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Asia Pacific

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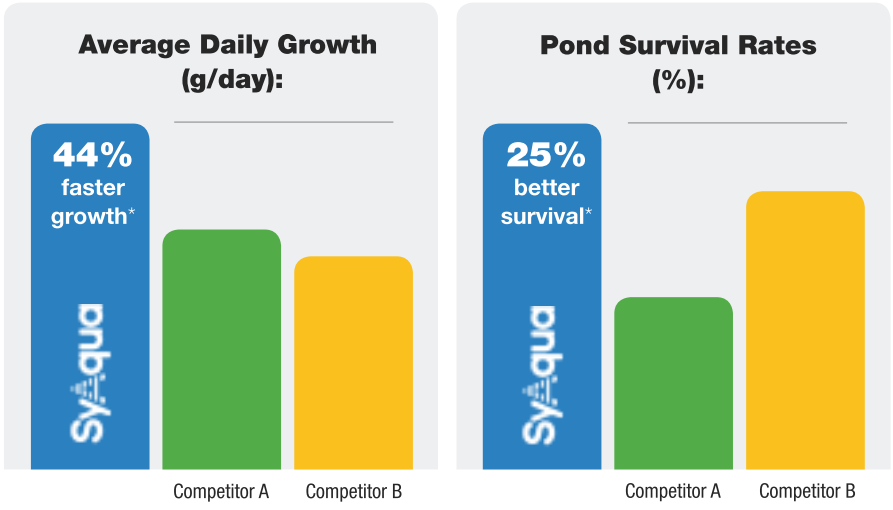

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Disease management: avoiding the perfect storm

Zuridah Merican

There is something new in our TARS meeting this year, the focus of which is on Shrimp Aquaculture and the need for change. As a post-TARS event, we will host a session on Shrimp Disease Management on Friday, August 17 2018. Diseases, whether WSSV, AHPND, EHP or WFS are affecting the Asian shrimp aquaculture production more than we care to admit. Our low production efficiency has become the new normal. There are various objectives from existing players to revive *Penaeus monodon* to create a dual species industry. The intention is good but what about management strategies to solve the very challenge that plagues the industry i.e. disease?

It would be helpful to start with the basics and etiology. Wikipedia describes etiology as the study of causation and is derived from the Greek origins meaning 'giving a reason for'. Diseases do not happen by chance. There is a reason or reasons which give rise to diseases. The history of shrimp disease is no different from human disease, where many physical phenomena were not well understood or when histories were not recorded. Shrimp farming has been adopted so much as an art that even the scientists have a great challenge to push it toward a science.

This post TARS session aims to focus on etiology and review the reasons for a disease outbreak. It will look at 3 key factors that come together to create the perfect storm: the immunity of the shrimp; strength of the pathogen and the conducive nature of the environment.

The immunity of the shrimp determines how well it can face the stress and challenge of the pathogen. Genetics has been one route taken. Mating stronger animals from the natural population has improved the genetics of shrimp. The industry must now take this further and the reach the holy grail of being able to produce an SPR stock in SPF conditions. The industry is reminded that SPR and SPF are not exclusive traits. Immunity is boosted by nutrition and functional additives but we all know that when shrimp are sick, they stop feeding, so the only mode of delivery for any element of immunological benefit is lost. Should immunity build-up start from larval and early life stages and not when the outbreak occurs?

Pathogens are always present in the current farming system. At the APA2018 plenary held in April, Dr Peter De Schryver said that in our current management of pond and hatchery ecosystems, we are already culturing microbes which can either be good or bad for the fish or shrimp. After water is sterilised, opportunistic bacteria (aka "r strategists") colonise the water system first. These are mainly Vibrios which can lead to a disease outbreak once they reach threshold numbers and exhibit quorum sensing. The objective is to prevent their multiplication but increase the numbers of the slower and generally harmless "K strategists" bacteria and create a stable equilibrium. The shrimp toilet has helped tremendously in keeping down levels of bacteria and increasing pond carrying capacities. Maintaining a sterile environment through-out the grow-out cycle today is still an impossibility as we use open systems.

This brings us to the third key factor: maintaining a conducive nature of the environment for the shrimp to grow and this translates to good and stable water quality while limiting the stressors and sudden changes in the environment. The industry today measures and monitors water quality but never in real time i.e. we cannot take immediate action to prevent the disease outbreak. To put it simply, the team at the farm is "not on the ball". In theory, after the outbreak, farms should then try to relate the cause of a disease outbreak to the water parameters but in most instances, farms are so busy fire-fighting that relating cause and effect is ignored and totally forgotten later. There seems to be a lot of data in the field but little of which is analysed. This analysis could help us determine when a pathogen becomes infectious.

The environment comes in many tiers. The first tier is the pond water and bottom which comes into contact with the shrimp but there is also the second tier such as the outlet canal and the creek into which sludge and effluent is deposited. Shrimp toilets are excellent disposal systems but where is this waste disposed to? If effluent is undiluted sufficiently, it becomes a hotbed of disease which will return to haunt the neighbourhood.

The above are some items on the wish list and hopefully this post TARS session will help the industry focus on science in search of a long term solution.

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Joint venture for aquafeed production in the west coast of India

Addressing aquaculture challenges in India through better nutritional solutions for the next growth in shrimp and fish farming.

Mumbai-based West Coast Group and Nutreco have formed a joint venture for the construction of a new aquafeed plant in Gujarat on the west coast of India. Nutreco will take a majority share in the joint venture. This marks an expansion into India's fish and shrimp market for Skretting, the aquaculture division of Nutreco, which is already exporting hatchery feeds for the Indian market. Operating in India's west coast, the West Coast Group is India's eighth largest exporter of shrimp with markets in the US, Europe, Japan and more recently China. It is a leading farmed shrimp integrator and with this joint venture, the West Coast completes its supply chain with feed production.

In its press release, Nutreco CEO Knut Nesse said, "I am delighted that we are announcing this joint venture. Working together with West Coast Group, we will be able to ensure we serve the growing needs of the Indian aquaculture industry while delivering on Skretting's ambition to further develop their warm water species activities."

West Coast Group Chairman Kamlesh Gupta commented, "This joint venture strengthens our chain of integrated aquaculture operations and gives us the capabilities we need as we expand. We are looking forward to working closely with Nutreco on developing this partnership. Our knowledge of the local market combined with Skretting's long history of innovation in shrimp and fish feed will ensure customers get the very best of both worlds."

A good match

"This is a good match for both parties. Our hatcheries, farms and plants are BAP (Best Aquaculture Practice) and ASC (Aquaculture Stewardship Council) certified. Eight years ago, helped by French buyers, West Coast became the first exporter from India to offer full traceability for the markets in Europe. Our premium 'Cambay Tiger' brand is recognised worldwide as a traceable product, certified with ISO 22000, IFS, BRC and USFDA. It is important that we keep doing our best and continue to demonstrate traceability. Now the proposed certified feed milling will complement this whole integrated business and offer unparallel traceability. We believe that by bringing in the latest technology and by having a partner like Skretting, we will be able to offer feed and nutrition solutions to our market. We want to continue to support our local farmers and offer them the best feeds possible," said Rahul Kulkarni, Director, West Coast Group.

West Coast has a 20-year history in India's shrimp industry. When farmers demanded supply of post larvae, in 1997 it built a black tiger shrimp hatchery (later vannamei shrimp) in Kotada, Gujarat. Subsequent development of demonstration farms to showcase farming technology and production, in three locations along the Gulf of Cambay in Gujarat, was followed by feed distribution in 2000 and the first processing plant in 2008, also in Gujarat. In 2011, with increased production of the vannamei shrimp, West Coast built another processing plant and leased a plant in Kakinada, Andhra Pradesh in 2016.

At the joint venture announcement in Mumbai. From left, Kamlesh Gupta, Rahul Kulkarni, Puneet Pokhriyal and Marc Le Poul, in exchanged T-shirts, displaying the spirit of the joint venture.

Marc Le Poul, General Manager, Skretting Asia, said, "At Skretting, we value traceability and sustainability engagement and in the West Coast Group, we have a partner with the same views on aquafeed which gives us a safe entry into the Indian aquafeed market. We believe that this joint venture will also support West Coast's commercial activity in Europe."

Push to farming with a difference

The joint venture will be managed by Skretting India's Country Manager Puneet Pokhriyal, who will also serve as a General Manager for this collaboration. "By December 2019, we will start production, and market shrimp feeds in the first quarter of 2020, when the farming season in the west coast starts," said Puneet. "Initially we will focus on the west coast market, mainly because of logistics but we will also target other regions simultaneously. Essentially, we will be introducing new-age feeds to address the issues farmers are facing today across India. Our feeds will be different from those available in the market today and it is important that we make our special feeds available to the rest of the country as well."

Le Poul added, "Farming is seasonal in western states of India, but we will run the feed plant the whole year round. The design of this new feed mill will allow production for aquafeed needs of all around India but also for other farming operations around South Asia (Sri Lanka, Bangladesh) and the Indian Ocean."

Initially, the capacity will be approximately 100,000 tonnes per year. In the first phase, while production will primarily be tilapia and shrimp feeds, marine fish feed production is also being planned. Until the production facility is operational, Skretting will supply feed from its other plants into India. Le Poul explained that the technical management will get continued support from Skretting's operations spread across the globe. "This feed mill in India will emulate closely the feed types produced by the Skretting feed mill in Vietnam: shrimp, tilapia, as well feeds for the Asian seabass, pompano, grouper, cobia, trout etc. and special feeds for recirculating aquaculture systems. As in Vietnam, we will not produce feeds for the carp and pangasius. Today, feed

exports to most of Asia and sometimes to Africa, come from the Vietnam feed mill."

Fish farming is not new to India and to the West Coast Group. Rahul said, "In India, many attempts to scale-up farming of tilapia, seabass, trout as well as the cobia has been without much success as we lack enough support on fish fry and nutrition. We expect this to change with our new feed mill which can give a big push to farm such species. Two years ago, we started tilapia farming, but only when we imported feeds from Skretting Vietnam last year, did our tilapia farming business become viable. India needs such solutions to expand our fish farming industry."

West Coast has a processing business of 12,000 tonnes annually and the raw materials come from its own as well as contracted farms. It also provides technical support to contract farmers using feed and post larvae supplied by the company. Rahul said, "This captive market helps but we expect a large share of future feed sales coming from the open market."

Le Poul announced that the joint venture is looking for talent, too, as it sets up professional teams in the plant and in marketing. "In Vietnam, we have invested in building a modern plant and we believe it is the most sophisticated aquafeed plant in Asia, focusing on health, safety and environment. We want to bring this same model to the feed industry in India."

The West Coast Group is the latest aquaculture company to enter feed milling, joining others such as BMR and Devi Seafoods. Rahul commented, "These companies are indeed strong either in post larvae supply or in seafood processing, but for us, each of these businesses in the supply chain are equally important and continue to have our focus. In the consumer market, our 'Cambay Tiger' brand is a leading seafood product brand and is supported by a strong distribution channel across the country. The traction for the brand in the US market has also been very encouraging. With our own seafood stores retailing live and fresh fish, and our home delivery platform for the choicest seafood, perhaps we are the only company with a real 'from farm to fork' model in India, by far."

First verified shrimp enters the US market

The first shrimp verified by the Asian Seafood Improvement Collaborative (ASIC) is hitting US markets.

True Food Kitchen is one of the first US buyers to initiate an ASIC partnership to source whiteleg shrimp *Penaeus vannamei* from Thailand from ASIC Shrimp Level 1 verified farms, which are equivalent to a Monterey Bay Aquarium Seafood Watch® program "Good Alternative" recommendation. At a time when the seafood industry is fraught with negative headlines, ASIC approaches shrimp aquaculture improvement differently than most by fostering improvement with the farmers and stakeholders themselves. As a result, ASIC farms and processors are providing environmentally and socially responsible shrimp with fully traceable supply chains.

"ASIC is the first improvement program that's built by stakeholders from the Southeast Asian region, which fosters greater change and stewardship." said Rosanna Contreras, ASIC Chair.

Shrimp in a feed tray. Picture credit: Thai Union

Shrimp is one of America's favourite seafoods with the majority of shrimp found in US markets imported from farms overseas. Roxanne Nanninga, Sustainability Director, Thai Union North America stated, "We are excited to be bringing the first ASIC shrimp to the US market. We plan to continue to grow and develop the farms taking part in this innovative program."

True Food Kitchen, known for its health-driven menu items, prides itself on offering high quality, sustainably sourced ingredients. As a growing business, flavour and consistency are paramount for True Food Kitchen. "ASIC shrimp checks all of the boxes for our priorities," said Taylor Domet, Director of Culinary Standards at True Food Kitchen.

In the coming year, ASIC plans to organise visits to their farms in Southeast Asia for engaged buyers and chefs to further educate on the importance of sourcing ingredients from responsible supply chains.

"The industry has been turning a blind eye to shrimp aquaculture for too long. ASIC is a groundbreaking initiative that is leading the way to revolutionize shrimp aquaculture and we are thrilled to be a part of it," added Domet.

ASIC creates a platform for Asian seafood industry stakeholders to collaborate on the issues of sustainability and standards improvement. It is developing the framework to translate strategies into meaningful action throughout the industry supply chain that incentivises producers and buyers on the local, regional and international levels. By engaging stakeholders at all levels of the Asian seafood supply chain to develop goals, standards and protocols, ASIC is advancing sustainability initiatives that support the health of the ocean and future global food security. (www.asicollaborative.org)

Tilapia in the midst of US-China trade war

A consequence of the new round of tariffs by the Trump administration will be on Chinese imports as soon as September. The list has Chinese-processed seafood including frozen fillets and reprocessed Alaska-caught species such as pollock, flatfish, cod and others. The main impact will be on the imports of frozen tilapia fillets; 133,728 tonnes were imported in 2017 valued at USD 426 million according to the National Marine Fisheries Service. Ninety five percent of the global tilapia comes from Asia, led by China and Indonesia. The US imports 83% of its tilapia supply. Imports of frozen tilapia fell by 13% in January-September 2017, but notwithstanding this, China is the main supplier to the US market (globefish.org). Over the past decade, tilapia consumption in the US has increased steadily since 2002 to 1.18 lbs (0.53 kg) per capita in 2016.

In June, 34 tilapia farms in Hainan, China, earned Best Aquaculture Practices (BAP) certification. The Fishin' Company, a leading tilapia supplier that is capable of offering four-star BAP tilapia, sponsored the farms to apply for BAP certification. "This is an exciting milestone in the industry's journey toward worldwide four-star BAP tilapia" said Justin Baugh, Director of Sustainability for The Fishin' Company. "Our team in China has been working tirelessly to see this initiative through. We are incredibly proud of the hard work the farmers have put in to achieve certification."

Origin of WSSV in Australia

In December 2016, there was an outbreak of white spot syndromes virus (WSSV) in commercial *Penaeus monodon* shrimp farms located on the Logan River in northeast Australia which resulted in the loss of all shrimp production in that location. In this short communication on the assessment of the origin of WSSV DNA sequences in farmed *Penaeus monodon* in Australia, teams from the GeneCology Research Centre, Faculty of Science, Health, Education and Engineering, University of the Sunshine Coast, Australia and Institute of Aquaculture, Nha Trang University, Vietnam highlighted the following: WSSV in Australia was due to invasion by an overseas strain; the Australia strain has highest identity to one from China and WSSV DNA sequences were in retail samples of imported shrimp. The data were consistent with the following hypotheses: an exotic shrimp virus, WSSV, which is of considerable economic importance, has breached Australia's biosecurity. The Australian WSSV strain is mostly closely related to one reported from Asia; a plausible physical route of entry may have been through the importation of WSSV infected shrimp for retail sale. Aquaculture journal, Volume 494, 1 September 2018, Pages 26-29. https://doi.org/10.1016/j.aquaculture.2018.05.018

Investment to combat disease in shrimp

In July, Nutreco announced that it has invested in Israeli startup ViAqua as part of its focus on combatting diseases in the aquaculture industry. ViAqua is developing the first orally-administered treatment for shrimp that improves resistance to viral diseases, including WSSV, and prevents viral epidemics. Nutreco has taken a meaningful minority share that will conditionally grow over time. The solution offered by ViAqua, which was founded in 2014, uses a proprietary particle to disable viral infections. In the future, ViAqua intends to expand to include more species, such as lobster and crab, and small fish.

Other shareholders in the company include The Trendlines and the Technion – Israel Institute of Technology, both based in Israel. The investment is in line with Nutreco's mission of 'Feeding the Future'; the company's ambition is to contribute to producing relevant technology to handle a significant health challenge with convincing proof-of-concept. Nutreco's aquaculture division Skretting will work directly with ViAqua to effectively deliver the solution to the market.

Viggo Halseth, Nutreco's Chief Innovation Officer and Head of Nutreco NuFrontiers – the company's startup investment arm said, "The solution that ViAqua has developed is a unique and highly innovative way of combatting diseases in shrimp. This is a very relevant technology to handle a significant health challenge and has convincing proof-of-concept. ViAqua is exactly the kind of innovative and technological partner we want to be working with in future."

Investing in seabass production in Brunei and Australia

Barramundi Asia Pte Ltd, founded in 2008 and operating the largest fish farm in Singapore is investing a total of BND 300 million to farm in Brunei, the Kuhlbarra Barramundi; a premium breed of sea bass which is also regarded as the "salmon of the tropics." In May, General Manager, Eva Lim and Acting Director of Fisheries Mariani Hj Sabtu signed the MOU where the Brunei Fisheries Department will provide a 6,613 ha area at the Nankivell Offshore Aquaculture site and 21 ha at Tanah Jambu to establish its land based fish hatchery and nursery as well as a processing plant. At full operation, the project will produce up to 40,000 tonnes/year by 2021 and help Brunei achieve BND 400 million production by 2020 and export to Singapore, Australia and Europe. In the Brunei Times, Barramundi Asia's Managing Director Joep Kleine Staarman said that the setting up might take 3.5 years and the company will utilise technology used for salmon farming from Norway, Chile and Canada.

Barramundi Asia has also made an AUD 18.5 million takeover bid for Marine Produce Australia (MPA), operator of the Cone Bay Ocean Barramundi farm near Broome in Western Australia, reported The Western Australian. MPA started as a small farm-focused operation, maturing into a business that incorporates the full fish farming process, from brood stock through to sales. The company was recently granted an increase in its production licence to 15,000 tonnes per annum and has a long-term lease over 1340 ha of sheltered ocean in the Buccaneer Archipelago.

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Do we need selective breeding of an indigenous shrimp species in India?

By Surendran V and Ravikumar Y

There is too high a dependence on the vannamei shrimp and India should have a Plan B on selective breeding of its indigenous species.

The introduction of the Pacific white shrimp *Penaeus vannamei* in 2009 brought a paradigm shift in the way shrimp aquaculture is practiced in India. We saw a phenomenal six-fold growth from 100,000 tonnes (2009-10) to 572,000 tonnes in 2016-17 (Figure 1).

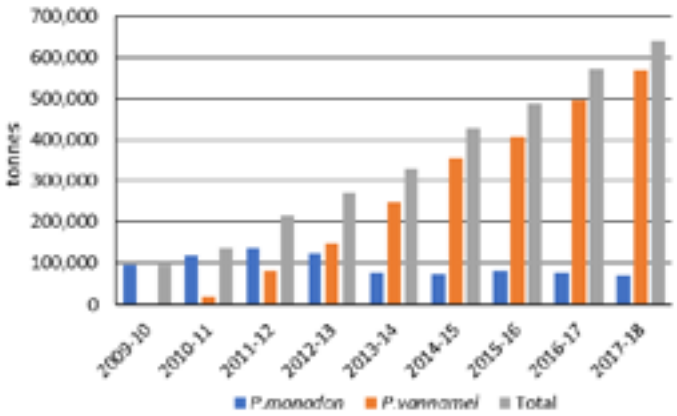

Figure 1. Farmed marine shrimp production in India from 2009 to 2016 and industry estimate for 2017-18 (source: MPEDA). Note: In India, the statistical data follows the financial year from 1 April to 31 March.

Farming of the vannamei shrimp improved the well-being of the industry and farmer: benefits include the scaling up of production with increased stocking density, faster harvesting of marketable size shrimp and and high market demand, even for small-size shrimp, at good prices. The increase in growth rate and stocking density were obviously the results of genetically improved stocks from global selective breeding programs.

The hatchery of Vaisakhi Bio-Resources Pvt. Ltd ran trials on nauplii and post larvae production on the 4th generation SPF monodon broodstock produced at RGCA's Andaman facility.

Quick facts on shrimp aquaculture in India (2016-17)

Second largest global farmed shrimp producer: 572,000 tonnes.

First in global shrimp exports: 0.434 million tonnes; USD 3.726 billion; 75% from culture.

Area: 153,000 ha in semi-intensive culture and 50,000 ha in traditional culture.

Productivity (tonnes/ha/year in 2016): 6.8 (*P. vannamei*); 1.2 (*P. monodon*); 3.8 (total average).

Number of shrimp hatcheries: >560 for 54 billion post larvae production.

Number of large shrimp feedmills: >20 with a capacity of 2 million tonnes/year.

While vannamei shrimp production grew at 14% (Figure 1), the production of the black tiger shrimp *Penaeus monodon* witnessed a negative growth of around -6% (average for 2012-2017). Farmed shrimp production in India is expected to cross the one million-tonne mark in 5 years (MPEDA).

While current statistics may look good, there are some worrying signs and stakeholders in the shrimp industry in India are aware that all is not well. Production has not been easy and there are serious problems, most of which pertain to diseases.

Threats to industry

Diseases

White spot syndrome virus (WSSV) is still rampant and can be considered as the most critical problem. A recent estimate on the loss due to WSSV is not available but earlier estimates (in the 1990s and early 2000s) indicate that for India alone, losses were around USD 100 million annually. Our calculations showed that losses today could be as significant or even more; for example, a 25% loss due to WSSV of 35 billion post larvae, i.e. 8.75 billion post larvae, would cost over USD 50 million/year @INR 0.35/PL (at INR 61.25 to the US dollar).

Today, white faeces syndrome (WFS) and the microsporidan *Enterocytozoon hepatopenaei* (EHP) are also causing significant damage to shrimp crops. Despite these challenges, the scaling up of production volumes, helped by good market demand and stable prices have enabled the farmers to overcome financial losses at each crisis.

Biosecurity

Biosecurity, or a lack of it, is a major constraint in Indian shrimp farming. With over 200,000 ha of farms and an average farm land holding of 2 ha, the industry is highly fragmented. Many farms are old, located inland and often have inlets and outlets located in the same creek. The lack of proper farm infra-structure such as reservoirs, effluent treatment systems (ETS) and drainage systems, etc., further aggravates the situation. As biosecurity cannot be totally ensured, horizontal transmission of diseases cannot be controlled effectively either, in spite of standard practices (certified specific pathogen free-SPF broodstocks, quarantine, physical barriers, and water treatments. The benefits of using SPF broodstocks thus remain limited.

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High summer temperatures

High temperatures during summer is a limiting factor for successful vannamei shrimp production. During the summer months in India, water temperatures reach >32-33°C and at times can even reach up to 37°C. Growth and feed conversion ratio (FCR) are affected by high temperatures. Running mortality syndrome (RMS) is common during summer in areas where vannamei shrimp is being farmed.

Production efficiency

Although the annual production has increased, we note that the productivity per million post larvae has decreased; it dropped from 21.4 to 10.4 between 2010 and 2017 (Table 1). This means that the industry is using more post larvae throughout the year to reach these production volumes. Thus, the question is how exactly is this linked to the issue of selective breeding of indigenous shrimp species? We explain with a detailed analysis of typical features of shrimp farming in India.

Farming in the traditional belts

Almost 90% of vannamei shrimp production comes from the non-traditional culture belts. The approximate area of the 'traditional belts 'is more than 50,000 ha, equivalent to more than 25% of total farm area. Traditional belts are those where traditional farming is practiced (e.g filtration ponds). Similarly, traditional shrimp culture belts account for about 93% of monodon shrimp production.

Monodon shrimp is farmed using post larvae from wild broodstock, where the chances for vertical transmission of virus such as WSSV cannot be ruled out completely. Shrimp survival is usually less than 25% in these traditional farms. There is a possibility to increase farmer profits by 3-4 times if we could introduce farming of selectively bred indigenous species, monodon shrimp and Indian white shrimp *Penaeus indicus* in these areas, bred to be free of, tolerant or resistant to certain specific pathogens.

India has a potential area of 1.2 million ha of brackishwater areas for aquaculture development. At present, roughly 16% is utilised for aquaculture. Some 48% of the developed area and 43% of the potential area belongs to the maritime states (West Bengal, Odisha, Kerala and Karnataka) where a substantial area is suitable for traditional shrimp farming only. In these states, current productivity from monodon shrimp is 1.2 tonnes/ha/year compared with 4.4 tonnes/ha/year from vannamei shrimp farming. As biosecurity could not be ensured, government regulations do not permit farming of the vannamei shrimp in the traditional belts. There are also modified-extensive and semi-intensive culture belts in these maritime states.

Dependence on imported broodstock

Almost the entire production of vannamei shrimp is dependent on broodstock imports which may reach more than 230,000 pieces during 2017-18 and valued at USD 17.5 million. The contribution of locally reared broodstock is small as the production capacity of the Broodstock Multiplication Centre (BMC) in India is only 40,000 shrimp.

Monodon post larvae

Table 1. Changes in production efficiency (tonnes per million PL) for *Penaeus vannamei* in India (2010-2017).

Year	Post larvae (billion)	Annual production (tonnes)	Production efficiency*
2010	2.2	47,000	21.4
2011	4.5	83,000	18.4
2012	9	145,000	16.1
2013	18	247,000	13.7
2014	28.5	320,000	11.2
2015	31.7	336,000	10.6
2016	36.5	385,000	10.5
2017	54	563,000	10.4
*calculated at annual production/million post larvae			

It is a 'TINA' (There Is No Alternative) situation for the industry and country; being totally dependent on imported SPF vannamei broodstock supply for post larvae production. Meanwhile, hatchery operators face high risks associated with the broodstock imports. These are both business and biological risks; these include difficulties in supply, price, logistics, customs duties and mortalities during transport.

Plan B

Before the introduction of the vannamei shrimp, the shrimp aquaculture industry in India was plagued by many disease problems such as WSSV, slow growth syndrome and loose shell syndrome. Production averaged 100,000 tonnes/year. The species cultured was mainly the monodon shrimp. The indicus shrimp was farmed in certain areas in small quantities. Back then, we depended on wild-caught broodstock for post larvae production. Without the option of domesticated and genetically improved broodstock, with WSSV outbreaks, the lull in production continued. However, the scenario now is too high a dependence on the vannamei shrimp and we need to learn from history. We need a plan B.

The additional reasons for pursuing selective breeding of ingenious species include the threat of emerging diseases and high risks with broodstock imports. Benefits expected out of a standard selective breeding program include fast growing, disease free and disease resistance or tolerance status (SPF/ SPR/SPT).

Advantages of indigenous species

Both the monodon and indicus shrimp rank among the top shrimp species suitable for aquaculture. They are some of the fastest growing shrimp species with good market acceptance and value (Figure 2). Reproduction in captivity and seed production are also not difficult with the indicus shrimp. In the case of the monodon shrimp, natural mating in pond-reared and domesticated populations is not easy; artificial insemination invariably may have to be practiced.

In other words, the current advantages/superiority of the vannamei shrimp over these two indigenous species of India, could be attributed solely to its genetic improvement programs since the late 1990s (Table 2). The monodon and indicus shrimp are found to be more robust (against environmental and disease challenges).

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WFS was not so rampant before 2009 when the main species was the monodon shrimp; EHP was also not reported then. The indicus shrimp is apparently refractory to WFS. RMS was not observed during the culture of monodon and indicus shrimp. As temperature tolerance is a trait that is probably not heritable, there is all the more reason to consider both monodon and indicus shrimp as new options for culture.

Production of alternative species

In the early 1990s, both monodon and indicus shrimp were farmed; with yields ranging from 3-10 tonnes/ha/crop of monodon shrimp and 12 tonnes/ha/crop of indicus shrimp. Monodon shrimp post larvae production reached around 10 billion/year, produced by an estimated 200 hatcheries. This earlier success showed the technical and economic feasibility of farming these indigenous species.

Table 2. Comparison of farm performance of *Penaeus vannamei* shrimp, wild* vs domesticated stocks

Post larvae source	Stocking density (PL/m^{2})	DOC	ABW (g)	AGD (g/day)	% survival	Yield (tonnes /ha)	FCR
Wild [1]	12	147	19.7	0.13	104	2.4	2.1:1
Domesticated [2]	15-60	150	50.0	0.25	100	5.4	1.6:1

[1]Wild*(Sandiferet al., 1993) USA. Note: It is not clear whether the broodstock source for these post larvaes were wild; if not wild, they could surely be from the early days of domestication; [2] imported SPF broodstock, India; DOC - days of culture.

Table 3. Farm performance for *Penaeus monodon* in India

Post larvae source	Stocking density (PL/m^{2})	DOC	ABW (g)	AGD (g/day)	% survival	Yield (tonnes /ha)	FCR
Wild (India)	15-30	120-150	20.0-36.0	0.14-0.24 (0.17)	50-80	2.5-8.0 (4.5)	1.8:1
Domesticated [1]	18	135	36.5	0.27	61-70	4.0–4.6 (4.3)	1.6:1

[1](MPEDA-SPF F4); DOC - days of culture

Domestication

In the 2000s, Rajiv Gandhi Centre for Aquaculture (RGCA), the aquaculture arm of the Marine Products Exports Development Authority of India, established a pilot project on broodstock domestication and selective breeding for the monodon shrimp at its facility in the Andamans. In 2015, it developed SPF broodstock up to the F4 generation, and supplied Vaisakhi Bio-Resources Pvt. Ltd to run trials on nauplii and post larvae production. These were successful and in turn, post larvae supplied to farmers for commercial farming showed encouraging results (Table 3). Moana Technologies also initiated a project on domestication and selective breeding in Srikakulam, Andhra Pradesh but stopped after a few years.

In addition to these, there have been several efforts to domesticate the monodon shrimp, including by the following teams (Hoa, N. D., 2009; Suresh, V., 2017; Ravikumar, Y., 2017): AQUACOP, Tahiti (French Polynesia), SEAFDEC (Philippines), TASPARC, MPEDA (India), National Center for Genetic Engineering and Biotechnology (Thailand), Aqualma (Madagascar), Department of Fisheries (Malaysia), CSIRO, Australia, MOANA Technologies Inc., Hawaii (USA), CPF (Thailand), RGCA, MPEDA

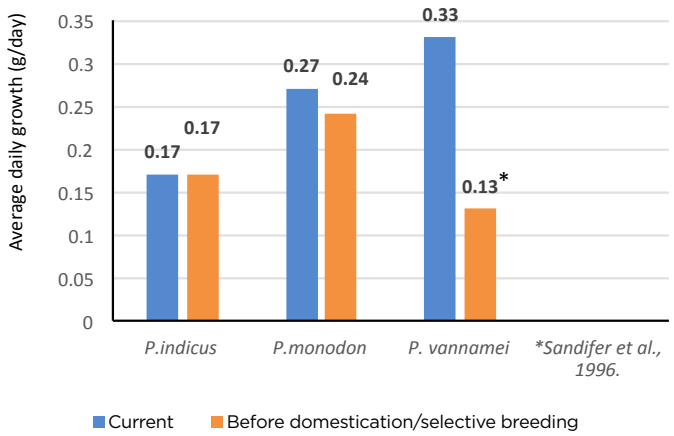

Figure 2. Comparison of average daily growth (g/day) for the three marine shrimp species.

(India), IAI (Brunei) and AkvaForsk Genetics (Columbia). In the case of the indicus shrimp, similar work were carried out only in the Middle East and at the Central Institute of Brackishwater Aquaculture (CIBA, ICAR), India.

Farm production trials using domesticated indicus shrimp in the Middle East from 2003 to 2006 (selected through mass selection with minimum broodstock pond-rearing facilities), yielded encouraging results with an average body weight (ABW) of 19.2 g in 140 days of culture (DOC). Pond rearing and domestication of broodstock was necessary due to the fact that there was no established spawner fishery (Table 4).

The average body weight (ABW) and the ADG of indicus shrimp showed an increase of 3.6% and 3.5% per year. This is below 5.4%/year (12.5% per generation) as referred by Gjedrem et al. (2013). The relatively low rate of increase in growth may be becuase this was not a family based selective breeding program but a mass selection program.

In the case of reproductive performance, the observation was that overall maturation was satisfactory in females with ABW of 30 g (minimum 27 g). Pond-reared broodstock was good for maturation at days of culture (DOC) of 250 days or more was The stock was productive for about 7-15 days after induced maturation, after which the quality of eggs deteriorated. Mating was natural, and took place in the broodstock rearing ponds as well as in the maturation tanks; hence artificial insemination was not practiced. A 1:1 male: female ratio was found to be sufficient.

A comparison on the reproductive performance of wild gravid (from India) and pond-reared, domesticated broodstock of different generations (F0 to F6 from the Middle East) is provided in Table 5. In terms of eggs/spawning, nauplii/spawning and % hatched,, the performance of the domesticated broodstock was considerably low in comparison to that of wild stock (from India). However, there remains considerable scope for improvement. Nauplii/g female improved from 210 to 1,047 in 6 generations (Table 4). This is indicative of the potential for nauplii/g female reaching 2,000 or more (comparable to wild broodstock performance).

Indicus post larvae

Table 4. Farm performance for wild *Penaeus indicus* in India versus domesticated stocks in the Middle East

Post larvae source	SD (PL/m²)	DOC	ABW(g)	ADG (g/day)	% survival	Yield (tonnes/ha)	FCR
Wild (India)	40-60	110-130	17.5-18.7	0.14-0.17	60-100	4-12 (6)	1.6:1
Domesticated (Middle East)	40-60	140-150	17.5-19.2	0.125 -0.137	70-100	4-12 (6)	1.6:1
Note: With regards to farm performance, there is still scope for improvement with the current improved ADG of 0.125-0.137 g (in 5 crops) with an average gain of 3.6%/year in ABW (17.5 to 19.2 g) with post larvae from 3 generations. DOC-days of culture							

Table 5. Data on reproductive performance for wild (India) and domesticated (Middle East) *Penaeus indicus* (pers comm, Surendran V).

Generation	DOC	ABW (g)	% hatch	Spawn/ female	Nauplii/ spawn	Nauplii/ female	Eggs/ spawn	Eggs/ Female	Nauplii/g (female)	Eggs/g
WILD Gravid (India)	n.a.	45	90	1.0	90,000	90,000	100,000	100,000	2,000	2,222
F0	202	32	37.6	1.0	34,870	34,497	92,814	91,690	1,078	2,865
F1	185	26	13.3	0.53	10,295	5,473	77,160	41,020	210	1,577
F2	331	34	20.3	0.82	14,005	11,547	68,938	56,895	340	1,673
F3	325	39	20.9	1.18	15,379	18,072	73,448	86,285	463	2,212
F4	267	38	46.8	1.00	35,816	35,816	76,531	76,642	938	2,006
F5	237	32	32.0	1.24	25,742	31,828	80,349	99,268	995	3,102
F6	252	33	40.5	1.15	30,100	34,543	74,295	85,252	1,047	2,583

SPF monodon broodstock

Performances of three sources of broodstock, wild (gravid), MAT-wild (induced maturation of wild adults), and DOM-SPF (domesticated SPF stock obtained from MPEDA, 4th generation) were compared (Table 6, Figure 3). Trials with both wild gravid broodstock and wild adults (induced maturation) were also conducted for 5 years (2012-2016) in the same facility, as part of routine hatchery operations. The highlights of the production performance of domesticated SPF broodstock supplied from RGCA/MPEDA could be summarised as follows:

- 200 females, productive for 100 days after induced maturation.
- 1,035 spawn.
- 170 million nauplii.
- All production through artificial insemination (AI).
- 6.4 spawn per female.

Overall reproductive performance of this 4th generation monodon broodstock was encouraging. At above 80 g ABW and at DOC 300, females reached maturation and spawned. The stock was productive for about 3 months, after which the quality of the males deteriorated. A male: female ratio of 1:1 was insufficient. For artificial insemination, males ratio of 3 to 4 to one female is advisable.

Indicus broodstock

Fecundity (eggs/spawning) and nauplii/spawning was much lower than wild brood stock; it was 2.5-4 times lower. The spawning rate per female was found to be encouraging at 6.4, which is about 5-6 times more than for wild broodstock. A potential for nauplii/female to reach 3 million or more (which is comparable to selectively bred vannamei shrimp) should be explored through an improved performance in egg/spawning and in nauplii/spawning.

Farm performance

Table 3 demonstrated that there is scope for further improvement with the current ADG of 0.27 g with post larvae from the domesticated SPF broodstock, though this ADG is more than that of post larvae from wild broodstock at 0.24 g.

Need of the hour

Results from the preliminary trials on production from domesticated indicus and monodon broodstock discussed here are positive and promising. On the question of whether to pursue development of SPF or SPT broodstocks, the Ecuadorian model is a classic case to study, especially with these two indigenous shrimp species. There is considerable scope for taking these projects forward. Considering the developmental nature of the projects, huge investments are required and the projects may have a long gestation period. Government or integrated large-scale corporate groups are the right entities to initiate such selective breeding programs. India is already late in realising the potential of these indigenous shrimp species; but we believe it is better late than never!

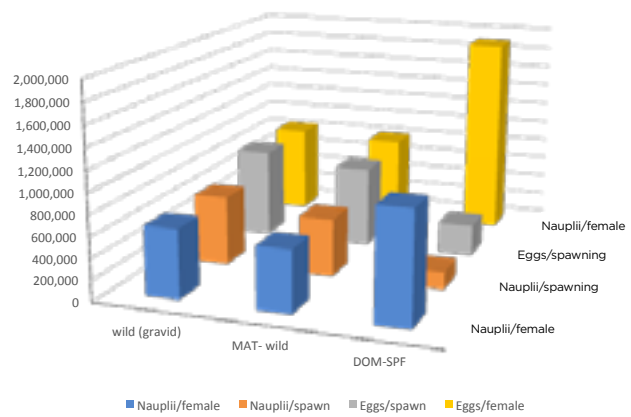

Figure 3. Comparison of reproductive performance of wild, Mat-wild and DOM-SPF *Penaeus monodon*

Table 6. Comparison of reproductive performance of wild, Mat-Wild and DOM-SPF *Penaeus monodon*

Source of broodstock	Wild (gravid)	MAT-wild	DOM-SPF
Female ABW(g)	137	126	80
Male ABW (g)	na	80	68
Duration (farm)	na	na	300
Duration (hatchery)	na	30	100
Duration after Induced maturation (IM)	na	27	80
Not spawned %	na	not monitored	8
Mortality %	na	6	30
Number of spawning/ moult cycle	na	1	2
#moult cycles (average)	na	not monitored	5
Moult span (days)	na	not monitored	16-24
% Fertilisation	80	75	56
% Hatching	77	72	55
Spawning/female	0.9	1.4	6.4
Nauplii/female	658,192	587,082	1,054,865
Nauplii/spawning	658,192	552,390	164,433
Eggs/spawning	851,087	768,831	296,844
Eggs/female	851,087	815,633	1,904,303
Nauplii/ g female	4,793	4,659	13,186
Eggs/g female	6,197	6,473	23,804
Infertile spawning%	3.5	10.7	0.0
MBV%	27.0	1.7	na
WSSV%	14.0	11.5	na
MBV+WSSV%	41.3	13.7	na
Good spawning %	55.3	75.0	100.0
Wild (gravid): Natural spawning of wild gravid females; MAT-wild: maturation (induced) of wild broodstock and DOM-SPF: (domesticated SPF broodstock)			

The shift to the vannamei shrimp has changed the shrimp market for India. The volumes of monodon shrimp, which used to be the main species exported have decreased but there is still a market for large size monodon in Japan, Europe and Australia. Branding, certification, niche marketing, etc., would be required to promote these indigenous species. An expansion of the domestic market presents a great opportunity for all three species but more so for the indicus and monodon shrimp which consumers in India are more familiar with. An over-dependence on one species alone is too much of a risk to take, both from a market and a production perspective. A plan B is the need of the hour.

Surendran V

Ravikumar Y

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A AQ012-07

Nursery operations at the farm site: A sustainable approach for Asia's vannamei shrimp industry

By Manuel Poulain

Protocols on risk management to achieve more consistent results which, in time, will improve with standardization.

Productivity parameters such as growth rate, feed conversion ratio (FCR) and tonnes/ha production are often used as references for success in shrimp farming. But, despite setbacks such as disease outbreaks, the sustainability of crop production is in fact a far more important parameter. This is why risk management, and more specifically, a thorough biosecurity control should be the main focus in shrimp farm operations.

Specialists from INVE Aquaculture have collaborated with farms throughout Asia to set up a sustainable approach that focusses on risk management to achieve more consistent results and thus a more robust business model. The approach is based on setting up nursery operations at the farm site, because this has proven to be the best way for farms to evolve towards a secure culture cycle with minimal water exchange and reduced risk of contaminations. The application of this approach leads to an overall production cost savings up to 30% compared to the usual practices.

After over 30 years of major disease outbreaks globally, it is clear that diseases are mainly responsible for the frequent disruptions of farm outputs in shrimp farming. Addressing this problem requires a solid risk management strategy that brings the three main contamination causes under control:

- **Post-larvae**. Realistically, a steady supply of quality checked disease free post-larvae is not an option, as post larvae remain the most significant cause of contamination.
- **Water**. Every time new water is introduced into the culture environment, there is a possible risk of pathogen introduction. This is why application protocols should aim to limit water exchange, thus reducing this risk.
- **Others**. Some causes of contamination (aerosol, predators, peoples, etc.) can be controlled physically with geomembrane lining of the bottom and side walls of ponds and tanks, plus their enclosure with shade cloth or greenhouse structures.

Learning curve

All of these measures require a considerable amount of capital investment (for infrastructure such as lining and covering) and time (for water exchange limitation). Adapting farming protocols to target minimal or even zero water exchange is a learning process to fully understand and control the environmental processes at stake in a shrimp pond.

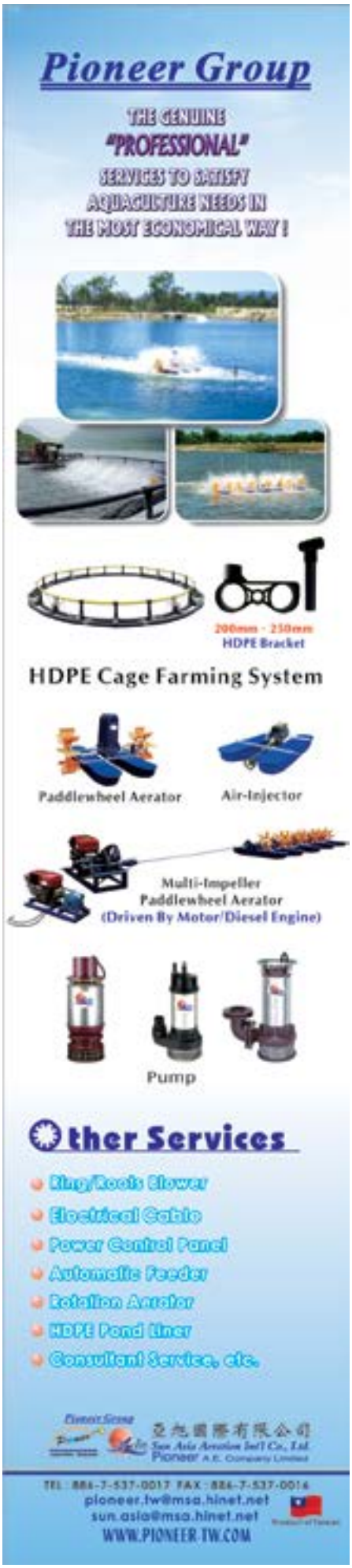
In this regard, the development of a nursery phase at the farm site is a crucial gateway to predictable and consistent grow-out operations. The introduction of the nursery phase allows farms to enter a progressive learning curve in management practices under limited water exchange conditions.

The nursery approach

Setting up a nursery stage at the farm site has multiple benefits with regards to a more sustainable development. In terms of disease outbreaks, the most relevant strategy will be a shorter grow-out cycle. By introducing 1 month of nursery operations in a separate tank at the beginning of the farm cycle, the last month of grow-out culture in the pond is no longer necessary. This is very interesting because diseases such as early mortality syndrome (EMS) and *Enterocytozoon hepatopenaei (EHP)* usually impact production after 60-70 days of culture (DOC). In other words: farms can replace a problematic period with a beneficial one.

Limiting water exchange

The main target of the protocol, however, is to limit water exchange to gain biosecurity together with increased control of the microbial communities. By limiting the need to introduce new water in the culture environment and by mastering biochemical water



quality and multi-trophic populations that evolve in a shrimp pond.

The level of water exchange applied during farming principally depends on three components:

- feed management;
- shrimp health, and
- environmental control.

The proposed nursery protocol applied by Inve Aquaculture during its operational trials is specifically targeted at these three components.

Protocol guidelines

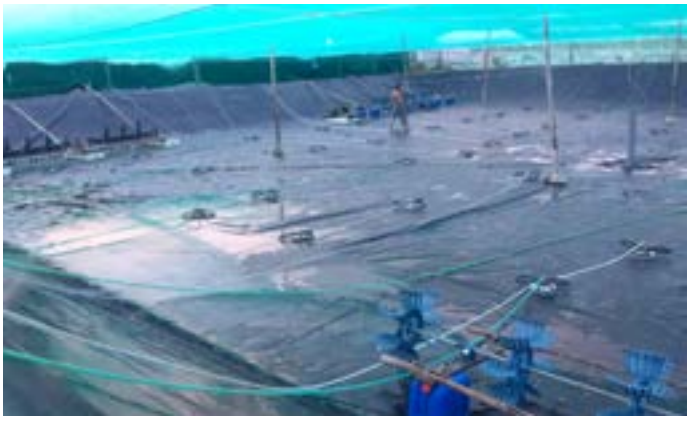
Table 1 presents the proposed nursery protocol that was used for the production of 1 million post larvae. This protocol has been adopted and optimized in commercial farms across Asia. It is based on the stocking of a 1000 m^2 fully-lined pond, with a central drain and shade-cloth enclosure.

Ten steps towards a biosecure culture cycle

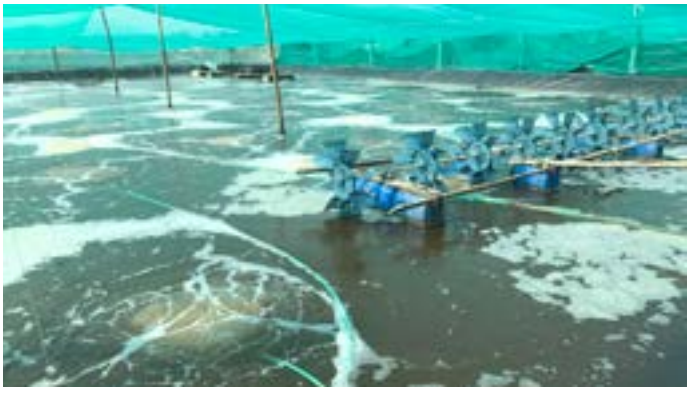
The full outline of the applied protocol can be summarized in 10 clear action points to gain maximal control of biosecurity hazards.

1. Days of culture

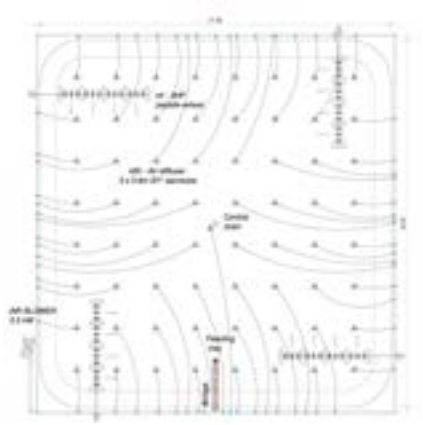
The total DOC considered in the protocol is 30 days. This nursery stage duration is determined according to the stocking density. It is based on two important criteria: shrimp biomass and daily feed load. A limit of 3 kg/m^3 in total shrimp biomass, and 150 g/m^3 of feed load per day have been identified as the maximum standard values to maintain an acceptable risk level. Higher values result in too high a risk due to dissolved oxygen limitations. In those conditions, the only alternative would be to increase water exchange, which compromises on the protocol targets (biosecurity for consistency).



In this nursery pond, geomembrane lining of the bottom and side walls plus shade cloth control contamination.



In this nursery pond, adequate aeration is critical to controlling the microbial communities.



An example of a nursery setup

2. Stocking density

The protocol considers the stocking of 1 million post larvae (PL10) at a density of 2 PL/L with 5% initial mortality due to stress during shipping/stocking. This number considers the actual post larvae number stocked, including the usual hatchery supply buffer. The overall nursery survival target is 80%; chronic mortality during molting is expected from cannibalism. However, a higher survival of 90% was observed. To avoid overfeeding, it is prudent to assume a lower survival rate in the culture batch. The total number of post larvae stocked in this protocol considers a safe maximum shrimp biomass of 2 kg/m^3 with a total maximum daily feed load of 100 g/m^3.

3. Weight

Shrimp growth mainly relies on post larvae quality, genetics, and feed efficiency. Growth expectations should be adjusted according to the post larvae conditions and the efficiency of the feed used.

During culture, sampling is done every 3 days. A minimum of 100 post larvae are weighed in bulk to determine the average weight of the animals. Visual observations are done on colour, hardness of shell, fullness of digestive track and overall size variation. This last point is especially important to determine if the animals are properly fed. The observed weights are compared to the assumed growth in the protocol, and feeding is adjusted accordingly.

4. Standard feed

The total feed per day is calculated according to an assumed required feeding rate, together with a standard feed load increase over the culture period. Feed loading to the pond remains a major factor for controlling environmental conditions. The unavoidable reality is that a big part of the feed goes into the water (directly because of leaching or non-consumption, or indirectly because of poor digestion). If the feed load increases too much from one day to the other, the pond ecology will not be able to cope. If the feed load drops too drastically, it will create a lack of nutrients for the developed organism acting on the environmental control of water quality.

The standard feed per day increase element is key to balancing the pond environment, as multi-trophic nitrification and bacterial concentrations are directly related to feed load levels.

5. Molasses

The protocol includes the use of 30 L of molasses added in three stages. Molasses are added following the addition of water to promote beneficial heterotrophic bacterial development (probiotic). This is especially important to promote brown water (bacterial based) over green water (phytoplankton based).

6. Enriched diet

The enriched diet is Sano®S-PAK (Inve Aquaculture), a highly attractive and balanced feed supplement, used as a health booster for the shrimp. The application represents 15% replacement of the total daily feeding regime. This application is set for a period of 2 weeks. The enriched diet is given as a whole during the first feeding in the morning.

Table 1. Nursery protocol guidelines.

DOC	Shrimp nos	Weight	Standard feed	Enriched diet		Top coating of feed		Disinfectant	Water conditioner	Molasses	Management
			0.5-0.8mm	*5 / 8*	*8 / 12*	*probiotic*	*immun.*		*probiotic*		
			for 1 million PL10					*for 1000 m² / 1200 m³*			
-2								1.6 kg			Disinfection surfaces
-1								1.2 kg			Water Initial fill-up & treatment
0			1 kg						480 g	10 L	
1	950,000	0.0025 g	3.9 kg	0.7 kg		39 g	39 g		240 g		Stocking
2	944,387	0.005 g	4.2 kg	0.7 kg		42 g	42 g				
3	938,807	0.008 g	4.5 kg	0.8 kg		45 g	45 g				
4	933,261	0.010 g	4.9 kg	0.9 kg		49 g	49 g		240 g		
5	927,746	0.012 g	5.3 kg	0.9 kg		53 g	53 g				
6	922,265	0.017 g	5.8 kg		1.0 kg	58 g	58 g				
7	916,816	0.023 g	6.4 kg		1.1 kg	64 g	64 g				
8	911,399	0.034 g	7.1 kg		1.3 kg	71 g	71 g		240 g		
9	906,014	0.047 g	7.9 kg		1.4 kg	79 g	79 g				
10	900,661	0.062 g	8.7 kg		1.5 kg	87 g	87 g				20% water exchange
11	895,340	0.079 g	9.5 kg		1.7 kg	95 g	95 g		240 g	10 L	
12	890,050	0.10 g	10.4 kg		1.8 kg	104 g	104 g				
13	884,791	0.12 g	11.4 kg		2.0 kg	114 g	114 g				
14	879,563	0.14 g	12.4 kg		2.2 kg	124 g	124 g				
15	874,367	0.16 g	15.9 kg			159 g	159 g		240 g		
16	869,201	0.19 g	17.2 kg			172 g	172 g				
17	864,065	0.21 g	18.5 kg			185 g	185 g				20% water exchange
18	858,960	0.24 g	19.9 kg			199 g	199 g		240 g	10 L	
19	853,885	0.27 g	21.3 kg			213 g	213 g				
20	848,840	0.30 g	22.7 kg			227 g	227 g				
21	843,825	0.33 g	24.2 kg			242 g	242 g				20% water exchange
22	838,839	0.36 g	25.6 kg			256 g	256 g		240 g		
23	833,883	0.39 g	27.1 kg			271 g	271 g				
24	828,956	0.42 g	28.5 kg			285 g	285 g				20% water exchange
25	824,058	0.45 g	29.8 kg			298 g	298 g		240 g		
26	819,189	0.48 g	30.9 kg			309 g	309 g				
27	814,349	0.51 g	27.2 kg		4.8 kg	272 g	272 g				
28	809,538	0.54 g	28.1 kg		5.0 kg	281 g	281 g				20% water exchange
29	804,755	0.57 g	28.8 kg		5.1 kg	288 g	288 g		240 g		
30	800,000	0.60 g	40.0 kg		5.2 kg	294 g	294 g				Transfer
TOTAL	800,000	0.6 g	509 kg	4 kg	34 kg	5 kg	5 kg	3 kg	3 kg	30 L	100% total water exchange

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The application of a superior quality diet enhances shrimp overall immune system and strength. For this reason, its usage is also recommended for the last 4 days of the nursery stage. This is to boost the shrimp defense system and to prepare them for the stress during transfer to the grow-out ponds.

7. Feed top coatings

Probiotics

Probiotic treatment represents the core of the microbial management approach. It follows a competitive exclusion strategy to inhibit opportunistic and pathogenic bacterial development. Competitive exclusion is based on two principles: occupying space and reducing food.

- Occupying space means the colonization of the environment by beneficial bacterial as soon as water is filled in the ponds. This limits the further growth of opportunistic and pathogenic bacteria.
- Reducing food means the reduction of the food (or niche) used by the pathogenic and/or opportunistic bacteria. Such food mainly consists of the shrimp molts and the overall solids/ organics present in the pond environment.

The principle is not to suppress 100% of the Vibrio sp. The target is to balance their concentration with beneficial bacteria, so as to induce a limitation to the growth potential of the Vibrio. This strategy considerably reduces the risk of bacterial disease outbreaks.

The treatment is based on the application of 200 million CFU/g of feed. Sanolife®PRO-2, at a concentration of 20 billion CFU of viable germinated spores/ g of product. This gives a coating dosage of 10 g of probiotic for 1 kg of crumble feed.

Immunostimulants

The high population density used for nursery phases causes stress to the animals. In such conditions, it is essential to provide immunity enhancers such as stable vitamins (C, E, B), minerals and carotenoids to the animals. The treatment is realised via top coating of the crumble feed with Sano®TOP-S, at a dosage of 10 g/kg of feed. This feed enhancement is done together with the probiotic top coating, mixing both together.

8. Disinfectant

Prior to stocking, it is important to properly clean, dry and disinfect all surfaces and equipment. To secure the proper removal of the entire biofilms and bacterial spores, 1% solution of Sanocare®PUR is sprayed over all surfaces of the culture facility.

The disinfectant is also used to treat the initial culture water directly after pond filling. For this application, 1 mg/L of the disinfectant is used. The treatment will result in a low initial bacterial load in the water. It represents a final disinfection stage just before the first application of microbial enhancers (water probiotic, molasses and first feed application), that will induce beneficial balanced biofilm formation.

9. Water conditioning

With the same approach as the probiotic top coating, a water conditioner is used to target microbial management. The water conditioner consists of a probiotic bacterial mix, designed to colonise biofilms and overall water environment, as well as supporting the degradation of dead organics (molts, solids, etc.). The application dosage of water conditioner is established to balance the microbial ecology considering a safe concentration of Vibrio of 500 CFU/mL . It also considers the worst-case scenario in multiplication time difference between Vibrio sp. compared to the specific Bacillus strains. A factor of 20 is established, considering a Vibrio sp. multiplication time of 20 minutes compared to 6 hours for *Bacillus*. This application strategy results in a dosage of 10,000 CFU/mL per treatment.

The water conditioner used is a probiotic mixture, Sanolife®PRO-W which comes at a concentration of 50 billion viable germinated spore per gram of product. It gives a product application dosage of 0.2 g/m^3.

The first treatment is realised 6 hours after the application of the initial water disinfectant, at a concentration of 20,000 CFU/mL (0.4 g/m^3). For the remainder of the time, the application is done two times per week. Each application is coordinated with the molasses additions and/or expected water exchange events.

10. Water exchange

The protocol aims for a holistic approach to multitrophic nitrogen control, via phytoplankton population control (shade-cloth), but also via heterotrophic digestion (probiotics) together with the enhancement of naturally occurring autotrophic nitrification processes. The water exchanges established in the protocol are related to the accumulation of nitrogen in the water.

The protocol gives priority to biosecurity over nitrogen concentrations. For this reason, acceptable limits for NH_3-N and NO_2-N are set up to a ceiling of 5 mgN/L. In normal conditions, these levels have repeatedly demonstrated to have no impact on the overall shrimp health. Management of lower nitrogen levels would require higher water exchanges. Now in terms of risk management, it is assessed that the contamination risk of the farm by pathogens via increased water intakes is too high compared to the risk involved in the mentioned nitrogen levels.

Summary

The enclosure of culture surfaces together with the reduction of water exchanges result in a drastic reduction of the contamination risk. This considerably increases the predictability of the farm's output thanks to a higher consistency of the farming process. Simply put, we can summarize this as: *Biosecurity + Consistency = Sustainability*.

The set-up of a nursery phase at the farm site lowers the investment required to enclose the ponds. It also creates a learning curve for farmers to manage their operation in limited water exchange conditions.

At the same time, a limited water exchange regime during the nursery phase can reduce the overall production cost compared to high water exchange protocols. The lower expenses in power consumption (pumping) and operations (treatment & maintenance) make room in the operational budget for the usage of superior quality diets and higher level of probiotic inputs. The commercial-scale trials done by Inve Aquaculture in farms across Asia have led to an overall production cost saving of 15 to 30% compared to usual practices. Water exchanges dropped with a minimum factor of 3. Subsequently, the risk of pathogen introduction into the culture via new water input is reduced by the same ratio.

This approach focusses on risk management to achieve more consistent results. Consistency and predictability of the output, together with risk reduction, will become even greater with standardization of the protocol in time.

Manuel Poulain is currently Project Manager (shrimp grow-out) at INVE Aquaculture in Thailand. His role is to help farmers in Asia improve their output and consistency. With over 20 years of extensive experience in shrimp hatchery, farm operations and genetic selection programs, he has headed various projects in Australia, Mexico, Seychelles and French Polynesia. Manuel was also responsible for the establishment and management of the first commercially successful indoor zero water exchange biofloc shrimp farm in Spain. Email: m.poulain@inveaquaculture.com

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Commercial shrimp farming ventures in Andhra Pradesh, India

By Charles M. James

Views on how shrimp farming is perceived through the eyes of two farmers; as a high risk profitable business or a sustainable long-term venture.

The farming of the white shrimp *Litopenaeus vannamei* in India, especially in Andhra Pradesh, is a success story. In 2017, Andhra Pradesh led with a total marine shrimp production of 353,000 tonnes, which was 61% of the total production of 572,000 tonnes. With efficient farm husbandry protocols, some farmers adopted intensive farming practices achieving more than 15 tonnes/ha/crop. However, there are several farms with outputs at the range of 6-10 tonnes/ha/crop. In general, farmers are cost conscious and avoid treating effluent water. Instead, they try to adopt different techniques of reducing pond waste to maintain good water quality.

Biofloc technology (BFT) is a challenge but farmers who have good knowledge and experience on intensive shrimp farming use BFT and enjoy high crop outputs. Government regulations do not encourage intensive shrimp farming and have stipulated restricted stocking densities for both extensive and semi-intensive farming for a sustainable industry. However, this has not prevented farmers from achieving high profitability through intensive farming practices.

Electrical energy

Since intensive shrimp farming is energy consuming, farmers have innovated with various mechanical parts which they could access to achieve their target. This includes using gear boxes from old scrapped automobiles to run paddle-wheel aerators. Air-injectors/jets are not used; instead they use micro-pore tube aeration hooked up to air-blowers. Technical advisers to the farms are trying to introduce solar aerators developed in Taiwan but farmers are hesitant as the capital cost is much higher in comparison to conventional aerators.

Paddle wheel aerators hooked up to old automobile gears.

Disease

Major disease outbreaks and crop losses are common. Outbreaks of early mortality syndrome (EMS) have occurred in some shrimp farms when farm technicians are unable to manage the water quality, irrespective of whether it is intensive or semi-intensive systems. White faeces syndrome (WFS) is very prevalent in some of the farms. A major problem seems to be the toilet effect; most farms do not treat their effluent water and neighbouring farms draw in the contaminated water for their operations. Pre-treatment of water exists and is equivalent to reuse of water in a closed culture system.

EMS is not encountered in farms having proper technical farm husbandry procedures to take care of the water quality. Farms encountering EMS range from 20% to more than 50%. If this goes on, in a couple of years this industry may crash. The survivors would be those who are using pre-water treatment and farm effluent water treatment procedures. But this should be a team effort, not restricted to individual farms and other farmers should not ignore these procedures in their area.

> **“Although, the value of the Indian rupee dropped against the US dollar, farmers are happy as most farm products, including feeds, are locally produced.”**

Market

Due to the large supply and lower demand of shrimp in the global market, drops in prices for Indian shrimp since late 2017 and continuing into 2018 is now a major concern for the farmers in Andhra Pradesh. Although the value of the Indian rupee dropped against the US dollar, farmers are happy as most farm products, including feeds, are locally produced. Some probiotics are imported but re-mixed in India to cut down production costs. Dubious feed additives are in the market, but the experienced farmer knows which to use.

Below are two case scenarios on farmers in Andhra Pradesh.

Case 1: A risk taking farmer with short term profits in mind

Traditional Jameenthar (landed family) having 200 acres (80 ha) of unutilised land came to know about the ‘profitable business’ of shrimp farming through government demonstration programs. He then decided to venture into shrimp farming in the mid 1990s. However, the problem is that his land had no access to a seawater source but he has access to a freshwater creek. Ground water test bore wells showed the presence of 48 ppt saline water at 60 m depth. By mixing these water sources he managed to get water of 15 ppt salinity and initiated tiger shrimp farming. After some successful crops, the black tiger shrimp production crashed within a few years due to the white spot syndrome (WSSV). He still managed to continue with a few ponds managing only a scant profit.

At farm 1, garlic paste and other additives are mixed with the shrimp feed.

With the introduction of *L. vannamei*, this farmer used his experiences with black tiger shrimp to farm the white shrimp. He also sought the technical guidance of shrimp experts on farm husbandry procedures that included using feed additives, water and soil probiotics which paved the way to achieving high productivity. During the first crop of the year this farmer enjoyed the farm output as shown in Table 1.

100 days old vannamei shrimp in the farm 1.

Table 1. Farm output for farmer 1.

Initial stocking density	80-100 PL/m^2	
Grow-out period	120-130 days	Partial harvesting during the grow-out
Final harvest size	30-35 g/ind	(about 30 counts)
FCR	1.3-1.4	
Farm gate price	INR 450/kg	equals USD 6.8/kg
Farm yield	15 to 20 tonnes/ ha/crop	

This farmer did not observe the stipulated government guidelines regarding stocking densities. He also refused to accept the guidelines on effluent water treatment procedures since he wished to use all his land for culture ponds. Early mortality syndrome (EMS) has since affected some of the ponds with up to 50% mortality. The occurrence of EMS is kept confidential without disclosing it to the media. I believe that this farm is sitting on a ticking time bomb and the farm will probably crash within a few years.

Case 2: A cautious farmer with sustainability in mind

An educated engineer initiated shrimp farming in the 1990s. After experiencing successful production of the black tiger shrimp, he established his own hatchery to support his shrimp farms of more than 300 ponds plus supply post larvae to other farmers. He has direct access to estuarine water. The water salinity ranged from 12 ppt during the peak of the monsoon season to 33 ppt during summer. He was a successful black tiger shrimp farmer until it crashed during the late 1990s due to WSSV. This reduced his farming efforts to a few ponds.

To resolve the problem, he treated the incoming water using a 2 ha reservoir which was limed, together with the use of sedimentation ponds. He refined the farm husbandry procedures with technical assistance from consultants. With vannamei shrimp farming, he further improved feeding and water quality management procedures. BFT for waste management in shrimp ponds was introduced using the basic principle of activated suspension technique. This provided an opportunity for the retention of waste and its conversion to biofloc as a natural food within the culture system. Sugar and molasses are easily available, and were used as a carbon source. Along with BFT and various probiotics, vannamei shrimp production hit new heights. He has also set up experimental shrimp ponds to test different stocking densities, growth and aeration systems.

Intake water treatment pond in farm 2. For a sustainable business, this farmer treated the incoming water using a 2 ha reservoir.

Experimental pond for BFT.

Our cautious farmer established his own hatchery to supply his shrimp farms of more than 300 ponds plus supply post larvae to other farmers.

90-day old vannamei shrimp, produced by the farmer in the case 2 scenario.

In addition, this farmer reduced energy costs for aeration by using micro-pore tubes. He established a shrimp hatchery with an annual production of 500 million post larvae. The grow-out farm output is given in Table 2.

Table 2. Farm output at a farm with refined feeding and water quality management procedures.

Initial stocking density	80-100 PL/m^2	
Grow-out period	120 days	With partial harvesting throughout the grow-out period
Final harvest size	30-35 g/shrimp	Size 30/kg
FCR	1.2 - 1.3	
Farm gate price	INR 450/kg	equals USD 6.8/kg
Farm yield	15 to 20 tonnes/ha/crop	

Concluding remarks

Presently, shrimp farming in Andhra Pradesh is based on hands-on experience over the years by the farmers and the risks involved are challenged and resolved by their practical knowledge. However, environmental issues and crop failures still exist. Implementation of regulatory procedures and species diversification are required. Yet, the shrimp farming industry in India is poised for a phenomenal growth because of the availability of vast coastal areas for development as well as due to the existing infrastructure such as feed mills, processing plants, hatcheries and business and promotional efforts of government and private agencies.

Dr Charles M. James is the MD/CEO of Farm Ocean Technologies India Pvt. Ltd. His professional contribution includes working as the Senior Technical Advisor for FAO/United Nations, in the Kingdom of Saudi Arabia as well as consultancy services in several countries. He has considerable experience in the tropical marine fish and shrimp hatchery and commercial grow-out production systems, especially in the Arabian Gulf and Asian countries. Email: oceanfarming@hotmail.com

How better disease management will make aquaculture sustainable and more profitable

OddGeir Oddsen *is CEO of UK based Sea Farms Nutrition. He set up the ProChaete brand in 2013 to create innovative feed formulations without depending on fish ingredients for marine farming.*

In a world with an ever-growing population, the need for healthy and safe food is one of the most important challenges faced. It is also becoming increasingly clear that the food must be produced in a sustainable way, without spreading diseases or environmentally harmful substances.

Aquaculture is in a unique position. Food produced from the sea is capable of delivering proteins at a much lower environmental cost than domestic animal husbandry. In many countries, the shrimp industry is an important food supplier. Regrettably, this industry is often poorly equipped to meet growing demands for food safety and environment protection. Disease in the shrimp industry is simply a major problem. In many places up to 50% of shrimp population die before they are harvested or reach markets. This not only weakens the environmental and animal welfare standards, but also makes the industry far less profitable than it should be.

Lost profits

"We are in a situation where a large and important industry has a significant potential which is not utilised. The industry can make its business a lot more environmentally friendly and earn more money. An alarming use of antibiotics, and subsequent resistance, is a serious concern with authorities around the world. In fact, some markets are now considering banning imports of shrimp from individual countries. *"What is the cause? And why has no one solved this problem?"* asked OddGeir Oddsen of Sea Farms Nutrition, a leading producer of effective aquafeed. Their mission statement is to create a sustainable industry through biotechnology and feed innovation, thus contributing to a clean and healthy aquaculture industry.

More knowledge

Oddsen is very confident that the answer lies in insufficient knowledge of the importance of high quality feed for more profitable shrimp farming. "Our researchers want to play an important role. Through many years of work at senior levels in aquaculture and feed production, I am aware of the problem. The aquaculture industry relies too heavily on fish meal and soy bean meal as the main protein sources in aquafeed. With an increasing demand for seafood around the globe, there has to be a sustainable alternative. Farmed fish and crustaceans will never thrive on plant-based diets only, so we turned to farmed polychaetes from bio-secure ponds in Europe, to be exact."

Specific pathogen free

The company uses specific pathogen free (SPF) polychaetes in all of its production. Shrimp has a primitive immune system that cannot be stimulated with vaccines, so immunity cannot be created. Therefore, shrimp can be infected at any time if the feed and the environment are not checked.

"Our feed is biologically safe for the species the food is intended for. The key is that raw materials are carefully controlled."

Feed for the environment

The idea behind ProChaete was, and still is, simple, said Oddsen. "Feeds made from worms are an environment-friendly and effective alternative in feed. Sustainable aquaculture needs to rely on environment-friendly feeds.

"This is where we want to make a difference. Sustainability means a more reliable supply chain, easier storage as well as entry into potential new desirable markets. So, while sustainability is at the very core of our brand, the customer should indeed see promises of profit, low maintenance, reduced cost and new exclusive buyers."

> **"..we must do something on the disease picture in the shrimp industry. We must create a sustainable industry and ensure that the market has confidence in the end product.."**
> **- Oddgier Oddsen**

Heat treatment

The feed produced in ProChaete is made up of different substances. First it is heat treated and sterilised. However, not so much that much of the nutritional content is reduced. The company also uses radiation to kill additional pathogens. "We must always weigh digestibility towards biosecurity. It is crucial that the feed also tastes the best possible. Therefore, we use lower temperatures," added Oddsen.

"Another very important point is that it is essential that the persons handling the feed on the farms are free of pathogens, and that the entire supply chain, such as transport and water quality, is checked and reinforced through follow-up measures.

"We must do something about the disease picture in the shrimp industry. We must create a sustainable industry and ensure that the market has confidence in the end product. We in Prochaete want to help set the agenda. Many players talk about sustainability and the environment. We are doing something about it," concluded Oddsen (oddgeir@prochaete.com).

Using science to get feed closer to nature

To understand what really happens in nature is the foundation of sound and sustainable feed science. Grow Pro is an innovative high-quality grower feed for shrimp with excellent protein retention. It is biosecure and sustainably created. We only use GMO-free raw materials, like our own brand of protein CEP PRO, based on farmed and processed polychaete. The FIFO value (fish in, fish out) is zero.

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Probiotics improves growth performances and supports the health status of Korean rockfish

By Eric Leclercq, Sylvie Roquefeuil and Stéphane Ralite

Amidst better growth performance was the reduction in the multiplication of pathogens in probiotic-fed fish compared to non-supplemented fish.

In recent years, several pathogens have been identified as resistant to important antibacterial and antiparasitic substances. In addition, there are increasing concerns on the safety of such substances for the animals, the consumers and the environment. Accordingly, we see a global shift towards production practices that lessen chemical interventions by supporting natural fish health, immunity and, in turn, performance. In this context, the development of natural functional feed ingredients and additives is gaining momentum.

Functional feed ingredients provide *"health and economic benefits beyond basic nutrition."* These benefits can range from improved digestibility and growth performance to better support of fish health and welfare under adverse conditions via maintenance of immunity, physiology and gut health. In fish, the gut microbiota is increasingly recognised for its benefits on the health, nutrition, development and well-being of its host.

Additives that are well recognised for their positive interactions with the microbiota include probiotics, prebiotics and their combination, together defined as symbiotics. Probiotics are defined as *"live microorganisms, which, when administered in adequate amounts, confer a health benefit on the host."* Among them, the lactic acid bacteria strain *Pediococcus acidilactici* MA 18/5 M is one of the most documented for its mode of action in aquatic species. This probiotic is the first to be authorised in the European Union (EU) as a feed additive for fish and shrimp. Until today, it remains the only probiotic authorised for aquaculture in the EU. A recently published trial (Rahimnejad et al., 2018) documents the benefits of this probiotic on the growth performance and immunity of the Korean rockfish (*Sebastes schlegelii*), which translated into better resistance against a common fish pathogen (*Edwardsiella tarda*) in an experimental challenge.

Rockfish trial

The Korean rockfish is among the most commercially important marine fish cultured in Asia. It has positive attributes for intensive farming and a high market value. However, to date, scientific work on potential benefits of pro- and prebiotics in this species is limited. A trial was conducted at the Marine Biology Center for Research and Education at Gangneung-Wonju National University, Korea, to evaluate the effects of the probiotic *Pediococcus acidilactici* MA18/5M (BACTOCELL, Lallemand Animal Nutrition) on growth parameters, immune response and resistance of the Korean rockfish against *E. tarda*.

The trial involved 270 juvenile rockfish (initial body weight: 18.2 ± 0.3 g), distributed between two treatment groups in triplicate (6 homogenous groups of 45 fish/tank; 135 fish/treatment). It was conducted in six 400 L flow-through circular tanks using filtered pumped-ashore natural sea-water at 17.2 ± 2.0°C. Following a two-week acclimation period, fish were fed a standard commercial diet (control) or the same diet supplemented with the probiotic (*P. acidilactici* MA18/5M); at 5x10^7 CFU/g of feed over the duration of the trial.

The trial consisted of two periods (Figure 1). Phase I assessed growth and feed performance under normal conditions for 8 weeks as well as non-specific blood immune parameters at the end of this period. Then, a subgroup of 10 fish per tank was challenged with a standard dose of pathogenic *E. tarda* by intraperitoneal (IP) injection and survival was assessed daily during the following 3 weeks.

Figure 1. Representation of the experimental protocol (Rahimnejad et al., 2018).

Improved performance and immune defenses

Under normal, non-challenging conditions (Phase 1), the probiotic group showed improved performance. The specific growth rate (SGR) and feed conversion ratio (FCR) were numerically improved compared to the control diet (SGR: +3.7 % and FCR: -10.0 %) (Figure 2).

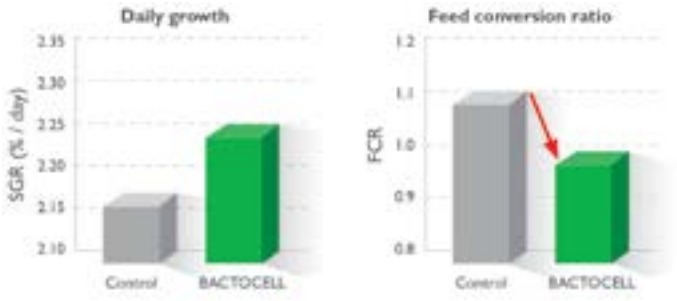

Figure 2. Effect of the probiotic supplementation (*P. acidilactici* MA18/5M) on fish growth parameters under normal conditions (Rahimnejad et al., 2018).

Under normal, non-challenging conditions, the fish natural defences also improved with the probiotic. White blood cell count and serum lysozyme activity, both key factors of non-specific blood immunity, significantly increased as compared to the control group (Figure 3).

Furthermore, a functional bioassay was performed. This bioassay consisted of incubating undesirable bacteria with serum from control or probiotic groups under controlled conditions to monitor its ability to inhibit pathogen propagation. The bioassay revealed a decrease in the multiplication of pathogenic strains of bacteria *Vibrio anguillarum*, *V. harveyi* and *E. coli* when incubated with serum from probiotic-fed fish compared to non-supplemented fish. In particular, the inhibition of *V. anguillarum* growth was 63.6% stronger with the probiotic. This functional assay confirms that enhanced levels of non-specific blood immune parameters in the probiotic group are associated with a stronger mitigation of pathogen proliferation.

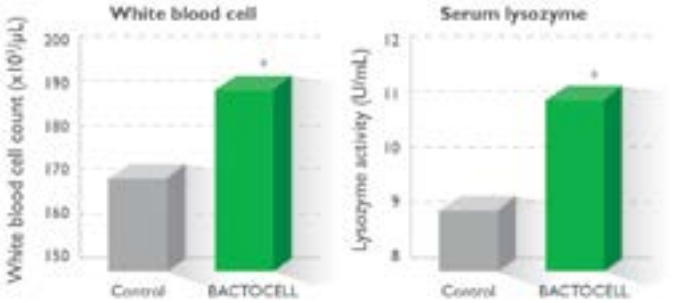

Figure 3. Effect of the probiotic supplementation (*P. acidilactici* MA18/5M) on non specific immunity indicators in fish (Rahimnejad et al., 2018).

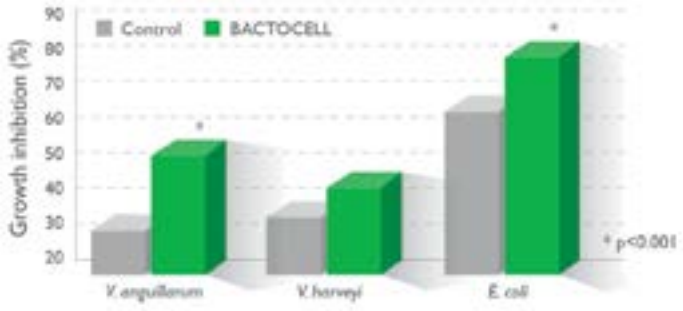

Figure 4. Effect of the probiotic supplementation (*P. acidilactici* MA18/5M) on fish serum activity against undesirable bacteria (Rahimnejad et al., 2018).

Resistance against pathogen challenge

Following a pathogen challenge with *E. tarda*, the survival pattern significantly improved in the probiotic group (Kaplan-Meier Survival Analysis procedure – Log Rank test). At the end of the trial, an additional 30% of the initial population had survived the challenge (Figure 5).

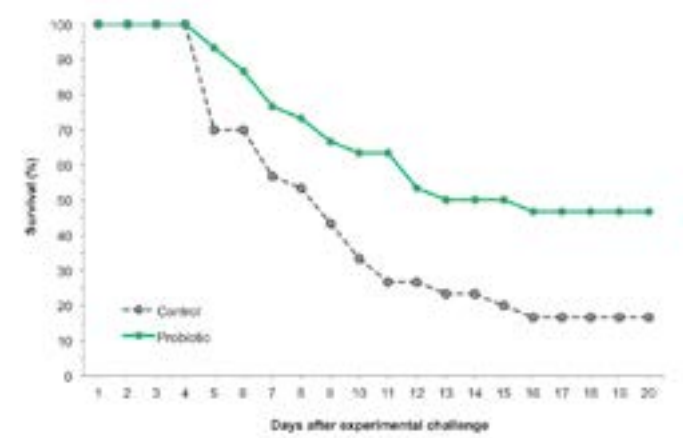

Figure 5. Effect of the probiotic supplementation (*P. acidilactici* MA18/5M) on daily survival rate following E. tarda challenge (from Rahimnejad et al., 2018).

> **"..while contributing to reducing the risk of disease outbreaks and possible side-effects of chemical-based treatments, upstream investments into a healthier, stronger stock can lead to an upward positive spiral helping to deliver volume, value, predictability and trust over successive cycles."**

A well-described mode of action

Years of research and field-based studies have demonstrated the benefits of this probiotic lactic acid bacteria *P. acidilactici* MA 18/5M on gut microbiota and intestinal integrity supporting gut health and improving performance of aquatic animals. Its four-steps mode of action has been described by Castex et al, 2014:

- Set-up, colonisation and survival in the intestinal tract of the host;
- Positive modulation of the host gut microflora, increasing the balance between beneficial and undesired bacteria;
- Modulation of the immune and antioxidant status of the fish. The gut microflora and its modulation via probiotic intervention impact the mucosal immune system and, in turn, enhance non-specific immune factors circulating in the blood. The latter was further confirmed in this trial;
- Enhancement of intestinal integrity and nutrient uptake. Through these effects on the local immune system, the probiotic helps maintain a higher gut wall integrity, enhancing the gut surface absorption area and leading to improved nutritional uptake by the fish.

Together, these mechanisms help to explain the benefits observed in this trial as well as in other trials with different marine species, including shrimp, that resulted in improved growth performance, reduced impact of potential pathogens and lower mortality. All of these results help lead to a higher return-on-investment at the farm level.

Conclusion

The current trial documents the positive effects of the probiotic Bactocell on growth and feed performance and basal immune levels. The positive immune benefits were further validated using functional bioassays and survival in an *in vitro* bacterial challenge. Together these results confirm the benefits of this probiotic to support performance and maintenance of good health in the Korean rockfish, as previously shown in other fish species.

In recent years, consumers and regulators are increasingly demanding healthy, safe and sustainably farmed seafood. At the farm level, health and performance must be recognised as sensitive traits that are best delivered by a strong commitment to best practices and preventive health management. Feed and feeding are important components of these commitments and the use of natural functional feed ingredients is gaining momentum as a central tool to achieve this goal.

This positive approach clearly pays: while contributing to reducing the risk of disease outbreaks and possible side-effects of chemical-based treatments, upstream investments into a healthier, stronger stock can lead to an upward positive spiral helping to deliver volume, value, predictability and trust over successive cycles.


Eric Leclercq


Sylvie Roquefeuil


Stephane Ralite

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Sylvie Roquefeuil is Communications and PR Manager at Lallemand Animal Nutrition. She graduated in microbiology from Toulouse University and holds an MSc. in immunology.

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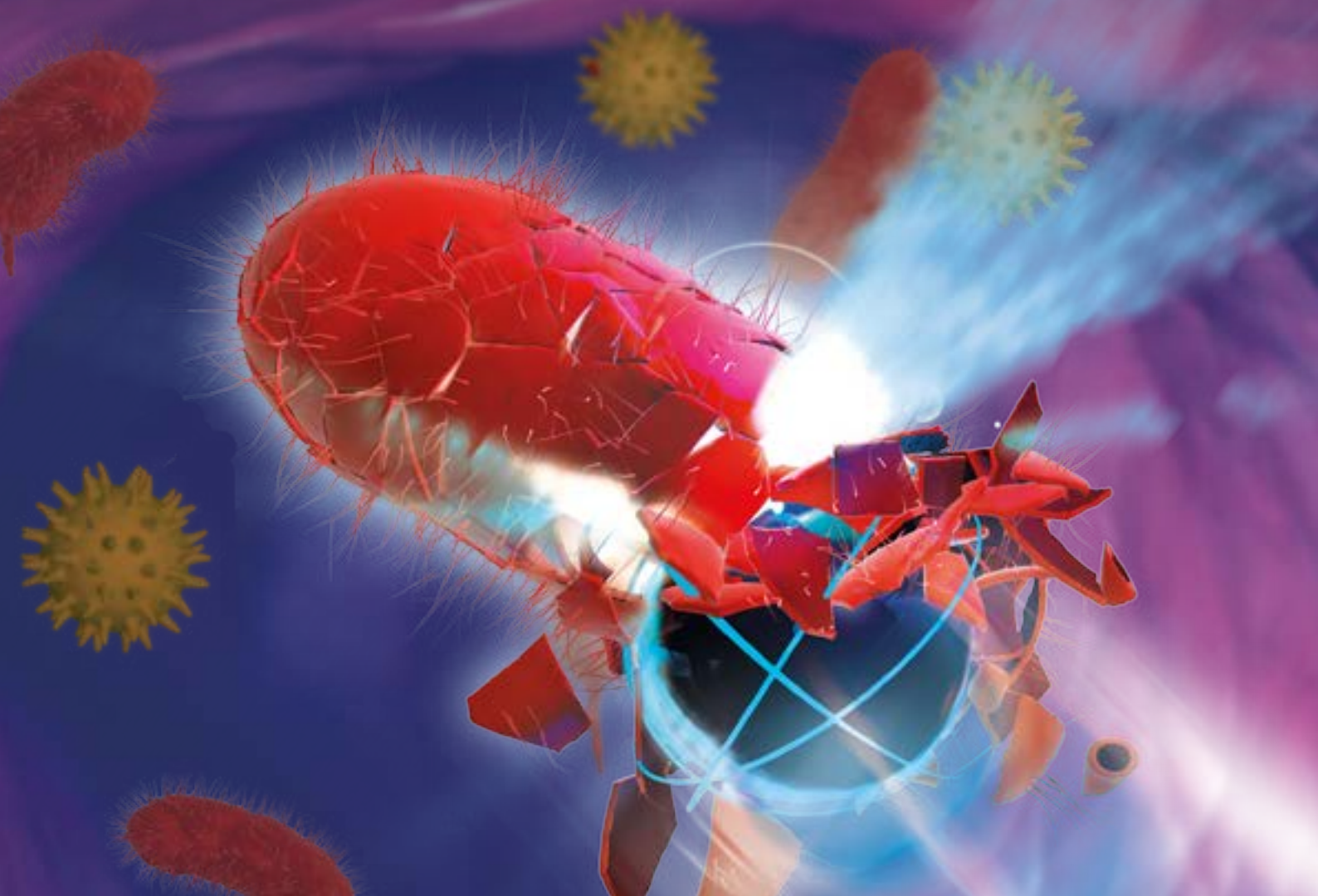

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Organic acids and autolysed yeasts reduce impact of pathogenic bacteria in fish

By David Bal, Antonia Tacconi, Benedict Standen and Anwar Hasan

An enhanced acidifier was most effective against gram-negative pathogens and an autolysed yeast with the full blend of immunostimulants perform better in supporting immune defense mechanisms.

The rising demand for aquatic protein has resulted in intensification of aquaculture production, which is directly linked to increasing incidences of diseases. High stocking densities and high organic outputs favour the spread of pathogens. Every few years, we discover the emergence of new diseases in the aquaculture industry. The major pathogens affecting farm operations include a wide range of microorganisms, viruses, parasites and fungi. In this article, we describe how two tools – organic acids and autolysed yeasts—can help support fish health and performance.

Bacterial threats

Bacteria can survive very well in aquatic environments, especially when water temperature rises or when farming systems are unbalanced. They can cause significant economic losses. There are many ways to control bacterial outbreaks in aquaculture. One common way is to use antibiotics. However, due to a growing awareness of consumers opposing the use of antibiotics, some farmers have been banned from selling antibiotic contaminated aquatic products to export markets. Also, the extensive use of such antimicrobials is linked to the development of antibiotic resistant strains and the transfer of resistant genes between different bacterial species.

The emergence of pathogenic resistant bacteria has negative impacts, not only in aquaculture, but also on human health. It negatively affects consumer perception as well. Therefore, the demand for a more sustainable alternative is higher than ever. Anti-microbial substances such as organic acids and plant extracts are now commonly used in the fish farming industry. Additionally, other products such as yeasts cell wall can prevent disease by enhancing fish innate immune system, whereas vaccines will enhance adaptive (acquired) immunity.

Organic acids to control pathogens in fish

Organic acids or combinations of them are efficient tools in aquaculture to improve fish growth performance, gut morphology and pathogen control. Recently, researchers have focussed on the role of organic acids and their salts to prevent and control diseases successfully. They demonstrated that dietary supplementation of organic salts, such as propionate and butyrate improves gut morphology under hypoxia and reduces enteritis symptoms (high soybean meal diets) in *Oreochromis niloticus* (Tran et al., 2016). Similarly, scientists have demonstrated the very strong anti-microbial effect of organic acids when tilapia were challenged with *Streptococcus agalactiae* (Ng et al., 2009). Organic acids also have beneficial effects on growth, nutrient utilisation and disease prevention in the tilapia.

While the effects of organic acids on pathogenic bacteria are not very clear, it is commonly understood that they can exert either bacteriostatic or bactericidal effects depending on the physiological status of the organism and the physicochemical characteristics of the environment. Undissociated organic acids are lipophilic and can bypass the plasma membrane of bacteria easily. Once inside the cells, where pH levels are usually more neutral than in the outer environment, organic acids dissociate into anions and protons. Traditionally, it has been assumed that the drop in cytoplasmic pH caused by this mechanism is the main toxic efficacy of organic acids. Recently, other toxicity mechanisms have been proposed such as the capability of these acids to interfere with cytoplasmic membrane structure and functionality as well as their ability to interfere with nutrient transport, electron transport and macromolecular synthesis inside the cells.

Scientists cultured a number of pathogens in a growth medium, with and without an enhanced acidifier Biotronic® Top3 (BIOMIN GmbH). The pathogens were chosen based on their ability to cause widespread disease and high economic losses in aquaculture, and included *Aeromonas* spp., *Edwardsiella* sp., *Pseudomonas* sp., *Streptococcus* sp., *Vibrio* spp. and *Yersinia* sp. Researchers observed that this product effectively reduced the growth of all pathogens (Figure 1).

This enhanced acidifier was most effective against gram-negative pathogens, although inhibition of *Streptococcus* was also observed. This is not surprising, since the formulation contains a unique Biomin® permeabilizing complex, specifically designed to weaken the outer membrane of gram-negative bacteria.

Choosing a science-backed solution

The organic acid market in aquaculture is vast. Choosing the correct solution can be a minefield. It is important that products are assessed using both *in vitro* and in vivo models. A recent peer-reviewed publication demonstrated how Biotronic® Top3 can be used to reduce pathogens and improve disease resistance in aquaculture (Menanteau-Ledouble *et al.* 2017).

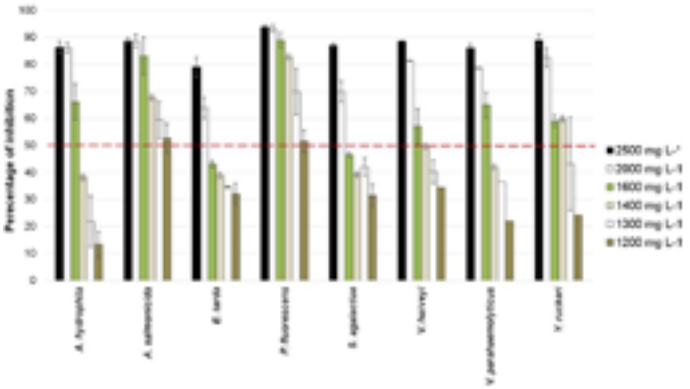

Figure 1. Growth inhibition of aquatic pathogens by Biotronic® Top3.

In one *in vivo* study, specific pathogen free (SPF) rainbow trout *Oncorhynchus mykiss*, were split into two groups, and received either a commercial feed or the same feed supplemented with an enhanced acidifier. After 25 weeks, fish were artificially infected with *Aeromonas salmonicida* by intraperitoneal (IP) injection, immersion and cohabitation. For quality control purposes, fish in both treatments were also 'mock' infected to take into account background mortality. Once the infection had taken its course, the survival was calculated (Figure 2). In control tanks, mortalities were observed immediately indicating the virulence of the pathogens, while in the treatments tank much slower death rates were seen, indicating that the infection could be slowed down. After 35 days of challenge, supplemented fish showed considerably higher survival (80%), compared to just 60% in control tanks, indicating the protective capabilities of this enhanced acidifier. Furthermore, rainbow trout receiving the enhanced acidifier had significantly higher survival (70%) than those not receiving the supplement (25%), when challenged via IP injection.

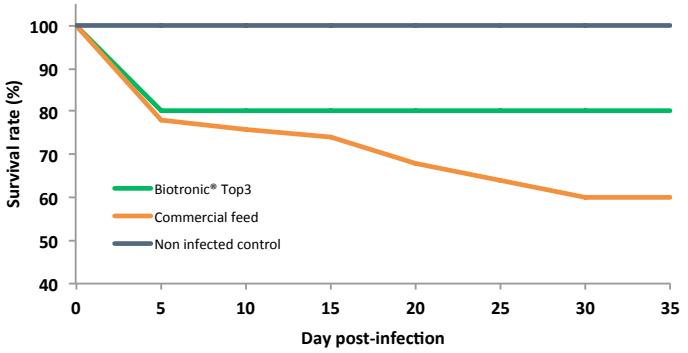

Figure 2. Survival curves of fish during pathogen challenge. Data represent the average mortality across three infection routes. Source: Biomin

Autolysed yeast to enhance immunity of marine fish

Asian seabass Lates calcarifer. Picture credit: David Bal.

The fish immune system

The immune system is a set of cellular and humoral components which defend the fish against foreign substances, such as microorganisms, toxins or malignant cells. These components also respond to endogenous and exogenous factors which subsequently stimulate the immune system. The fish immune system is made up of innate and acquired components, both of which are divided into cell mediated defense and humoral

factors (soluble substances). Today it is known that the innate and adaptive components work together to destroy invaders or to trigger defense processes. The innate system is the first line of defense that acts faster than the specific system. The defenses are composed of the skin that constitutes a physical barrier, antimicrobial enzymes, interleukins, interferon and the organic defense cells, such as granulocytes, monocytes, macrophages and *natural killers* cells (Bayne and Gerwick, 2001, Ellis, 1999, Magnadottir et al., 2011).

Yeast for immune defense support

Autolysed yeast (containing the cell walls and available nutrients) is well known in the aquaculture industry to support immune defense mechanisms. They consist of concentrations of yeast cells that are allowed to die and break up, so that the yeast endogenous enzymes break their proteins down into simpler compounds (amino acids, peptides, and nucleotides).

Autolysed yeast cell walls contain mannan-oligosaccharides (MOS), ß1,3 and ß1,6 glucan, chitin and nucleotides. ß-glucans are glucose-based polysaccharides that have an immune-stimulant effect in aquatic species. They activate several immune cells including macrophages, neutrophils, monocytes, natural killer cells and dendritic cells. As for MOS they have three main modes of action which are the improvement of gastrointestinal health, modulation of the immune system and pathogen absorption.

A study was conducted to evaluate the effect of several immune-stimulants in the Asian seabass *Lates calcarifer*. A total of four treatments were tested: control (fed with commercial feed), commercial feed supplemented with an autolysed yeast product (Levabon® Aquagrow, Biomin GmbH), commercial feed supplemented with ß-glucan, and commercial feed supplemented with nucleotides. After 8 weeks, fish were artificially infected with *Streptococcus iniae* (10^7 CFU/mL) by IP injection. The result of this study showed that in the control tanks, mortalities hit 37%, 11 hours post challenge. In the treatment containing the autolysed yeast, the highest survival rate was observed (57%). Single immune-stimulants (ß-glucan and nucleotides) showed intermediate survival rate of 43% (Figure 3).

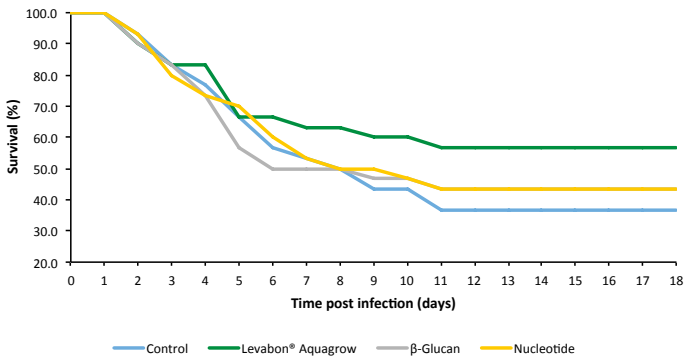

Figure 3. Survival rate of Asian seabass *Lates calcarifer* after *Streptococcus iniae* challenge. Source: Biomin.

Fish which were fed diets supplemented with autolysed yeast product had considerably higher circulating white blood cells (Figure 4). Considering the important protective role leukocytes play, it is not surprising that fish with higher abundances of these immune cells can fight pathogens more effectively, thus improving survival.

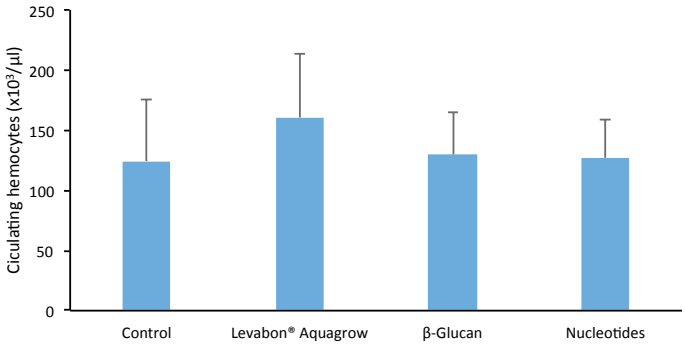

Figure 4. Circulating leukocytes (white blood cells) after 8 weeks of feeding experimental diets and prior to pathogen challenge. Source: Biomin.

Conclusion

Disease outbreaks are persistent threats to profitability. Dietary supplementation of the enhanced acidifier Biotronic®Top3 can improve survival in rainbow trout during a challenge with *A.salmonicida* but it can also inhibit the growth of a wider range of gram-negative and gram-positive bacteria pathogens. Acidifiers can improve gut health and nutrient utilisation by reducing the pathogen load, and increases disease resistance without compromising growth performance.

Additionally, several immune-stimulant substances have demonstrated positive improvements on survival rate of tropical seabass after a bacterial disease challenge with *S. iniae*. In this study this autolysed yeast containing the full blend of immunostimulants had better efficacy than single ß-glucan or nucleotides application. The enhanced acidifier and the autolysed yeast can reduce the need for traditional pathogen control substances, such as antibiotics, opening the door to higher profitability and improved sustainability.

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Functional protein hydrolysates: supporting high and consistent performance of novel aquafeeds

By Fabio Soller, Paul Seguin and Vincent Fournier

Key is a highly standardized ingredient to benefit farmers and feed manufacturers.

Marine ingredients are less frequently used in aquafeeds nowadays due to concerns on sustainability and high market price when compared to other ingredients. Such concerns put pressure on feed formulators and companies to change their traditional diet formulations to be competitive without losing the quality and functionality of their products.

During the transition from marine ingredients to novel aqua feed formulations, attention has to be paid to carefully balance the composition of essential nutrients. In addition, diets should have good shape, durability, water stability, digestibility and low fish in-fish out ratio, while maintaining optimal animal nutrition and health to minimize stress and disease resistance that could adversely affect production and, consequently lead to profit losses. It is imperative that shrimp and fish are well fed with palatable diets for high feed intake, have good digestibility for good growth performance and optimal health.

Marine ingredients are regarded as the "gold standard" in aquafeed formulations, thanks to their near perfect amino acid profile, good digestibility and palatability for most farmed species. Moreover, the water soluble nitrogen compounds (peptides, free amino acids, amino acids derivatives etc) in marine ingredients make them very unique and difficult to replace. Indeed, land-based and more specifically plant-based protein contains low or no water- soluble nitrogen compounds. This very specific water-soluble fraction could be responsible for the outstanding performance of marine ingredients (Kousoulaki et et al. 2009). Thus, their standardization (i.e. content in water soluble compounds) is a major goal to reach for the best and consistent feed and animal performances.

Marine protein hydrolysates: product, process and specifications

More and more functional ingredients are being marketed to help feed manufacturers replace marine ingredients while maintaining the high feed and fish/shrimp performance of this novel feed. Among them, functional protein hydrolysates show great potential as they have many benefits. They are made from marine co-products from fisheries or aquaculture, and have low impact on the environmental footprint. The enzymatic hydrolysis process applied on these raw materials will bring more functionalities to the finished product than the classical cooking/drying process applied during the manufacturing of marine meal. Indeed, the application of enzymatic hydrolysis will produce a high level of soluble protein, peptides and free amino acids. The low molecular weight compounds (small peptides and free amino acid) could reach values more than 10 times higher than the best quality fish meal (Figure 1). Finally, the operation of enzymatic hydrolysis in a batch system will contribute to a high standardization of the finished product.

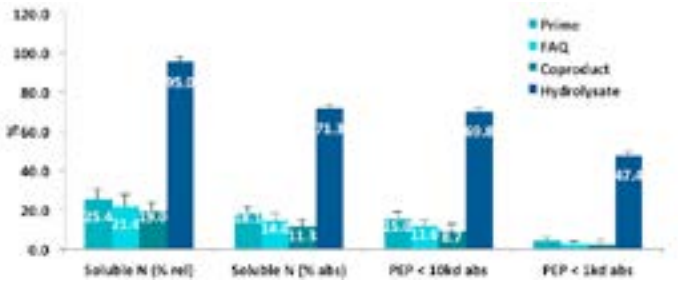

Figure 1. Level of soluble protein, peptides <10Kda and peptides <1Kda in fish meals of different quality (prime, standard/FAQ and co-product) and protein hydrolysates. Values for fish meal are means ± standard deviation of analysis of 8 prime fish meal, 7 standard/FAQ fish meal, 22 co-product fish meal and 12 hydrolysate samples. (Copyright @2018 Diana Aqua)

There are many ways to manufacture protein hydrolysates, all of them resulting in the production of finished products with different specifications and functional performances. Functional protein hydrolysates produced by Diana Aqua are the results of many years of process development consisting of testing different enzymes on raw materials, different hydrolysis conditions and then, checking the peptide profile, *in vitro* biological activities (antioxidant, antimicrobials, immuno-stimulations, etc) and *in vivo* performances in fish and shrimp. As such, every single product developed and launched in the market is the best combination of raw material, enzyme, hydrolysis process parameters and performances in fish and shrimp.

When producing a marine protein hydrolysate, the high level of control applied on the manufacturing process is key to guarantee standardized peptide profiles and consistent product performances, batch by batch over time. Figure 2 shows the high deviation in soluble protein and peptide content in fish meal of different quality while Figure 3 shows the good standardization of functional protein hydrolysates.

Silages

Salmon silages are often confused with marine protein hydrolysates. It is important to understand that during the manufacturing process for a silage no enzyme is included. The

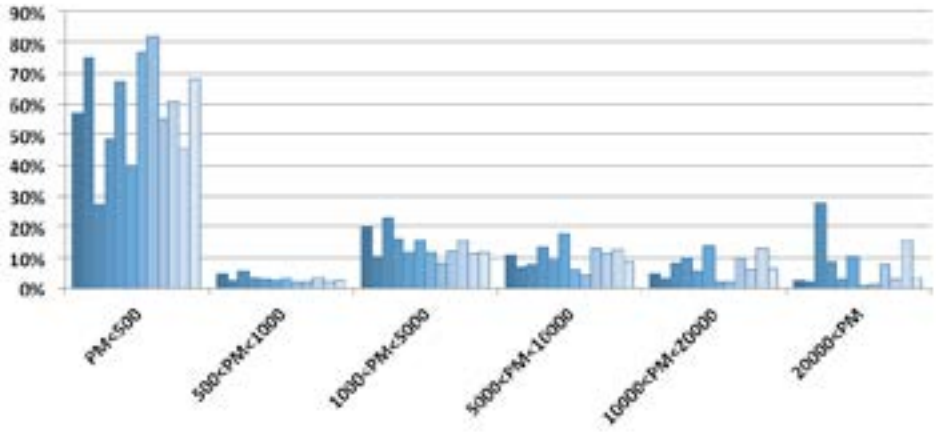

Figure 2. Peptide profiles of 12 different batches of prime fish meal. (Copyright @2018 Diana Aqua)

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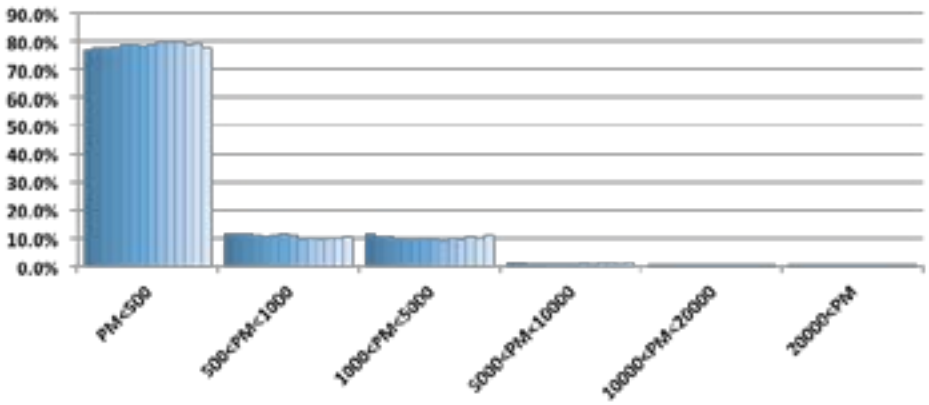

Figure 3. Peptide profiles of 14 different batches of functional protein hydrolysate. (Copyright @2018 Diana Aqua)

process is the result of protein autolysis (in acidic conditions, pH<4.0) due to the presence of endogenous enzymes in salmon viscera liquefying the raw materials. Additionally, the process time is not controlled as accurately as for batch enzymatic hydrolysis and the time of autolysis may vary from one batch to another. Most of the time, the silage process will result in the production of a high level of free amino acids, and a less diverse peptide profile than for enzymatic batch hydrolysis, resulting in reduced and no consistent functionalities.

Benefits of functional protein hydrolysates

The high content of peptides and free amino acids in a functional protein hydrolysate is a key driver for a balanced and performing diet that can be readily accepted by the fish and shrimp, hence reducing feed waste and water pollution. Figure 4 shows the increase in these small nitrogen compounds in a feed supplemented with a functional protein hydrolysate.

Figure 4. Peptide profiles of the same diet including or not functional protein hydrolysate. (Copyright @2018 Diana Aqua)

In the long run, a well-balanced diet enriched with these high-quality ingredients will bring significant benefits to feed manufacturers and farmers in terms of animal production and profit. In turn these strengthen their market competitiveness and the sustainability of their business.

Increase in feed intake

The small peptides and free amino acids generated during the hydrolysis process will promote a high palatability of aquafeeds formulated with functional protein hydrolysates. Since fish and shrimp are very sensitive to these small soluble nitrogen compounds, their taste receptors will trigger a set of metabolic pathways leading to a better feeding behavior and thus a higher feed intake (Figure 5).

Applications of functional protein hydrolysates for the feed manufacturers and farmers are numerous and include: a guarantee of standardized feed palatability allowing more flexibility in feed formulation, consistent fish and shrimp feeding behavior, whatever the feed formula and environmental change (temperature, salinity), and better feed intake recovery after handling or veterinary treatment.

Figure 5 . Peptides and free amino acids enhance shrimp feeding behavior. (Copyright@2018 Diana Aqua)

Figure 6 . Peptides and free amino acids enhance feed assimilation in shrimp. (Copyright@2018 Diana Aqua)

Digestibility improvement

The action of enzyme(s) during a controlled hydrolysis process will produce a high quantity of soluble protein, peptides and free amino acids resulting in an increase of protein digestibility of the functional protein hydrolysate. Peptides (particularly di and tripeptides) as well as free amino acids supplied by functional protein hydrolysates will be readily available for the animals as they will, very quickly, pass through the intestinal barrier to be distributed to the different tissues and metabolic pathways of the animal (Figure 6).

The application of such a functional ingredient in aquafeeds will help enhance feed digestibility by balancing and standardizing the peptide profiles of the formula, regardless of the origin and level of raw materials used. Feed conversion will therefore be improved and feed/nitrogen waste reduced.

Health enhancement

Functional protein hydrolysates also contain a high level of bioactive peptides. The controlled hydrolysis process allows for the production of a very large quantity and diversity of peptides from the raw materials. Many biological activities, from immuno-

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stimulation, antioxidative to antimicrobials have been documented in marine peptides (refer to the review by Harnedy and FitzGerald, 2012). Bioactive peptides will positively affect body functions and animal health (Figure 7). They are characterized by their amino acid sequence, their molecular weight and their physico-chemical properties and could have a synergistic effect when they are in mixture. In protein hydrolysates, bioactivity is supported by specific families of peptides resulting from the action of a given hydrolysis process (enzyme, hydrolysis time, equipment specifications etc) on a given raw material. Again, with such claims regarding product bioactivities, standardization of the hydrolysis process is essential to guarantee the presence of these bioactive peptide families and consistent performance of protein hydrolysates, batch by batch.

Feed manufacturers and farmers will take most of the benefits from using functional protein hydrolysates in aquafeeds: fish resistance to pathogens will be improved and fish and feed performances will be increased accordingly.

Figure 7. Bioactive peptides enhance body functions and animal resistance in shrimp. (Copyright@2018 Diana Aqua)

Conclusion

Functional protein hydrolysates combine many benefits that can help feed manufacturers and farmers improve their farm performances. One of the key words associated with such a functional ingredient is “standardization” which reaches today a high level thanks to a very strict control of the manufacturing process as well as the right specifications of the finished product. This sets up a new standard in the world of functional ingredients, and in particular that of the protein hydrolysates.

In this article, we documented how Diana Aqua focuses on the three main benefits (palatability, nutrition and health) of functional protein hydrolysates in different fish and shrimp species, through collaboration with universities or on behalf of trials conducted in its own facilities. Further information and results are available from Seguin et al. 2018; Khosravi et al. 2017, 2015a, 2015b; M. Herault et al. 2014; Bui et al. 2014).


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Effects of diets with a protease complex on Pacific white shrimp in a super-intensive system

By Wutiporn Phromkunthong, Supornchai Sri-Nhonghang and M A Kabir Chowdhury

White shrimp fed a cost-effective diet supplemented with protease complex performed similar or better compared to regular commercial diet in both field and laboratory conditions.

The volatility in price and supply of quality protein sources has forced feed manufacturers and formulators to use poorly digestible alternative protein sources. These alternative sources usually have imbalanced amino acid profiles and may contain some anti-nutrients severely limiting their use in animal feed. By improving the digestibility of proteins and amino acids from alternative sources, dietary protease could minimise the variations in quality and optimise the diets for stable performance of farmed animals.

The use of protease in aquafeed has increased significantly in the last few years. Several publications reported positive effects of dietary protease or protease complex in improving growth performance and nutrient digestibility in fish and crustacean. However, most of the crustacean (specifically Pacific white shrimp *Litopeneaus vannamei*) trials were conducted either in laboratory conditions with laboratory made diets or in farm conditions with commercial diets at very low density of ~10/m^2.

Stocking density in Asian shrimp farms is much higher (>25/m^2) compared to that in other parts of the world. In some super-intensive systems, the density may reach up to ≥ 100/ m^2. Therefore, there is a need to study the effects of the protease complex on Pacific white shrimp in such super-intensive systems.

In response to the need, a commercial high stocking density field trial with Pacific white shrimp was conducted in Thailand together with a laboratory trial to investigate whether dietary protease could improve the performance of animals in high density conditions when fed a poorly digestible diet.

Treatment diets

Two diets were formulated and manufactured in a commercial shrimp feed mill. The first diet (RC) was a regular commercial diet while the second one was a modified diet (MC). In the MC diet, some of the fish meal was replaced with poorly digestible protein sources bringing a cost savings of about USD 25/tonne feed compared to the RC diet. Both diets were formulated to be isoproteic (43.4 ± 0.2% crude protein) and isolipidic (8.7 ± 0.2% crude lipid), calculated on a dry matter basis.

In both trials, shrimp normally consumed the experimental diets. Despite the slightly higher survival in the protease supplemented treatments, there were no significant differences among the dietary treatments.

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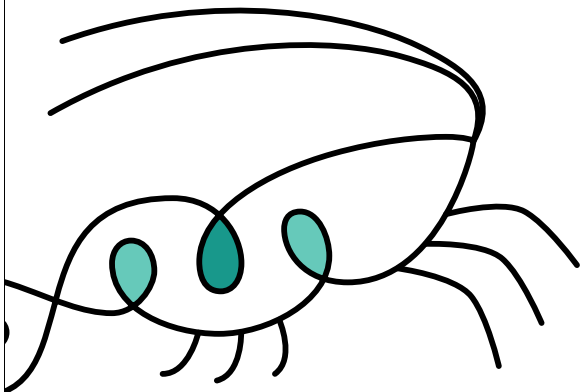

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Field trial

The field trial was conducted in eight 177m³ circular plastic commercial rearing tanks with four replicates per treatment for 70 days. A total of 70,000 shrimp juveniles (0.30 g each) was stocked in each tank at an initial stocking density of 396 juveniles/m³.

In the field trial, no significant differences were reported in any performance indicators. However, the average body weight at harvest and feed conversion ratio improved by 9.8% and 4.7%, respectively for the RC diet treatments (Figure 1).

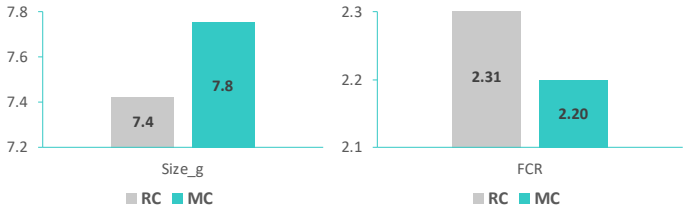

Figure 1. The average size at harvest (g) and feed conversion ratio (FCR) of shrimp fed regular commercial (RC) and modified commercial (MC) diets in field conditions

In addition, there was much higher average production (kg/tank) of large size shrimp (size 120/kg) in treatments fed the MC diets compared to those fed the RC diets although there were no significant differences between the treatments (Figure 2).

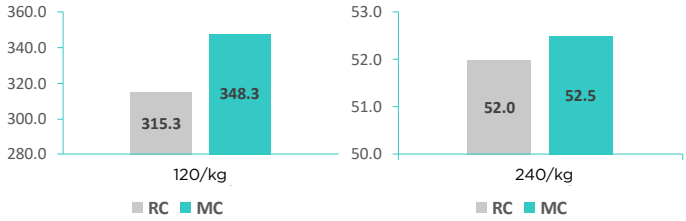

Figure 2. The average production (kg/tank) of two difference size count (size 120/kg and size 240/kg) of shrimp fed regular commercial (RC) and modified commercial (MC) diets in field conditions

Laboratory trials

The laboratory trial with the two commercially manufactured diets was conducted in 10 tanks (100L capacity) with five replicates per treatment at the Department of Aquatic Science, Prince of Songkla University, Thailand for 56 days (Figure 2). Each tank was stocked with 30 shrimp or at 300 shrimp/m³ with an average body weight of 2.3 g.

Results showed no differences (P>0.05) in the average final body weight, feed intake, FCR and average daily gain (ADG) between the treatments despite the numerically better performance of shrimp in treatments supplemented with dietary protease complex (Table 1).

Diet performance

One of the interesting findings of the trials was that survival was significantly better in shrimp fed the regular commercial (RC) diets under both the laboratory and field conditions. In a follow-up trial with graded levels of fish meal (0%, 10% and 18%) in the diets with or without protease, survival rate (%) was actually higher (P<0.05) in treatments fed the protease supplemented diets. The lower survival rate (%) in the trial with commercially manufactured modified diets can be attributed to the deficiency of some micro-nutrients in the modified (MC) diets.

The numerically (but non-significant) better performance in growth and feed conversion, and significant savings in the formulation costs (USD 25/tonne of feed) of modified commercial diets (MC) supplemented with the dietary protease complex compared to the regular commercial (RC) diets is similar to those observed in other published studies with the same protease complex (Li et al., 2016; Lucien-Brun et al., 2016; Song et al., 2017).

Table 1. Growth performance of shrimp fed regular commercial diet (RC) and modified commercial (MC) diet reared under laboratory conditions

	Treatment diets	Mean	Std. Deviation
Average body weight (g)	RC	10.9	0.69
	MC	11.2	0.28
Feed intake (g/ shrimp)	RC	12.7	0.80
	MC	13.0	0.32
Weight gain (%)	RC	370.8	29.58
	MC	383.1	12.84
Feed conversion ratio (FCR)	RC	1.48	0.09
	MC	1.47	0.08
Specific growth rate (SGR)	RC	2.87	0.11
	MC	2.92	0.05
Survival (%)	RC	94.2b	4.19
	MC	85.0a	4.30

> **"..attention must be given to the amino acid and micro-nutrient profiles of the modified diets.."**

In summary, the dietary protease complex can improve the performance of shrimp when poorly digestible raw materials were partially replaced with the highly digestible raw materials in the diets.

Use of the dietary protease complex would:
- Reduce variations in raw material quality;
- Allow the use of increasing amounts of poorly digestible raw materials;
- Bring better environmental sustainability by reducing waste output;
- Bring significant cost savings.

However, attention must be given to the micro-nutrient profiles of the modified diets. Deficiency of one or more micro-nutrients may affect the performance of shrimp despite the increased availability of amino acids and other macro-nutrients.

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Aquafeed Horizons 2018

Developments in aquafeed processing, functional feed additives, single cell proteins and insect meals.

This is the 11th in the series of conferences organised by the news portal, aquafeed.com in association with Victam International. Aquafeed Horizons Asia 2018, supported by the Department of Fisheries, Thailand took place on March 27 in Bangkok, alongside Victam Asia, the feed, grain and biofuels exhibition which was held from 27 to 29th March. This year, the technical presentations covered subjects on extrusion and drying, mycotoxin control, functional feed additives and novel ingredients such as single cell proteins and insect meals.

During the opening, **Dr Kevin Fitzsimmons**, University of Arizona introduced the F3 Fish Oil Challenge (f3challenge.org). This second F3 challenge has a prize of more than USD 100,000, depending on the collection via crowdfunding. Registration closed on April 30, 2018 and the qualifying F3 oil sample should be submitted by November 30, 2018. Sales must be reported in January 2019. The goal is to *'Create a Fish-Free Fish Oil'* substitute and accelerate the availability of cost-competitive, viable alternatives to fish oil. The F3 Fish Oil Challenge has compiled the target values from four known fatty acid profiles found in forage fish that the contestants must meet: on % of total fat, minimum ARA 0.2%, EPA 8.4%, DHA 4.9% and n3: n6 ratio, 12.

Dr Juadee Pongmaneerat, Department of Fisheries, Thailand in her welcome address related how the aquafeed industry in Thailand must overcome many challenges, including the reduction of pollution from feed mills, and to ensure healthy and safe aquaculture products. The aim is also to identify marine proteins with high digestibility as alternatives to fish meal. These alternatives may also require innovations in processing technologies. The policy of the Ministry of Agriculture and Cooperatives is to address illegal, unreported and unregulated (IUU) fishing and focus on promoting a sustainable aquaculture Industry for food security in Thailand.

> **"The goal is to 'Create a Fish-Free Fish Oil' substitute and accelerate the availability of cost-competitive, viable alternatives to fish oil." - Kevin Fitzsimmons**

Extrusion and drying

Thomas Ellegaard Mohr, Andritz Feed & Biofuel, Denmark discussed the ongoing relationship between technology and extruded aquafeed quality. There has been a clear change in feed ingredients concepts: less marine proteins and oils with increased inclusion of vegetable proteins and oils and food by-products. Environmentally friendly aquafeeds should reduce environmental impact from fish farming and in the Philippines, there is a ban on the use of pelleted feeds in some water bodies. Cost/tonne of feeds is important both for the feed producer and farmer. At the feed mill, there is the increased focus on food safety, feed ingredients and process traceability as well as on industrial plant efficiency, process cost reductions and plant emissions. To keep pace with these increasing demands, industrially produced feed is undergoing a continuous quality improvement process.

Recent research on drying of extruded feed by **Dr Anders Fjeldbo Haubjerg**, Graintec A/S and University of Southern Denmark showed a connection between drying parameters and mechanical durability. Extruded feed products dry immediately when exiting the extruder, hence focus needs to be put on the design. "The quality obtained in the dryer will only be as good as the pre-drying transport process allows," said Haubjerg, who went on to discuss the three solutions for pre-dryer transport: airlift, transport belt and stacked extruder/dryer design.

From left, Maarten Jay van Schoonhoven; Dr M.A Kabir Chowdhury; Dr Albert Tacon, Consultant, USA and Liu Yao, Shanghai Nutritech Solutions, China

Dr Juadee Pongmaneerat (centre) and Suzy Fraser-Dominy with Thai participants. From the right are Luxsanawadee Soonngam, BCF Life Sciences; Jarin Sawanboonchun, Ridley Corporation (Thailand) and Thayada Plyhirun, TRF Feed Mill Co., Ltd.

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> In micro feed production, volumes are small and quality is critical.
> - Ramesh Gangatharan

In micro aquafeed extrusion, **Dr Ramesh Gangatharan**, Wenger Manufacturing Inc., USA said that micro aquafeeds range in size from 0.5 to 1.2 mm. With demand from the intensive shrimp nursery sector, feed millers are changing from standard pelleted and crumbled feeds to high quality complete extruded diets as starter feeds. In processing such feeds, a series of meticulous steps are essential, right from the selection of high quality ingredients to ultrafine grinding, sifting, mixing, precision twin screw extrusion and optimal drying process. In micro feed production, volumes are small and quality is critical.

Oils should be screened and sieved and added internally at the early stage before the extrusion process. Pulverisers give a consistent fine and low heat grinding to avoid nutrient degradation. Pulverisers are used for particle sizes of 150- 400 µ and a 40 mesh is required for 420 µ particles and 70 mesh for 177 µ particles.

The sifting of ground material is essential to ensure continuous operations. Self-cleaning screens are recommended. High intensity preconditioners will mix, hydrate and heat to convey more uniform product into the extruder. The latest twin screw extruders from Wenger can handle die holes size from 0.4 mm for direct extrusion of sinking shrimp feeds and is commonly used by some multinational feed millers. Advanced computer controls, variable frequency drives, unique die designs and specially selected dryer screens all contribute to a smooth process at high production capacities. In-line moisture and density monitoring systems can be fixed at critical points to monitor the production process so as to minimise production of out of spec product and to have a final product that is uniform in size, shape and density.

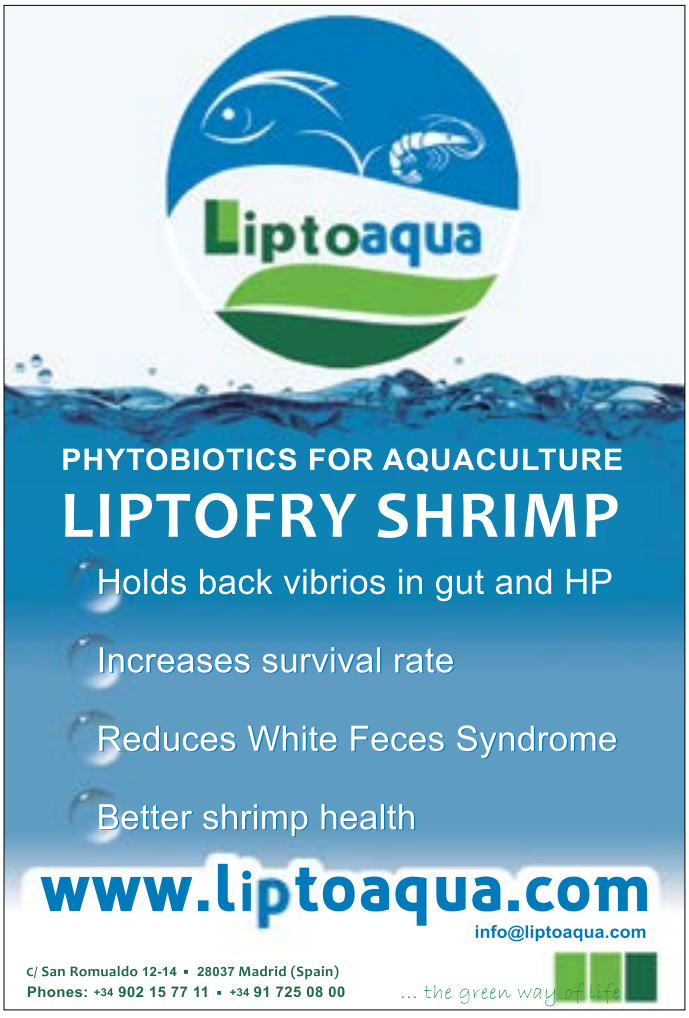
Challenges with aquafeeds

"The increasing use of plant ingredients in aquaculture feeds comes with an increasing risk of mycotoxin contamination," said **Maarten Jay van Schoonhoven**, Olmix group, Netherlands. Unfortunately, mycotoxin effects on aquaculture species are poorly studied, particularly with the large number of species cultured. "We cannot extrapolate effects from one species to another," said van Schoonhoven. Clinical signs of mycotoxicosis can easily be overlooked or misinterpreted, most often leading to a wrong approach in dealing with the negative effects. Knowledge and awareness of the role of mycotoxins in aquaculture production are necessary, just as adequate strategies with a wide spectrum are necessary to deal with mycotoxin risk management.

In his presentation on 'Balancing nutrient levels through the application of functional additives', **Dr Peter Coutteau**, Nutriad, shared the results of a survey organised by Nutriad in India in 2016. This was an analysis of nutrient levels of commercial shrimp feeds. The study sampled eight commercial brands of shrimp feeds and analysed several key nutrients, including proximate composition, amino acids, fatty acids, cholesterol and phospholipid levels. The analyses revealed the general lack of standardisation of nutritional standards in the shrimp feed industry, showing high variability in nutrient levels among different commercial feeds. Furthermore, the study indicated that the industry is responding to the increasing scarcity of fish meal and fish oil, by reducing the levels of cholesterol and n-3 highly unsaturated fatty acids, while compensating this with increasing levels of phospholipids.

"The increasing cost of essential nutrients such as cholesterol and n-3 HUFAs which cannot be synthesised by shrimp, offer good opportunities for some of our digestive enhancing feed additives which have been designed specifically for shrimp to improve the digestion and absorption of essential fats. This is far more cost-effective than to supplement with expensive sources of n-3 HUFAs and cholesterol", said Coutteau in a press release.

In his presentation on aquafeed probiotics, challenges and opportunities, **Dr Benedict Standen**, BIOMIN GmbH, said that different probiotic strains have different modes of action, thus they can bring different benefits to the host. Benefits are dependent on probiotic species; *Bacillus* sp for example, can produce enzymes which contribute to improved digestibility and feed conversion, and lactic acid functions in the intestines and improves immunity. Standen discussed in detail some results of *in vivo* trials in fish and shrimp, including benefits such as improved growth, lower feed conversion ratio and increase in disease resistance. However, since probiotics are `live' microbial components, they are sensitive to heat and pressure, and their inclusion in aqua feeds is therefore difficult, regardless of whether pelleting or extrusion technologies are used. Post pelleting application (PPA) offers the greatest flexibility. Biomin has been developing a novel application for probiotic usage in fish and shrimp feeds, guaranteeing high probiotic viability without compromising the shelf life of the compound feed.



> **There is success as insect meal is being successfully incorporated into feeds for the salmon, trout and shrimp.**
> **- Tarique Arswalla**

According to **Dr Francisco González**, Bioiberica S.A.U., Spain, applying innovative solutions such as dietary nucleotides can promote growth, improve immunity, gut heath and survival rate. Bioactive peptides can improve intestinal health, digestibility and palatability. González discussed how to choose a good source of nucleotides. Nucleotides and bioactive peptides developed by Bioiberica focused on promoting growth, immunity, intestinal health and increased productivity, digestibility and palatability. Dietary nucleotides and nucleotides plus α-glucans lead to improvements in survival in white shrimp *Litopenaeus vannamei* affected by acute hepatopancreatic necrosis disease (AHPND). In general, the goal is to increase the scientific knowledge on the benefits of nucleotides and bioactive peptides in aquafeeds.

Novel ingredients

David Tse, Novo Nutrients, USA compared novel single cell protein technologies for economical fish meal replacement. Less fish meal is incorporated into aquafeeds and new technologies are emerging to take on the growing opportunity to replace the remaining fish meal portion, in whole or in part. Non-plant fish meal alternatives have attracted research, entrepreneurship and investment, both strategic and financial. A Rabobank report said that those with production volume, lower costs and acceptance will have a strong advantage. Tze added that there is an 'advanced' soy protein which is still in its exploratory stage of development, insect meals where stakeholders are still to establish the products' competitive advantages, and single cell proteins. Algae are good sources of oils. With regards to single cell proteins, the question being asked is on the composition and what makes a good single cell protein. These newer technologies include fermentation by bacteria, microalgae, yeast, and other fungi. Novo Nutrients has a bacterial single cell protein produced through a gas fermentation

Dr Jirasak Tangtrongpiros, Chulalongkorn University (centre) with Dr Orapint Jintasataporn, Kasetsart University, Thailand (right).

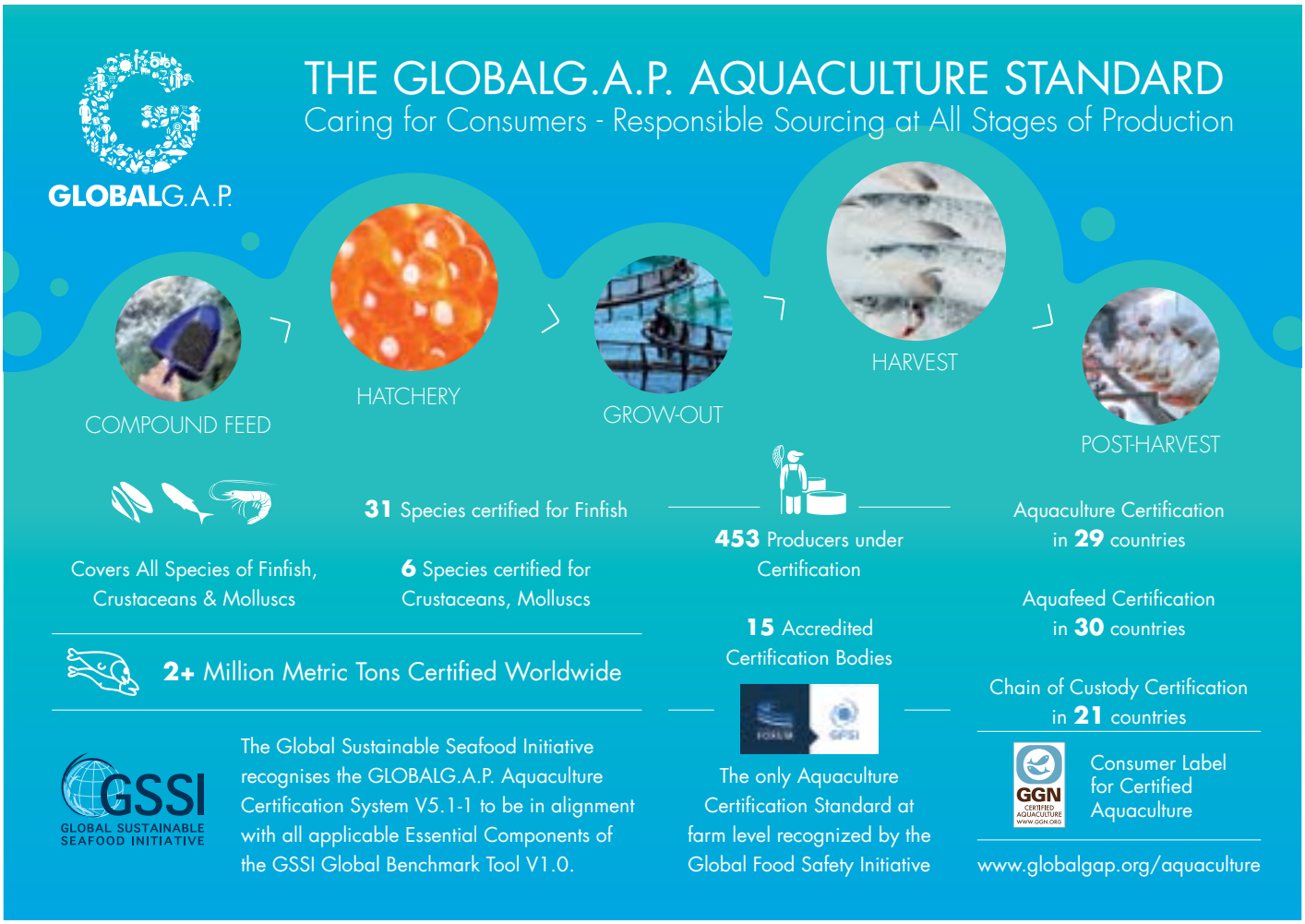
Peter Coutteau (second right) with the Nutriad aquaculture team, from the right, Allen Wu, Regional Manager – Aquaculture, Asia Pacific; Poonmanee Kanjanaworakul, Sales Manager-Aquaculture, Thailand and Ho Gim Chong, Product Manager-Farm Products, Aquaculture.

process of defined microbial consortium. In comparison with fish meal, Novomeal has an equivalent protein content and all 10 essential amino acids for fish.

Tarique Arswalla, Protix, Netherlands said that the European Commission approved the use of insect protein for use in aquafeeds since 1 July 2017, as it is convinced that this new feed ingredient can be produced in a safe manner and offer the quality needed for strong performance and health of fish. Since 2014, Protix has been conducting trials with salmon and trout where insect meals replaced fish meal by 25% and 100%. There is success as its insect meal is being successfully incorporated into feeds for the salmon, trout and shrimp. Arswalla said for salmon and trout, results of taste panels are important. The company went on to get the opinions of high end buyers and chefs. Protix has a second factory which will be able to serve the needs for aquafeeds. Recently, Protix joined the Swiss engineering company, Bühler, to produce commercial scale insect protein.

Immunity - The Next Frontier

"In the final presentation for the day, **Dr M.A Kabir Chowdhury**, Jefo Nutrition Inc., Canada, asked "Is Immunity The Next Frontier in Aquaculture Nutrition?" He said immunity is a black box despite the many sporadic outbreaks of diseases in major commercially important farmed aquatic species. Immunity is important because of changing farming technologies. Immunostimulants are naturally occurring compounds that modulate the immune system by increasing the host's resistance against diseases caused by pathogens. Various strategies in solving this issue are available, i.e. genetics, nutrition and environment, but Kabir focused on the nutritional aspect; as in genetics selection, growth and fillet quality supersede the desire for immunity traits. Kabir discussed the role of non-essential amino acids, for example glutamine, proline, hydroxy-proline and glycine which are also as important as some essential amino acids (methionine-cystine, phenylalanine, tyrosine and tryptophan). "Protease activated receptors play a role in immunity and gut health. Protease in fish meal free diets alleviated villi height in fish and increased survival in shrimp. Immunity needs to be enhanced for animal welfare. There are a variety of products to choose from; farmers need to make the right decisions on the species, environmental and farming conditions," said Kabir.



Developments in global tilapia production

By Eric Roderick

As the tilapia moves up the white fish ladder, issues of low omega-3s are likely to be addressed in the near future with exciting new research in alternatives to fish oil.

The world's population is outstripping the global food production, and the Food and Agriculture Organisation of the United Nations (FAO) predicts that world food supply needs to double by 2050 from its present tonnage in order to cater for the increasing human population. With aquaculture already accounting for over 50% of all the seafood consumed, and one in five people worldwide relying on fish for their primary source of protein, aquaculture needs to step up and deliver its share of the predicted shortfalls. The World Bank produced a report "Fish to 2030" which predicts that 62% of food fish will come from aquaculture by 2030 with the highest supply coming from tilapia, carp and catfish.

Tilapia is currently produced in over 140 countries in a wide range of culture conditions, from extensive subsistence level rice fish farming throughout Asia, to earthen ponds, cages in lakes and rivers, intensive and super-intensive recirculating aquaculture systems (RAS), biofloc systems and more recently as the fish component of aquaponics systems. In 2017, 6.5 million tonnes of tilapia were produced with a global value of USD 12 billion. Tilapia production is still growing worldwide and 6.8 million tonnes are predicted for 2018, despite an apparent slowdown in consumption in the USA and Europe, mainly due to the negative press releases on the health issues related to eating tilapia, which were dubious in the least. Global tilapia production is expected to reach almost 8 million tonnes by 2030.

.. "high quality firm mild tasting flesh, tilapia is seen as a real challenge to the dominance of other white fish.."

In Egypt, polytunnels erected in tilapia ponds which enable the tilapia broodstock to swim inside during the colder winter periods as temperatures around Cairo can get very cold in winter.

A large tilapia farm and hydroponics business near Johannesburg, South Africa

Tilapia, a fish able to meet the challenges of the future. Marketing tilapia fillets in Ecuador

There has been a rapid global expansion of tilapia production over the last 10 years with particular focus on big agri-industrial businesses using intensive rearing systems. Tilapia is a major global commodity and provides food security for millions of people in developing countries. Tilapia is now part of the global "white fish" market, competing with wild caught cod, pollock, hake and hoki, as well as farmed pangasius and catfish. With its green credentials, and its ability to convert most forms of plant protein into a high quality firm mild tasting flesh, tilapia is seen as a real challenge to the dominance of these other white fish, in terms of the value added convenience foods market which is expanding year on year. Tilapia will move up the consumption tables in the USA (often used as a barometer for the health of the industry) from 4th place, to overtake salmon and catfish to 2nd place after shrimp, which will remain in 1st position.

Asia is a clear leader

The league tables for tilapia production are holding firm with **China**, the clear leader producing 1.7 million tonnes in 2017, followed by Egypt with a reported 900,000 tonnes, and closely followed by Indonesia with 800,000 tonnes. China's production is stagnating due mainly to the drop in demand from the USA, but this surplus is being taken up by a rising demand from its domestic market, particularly for premium quality tilapia, and value added tilapia products for the wealthier Chinese consumers.

In 2018, 34 Chinese farms (part of a group working with the US tilapia importer " Fishin Company" from Pennsylvania, have been granted Best Aquaculture Practices (BAP) status, and this status has also been granted to 84 tilapia processing plants giving it much easier access to the export markets in the USA and Europe. Regal Springs CEO Achim Eichenlaub sees a demand for premium tilapia from China, stating that a perceived food safety improvement from imported brands compared to home grown, influences consumers. Regal Springs will also launch a high end premium tilapia brand in Indonesia in June 2018.

There is similar increase in domestic consumption throughout all the main producer countries, as consumers appreciate a premium product. The **Philippines**, where tilapia has displaced the endemic milkfish as the national fish, has virtually no exports, and there is also a big increase in value added products. There is even a tilapia ice cream sold in some regions. **Vietnam** is expanding its tilapia production in an effort to diversify from its dependence on pangasius export and it plans to double production by 2020. Many of the old pangasius cages along the Mekong are now used for tilapia as many of the pangasius farmers move to closed system pond production away from the rivers in an effort to improve biosecurity. **Malaysia** is also expanding its tilapia production with its "Aquapark" developments being expanded. **Myanmar** is also a major producer but is currently focussed on polyculture mainly with Indian major carps and Chinese carps.

The Indian subcontinent is also rapidly expanding its tilapia production, with **India**, **Pakistan** and **Nepal** all seeking to replicate **Bangladesh**'s successful production of almost 400,000 tonnes of tilapia in 2016. The production comes from 15,000 small, medium and large tilapia farms, with 5 billion fry supplied by 400 hatcheries, of which 150 million fry were exported to neighbouring countries. The Bangladesh Fisheries Research Institute (BFRI) is instrumental to this success story, and it predicts production of 1 million tonnes by 2030. Governments as well as private investors are all eager to support the growth of the industry throughout the Indian subcontinent. India in particular is eyeing the export market as it is already a global leader in shrimp production and export through the expertise of the Marine Products Export Development Authority. MPEDA is also now launching a new multi-species aquaculture complex. The Indian government in 2018 has invested USD1.55 billion in support of the fisheries and aquaculture sectors through its Fishery and Aquaculture Development Fund.

Interest in the Middle East

The **Middle East** is a latecomer to aquaculture, but rising food security issues and increasing importation costs are prime reasons why many Middle Eastern countries are investing heavily in aquaculture to reduce their dependence on expensive imported products. The Middle East is currently importing 1.8 million tonnes of seafood and with per capita consumption rising, aquaculture is seen as a solution. High imported feed costs, low seed availability and limited local technical skills are the main obstacles to be addressed. With the shortage of water, many high tech RAS and aquaponics projects are under construction throughout the region. A Lebanese company promoting aquaponics has coined the slogan "more crop for your drop". Several government funded research centres are also under construction or in operation, such as the **Qatar** Aquaculture Research Centre (costing a reported USD 63 million) and also in **Oman**, a new aquaculture centre which offers training courses and carries out research on local and imported species. There is considerable interest in the salt water tolerant strains here as freshwater is at a premium, so brackish or saline water culture would work extremely well.

Recent expansion in Africa

Africa, the origin of the hundred or so different tilapia species, has seen many false dawns in its aquaculture industry, but the recent expansion has significant momentum, with investors eager to capitalise on the growing demand for tilapia throughout Africa due mainly to the dramatic decline in capture fisheries over the last few years. Although only a handful of tilapia species are commercially farmed, there is a vast gene pool waiting to be tapped in the other tilapia species found throughout Africa. African tilapia production usually means Egyptian production plus a small percentage spread thinly throughout Africa. **Egypt** is also scaling up its production through intensification with many

new projects underway, such as the Suez Canal project. With huge areas of brackish water in the north, a lot of research is focussed on saltwater tolerant strains of tilapia. Much of this is undertaken at the El Max Research Institute in Alexandria. Egypt's importance as a tilapia producing country was emphasised recently when Skretting held its Tilapia Forum there, inviting all the big global tilapia producers to catch up on recent advances in tilapia farming. Aquaspark, the Dutch aquaculture investment fund, has recently pledged USD 15 million to increase African aquaculture focussing on tilapia and catfish. In the Aquavision Aquaculture Business Conference in Stavanger Norway in June 2018, Africa's Victory Farms (now the largest farm in East Africa) was seeking partnerships to drastically scale up tilapia operations to meet the growing demand.

There are new farms planned in Egypt, Namibia, Zimbabwe, Uganda and South Africa. In **Uganda** with its abundance of freshwater there is a major expansion through "Aquaculture parks" on Lake Victoria for tilapia production. In **South Africa** the Tilapia Aquaculture Association of Southern Africa (TAASA) is helping to drive the expansion. Lack of good quality feed and high quality fry have been major limiting factors in Africa's expansion, but new confidence in the region has led to Aller Aqua building a new tilapia feed mill in Zambia and expanding its factories in Egypt. The Zambian mill will produce 50,000 tonnes/year and is now fully operational. It has already signed an agreement with Yalelo, which is proposing significant expansion of its Zambian cage farm operations in Lake Kariba to produce 30,000 tonnes/year. Yalelo is owned by the investment group Oakfield, and currently produces 7,200 tonnes a year. Another big farm is being built by the Luangwa Bridge Fish Farms Ltd for tilapia and catfish. Indaba Aquaculture Policy and Research Institute (IAPRI) has recently cited high cost of quality fingerlings and feed and also the lack of fish storage facilities as constraints hindering the expansion of aquaculture in Zambia, where there is significant demand for fresh tilapia and consumers are willing to pay a high price for a good quality product.

Lake Harvest is based on the **Zimbabwean** side of Lake Kariba and has its focus on exports of fillets to the EU. It is selling a lot more locally now as tilapia prices are increasing throughout the region. There are significant government backed expansion plans for Zimbabwe to supply a serious shortage of tilapia in the country which is currently filled by frozen Chinese imports. There is also a new feed factory in Nairobi, **Kenya**, developed in partnership with Nutreco and Dutch funding, which is producing 5,000 tonnes/year to supply local tilapia farmers in the region. This, combined with the news that Alltech has purchased Coppens, the Dutch feed supplier with a strong customer base in Africa, shows that confidence in the continent is improving.

Focus on Brazil

In the **Americas** where most of the production is either consumed domestically or exported as fresh fillets daily to the USA, there is a steady increase in most of the main producer countries, comprising Ecuador, Honduras, Costa Rica, and Colombia but **Brazil** is where major expansion is occurring mostly to meet local demand but also to export to an overcrowded USA market. Brazil's aquaculture sector is worth USD 13 billion, and its expansion is led by the fast growing demand for tilapia, with an 8% increase in production in 2017. Tilapia farming is Brazil's largest aquaculture industry, helped by the abundance of freshwater and its tropical climate.

Brazilian tilapia company Geneseas CEO Breno Davis says the company plans to double its output by 2019. Another interesting trend is the consolidation amongst the fish genetics companies, and in tilapia, the recent purchase of Genomar by AquaGen (EW group) is significant. EW has recently also acquired Aquabel, a large Brazilian tilapia breeding and distribution company which emphasises the importance of good genetic strains in global tilapia expansion plans.

Regal Springs, the largest tilapia producer in the world, plans to increase production to 100,000 tonnes of fillets in 2018 with most of the growth coming from their Mexican and Honduran operations. Mexico is where most of the increase will be generated, with a planned 30-35% increase in production as new farms come on line fully. Regal Springs is also expanding its frozen value added products. In 2018, it hired Petra Weigl as general manager of sales in Europe who previously worked for Birds Eye, Iglo and Findus, the brand leaders in value added fish products in Europe.

TiLV

A major new challenge to the tilapia industry is the tilapia lake virus (TiLV) sweeping through many countries including Ecuador, Colombia, Thailand, Egypt and Israel. Locally known as "summer mortality" in Egypt, 37% of Egyptian farms were affected in 2015. Thailand reported outbreaks in 2015/16. Most of the outbreaks occur 1 month after the transfer of fish from the hatchery to the grow-out cages in rivers and reservoirs. At a recent disease conference in Asia, TiLV was the hot topic, with research aiming for quick detection kits. All the main tilapia producing countries are monitoring the spread of TiLV closely with some countries reporting mortalities of up to 90%. A mortality rate of 9% occurred in medium to large tilapia recorded in 2017. There is some evidence that certain genetic strains of tilapia are resistant. Ferguson et al. (2014) noted that one strain of tilapia (GMT-genetically male tilapia) incurred a significantly lower level of mortality (10-20%) compared with other strains. This was echoed by the OIE (World Organisation for Animal Health).

Low omega-3 PUFAs

One of the main drawbacks of tilapia is the low levels of omega-3 polyunsaturated fatty acids (PUFAs), and higher levels of omega-6 PUFAs, as the consumer is being told to eat fish high in omega-3 PUFAs. Global recommendations are for omega-3:omega-6 ratio of 1:4 in a healthy human diet. This is an issue likely to be addressed in the near future with exciting new research from Cargill using omega-3 rich GM canola oil added to the feed. Not only will this reduce our global dependence on fish oils high in omega-3 PUFAs but could be a very cost effective way of boosting omega-3 levels in mainstream commodity fish such as tilapia. In successful trials with salmon feeds, Cargill was able to completely replace the fish oil with canola oil.

Another big story that has enormous benefits for the aquaculture industry is the single cell protein produced by Calysta in collaboration with Cargill and many other investors. This fermentation product has 71% crude protein which seems suited as a very cost effective fish meal alternative. There is significant investment in this new technology and hopefully it will help fuel a rapidly expanding global aquaculture industry. These new feed ingredients combined with extensive research on microalgae (DSM and Evonik are leading the field) as sources of many essential feed ingredients especially omega-3 PUFAs, bode very well for feed suppliers and consumers. TerraVia™ (now Corbion) has AlgaPrime™ DHA, a long chain omega-3 rich whole algae ingredient for the aquaculture feed market.

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

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

Offshore Mariculture Asia 2018

Successes and challenges for the emerging industry in Asia.

This first Offshore Mariculture Conference (OMC) in Asia was held in Singapore from 15-17 May. The program covered the full process on the setting up of offshore cage culture farms to general cage culture operations, based on the experiences garnered from established operations in several regions such as by industry pioneers in Europe. OMC is a conference series organised by the UK based Mercator Media Ltd. This 2018 conference was attended by 121 participants and was supported by the World Aquaculture Society-Asian Pacific Chapter (WAS-APC). Sponsors were the US Soybean Export Council (USSEC) as platinum sponsor as well as Wieland, Refamed, Empyreal and Steinsvik.

There were 22 presentations in seven sessions, including a breakout session on the adaptation of proven offshore mariculture technology for the Asian region. A farm visit was either to the Agri-Food & Veterinary Authority of Singapore's Marine Aquaculture Centre (MAC) or Barramundi Asia, a leading Asian seabass farm in Singapore. In his introduction, **Alessandro Lovatelli**, Regional Fisheries and Aquaculture Officer, FAO noted that when fish cage culture moves from inshore to offshore, it will require a greater awareness on the biodiversity and environmental conditions of the surrounding waters in order to stop diseases from occurring. He believed that with the growing demand for aquaculture to produce more food, open sea culture is the way to go. **Dr Guillaume Drillet**, immediate Past-President of WAS-APC is convinced that offshore aquaculture will become increasingly important in Southeast Asia, including Singapore.

Bjørn Myrseth, Vitamar A.S. gave a short history and the future of offshore cage farming. His definition of offshore included more than 5km from the shore base, wave height of more than 2.5m and frequency of high waves, more than once. Accessibility is around 7-14 days/year with no landing versus 99% on a daily basis for coastal cage farms. With regards to species suitable for offshore cage farming, he suggested the Asian seabass *Lates calcarifer*, yellow tail *Seriola quinqueradiata*, snappers *Lutjanus* sp, pompano *Trachinotus sp*, yellow croaker *Larimichthys* sp and cobia *Rachycentron canadum*, mainly because juveniles are readily available. "Offshore farming needs good, stable and reliable supply of juveniles, usually from RAS hatchery or nursery, sensors and remote control of offshore farms as well as autonomous boats for service of offshore farms. There is a great future if cost is right."

Prospects and challenges in tropical Asia

Niels Svennevig, Independent Aquaculture Advisor discussed prospects and challenges in sea cage farming in tropical Asia. "In terms of production volumes, Southeast Asia (SEA) produced only 218,000 tonnes using cage technology whereas in Norway, production was 1.3 million tonnes. Norway has 800 times more production in sea cages/capita, although its coastline is equal to Vietnam only. Thus, the use of marine areas in SEA for food production has not reached its potential."

He added that presently, marine fish production in SEA is predominantly carried out mainly by small-scale fish farmers who lack sound protocols for biosecurity and feed management. They also often lack the modern scientific approach in fish culture. Often these small-scale farmers seek sites where their wooden cages will be protected but these sites are often not the most optimal for fish survival. This is a highly resource inefficient and risky enterprise where fish mortality may be as high as 50%. Production volume is constrained by high costs of production. They target domestic and regional markets with high value and small live-fish segment.

According to Svennevig, the interlinked challenges in the sector in SEA with the existing business include multispecies, lack of generic marketing and technology or market driven business plans. "As a result, local corporate investors are wary about investing in such an enterprises. Large-scale foreign investors in this sector face problems including the lack of local legal framework. There is also a constraint in marketing species that are not known in a global market. Aside from the barramundi, Asian fish like the milkfish and pompano are relatively 'unknown' species in the global market."

Large volume approach, in the form of corporate based vertically integrated business structures with intensive investment, is emerging in Asia. However, these business plans are or have often been production driven rather than market driven. The entrepreneurs target the global fish market in their business plans, copying the salmon approach but not taking into account the huge generic marketing efforts by the salmon sector.

Successful offshore farming

Several presentations feature success stories. **Erik Vis**, Director of farming operations of Open Blue, said that the company has a three-pillar approach to sustainability: social responsibility, full accountability and environmental care. Open Blue operates the largest offshore cobia fish farm off the coast of Panama.

In 2017, 1 million fish fry were produced from its land based hatchery and nursery facilities. Fish of 100g size are transferred from the nursery to grow-out offshore cages and it takes 12-14 months to reach marketable size of 5.6 kg. Autogenous vaccines are used to boost the immunity of the fish; at a stocking density of 20kg/m^3 a survival rate of 85-90% can be achieved. The Sea Station cage technology used allows for harvesting in 7m waves. Open Blue is certified by several accredited agencies: GlobalGAP, Friend of the Sea (FOS), Aquaculture Stewardship Council (ASC) and BRC Food.

Joep Kleine Staarman, Barramundi Asia gave a local example of open sea farming in Singapore. Asian seabass or barramundi, is a choice whitefish that is popular among consumers and is suited for aquaculture due to the following characteristics of this fish: hardy with wide physiological tolerances, one of the most efficient fish in terms of food conversion ratio, high fecundity of female fish, feed well on pellets and grow rapidly, and the large size of the fish makes it suitable for thick boneless fillets.

Participants during the post conference visit to the Marine Aquaculture Centre, Singapore.

Observation and feeding platform for a 48 m diameter cage holding tuna broodstock belonging to the Gondol Research Institute for Mariculture (GRIM) in North Bali, Indonesia. AAP photo.

Barramundi is also adaptable to offshore farming, and technology and infrastructure are readily available for such ventures. As a company, Barramundi Asia has been growing steadily and is expanding (see news on page 6).

Barramundi Asia has developed in-house expertise in vaccine development (UVAXX) to mitigate fish mortality. Eight key pathogens can affect barramundi across the growth cycle and UVAXX is producing autogenous vaccines that can address three of them. Vaccines developed by UVAXX reduce mortality rates to 10-15% overall, compared with the industry average of 40-50%. Today, Barramundi Asia sells fish in Singapore, USA, Hong Kong, and Australia, with plans to expand to China in mid 2018.

Moving to offshore operations

In his presentation, Svennevig said that the Turkish government moved farms from near shore into better environments offshore. The result has been a large growth in production, from 8,000 tonnes in 1995 to 148,000 tonnes in 2016 and attracting corporate investors. The culture of the European seabass *Dicentrarchus labrax* and seabream *Sparus aurata* had their beginnings in 1985 in the Aegean Sea. In the 1980s, sea farming was conducted in traditional small wooden cages located in protected shallow bays. **Dr Hayri Deniz**, General Secretary of Mugla Fish Farmers Association & External Consultant of Kiliç Seafood Company said that in the 2008s, the Turkish government drew up a National Mariculture Development Plan aimed at minimising conflicts and to provide a sustainable fish farming plan for the future. In 2009, inshore marine farms were moved offshore to new allocated zones, raising marine fish production. In 2016, aquaculture contributed around 43% by volume and 71% by value to the total fisheries production. The total fisheries production in 2016 was 588,715 tonnes with aquaculture contributing to 253,395 tonnes. In the past decade aquaculture production increased by 293% and it is the fastest growing food production sector in the past 4 years. In 2017 there were 2,308 fish farms with a total capacity of 487,859 tonnes. Turkey now occupies first place in trout and seabass production and second place in seabream production among European countries, and has a 31% share of the seabass and seabream European market. It is now the largest fish producing country in the Mediterranean Basin, and the second largest fish producer in Europe after Norway.

Deniz also described operations at Kiliç Seafood, Turkey's largest fish farm operator and one of the largest in Europe with modern and efficient operations. Over the years, it has expanded operations through new investments and capacity increases by implementing a fully vertically integrated business model. Kiliç produces 65,000 tonnes of fish per year and 450 million fish fry/year from farms and hatcheries in several locations to minimise disruption risks. Feed production is 160,000 tonnes/year. The processing and packaging facilities were recently modernised to support the strategy of diversifying in value added products. The export volume was USD 160 million in 2017. The major species are the seabream, seabass, meagre, trout and tuna. In addition to the fleet used in harvesting, Kiliç owns three large sea vessels to transport juveniles to Tunisia and other domestic players. In recent years, Kiliç has entered the Russian market with the sales of trout, seabream and seabass, which have been increasing at a rapid pace.

Production of large quantities of high quality fingerlings

Dr Daniel Benetti, Director of Aquaculture, University of Miami's Rosenstiel School of Marine and Atmospheric Science gave an overview of developments globally. Some of the important marine fish species whose aquaculture technologies have become available in the Americas and the Caribbean regions are cobia, hamachi/kampachi *Seriola rivoliana, S. lalandi/S. dorsalis*, pompano, Pacific red snapper *Lutjanus guttatus*, mahi mahi *Coryphaena hippurus*, hirame or Japanese flounder *Paralichthys olivaceus*, Nassau grouper *Epinephelus striatus*, *Totoaba macdonaldi*, red drum *Sciaenops ocellatus*, barramundi and snooks *Centropomus* spp. Progress towards full cycle farming of the bluefin tuna *Thunnus thynnus* and yellowfin tuna *T. albacares* is also being reported, as well as efforts to develop technology to close the cycle of blackfin tuna *T. atlanticus*.

Recently, progress in recirculating aquaculture systems (RAS) and flow-through seawater or brackish water ponds have also been used to raise high-value species. Techniques still need to be fine-tuned and improved to achieve consistency. The same larval husbandry methods to produce two very closely related jacks of the Carangidae family, *S. lalandi* and *S. dumerili* were used; many hatcheries consistently achieve 20-50% survival rates with the former and 0-5% with the latter.

According to Benetti, gaining control over the microbiology of the hatchery systems including water quality, live feeds and the microbiome of early development stages of sensitive larvae is key to increasing and stabilising survival rates of a number of tropical and subtropical marine fish species. Biosecurity measures such as disinfecting water and irradiating feeds provided to broodstock may have an effect on egg and larvae microbiome development. Research on microbiome and microbiological control must be given priority by modern hatcheries.

In Singapore, AVA's Marine Aquaculture Centre (MAC) was established in 2003 to spearhead aquaculture development. "MAC collaborates with the local industry and research institutes to work on key R&D initiatives such as selective breeding and development of large scale hatchery technology," said **Lim Huan Sein**, Director, Aquaculture Technology Department, AVA, in his presentation on R&D in hatchery technology for the Asian seabass and other marine species.

Some of these efforts included the application of RAS technology for intensive fry production, the genetic improvement of the Asian seabass, captive breeding of new species, and the development of closed containment systems for coastal fish farms. Some breakthroughs achieved include the solution to overcome big-belly disease, a novel disease in seabass culture. This disease affects fry (18-30 days old) to fish of 20g size. Survival rates of disease affected fry can be improved from 10% to 90% by reducing the salinity in the RAS from 30 ppt to 10 ppt, MAC has also designed a compact RAS with a footprint of $1m^2$ which can support a production of 120,000 seabass fry with a total culture area of $9m^2$. MAC is also working on the selective breeding of seabass, with a target to produce F2 super seabass with a 30% increase in growth rate.

Cobia from traditional farms in Asia. Picture courtsey of Hsiang-Pin Lan, Asia Marine Aquaculture U.S. Soybean Export Council.

Identifying species, markets and standards

Troy Keast, Director of Aquaculture and Sustainability, Phillips Foods in Indonesia said that selecting the right species, the right finished products and the right certification program/s are all crucial to the success of an aquaculture operation. "These processes are made easier when they are driven by an existing marketing plan." He added that the key elements such as quality seed, species specific feed and health management programs are supplementary to the ever evolving marketing strategies that drive production.

"The selection of what species to culture should be market driven for existing species or a 'leap of faith' for new species or products. Suitable candidates should have the following attributes: quality and biosecure seed or fingerlings, specialised feeds and the presence of an existing or developing health management program.

" All too often failures are due to weak marketing strategies, naivety or the total absence of a structured plan leaving an operation open to the brutal markets. It is important to determine what physical markets and which market sectors to target: fresh or frozen, food service, value added, retail, and ready meals/kits. Once the permutations have been investigated the market plan should then be used to configure the integrated operation. Working back from finished product specifications and volume, we can now calculate hatchery capacity, grow-out footprint and cage configuration, production facility capacity and requirements."

However, added Keast, with markets, supply chains and processing technology in a state of constant flux, the marketing plan needs to be continuously evolving. Diversification into other markets can reduce exposure and provide a level of safety for the operation.

With regards to sustainability, first and foremost, there is economic sustainability which must be met prior to production at scale. Pivotal to determining economic feasibility is the sales end of the equation as production costs are relatively easy to calculate. It is crucial to have a marketing plan to determine what to produce, how much can be marketed and at what price. Sustainability standard selection should be market driven and requirements of customers must be taken into consideration. Multiple markets will necessitate multiple standards. "Your customers shall provide the answers on what they need. Pushing redundant standards on them is a huge waste of resources," added Keast.

Next issue: Offshore cage technology and maximising efficiency of operations.

"The selection of what species to culture should be market driven for existing species or a 'leap of faith' for new species or products," said Troy Keast, pictured here at his farm.

See related article: From Bali to global markets in issue November/December 2017 Aqua Culture Asia Pacific, pp20-22.

Industry meets academia in Taiwan at APA18

The Asian-Pacific Aquaculture 2018 (APA18) conference and trade show at the Taipei International Convention Centre, Taiwan, was attended by around 2,000 participants from 48 countries. Organisers, National Taiwan Ocean University (NTOU) and the World Aquaculture Society - Asian Pacific Chapter (WAS-APC), attributed the success to the collaboration and joint efforts of various organisations in the APA18 steering committee. The conference and 100-booth trade show held from 23-26 April saw 445 abstracts with 295 oral presentations and 150 posters at the conference. APA18 attracted several contingents of farmers and industry stakeholders, such as those from Indonesia, Vietnam and Malaysia.

The opening was by Dr Ching Fong Chang, (President of NTOU), Dr Guillaume Drillet (WAS-APC President) and several officials; Tian-Shou, Chen, Ex-Director General of Fish Agency of Taiwan; Dr I-C Liao, Academician of the Academia Sinica, Taiwan; Hong-Yen Huang, Director General of Fish Agency of Taiwan; Allen Ming-Hsun Wu, Regional Manager-Aquaculture, Nutriad; and Jeff Chuang Cheng-Jie, General Manager of Sheng Long Bio-Tech International.

The conference was strengthened by industry supporting the sessions. Vietnam based sponsor, Sheng Long Bio-Tech International, Gold sponsor at APA18 supported the session on "Advanced nutrition and disease research on fish and shrimp". The standing room only session indicated industry interest in diseases, particularly white spot syndrome virus (WSSV), affecting farms not only in Asia but elsewhere. Professor Grace Chu-Fang Lo, National Cheng Kung University, Taiwan started the session with a discussion of her work on production on WSSV resistant *Penaeus monodon*. She detailed virus versus host relationships and anti-host defense strategies, demonstrating the difficulties in controlling WSSV. At 32-33° WSSV replication is suppressed but with transfer, replication is rapid (related article: Working towards 'No more threats' from WSD in black tiger shrimp farming. *Aqua Culture Asia Pacific*, March/April 2018).

Dr Loc Tran, ShrimpVet Lab, Vietnam looked at holistic approaches in bacterial disease prevention focusing on EMS/AHPND and white faeces disease (WFD), growing problems in Vietnam where shrimp are susceptible to EMS after 2-3 weeks following stocking. The laboratory worked on transmission models for WFD with a focus on bacterial etiology and several management strategies such as algal bloom control, better feed management, probiotics application, better bioremediation strategies, and functional diets to reduce WFD both in laboratory and during grow-out. On management of bacterial problems, Dr Chi Man, BASF, presented on an innovation using enhanced monoglycerides of short (C1-C5) to medium chain length (C6-C12) fatty acids. Trials in Thailand and Vietnam showed that the monoglycerides could inhibit the targeted Vibrio spp. and some other bacterial species, whilst not affecting the healthy bacteria (probiotics or heterotrophs). Tank trials have shown promising results for shrimp and demonstrated up to 30% improvement in survival rates in AHPND challenge studies.

Taiwan based aquafeed producer, Grobest sponsored the session on "Sustainable environment for aquaculture" and Belgium based Nutriad the session on "Functional feed for health management". In the latter session, Dr Yu-Hung Lin, Pintung University, Taiwan presented a review on cholesterols and bile salt. (An article on this will be published in the next issue of *Aqua Culture Asia Pacific*.) The session also included the 3-C strategy for health management in Thailand's shrimp farming industry by Dr Prakan Chiarahkhongman, Charoen Pokphand Public Foods, Thailand. Focusing on tilapia health, MSD Animal Health's session saw presentations on disease and health management in Singapore (Frank Tan) and Hong Kong (Aaron Leung) as well as by Dr Win Surachetpong, Kasetsart University, Thailand on controlling tilapia lake virus (TiLV) and bacterial diseases in farms. Kemin conducted a session on feed quality and safety with presentations from academia in India, Thailand and Brazil, while Dabomb Protein, Taiwan, sponsored the session on functional aquafeeds for aquaculture (see pp 58). In this session, Alex Diana from Dr. Eckels discussed the phytogenic feed additive Anta®Ox FlavoSyn and how it improved harvest volumes of red nile tilapia with higher survival rates leading to higher profitability.

Pitoyo Hardi, Vice President of Shrimp Club Indonesia (SCI, left) with some members. SCI organised a group of 100 shrimp farmers and family to attend the tradeshow and conference.

Malaysians at APA18; from right, Ismail Abu Hasan, Vio Star International (Malaysia) Sdn Bhd and from Blue Archipelago Berhad, Wan Nadhri Wan Fauzi, Nazrul Fadhlee Mahmud (standing) and Anuar Sani Abdul Rahman.

The Sheng Long Biotech team, from left, Hannah Hung (Taiwan), Quach Bao Le, Maple Hung, Jeff Jie-Cheng Chuang from Vietnam, Chun Xin Tsai (Taiwan) and Dr Hu Hai-Bin (Vietnam).

This year's trade show featured several new exhibitors targeting the aquaculture market in Asia. These included Great Lakes Bio Systems, Inc (USA), a frequent exhibitor at Aquaculture America, Aliga Microalgae (Denmark), Aqualande (France) and Artkom (Turkey); the latter distributes artemia cysts from K-Nikom, one of the 3 largest producers of artemia cysts in Russia.

Showcase of technology from Taiwan

Companies in Taiwan dominate the aquaculture technology and equipment realm for industry in Asia, from disease diagnostics, basic equipment to IOT and feeds. GeneReach Biotechnology is a global player for molecular diagnostics in fish and shrimp farming. Its products including IQ REAL quantitative systems and the pond side IQ 2000 detection and prevention system and IQ Plus Aquaculture Pathogen Detection, are essentials for detection and management of fish and shrimp diseases. The new product introduced at the trade show was the cartridge based POCKIT™ which allows for the full automation of nucleic acid extraction amplication and detection at pond site (www.genereach.com).

Taichung based Bigbest Solutions Inc introduced an intelligent aerator motor with IOT for paddle wheel aerators and wave makers, leading to 40-50% savings in energy use in comparison to AC induction motors. Tests with these direct drive motors at a farm in Pingtung Province with 3 ppt water, showed a reduction in power consumption at 3,942 kW/year (www.bigbest.com.tw). Tian Chang Ying Aquaculture Equipment & Engineering with factories in China, focused on its innovative impellers for aerators

Professor Han-Ching Wang (second left), National Cheng Kung University and team.

At the booth of Jade & Gold Agriculture Products, Jimmy Wang (right) with guest Leonido C Tala, Aquaculture Dela Mahajamba, Madagascar (left) and distributor in Indonesia, Burhan Irawan.

to achieve less resistance and high oxygen generation. The series of aerators include bottom circumferential aerator, deep water jet machine, swell machine and 3 models of traditional paddle wheel aerators with 16 slices of impellers. HCP Pump Manufacturer Co. Ltd is the leading producer of submersible pumps in Taiwan with a large aquaculture market in the region. It is a major producer of pumps with an almost 50-year history. The focus is in developing and implementing better hydrodynamic techniques with lower energy consumption. In aquaculture, HCP Pump is also well known for its energy saving paddlewheel aerators (www.hcppump.com.tw). Trundean Machinery is a leading manufacturer of root blowers and pumps and at the show introduced its new root blower for shrimp farms (www.trundean.com).

Quadlink Technology Inc. has smart aquaculture systems employing solar energy. The company uses sensors, audio/video monitors, cloud and big data technologies to optimise aquaculture and agriculture production and distribution. The Quadlink aquaculture monitoring system powered by solar cells, monitors temperature, pH, oxidation-reduction potential (ORP), dissolved oxygen and salinity of pond waters and periodically sends the measured data to cloud and clients (www.quadlink-tech.com). Trovan Ltd is the world's leading supplier of RFID systems to the commercial aquaculture industry with a 25-year history. The new product from Trovan is a FishReader automated data collection station with keyless data entry. This cutting edge solution allows operators to capture complete information on each specimen in seconds. This drastically cuts back on processing times and data retrieval (www.trovan.com).

The Uni President team, from left, William Check (Vietnam), Liou Hai-Hua (Vietnam), James Hung (China, centre) and Ma Chen Tien (third right). Also in the picture is Nguyen Ngo, Aquativ, Vietnam (third left).

Jade & Gold Agriculture Products Company is a relatively new company, set up by Jimmy Wang to market probiotics as feed additives. Wang listed the products. Bio-Great is for top dressing of shrimp pellets. Bio-Ferm is a water probiotic with enzymes and UGF added 14 days before stocking to enrich the zooplankton population and enhance immunity of post larvae. Together with Bio-Activator, containing photosynthetic bacteria (PSB), Bio-Ferm may inhibit *Vibrio parahaemolyticus* in shrimp gut and pond water, respectively acting as a treatment for white faeces syndrome (WFS). Mixed with molasses and applied to clean highly polluted water, BioActivator will prevent black gill disease. The company has been successful in marketing these products in Indonesia, said Wang. The protocols for its use are detailed in a large-size leaflet for easy reference in farms. (www.facebook.com/jadengoldagri)

Aquafeeds

This year saw the addition of Grobest Group, which is Taiwan's leading and dedicated only to aquafeed and aquaculture company. 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. Integration of the various subsidiaries in several countries in Asia varies. In its feed business, it has feed mills in Thailand, China, India, Indonesia, Vietnam, Philippines and Malaysia (www,grobest.com). Sheng Long Bio-Technology International shares the global vision of its parent company, Guangdong Haid Group. Sheng Long works out of Vietnam from 2 feed mills and another one scheduled to operate in 2019. It is actively marketing shrimp and fish feeds in the region and is expected to start shrimp feed production in India in 2018 (www.shenglongbt.com).

Two established feed producers were also exhibiting. Fifty-seven year-old Uni President now operates aquafeed production out of Vietnam, producing shrimp and fish feeds with a regional outreach. It has a large market share in shrimp feeds in Vietnam and exports regionally. A recent development was the entry into the Thai market with seabass feeds. It is already a major exporter of both seabass and grouper feeds to Malaysia. This is the second consecutive time Japan's Higashimaru Co. Ltd, exhibited at an APA event. Founded in 1947, Higashimaru has a range of feeds for the shrimp and marine fish feeds, sold in 19 countries. Its marine fish feeds which although are more expensive than its competitors, are favoured by some farms in the region for its growth performance (www.higashimaru-k.co.jp)

Asian-Pacific Aquaculture 2019 (APA'19) will be held from June 19-21 in Chennai, India. www.was.org; www.marevent.com (for exhibition)

Aeration hose to create air bubbles

This is the innovative shrimp farming without any paddle wheel aerators according to the team at Kasipantarut Co Ltd at their booth. The aeration hose creates fine bubbles to increase dissolved oxygen in the ponds. The team demonstrated the options for the installation of the aeration hose. It can either be tied to a PVC pipe on the floor of tank or pond, assembled around a stainless steel ring, attached to a rectangular panel frame made of 100% ABS or attached to an old paddlewheel in ponds. The hose is then attached to an air compressor. It can be used to create a venturi effect for a depth of 2 m. The company has developed an 'airfloc' equipment, where there are six sticks on a round base which gives an air flow of 120 L/minute. This is recommended for hatchery, earthen or lined ponds, various types of culture tanks and for transportation. With this new solution, farmer Atthasit Phorat in Trat has attested a total harvest of 100 tonnes/0.8 ha (www.kasipantarut.com)

Piyawan Jiravanstit (right) and Navaporn Jiravanstit with trade visitors from India, Gopakumar V Nair (left) and Viju Jacob.

New development for Singapore's marine aquaculture

This was introduced by the team from the Aquaculture Centre of Excellence Pte Ltd (ACE), Singapore. Leow Ban Tat, the Director and Founder of AME2, has developed the revolutionary patent pending Novel Offshore Advanced Hull system (NOAHs) Eco Ark®. NOAHs Ark is a 90% submerged hull system, close containment flow through floating fish farm. This is a low-energy design for "pushing" sea water as in-flow and no energy siphonic out-flow. Scalable and expandable high-density farming technology that is not affected by harmful algae bloom and marine oil pollution during external adverse sea-water conditions, NOAHs Ark is the future of fish farming.

A springboard for Singapore's marine fish aquaculture industry, it features the use of specially designed in-flow water treatment starting from filtration, ozone and UV sterilisation, and saturated oxygen water for cultivating healthy fish. Proper treatment of effluent water and gravitational patent pending automatic tank cleaning system and post-harvest processing facilities are also on-board. Approved by Classification Society, Bureau Veritas, the design focuses on low manpower utilisation with automated and smart equipment for the internet of things, with energy-saving design and use of solar energy.

The ACE team, from the right, Frank Tan, Ong Beng Ann and Leow Ban Tat.

Functional feed ingredients for aquafeed

Taiwan's DaBomb Protein Corporation's theme at its booth was "Green, Smart and Safety". It also sponsored a half-day session "Functional feed ingredients for aquafeeds", and invited Dr Yu-Hung Lin from the Department of Aquaculture, National Pingtung University of Science and Technology, Taiwan, to present on the "Effects of dietary *Lactobacillus* fermented soybean meal and lactic acid supplementation on growth, nutrient digestibility and intestinal morphology of grouper." Jeffery Jhih Jie Jiang, Regional Manager, DaBomb Protein, was the session chair.

"The demand for food safety and quality is increasing and is forcing us to optimise aquaculture production. Functional feeds is a growing need in the aquafeed industry in recent years. Feed manufacturers are working on developing functional feeds to withstand the challenges of farming fish and shrimp under intensive systems, for disease prevention and health care," said Jeffery.

Application of organic acids in aquafeed

Lin covered benefits of organic acids and a comparison of different organic acid sources in his presentation. Although, soybean meal is widely used as an alternative to fish meal in aquafeeds, it has several anti-nutritional factors and an imbalanced nutrient composition. There are morphological changes and inflammation in the intestine of soybean meal-fed rainbow trout (Heikkinen et al., 2006).

Organic acids play an important role in animal health, but they are too difficult to pass completely through the intestine. "Based on this, we conducted a trial to compare the effects of two lactic acid sources; fermented soybean meal containing lactic acid and free L-lactic acid for the giant grouper", said Lin. The results showed better nutrient digestibility and intestinal morphology in fish fed diets containing either lactic acid sources, compared to fish fed diets containing soybean but without any lactic acid.

"Interestingly, we found that when fish was fed a diet supplemented with 1% lactic acid or a diet with fermented soybean meal (containing 1% lactic acid), the intestinal flora was similar to that in fish fed a fish meal diet. This was mainly because of the significant reduction of *Vibrio*. This study demonstrated that lactic acid, no matter from *Lactobacillus* fermented soybean meal or pure lactic acid has beneficial effects on nutrient digestibility, intestinal morphology and microflora in grouper fed diets with high levels of soybean meal," added Lin.

'Must have' functional product

Jeffery presented on "Functional feed ingredients as a nutritional strategy in antibiotics-free aquaculture" including the application of bio-hydrolysed soya protein in aquafeeds. "Intensive aquaculture is often accompanied by diseases, overuse of antibiotics and aquafeeds with high specifications to meet consumer demand for quality and specific products. Functional ingredients have become a must-have in facing these challenges," said Jeffery. "This is the reason, we continue to develop fermented soybean meal with functional properties. Our bio-hydrolysed soya protein called 'DaBomb-P' has three major functions: highly digestible protein, enhanced immunity and gut health to face all kinds of challenges."

This ISO 22000 registered premium fermented soybean meal was produced via bio-hydrolysation with *Lactobacillus*. More than 75% of protein in the product are small peptides (molecular weight < 30 kDa), according to Lin et al., 2014. Lin demonstrated

The DaBomb Team from right, CEO, Alice Liu, Jeffery Jiang, Daisy Hsieh and Jesica Tasi.

that protein digestibility improved in white shrimp and grouper fed a diet with 30% bio-hydrolysed soya protein as compared with those fed soybean meal. Jeffery said, "At Da Bomb, 'The Best Protein, Beyond Protein' is the goal. We have been working hard to help the industry face disease challenges in an antibiotic-free aquaculture."

Enhancing immunity

Bioactive peptides released from the microbial proteolysis of soybean play an important role in immune response modulation (Singh et al., 2015). A study showed that significant up-regulation of the immune response was observed when the commercial soybean meal was replaced by this bio-hydrolysed soya protein which was also equal to shrimp fed a fish meal diet (Lin and Mui, 2017). "In order to prevent any disease outbreak, we have to maintain the animal's immunity when we replace fish meal with plant ingredients in diets," said Jeffery.

Gut health

Lactic acid (organic acid) is key to DaBomb's fermentation process to balance intestinal microflora and improve gut health. "In our previous study, adverse effects on intestinal morphology, such as increased cell infiltration of the submucosa and extended lamina propria caused by soybean meal, could be improved in grouper fed a diet containing DaBomb-P," said Jeffery. In addition, studies showed that the lactic acid will move directly through the cell wall of a pathogen and then reduce internal pH by releasing hydrogen ions to inhibit pathogen growth and balance microflora (Mocherla et al., 2015). "As we know, the gut is the most important organ in animals; if we ensure a healthy gut, we have a healthy animal."

Nutritional strategy to challenge diseases

"This is an era where production traceability is important. We uphold the 'Feed to Food' spirit, to ensure food safety. DaBomb Protein's Golden Triangle is based on high digestible protein, balancing intestinal flora and boosting immunity which can significantly inhibit pathogens in the gut to improve survival. The process is natural and harmless, emphasising on the sustainability concept," said Alice Liu, CEO, DaBomb. www.dabombprotein.com.

Innovative microbial-based solutions for sustainable shrimp farming

At the Lallemand booth, from left, Khurshid Anwar (Bangladesh), Dhanunjaya Goud (India), Stephane Ralite (France) and visitors, Thomas Levallois and Teddy Njoto, Maqpro, Indonesia.

Lallemand Animal Nutrition, shared the results of new studies conducted in partnership with ShrimpVet Laboratory at Nong Lam University. These studies encompass the development and evaluation of functional feed ingredients to help address important shrimp health issues such as *Enterocytozoon hepatopenaei* (EHP) challenge, or white faeces syndrome (WFS), as well as the development of integrated bioremediation strategies for pond water management. They suggest different approaches to answer important issues of shrimp health, nutrition and management in a sustainable way.

New perspectives on microbial-based functional ingredients

EHP is an intracellular parasite that targets the shrimp hepatopancreas and gut epithelial lining, causing stunted growth. It generates severe losses across Asia, either directly or in association with other pathogens. The trial results were presented by Eric Leclercq, Ph.D., Aquaculture R&D and Technical Support Manager with Lallemand Animal Nutrition. The trial was conducted at ShrimpVet Laboratory in Ho Chi Minh City, Vietnam, on EHP-challenged juvenile whiteleg shrimp. It evaluated a multi-strain yeast-based additive (YANG) developed by Lallemand Animal Nutrition with enhanced immune-modulating properties and binding activities against undesirable bacteria. The additive was fed for 14-days prior to the disease challenge and during the challenge period. "With YANG, the pathogen load in the hepatopancreas, measured by qPCR, was reduced at all time points and by up to 64% at the peak of infection. As a result, the body weight of challenged shrimp was 7.9 % higher, thanks to, interestingly, a much reduced prevalence of severely compromised animals," Leclercq explained. "YANG, applied preventively and over an EHP challenge period, can thus help contribute to reducing the severity of the EHP outbreak and related loss of growth. Importantly, 'runt' shrimp typically act as disease reservoir, so reducing their prevalence can help safeguard the crop to harvest."

As with EHP, WFS is a pathology that not only strongly affects shrimp growth and FCR, but also survival. The infectious nature of the syndrome, and development of a challenge model, were only recently described by Dr Loc Tran from ShrimpVet Laboratory. The trial presented at the conference assessed the potential of YANG to help mitigate the severity and impact of the syndrome, using the recently available WFS challenge model. Results indicated a lower prevalence of gross symptoms at the peak of infection, a lower loss of body-weight and a clear trend towards a higher survival. This highlights for the first time, YANG's unique properties, the potential of a microbial-based solution as part of an integrated management program to support good health and performance under these conditions.

Bioremediation approach

Bioremediation is defined as: "The treatment of pollutants or waste by the use of microorganisms (such as bacteria) that breakdown undesirable substances." The concept has been applied to aquaculture for decades with the goal of managing organic matter accumulation and nitrogen compounds in ponds. Bioremediation can be powerful but is also a complex technology requiring informed management attuned to local conditions and targets. Based on *in vitro*, pilot-scale and field trials, Leclercq discussed some key success factors in the selection and deployment of an effective bioremediation strategy for shrimp farming. Distinct microbial solutions are available, each addressing specific aspects of the pond system. When properly applied and combined, bioremediation solutions can become powerful tools to secure and increase the capacity of the pond to carry a healthy crop to harvest. (www.lallemandanimalnutrition.com).

Presentations at Asian-Pacific Aquaculture 2018 conference, April 22-26 2018, Taipei, Taiwan.

Eric Leclercq, Stéphane Ralite, Phuc Hoang, Loc Tran, and Mathieu Castex. Effect of a multi-strain yeast-based functional additive on EHP-challenged juvenile white shrimp.

Eric Leclercq, Stéphane Ralite, Diên Nguyễn, Loc Tran, and Mathieu Castex. Effect of selected functional health feed on white shrimp *Litopenaeus vannamei* challenged with a novel infection model for white faeces syndrome.

Eric Leclercq, Stéphane Ralite, and Mathieu Castex. Some critical steps to the successful development and deployment of an integrated bioremediation strategy in pond aquaculture.

Application of biotechnology to improve productivity, efficiency and sustainability in aquaculture

The Centre for Aquaculture Technologies (CAT) continues to be be active at Asian-Pacific Aquaculture (APA) events. This participation in Taipei followed the last APA in Kuala Lumpur, Malaysia in 2017. Established in 2012, CAT is a full-service R&D organisation with facilities both in the San Diego, California, USA and Souris, Prince Edward Island, Canada, focused on the application of biotechnologies to improve productivity, efficiency and sustainability in aquaculture. "Our goal is to reduce technologies to practice and then deploy them commercially to improve aquaculture," says CEO Dr John Buchanan. "This can take the form of refining disease challenge models, or genotyping services tailored for aquaculture applications, or development of novel biotechnologies that directly influence production practices."

The facility in Canada, the Centre for Aquaculture Technologies Canada (CATC), is focused on contract R&D in cold water aquatic species, with expertise in GxP-compliant research. The 21,000 sq ft (1951 m^2) aquaculture research facility was completed in 2015 and in 2016, CATC received approval from the Canadian Food Inspection Agency (CFIA) to operate as an Aquatic Animal Pathogen Containment Level 3 (AQC3) facility. This certification allows the company to work with pathogens from around the globe and also to bring in warm water species such as tilapia and shrimp, expanding the capacity for disease challenges and nutrition trials.

The facilities in San Diego are focused on collaborative research in genetics and molecular biology. Areas of research include the development and application of molecular diagnostics and genotyping, development of *in vivo* models, and application of molecular techniques such as genetic engineering in aquaculture. The Center for Aquaculture Technologies provides a full suite of services across multiple disciplines to help its clients make important technological advances in fish health, nutrition, and genetics.

Director of Fish Health, Dr Mark Braceland, brings expertise in proteomics and biochemistry, as well as novel assay development to the team in Canada. Dr Andre Dumas, Director of Fish Nutrition, has extensive experience in both warm and cold, marine and freshwater fishes. His area of expertise relates to ingredient development, feed formulation and processing, and nutrigenomics.

The skilled team of researchers offers expertise in genotyping, genomics, and selective breeding programs, and supports for collaborative research studies in a range of aquatic species. "Technology-driven solutions are critical to the future growth of aquaculture", said Jason Stannard, Vice President of Genetics. Stannard explains that the company's ability to work with diverse array of species using innovative methods and technologies across multiple scientific disciplines allows them to play a unique role in contributing to advances that clients can make in aquaculture. Providing expertise in the use of genomic tools at CATC, Dr. Tiago Hori, Associate Director of Genomics brings over a decade of experience in genomics and broodstock development, toxicogenomics, immune-relevant global gene expression, and stress and growth physiology.

The team at CAT believes that applied research in genetics and genomics, a better understanding of disease mechanisms and nutritional requirements, and insight into critical physiological processes involved in health, growth and sexual maturation will lead to the development of practical and sustainable solutions for collaborators and clients. www.aquatechcenter.com

Appointment

New Country Manager China

Belgium headquartered feed additives specialist Nutriad announced the appointment of **Liza Fan** as Country Manager China. Multinational Nutriad has been active in China for many years under the brands FFI and NATS, and recently invested in a new state-of-the-art production facility in Nantong. The company offers a broad portfolio of additive solutions for livestock and aquaculture to Chinese producers, supported by scientific data and technical management.

Liza holds a degree in Biotechnology from East China University of Science and Technology and a degree in Business Administration and Management from China Europe International Business School. She has more than 20 years of experience in the feed industry in China and worked for several international companies. Liza said, "I am excited and honoured to be joining Nutriad. Even though the company is a world leader with sales in more than 80 countries, our presence in China is still limited when looking at the size of the market."

Erik Visser, CEO Nutriad added, "The potential of the Chinese market for our products is very strong. Not only due to the size of the market but also because of the support our products and team can provide Chinese producers. Limited availability and changing quality of raw materials challenge intake, growth and performance. Cost of production challenges profitability of producers. Growing customer awareness and restrictions of use of certain products provide further challenges to the market. Nutriad is ready to partner with Chinese producers to address today's and tomorrow's challenges and share our insights."

Aquaculture at Livestock Asia 2018

In April, the inaugural Aquaculture Asia 2018 was held as part of Livestock Asia 2018 expo and forum, the latter a biennial event for the livestock industry within Asia. Aquaculture Asia 2018 was supported by the Department of Fisheries Malaysia (DOF), which organised a half day seminar within the exhibition hall at the Kuala Lumpur Convention Centre. With aquaculture added, Livestock Asia clearly demonstrated the importance of all three sectors; livestock, meat and aquaculture to Malaysia and other ASEAN countries. These events organised by UBM Exhibition attracted 200 exhibitors from 31 countries to showcase their latest innovations and technologies. This year, the 9th edition of the exhibition, was a platform for networking, learning and sharing experiences.

For its pavilion at the show, DOF gathered leaders in Malaysia's shrimp farming business. Present with displays were the leading producers; Blue Archipelago Berhad which produced 3,900 tonnes in 2017 from two farms on the East Coast and West Coast of Peninsula Malaysia; Asia Aquaculture with a production of 3,800 tonnes in 2017; QL Aquamarine with a production of 1,600 tonnes in 2017 from a farm in Kudat, Sabah; SBH Perak Agro Aquaculture in Perak, which produced 2,500 tonnes in 2017; LKPP Corporation in Pahang which produced 1,500 tonnes in 2017 and Sunlight Inno in Sabah, with 2,700 tonnes in 2017.

DOF sponsored 120 farmers to attend the seminar. Speakers were from DOF and industry. In her opening address, Deputy Director General (Development), Tan Geik Hong recounted the status of the industry to date and current challenges. Inclement weather such as droughts, high temperatures and floods have caused losses by as much as MYR 45 million, affecting 1,600 farmers whereas the loss from early mortality syndrome affecting the shrimp industry could have reached MYR 1 billion. A recent challenge is tilapia lake virus (TiLV) resulting in high mortality of tilapia stocks. Rising operational costs mainly from increases in feed costs, is another concern for the industry in Malaysia. DOF's target is to increase aquaculture production to 1.4 million tonnes mainly of these commodities; marine shrimp, freshwater prawn, groupers, seabass, mahseer fish, catfish and ornamentals. This will be through planned development of intensive farming for high volume production, an educated workforce and good aquaculture practices.

At the Taiwan pavilion was Bigbest Solutions Inc, which has developed an intelligent aerator motor with IOT for use with paddle wheel aerators and wave makers, leading to 40-50% savings in energy use in comparison to AC induction motors.

Giva Kuppasamy, GK Aqua, discussed all-male technology for a better future in the farming of the freshwater prawn *Macrobrachium rosenbergii* in Malaysia. In 2015, Malaysia only produced 334 tonnes of this prawn, far below the 124,200 tonnes produced in China and 8,000 tonnes in Taiwan. Giva calculated that the production of the freshwater prawn can be multiplied by using only 15% of idle paddy areas. A production of 35,000 tonnes is possible. Current supply has not been able to meet the demand of local markets leading to high prices (USD15/kg). Currently, hatcheries depend on wild broodstock for post larvae production which means that production of strong post larvae has been difficult and hatcheries cannot fulfill the demand of grow-out farmers. In grow-out ponds, segregation of the fast-growing males from the females is by hand.

According to Giva, the way forward is production of all male juveniles to stock ponds. His business plan is using neofemales broodstock to produce all male post larvae in his hatchery, culture to juvenile stages and then outsource production to contract farmers. Results from his trials showed average growth to 35-50 g

Priscilla Ong and Jeremy Tan, Leong Hup (Malaysia) Sdn Bhd with Marilyn Sim, DiamondV, Malaysia (right).

Dr V Raghavan, livestock feed consultant with research officers, from left, Wan Nooraidah Wan Mohamed, Abidah Md Noh and Nur Atika Ibrahim from the Malaysian Palm Oil Board. They have developed an enhanced palm kernel meal Purafex for livestock and aqua feed production.

Giva Kuppasamy estimated that the production of the freshwater prawn can be multiplied to 35,000 tonnes with production from 15% of current idle paddy areas.

at days of culture (DOC) 50 and 60-75 g at DOC 90. Stocking was 20,000 juveniles/0.4 ha pond. With mixed sex post larvae from wild broodstock, the same growth was only achievable in 6-7 months.

Dr Azhar Hamzah, Fisheries Research Institute, described work on the genetic improvement to increase harvest body weight of red tilapia. Using founder stocks from several countries and family based selective breeding, a 12.3% genetic gain/generation was obtained in the patented DOFIA strain. In comparison, with the Nile tilapia, the gain was 5.8%/generation. Azhar concluded that the institute has been successful in producing a genetic line of red tilapia with favourable characteristics for commercial production in cages or ponds.

DOF's session ended with a presentation on the importance of good aquaculture practices and certification for the industry in Malaysia. The seminar continued with technical presentations by exhibiting companies; Dr Dhanpong Sangsue, Evonik SEA Singapore, presented on advances in amino acid nutrition for sustainable vannamei shrimp farming.

Deputy Director General (Development), Tan Geik Hong (third left) and Yeo Moi Eim, Director Aquaculture (centre) with the DOF team at the seminar

At the Sunlight Inno booth, Mohd Affandi Mustafa (left) and Hamid Shukor.

Rebrand for hygiene solutions company

In June, Coventry Chemicals part of the Coventry Group of companies formally announced, a complete change of name and new visual identity for its 55 year old business. From today Coventry Chemicals will now be called: **Mirius™ - Global Hygiene Solutions**.

Since 1963 Coventry Chemicals has been a leader in the manufacture and supply of cleaning liquids, powders and tablet to suit all professional, retail and international cleaning and hygiene requirements. 2018 sees a change of name for the business to better reflect the company's global commitment and its expertise in driving innovation within the cleaning and hygiene industry.

As part of the rebrand the business has created individual brand identities for each of its divisions – Retail, Professional and Healthcare. The new branding establishes Mirius™ as a modern business at the cutting edge of the cleaning and hygiene industry.

Steve Quinlan, CEO of Mirius™ said, "The new name better reflects who we are today, tomorrow and for the future - we are more than just a chemicals company - we provide solutions. With hundreds of customers in over 80 countries and millions of end-users, we felt it was a good time to capitalise on the momentum of our growing success. To meet the changing needs of our clients, we're taking a bold step to redefine our company and build a new model for our industry. The change of name enables us to leverage the strengths of our different product categories and at the same time align our corporate and divisional brand identities. Our capabilities are second to none, offering quality products, a swift and proven distribution service and in-depth scientific and technical back-up to support our UK and worldwide customers. While our company name is changing, all core elements of the organisation will remain the same - Mirius™ will continue to provide our customers with excellent quality products and reliable customer service at highly competitive prices."

The new Mirius™ branding is now clearly visible in the public domain with a new website projecting the business powerfully online, www.mirius.com

First with certificate to export its Artemia cysts, feed and health products into Ecuador

Philippe Léger (fourth left) and his team.

INVE Thailand, part of Benchmark, has become the first company in Asia to be awarded a certificate to export its Artemia cysts, feed and health products into Ecuador. It will now be used as a reference in the region for other companies seeking similar certificates.

The announcement came after three full days of audits by COTERI (Technical Commission for Import Risk, Ecuador) at the company's factory in Thailand. The certificate, which is valid for four years, was presented by Ecuador's Minister of Aquaculture and Fisheries Ana Katuska Drouet and Daniel Carofilis, sub-secretary of Aquaculture and Fisheries, during a ceremony at Inve's office in Bangkok.

The minister commented on the high standard of operations at the factory which will now be used as a benchmark for other companies applying for a similar certificate in the future. Addressing his team after the ceremony, Philippe Léger, CEO of Benchmark's Inve said: "We are proud of the dedication of our management team and staff in Thailand. This is not only a milestone achievement for Inve and Benchmark, but also the next step towards a more efficient supply chain and enhanced service for our customers in Ecuador. "Working closely together with ambitious aquaculture entrepreneurs worldwide, Inve is privileged to witness many successes, innovations and breakthroughs. We look forward to working with producers in Ecuador to share and develop concepts, best practices and technologies to drive the growth of their business and the industry as a whole."

Inve Aquaculture has been enabling growth in aquaculture for 35 years; the healthy growth of fish and shrimp, the growth of local businesses and the growth of global aquaculture. Since December 2015 Inve Aquaculture has become part of Benchmark Holdings, the leader in applied biotechnology. Together the group offers the most complete nutrition, health and environment solutions portfolio in the market. www.inveaquaculture.com

Exceeding expectations on sustainability KPIs for raw materials

The **BioMar** Group has released its Integrated Sustainability Report. Three years ahead of schedule, four out of five KPI's for raw materials have reached the 2020 target. BioMar's Integrated Sustainability Report is a comprehensive report that is aligned with the UN Sustainable Development Goals and referencing the Global Reporting Initiative guidelines. It gives complete transparency on operations not only with their sustainability KPIs but their finances and growth ambitions. The report takes an in-depth look at the role and importance of traceability and data analytics in the future of sustainable aquaculture. Traditionally, the feed comprises about 80% of the impact in raising fish. The feed ingredients and operations account for most of the mass energy flows in the value chain and hence it plays a crucial role in the overall sustainable, and the environmental and social development of aquaculture.

"Sustainability in the aquaculture industry begins with the feed and in BioMar we believe it is our responsibility to provide our customers with innovative, high performance feed solutions that also reduce the impact on our environment", said Carlos Diaz, CEO BioMar Group. In 2015, the company addressed the sustainability of raw materials by setting ambitious targets for the use of certified products. These KPIs included 100% certification of all soy protein, krill and palm oil and 70% of all fish meal and fish oil. While soy protein remains on track to achieve its 2020 objective, all other ingredients have meet or exceeded expectations. BioMar will now raise the bar on their targets for fish meal and fish oil to 80% certified material by 2020. "Sustainability and responsible sourcing is an ongoing challenge. To continue to be leaders in sustainability we will look to set even more demanding targets beyond 2020 that will help drive us to new heights", added Diaz.

BioMar will continue with their commitment to driving sustainability in 2018 and by year-end will have finalised a full source-to-market sustainability rating of their entire raw material portfolio. This comprehensive assessment tool will enable them to steer their raw material purchasing toward more sustainable solutions and enable aquaculture farmers and the wider value chain to have a more complete understanding of the sustainability of every raw material found in aquaculture feed. www.biomar.com

New phytase to unlock vital nutrients for Vietnam's feed industry

Stephen Crisp, Regional Sales Head, BASF Animal Nutrition Asia Pacific (left) and Marc Guinnement, Managing Director, BIOMIN Asia Pacific, signing the partnership agreement.

BASF and **BIOMIN** will introduce a new phytase Natuphos E to help the swine, poultry and aquaculture better utilise phosphorous, amino acids and energy, resulting in economic and environmental benefits. BASF, the first company to market a phytase for feed almost 30 years ago, has once again set a new standard in phytase technology with Natuphos® E. As a new generation phytase which helps pigs, poultry and aquaculture better utilise phosphorous and other key nutrients, Natuphos E ensures more productive and sustainable output for the animal feed industry and local farmers. BASF will be launching the product in Vietnam, and Biomin Vietnam will be responsible for the distribution in the country. The two companies officially announced the partnership as part of the 20th anniversary celebration of the Biomin Vietnam.

"Biomin is honoured and excited to bring Natuphos E to the Vietnamese market with BASF. This cooperation has been built on a strong relationship and trust that we developed over time. Innovation and quality are our focus and we look forward to building our partnership and further developing the business footprint of both Biomin and BASF in the region," said Marc Guinnement, Managing Director, Biomin Asia Pacific.

"High quality products, good access to the market and sound technical support are the keys to success in any market," said Stephen Crisp, Regional Sales Head, BASF Animal Nutrition Asia Pacific. "Biomin is a multinational company with a strong market presence and penetration in Vietnam. Through our partnership with Biomin, feed manufacturers and farmers will benefit from considerable cost savings through a more efficient diet. Natuphos E releases phosphorus, amino acids and energy which can be utilized by the animal. This makes Natuphos E the most efficient choice available in the market."

The majority of phosphorous in grains and oilseeds is bound to phytic acid, an anti-nutritive factor found in feed. Phytate-bound phosphorous cannot be absorbed well by animals such as pigs and poultry, and is therefore excreted and lost as a potential nutrient. As a result, manufacturers need to supplement the feed with either inorganic phosphates or very effective phytases to make sure the animals are supplied adequately with the required amounts of the essential phosphorous. Natuphos E also releases other valuable nutrients, making animals generally more efficient at digesting their feed. This leads to less excretion of undigested phosphate, which, as a result, helps reduce water pollution. www.biomin.net and www.basf.com

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http://www.asianaquaculture.org/AA-2018-Sponsor.pdf for sponsorship packages

Contact

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Half-time for algal oil production facility in Nebraska

Veramaris, the joint venture of DSM and Evonik, held a topping-out ceremony on site in Blair, Nebraska.

Veramaris, the DSM and Evonik joint venture that will revolutionise aquaculture with its sustainable omega-3 oil from natural marine algae, has celebrated a major milestone in the construction of its new production site in Blair, Nebraska. In the presence of Nebraska Lieutenant Governor Mike Foley, the management of Veramaris and the two parent companies Royal DSM and Evonik, a topping-out ceremony was held in June in Blair, Nebraska.

The construction of the USD 200 million facility is progressing on time and according to plan. Commercial quantities of algal oil will be ready for delivery in mid-2019. Pilot-scale quantities are already being supplied to selected feed producers and farmers for market development.

"Our algal oil is the response to the industry's call for a sustainable source of the omega-3 fatty acids EPA and DHA. The known provenance of all the raw materials used in our process makes the product fully traceable," Veramaris CEO Karim Kurmaly said. The initial annual production capacity of the Nebraska plant will meet roughly 15 % of the total current annual demand for EPA and DHA by the global salmon aquaculture industry.

"The raw material for this disruptive Veramaris technology comes from the heart of American agriculture - from Nebraska. Nebraska corn helps conserve marine life in the ocean. This is a wonderful story and I wish Veramaris all the best in making aquaculture more sustainable," Nebraska Lt. Governor Mike Foley said.

Until recently, the omega-3 fatty acids EPA and DHA added to animal feed have been almost exclusively from marine sources. Currently, a total of 16 million tonnes of wild fish are caught for the production of fish oil and fish meal. With the help of natural marine algae, Veramaris contributes to closing the supply-demand gap for omega-3 EPA and DHA, while helping to conserve marine life and biodiversity in the oceans.

The existing Evonik site in Blair was chosen for the production of the omega-3 fatty acids EPA and DHA to take advantage of Evonik's decades of operational experience for large-scale biotechnology operations. The company has been operating a facility there for the fermentative production of Biolys® - the amino acid L-lysine - for almost 20 years. www.veramaris.com

Veramaris celebrated half-time for its algal oil plant in Blair, Nebraska, as construction is on schedule, from left, Reiner Beste (Evonik), Christoph Goppelsroeder (DSM), Lieutenant Governor of Nebraska Mike Foley, and Karim Kurmaly (Veramaris)

NEXT ISSUES

September/October 2018

Issue focus: Genetics & Genomics

Industry review: Monodon Shrimp

Feed/Production Technology: Feed Safety and Hygiene

Deadlines: ***Articles – July 13, Adverts - July 20***

Shows: 8th International Conference of Aquaculture Indonesia (ICAI 2018), ***October 25-27, Yogyakarta***

Taiwan International Fisheries and Seafood Show, ***November 22-24, Kaohsiung***

November/December 2018

Issue focus: Integration and Supply Chain

Industry review: Catfish/General Freshwater

Feed/Production Technology: Functional Feeds/ Organic Aquaculture

Deadlines: ***Articles – September 14, Adverts - September 21***

Shows: Asian Aquaculture 2018, ***December 3-6, Bangkok, Thailand***

Email: zuridah@aquaasiapac.com; enquiries@aquaasiapac.com for details

First MSC certified hotel group in Asia

One of Shangri-La Hotel group's new seafood dishes featuring MSC certified Australian Rock Lobster.

In June, Shangri-La Hotels and Resorts announced it has received Marine Stewardship Council (MSC) Chain of Custody certification (CoC) for all 53 of its properties across mainland China and Hong Kong. With all hotels in the group participating in the MSC program, Shangri-La Hotels and Resorts have the greatest number of properties in Asia certified by the MSC.

The Shangri-La group recognised that overfishing and increased demand from consumers in Asia, the world's biggest seafood exporter, whose population accounts for one-third of all fish consumption – are putting pressure on the oceans. This new certification will allow their guests to make sustainable and healthy choices. The Shangri-La group initiated the certification program as part of their sustainable sourcing strategy, commitment to protect future seafood supplies and to make a positive impact on the environment. Guests can now identify sustainable seafood culinary offerings by the trusted MSC ecolabel printed on restaurant menus alongside the dish description.

"By being the first to partner with the MSC in Asia, we hope to galvanize others in the hotel industry to join us in offering certified sustainable seafood to make a positive impact in the world collectively," said Shangri-La President & COO Oliver Bonke. "Providing our guests locally and ethically sourced food offerings has been a priority since we launched Rooted in Nature, our culinary sustainability initiative, in 2014. Our partnership with the MSC is the next milestone in our journey." Hong Kong-based Shangri-La Hotels and Resorts, one of the world's premier hotel owners and operators, currently manages over 100 hotels in 22 countries and 76 destinations under the Shangri-La, Kerry, Hotel Jen and Traders brands.

Rupert Howes, Chief Executive of the MSC, said, "The leadership shown by Shangri-La is a visible commitment to meeting the highest globally recognised standards for seafood sustainability and traceability. The MSC ecolabel assures hotel guests that seafood is sustainably caught and can be traced back to a certified fishery.

Trials to promote sustainable seafood

Calysta, Inc announced in May a partnership with Nofima to conduct large-scale trials in Atlantic salmon using Calysta's FeedKind®protein as a means to improve feed efficiency and fish health. FeedKind protein is a family of natural, sustainable and traceable feed ingredients for livestock, fish and pets.

FeedKind has been shown to improve key nutritional metrics for commercial aquaculture – increased feed efficiency and the maintenance of a healthy digestive tract and immune system. It provides the industry with the first scalable alternative protein requiring no wild caught fish or agricultural land, contributing to global food security. The trials, to be designed by Nofima, will begin in early 2019.

"FeedKind protein is a cost-effective, sustainable feed ingredient for major farmed seafood species including salmon, trout and shrimp," said Allan LeBlanc, Senior Director and FeedKind Product Manager. "The aquaculture industry is actively seeking new solutions to reduce costs associated with biological challenges and environmental impact. We look forward to working with Nofima, the industry's preeminent research organisation, to address these compelling market demands."

Mari Moren, director of research at Nofima, said: "We are eager to do research on FeedKind as we believe that this may be an example of new protein sources that can contribute to a more sustainable aquaculture. Feedkind's effect on salmon will be thoroughly tested at Nofima's research facilities along with the effects this protein may have on the physico- chemical qualities of the feed pellet."

FeedKind is a natural, safe, and sustainable non-animal source of protein approved for sale in the European Union and several Asian countries. It has been shown to use 77-98% less water and >98% less land than alternative ingredients such as soy or wheat proteins. In salmon, trout, and shrimp trials, FeedKind has been shown to produce equivalent growth and survival rates when compared to a conventional fishmeal diet. It is approved as an ingredient in organic systems for animal feed in the United Kingdom and EU. www.calysta.com

Aqua Culture Asia Pacific in 2019

Volume 15 2019						
Number	**1 – January/ February**	**2 – March/April**	**3 – May/June**	**4 – July/August**	**5 – September/ October**	**6 – November/ December**
Issue focus *Trending issues and challenges for the next step*	Fish/Shrimp Nursery	Health & Disease Management	Hatchery	Sustainable & Responsible Aquaculture	Genetics & Genomics	Integration and supply chain
Industry Review *Developments, outlook, demand & supply*	Marine Shrimp	Marine Fish	Aqua Feed Production	Tilapia	Functional Feeds	Catfish & Freshwater Fish
Feeds & Processing Technology *Technical contributions from feed industry*	Fish meal Replacements Feed Enzymes	Feed Additives Omega 3 oils	Health/Safety/ Environment in feedmills	Lipids & Minerals Nutrition	Extrusion & Processing	Larval & Nursery Feeds
Production Technology *Technical information and ideas*	Controlled systems/RAS	Offshore and Industrialisation	Innovations	SPF/SPR/SPT shrimp	Post-Harvest Technology/ Processing	Organic Aquaculture
Market and product developments, market access, certifications, branding, food safety etc)	Shrimp	EU	Tilapia	China	USA	Marine Fish
Aqua business *Feature articles*	Experiences from industry and opinion article covering role models, benchmarking, health management, SOPs, social investments, CSR, ancillary services, self-regulation etc					
Company/Product news	News from industry including local and regional trade shows					
Technical articles	**November 16, 2018**	**January 18**	**March 15**	**May 17**	**July 12**	**September 13**
Advert booking	**November 23, 2018**	**January 25**	**March 22**	**May 24**	**July 19**	**September 20**
Show Issue & Distribution at these events as well as local and regional meetings ****Show preview***	**Brackishwater Aquaculture 2019** January 23-25 Chennai, India **VIV Asia 2019** March 13-15 Bangkok, Thailand	**Seafood Expo Global 2019** May 7-9 Brussels, Belgium	***Asian Pacific Aquaculture 2019** June 19-22, Chennai, India	***The Aquaculture RoundTable Series, (TARS 2019)** August 14-15, TBA **Vietfish 2019** (TBA) Ho Chi Minh City, Vietnam	**Aquaculture Europe 2019** October 8-10 Berlin, Germany	

2018

Details on the events below are available online at **http://www.aquaasiapac.com/news.php**
To have your event included in this section, email details to **zuridah@aquaasiapac.com**

August 15-16
TARS 2018: Shrimp Aquaculture
Chiang Mai, Thailand
www.tarsaquaculture.com

August 20-22
Food & Feed Extrusion Technology
Melbourne, Australia
www.foodstream.com.au

August 22-24
Vietfish 2018
Ho Chi Minh City, Vietnam
www.vietfish.com.vn

August 22-25
Aquarama 2018
Shanghai, China
www.aquarama.com.cn/en/

August 25-29
Aqua 2018 Montpellier, France
www.was.org/www.aquaeas.eu

August 26-31
25th Annual Practical Short Course on Aquaculture Feed Extrusion, Nutrition and Feed Management
Texas A&M, USA
http://perdc.tamu.edu/extrusion/

October 1-4
AquaSG'18
Singapore
www.aquasg.com

October 18-20
Future Fish Eurasia 2018
Izmir, Turkey
www.future-fish.com

October 23-26
LACQUA 2018
Bogotá, Colombia
www.was.org

October 25-27
The 8th International Conference of Aquaculture Indonesia (ICAI 2018)
Yogyakarta
www.icai.aquaculture-mai.org

November 7-9
China Fisheries and Seafood Expo
Qingdao
www.chinaseafoodexpo.com

November 21-23
Taiwan International Fisheries and Seafood Show
Kaohsiung
www.taiwanfishery.com

December 3-6
Asian Aquaculture 2018
Bangkok, Thailand
www.asianaquaculture.org

2019

January 23-25
Brackishwater Aquaculture (BRAQCON 2019)
Chennai, India
Email:cibabraqcon2019@gmail.com

March 7-11
Aquaculture 2019
New Orleans, Louisiana USA
www.was.org

March 13-15
VIV Asia 2019
Bangkok, Thailand
www.vivasia.nl

June 19-22
Asian-Pacific Aquaculture 2019
Chennai, India
www.was.org

AQUA 2018

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

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

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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