00
Soybean Meal 47% (b)	46.00	46.00	46.00
Wheat gluten (c)	5.00	5.00	5.00
Corn starch (d)	3.0	1.2	1.65
Cassava meal (e)	22.95	22.95	22.95
Rice bran (f)	11.50	11.50	11.50
Premix-vitamin-mineral (g)	2.50	2.50	2.50
Fish oil (h)	2.90	2.90	2.90
Lysine (i)	0.50	0.50	0.50
Methionine (j)	0.35	0.35	0.35
Choline chloride 60% (k)	0.15	0.15	0.15
Stay C 35% (l)	0.05	0.05	0.05
Anti-mold (m)	0.10	0.10	0.10
Chromic oxide (n)	1.00	1.00	1.00
DCP(*)	-	1.80	-
MCP (**)	-	-	1.35
Total	100.00	100.00	100.00

(a) Minh Tam, Kien Giang, Vietnam; (b) Bungee, Vietnam; (c) Vital Wheat Gluten, Zhangjiagang Hengfeng Starch Products Co., Ltd, China; (d) Roquette Riddhi Siddhi Private Limited, India; (e) Tay Ninh, Vietnam; (f) Tien Giang, Vietnam; (g) Zagromix F362B- free Phosphorus- (Tilapia Vitamin-Mineral Premix), Zagro Asia Limited, Singapore; (h)Chilean Stabilized Salmon Fishoil, Pesquera Pacific Star S.A, Chile; (i) Ajinomoto, Thailand. (j)Sumimoto Chemical, Japan; (k) Corn Cob, Be-Long Co., Ltd, China; (l) Rovimix stay – C 35, Roche Vietnam Co., Ltd; (m)Micofung, Dex Ibérica, S.A, Spain; (n)Sigma-Aldrich Co. LLC, (Oxide powder ≥ 98%); (*), (**) Phosphea, France.

Table 2. Composition of experimental diets

Composition	Diets		
	CTRL	DCP_{18}	$MCP_{22.7}$
Moisture (%)	8.28	8.24	8.67
Gross Energy (kcal/g)	399.13	396.7	394.98
Crude Protein (%)	31.37	31.89	31.63
Crude Lipid (%)	4.61	4.23	4.64
Ash (%)	7.57	8.87	8.44
Crude Fibre (%)	4.70	3.73	4.59
Calcium (%)	0.73	1.01	0.97
Total P (%)	0.80	1.07	1.05
Chromic oxide (%)	0.97	0.98	0.98

Table 3. Inorganic feed phosphate source characterisation

Ingredients	DCP(*)	MCP(**)
P (%)	18	22.7
Ca (%)	27	15
P 2% citric acid solubility (%)	> 95	> 95
P water solubility (%)	< 10	> 85
Particle size	Powder	Micro-granule
*dicalcium phosphates and **monocalcium phosphates from Phosphea		

The faecal samples were stored in the freezer at -30 °C until ready for lyophilization in order to evaluate ADC of phosphorus. At the end of the experiment, fish were weighed to evaluate their weight gain. During the trial, water parameters (temperature, dissolved oxygen, pH, NH_3-N and NO_2-N) as well as survival and feed intake were recorded in order to evaluate rearing conditions and survival rate. Water quality parameters (Table 4) were in a suitable range for health and growth of fish.

Table 4. Water quality parameters throughout the trial duration

Parameters	Mean ± SD
Water temperature (°C)	28.3 ± 0.77
pH	7.44 ± 0.27
Dissolved oxygen (mg/L)	6.24 ± 0.18
NH_3-N (mg/L)	0.05 ± 0.05
NO_2-N (mg/L)	0.20 ± 0.25

ADC of phosphorus from inorganic feed phosphates

Phosphorus content in the diet and faeces were determined according to ISO 6491:1998 and phosphorus from DCP and MCP were determined by the method AOAC 965.17. ADC of P in experimental diets (ADCPdiet) were calculated according to the formula from Maynard & Loosli (1969).

ADC of P from inorganic feed phosphates or IFP ($ADCP_{IFP}$), based on the ADCP of the CTRL and test diets were calculated following Forster (1999) and Bureau and Hua (2006).

Analysis of variance of data followed Duncan's multiple range tests using SPSS version 18. Differences were considered significant at $P< 0.05$.

Growth performances

Survival rates were high for the treatments and control diets but without significant differences (Table 5). The final body weight was significantly higher for fish fed diets DCP_{18} or $MCP_{22.7}$ in comparison with the CTRL diet ($p<0.05$). Weight gain was higher (but not significantly) for fish fed with added feed phosphates.

Digestibility of phosphorus

The apparent digestibility coefficients (ADC) of test diets and IFP are presented in Table 6. Diet ADCs for phosphorus are

Table 5. Survival rate (SR), initial body weight (IBW), Weight Gain (WG), and Feed Conversion Ratio (FCR) of tilapia fed test diets (Mean ± SD)

Parameters	Treatment diets		
	CTRL	DCP_{18}	$MCP_{22.7}$
SR (%)	$95.57^{a} \pm 7.68$	$97.77^{a} \pm 3.87$	$100.00^{a} \pm 0.00$
IBG (g)	$50.50^{a} \pm 1.87$	$52.60^{a} \pm 1.05$	$51.80^{a} \pm 2.15$
FBW (g)	$101.94^{a} \pm 0.10$	$107.70^{b} \pm 1.57$	$105.82^{b} \pm 1.13$
WG (g)	$51.40^{a} \pm 1.80$	$55.10^{a} \pm 2.48$	$54.03^{a} \pm 3.21$
$^{a, b}$: values in the same row with different superscripts are significantly different (P<0.05).			

Table 6. Apparent digestibility coefficient of phosphorus in the diet and test ingredient (Mean ± SD)

Parameters	Treatment diets		
	CTRL	DCP_{18}	$MCP_{22.7}$
Diet	$38.30^{a} \pm 1.90$	$45.00^{b} \pm 0.28$	$49.99^{c} \pm 0.20$
Ingredient		$60.22^{a} \pm 1.00$	$79.88^{b} \pm 0.74$
$^{a, b, c}$: values in the same row with different superscripts are significantly different (P<0.05).			

significantly different among treatments (p<0.05). The highest ADCs for phosphorus were provided by the diet containing MCP22.7 (49.99%), followed by DCP18 (45.00%) and the reference diet (38.3%). The fish fed with the reference diet without supplemented test ingredient presented significantly lower ADCs of phosphorus as compared to the supplemented diets. In terms of ADC for test ingredient (IFP), data indicated that phosphorus diet digestibility values were significantly higher for diet $MCP_{22.7}$ (79.88 %) than for DCP_{18} (60.22%).

Conclusion

Among calcium phosphates, water soluble P sources as Phopshea's AQUA MCP22.7 provide a highly digestible phosphorus for tilapia which improve its utilisation and decrease its release in the environment. Moreover MCP22.7 is one of the most concentrated sources of phosphorus which saves space and optimise feed formulation. Finally, MCP22.7 contains less calcium than DCP_{18}; Ca is already available via ion absorption through the gills. This is an important fact especially as phosphorus absorption also depends on Ca:P ratio.

Acknowledgment

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An environmentally friendly approach for healthy aquaculture production

By Cristina García-Diez, Álvaro Rodríguez Sánchez-Arévalo and Antonio Martínez.

Aromatic and medicinal plants with ancient origins are now developed as eco-friendly alternatives for health management and to provide antiparasitic effects in fish and shrimp.

The main risk in fish production is the occurrence of diseases that may adversely affect the overall operating costs and production durations, thus resulting in a loss in profitability. A direct consequence of high culture densities is the appearance of opportunistic pathogens which thrive in a crowded environment and affect negatively the immune response of the species cultivated. The inclusion of specific phytobiotics in feed leads to zootechnical parameter advantages, such as better survival rate and feed conversion ratio (FCR), and higher daily gain growth.

Natural products made from plants and their extracts provide efficient solutions to the cultured animal helping it to fight against parasites, bacteria and/or fungal pathogens. Preventive strategies as well as best management practices are recommended for better profitability and sustainable farm production. The continuous inclusion of phytobiotics in the feed given to fish and shrimp will produce healthier animals, with better immune system and growth performance ratio.

Learning from the past

The use of aromatic and medicinal plants has an ancient origin. The first known document is a table made of Sumerian clay 4.000 years ago, depicting a collection of remedies for various diseases. Egyptian papyrus described, as well, hundreds of remedies. In India, herbal medicine is described as early as several thousand years ago in the Rig-Veda, Hindu sacred verses collection. From centuries ago until now, we have developed medicine with the use of different therapies. The discovery of antibiotics in the last century has probably led to the biggest change in our history in terms of pathogen control. However, the frequent and injudicious use and abuse of antibiotics has led to the development of resistant bacterial pathogens to many antibiotics.

There are many scientific studies showing the potential action of medicinal plants as nonspecific immune boosters that have antibacterial, antifungal, antiparasitic and antiviral functions. Phytobiotics are also very good natural growth promoters and since 2006, when the European Union banned the use of antibiotics as growth promoters, the use of plants is increasing rapidly in animal nutrition. In addition, pathogenic organisms do not develop immune resistance against these substances; they also do not need any withdrawal period nor veterinary prescription and, of course, are environmentally friendly.

Mechanisms of action

The most important active ingredients from the point of view of health are essential oils, alkaloids, glycosides, mucilages and gums, and tannins. Phytochemicals with main important active principles are secondary metabolites (not essential for metabolism but are synthesized as mechanisms of defence, adaptation, etc.) of plants: glycosides, polyphenols (phenolic acids, flavonoids, lignans, tannins), terpenoids (essential oils) and alkaloids.

Essential oils are chemical substances composed of various volatile organic substance. Plants produce them to defend themselves against bacterial infections, parasites and fungi. Examples are thymol and carvacrol derived from plants like oregano. Feng Zhou et al. (2007) state that organic acids boost the effectiveness of essential oils, which together with the extracts allow better penetration of the acid through bacterial membranes, increasing the permeability and allowing the acid, in its dissociated form, to enter the bacteria at the small and large intestine level (Figure 1).

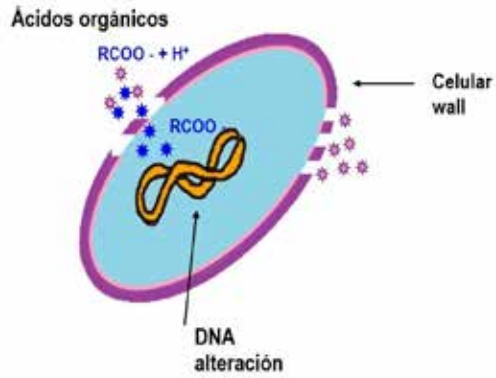

Figure 1. Mode of action: synergistic effect of organic acids + essential oils against bacteria.

Studies have also shown that the effect is not only caused by the key substance but significantly by the quantitatively less important ingredients. Essential oils combine the effects of antibiotics (antimicrobial activities of certain plant ingredients like thymol and carvacrol) with the effects of prebiotics (well balanced gut flora and its stabilisation).

Combination of essential oils and organic acids also have antiparasitic effects. It is believed that the mode of action may be lysis of the cells (Moon et al. 2006) and studies on an Amazonian plant against malaria showed the inhibition of glycoprotein biosynthesis (Lopes et al. 1999). In fish, oil of *Origanum* has been reported to provide varying degrees of protection and therapy in fish infected with myxosporean and coccidia parasites (Athanassopoulo et al. 2004; Karagouni et al. 2005). As known, the histopathological damage caused by *Enteromyxum leei*, internal parasite, includes the usual disruption of the mucosa integrity and epithelial desquamation (Estensoro et al. 2013), as essential oils together with the organic acids are known to modulate mucus secretion; this barrier that covers the intestinal epithelium against enteric pathogens, sweeps the parasites by desquamation.

Valladao et al. (2016) used a mix of three essential oils to treat, through baths, ichthyophthiriasis in pacu fish from Brazil; parasitological analyses showed an efficacy of nearly 100% in the skin and gills. Furthermore, the potential positive effect of *M. alternifolia* essential oil against opportunistic bacteria such as *Edwardsiella tarda* and *Citrobacter freundii* was discussed.

The most solid hypothesis, in terms of mode of action, for gill and cutaneous trematodes and flagellate protozoa, is the repellent effect that essential oils and medium chain fatty acids are believed to possess. Trials made by Liptosa under a preventive strategy with sea bream production in the Mediterranean Sea show big variations in the number of *Sparycotile chrysophrii* in gills. Juvenile parasites may remain in number whereas adult parasites may decrease showing how phytobiotic interfere differently with the life cycle of these parasites.

Another property that justifies the use of essential oils is its immunomodulatory activity. In this regard, the medicinal plant extracts and their products act as immunostimulants modulating the immune response to prevent and control fish and shellfish diseases. The immunostimulants mainly facilitate the function of phagocytic cells by increasing their bactericidal activities, stimulating the natural killer cells, and complementing the antibody responses in fish and shellfish which confer enhanced protection from infectious diseases (Harikrishnana et al. 2011).

Trials and results

As seen in trials carried out with tilapia fingerlings in Guatemala, where a combination of protected organic acids, essential oils, plant extracts and flavorings (LGP) was included at a rate of 5kg/tonne of feed, the phytobiotics helped to increase survival rate (+18.37%), improved average weight by 23.81% and reduced skin and gill parasitic infestations of *Gyrodactilus* sp. and *Trichodinas* sp. (Figure 2). LGP is a phytobiotic product for intestinal integrity improvement with growth enhancer effect leading to a reduction of bacterial and parasitic diseases. It is manufactured by Liptosa, a Spanish company specialising in the manufacturing of specific phytobiotics and nutraceuticals for animal feed.

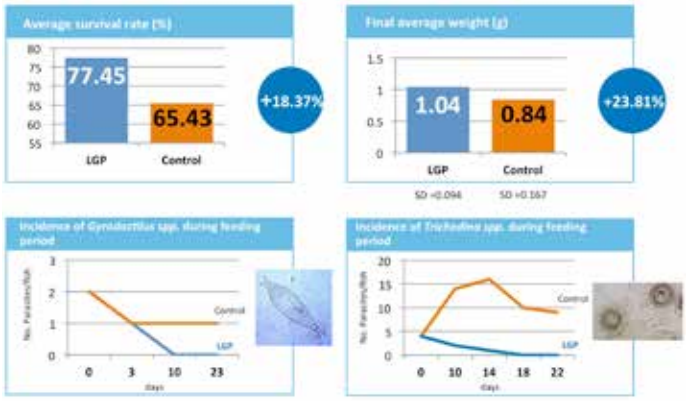

Figure 2. Liptosa results from trials done in Guatemala in 2016 in a tilapia farm.

Another trial carried out in a semi extensive shrimp farm *(Litopenaeus vannamei)* in Ecuador combining natural plant extracts and essences, organic acids and organic acid salts showed a significant reduction on the number of gregarine trophozoites. Starting with a high level of parasites and using different dosages and application times in the shrimp feed, a considerable reduction of parasites (99.5% and 100%) was seen, together with an improvement on daily growth gain depending on the dosage used (Figure. 3).

Farm	Trophozoites initial count	Trophozoites final count	No days	Weight increase (g)	Inclusion (kg/tonne)
A	56	0.3	10	1	2.5
B	63	0	6	1.5	3.25

Figure 3. Results from a Liptosa trial at a shrimp farm north Manabí, Ecuador in 2008.

Eco-friendly alternative

Since aquaculture production is growing at a rate of 6% per year (FAO, 2016), intensive production leads to a higher risk of microorganism and parasite outbreaks. Phytochemicals are very good alternatives to prevent diseases which lead to high mortalities and higher production costs. The sustainability of a farm system greatly depends upon the health of the cultured animals, especially in shrimp farming where organic matter wastes in the pond are threats to continuous production.

Issues such as animal welfare, food quality and production protocols have always been of great interest to consumers. In developed markets consumers are getting increasingly aware of food safety and environmental issues related to food production and are demanding high standards of quality assurance.

References are available on request

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Genetic improvement of the giant freshwater prawn based on SPF populations

By Donghuo Jiang

A SPF prawn genetic improvement program attains 38% genetic gains through combined between- and within-family selection.

The giant freshwater prawn (GFP), *Macrobrachium rosenbergii*, is an economically important freshwater species farmed on a large scale in many countries. The major producers consist of China, India, Bangladesh, Thailand, Vietnam and Malaysia in Asia, and Brazil and Ecuador in South America. World aquaculture production of GFP reached a peak of 226,800 tonnes in 2007 (FAO, Fishstat 2016) and the production level has been fluctuating considerably since then (Figure 1).

Among the reasons for the decrease in production was outbreaks of diseases, especially the white tail disease (WTD) which resulted in low numbers and poor quality of prawn post larvae (PL). Others were genetic deterioration, possibly due to unintentional inbreeding from improper broodstock management and the shift to farming the Pacific white shrimp, *Penaeus vannamei*, in low salinity or freshwater areas.

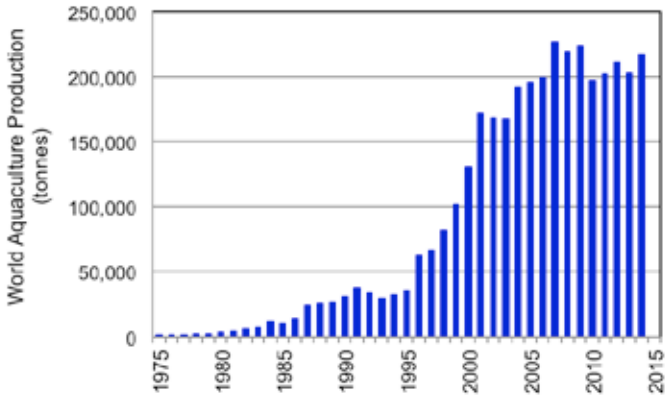

Figure 1. World Aquaculture production of giant freshwater prawn (FAO Fishstat 2016).

In Thailand, the giant freshwater prawn is a favourite seafood species with both high market value and demand. It is the main ingredient for a famous Thai signature cuisine, Tom Yum Goong (**ต้มยำกุ้ง**), the hot and sour prawn soup. Aquaculture production of GFP in Thailand had been steadily increasing until the white tail disease (WTD) first struck the industry in 2003. The causative agents of WTD have been identified as two viruses, *Macrobrachium rosenbergii* nodavirus (MrNV) and its associated extra small virus (XSV). The viruses not only caused a milky whitish appearance in larvae, post larvae (PL) and early juveniles, but also resulted in mass mortality in prawn hatcheries and consequently huge economic losses. The hosts of these viruses include marine shrimp, *Artemia* and aquatic insects. Studies showed that WTD can be transmitted both vertically from infected brooders to their offsprings and horizontally in culture systems.

In order to systematically address the common issues of deteriorating genetics and high risks of diseases to the prawn farming industry, a genetic improvement program based on the specific-pathogen-free (SPF) concept was initiated by Charoen Pokphand Foods Public Co. Ltd. in Thailand (CPF) in late 2009.

Development of SPF based populations

To establish a broad genetic base for a selective breeding program, eight founder populations were collected from various geographic locations in India, Myanmar, Vietnam and Thailand. The procedure of developing SPF based populations was adapted from Moss et al. (2003) and outlined in Figure 2. At initiation, adult prawns of each founder population were selected based on their size and health appearance, and held in individual containers in a designated quarantine station. Pleopod samples were taken from each prawn and checked for MrNV and XSV using reverse-transcription PCR (Yoganandhan et al., 2005). Males and females with negative PCR results were used for mating under strict biosecurity conditions. Nauplii were reared in individual tanks till PL10, when they were tested again to verify their health status. During 2009-2010, roughly 1,000 individual adult prawns were screened, yielding a total of 294 broodstocks with negative PCR results from the two rounds of screening. These broodstocks were then used to produce 159 full-sib and half-sib families during 2010-2011. Upon confirming their health status, the juveniles were transferred into biosecured nucleus breeding centre (NBC) as SPF base populations to initiate the genetic selection program.

NBC nursery tanks

NBC growout tanks

Throughout the breeding program, routine health surveillance was implemented in the NBC, with monthly sampling of different stages of prawn for PCR tests in the CPF Central Research Laboratory. In addition to MrNV and XSV, other known shrimp viruses, including the infectious hypodermal and haematopoietic necrosis virus (IHHNV), Taura syndrome virus (TSV), white spot syndrome virus (WSSV), yellow head virus (YHV), infectious

myonecrosis virus (IMNV) and monodon baculovirus (MBV) were monitored periodically. New viruses discovered in recent years, such as covert mortality nodavirus (CMNV) and Macrobrachium rosenbergii Taihu virus (MrTV), were also added to surveillance list in 2015. All stocks in NBC remain free of these viral pathogens for the past five years.

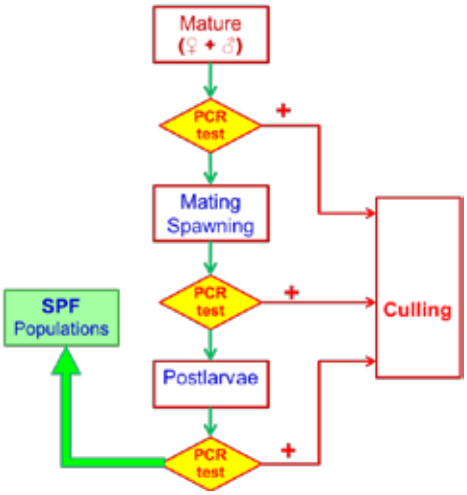

Figure 2. Process of SPF base population development

Selective breeding program

The breeding goals of a SPF prawn genetic improvement program were to improve: mature body size; growth rate; survival and to a lesser degree, density tolerance. A combined within- and between-family selection scheme was applied. Individual family was produced via designed pair mating. Hatched nauplii from one single family were reared in individual tanks to 3-5 g when juveniles were sexed. Twenty biggest individuals of each sex were tagged for each family with visible implant elastomer (VIE) as familial identification.

Communal tests of tagged prawns were carried out in recirculating concrete tanks, with ~20 families per batch. At the termination of the performance test, the prawn was individually weighed and recorded with sex and number of claws (zero, one or two). Male prawns were further classified into four categories according to their morphological appearance, blue claw (BC), orange claw (OC), small (SM) and no claw (NC). Female prawns were classified into two categories, the egg-carrying females as berried (BF) and non-berried females (NF). All data were stored in the database and used for further analyses.

Variance and covariance components were estimated using the restricted maximum likelihood method (REML). The estimated breeding values (EBV) of individuals were calculated for various traits, harvest weight (HWT, g), average daily gain (ADG, g/day) and survival rate (SR%), using different statistical models. In all models, communal tanks and sex of prawn were always set as fixed effects; male morphotypes were not included because nearly all males were BC but with different number of claws. Other factors, such as age and initial stocking weight (IWT, g), were used as covariates for exploring estimations using various models. Families were ranked and selected within each batch, based on an selection index. Within each family, best males and females were visually selected for breeding based on their body size, morphotype, reproductive status and health appearance.

Currently, the selective breeding program is at its 5th generation (Table 1). In the F1 generation, only within-family selection was conducted with no communal test. The percentage of families selected in each generation decreased from nearly 60% in the 2nd generation to 40% in the 5th generation, corresponding to an increase of selection intensity (i) from 0.644 to 0.966 for the between-family selection, as routine operation became more consistent. On average, the top 20% males and 30% females were kept from the selected families as breeding candidates to produce the next generation. Genetic analyses showed consistent gains have been made for HWT and ADG (Figure 3), while improvement for SR% was not significant. Across five generations, the h2 estimate obtained from the animal model was 0.4066 for harvest body weight, which was likely over-estimated because the testing design did not allow the distinction between common environmental effects and maternal effects. The cumulative genetic gains were estimated to be 38% in five generations, with a lower selection intensity in G1. The results were comparable to the genetic gain for ADG ~7% per generation obtained in a prawn selective breeding program in Vietnam (Dinh and Nguyen, 2014).

Many growth trials have been conducted to evaluate production performance of the genetically-improved SPF strain under commercial prawn farming conditions in Thailand. For prawn growout ponds stocked with 1-2 g small juveniles at a density of ~15 pcs/m^2, average weight of males and females can reach 40 g and 35 g, respectively, in 90 days (Figure 4) with survival rates of 80-85%. Currently, the SPF prawn strain is being introduced to China and Myanmar for commercial farming.

Table 1 Genetic selection program of SPF giant freshwater prawn in CPF

Generation	Year	# Family
F0	2009-10	SPF development
F1	2010-11	159
F2	2011-12	366
F3	2013-14	383
F4	2015	381
F5	2016	450+ (in process)

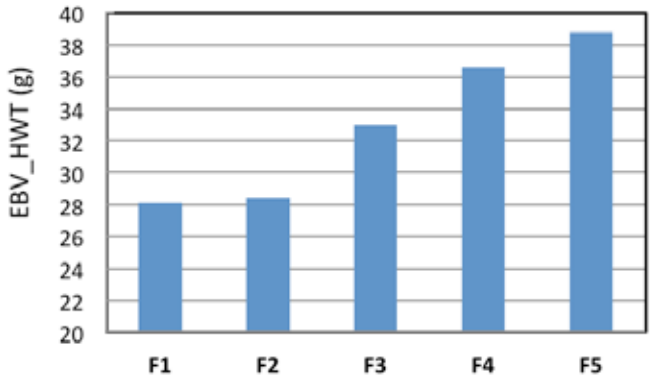

Figure 3. EBVs of harvest weight during the five generations of genetic selection

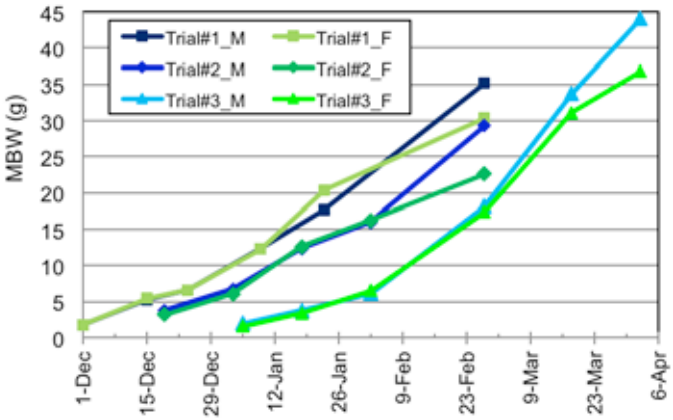

Figure 4. Growth performance of SPF prawn juveniles in 2015 under commercial farming conditions

Considerations for further genetic improvement

SPF and SPR

GFP has been considered to be less susceptible to disease problems when compared with other farmed penaeid shrimp. However, as farming moves towards intensification, and especially polyculture with fish, shrimp, crab, bivalves, etc., disease problems became an increasing concern in recent years. Evidences showed that polyculture with *P. vannamei* might have led to the infection of *Enterocytozoon hepatopenaei* (EHP) to the GPF, resulting in a significant slowing-down in growth rate. *Spiroplasma eriochieris*, which was originally found to be the cause of tremor disease for the Chinese mitten crab, might also infect the GFP resulting in chronic mortality during the growout stage. To achieve sustainable genetic gains in the long term, we established this genetic improvement program based on SPF populations. The family selection scheme employed also allows effective selection for disease resistance (SPR).

Selection for mature body size vs. fast early growth

Commercial farming of giant river prawn is moving towards two extremes to meet the growing demands of target markets, as represented in Thailand and in China. In Thailand, prawns of large harvest sizes (> 50 g/pcs) are preferred in order to get premium prices. GFP culture is typically divided into two phases, nursery and grow out phases. In the nursery phase, prawn post larvae are directly stocked in smaller ponds at a density 30-50 pcs/m^2 and grow for 2-3 months to reach a size of 5-8 g. The juveniles are then transferred into large grow out ponds at a density of 3-5 pcs/m^2, polyculture with 15-20 pcs/m^2 of *P. vannamei* post larvae, for another 2-3 months prior to harvest. In China, GFP post larvae are directly stocked into culture ponds at moderate to high density (50-100 pcs/m^2) and partially harvested as soon as the large animals in the ponds reach 10 g. A typical crop involves three or more times of partial harvesting before the final dry out.

The two modes of commercial prawn production actually set forth two different breeding goals for genetic improvement, the large mature body size at low density and the fast early growth rate at very high density. Given the social structure and competition effect among GFP, it is reasonable to expect that the genetic correlation between these two traits is very low or even negative, thus two different breeding strategies would have to be implemented in order to achieve these two breeding goals tailored for different target markets.

Prawn harvesting

Addressing the unintended competition effect

GFP has a complex social hierarchy in the populations. For commercial prawn farming, BC morphotype is generally unfavourable due to its dominance, territorial and aggressive behaviours that suppress growth of other males. OC morphotype is more desired because it has a fast growth rate, possesses higher abdominal carcass weight than BC, and is not territorial and hence can tolerate a higher culture density. In the communal tests of the current breeding program, a large number of individuals from many families were stocked into one tank. Large variations of body size at stocking may inflate the competition for space and feed, which in turn affect feeding behaviour and cannibalism in tanks and consequently influence both growth rate and survivability of the suppressed individuals. Therefore, in addition to the direct genetic effect of individual performance, social genetic effects would have to be properly determined in order to increase the accuracy of selection and to avoid the undesired changes in male morphotypes, which will lead to unintended increase of competition, after generations of selection for growth at competitive environment (Sae-Lim and Bijma, 2016). Ideally, we could increase the proportion for desired male morphotypes through genetic means to improve both growth rate and density tolerance.

To our knowledge, this is the first GFP selective breeding program in the world that was based on SPF populations and has maintained SPF status consistently for 5 years. Cumulatively 38% of genetic gains have been achieved through a combined between- and within-family selection scheme. More initiatives will still need to be taken to increase the accuracy of selection, to avoid unintended consequence of increased competition, and to generate greater yield and profitability for the prawn farming industry.

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From pond to market: Quality shrimp for best prices

Part 2: At the processing plant

By Herve Lucien Brun

The decision on product types depends on the condition of shrimp arriving at the plant and procedures must be meticulously carried out to ensure consistent product quality.

It is the wish of every shrimp farm to market the right quality shrimp and achieve higher market prices. Part 1 of this article (refer to issue November/December 2016, p 45-48) detailed decisions prior to harvesting, and also during harvesting and chilling, and treatment for melanosis at the pond side. In Part 2, we continue the journey of the shrimp to the processing plant and finally to packaging.

Hygiene

Once harvesting is over, the shrimp must be shipped as soon as possible to the packing plant. Similar to the staff working at the packing plant, the harvest team must also wear clean clothes. They must have impeccable hygiene standards, especially to wash their hands before touching any equipment or shrimp. All equipment must be washed and disinfected before and after harvesting. The water used for chilling the shrimp and for the preparation of sodium metabisulphite (SMBS) solution must comply with microbiological quality of food biosafety standards. The ice used for harvesting and processing must be prepared with potable water in compliance with the international microbiological norms.

Transport to packing plant

In preparation for transport to the plant, at the pond side, the shrimp harvest could be directly transferred to insulated bins. Alternatively, as soon as they have been chilled and treated with SMBS, the harvest in crates should be immediately transferred to either insulated or refrigerated trucks. If bins are used, it is important to avoid opening them unnecessarily to maintain the cold temperature. The bin must be opened only at the time of receiving shrimp and closed immediately after the bin is completely filled. It can be opened again when mixing of its contents is required to homogenise the temperature.

Temperature in the packing plant

As soon as the shrimp arrive at the packing plant, they will be transferred to a cold room where the temperature is between 0°C and 3°C , where they will wait until they are processed. The quality control team must extract a representative sample for organoleptic quality checking before deciding on the type of packaging: head on shell on (HOSO), headless shell on (HLSO) or for value adding, depending on the organoleptic quality of the shrimp on arrival. If necessary, a check on the sulphite residual levels will be carried out at this time to determine if the batch complies with international requirements.

Previously, at every stage of harvesting, special attention was paid to chill shrimp as fast as possible and to keep them at temperatures lower than 3 °C. All these efforts would be pointless, if the temperature of the shrimp rises during processing because the room temperature in the packing plant is too warm.

Equipment for mechanized SMBS treatment in Venezuela

In the packing plant, all the procedures must be completed very fast. The objective is a maximum of 2 minutes between the time the shrimp leave the chilled wash tank in the reception area to enter the freezer. During all this time, the temperature of the shrimp must stay below 3°C. This will only be possible if the ambient temperature in the process rooms is lower than 12°C. Cheap protective clothing against the cold such as polaire vests, are available for the staff working in the plant. Staff working in the packing plant must be suitably dressed to maintain good hygiene in the plant. However, if for any reason this is not the case, the supervisor should never accept a worker without the correct uniform.

> **“There is no excuse for any processing plant in any country not to obtain the highest quality of the final product if the shrimp in the ponds are in a very good condition.”**

Inspection and grading

Inspection and sorting are fundamental steps to ensure the quality of the final product. At this level, we remove shrimp which do not comply with product specifications. Allowing shrimp which do not meet the specifications to go through this stage will negatively affect the quality of the end product.

Inspection on lateral packing belts

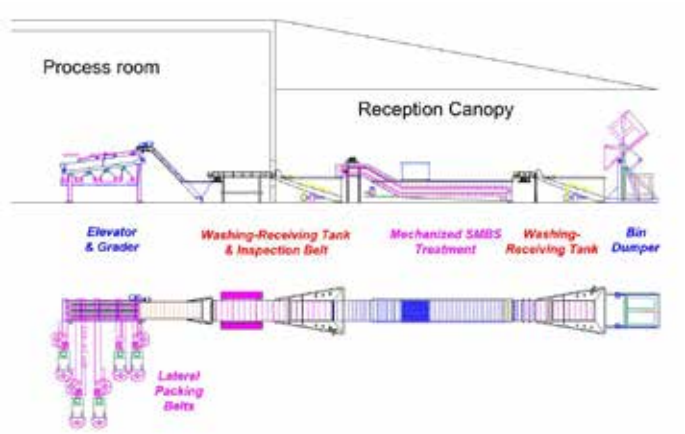


Figure 1. An example of a combination of SMBS machine and grading line. At the plant, the temperature of the SMBS solution can be controlled using the cold primary circuit of the plant without using ice. This will significantly reduce the need for additional SMBS to maintain concentrations. An automated SMBS treatment unit could be combined directly with the inspection belt and the grader.

Inspection and removal of soft or broken parts of shrimp are carried out in the receiving wash tanks and inspection belts prior to feeding the shrimp to the grader. For an effective inspection, shrimp must be distributed in a single layer over the entire width of the inspection carpet. If shrimp are in several layers, workers cannot see and remove defective shrimp lying below. To achieve this, the inspection belt must be properly designed.

An efficient wash tank must be equipped with at least a jet wash system, an ice baffle to prevent ice on the inspection belt and volume control paddle to control the flow of shrimp on the inspection belt. The wash tank must contain a lot of ice to keep the shrimp chilled but this ice must not go to the inspection belt because it would then interfere with the work of the operators. The paddle to control the flow of shrimp is a key equipment. Without it, the flow of shrimp will vary from over to under loading according to the quantity of shrimp in the wash tank.

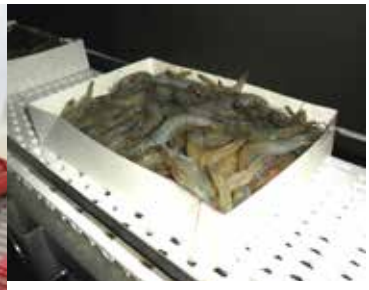
The inspection belt should be wide enough to allow operators working on each side to reach shrimp passing in the middle. If the belt is too narrow, it will not be getting enough shrimp in a single layer to have an optimum efficiency of the plant. If the belt is too narrow, most of the time, production managers tend to favour the flow at the expense of quality.

This belt must be long enough and suitable number of staff assigned to sort the shrimp. The number of persons needed to work on the inspection belt depends on the quality of the raw products and the amount of shrimp which should be removed. The organisation of the people working on this belt is important. The best is to have a team of 2 or 4 persons on each side of the belt, according the quality of the raw material. The staff must be organised as a squad with specific tasks, as below.

- The first two staff after the wash tank are the ones to remove most of the waste: stones, fish etc
- The second group of two or four staff must remove off-specs shrimp
- The last persons at the end of the belt, the one nearest to the elevator and to the grader, must be the leader of the squad. He must do his production job and also he has to control the efficiency of each member of the squad and give instructions to improve efficiency.

Calibration and graders

Calibration involves determining the number of pieces per unit of weight and the uniformity. It is very important to define clearly with the marketing department how the calibration is to be carried out. Today, most of the time calibration of the shrimp is done mechanically using a grader specially designed for the species of shrimp. It is important that the grader used is designed for the type of penaeid shrimp being packed. Often, we find the use of graders designed for the coldwater shrimp *Pandalus* spp. These graders often pose problems, especially to attain good uniformity. *Pandalus* spp. are very different from *Penaeus* spp. in particular because the latter group has longer antennas.



When the shrimp is poorly positioned in the box, certain parts of the shrimp body may protrude from the box. After freezing, most of these pieces protruding out of the boxes will be broken when the boxes are placed in the master cartons.

The problem is that the graders for cold water shrimp are designed with grading channels composed of only two rollers each. The graders for tropical shrimp are done with four rollers per channel. This prevents the wrapping of antennas around the rollers to avoid shrimp falling into the wrong size group. When the antennas are wound around the rollers, there is an accumulation of shrimp trapped in the channel or they pass to the other side of the roller and fall outside the channels. This creates numerous classification errors.

Special attention should also be paid not to overload the grader. Each machine is designed to have a maximum capacity. Exceeding this will also cause many misclassifications, regardless of the type of grader used.

Each chute of the grader must be equipped with a lateral belt. This is the last inspection point before shrimp fall into the box or into the trays to be frozen. This inspection is the last opportunity to pick out pieces of non-conforming shrimp or foreign materials before packing.

Weighing

The net weight in the boxes is very often the source of contention between packers and clients. The complex anatomy of shrimp does not allow the rapid draining of water coating the shrimp. At the plant, often, it is not easy to rapidly drain water out of the box and shrimp completely, and to weigh the shrimp within a specified time.

The Codex Alimentarius defined a very precise method for the control of the net weight, in particular with regard to the draining time before weighing. This specific condition must be made clear with the client. CODEX STAN 092-1981, Rev. 1- 1995 states *'Empty the contents of the container on the previously weighed sieve with nominal size of the square aperture 2.8 mm (ISO Recommendation R565) or alternatively 2.38 mm (US No. 8 Standard Screen). Incline the sieve at an angle of about 20º and drain for two minutes.'* In practice, it is not possible to determine a draining period before weighing shrimp boxes. It is therefore necessary to determine the best estimate, empirically by a series of boxes weighing before and after draining, of the amount of water lost during this time. The scales are then set to take into account this loss of water.

A bad example of an overloaded cold room

After weighing, shrimp should be properly arranged to prevent parts of the shrimp from exceeding the dimension of the boxes. It often happens that crustaceans are poorly positioned, and certain parts of the shrimp body may protrude from the box. It is necessary to understand that after freezing most of these pieces protruding out of the boxes will be broken when the boxes are placed in the cartons. This will increase the percentage of rejections. Quality is compromised because of bad practices.

Freezing

Several techniques could be used to deep freeze the shrimp. The two most commonly used are the air blast freezer and the contact plate freezer. There are other techniques such as IQF spiral freezer, brine freezer by immersion or by aspersion, single retention time tunnel (SRT) freezer, and cryogenic tunnel freezer using nitrogen. Each system has its advantages and inconveniences; which differ between the type of presentation (2 kg blocks, IQF bag, etc) and will decide on what freezer technique is suitable. Thus, the selected freezing technology must be adapted to the type of packing. For example, it is not suitable to freeze 2 kg block in a spiral freezing tunnel, neither is it suitable to freeze IQF products on shelves in a classical air blast freezer.

Nevertheless, the choice of the technology must be driven by several criteria. First of all, the type of product to be frozen and the type of presentation must first be understood. The other point is deep-freezing which means that the product reaches a temperature at the core equal or lower than -18°C.

The faster the freezing process, the smaller would be the intracellular ice crystals and the better will be the product after thawing. With a low exudation during thawing, the shrimp keep their taste well. On the contrary, a slow freezing process will induce the formation of larger crystals which would damage the cell wall, causing loss of water at the time of thawing and will alter the product structure.

Cartoning and storage

After freezing, all the operations must continue to be done well. Unfortunately, very often the quality control (QC) team does not supervise these steps carefully enough. Often the assumption is that processing has ended. This is very wrong.

Frozen shrimp are fragile. Rough handling of frozen products often causes breakage of shrimp. The cartoning and container loading must be done carefully to avoid jarring the products and thus prevent breakages. When the master cartons of finished products are stored in a negative temperature cold room (lower than -18°C), they are generally stacked on top of one another. Often, these rooms are equipped with racks in order to facilitate handling. However, this is not always the case and often there are excessively high stacks of cardboard boxes. One must remember that each shrimp in the carton has a limited resistance to crushing.

Frozen products are stored in cold conditions under negative temperatures; it is important to consider that each cold room has a maximum capacity. This is not only in terms of volumes, but also in terms of energy. If the room is over loaded, the evaporators will not be strong enough to maintain the target temperature. In such cases, the temperature of the shrimp will rise and the resistance to crushing will be lower.

Traceability

Traceability is a very important tool not only for the consumer but also for the producer. By following the history of each batch of shrimp from the hatchery to the frozen products, it will help farmers and packers to follow strictly manufacturing procedures by the entire staff. In case of any claims, the presence of a traceability system will make it easier to detect weak points and to implement corrective actions. If defects require rejection of products, a specific system will accurately identify problematic batches and therefore limit the quantities to be removed from the market.

Conclusion

In any country and for any market, there is no reason not to aspire for optimal quality especially, if the shrimp in the ponds are in a very good condition. It is prudent to be aware that more shrimp will be available in markets and as living standards of customers increase, the quality requirements will be elevated. This is a normal trend for all markets, be it livestock or aquaculture products.

The improvement of quality of end products is not the result of improvisations but of rigorous work to establish precise manufacturing procedures for each phase of the process and strict control to verify that they are properly applied. There should be a natural concern to achieve the best possible quality and adopt the necessary measures to reach this objective, while strictly controlling production costs. This must be the daily preoccupation of the farm owners and teams at aquaculture facilities.

Most of the time, these measures involve common sense and do not require any additional financial investments. It is necessary, however, that harvest or processing facilities are correctly designed from the beginning. Prior to this, it is crucial to know well the market demand in terms of products and quality and make appropriate decisions on equipment. It is also necessary to try to design the packing plant in order to preserve a certain degree of flexibility because market demands can change.

However, at the same time, it is important to be reasonable with investments. This is because higher quality does not always come with better prices. Often it is to match customer's preferences.

Herve Lucien Brun is an aquaculture consultant based in France. He specialises in shrimp aquaculture: hatchery, farming and post harvest handling and packing and covers shrimp operations around the world. He has worked in Latin America, Asia, Madagascar, Middle East and Oceania for more than 30 years. Email: hervelb@gmail.com

Aquatic at VIV Asia 2017

Aquaculture will receive special treatment VIV Asia. A Special Event called Aquatic features a pre-show conference, several show-time seminars and a pavilion of exhibitors. The primary purpose is to reach out with products or services for the aquaculture sector.

Aquatic will offer visitors and industry a focus on aquaculture and learn more on health products and solutions, feed additives, ingredients and feed processing equipment. VIV Asia 2017 will be held at the BITEC exhibition centre in Bangkok, Thailand, on 15-17 March as the heart of a week-long series of business opportunities, networking and knowledge updates for professionals working in Asia's animal protein industries.

Asian aquaculture: a growing business

Asia leads the way in producing aquatic animal proteins and aquaculture therefore deserves a central place in the VIV Asia platform. Show Manager, Zhenja Antochin said, "Asian aquaculture is a growing business. Our investment in this has been on track with growth at each edition of the show since it was first included in 2009. At this 2017, edition we will be responding to surveys and feedback showing that aquaculture is highly relevant to VIV Asia's audience. In 2015 we received about 38,500 visitors and over 19% of them showed an interest in the production of fish or shrimp. We expect that people who are involved in the business will form an even higher proportion of the attendance in 2017."

Three-part menu of attractions

"Aquatic features a three-part menu of strong attractions for visitors with a business interest in aquaculture," says Roel Schoenmaker, who is co-ordinating the Aquatic activities on behalf of VIV worldwide. "The Aquatic Pavilion is going to be fully integrated as a central feature in the main hall of the show. It will be located within the section highlighting animal health and feed ingredients and additives. The location also puts the pavilion close to other exhibiting companies that have feed and health products for aquaculture as part of their wider product range."

As an additional feature of Aquatic, a meeting room at BITEC has been set aside on *Wednesday 15 March* for aquaculture-related exhibitors to have an opportunity to organise their own 1 hour commercial seminars close to the exhibition floor during the course of the show.

Aquatic Pavilion

To date, 14 companies have reserved their places to exhibit in the Aquatic Pavilion. These include, Aliphos, APC, Blue Aqua, Changsha Xian Sha Yuan, Empyreal, Kasipantarut, Genereach, Sino-shark, Qingdao Xinhaiyayuan, Toan Thang, Soleval, Proteus, Marine Leader, Aqua Culture Asia Pacific and International Aquafeed. The international line-up of companies - all fully dedicated to aquaculture - reveals an emphasis on feed and health supplies for the industrial production of fish and shrimp.

Sector guide

Antochin pointed that outside the Aquatic Pavilion, many other international suppliers of aquaculture will be found elsewhere in the exhibition because they have products for land-based livestock as well as aquatic species. "With about a total of 1,000 exhibitors at VIV Asia in 2017, we realised we needed to help our aquaculture visitors find the supply companies of interest to them. Therefore, in addition to the Show Guide that every visitor receives upon arrival, we have created a practical English-language booklet in a distinctive sea-blue colour and with the Aquatic logo, to highlight where the suppliers are located. The booklet will have a different version of the show's floor plan, highlighting the aquaculture exhibitors. It will also list the seminars that are part of Aquatic."

Pre-show conference

A pre-show one day Aquatic Conference will be held on 14 March. This conference has a non-commercial management theme discussing issues of biosecurity, feed and recirculation in relation to health control at aquaculture sites. The conference will be in English and Thai and is presented by VIV and International Aquafeed Magazine with Asian aquaculture's talent development company Progressus. More information: www.vivasia.nl

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BIOMIN harnesses the power of science to support animal health and performance. By applying state-of-the-art and proprietary technology, Biomin delivers natural, sustainable and profitable solutions to the livestock industry. For over 30 years, it has pioneered innovative solutions for mycotoxin risk management and gut performance. **www.biomin.net**

Highlights: Biomin will launch a new phytogenics product exclusively at VIV Asia. There will be Austrian wine tasting on 15 and 16 March.

Special phytogenics seminar on 16 March, 2pm-4pm, Room TBA.

BOOTH: H102. 1000

Justin Tan, Regional sales and Marketing Director (justin.tan@biomin.net)

Amelia Low, Regional Marketing Communications Officer (amelia.low@biomin.net)

Marine Leader Co., Ltd is a distributor and a producer of products for the hatchery and farming of shrimp, marine fish and ornamental fish. It was founded in 2000. With several years of experience in shrimp aquaculture, Marine Leader sees the opportunity to develop technologies and promote good farm management for a sustainable industry. It collaborates with professors from renowned universities and researchers from leading organizations in Thailand, to bring innovative products to market and help customers improve farm management and production. **www.marineleader.co.th**

AquaShop by Marine Leader offers the following: SPF Broodstock Frozen Feed • Larval Feed • Race way/Nursery Feed • Supplements • probiotics • Water Quality Test Kits • WSSV Diagnosis Test Kits • Scoop nets

BOOTH: H103. 957

Chatirot Intaraksa, Sales and Technical Support (marineleader@hotmail.com)

DaBomb Protein Corp. is Asia's leading fermented soybean meal manufacturer with ISO 22000 certification. The product, DaBomb-P, is fermented with food grade *Lactobacillus* and have multiple functions. The 3 characteristics of DaBomb-P is high protein digestibility, balance intestinal microflora and enhance immunity. DaBomb-P with multiple bioactive peptides, can enhance nutrient absorption and improve water quality. The rich small peptide of DaBomb-P also offers excellent binding capacity in feed pelleting. **www.dabombprotein.com**

Seminar: Multiple functions of *Lactobacillus* spp. fermented soybean meal in Aqua feed. Time : 13:00, March 15, Room No. 211

BOOTH: H103. 726

Daisy Hsieh, Sales Team Leader/Marketing (service@dabombprotein.com)

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 phytobiotic products focused on health improvement of fish and shrimp. **www.liptoaqua.com**

- Liptocitro Growth Plus is a growth promoter for for shrimp and fish
- Liptofry is a growth promoter with high antibacterial effect for post larvae and fry of shrimp and fish
- Liptocitro G is an antiparasite against gregarines, myxosporidium and microsporidium in shrimp
- Liptocitro Fertiplus is a fertility stimulant for shrimp brood stock
- Saprosafe is a natural antifungi against *Saprolegnia* and related fungi in freshwater fish
- Liptocitro MMM is antiparasite against trematodes, myxosporidium and microsporidium in fish

BOOTH: H103. 866 & H101. 1631

Cristina García Díez, (cristina.garcia@liptosa.com)

Alvaro Rodríguez (ara@liptosa.com)

Evonik Nutrition & Care GmbH produces and markets essential amino acids. Complementing their product portfolio are innovative products such as AQUAVI® Met-Met, a methionine dipeptide specially tailored for crustaceans. During VIV Asia 2017, Evonik will launch a new line of probiotics – Ecobiol® and Fecinor®, an effective solution to support gut health in livestock that helps producers to solve quality, profitability and sustainability challenges. **www.evonik.com/animal-nutrition**

Seminar: Gut Health Solutions from Evonik
Time: 11:30-12:30, March 16
Room 214
Product Launch
Time: 14:00-17:00, March 16, Hall 103, VIV Square Abu Dhabi

BOOTH: H103.716

Grant Xie (grant.xie@evonik.com)

The **Phileo Lesaffre Animal Care** team and aqua experts will present their 'avant premiere' launch of the new Aquasaf range, a ready to use innovative all in one formula to address the specific needs of shrimp and fish farmers or feed manufacturers at each production stage from hatchery till processing. They will also present the latest research in fish and shrimp on how to improve health through nutrition. This is thanks to Safmannan exclusive solution, with many scientifically proven beneficial effects on pathogens binding, gut integrity and immune modulation.

Also available will be free technical guides on health prevention and management in fish and shrimp, designed by Phileo in cooperation with the international group of fish vets specialists. **www.phileo-lesaffre.com**

BOOTH: H102.1140

Leiber GmbH has been supplying customers worldwide with premium "Made in Germany" brewers' yeast products since 1954 in the fields of animal nutrition, the food industry and food supplements. The product portfolio includes a wide range of pure brewers' yeast, brewers' yeast bound to carriers with certain additional effects, special products with specific effects and yeast extracts. Brewers' yeast is one of the most valuable natural products in animal nutrition acts both as an active ingredient and also as a nutrient carrier. The multibiotic action of Leiber products is important to animal health and performance by prophylactically strengthening the animal against stressors. **www.leibergmbh.de**

BOOTH: H103.543

Nikolaus Jungbluth, Business Unit Director Animal Nutrition (n.jungbluth@leibergmbh.de)

Dr. Holger Kühlwein, Key Account Manager Aquaculture (h.kuehlwein@leibergmbh.de)

Dr. Pradeep Padmaja Jayaprasad, Regional Sales Coordinator APAC (p.padmaja-jayaprasad@leibergmbh.de)

Soleval is a French producer of premium land animal ingredients dedicated to aquafeed and petfood: poultry meal, hydrolysed feather meal, hydrolysates, poultry blood meal, poultry and pork blood meal, poultry fats and pork fats. Made from carefully selected by-products exclusively sourced from animals fit for human consumption and processed in separate lines, all the products guarantees impeccable traceability, food safety and high nutritional value regarding to digestibility and protein content.

This year, Soleval will introduce Prossential, its new commercial organization built with the Tessenderlo Group with focus on customer attention and first class service. **www.prossential.com**

BOOTH: H103.856

Lionel Flament, Key Accounts Manager Petfood and Aquaculture (lionel.flament@prossential.com)

Roel Ebbinge, Commercial Director (roel.ebbinge@prossential.com)

Green Wonder Biotech Co., Ltd., will be marketing 2 products.

Bio-Hit 99 is a complex probiotics which is the unique probiotic compound formula which help to maintain healthy gut flora, strengthen the immune system and inhibit the growth of pathogenic organisms.

High Speed Animal Waste Recycling System includes equipment to ferment the carcasses, waste from aquatic processing and livestock farms working at high temperature at around 95˚C. The final product can be used as a protein source for feed or fertilizer. **www.greenbtk.com**

BOOTH: H100.1776
Gwo-Terng Lin (greenprozyme@gmail.com)

CreveTec BVBA offers products and services for intensive shrimp production. The range of feeds includes shrimp hatchery feeds (mysis-PL12), post larval diets, algae flakes and broodstock feeds; Nursery diets, premix for shrimp feeds adapted to low salinity, high salinity and intensive culture. Feeds can be tailor made to customer requirements. Other services include formulation and production technology, startup of new feed production units, system design for biofloc culture, contract research for development of feeds, raw materials and additives at CreveTec's research station in Belgium. It also organises seminars for biofloc farming. It is also looking for distributors for the feed business. **www.crevetec.be**

BOOTH: H102.1273
Eric De Muylder (eric@crevetec.be)

Phosphea is a global leader in feed phosphates, committed to deploy its industrial know-how, quality and logistics across all continents since 1976. The company is driven by passionate commercial and technical teams located in the heart of the markets. From five certified production facilities, Phosphea manufactures and export the widest range of feed phosphates, from premium calcium phosphates to innovative solutions. By caring for the right formula, we contribute to increase competitiveness and efficiency for the animal nutrition industry anywhere in the world. We are now the N° 1 MCP worldwide player, have more than 290 employees with 670,000 tonnes of production capacity from 5 plants. We are active in more than 100 countries. **www.phosphea.com**

BOOTH: H103.535
Pol Abiven (asiapacific@phosphea.com)

Lallemand Animal Nutrition is committed to optimising animal performance and well-being with specific natural microbial product and service solutions. The company range of scientifically selected microbial solutions for aquaculture includes probiotic bacteria and yeasts and their derivatives, developed to support the health and performance of all aquatic farmed species:

- A complete range of solutions for feed applications that target gut health, immune modulation, antioxidant status and micro-nutrition. It includes the probiotic bacteria BACTOCELL and YANG which is a combination of different strains of inactivated yeasts that supports animals during challenging conditions.
- LALSEA range dedicated to water quality control for improved pond environment quality and animal performances.

BOOTH: H101.1701
Anupong Santisukwongchote (asantisukwongchote@lallemand.com)

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About TARS

Initiated in 2011, The Aquaculture Roundtable Series (TARS)® is a stakeholder-driven effort to facilitate the sharing and exchange of information and experiences for a common goal, to equip the industry for its next phase of growth. It is a platform for all – public, private sector, academia, government and non-government organizations - to share new knowledge, deliberate on critical issues, and identify clear strategies to ensure a sustainable industry for the next generation. **TARS** is designed as a series of roundtable sessions to focus on specific sectors of the industry.

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Driving the protein economy

The aquaculture breakout session at WNF 2016 says protein from aquaculture is the future but what are the challenges?

The aquaculture program at the World Nutrition Forum conducted by BIOMIN in Vancouver in October 2016 comprised eight thought-provoking presentations from industry experts. The session was led by Biomin's Goncalo Santos, R&D Manager, Aquaculture and Anwar Hasan, Technical Sales Manager, Aquaculture Asia Pacific. Santos, in introducing the program and speakers said that the focus of WNF2016, 'Driving the protein economy' is apt for aquaculture. Aquaculture is positioned as a major source of protein today and with incredible growth potential in the future. However, the intensification of aquaculture comes with numerous challenges.

Professor Barry A Costa-Pierce's outlook on 'Global expansion of ecological aquaculture to meet the aquatic protein needs of the future' describes how it is the ocean and not the land mass which is the future for industrial aquaculture. This is where there will be marine entrepreneurship. "The dense omega-3 rich aquatic foods are also better food choices from a human health perspective," added Costa-Pierce who is from the Department of Marine Sciences, University of New England, USA. He said that there are two tracks for aquaculture: industrial and ecological aqua systems, and the latter is the paradigm for the future.

"The ratio of fed: non-fed aquaculture is 70:30, but the non-fed species such as the mussels feeding on protein rich (70%) detritus in the ocean's thermocline could produce volumes equal to that of swine and chicken in the US," added Costa-Pierce. Aquaculture-based capture fisheries, where hatchery bred juveniles are added into the oceans for production of 'wild fish' such as the salmon in Canada shows how aquaculture and fisheries are intertwined.

Fish meal dilemma

In her presentation on 'The Fish Meal Dilemma: What are the alternatives?' **Professor Ashild Krogdahl**, Norwegian University of Life Sciences said while there are reductions in the use of fish meal for almost all fish feeds, with the exception of eel feeds, overall. aquaculture is still using most of the global fish meal supply.

"There are tools to reduce the use of fish meal in aquafeeds but we need more information on nutrient requirements. Breeding programs can reduce the pressure through better feed efficiency and increased tolerance for new ingredients. An example is the fourth generation of salmon and rainbow trout fed soybean meal which did not show enteritis in the intestines.

"While we seek alternatives, the nutritional quality of fish meal can be improved as currently, there is a high variation in digestibility of protein and energy in fish meal. The digestible energy value can vary by 90% and digestibility of protein can go down to 70%. Alternatives from the marine environment are underutilized resources such as krill meal. The copepod, *Calanus* is another option.

"In the longer term, we may not be able to use plant meals too as they may be used as human food. We need to look at carbon sources such as wood waste, methane gas, sewage, food waste which is 13,000 million tonnes/year. Kelp is an option but the protein is 5-30% and fibre is high at 40-80%.

"We realise that nutrient composition will not be optimal such as the composition of soybean meal relative to the needs of the salmon. We will need to balance with tailor made supplements and make nutrients more available," said Krogdahl.

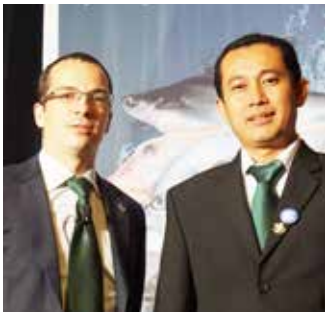
In the case of alternatives for fish meal in shrimp feeds, **Professor Alberto Nunes**, LABOMAR/UFC, Brazil said that the difficulty in working with alternative ingredients is that we need mineral and amino acid supplementation and the use of attractants. "When fish meal is removed, essential fatty acid composition is affected. For example, soy protein concentrate (SPC) can replace 31% of fish meal with the addition of 2% fish oil. We cannot do replacement with SPC with 1% fish oil.

According to **Rui Goncalves**, Scientist - Aquaculture at Biomin Holdings, plant meals are promising replacement for fish meal but the presence of antinutrients is detrimental to fish health. There are processes to remove these or inactivate some compounds but the same cannot be said for mycotoxins which are relatively stable to processing conditions. Goncalves gave information on the occurrence of mycotoxins in different plant sources and aqua feeds. Their presence presented a risk. More work is required to increase knowledge on their effects and also to define acceptance levels as is already done in livestock production.

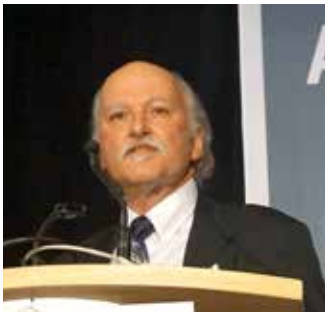
Shrimp nutrition

In his presentation on shrimp nutrition, Nunes said that there are three basics for shrimp feed formulation: species (monodon or vannamei shrimp), systems used (intensive or semi-intensive) and life stages. "Shrimp farming is dynamic and neighbouring farms can be different, in terms of water salinity and pond designs which can affect how we formulate the feed. High crude protein feeds (40%) for the monodon shrimp, are mainly marine-meals based whereas low protein vannamei shrimp feeds average 35% are mainly soy-based diets and there are commercial diets with as high as 50% soybean meal.

"Although 80% of marine shrimp production is focused on the vannamei shrimp, we do not know the nutrient requirements for this shrimp like what we know for monodon shrimp. If we



Goncalo Santos (left) and Anwar Hasan



"Hatchery bred juveniles added into the oceans for production of 'wild fish' shows how aquaculture and fisheries are intertwined" - Barry A Costa-Pierce

Shrimp grows better with constant feeding - Alberto Nunes

There are tools to reduce the use of fish meal in aquafeeds but we need more information on nutrient requirements - Ashild Krogdahl

The challenge is measuring the health threshold, the turning point of conditions which causes the outbreak- Simon Mackenzie

Probiotics also stimulate increased intestinal enzyme activity-Daniel Merrifield

Presence of antinutrients is detrimental to fish health- Rui Goncalves

There are no efficient cures for any of the diseases occurring in shrimp farming-Matthew Briggs

think of formulating vannamei shrimp feeds using data for the monodon shrimp, we may be over formulating. Even amino acid requirements are different, such as for lysine. We do not know the requirements for methionine but we estimate it to be between 0.7 to 0.8% of the diet, DM basis," Nunes said.

"The irony is that we do trials in clear water but shrimp is commercially farmed in green water ponds. In some trials in our laboratory with flow through systems, we showed that requirement for methionine was 1% and the final body weight increased linearly with the dosage. But with limited water exchange, we had a quadratic response, the maximum level was 0.8% dietary methionine content," added Nunes.

Shrimp feed all day to attain sufficient energy. "In a recent trial to determine the optimal number of feeding per day, we showed that growth was better with constant feeding, with either multiple manual feeding or with automatic feeders. This is also because with more water soluble additives in feed, leaching will be higher with less feeding. Attractants are important. Even 2% krill meal helps to improve shrimp performance," explained Nunes.

Sustainable shrimp farming

Consumers are increasingly driving the adoption of sustainable practices to reduce discharge of waste feed and excessive use of water. "These practices require a shift from flow through systems to recirculating aquaculture systems," said **Dr Tzachi M Samocha**, Texas A&M University, USA. He described factors to consider in the design and operations of an intensive biofloc system in his presentation on 'Sustainable farming: high density biofloc dominated, no water exchange systems'. Samocha highlighted some data on grow-out trials with vannamei shrimp juveniles and nursery rearing in recirculated water systems. The information is based on a recently published manual on biofloc shrimp farming - Design and Operation of Super-Intensive Biofloc-Dominated Systems for Indoor Production of the Pacific White Shrimp.

Health challenges

Dr Mathew Briggs, Ridley Aqua Feeds, Australia, discussed how some recent disease challenges are affecting the Asian shrimp industry. Acute hepatopancreatic necrosis (AHPND) actually affected only 20% of shrimp ponds in Thailand according to a survey. However, AHPND does not act alone. The survey showed multiple co-infections with other pathogens including other bacteria (*Shewanella* and *Delftia spp.*), microsporidians (*Enterocytozoon hepatopenaei* or EHP), viruses including the white spot syndrome virus (WSSV) and an unknown disease called aggregated transformed microvilli (ATM). In 2015, there was a new variety of early mortality syndrome in Australia with monodon shrimp which has been called Penaeus-monodon-mortality-syndrome (PMMS), caused by the same toxins, but this time produced either with or without a plasmid in *Vibrio harveyi* instead of *V. parahaemolyticus*.

"There are no efficient cures for any of the diseases occurring in shrimp farming. None of the biosecurity measures developed to combat viruses work with bacterial or microsporidian infections. There are some vannamei shrimp stocks which are specific pathogen resistant to WSSV, TSV, IMNV and even AHPND. These stocks have been developed in South America and now are being developed in Asia. Overall, there is a need to look more closely at the development of these stocks and also more effective implementation of biosecurity measures. Living with pathogens is all about management, keeping good water and sediment quality, stock selection and good nutrition. If optimal conditions are maintained then the shrimp can thrive in the presence of multiple pathogens".

"Central to the effort to reduce losses due to diseases is the understanding of the concept of good health and the development of robust health biomarkers to facilitate management of aquaculture environments worldwide, and and the ability to diagnose the early symptoms of impaired animal welfare," said **Dr Simon Mackenzie**, Stirling University, Scotland. In his presentation on 'Bringing Science to the Field: Innovative Molecular Tools for the Benefit of Farmers', he said that early diagnosis is crucial to prevent the spread of disease. The challenge is measuring the health threshold, the turning point of conditions which causes the outbreak.

Significant interdisciplinary effort is required, combining diagnostics, immunology and epidemiology. The Stirling team is developing mobile PCR diagnostic systems in two challenging fields, in Egypt with tilapia farming and in Scotland with the salmon. In Egypt, Mackenzie described how maintaining fish health is a problem when farmers depend on shared resources. Here they have adopted behavourial prophylaxis, the concept where fish challenged by common pathogens is capable of improving the immune response and survival by selecting an optimal temperature regime.

In the presentation on probiotics enhancing gut performance, **Dr Daniel Merrifield**, Plymouth University, UK focussed on the functional benefits of probiotics. The abundant diverse communities in the gut stimulate modulation of the host immune system and enhance survival, feed utilisation and disease resistance. Lactic acid bacteria are friendly biota and can account for 30-40% of gut biota. *Aeromonas* and *Vibrios* account for 20% of the bacteria population in a healthy fish. The first layer of defense against pathogens is the mucus layer with its cells providing a mechanical physical barrier against microbes and pathogens and binds and washes out with faeces.

Host benefits of probiotics include an increase in goblet cells, elevated lysozyme activity and microvilli increase in the brush border. Longer villi increase absorption of nutrients. Probiotics also stimulate increased intestinal enzyme activity. Merrifield also described work done with the seabass fed concentrated soybean diets spiked with saponin to induce enteritis. With the application of probiotics, the mucosal fold increased with a significant reduction of HSP70 (heat shock proteins) gene expression.

Joint Venture in China has acquired fish feed company Haiwei

BioMar-Tongwei Biotech (Wuxi) Ltd, the Joint Venture in China between BioMar group, Denmark and Tongwei Co Ltd, China, has acquired 100 % of the shares in the fish feed company Haiwei, which is situated in South China. Carlos Diaz, CEO of the BioMar Group, stated that the acquisition fits perfectly with BioMar's strategic focus in the top end of the Chinese aquaculture market.

"We are very pleased to have concluded this agreement on behalf of BioMar-Tongwei. Haiwei has a very good reputation among fish farmers and we will continue to build on the Haiwei brand and carry on with the company setup. We are confident that BioMar can contribute to the further development of Haiwei and continue their success through process knowledge, R&D methodology, and continuous improvement of feed recipes."

During the last 3 years, Haiwei was part of Tongwei Co Ltd. The latter has concluded a successful turnaround of Haiwei and today the company is a leading supplier of feed to high value fish species such as the Japanese sea bass in South China.

Carlos Diaz emphasised that the acquisition is in line with BioMar's global strategy 'Shaping the Future'. "The acquisition is an important initiative, consistent with our growth strategy in core markets as well as within new species and geographies. In this regard, this is also an important step for our Emerging Markets Division, which plays a significant role supporting the strategy, securing growth for BioMar and building up new markets, integrating acquisitions, and servicing new species."

Geographically the acquisition of Haiwei is in line with BioMar's ambitions for the joint venture in China due to its location in the south of the country, near Macau, an important aquaculture region. The acquisition will add more than 60,000 tonnes of volume to BioMar's Chinese joint venture company.

"Since the announcement of the joint venture between BioMar Group and Tongwei Co Ltd to establish a feed company in China, the shared project has had a very positive development. There is continuous collaboration with our partner and we are working to bring high performance feeds to the Chinese market. BioMar fish feed is already being produced in Chengdu in South Central China and a new factory is being built in Wuxi area, nearby Shanghai, with an initial capacity of 50,000 tonnes with a possibility for expansion to 100,000 tonnes in the future", added Diaz. The construction of the BioMar-Tongwei plant in Wuxi is in progress and according to schedule. It is expected to start operations in the second half of 2017.

More information: www.biomar.com; Carlos Diaz (cdz@biomar.com); Henrik Aarestrup, Vice President Emerging Markets Division, BioMar Group (haa@biomar.com); Sif Rishoej, Director, Global HR & Corporate Communication, BioMar Group (sri@biomar.com)

Signing the documents, Guo Yizhong, CEO, Tongwei (left), and Carlos Diaz, CEO, BioMar Group Standing from the left: Ricle Chen, Business Development, Tongwei; Yuan Shihua, Chairman of the Board, BioMar-Tongwei; Henrik Aarestrup, Vice President Emerging Markets, BioMar Group and Niels Alsted, Vice President Asia, BioMar Group.

3rd Jefo Graduate scholarships in aquaculture

Six post-graduate students from three Chinese universities were awarded the 3rd Jefo Graduate Scholarship in Aquaculture. The 2016 class of recipients include He Jie and Zhu Jianming of Soochow University, Liu Kang and Xie Rui-Tao of Guangdong Ocean University, and Zhao Xinxin and Shi Ze from Shanghai Ocean University.

The Jefo Graduate Scholarship in Aquaculture program was launched in 2014 to recognise outstanding post-graduate students, not only for their academic merits and research skills but also for their social aptitude and contribution to the society. A scientific committee selected this year's winners from an outstanding pool of four shortlisted applicants from each university after initial screening.

The winners of 2016 are involved in a diverse array of research such as toxicity of heavy metals and pesticides, nutritional requirements of some novel species, gut microflora and enzyme application in a variety of aquatic species from mussel to catfish to cobia to carp to crab.

The scholarships were awarded at each university in November this year in an award ceremony attended by deans, professors and students. The ceremony was followed by a seminar on 'State of Global Aquaculture, Its' Challenges and The Role of Nutritional Studies' by Dr M A Kabir Chowdhury, Global Manager – Aquaculture of Jefo Nutrition of Canada.

At the award ceremony, Professor Leng (second left), Shanghai Ocean University and Kabir Chowdhury (second right) with two Shanghai Ocean University winners of the scholarship

Jefo hopes to continue support the aquaculture industry by recognising the talents needed for a sustainable and ecofriendly growth of the industry. More information: www.jefo.com

TIFSS 2016, PART 2: Taiwan's innovators & movers in aquaculture

A showcase of technological advances relevant to local and regional markets

In Taiwan, academia, industry and government agencies strive to have a leading edge in aquaculture technology. This year, they were there at the Taiwan Seafood and Fisheries Show (TIFSS 2016) to showcase technological advances relevant to local and regional markets. AAP interviewed several of them for this report. The innovators are moving the industry in Taiwan for the next phase of growth where biotechnology and information technology will play an important role in increasing efficiency and reduce production costs.

Farmed fish complex

Taiwan's industry has been paving the way for the farmed fish complex, from food to industrial products, utilising every part of the fish. Displays at the booth of the Fisheries Agency, Council of Agriculture, showed that with cooperation among farmers, government and biotechnologists, the tilapia (or Taiwan bream), once a simple food, has become a high-tech multi-functional fish species. All parts are used; scale collagen for cosmetics and skincare products, skin for handbags, tail fins for imitation shark's fin, bone for fish food, belly for grilling, scales for artificial cornea and eye for hyaluronic acid. With regards to milkfish, the scale contains two major functional elements; collagen and hydroxyapatite (Hap).

Farmed seafood

Farmed grouper is a favourite for year-end feasts and wedding banquets. In 2013, the production of various species of the grouper reached 25,000 tonnes valued at USD 221 million (Chu et al, 2013). The export market is very important for producers and 70% of live groupers are exported to China. As local production in China is increasing, reducing demand for Taiwanese groupers, the government is helping to find alternative markets for the fish. High value coral grouper *Plectropomus leopardus* is airfreighted to as far as the US where offer prices are very high. These are niche markets for some producers using proprietary closed culture systems.

One positive development is the acceptance of frozen grouper steaks by local consumers. Traditionally, the preference has been for whole fish, live or chilled. One producer is Haishi Frozen Aquatic Products Processing Ltd which focuses on the orange spotted grouper *Epinephelus coioides*, brown marbled *E. fuscoguttatus* and giant grouper *E. lanceolatus* and the fourfinger threadfin *Eleutheronema rhadium*.

Consumers are emphasising more on food safety and producers are meeting demands for quality seafood. Certification programs are Taiwan Quality Food (TQF) and the Traceability system of Taiwan's agriculture products (TAP), which in the case of fish/shrimp farming, ensures that processes at different stages are recorded.

While aquaculture biotechnologists and farmers look at ways to overcome diseases and poor survival rates with better management, seafood processors look at advances to raise processing standards. Anyong Biotechnology says that it has a state of the art processing plant in Mituo, Kaohsiung, with an investment of NTD100 million. Product lines are ISO 22000 and HACCP certified. It has imported a cutting edge freezing technique called 'cells alive system' from Japan which keeps the cells alive and retains the nutrients and freshness of fish at -50°C. This uses electromagnetic fields and mechanical vibrations to prevent ice crystals formation which destroys food texture.

Taiwan's Innovators

Internet of Things

Quadlink Technology Inc. is a company developing the 'Internet of Thing(IoT)" systems by using sensors, audio/video monitors, cloud and big data technologies to optimise aquaculture and agriculture production and distribution. At its booth, Otto Tsai and his team showed how the company's data application technology in aquaculture is pushing boundaries in fish farming management in Taiwan. This experienced team with members from wireless communication and cloud computing backgrounds has been in business for six years. "We combine talents and technologies groupers from Taiwan, Europe and the United States, focusing on the 'Internet of Things' for precision farming. Our motto is 'For better food and environment'", said Tsai.

The Quadlink aquaculture monitoring system powered by solar cell continuously monitors temperature, pH, oxidation-reduction potential (ORP), dissolved oxygen and salinity of pond waters and periodically sends the measured data to cloud and clients

Eric Wu (right) and team with a giant grouper steak at the Haishi booth

Otto Tsai (second right) and team at their booth explained the technology behind their 'smart connect products for aquaculture'

in real time. Farmers not only receive the data and alerts if any abnormal condition happens, at any time and place, but also can observe and analyse the historical data since all the data are stored and secured in the cloud.

"Through this monitoring system, farmers no longer need to stay by the ponds to manually measure the quality of water several times every day. Recently, with rapid and unpredictable climate, the real time alert can minimize the damage to stock with fluctuations in water parameters such as pH and dissolved oxygen. The monitoring system can also work with paddle wheel controllers to move the water only when dissolved oxygen is low or suboptimal to save electricity and operational cost. Similarly, auto feeders are activated only when required, saving on feed cost and reducing impact on the environment from uneaten feed.

After two years of field trials, Quadlink now has clients in Taiwan with various sizes of farms, culturing grouper, eel and shrimp farms and some hatcheries. They are also looking for potential customers in Asia.

According to Tsai, farmers have already benefited by getting advance alerts to prevent potential loss, save energy consumption by 30-50%, and get access to data from the cloud for their day to day management.

Tsai said, "I believe that there is a huge potential for such technology to modernise aquaculture. By adopting the IoT technology, we remove one barrier for the young generation to enter aquaculture. Aquaculture becomes more fun and less labour intensive. The environment of farms and the growing process are precisely monitored and controlled. Eventually the traceability and quality of food are assured. This is what we claim 'for better food and environment'. Next, we plan to look into the processing, transportation and warehousing segments of aquaculture and agriculture." (www.quadlink-tech.com)

High moisture pelleting system

Yilan County based **IDAH Company** is a provider of solutions for the production of shrimp and premium aqua feeds. Established in the 1974, IDAH is proud that it has completed numerous turnkey projects and is supplying equipment to major feed mills across the globe. All machinery is manufactured in Taiwan.

"More than 50% of aqua feed millers in China have chosen IDAH for their aqua feed processing needs. We recently completed new fish feed lines in Saudi Arabia and in Egypt," said Evon Lin, Sales Representative.

At the show, the focus was on the recently developed high moisture pelleting technology. This new PM-53F pelleting technology increases material moisture. Feed pellets have a glossy appearance, better water stability and degree of gelatinisation. "Many customers have given us feedback that the effect of this technology is very significant and their production capacity increased by 10-15%. In our system, we utilise a post conditioner tank for maximum gelatinisation. This process will eliminate the use of binders." said Evon.

Idah's extrusion system is the only one independently developed in Asia and has been awarded with a US patent. The company attributes this success to more than 20 years of research in extrusion systems. "We have managed to increase the production efficiency of sinking fish feed, slow sinking and fast sinking feed by 10-20%. The moisture during processing can be reduced by 3-5%, to lower drying costs. Feed pellets have uniform and good appearances. Furthermore, it allows for more flexibility in raw material selection. The latest design for post conditioners is the vertical post conditioning cooker which offers more benefits than the horizontal version. It is more efficient and produces better quality feed. Operation costs are lower because of better heat exchange."

Evon Lin (right) with Liang-Chuan Hsu, Senior Customer Service Engineer.

"To have a competitive edge and ensure the best technical services, Idah is planning to hold a short extrusion course, which will be located in our Food Innovation Centre, where we train current and future clients on extrusion processing. We welcome all feed mill-related practitioners to join the programme," said Lin. (www.idah.com.tw)

Large cages and solar floating systems

Sun Rise E&T Corporation is the leading manufacturer of cages in Taiwan and the second largest globally. It was established in 1995 by Joshua Tung who developed the first HDPE cage for marine fish farming in Taiwan. The made in Taiwan cages, which use injection technology, are exported to 51 countries. In Taiwan, sales began with 20 m diameter cages and are used for the farming of cobia and pompano by Ever Spring Aquaculture, the largest marine fish cage farm in Taiwan (see page 5). Following a damaging typhoon in 2000, the company has been adding new cages and today has 30 cages manufactured by Sun Rise. Sales is also to small farms all over Taiwan. The company has sold almost 400 cages (20 m diameter) to farms in the Philippines. Cage sizes have grown larger to 30-50 m diameter cages for farming of tuna juveniles.

Tung, who is chairman of the company, said, "The breakthrough in 2016, is the export of our 60 m diameter cages to Norway. This is important for us as the Norwegian market is dominated by AKVA, the global leader. This is a very discerning market and our entry proves that we meet their standards. It helped that we use injection technology which fish cage users in Norway are familiar with. Since 2009, we have sold cages to Japan and today, Sunrise has supplied almost 90% of HDPE used in the country. The number is small as Japanese marine fish farms prefer metal cages which they replace every 3-5 years."

"Our R&D has been systematically and efficiently performed as we seek breakthroughs. We continuously introduce up-to-date technology, developed locally or adopted from abroad, with a view of reducing cost and upgrading quality. Our latest

Joshua Tung (right) and Eric Tung with Shinichi Asami, Nippon Kanzai Centre, a Sun Rise cage technology distributor in Japan (left).

technology is the solar floating system with radar and camera. Solar power is tapped to run the camera and some lights. This is a first in the world, said Eric Tung, Sales Specialist, the second generation in the company.

"We are also investigating the development of a solar system in ponds or dams. We have a two-year project with the Philippines Bureau of Fisheries and Aquatic Resources to determine whether a 30% coverage will affect fish survival as these panels will block sunlight in the ponds." Sunrise will continue to target the Norwegian market. Next, it is researching on the mooring systems for loads of 50 tonnes or more as compared to the smaller loads of 20 tonnes common in Taiwan.

"This is the second time we are participating in this seafood and fisheries event. The other important events for us is Japan Seafood and Fisheries Show and AquaNor in Norway", added the elder Tung. (www.srise.com.tw)

Probiotics and delivery of anti WSSV vaccine

Nobel International Biotechnology was established in 2005 as a leader in innovations for the aquaculture and aquarium industry. The company brings to market biotechnology products developed by in-house researchers as well as innovations from research at the National Taiwan University, National Cheng Kung University, National Kaohsiung Marine University and National Pingtung University of Science and Technology. The tagline "always innovation" underlines the drive to actively use technology and product development for aquaculture and aquarium. Nobel's way is to focus on 'green' products following a trend towards organic aquaculture and demand for safe foods.

Ying-Tang Huang (left) and Kuang Chan Lee, CEO (second right) with the NBL team, Jia Lun Xu and Chung Chih Chang-Chieh.

The company is marketing probiotics and hatchery feed. NBL1 is feed and water probiotics with *Shewanella* bacteria for denitrification of water. NBL2 Pandora Bacteria is a powerful aquatic microbial product and was developed using bacteria from the Kuroshio current, off Eastern Taiwan. NBL 3 is a saline photosynthetic bacteria which reduces ammonia and hydrogen sulphide in water. It also has enzymes to inhibit pathogens. Greensure is an algal extract combined with water-soluble peptides and amino acids to accelerate growth of larval fish and shrimp and stabilise the algae phase in hatcheries.

Professor Ying-Tang Huang, Department of Marine Biotechnology, National Kaohsiung Marine University was at the booth to explain mechanisms of some of Nobel's bacterial strains for aquaculture.

"Over the years, the NBL team researched several bacteria strains from the marine environment and after separation, laboratory identification and large-scale testing, developed a product called 'NBL Shewanella'. This is a gram-negative rod-shaped non spore forming bacteria found in the gut of wild aquatic organisms. It has strong denitrification properties and is resistant to 65 ppt salinity. NBL2 is a probiotic to reduce total ammonia and nitrite in water. In addition, NBL2 can combine with α-ketoglutarate and ammonium to form glutamate."

Another development which started two years ago is the anti-white spot syndrome virus (WSSV) vaccine. The research was on the delivery of the envelope protein VP28 of WSSV using probiotics. "We cloned the protein to express in *Pseudomonas* bacteria and added to water and feed. *Pseudomonas* was found to be better than *Bacillus*. We tested using ponds farming monodon shrimp in Taiwan and vannamei shrimp in Vietnam. No WSSV infections were recorded. The probiotics has to be added daily for at least 7 days continuously and then at weekly intervals during the whole culture period.

"At the hatchery, the probiotic can be added at 200 ppm for 7 days before stocking into ponds. However, the probiotic must be added into the pond. Our next target is to add the probiotic into feed. An obstacle is converting this into a powder. We will continue to run more trials before commercialising," added Huang. (www.nbl.tw)

Movers

Support farmers with shrimp processing

The **Grobest Group** is Taiwan's leading aqua feed producer. It is also one of Asia's leading multinational companies involved in feed production, hatchery, farming and processing for farmed fish and shrimp. It has 8% of the global shrimp feed market. The integration level of its subsidiaries in several countries in Asia varies. In its feed business, it has four feedmills in Thailand and China, one in India and in Vietnam, a newly established feed mill in the Philippines, and in Malaysia, the feed mill currently under construction will be operational in early 2017. In Thailand, it produces aqua feeds, farms the tilapia and has a fish processing plant. In China, it also has fish processing facilities. Grobest has shrimp hatchery businesses in Thailand, India and Vietnam.

At its booth, Vincent Lin, General Manager, HQs/Food, explained the new strategy to enter into the farming and shrimp processing segments in some countries and expand on existing ones.

"Grobest is very well regarded as a leader in shrimp feed production. When farmers use our shrimp feed, they are assured that their shrimp are of high quality. We strongly believe that only

Vincent Lin (right) with Jennifer Kuo at their booth, displaying the new focus on shrimp processing in the background.

Jack Hsu (right) and Ken Lee, Sales and Design Engineering Manager. Their participation at TIFSS 2016 is to network with local clients and those from Malaysia and the Philippines

with good feed can we have good shrimp. By this I mean, shrimp acceptable to consumers; sweet, bright colour and firm flesh.

"Consequently, we are very keen to grow on this strength by expanding into the shrimp processing business. In 3-5 years, we will be building up our shrimp processing capability. Now, we do shrimp processing in two plants, one on contract basis and the other as co-owner. In the future, we expect our own plants in various countries to process shrimp for the US and other markets."

In Taiwan, Grobest has farms producing shrimp but these supplies constitute a limited amount of raw material for the processing and local markets. Lin added, "We will continue to work with small farms and may also enter into contract farming to have sufficient raw material for the processing plants. We provide technical support from Grobest teams and will be helping farmers to increase farm profitability."

The shrimp aquaculture industry in Asia continues to show a downward trend in production. How can a company like Grobest, help to bring back production. Jennifer Kuo, General Manager, Animal Health Department said, "The entire industry in Asia is working together with new solutions. We have reformulated our feeds, and ran trials over two years. There are examples of farmers (vannamei shrimp farmers in Thailand, Vietnam, China India and Taiwan), doing well with our feeds and combination of products, as we insist on a change of mindset and changing management protocols. We are optimistic that more will do so in the future. Our solutions are not radical approaches, we merely suggest water and soil management and use of probiotics. We support with technical guidance and monitoring services and consultancy."

Lin added, "We have different strategies for different systems. Farmers are key, and if we all pay enough attention at the beginning, the chances of success will be higher for all in this industry." (www.grobest.com)

Forte with single screw extruders

One of the earliest feed equipment manufacturers in Taiwan, **Soon Strong Machinery Works**, continues to dominate the Asian aqua feed industry. It has new products such as pellet mills, extruders, fine pulverizers, board dryers, floating dryers etc for animal and aqua feed production. Soon Strong was started by the father of the current General Manager, Chang Keng Hsu and a partner. The first shrimp feed plant was established in 1989 and five years later, it developed its first extruder. Another major achievement is equipment for flake feeds sold to a company in Thailand in 1989, which is still using the machinery and has 70% of the Asian market for flake feeds.

"Over the years, we have had a strong hold in the feed processing equipment market in Asia. We have supplied to 40 feed millers in Indonesia and 30 in Vietnam for the production of aqua, animal and poultry feeds. Our other markets are in Taiwan, Thailand, China, Malaysia, Mauritius and India," said Jack Hsu, General Manager.

"We continue our long term relationships with aqua feed millers in Indonesia such as PT Matahari Sakti. We began working with them 20 years ago and recently provided equipment for the expansion of their shrimp and fish feed lines. The company is the only one in Asia producing 500 μ floating fish feeds".

"Our strong point is single screw extruders which we believe producers in Asia need. Single screw extruders cost half the price of twin screw extruders. We also have been servicing our clients well, even after 20 years. For example, some of extruders and pellet mills are still in use after 15 and 20 years, respectively. Our technical experts are always available to help clients. Unlike manufacturers in China, we still manufacture spare parts for these machinery."

Ten years ago, Soon Strong started a design company in China where most of the R&D is carried out. However, the production is done in Taiwan as it is important to maintain quality of the equipment by using local raw materials. (www.soonstrong.com.tw)

At the Shiuh Ger Trading booth, from left, Gordon Chen, Tony Chen and Chia Hsin Weng, with Dr Yew-Hu Chien, Professor, National Taiwan Ocean University (second right)

Jung Fu Chen (left) and son, Chen I-Ting with their multifunction aerator

Improving feed efficiency

Shiuh Ger Trading Co Ltd supplies feed additives for aquaculture and animal production and currently imports natural products from Europe, Asia, America and other continents. The company was set up by Tony Chen, General Manager. This was the second time that the company exhibited at TIFSS and the team comprising Gordon Chen, Deputy General Manager and Chia-Hsin Weng, Sales Manager and Veterinarian, was there to meet local clients. Aquaculture accounts for 15% of Shiuh Ger's business. The rest is in the animal production industry.

Shiu Ger imports products into Taiwan and China. Among the feed additives used for shrimp farming is the nucleotide Vannagen produced by the Swiss company Chemoforma AG. For aqua feeds, it supplies farmers this feed additive for shrimp, threadfin, eel and seabass farming. Another feed additive is Nutrafiro Plus, a combination of two plants (Yucca and Yucca schidigera), products of US based Desert King International. Nutrafiro Plus is for gut health modulation in tilapia, milkfish and seabass, farmed in freshwater ponds. In both cases, the farmers give the additives to feed millers to be incorporated into feeds. For larger farms, the company will work directly with the feed millers.

Chen added that in Taiwan, they and other companies are lucky as there is a close working relationship between industry and researchers, where the latter develop products and depend on the industry for marketing. Shiuh Ger works with the Fisheries Research Institute. Shiuh Ger sees that the potential for further growth in its aquaculture business will ultimately depend on the progress of the aquaculture industry in Taiwan.

"Grouper farming is important for Taiwan and for successful production of the green grouper, farmers tend to use antibiotics for disease treatment. However, our achievement with these products is that farmers have moved away from using antibiotics. The threadfin is the latest target species as grouper prices have declined 50% from NTD 250/kg in 2015 to NTD120/kg in 2016," said Chen. "It will be possible to bring down feed costs to around NTD 9000/tonne (USD 280/kg) with a one third partial replacement of fish meal with a combination of soya protein, poultry meal and soya bean meal with the addition of feed additives. In the local markets, we plan to develop in house products and have fish meal replacers on trial."

"We are also looking at products for water treatment. We would like to expand into the markets in other parts of Asia too." (www.shiuhger.com)

Environmentally friendly fish farming

Gemann Enterprises Inc is a family company established in 1975. It started in the aquaculture trade and gradually moved into the farming of the monodon shrimp with a shrimp farm in Fangliao. Now with more than 40 years of farming experience and with three fish farms in Linbian, Pingtung and Donggang, it is moving into environmentally friendly culture. The reason is to push for traceable products certified under Taiwan's Traceability Agriculture Product (TAP) for supply to top end restaurants. Jung Fu Chen, founder and General Manager, said, "Specifications on traceability are important and as producers we have a social responsibility for the industry."

The products displayed at their booth include an aerator, probiotics containing Biozyme Bacillus spp at 10^9 CFU/mL. Chen added, "My probiotics business is larger than the aeration business at a ratio of 70:30. I learnt how probiotics are used in the animal production industry where they understand its functions in waste management.

"My concept is that probiotics added to fish and shrimp feed can have positive effects such as immunity. Rapid decomposition of the organic matter will reduce harmful substances in the pond. My clients are small farms who top dressed probiotics in their feeds. They farm tilapia *Oreochromis aureus* in seawater (32 ppt salinity) and red tilapia *O. niloticus* in brackishwater ponds. Fillet quality is higher with a yield of 600 g from one kg tilapia and texture is firm."

The aerator business came about after several years as an AireO2 distributor. The Jet-Mix horizontal aerator is a surface mounted propeller type aerator that distributes air in fine bubbles to maintain an oxygen rich environment in the pond. This design is highly efficient with an excellent mixing and circulation pattern. According to Chen, this is an easy way to maintain biological solids in suspension, eliminate stagnant spots and improve treatment of biological oxygen demand (BOD) at as high as 98%. It is manufactured in Taiwan.

"Ten years ago, we exported products to Indonesia but as we are only 13 in the company, we decided to focus on the business in Taiwan. We also have our own farm here in Kaoshiung producing seabass and red tilapia. However, soon we want to export our aerator products to other markets," added Chen.

TIFSS 2017 will be held in Kaoshiung from 9-11 November, 2017.

Fish vaccine receives market authorisation

In December 2016, PHARMAQ's vaccine ALPHA JECT® Panga 2 received a marketing authorisation from the Department of Animal Health, Vietnam. The vaccine will be available for customers in Vietnam in early 2017.

"The approval of the new vaccine is a great contribution to a more sustainable aquaculture industry in Vietnam. Behind this product are many years of research, development and documentation to ensure that the product provides a significant level of protection as well as being safe for the fish and the environment", said Pham-Cong Thanh, Country Manager Pharmaq Vietnam.

ALPHA JECT® Panga 2 is an injection vaccine that provides protection against the main diseases in the pangasius farming industry in Vietnam, *Edwardsiella ictaluri* causing white spot disease and *Aeromonas hydrophila* causing septicimia and hemorrhage. These occur during the whole production cycle and are associated with high mortalities and large economical losses.

"Vaccination is an important step forward in controlling two of the major diseases in farmed pangasius in Vietnam and reduce the use of antibiotics. The vaccine is well documented through field trials conducted in close cooperation with our customers over the past years," added Thanh.

"To achieve a more predictable and reliable fish production for pangasius, Pharmaq aims to continuously support the Vietnamese aquaculture industry towards more advanced fish health solutions in the prevention of diseases. The approval of this vaccine is an important step towards production of safe and healthy seafood in Vietnam" said Morten Kr Nordstad, President. Pharmaq.

Pharmaq is the global leader in vaccines and innovation for aquaculture. It is part of Zoetis, the world leader in animal health. The company provides environmentally sound, safe and efficacious health products to the global aquaculture industry through targeted research and the commitment of dedicated people. Production facilities, administration and research and development activities are based in Norway with subsidiaries in Chile, United Kingdom, Vietnam, Turkey, Spain, Panama and Hong Kong. The company's products are marketed in Europe, North and South America, and Asia.

More information: www.pharmaq.com; Pham-Cong Thanh (pham-cong.thanh@zoetis.com

Collaboration to develop Thailand's tilapia industry

INVE Aquaculture and Manit Farm recently came to an agreement for the distribution of Inve products, specially developed for the Thai tilapia market. In November 2016, Manit Farm and INVE organised product training for technical, production and sales teams of Manit Farm. As part of the workshop, Inve introduced its unique product range for the tilapia market in Thailand. These products included a biocide 'Sanocare CID', water treatment 'Secure POND' and feed probiotic 'Secure YIELD'.

Amorn Luengnaruemitchai, Managing Director, Manit Farm, opened the day's activities by reviewing the challenges in Thailand's tilapia industry and introduced the partnership with Inve. This was followed by a technical-commercial presentation by Inve's Dr Olivier Decamp, Product Manager and Tavatchai Chidchomsrichantra, Technical Support Manager. During the product demonstration, Tavatchai and Saran Kayankarnnavee, Inve Area Manager, Thailand, demonstrated the ease of using the products.

Several discussions were later held on the commercial side between Amorn, Will Wong, General Manager and Kittipon

Krittiyarat, National Sales Manager, Manit Farm and Mario Hoffmann, Regional Key Account Manager, Inve and Decamp. The collaboration between Manit Farm and Inve will be introduced to the Thai tilapia industry in early 2017. More information: www.inveaquaculture.com.

SFT awards diplomas to 14 graduates

The Swiss Institute of Feed Technology (SFT) in Uzwil, Switzerland Technology awarded diplomas to 14 students after they successfully completed the 34th Specialist Course. SFT Director Daniel Müller recognised the graduates for accepting the Institute's higher challenge during an award ceremony following an intensive ten-month training. He also recognised Maike Junker (Bühler AG, Uzwil, Switzerland), the tenth woman in the Institute's history to successfully complete the course.

"These students are now equipped with knowledge that will enable them to meet the highest standards in feed production," said Müller. "They've mastered the requirements of a long tradition of instruction in engineering and this will enhance their contributions to the industry. We are especially proud of Maike Junker and hope that she will inspire more women to consider this career training."

Reaching the top

These Diplomas qualify graduates as Feed Production Engineers or confirm their attendance of the course. In his address, Daniel Müller emphasised the significance of training and continuing education. He expressed his admiration for the students' decision to go back to school: "By making this far-reaching decision, you took up a challenge that you have now successfully met. Today, you have reached the top. With the knowledge you have acquired and your great commitment, you now have the right instruments available to satisfy the rigorous requirements of safe and economical animal feed production." He said that the goal was on one hand to meet consumers' needs for hygienic feeds that are safe for humans and animals alike. On the other hand, he said that companies were increasingly facing the challenge of producing and marketing feeds more efficiently and more responsibly while meeting legal regulations and directives.

Each year, the SFT recognises one student with the highest score. This year the distinction went to Eric Droz, employed by Albert Lehmann Bioprodukte AG in Gossau, Switzerland.

Program schedule

The Feed Production Engineer Diploma course starts with a 15-week preparatory correspondence course followed by a four-week intensive course in Uzwil. A second block 15-week correspondence course follows, with the final intensive training again in Uzwil. Students work through 21 subject areas and must pass 14 written exams. The highlight and completion of each block are two verbal examinations in the core subjects in front of a panel of experts. The next training program will begin in January, 2018. This will be the 35th Specialist Course in Feed Manufacturing Technology and the working language will be English.

More information: Daniel Müller, (sft.uzwil@buhlergroup.com)

Daniel Müller, School Director of the SFT (bottom left); Marcel Scherrer, President of the SFT Board and Head of the Bühler Business Unit Feed (bottom right); and SFT Members of the School Board Urs Wuest (rear left) and Peter Hofer (rear right) congratulate the best in class of the 34th Diploma Course, Eric Droz from Switzerland (center).

ASIAN-PACIFIC AQUACULTURE 2017

Transforming For Market Needs

Putra World Trade Centre

July 24-27, 2017 • Kuala Lumpur, Malaysia

Hosted by: Department of Fisheries, Ministry of Agriculture & Agro-Based Industries, Malaysia

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**

February 8-10
2nd International Ornamental Fish Trade and Technical Conference
Colombo, Sri Lanka
Email: info@infofish.org
Web: www.infofish.org

February 19-22
Aquaculture America 2017
San Antonio, USA
Web: www.was.org

March 15-17
VIV Asia 2017
Bangkok, Thailand
Web: www.vivasia.nl

March 14-15
International Conference on Marine Science & Aquaculture 2017
Kota Kinabalu, Sabah, Malaysia
Web: www.ums.edu.my/ipmbv2/icomsa/

March 20-24
Giant Prawn 2017
Bangkok, Thailand
Email: salinkr@ait.asia/
new.macrobrachium@yahoo.co.uk

April 4-6
International seminar on Advances in Fish Health
Putrajaya, Malaysia
Email: isafe@upm.edu.my
Web: www.isafe.my

April 25-27
Seafood Global Expo
Brussels, Belgium
Web: www.seafoodexpo.com

May 31- June 4
5th International Trade Exhibition for the Seafood Industry in Asia
Bangkok, Thailand
Web: www.worldofseafood.com

June 27-30
World Aquaculture 2017
Cape Town, South Africa
Web: www.was.org

July 25-27
Asia Pacific Aquaculture 2017
Kuala Lumpur, Malaysia
Web: www.was.org

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

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

What to look forward to in **Aqua Culture Asia Pacific in 2017**

In 2017, we will cover what is trending and technologies for the next step in aquaculture in Asia Pacific. Our topics are most relevant to the industry to help companies reach marketing targets.

Volume 13 2017						
Number	**1 – January/ February**	**2 – March/April**	**3 – May/June**	**4 – July/August**	**5 – September/ October**	**6 – November/ December**
Issue focus *Recent developments and challenges for the next step*	Microbial Management	Hatchery & Nursery Technology	Sustainable & Responsible Aquaculture	Revisiting Shrimp Nutrition	Biosecurity & Disease Management	E-aquaculture & commerce
Industry Review *Trends and outlook, demand & supply*	Marine Shrimp	Marine Fish	Aqua Feed Production	Tilapia	Catfish	Genetics
Feeds & Processing Technology *Technical contributions from feed industry*	Fish Meal & Marine Protein Replacements Feed Enzymes	Novel Ingredients Micro Feeds Feed Additives	Lipids & Minerals Performance Feeds for Intensification	Extrusion & Processing Feed Additives	Sustainable Feeds Feed Safety and Hygiene	Functional Feeds for Health
Production Technology *Technical information and ideas*	SPF/SPR/SPT shrimp	Cage Culture Automation	Controlled systems/RAS	Disease Mitigation	Finfish Industrialisation	Aeration Technology & Waste Treatment
Aqua business Feature articles	Experiences from industry and opinion article covering role models, benchmarking, health management, SOPs, social investments, CSR, ancillary services etc					
Markets	Developments in markets (live fish, product development, market access, certifications, branding, food safety etc)					
Company/Product news	News from industry including local and regional trade shows					
Deadlines for Technical articles	**November 16, 2016**	**January 16**	**March 13**	**May 15**	**July 17**	**September 18**
Deadlines for Advert Booking	**November 23, 2016**	**January 23**	**March 20**	**May 22**	**July 24**	**September 25**
Show Issue & Distribution at these events as well as local and regional meetings ****Show preview***	**VIV ASIA 2017** March 15-17 Bangkok, Thailand	**Giant Prawn 2017** March 20-24 Bangkok, Thailand **Seafood Global Expo** April 25-27 Brussels, Belgium	***World Aquaculture 2017** June 26-30 Cape Town, South Africa	***Asian Pacific Aquaculture 2017** July 24-27 Kuala Lumpur, Malaysia **The Aquaculture RoundTable Series, (TARS 2017)** August 16-17 Bali, Indonesia **Vietfish 2017** August 29-31 Ho Chi Minh City, Vietnam		

VIV ASIA 2017

MARCH 15-17,
BANGKOK, THAILAND

INTERNATIONAL PLATFORM FROM FEED TO FOOD

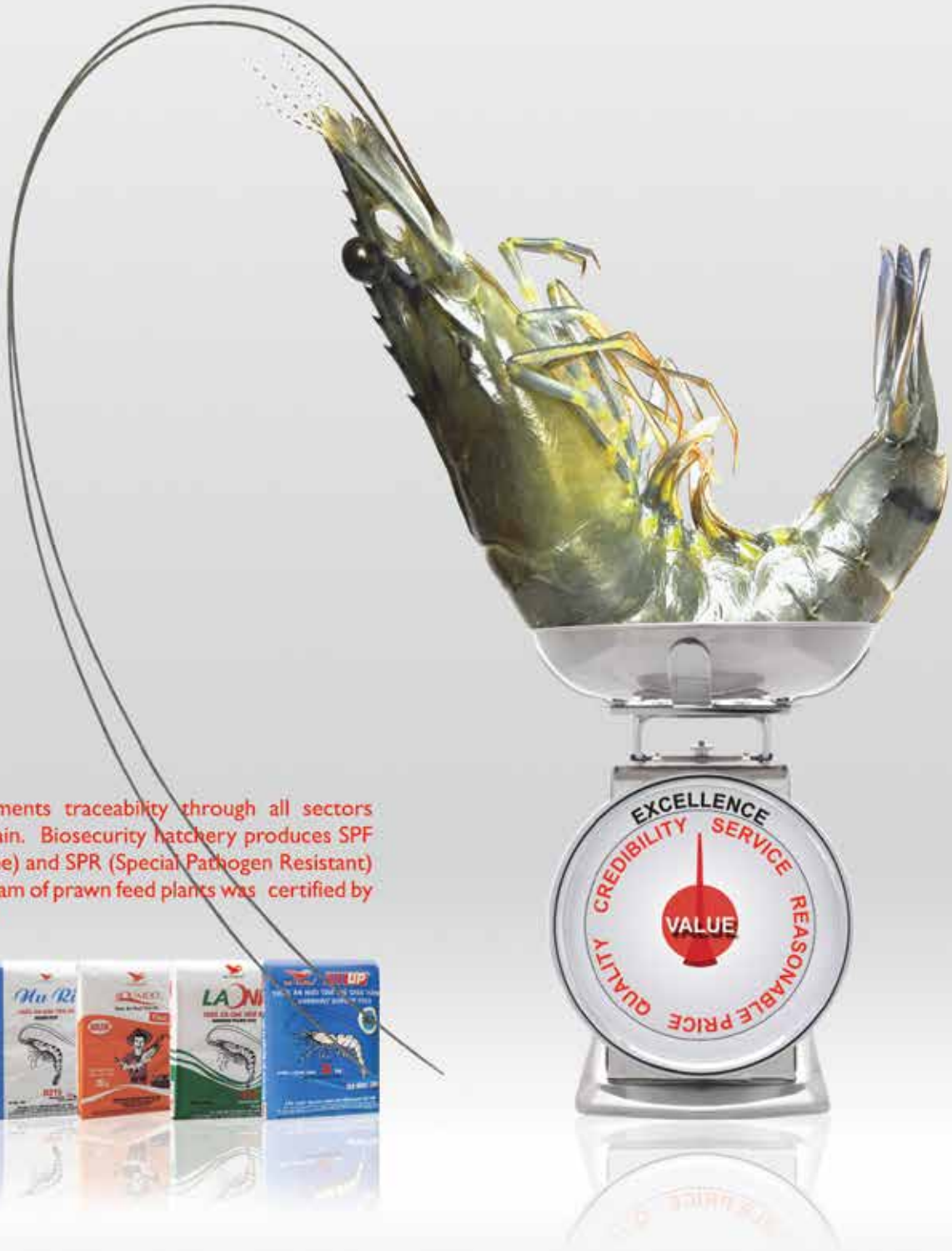
WWW.VIV.NET

vnu exhibitions asia pacific

vnu exhibitions europe

Uni-President®

CREATES THE VALUE OF PRAWN



Uni-President implements traceability through all sectors along with supply chain. Biosecurity hatchery produces SPF (Special Pathogen Free) and SPR (Special Pathogen Resistant) larvae. Quality program of prawn feed plants was certified by ISO 22000 & HACCP.

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Establishing a Healthy and Happy Tomorrow