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Zuridah Merican

Sustainability - an Asian perspective

In Asian aquaculture, sustainability is perhaps one of the least understood words. It is often used by the consumer as licence to buy a product. Some Asian farmers have taken this as conspiracy and a non-tariff barrier to alienate farms in Asia just because they can be low-cost producers. There are three major drivers of sustainability, namely economic, social and environmental, and this editorial will focus on the latter two. We assume that economic sustainability is a no-brainer to remain in business. Let's have a look at the other two sustainability issues along the aquaculture supply chain.

When we discuss environmental sustainability, farming in an aquatic environment poses new challenges. The hatchery and the grow-out farm face similar issues with effluent water. Incoming water is in the proper sense "borrowed" and not consumed and hence should be returned to the environment in the same quality as it came in. That is why compliances such as effluent treatment of water prior to discharge, reported in our article (pages 8-10), raises the sustainability ticket of a farm. Recirculating aquaculture systems (RAS) will help to reduce water usage and manage the resource. But the capital and operational expenditures are high. Grow-out farms tend to appropriate land close to the sea which will invite scrutiny from environmental NGOs. Many Asian governments have regulated that farms must maintain a natural border between itself and the sea and replanting of mangrove is encouraged, but NGOs are still not happy.

Aquaculture also tends to be large employers in rural areas, providing economic sustainability and raising standards of living. This point is often overlooked. Stocking density has also entered the sustainability debate. Are stocking higher densities testing the carrying capacities of the system such that the risk of disease outbreak is being tempted? Waste and uneaten feed have damaging consequences in a pond, lake or coastal areas. In all three environments, water quality will deteriorate leading to disease.

Perhaps the most discussed topic on sustainability centres around feed and the use of fish meal as an ingredient. There is also the question of the source of fish meal. The IUU and slave labour issues plaguing the Southeast

Asian fishing industry remain. Today, we know that replacement of fish meal is possible but to attain the same growth performance would lead to an increase in formulation cost. This is made worse by the fact that the price of the alternatives is positively correlated to the price of fish meal; so the result is unchanged.

The retailers and the distribution chain tend to rely on third party certifiers to ensure sustainability. The media-driven stories influence consumers to make their choice. NGOs have to learn to work with producers rather than threaten and alienate them. Certification increases the cost of doing business which has to be passed on to consumers. Fortunately, we now have certification bodies working with each other to streamline the process. The objective is noble but the way of doing business (it is a business) could be more user friendly.

Pursuing sustainability is a necessity but should there be a question of moderation. Taking extreme positions one way or the other will be counter-productive for the consumer as the industry itself will not be sustainable. Asia faces the brunt of sustainability issues because we are a fragmented industry. For example, meeting the image and sustainability agenda of European and American consumers has been an uphill climb for Vietnam's pangasius industry. It has been working hard to overcome negative perceptions of the fish and has achieved certification from international bodies but the recent price increase due to lower supply has prompted EU retailers to remove the product from the shelves. According to seafoodsource.com, retailers are attributing the action to health concerns and increase in price. Surely, something has got to give (see Spotlight on the pangasius in Vietnam, p6).

Asia has learnt to produce well but there is a still a lack of cooperation amongst producers. Government regulation can only go so far and we have to promote self-regulation within the industry to achieve a position of strength. We have been able to sell the product but we are poor in marketing the product.

OUR MISSION

We strive to be the beacon for the regional aquaculture industry.

We will be the window to the world for Asia-Pacific aquaculture producers and a door to the market for international suppliers.

We strive to be the forum for the development of self-regulation in the Industry.



TARS 2017 will be on Finfish Aquaculture: Strategies for Growth.

It will be held from 16-17 August in Bali, Indonesia. For updates, visit www.tarsaquaculture.com

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AFFIA: Insect production pioneers join forces in Asean

The aim is to achieve a sustainable and efficient development of a young but determined sector: entomoculture in the ASEAN region.

Representatives in the Executive Council of the ASEAN Food and Feed Insects Association (AFFIA) include regional players from various countries: Thailand, Dr Wasaporn Chanput, from the Department of Science and Technology, Faculty of Agro-Industry, Kasetsart University, Massimo Reverberi from Bugsolutely and Paijit Sangchai from Star Bugs; Malaysia, Anne Deguerry from Entofood, and Bart Verstappen from EAWAG, Indonesia. AFFIA joins other regional associations which include the International Platform of Insects for Food and Feed (IPIFF) which is active in Europe and worldwide, UK's Woven Network CIC and North American Edible Insects Association (NAEIC).

"All players from the insects as feed and as food sectors are experts in different aspects of the industry and research. They are willing to learn from one another. The mission of AFFIA is to bring industry and research stakeholders from the insects sector in a collaborative movement towards the development of entomoculture, entomophagy and their related activities," said Nathan Preteseille, AFFIA's Coordinator, based in Thailand.

Some of AFFIA's goals are to define regulatory requirements at the national and ASEAN levels for insect products and to work in collaboration with related authorities at the national, regional and international levels. It will also work together to promote market access, at the local, regional and international levels, especially to access EU and US markets. There are subgroups for the two main sectors, food and feed. Food includes insect species having most of their applications as human food (e.g. crickets). Feed includes insect species used as ingredients in animal feed and waste management. AFFIA also promotes the human consumption of insects and works together on trans boundary issues to define shared positions (e.g. halal status).

This first meeting of its kind in Southeast Asia showed how shared development goals can overcome national differences.



Next will be to define detailed status and plan for activities to reach the association objectives through exchanges among the members. A mapping of the industry in Southeast Asia will be defined to ensure the association represents most of the insects' industry actors in the region.

In November 2016, AFFIA introduced insects as food and feed through a short course organised by the Food Security Centre at Kasetsart University, Thailand. The main expert from Laos, Dr Thomas Weigel, researcher on edible insects raised awareness on the nutritional benefits of edible insects as food. There was also a discussion on insects as a potential replacement for fish meal. The potential of insect meal for land animals was discussed by Dr Attawit Kovitvadh, Faculty of Veterinary Medicine, Kasetsart University. This was based on his PhD research on the use of black soldier fly larvae as a feed source for the rabbit. Nathan Preteseille discussed the use of insect meals in aqua feeds. Participants also had the opportunity to see insect production from farm to table with food tasting of seven products, from cricket energy bars to cricket pasta.

AFFIA hopes that this awareness on insects as feed will drive the development of sustainable food sources, overcome drawbacks on current food production systems and finally, create interest for this sector in the food industry. (www.affia.org)

The Europe-Asian Technology and Innovation Platform

Satisfying seafood demand is a key issue within global food security that should be addressed by increasing sustainable production and management practices. Southeast Asia is a dominant player in aquaculture production while Europe not only produces but also provides a cornerstone market for seafood, where more than 65% is imported.

EURASTIP will provide a new mechanism to create and reinforce international cooperation on sustainable aquaculture between Europe and Southeast Asia, involving stakeholders from both regions and focusing on actions that will provide mutual benefit. The EURASTIP consortium is made up of partners from Europe and Asia, whose organisations and personnel have the skills and experience to address and achieve these objectives. This consortium is supported by extensive networks to facilitate outreach to professionals and education and training for all stakeholders.

The core objective of the EURASTIP project is to evaluate and prepare for the launch of an international multi-stakeholder platform, the European-Asian Technology and Innovation Platform (EATiP), which will provide a new mechanism to create and reinforce international cooperation on sustainable aquaculture between Europe and Southeast Asia. This platform will comprise of stakeholders from Europe and Southeast Asia, and will focus on actions that will provide mutual benefits to both regions.

Under this EURASTIP platform, national pilot multi-stakeholder platforms (NMSP) will be created in Thailand, Vietnam and Bangladesh, involving industry, associations, researchers and teachers. EURASTIP will be linked to EATiP and will be the focal point for creating links between the European and Southeast Asian industry players and will help the development of partnerships for business opportunities and the promotion of innovation uptake.

EURASTIP will also help to identify and address common standards for planning and operation of sustainable aquaculture,

covering site planning/zoning, aquatic animal health and welfare, food product safety and farming governance. Reinforcing the professional skills of both aquaculture professionals and researchers is an additional objective, linking specifically to ASEAN-FEN to promote an international education/training network.

EURASTIP will facilitate, through brokerage events, not only new partnerships but also achieve analysis and foresight actions to clearly identify opportunities and challenges facing sustainable aquaculture development. The work and actions of these national platforms will be used to develop roadmap models for the creation of other NMSPs in Southeast Asia that, collectively, would be the foundation for the long-term success of EURASTIP.

Running from 2017-2019, EURASTIP has ambitious goals whose progress will be followed and accompanied by transparent dissemination activities and impact assessment. The

consortium contains EATiP, the Universities of Ghent, Stirling and Wageningen from Europe and the WorldFish Centre, Nong Lam University, Vietnam and Universiti Malaysia Terengganu, Malaysia (responsible for ASEAN FEN). EATiP members that will be active in EURASTIP include Inve Aquaculture, European Aquaculture Society, AquaTT, Norwegian University of Science & Technology, Nofima and Sorgeloos4Aquaculture.



The first major activity of EURASTIP for the larger public in Asia will be at the Asian Pacific Aquaculture Conference in Kuala Lumpur, 26-29 July 2017. There will be a special EURASTIP session to introduce the different work packages and explain how the sector in Asia (and in Europe) can be involved in this project. (www.eurastip.eu)

Eight global contestants advance in Fish-Free Feed Challenge

Teams compete in a multi-stage contest to develop fish-free feed for the aquaculture industry.

The F3 Fish-Free Feed Challenge launched in November 2015 on the HeroX crowdfunding site is to encourage innovation of alternative ingredients for aqua feeds, improve the industry's sustainability, and to reduce pressure on wild-caught fish to supply fish feed components. The contest is intended to help catalyse the development and sale of cost-competitive, viable aqua feeds free of fish meal and fish oils.

In February 2017, it announced that eight multinational teams have qualified to participate in the global fish-free feed technology contest. Contestants from Thailand, Indonesia, China, South Africa, Australia, Pakistan, Myanmar, the Netherlands, Belgium, and the US are advancing to the first sales reporting stage of the multi-stage contest to develop fish-free feed for the aquaculture industry.

"While the global aquaculture industry has made strides to stretch the limited amount of fish meal and fish oil to rear more fish and shrimp, there is a severe need to find alternatives to these marine products to feed aquaculture-raised fish," said University of Arizona Professor Kevin Fitzsimmons, lead spokesperson for the F3 Challenge. "The eight registered teams which have qualified for the contest have each submitted feed specimens which are currently being analysed to ensure that they are free of fish meal and fish oils.

"The first company to produce and sell 100,000 tonnes of aqua feeds that do not contain marine animal meal or oil will be awarded a prize of more than USD 200,000 to support their fish-free aqua feed business. If none of the contestants have met the 100,000 tonnes target by September 15, 2017, the prize will go to the company closest to the target."

Contestants ranged from companies with their own mills and farms with multinational sales to start-up farms and ingredient companies. Farms and ingredient suppliers partnered with feed mills to form larger teams. Companies submitted feeds for a range of aquatic animals including shrimp, tilapia and trout.

The Monterey Bay Aquarium, New England Aquarium, University of Arizona and World Bank are sponsoring the F3 Challenge,



Team	Diets submitted
AgriProtein (Gibraltar), Abagold (South Africa)	Rainbow Trout
Guangdong Evergreen Feed Industry Co. (China)	Tilapia, Carp, Dace
Htoo Thit Co. (Myanmar), Biomin (Austria)	Tilapia/Carp
JAPFA Feeds (Singapore/Indonesia)	Tilapia
Oryza Organics (Pakistan)	Tilapia (x2)
Ridley (Australia), Sureerath Prawns (Thailand)	Shrimp
TomAlgae (Belgium)	Shrimp
TwoXSea (US California), Star Milling Co. (US California), Alltech (US Kentucky), TerraVia (US California)	Trout

with additional donations to support the administrative costs of running the contest.

The contest arose out of discussions first held at the 2015 World Aquaculture Society meeting in Busan, Korea, between Fitzsimmons and several environmental non-profit organisations, and demonstrated how industry and environmental groups can come together to achieve the common goal of developing cost-effective substitutes. The aim of the contest is to ensure that the feeds are at least as nutritious for the farmed-raised seafood being fed and that the final seafood produced is just as nutritious for consumers.

"Eventually we would like to see that fish meal free seafood would be considered as sustainable and good for the environment as grass-fed beef or free-range poultry," said Fitzsimmons.

The F3 Challenge team is optimistic that the 100,000 tonnes target, which would represent a major milestone in validating the market viability of fish-free feeds, will be met. (www.herox.com/F3)

Spotlight on the pangasius in Vietnam

Pangasius fish farm gate price has been moving up in the Mekong Delta, according to vasep.org. In March, the price reached VND 23,000-26,000/kg (USD 1-1.1/kg), up VND 1,000-3,000 (USD 0.13/kg) since January. With this price, profit margins for farmers reached an unprecedented VND 5,000/kg or USD 0.22/kg. However, despite this price hike, farms do not have enough fish to sell and processing plants were operating at only 40-60% of capacity due to material shortage. The Vietnam Pangasius Association reported that the farming area was 3,400 ha in 2016 and production was 1 million tonnes.

The “Crisis for Vietnam’s pangasius” news item on seafoodsource.com reported that this short supply and high demand arising from adverse weather conditions and a cash crunch have hurt production cycles of farmed pangasius in Vietnam. Some processors have even stopped giving quotes to retailers. The estimated farm production for pangasius in Vietnam in 2017 is only 500,000 tonnes; with a fillet yield of 30% this production may only fulfill 40% of the market demand in 2016. Top-grade, 100% net weight pangasius with 5% glazing and no chemical treatment is now sold at about USD 3.70/kg CNF; a year ago, the same specification could be sourced for about USD 2.90/kg. Some supermarket buyers have stated that if the price for the fish cannot be kept at the same level as 2016, they simply will not sell it anymore, and this will be a possible massive setback for the pangasius industry in Vietnam.

Controversy again

Recently, the Spanish Cuatro TV highlighted pangasius farm conditions and how its culture impacts the environment (talkvietnam.com). VASEP (Vietnam Association of Seafood Exporters and Processors) said this documentary cannot represent the entire catfish industry of Vietnam. Nevertheless, there are repercussions. Carrefour, one of the largest European supermarket chains stopped selling fresh/frozen pangasius in its supermarkets in Spain, France, Italy and Belgium (carrefour.com). However, it said that although it is certain that the quality of the pangasius that it has been selling has been impeccable, the adverse impacts that these fish farms have on the environment cannot be totally denied.

Support for responsible pangasius producers

In 2016, more than 187,000 tonnes of pangasius production are certified by three main agencies, Aquaculture Stewardship Council (ASC), Global Aquaculture Alliance (GAA) and GlobalGap (VASEP, 2016). Farm certification began as early as 2012. The leading pangasius producer and exporter, Vinh Hoan has a self-supply ratio of 65% and ASC-certified farm area of 115 ha, the largest in Vietnam (vasep.com). Vinh Hoan is the largest pangasius exporter to Spain, which imported 21,100 tonnes of the fish in 2016 (fis.com).

As Vietnam’s pangasius industry finds itself in the media spotlight, GAA has issued a statement to set the record straight on several issues (gaalliance.org). It said that the pangasius can be produced responsibly to meet rigorous food-safety standards, and therefore can be purchased with confidence. Pangasius producers certified to meet Best Aquaculture Practices (BAP) standards are subject to rigorous food-safety inspection and environmental production controls. These producers have invested in their businesses to meet these requirements and should be respected



for their proactive leadership. There have been anti-pangasius campaigns, often promoted by competing seafood interests and spread on social media, that can easily misrepresent the realities. However, the claims made in these campaigns have been successfully challenged by scientific studies and published science reports, including Murk et al. (2016), Huysvedt et al. (2013), Little et al. (2012) and Anh et al. (2010).

The co-author of one of these papers, Simon Bush, professor of environmental policy at Wageningen University, responded to recent developments by saying, “Pangasius has been the subject of food and environmental scares, but on closer inspection these claims lack substance. Our analysis shows that the bad press on pangasius do not concur with the findings of scientific studies which showed very limited food safety risk and limited adverse environmental impacts. In reality, pangasius, a relatively new product in Western markets, has found an important niche in retail and foodservice outlets and is perhaps a victim of its own success.”

Ghent University Professor Emeritus Patrick Sorgeloos told VTM news, “In the media, the fish has wrongly been given a bad image. Research of Dutch scientists has showed that the contribution of the pangasius industry to pollution in the Mekong River is negligible.”

In its press release, ASC said that when farmed responsibly, and according to robust environmental and social criteria as defined in the ASC Pangasius Standard, buyers and consumers can have confidence in their choice of pangasius for their families (asc-aqua.org). It added that pangasius can be farmed efficiently, with low land use and low use of feed, and can be produced in a way that respects the environment and communities. More importantly, research has shown that because the fillets are boneless, mildly flavoured and easy to prepare, it is an excellent “entry” fish and encourages consumers new to seafood consumption to engage with seafood, and further experiment with other seafood varieties. The pangasius farmers in the ASC program, including CP Vietnam Corporation and Thuan An are two real-world examples of the benefits that certification can bring.



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Raising the bar in Malaysia

By Zuridah Merican

With the implementation of IETS in its farm and hatchery, Blue Archipelago is raising the bar for all large shrimp farms in Malaysia to have a sustainability ticket.

Marine shrimp aquaculture has chalked up noteworthy achievements since the 1980s with the start of industrial farms; among these achievements are its improvement in sustainability and care for the environment. Today, practices with minimum or zero exchange of pond water throughout the duration of the culture cycle minimise the impact of farming activities on the environment. However, often this is insufficient and in countries such as India, there are regulations for small and large farms to have treatment of waste water prior to discharge into coastal environments. In Malaysia, an effluent treatment system is a statutory requirement by the Department of Environment (DOE) for a premise that discharges industrial effluent into any inland water or Malaysian waters.

The tag-line for Malaysia's Blue Archipelago Berhad (BAB) is "Quality/ Safety/ Ecology". In keeping with the ecology mission, the 500 ha iSHARP farm Phase 1, as well as its hatchery, both located in Terengganu, on the eastern coast of Peninsular Malaysia, each has an industrial effluent treatment system or IETS. At these two facilities, the IETS is based on the conventional aerated lagoon system, where the waste water is channeled into a series of large ponds installed with aerators. The waste water is held in settling and treatment ponds before it is discharged into the environment.

Abu Bakar Ibrahim, CEO said, "Regulation notwithstanding, the shrimp aquaculture industry has to follow the role model set by its bigger brother in Malaysia ie. the palm oil industry where sustainability and effluent treatment can influence the image of Malaysian products in the export market. I was recently asked to peer review a report on Malaysian shrimp by Seafood Watch and effluent treatment is a major criterion for this program that helps consumers make choices for a healthy ocean. The IETS is a significant investment but it is also a long term investment for the credibility of our shrimp and our operations."

Control of effluent water quality

The 264 ponds at the iSHARP farm undergo minimal water exchange during the 90-day culture duration. There are usually two partial harvests prior to a final harvest. After the final harvest, the pond is emptied and the water is drained into the main discharge canal. BAB's IETS is designed to receive discharge water on a daily basis, calculated at 13,000 m³. The system has a built-in safety factor and can handle daily a volume up to 15,840 m³.

In an area of 21 ha, located 6.7 km from the outfall site, there is a 6.59 ha equalisation pond which receives waste water from the main discharge canal. Water then moves sequentially into the three aeration lagoons (each of 2.25 ha) where aerobic bacteria treatment is carried out. Water from the third aeration lagoon flows by gravity into the 2.25 ha sedimentation pond. From here, a pipe removes sludge into a sludge drying shed. The overflow of water from this sedimentation pond enters the 2 ha holding pond for treated water and finally, treated water is pumped out to the marine water outfall, 200 m out at sea (Figure 1).

"The whole process takes 12 days. We culture the aerobic bacteria for bio-remediation in the aeration lagoons. We run 10 units of 2 HP paddlewheels in the equalisation pond and a total of 50 units of 2 HP paddlewheels in three aerations lagoons, depending on our needs. Our system removes organic and inorganic pollutants. The treatment process is to meet the physico-chemical standards in accordance with the DOE regulations. DOE does not require us to monitor bacteriological parameters. We do this when requested by the farm," said Shaifaidil Adha Salleh, who is responsible for the running of the IETS/iSharp, Wastewater Department.

Among the seven-member team, are three graduates. The success in the operations of an IETS is dependent on a clear understanding of the factors affecting its performance, operational conditions, maintenance of the system and also the legal implications for non compliance. Therefore, it was a prerequisite for Shaifaidil Adha and team mates to follow a certificate course conducted by the Environment Institute of Malaysia.



The IETS at iSharp, Phase 1. Aeration ponds with paddlewheels lead to the sedimentation pond. The marine outfall pump house is at the extreme right of the photo



Shaifaidil Adha Salleh (right) and team mates at the sludge drying shed

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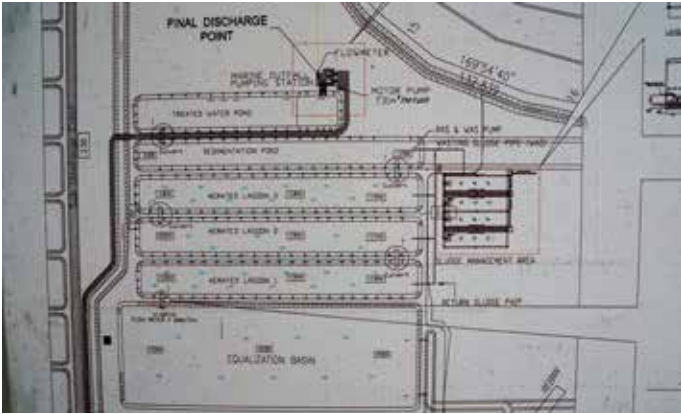


Figure 1. Layout of the IETS at iSharp Phase 1

A very serious Shaifaidil Adha, a graduate in environmental studies at Universiti Malaysia Terengganu, explained, “Our role is also to justify that the water is clean and treated well enough. If not, we will continue to recycle the water. We ensure that the IETS is functioning efficiently and submit data monthly to DOE. The penalty for non-compliance is very stiff and local DOE officials check on our performance as well as on the functioning of equipment such as the water analysis probes and kits. Their most critical requirement of us is that we maintain our equipment well and that our data are reliable.”

Monitoring process

The team has daily, weekly and monthly routine measurements for several parameters, depending on the stage in the treatment process. The list is long and include flow rate, pH, temperature, suspended solids (SS), volatile suspended solids (VSS), sludge volume in 30 minutes (SV_{30}), dissolved oxygen, oxygen uptake rate, biological oxygen demand (BOD), nitrate, nitrite, ammonia nitrogen and phosphates. In addition, they carry out odour and visual observations, sludge transfer and housekeeping activities.

“Most of the physical tests are conducted on a daily basis and samples for some chemical tests are sent to the laboratory weekly. According to the DOE’s Standard B, Environmental Quality (Industrial Effluent) Regulations 2009, the acceptable level for ammonia nitrogen is 20 mg/L and our level is 4 mg/L. This standard does not indicate any level for phosphate but we keep this at 2 mg/L. In addition, on a monthly basis, we send out samples to an external laboratory for confirming pH, BOD, SS and ammonia readings. Prior to the set-up of the system, the consultants carried out the hydrological mapping of the intake and outfall locations. The intake is located a further 1 km away



Aeration ponds at the hatchery

from the outfall location, towards the open sea. We monitor conditions (ammonia nitrogen, nitrite, nitrate, phosphates, SS, BOD, pH, DO and temperature) in accordance to the Malaysia Marine Water Quality Criteria and Standard at these two locations as well as at three more predetermined locations, surrounding the these two points. In short, all of the treated water will have to satisfy DOE’s Standard B before they are being discharged into the sea,” explained Shaifaidil Adha.

“The salinity of the waste water ranges from 20 – 35 ppt. Because of this, we are mandated to discharge directly into the sea rather than into a river close by. There is a proposal to recycle treated water into a reservoir in the future.”

Pumps in the marine outfall station discharge water at night when electricity rates are lower. Overall the operational expenses of this IETS is around MYR 100,000/year (USD 23,000/year) and this excludes the infrastructure costs. There are plans to improve the water quality analyses, in particular microbiological



Pumps in the marine outfall station

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Equipment for hatchery:	Scoop net



Wan Nadhri Wan Fauzi (right) and his team at the hatchery

parameters of waste water leaving ponds and after treatment which could possibly add to farm epidemiology data.

A parallel system at the hatchery

Over at the BAB hatchery in Telaga Putat, 15 km away from the iSharp farm, there is a parallel system for waste water treatment. The hatchery has an annual capacity of 1 billion post larvae and supplies post larvae to the iSharp farm and third party hatcheries and farms.

The IETS occupies 1 ha of the 8 ha hatchery site. Each of the two collection ponds can hold a day's waste water from the hatchery. This caters for the future expansion of the hatchery. Water from the collection ponds flows via gravity to treatment and sedimentation ponds and finally out to sea. This marine outfall is 100 m from the beach line. Here, all ponds are HDPE lined.

“These waste water collection ponds are part of MyGAP (Malaysia Good Aquaculture Practices) and Fish Quality Certificates as well as a DOE requirement. This is an investment we have made at a cost of MYR 400,000 (USD 90,000) although it does take up land area. However, I am proud to say that this is the only hatchery in the country that has invested in such a system as part of its environmental protection plan,” said Wan Nadhri Wan Fauzi, Head of BAB Hatcheries.

“The system does seem traditional with ponds rather than tanks for such a modern hatchery here, but for the moment, the volume of discharge water is manageable.”

There are some small differences between the systems at the hatchery and the farm. At the hatchery, the waste water undergo bioremediation with aerobic bacteria in the aeration ponds. The water stays in these ponds for 3 days before channeling to a large sedimentation pond. The overflow from this pond is channeled to the holding pond for treated water. Water, usually with a salinity of 32 ppt, is chlorinated before discharge into the sea to ensure no escapees into the environment.



Culture ponds at iSharp, Phase 1

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Perspectives on mariculture in India

By Sekar Megarajan, Ritesh Ranjan, Biji Xavier, Muktha Menon, Loveson L Edward, Narasimhulu Sadhu and Shubhadeep Ghosh

A slow start but a big leap in the near future with progress in hatchery seed production of several species and feed development.

The aquaculture sector in India has a long history and has witnessed an increase in production for the last two decades with an annual growth rate of 6-7%. This means that India is the second largest producer of farmed fish in the world after China. At present, freshwater aquaculture contributes to a major proportion of the aquaculture production from India (FAO, 2014).

In India, brackish water aquaculture is a traditional practise in natural coastal low land areas such as pokkali fields (salt resistant deepwater paddy fields along the Kerala coast), bheries (man made impoundments in coastal wetlands of West Bengal state), khar lands (tidal lands in Karnataka state) and khazan lands (saline flood plains along tidal estuaries in Goa) with varying production capacities and depending on tidal influences and natural supply of seeds (Kutty, 1999). After several trials, under different R&D programs, scientific coastal farming was initiated in the early 1990s with the active involvement of different stakeholders. Since then, shrimp farming has grown tremendously and at present, dominates coastal aquaculture. However, the frequent problems in shrimp culture raises the question on the sustainability of coastal aquaculture as it is solely dependent on a single group i.e. shrimp. Therefore, species diversification with high value marine finfish is now being considered to develop a sustainable and eco-friendly coastal aquaculture industry in India.

Status of mariculture in India

India has vast potential areas for mariculture with 8,129 km of coastline, 2.2 million km² of the exclusive economic zone (EEZ) with 0.5 million km² of continental shelf, 1.2 million ha of brackishwater areas and 20 million ha for sea farming (Modayil et al., 2008). In spite of having huge mariculture resources, the country is still at the initial stage in marine finfish production with only 1.43% contribution to the global farmed marine finfish production (FAO, 2016). Marine finfish culture in India has not taken up in a big way due to several problems associated with its farming.

However, this may soon change with recent developments. The breeding and culture technology of some species, namely the Asian seabass (*Lates calcarifer*), cobia (*Rachycentron*



Open sea cages



Cages in brackish water creeks

canadum), silver pompano (*Trachinotus blotchii*) and orange spotted grouper (*Epinephelus coioides*) have been developed and successfully demonstrated in Andhra Pradesh, Tamil Nadu, Kerala, Maharashtra, Gujarat and West Bengal. Farming in sea cages and cages located in earthen ponds use both hatchery produced and wild caught seeds.

Culture system and species

In 2007, the Central Marine Fisheries Research Institute (CMFRI), under the Indian Council of Agricultural Research (ICAR) initiated open sea cage culture for marine finfish. After several modifications of the mooring system and frame structure, an appropriate low cost cage design suitable for Indian conditions was developed. Thereafter, experimental culture of seabass, mangrove red snapper, pearl spot, milk fish, cobia, silver pompano and different species of mullet were carried out in floating sea cages off several states (Kerala, Tamil Nadu, Karnataka, Andhra Pradesh and Odisha) with varying degree of success.

Nevertheless, the progress in cage culture has convinced several government organisations, entrepreneurs and farmers to venture into cage farming using hatchery produced and naturally available seed stock of high value marine finfish. In addition to cage culture, the culture of marine finfish in earthen ponds is also gaining importance among farmers as the pond design and pond preparation are similar to shrimp culture ponds. Some shrimp ponds have been converted for finfish culture as shrimp farming was facing frequent disease outbreaks, high production costs, and low prices in international markets.

ICAR-CMFRI and ICAR-CIBA (Central Institute of Brackishwater Aquaculture) have developed and standardised hatchery production of the Asian seabass, cobia, silver pompano, pearl spot (*Etroplus suratensis*) and orange spotted grouper. The Rajiv Gandhi Centre for Aquaculture (RGCA) has developed commercial hatchery seed production for Asian seabass, cobia and silver pompano. In addition, Asian seabass, milk fish, mullets, pearl spot and mangrove red snapper juveniles are collected from the wild for grow-out culture. Research showed that these species are suitable for cage culture and the Asian seabass, orange spotted grouper, silver pompano, milk fish and mullet are suitable for culture in ponds.



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Silver pompano harvest from brackish water cages



Asian seabass culture in brackish water cages

Challenges and prospects for finfish mariculture

Finfish culture was initiated in 1940 at Narakkal, Kerala. Initially, the culture began with milkfish (*Chanos chanos*) and grey mullets (*Mugil cephalus*) and they had registered an encouraging production of 1,000 kg/ha/yr (Regunathan & Kitto, 2007). However, since then the progress was not as expected and there are several underlying reasons for the poor growth of mariculture in India.

Hatchery production

The major bottleneck for the development of a finfish mariculture industry is the availability of hatchery produced seeds. Hatchery seed production technology for several tropical marine finfishes are well developed in several Asian countries but only at an initial stage in India. Marine fish culture using hatchery produced seeds is popular in Taiwan, China, Thailand, Philippines, Indonesia and Malaysia. However, the efficient transfer of these hatchery technologies to India is a major challenge. Unlike shrimp post larvae and fresh water fish fry production, marine fish fry production is comparatively difficult, because of the lengthy larval cycle and low survival rates. These factors prevented farmers from venturing into marine fish fry production. Therefore, more effort on training and demonstrations on marine fish fry production is required to impart confidence among farmers to undertake such activities.

To this end, several R&D organisations frequently conduct training programs for aqua entrepreneurs and farmers. With successful technology transfer, the setting up of hatcheries by private entrepreneurs may be realised in the near future. The use of wild seeds for fish culture is another option. Recently, CMFRI took the initiative to prepare the seed calendar for marine finfishes making available information on species availability, location and seasonality under the All India Network Project (AINP) on mariculture. Certainly, it gives a correct picture on the available seed resources in India and may help the grow-out sector.

Feed

Feed is another constraint for marine finfish culture. In most farms, low value fish and trash fish are used as feed (Yamamoto, 2006). Nowadays, the availability of trash fish is scarce. Therefore, imported and locally produced artificial feeds are used as an alternative to trash fish. However, the use of artificial feeds is constrained by cost, availability, performance and other issues. Recently, feed company, Growel Feeds Pvt Ltd, introduced sinking and floating feeds for the cobia, silver pompano, and seabass. Initial trials using these feeds in several locations were

encouraging. Thereafter, the feed is being commercially used by different stakeholders. In a similar way, many Indian feed companies may come up with different feeds for marine finfish, similar to that in the shrimp industry.

Markets

In general, there are large communities within a 50 km vicinity from the coast and these communities consume marine fish, usually low cost fish such as anchovy, sardines, barracuda and trevally. Initially, they were the target market for farmed marine fish. However, it was certainly difficult for the marine fish farmers to produce fish matching prices of these lower cost fish from capture fisheries. This price constraint prevented farmers venturing into marine finfish farming. However, in recent years, there are changes. Fish consumption in India has increased significantly due to lifestyle changes and higher cost of meat (Salim, 2014). In addition, the perception of fish as a healthy food with high omega 3 fatty acids with cholesterol lowering properties promotes marine fish consumption. This positive preference on fish consumption among the domestic consumers has given hope to farmers to venture into marine fish farming.

The lack of demonstrations for large scale farming systems such as sea cage farming and pond culture of finfish is another constraint in this sector. However, after the development of sea cages by CMFRI, several government organisations have taken the initiative to train and demonstrate sea cage farming to various stakeholders. In addition, culture of finfish in ponds were also demonstrated by CMFRI, CIBA and RGCA. These demonstrations reached the different stakeholders across the country.



An Asian seabass culture pond



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Asian seabass sampled from culture ponds

References are available on request



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Conclusion

A huge gap exists between the contribution of freshwater and marine finfish aquaculture to the national aquaculture industry in India. There is scope for mariculture development in India via the efficient use of technologies, resources and species available in the country. Understanding the importance of mariculture in food security and income generation, the government of India has taken several initiatives to provide a greater boost to mariculture development through several welfare schemes and research programs and it is envisaged to bring a big leap in Indian mariculture in the near future.



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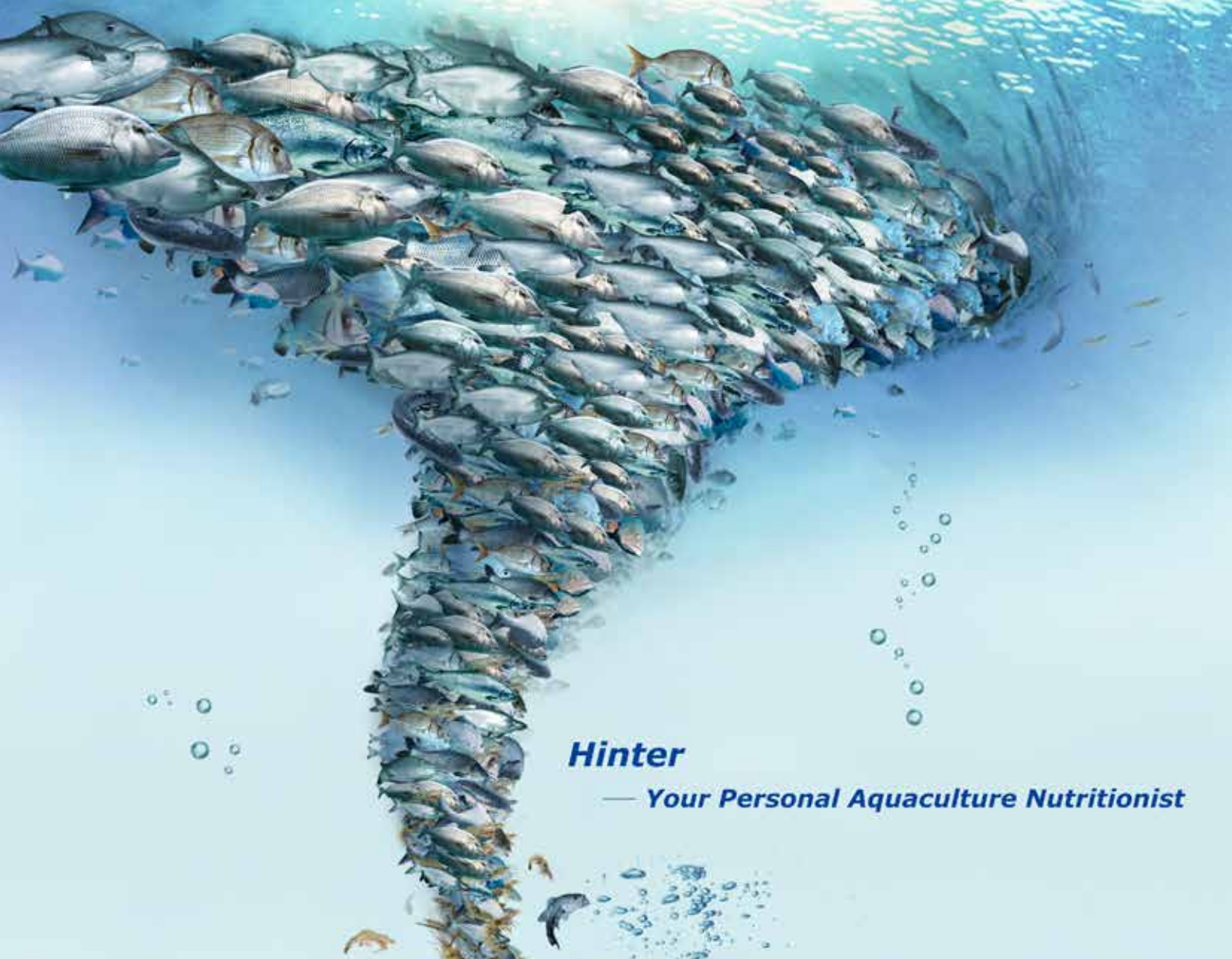
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Is 100% replacement of *Artemia* possible?

By Craig Browdy, Peter Van Wyk, Chris Stock, Diego Flores and Ramir Lee

Part 1: *Artemia* supply is a potential bottleneck to aquaculture's growth

Achieving increasing global aquaculture production goals will strain *Artemia* supplies if the industry does not break its dependence on this natural resource. No commercially farmed species evolved with a requirement for *Artemia* and therefore it is not *Artemia* but its nutritional components that have proven so valuable to aquaculture.



Shrimp larvae do not need Artemia, they need the nutrients in Artemia.

Artemia is a primary feed for larval stages of various shrimp and fish species commercially-farmed throughout the world. The increasing demand globally for *Artemia* could make its supply and availability a bottleneck for the future growth of aquaculture. As supply is based on harvests of wild populations, it is unpredictable and subject to considerable variation due to factors such as changing environmental conditions. For example, various natural phenomena influence the harvests from the Great Salt Lake or GSL (Utah, USA), which provide between one-third to half of the global *Artemia* supply. Fluctuations in water level and salinity in the lake have been related to some of the most dramatic production irregularities.

Higher salinities can stress *Artemia* and limit reproduction while lower salinities make harvests more difficult because of reduced buoyancy of the cysts. These changes in the local environment can affect the natural food chain which *Artemia* depend on. Changes in the algae populations (with incidences of harmful algal blooms) and falling water levels in the GSL can considerably limit total *Artemia* populations, resulting in a significantly reduced global supply of cysts. The aquaculture industry continues to be exposed to significant fluctuations of *Artemia* cyst supply and pricing.

Various authors have projected an additional global seafood demand in the next two decades at up to double our current

annual production of around 80 million tonnes. A recent World Bank report (Kobayashi et al., 2015) projected that global seafood supply will increase from 154 million tonnes in 2011 to 186 million tonnes in 2030. Almost all of the increase will come from aquaculture development. The fastest growth in aquaculture is expected for tilapia and shrimp (over 90% increase), while the largest expansion is expected in India, Latin America, the Caribbean and Southeast Asia, which are currently all major shrimp farming areas. *Artemia*, or rather, the nutrition currently provided by *Artemia* to larval shrimp, is critical in the production of shrimp seed stock.

Global *Artemia* production during the last 15 years has fluctuated. There are three main *Artemia*-producing regions in the world; GSL, various countries in the Commonwealth of Independent States (CIS or the Russian Commonwealth) and China. According to Litvinenko et al. (2015), total global production of *Artemia* in recent years is between ~3,000 and 4000 tonnes annually. This production comes from GSL with 1,000-2,000 tonnes; Russia, 550 tonnes; Kazakhstan, 20 tonnes; Uzbekistan, 20 tonnes; China (Bohai Bay, Mongolia, Aibi, Balikun and other areas), 900 tonnes; Vietnam, 20 tonnes; and other countries (Thailand, Argentina, Brazil and other salt ponds and lakes in the world) contributed ~60 tonnes. Thus, the three largest centres of *Artemia* cyst production are in the GSL, combined West Siberia and Kazakhstan and China.

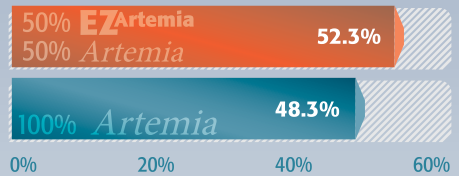
More natural production is possible from a few areas such as the Crimea. But extractive and selective exploitation of a natural resource like *Artemia* cysts may not be a long-term, viable course of action to support the projected growth of aquaculture. There is evidence that harvesting of these populations may have negative effects. One example is the recent research by Sura and Belovsky (2016) who carried out a study of brine shrimp (*Artemia franciscana*) cysts in GSL to determine if selective harvesting can cause evolutionary responses in populations through changes in phenotypic characteristics, especially those affecting life history. Studying cysts harvested from 1991-2011, the authors reported that cyst buoyancy decreased and nauplii mortality increased over time. The authors concluded that harvesting *A. franciscana* cysts in the GSL is causing evolutionary changes with implications for the future sustainable harvest and management of the resource. These findings are from the GSL which many believe to be the best managed *Artemia* source in the world. Other global sources are not known to have such carefully regulated harvest systems in place and there are concerns on the impacts of poaching and illegal harvesting in some places. These factors only further undermine the predictability and sustainability of global *Artemia* supplies.

The *Artemia* supply situation today is very similar to that of the fish meal and fish oil supply some years ago. Growth of aquaculture was correlated with the increasing use of fish meal and fish oil, mainly derived from reduction fisheries. As both fish meal and fish oil reached maximum sustainable levels many years ago, there are increased efforts to expand the use of terrestrial and plant meals and oils as alternatives. The commercial aqua feed industry has been shifting and evolving; from using marine sources, mostly from capture fisheries which are subject to

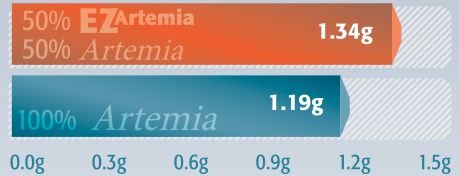
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Artemia is a major diet of larval stages of various shrimp and fish. Increasing demand could make its global supply and availability a potential bottleneck for the growth of the aquaculture industry in the near future.



Can all hatcheries immediately replace 100% of the Artemia cysts they use? No, it depends on the particular hatchery, its infrastructure, resources, technical capabilities and other aspects.

quotas, seasons and other limitations, to using land-based sources, farmed and industrial by-products (produced under controlled, scalable, sustainable and certifiable conditions). The same shift and evolution are possible for *Artemia*.

The demand for *Artemia* for such a fast-growing aquaculture industry will overtake its production, and alternatives should be explored. Is *Artemia* production on land possible? Maybe, and there have been numerous attempts, often associated with the production of various microalgae species such as *Dunaliella salina*. However, to date large scale cultures have not been successful and an alternative to *Artemia* is critical.

Developing a replacement diet

It is relevant to develop a single replacement diet for *Artemia* in shrimp hatcheries as well as understand how *Artemia* is used in different parts of the world. In the Eastern Hemisphere, hatched *Artemia* are traditionally fed based on visual macroscopic observations of available feed in the water. Microscopic observations are not commonly used. Also, larval production tanks normally have flat bottoms and low aeration levels, which make the suspension of artificial feeds difficult. Therefore, there is a very high dependence on live *Artemia*, which are easily seen with the naked eye and maintained in suspension.

In the Western Hemisphere, the use of artificial diets is considerably higher. Feeding is based more on frequent microscopic observation of the animals than on observations of the water column. Larval production tanks with parabolic bottoms are used, with high levels of aeration in the centre to maintain all feeds in suspension and minimize dependence on live feeds.

Most *Artemia* cysts are used to produce Pacific white shrimp (*Litopenaeus vannamei*) and black tiger shrimp (*Penaeus monodon*), each with different feeding characteristics. *P. monodon*, up to the post larvae (PL20) stage, are mainly pelagic feeders feeding near the top of the water column. They are mainly cultured in flat bottom tanks and are not efficient at feeding off the bottom, making it difficult to feed dry diets up to the time of harvest. They can only feed on what stays in the water column in a flat bottom tank (i.e. live *Artemia*). It is typical to use 5-10 kg of *Artemia* 80% hatch-out cysts/million *P. monodon* post larvae produced.

Litopenaeus vannamei are pelagic feeders up to the PL5 stage, and then become benthic feeders from PL6 to the time of harvest, which permits significant use of inert diets in the later stages and lowering of the amount of *Artemia* needed. They are mainly cultured in tanks with parabolic bottoms until PL5. After PL5, *Artemia* hatched from cysts are no longer used as feeds and the animals are fed at the bottom with heavier, sinking diets as well as de-capsulated cysts or *Artemia* biomass. It is typical to use 1- 5 kg of *Artemia* 80% hatch-out cysts/million *L. vannamei* post larvae produced.

A replacement for Artemia

Earlier we stated that there is a better alternative to sustainably meet the nutritional requirements for the production of shrimp post larvae. Recognizing the limitations and biosecurity risks of live feeds, our company developed a commercial, cost-effective replacement diet for the *Artemia*.

Artemia has many benefits but it also has some significant disadvantages. The high variability in cost, availability, nutritional value, and hatch rates are growing concerns. In addition, *Artemia* can be a potential disease vector, particularly for *Vibrio* contamination, thus raising biosecurity concerns. For example, the microsporidian parasite that causes the EHP disease, *Enterocytozoon hepatopenaei*, has been identified in *Artemia* biomass. Hatching and rearing of *Artemia* require considerable resources in terms of infrastructure, labour and time which are often not accounted for in the cost of using cysts.

In contrast, a complete and artificial *Artemia* replacement has several benefits. Artificial feeds can be produced with a consistent nutritional profile that can equal or exceed that of *Artemia nauplii*. Artificial feeds can also be certified as pathogen-free alleviating biosecurity concerns. Prepared diets have consistent availability and quality. There are no inconsistencies related to hatching percentages or presence of shells and unhatched cysts, and no infrastructure or variable costs to the hatchery. The feeds can be used for delivery of immunostimulants, enzymes and other beneficial compounds, as well as probiotics to enhance digestion and improve water quality and animal health. Overall, using an artificial, biosecure product that delivers the nutritional needs and can be produced on demand, enhances planning, operations and predictability while reducing risks.

Our 100% replacement diet for the *Artemia* is the result of almost 20 years of experience and continuous improvement. It is a liquid diet and with near neutral buoyancy and was formulated to match the nutrient profile of high quality enriched *Artemia* with high levels of highly unsaturated fatty acids (HUFA). It is designed to completely replace *Artemia* cysts by up to 100%, depending on various factors. Nutritional composition is optimal for shrimp post larvae; on dry weight basis, 52% protein and 17% lipid and on wet weight basis, 14 % protein and 4.5% lipid. The diet has two practical presentation sizes: 50-200 microns for feeding zoea, mysis and post larvae stages (Z1 - PL2) and 300-500 microns for PL2 - PL12. This replacement diet provides consistent nutrition and has no disinfection or hatching costs. Its cost is significantly less than *Artemia* cysts. In addition, it has been shown to extend the transport time of shrimp post larvae by helping maintain good water quality and dissolved oxygen levels.

Liquid diets for shrimp larvae have several advantages when compared to other products such as dry diets, because they are microencapsulated; the cold manufacturing process protects sensitive ingredients (enzymes, fatty acids, pigments, etc.) from heat degradation. They have a semi-moist texture, are highly attractive, palatable, and water stable as well as significantly better in reducing leaching and water pollution in the rearing units.

Next issue: Part two of this article will cover results of field trials at the hatchery and pond stages in commercial facilities as well as some perspectives for this important resource.

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All-female culture – a novel strategy in crustacean aquaculture

By Assaf Shechter

All-female intensive crustacean culture, a new strategy that improves growth performance and uniformity.

In most cultured animal species with sexually dimorphic growth patterns, there are clear economic advantages to growing animals of only one sex. Particularly, in animal production that relies on seed stock supply from breeders or hatcheries, undesirable reproduction during the growout period reduces growth and feed conversion ratios. To address this problem, certain lines of males or females are selectively bred to maximise yield and to produce specialised crops.

In most cultured penaeid shrimp, there are distinct advantages to growing only females, rather than males, in terms of their size and performance. Studies on the whiteleg shrimp *Litopenaeus vannamei* suggest that females utilise feed more effectively than males but are slower to reach the feed than the quicker, slower-growing males (Moss et al. 2002; Moss and Moss 2006). In the giant tiger prawn *Penaeus monodon*, mono-sex trials of hand-segregated populations demonstrated ~20% female superiority in growth rates (Gopal et al. 2010). In addition, an all-female mono-sex culture can eliminate inbreeding and support the protection of highly selective bred lines, by reducing the incentive and ability to perform second generation inbreeding. The idea of an all-female culture that can realise the full growth potential of females in shrimp, while providing selectively bred line protection, has been suggested in several studies but has never reached commercialisation.

Mono-sex populations

The first step towards producing mono-sex populations for commercial breeding was taken by Professor Amir Sagi of Ben-Gurion University of the Negev, a crustacean endocrinologist who has been studying sex differentiation mechanisms in crustaceans for over three decades. Identification of the key factors that control sex differentiation by his research group led to the development of an RNAi-based technology for the production of an all-male population. This technology, commercialised in 2013, is economically important in crustacean species where males exhibit size domination and in farming strategies that focus on marketing large size products. This success provided the impetus to continue the development work, this time for the production of all-female populations.

All-female technology

Prof. Sagi, together with Dr. Ohad Rosen of Enzootic HK Ltd has recently completed the development of another novel proprietary technology for the production of an all-female population. The technology is based on an androgenic gland (AG) cell transplantation approach that circumvents the use of hormones, chemicals or genetic modification. The principles underlying this technology were recently published by Levy et al. (2016) in *Marine Biotechnology* and are briefly described here.

In most decapod crustaceans, males have two Z sex chromosomes (ZZ), and females have one Z and one W chromosome (WZ). AG cells are obtained from male donors and

transplanted in suspension into young females to induce a fully functional sex reversal into neo-males (WZ). These neo-males are genetic females that reproduce as fully functional males. Crossing WZ neo-males with WZ females produces progeny comprising WZ females (50%), ZZ males (25%) and WW females, also known as 'super-females' (25%). Using chromosome-specific DNA markers, WW females can be identified and isolated. Crossing of WW females with ZZ males leads to the production of 100% WZ all-female progeny (see Figure 1 for the reproduction scheme).

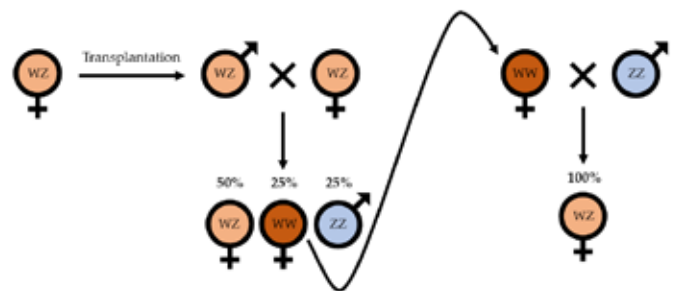


Figure 1. Reproduction scheme for producing all-female crustaceans

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All-female *Macrobrachium rosenbergii* as a model population

Although the above-described technology essentially targets commercial penaeid shrimp, its technological concepts are valid in most decapod crustaceans. This was first demonstrated in the freshwater prawn *Macrobrachium rosenbergii*. In contrast to penaeid shrimp, *M. rosenbergii* males exhibit distinctive hierarchical morphotypes which determine growth and size. A small fraction of the males (~5%) are large dominating males, which exhibit aggressive and territorial behaviour and suppress the growth of the majority of the population, both the females and the remaining males.

Enzootic's ability to produce a 100% all female population has enabled, for the first time, a comparison of an all-female culture with a normal mixed population in a large-scale (over 80,000 animals) field study in earthen ponds. The study monitored growth parameters, survival, product uniformity, reproductive activity, feed conversion ratios and susceptibility to stocking densities. The field study data clearly demonstrated the superiority of all-female cultures over mixed cultures in all the tested parameters.

Firstly, with no males found in the all-female ponds, the undesired reproductive-related processes in the growout pond were eliminated (as evidenced by the lack of females carrying eggs in these ponds). Instead, energy was fully directed towards somatic growth. Secondly, the total crop increased by up to 36%, with a production of over 3,000 kg/ha. Thirdly, survival was 22% higher in the all-female ponds than in the mixed ponds, and reached up to 95% at the end of a 24-week grow-out period. In addition, a 20% improvement in feed conversion ratio was observed and an average weight of nearly 40 g.

Finally, the most impressive outcome in this trial was the uniformity of the population, with over 75% of the animals within 7.5 g of the average weight (see Figure 2a for size distribution). The typical size variability of almost any crustacean population, especially that of the freshwater prawn, was replaced by highly synchronised growth and a uniform product (see Figure 2b for harvest images). These clear advantages in performance, high uniformity, and elimination of the labour-intensive activities of grading and selective harvest, position such all-female culture as a superior farmed product.

A novel technology

Our results support the notion suggested over two decades ago that all-female crustacean culture is superior (Malecha et al. 1992). By applying our novel technology, we were able to conduct, for the first time, a large-scale field study of all-female culture. This demonstrated that the elimination of reproduction together with improved performance and unprecedented uniformity results in a product far more suitable for large-scale intensified aquaculture production.

The ability to protect highly selectively bred elite lines by the use of all-female culture will not only provide incentives for breeders but will also lead to higher quality seed stock. This will stabilise the crustacean industry by eliminating or reducing production of inferior quality inbred stock. Since the launch of this *M. rosenbergii* product in 2016, hatcheries worldwide have begun acquiring WW super-female broodstock to locally produce superior all-female populations. Enzootic plans to commercially launch the all-female technology in penaeid shrimp in 2017 and is working with some of the leading shrimp-breeding companies on the implementation of this technology for their elite lines.

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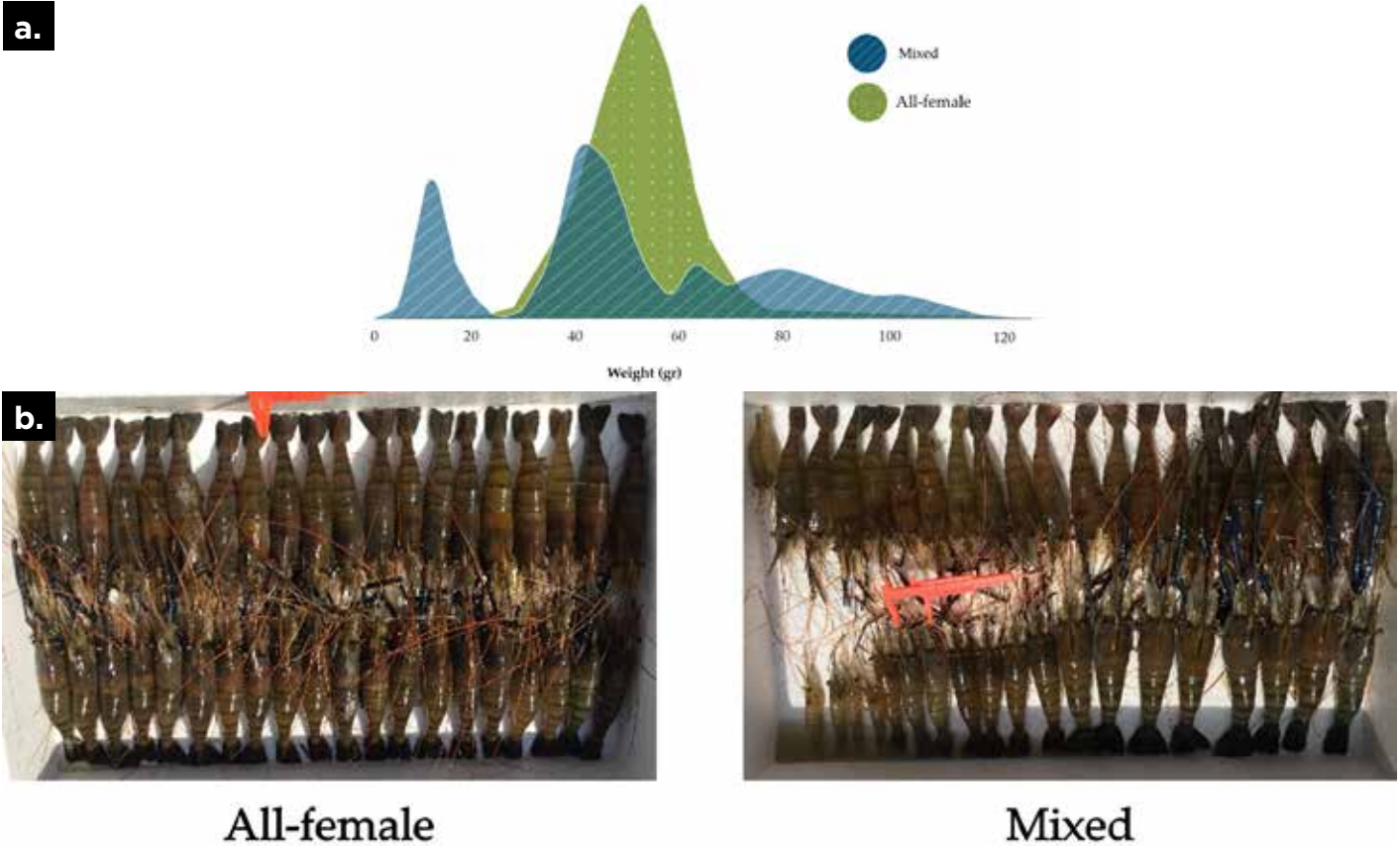


Figure 2. a. Size distribution in all-female vs mixed populations. b. Samples of the two populations at harvest

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Dr Assaf Shechter is the co-founder and CEO of Enzootic HK Ltd., an agro-biotech company engaged in the development and commercialisation of innovative biotechnologies for crustacean aquaculture. Shechter has a PhD in molecular biology from Ben Gurion University. Email: assaf@enzootic.com



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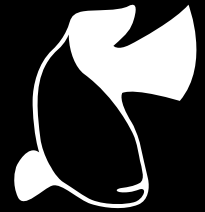
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SM-A-AP-15-07-EN - Axatone

The science of feeding a growing world population

By OddGeir Oddsen

An endeavour to create aqua feeds of tomorrow using the best possible polychaetes.

By 2055, the global human population will likely exceed 10 billion people, all of whom need to eat. Aquaculture feed supplier, ProChaete hopes to solve some of our future food supply problems at the company's new laboratory in Wales.

Population problems

The human population is growing fast. Currently, more than 7 billion people populate this earth, which amounts to roughly 6.3% of all the people who have ever lived. Each one of us needs to consume protein in order to survive.

Today, an estimated 2 billion people suffer from malnutrition due to lack of micronutrients. In emerging economies, the demand for animal protein is growing explosively, partly due to rising incomes and urbanisation.

High quality proteins will be hard to come by in the years to come, at least in high enough quantities. However, we need to get them from somewhere. Trying to feed the world using land-based animal proteins will have dire consequences. In addition to deforestation, greenhouse gas emissions and waste, industrial animal farming on a large scale leads to soil degradation on an unsustainable scale. So a large part of our food supply needs to come from aquaculture.

More than 90% of our global fish stocks were overexploited back in 2011. This kind of overfishing takes an enormous toll on marine ecosystems, and so the world is relying more and more on farmed seafood. The protein we feed to marine animals needs to come from somewhere. And the overall global fish meal production cannot exceed six million tonnes per year before it will take too large of a toll on fish populations. So how are we going to meet aquaculture protein demands effectively?

Waste management

We need to start thinking about consuming and producing proteins sustainably. The development of sustainable animal feed, both on land and under water, represents a giant leap in the right direction. One of the key elements in this area is the conversion of different waste materials into proteins. A very efficient way of doing this, is by using worms, more specifically polychaetes.

Polychaetes contain nutritious, versatile proteins that can form a solid foundation for high quality aquaculture feed. Polychaetes convert a wide range of nutrients into protein, which allows our company to convert nutrient sources that would normally be considered waste, into valuable protein sources. But we are not just satisfied with turning polychaetes into a high quality aquaculture feed. ProChaete is determined to use polychaetes to create the best and most effective aquaculture feed in the world.

Science in progress

This is why the company has built its new aquaculture lab facilities in Wales. Currently, the facility has two wet laboratories based on recirculation aquaculture systems (RAS). The two units can run freshwater and saltwater at high or low temperatures. It is also possible to run freshwater in one laboratory and at the same time run saltwater in the other. Currently, it is testing shrimp in one wet laboratory and tilapia in the other, but the possibilities here are myriad. The laboratories will, among other things, be used to test feed conversion ratios (FCR) and specific growth rates (SGR) in many different aquacultures concepts. This is where our endeavour is to invent the aquaculture feed of tomorrow. The tanks are relatively small, between 60 and 200 L, allowing data to be effectively collected from many small populations simultaneously.

The future of aquaculture

The company's goal is first and foremost to create an exceptionally effective aquaculture feed protein, but in order to do that, it needs to cultivate the best possible polychaetes. By constantly testing and developing different types of feed, it will be able to lower FCRs and increase SGRs substantially, so that the industry can produce better food more easily. With a rapidly growing human population, we need to make the best of the resources we have. That is exactly where ProChaete wishes to contribute.



OddGeir Oddsen is CEO of Sea Farms Nutrition. The ProChaete brand was set up in 2013 in order to create innovative feed formulations without the dependency of fish ingredients for marine shrimp farming. Email: oddgeir@prochaete.com

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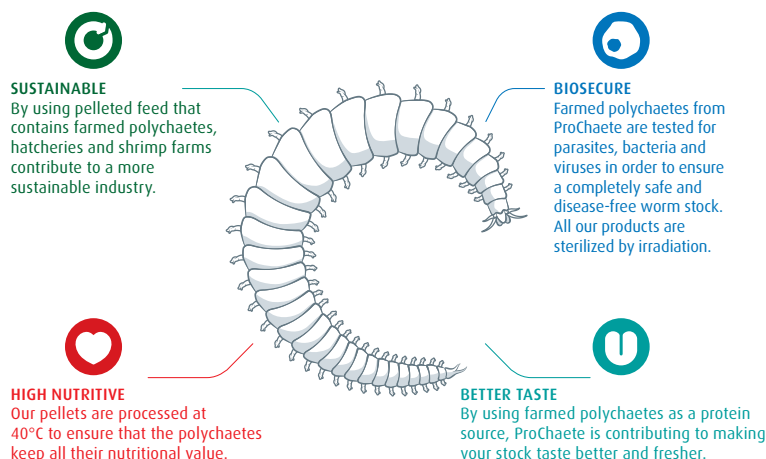


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The future of aquaculture is PRO

With a rapidly growing human population, we need to make the best of the resources we have. High quality proteins will be hard to come by in the years to come, at least in high enough quantities.

Farmed polychaetes is an effective way of producing edible protein sustainably. Polychaetes contain nutritious, versatile proteins that can form a solid foundation for high quality aquaculture feed.

Our goal is to create an exceptionally effective aquaculture feed, making the industry able to produce better food more easily. And that's exactly where ProChaete wishes to contribute.

**The future of aquaculture is only for the pros
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Of passion, innovation and knowledge transfer

An interview with Cargill Aqua Nutrition's Einar Wathne, on how he intends to steer the new group into Asia's aqua feed industry, riding on the innovation experience in Ewos.

The 2015 Cargill acquisition of Ewos, a leading supplier of feed and nutrition, and strong in the major salmon farming regions, was an industry milestone. The new business unit, Cargill Aqua Nutrition (CQN) combines the feed operations of Ewos for cold water species in Norway, Chile, Canada and Scotland and a feed plant in Vietnam, with all the aqua feed activities for warm water fish and shrimp species under Cargill Animal Nutrition.

During a recent visit to Singapore, AAP caught up with **Dr Einar Wathne**, President and group leader of CQN, to find out his plans and strategies for the new group. Einar who is based in Bergen, Norway also gave some of his insights on aquaculture in Asia.

"The idea behind this acquisition and Cargill investment is because Cargill wants to grow in the seafood sector. This complements its decades-long existence in food production which has been largely land based; beef, pork and chicken. Clearly, this is a strategic choice on the part of Cargill to be in this sector," said Einar. "Size-wise we are now made up of two thirds from Ewos and one third from Cargill. Out of the 20 countries where Cargill already has a history, there is only one overlap; Vietnam where Ewos produces feed for Vietnam's pangasius and marine fish industry."

Einar has spent his entire 30 year career within the aqua feed industry and all of them with Ewos. With a PhD in aquaculture from the Agricultural University of Norway and an MBA from the Norwegian School of Management, Einar was an industrial nutrition scientist for more than 10 years. Fifteen years ago, he entered a range of management roles within Ewos, before he took over as CEO of the Ewos group in 2013. Now as CQN group leader, Einar brings with him the culture of driving feed innovations in cold water species and transferring the innovation capabilities into warm water species.

"Clearly, we know that salmon nutrition has the leading technology. This acquisition was a necessity if Cargill wanted to execute its strategy. The alternative which would be to build up from ground zero, would have taken a long time."

On the to-do list

On the top of Einar's list are three areas; building the team, transferring technology and extending the sustainability philosophy.

"My first focus is to build an aqua team; one with a passion for aquaculture. This is our entrepreneurial spirit."

The next step of the journey will be transferring the knowledge across species identified as tilapia, shrimp and salmon. One global project already in process focuses on product quality, such as a super purified pellet that is uniform with the right floating properties. This is a unique demand from aqua farmers versus that from land based farmers. This is a competence being



Einar Wathne. As CQN group leader, Einar brings with him the culture of driving feed innovations and transferring these into warm water species

transferred from the salmon industry where feed handling is very harsh with advance feeding systems and very high mechanical stress on the feeds.

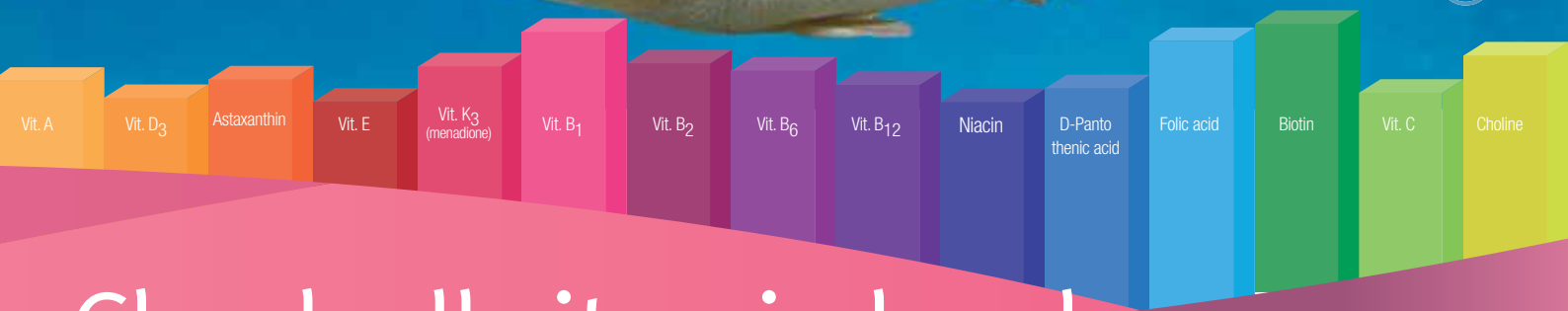
"The next focus revolves around our expertise in salmon nutrition - which is lower in fish meal and other properties compared to other aqua feeds - and transferring this to feed technology for the marine shrimp, tilapia or pangasius. For example, Ewos has a history of developing functional feeds and solutions that can be effective across a variety of species.

"Thirdly, is our focus on sustainability, an area driven by consumers. The salmon industry is well ahead in this as compared to warm water fish species. Our role is to work to transfer the system on reporting and communication which we had in Ewos for several years to this new group. For several years, Ewos' sustainability report was voted the best in the industry and we plan to maintain this as well as expand this for the whole aqua feed business of Cargill," said Einar.

"This has to do a lot about transparency. Our consumers are asking on not only the kind of fish, but where is it farmed, what it is fed on, what is the origin of components used and is it sustainable? We have learnt that this can give a good platform for dialogue and understanding and in some areas, improvements. We are focussing not only that the feeds are sustainably produced but on the ingredients, either land based or that the fisheries are sustainably managed."

Building a competitive edge in Asia

CQN has to its advantage Cargill's presence in many countries and facilities co-located with animal production facilities. This provides a synergy in operations. However, Einar's emphasis is on the need to invest in animal testing facilities.



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“Our strength is the strong innovation approach and continuous research and seeking answers on what is best for the fish. We need to measure in the specific species, for example digestibility. We are investing in a global innovation centre in Thailand, just outside Bangkok. The model is a high capacity facility for animal testing. We need to have the same setup as we had for development of salmon feeds. Learning to formulate feeds for salmon has been a long planned journey, defining nutrient value and how the fish performs. This innovation is something we are bringing to Asia and we are confident that we can make a change.”

“ We need to have the same setup as we had for development of salmon feeds.. ”

The contribution from Cargill is not only providing the footprint but also establishing its presence in the whole value chain; from ingredients to food processing and distribution. The Cargill advantage is in the production of soybeans and corn, milling and oil extraction to food production and distribution and marketing to retailers. The recent benefits from Cargill are algal oil, a new bacteria protein FeedKind (produced together with Calysta) and a high omega 3 canola or rapeseed oil (in 3-4 years' time). This high omega 3 oil has been tested in fish feeds to replace fish oil but it has to undergo the regulatory process as it is oil extracted from GM (genetically modified) rapeseed plants. (More on the high omega3 canola oil on page 58).

“Cargill is willing to invest to grow, organically and through future acquisitions, to meet targets and to be relevant. The Cargill family has said that this is sector we want to be in; we cannot be in the seafood sector without being in Asia.”

Managing water resources

Einar gave his take on how aquaculture in Asia can continue to grow. According to him, growth will depend on how the water resources are managed. Management of aquaculture systems must reflect the carrying capacity of the recipient. We see many lake farms overloaded creating upwelling and fish mortalities. We also believe that sedimentation treatment for discharge water from pond systems should be made compulsory. The ultimate change in Asia's and the world's aquaculture will be when recirculated aquaculture systems are further developed. “To me, the success recipe will be in countries with strong and established regulatory and enforcement regimes,” said Einar.

The future of aquaculture is dependent on productive marine environments, which are currently poorly utilised. There will be a lot of technology which can overcome some climatic disadvantages such as typhoons. Einar proposed that, “The amazing technology in marine construction from the offshore oil and shipping sector may pave the future in marine fish farming.”

Positioning CQN

Cargill has a long history in Asia and can build the business by capitalising on its deep and well-founded knowledge of Asia. “Even though we have not been so fast paced in aquaculture, we have been developing as a corporation in Asia. Cargill may have taken some time before it identified the special needs of Asian aquaculture. But with the growth ambitions and strengths of the company, we are poised to have a strong position in Asia.

“We think we can grow in India, Indonesia and China but this has to do with where we are today in these countries,” added Einar. “Today, we have a very strong presence in the snakehead feed market in Vietnam and in China, feed for the hairy crab. We can do more to be present in supply chains that want to differentiate. In Asia, we see that we can be the traceable supply chain with special standards and certifications and this draws on Cargill's insights and strengths in the supply chain.”

Today, Cargill has a small share of the fish feed market in Asia in comparison to the dominant position it enjoys in the fish and shrimp feed markets in Latin America and in the salmon feed market in Europe. “We know that we need to grow our market share in Asia, to get to scale and to be relevant. We see the recent ongoing consolidation changes in Asia that are forming larger and more professional entities. Such changes are right for us with the competency and capabilities we bring to the market place. This restructuring within the industry in Asia is also good for the market orientation among farmers,” said Einar.

“It is also critical that we tackle the health situation of aquaculture together. Today, the risk is too high. To survive as a sustainable food production source, we will have to manage diseases better. Perhaps this is about too many species and the warm water environment which favours disease. But it is also about the execution of regulatory systems. If the role of regulators is as strong as in Europe, we will be in a better position.”

Areas where CQN can improve are in vaccines, feeds and genetics. Einar has a strong belief in genetics. “I have seen what it could do when it is systematically executed as in the salmon industry. We can succeed if we have the best genetics but it is not enough that one company has this. We need a collective approach in genetics to strengthen the whole population, for example on disease resistance.”

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Needs and lessons for Asian aquaculture

Top of the agenda for CQN is the consumer perspective. “We need to respect the consumer and adapt production to what the consumer needs. I appreciate that Asian farmers are hardworking and very dedicated and this is a competitive advantage but we need to be open and see what is happening in society and markets in other parts of the world. There are other things aside from farming that matter for success.

“With regards to innovations, we should explore new feed ingredients, functional feeds to prevent diseases or parasites and use of natural components in feeds versus chemicals. Understanding all the biological components and combining them with good nutrition. There are lots of undiscovered properties in many biological components. These are areas to be explored and will be part of the innovation portfolio.

“The nutrition for the salmon is far ahead that of other species in making feeds the least cost in the production chain. We have many success stories to impart such as genetics, nutritional understanding and feed management tools to step up technology in farms in Asia. We also have experiences to impart, such as how the cost of production for the salmon has gone up because of sea lice infections and regulatory requirements but unfortunately, also due to complacency with high sales and high prices.”



Einar Wathne with Adel El-Mowafi, Cargill's Global Aqua Technology Director at the research centre in Dirdal, Norway

Keeping up with the solid company strategies, the natural expansion is in seafood processing to complement land-based protein supply businesses. The future will also see some acquisitions and the building of new plants. Important for the group in Asia, is the innovation centre which will work on feeds and also cover general nutrition and fish and shrimp pellet technology.

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2017 Global Feed Survey

A milestone as the global feed tonnage exceeded 1 billion tonnes and aqua feed tonnage increased following the upward trend in fish consumption.

The annual Alltech Global Feed Survey assesses compound feed production and prices through information collected by Alltech's global sales team and in partnership with local feed associations. It is intended to serve as an information resource for policymakers, decision makers and industry stakeholders. The survey has become more comprehensive and the data for 2016 released in January 2017, includes that from 141 countries covering more than 30,000 feed mills.

"This is the most complete and extensive evaluation of the state of animal feed production and consumption available today. Each year, the survey gains deeper insight into the industry, therefore making the analysis more thorough and robust than ever before. This year clearly demonstrates the growing efficiency and consolidation of the feed industry," said Aidan Connolly, Chief Innovation Officer and Vice President of corporate accounts for Alltech. "Not only has total feed production exceeded 1 billion tonnes for the first time, but it has done so with fewer facilities, which means greater efficiencies and a decreased environmental footprint. We estimate the value of the feed industry at USD 460 billion."

The results showed that the United States and China were the top two countries, producing one-third of all animal feed. Growth in feed production came mainly from the beef, pig and aquaculture feed sectors as well as several African, Asian and Middle Eastern countries. This year's survey showed that the top 30 countries, ranked by production output, were home to 82% global feed mills and produced 86% global feed. The top 10 feed-producing countries in 2016, in order of production output, were China, the United States, Brazil, Mexico, Spain, India, Russia, Germany, Japan and France. These countries contained 56% of the world's feed mills and accounted for 60% of total production.

Regionally, Asia Pacific led with 37% of total feed production and grew at 5% annually. China was the top feed-producing country with 187.20 million tonnes while increased production for the Asian region also came from Vietnam, Pakistan, India and Japan. Vietnam in particular grew at 21% over the past year and moved into the top 15 countries list for the first time, specifically led by increased production of pig and broiler feed. However, Asia continued to be one of the most expensive locations in the world to raise animals, as Japan's feed prices were some of the highest in the world and China's prices were double that of most of the top 10 producing countries.

Aqua feed volumes

In 2016, this rose to 39.9 million tonnes, up from 35.47 million tonnes in 2015. Asia Pacific led with 26.7 million tonnes (67% of the total aqua feed production). The top producer was China with 16.4 million tonnes. "Globally, aquaculture continued its year-

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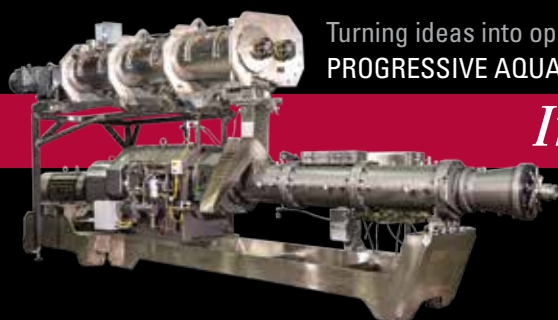
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over-year growth with a gain of 12% in feed production in 2016. Increased production from Turkey, Germany, the UK and France contributed to a strong performance from the European region. Africa increased production by almost 1 million tonnes, led by Nigeria and Egypt, while Asia maintained its volume. The increase in aquaculture feed correlated to the consumption of farmed fish, growing at approximately 8% annually,” said Connolly.

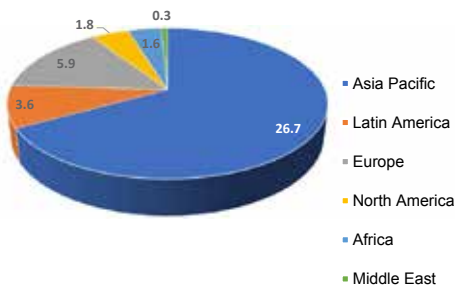
“Asia maintained its volumes but there were some interesting changes. Production was down in the Philippines, China and Myanmar while Vietnam, India, Indonesia and South Korea made gains.”

For the first time, the survey indicated feed volumes at the species level such as 32% for carp, 8% for catfish, 21% for marine shrimp and freshwater prawn and 12% tilapia. Within Asia, 62% of production in China was for the carp; 36% production in Bangladesh and 35% in Vietnam were catfish feeds; 66% production in India, 42% in Thailand and 33% in Indonesia were feeds for the shrimp.

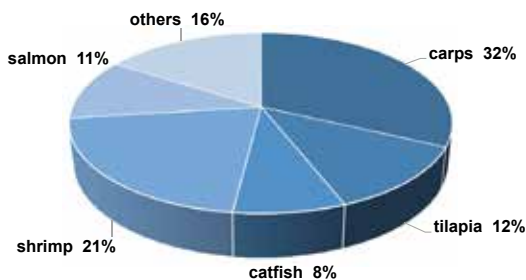
“Projecting growth in terms of aquaculture was by far the most complex with larger farms, consolidation and intensification ongoing,” added Connolly.

Source: 2017 Alltech Global Feed Survey and accompanying webinar. www.alltechfeedsurvey.com

Aqua feed production in million tonnes by region
Total: 39.9 million tonnes in 2016



Aqua feeds by species in 2016



Top 10 producers of aqua feeds in Asia in 2016 (million tonnes)

Country	Million tonnes
China	16.400
Vietnam	3.408
India	1.700
Indonesia	1.500
Thailand	0.960
Bangladesh	0.900
Taiwan	0.480
Japan	0.400
South Korea	0.300
Philippines	0.270

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Penaeid shrimp feed ingredients vs nutrients and performance

By Martha Gabriela Gaxiola Cortés and Gerard Cuzon

Shrimp feed formulation is still dependent on earlier nutrition research carried out in clear water systems. In today's shrimp feeds, is there a balance between feed composition and fulfilment of requirements? How can a feed manufacturer cope with the diversity of rearing conditions?

For the last 40 years, our knowledge on shrimp nutrition has progressed at a relatively slow pace due to constraints on feed quality, shrimp behaviour, data derived from experiments in clear water and then applied to various culture conditions, cannibalism and reingestion of exuvia. The search for optimum or maximum weight gain was, in fact, subject to many factors (biotic and abiotic). Shrimp can express maximum weight gain only when these biotic and abiotic factors are at optimum conditions. With advances and availability of more nutritional information, research on ingredients in shrimp diet was given greater focus. Unfortunately, the focus seems to be directed more on ingredients rather than requirements.

A multitude of tests on amino acid profile, fatty acids content, carotenoids and carbohydrates helped nutritionists to formulate feeds for the growth of shrimp in captivity, in clear water system. Marine protein sources produced consistently favourable results for juveniles up to the reproduction phase. However, the recent constraint on the use of fish meal led us to reconsider alternative ingredients, among them, plant protein sources. Moreover, the myriad rearing conditions brought "background noises" and manufacturers need to have different formulations to suit the requirements in different rearing conditions. At the experimental level stable isotopes helped to determine the contributions of natural productivity vs compounded feed for shrimp cultured in a pond.

Today with the current use of the least cost formulation model, quality ingredient selection should be given priority to cope with the many types of production systems. Maturation feed remained the only phase where ingredients are selected for effectiveness rather than cost. A few key nutrients and premium quality ingredients (most of them marine origin) are used to maintain performances without using live or fresh marine foods.



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Camilo Pohlenz (Aqua Culture Asia Pacific, 2016) commented, "We need to formulate for optimal performance which is not based on composition of feed ingredients and nutrients". Such a statement is partially true. The statement, 'not based on nutrients' bears considerable truth because the rearing conditions in shrimp culture are so diversified. Initially, experiments were carried out in clear water to determine nutrients for juveniles (Deshimaru and Kuroki, 1975; Kanazawa, 1981; Lawrence et al., 1986; Aquacop, 1987, 1989; Davis et al., 1990). There exists a lot of information on nutrients, especially protein, lipid, carbohydrates and less on minerals or vitamins. Today there are so many rearing conditions that it is difficult to stick to requirements in clear water systems. For example, animals raised in ponds or raceways using biofloc may have different nutrient requirements from those raised in clear water.

Methodology for assessment of requirements

Juveniles used for the experiments were obtained from earthen ponds, which were previously stocked with post larvae (PL) obtained after reproduction in captivity (Aquacop, 1975, unpublished). Stocking density was 20 PL/m². A careful calibration minimised initial size variation with a low standard deviation. Each treatment was replicated either three or five times in 220 L tanks housed in an indoor facility with controlled photoperiod and low light intensity from neon tubes. According to the experimental protocol, feed was distributed by hand twice a day or with an automatic belt feeder. Each morning uneaten feed and molts were recorded. Oceanic seawater was pumped from the lagoon at 8 m depth and passed through a sand filter before channelling to feeding tanks at a constant flow of 2 L/hr. The bottom of tanks had either a false bottom covered with a sand layer or without a false bottom. Water parameters (27 °C, pH 8.2) and levels of ammonia, nitrite and nitrate were controlled daily.

Feed used was produced in a small workshop. Collets or extruded feeds were prepared using a meat-mincer. The duration for the trial was 30 days. Sampling was carried at the end of the trial. The following measurements were carried out: average body weight, number of individuals, feed conversion ratio (FCR),

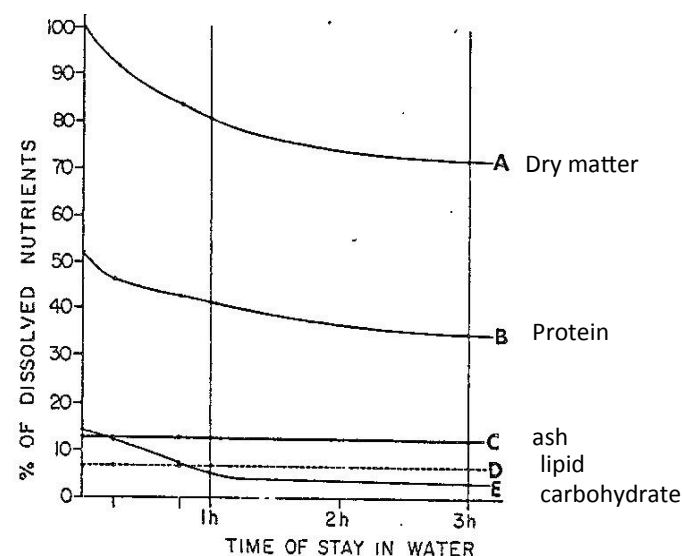


Figure 1. Loss of dry matter (A), protein (B), ash (C), lipid (D) and carbohydrates (E) in seawater from 76.1.1.0 diet, calculated by difference (Cuzon et al. 1980). A drop in vitamin (A) followed by protein (B) negatively affected weight gain of *P. monodon* reared in water with weak aeration.

survival, molt frequency and specific growth rate (SGR). Shrimp were reared in various conditions, full seawater (35 ppt), clear water, diluted seawater (10 ppt), well water rich in alkalinity, "floc" with heterotrophic bacteria, copepods, green water (Cam et al., 1991), natural productivity in ponds, and cages with a zooplankton bloom.

Slow feeding animals were an immediate concern. The steps taken included increasing the feed palatability or augmenting the binding of ingredients in pellets or collet. Wheat gluten was used as binder (Figure 1). A drop in vitamin (A) followed by protein (B) negatively affected weight gain of *P. monodon* reared in water with weak aeration supplied by an air lift).

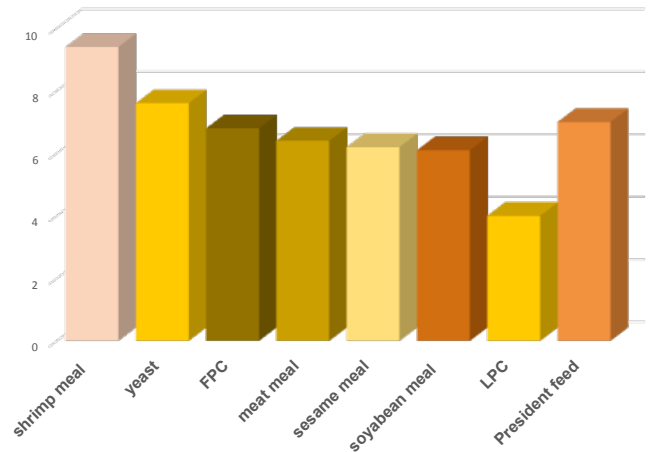


Figure 2. Comparison of weight gain after 30 days of culture for shrimp fed different protein sources, included at 30% in diets. (Redrawn from Aquacop and Cuzon, G. 1989)

These showed that despite these constraints, it was possible (all things being equal otherwise) to find differences among protein sources. Shrimp meal (Blum & Bergeron Cie, USA) produced the best weight gain after 30 days followed by yeast which was better than the control (President feed) and fish protein concentrate (FPC). Weight gains for the other ingredients, meat meals, sesame meal and soybean meal were better than alfalfa concentrate (LPC). These meals were incorporated at 30% of the diet (Figure 2).

In Table 1, we tested two commercial extruded feeds and a local feed in a short-term trial to determine the differences in weight gain and survival in shrimp and FCR. Pi and pf indicate initial and final mean body weight of shrimp respectively. In "floc" conditions, *P. vannamei* juveniles fed for 30 days did not show any difference between extruded feeds rich in cereals at two protein levels (MR³⁰ and MR²⁵) in two stocking densities while a local experimental shrimp feed (nomenclature for raw materials, vitamins, minerals and additives 18.1.1.0) responded in a different way. This means that the composition of ingredients affected weight gain.

Results on simplification of feed formulations to be tested under laboratory conditions tended to prove some limits to the restriction of the number of ingredients put in a diet but with the advent of "floc" (1975) it was possible to decrease consistently the protein content in a grower feed (such as MR²⁰ for *P. vannamei*) and increase considerably the amount of carbohydrates to spare to a certain extent some marine protein sources.

Table 2 shows a classification of ingredients where clam or *Mytilus* distributed live were superior to all other diets. Feeds containing marine protein sources always produced better growth than plant meals.

Table 1. Trial in floc “moulinettes” with *P. vannamei* for 27 days (Aquacop, 1975). (“moulinette” is a term in French used in Tahiti to describe a tank with “floc” where there is strong aeration to move the water in a circular motion to keep all particles comprising floc particles, faeces, exuvia, feed and dissolved organic matter in suspension).

Feeds	PL/m ²	pi (g)	pf (g)	weight gain (%)	survival (%)	FCR
MR ³⁰	40	3.3	6	81	100	1.7
MR ²⁵	40	3.2	5.8	78	95	1.7
Local feed, 18.1.1.0	40	3.2	4.9	53	100	2.2
MR ³⁰	150*	3.1	5.5	77	91	-
MR ³⁰	260*	3.3	5.6	70	91	-

Pi, pf for initial and final mean body weight, respectively;
 *At 150 PL/m² and 260 PL/m², weight gain was poor. Source: Aquacop, 1975. First trial in floc with commercial and experimental diets (unpublished results).

Table 2. Quality criteria for ingredients

High quality fresh food	High quality	Average quality	Low quality
Clam*	LT fish meal	DDGC	alfalfa
Mytilus*	squid meal	corn gluten	copra meal
testis *	freeze dried marine sources	wheat	brewers yeast
squid*	shrimp meal B&B	casein	peanut meal
	native wheat gluten*		
several penaeids	Bel lactic yeast		
	CPSP ⁷⁰ , fish soluble protein concentrate (Sopropêche, France)**		

*for *P. japonicus* (Deshimaru, 1975). **for *L.stylirostris*
 DDGC- corn dried distillers' grains

The question of multi-ingredients was raised and its real effectiveness was compared to more uniform formulation (Table 3). The diets (1 to 5) were compared to two commercial feeds that were reputed for their performances on juveniles (President) and breeders (Nippai). Trials were conducted in conditions described above.

Table 3. Formulations of feeds with ingredients shown as % feed composition (as fed basis) and proximate composition of control feeds

Feeds	1	2	3	4	5		Nippai feed (Japan)	*President feed (Taiwan)
CPSP ⁸⁰	10	15	20	26	36	Proximate analysis (%)		
Shrimp meal	15	15	15	15	-	water	10	10
Bel lactic yeast	15	15	15	-	-	crude protein	54	42
dried whey	10	10	-	-	-	crude lipid	8	4
Blood meal	10	-	-	-		NFE	10	25
wheat	30	35	40	39	40	ash	18	14
vitamin mix (Roche) & mineral mix (Protector, France)	10	10	10	10	10			
	100							



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Table 4. Summary of experimental diets with *P. monodon*. (1984)

Experimental diets	1	2	3	4	5	6	Nippai	*President
Weight gain/28 days	2.5	1.6	1.1	1.6	1.3	0.4	2.3	2.4
Survival %	100	100	100	100	100	100	100	100
Molts/28days/shrimp	2.5	1.6	1.1	1.6	1.3	0.4	2.3	2.4

Commercial feeds produced the best weight gain similar to experimental diet 1. This response was in line with the number of molts recovered in each replicate tank; this indicator, rarely reported, was considered as a sign of superior feeding conditions correlated by an absence of cannibalism. An accumulation of data obtained in similar experimental conditions led to the proposed ingredients for penaeid shrimp (Table 5). Fish meals identified by origin were not equal in contributing to body tissue build-up. They could be classified with a certain number of indicators to reflect their respective contribution to growth performance when shrimp were raised in clear water. Thus, it was not surprising to include fish meal up to 40% of the feed content.

Table 5. Selected ingredients for shrimp feeds and optimum inclusion rates (%).

1- Fish Meals Marine Protein		4- Yeast unicellular proteins	
NSM	10-25 %	Lactic yeast	20%
WFM		Torula yeast	<15%
Tuna fish meal		Brewer yeast	10-15%
Chilean Fish meal	<40%	Bakery yeast	20%
Peron Fish Meal	<20%		
Alaska Fish Meal			
NZ Talley Fish Meal	15%		
Fish protein concentrate	8-20%		
2- Shrimp Meals		5- Meat/Bone meal: Conventional protein source	
Blum and Bergeron	30%	MBW 48% cp	<15%
Alaska		Blood Meal	
Ecuador	30%	-Drum dried	3-4%
		-Atomized	10%
		Chicken of falls meal	10%
3- Squid Meal		6- Soya bean meal	
Japan	5-40%	Regular SBW meal	48% CP
India	5-40%	Soy protein concentrate	10%
		7- Leaf protein concentrate	<6%
		8- Wheat Gluten	5-20%

Source: Aquacop and Cuzon, G. 1989

Marine protein sources ranked high in % incorporation without any worry on their availability in the 1970s, followed by yeasts and meat meals. Among plant sources, wheat gluten and soybean meal performed better than leaf protein (Table 5).

Historical review

A review on the feeding of shrimp under intensive culture conditions, showed that there are many aspects to consider.

Rearing conditions

When our knowledge on requirements was scarce, the best way to classify ingredients and to formulate for maximum feed efficiency was through trials in clear water. At that time the shrimp model used was *P. japonicus*. for nutritional requirements and a kind of transfer was already operated to non-grooved species such as *P. stylirostris* or *P. vannamei* (Table 1). Later on, it helped to proceed to practical feed, where shrimp could have access to supplemental food especially under intensive systems in earthen ponds.

Table 6. Synthesis on quality ingredients. Freeze-dried are obviously of higher quality than regular dried meals using heat or the sun.

Raw Ingredients (Generic)	Quality presentation	Comment, Limits
Meat & bone meal	meal< concentrate	saturated fat
Wheat	native wheat gluten	100% apparent digestibility
Squid	meal<<<<freeze-dried	Growth factor
Mussel	meal<<<<freeze-dried	Free amino acids content
Fish meals	ABVT+POV+histamine +NH ₃	reg: FM<prime<Chile= Peru<NSM
Yeasts	Torula<beer<lactic	High quality bel yeast
CPSP, Hydrolysate	CPSP<10%	to incorporate, acidity?
Soya	SBM<concentrate <isolate	Presence glycinin, β-conglycinin

Commercial feeds

In the early days, there were few commercial feed plants. Feed manufacturers produced pelleted or collet feeds for shrimp culture for all types of culture conditions. Therefore, these feeds can be nutritionally adequate or the feed is too rich in nutrients for the culture condition, which means a waste of money. Other times, it may be nutritionally deficient, resulting in reduced growth performances. This shows that we are still far from the feed concept for terrestrial animals (Figure 3) which has very precise specifications to meet daily needs.

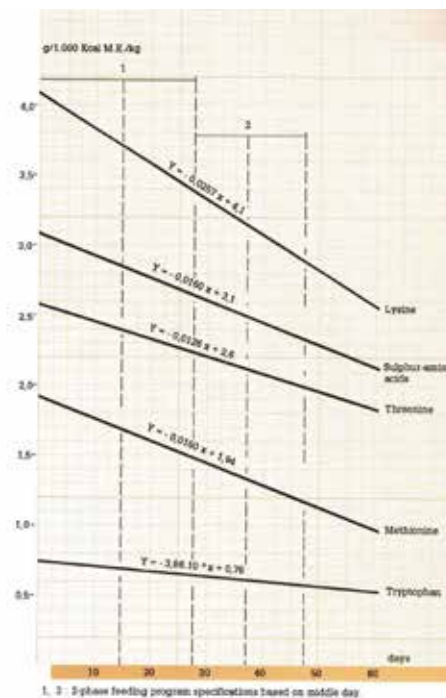


Figure 3. Graph on amino acid recommendations for broilers showing precise specifications to meet daily needs. AEC, 1987.

Raising shrimp from post larvae to market size requires a certain amount of estimation on their feed formulation. Due to different rearing conditions, we cannot rely on one specific formulation. This is the case also for grow-out and maturation diets. However, we are still unable to replace completely what we

call 'fresh food' (squid, mussel, worms etc) with a compound feed after many attempts. Animals cultured in clear water rely entirely on exogenous feed inputs such as Nippai, Monogal, Ziegler and Itoh. The nutritional requirements for breeders are not yet fully assessed in spite of some understanding on their need for long chain polyunsaturated fatty acid (LC-PUFA) requirements, vitamin E and C, and few other specifications.

Vitamins and leaching

The grow-out phase is the costliest in terms of feed supply for the long culture cycle. Here the question is whether to have vitamins included or none at all. It is also whether to have low dietary protein or optimum level from previous data on requirement studies in feeds. Next is whether there should be fortifications of minerals or not. Another factor will be the degree of leaching of nutrients in feeds (Cuzon et al., 1982; Lim and Cuzon, 1994). This makes the actual feed composition different from the sheet formulation and what exactly the shrimp has ingested.

Feed ingredients

The remark of Pohlenz on placing emphasis on growth performances rather than on ingredients is not totally agreeable. Why is this? Some decades ago the trend was to formulate on the properties of ingredients i.e. % CP, native or processed protein sources, amino acid composition, physical properties (for example with wheat gluten), growth factor (Cruz et al., 1987; Williams et al., 2005), attractability (e.g. brewery yeast) and with the use of least cost formulation (Barbieri, 1975). The objective was to adopt an economical approach, or the choice of a blend of fish meal sources to limit variations in feed composition from one batch to another and to mimic shrimp body composition (Table 6). Unfortunately, this option will remain because feed manufacturers need some flexibility to maintain some constancy in feed composition for shrimp feed.

Based on a series of five ingredients, a trial was conducted to see to what extent it was possible to limit the number of ingredients in a diet. There is some apprehension that a potent ingredient may be missed out. On the other hand, the more ingredients at the production level the more is the concern in terms of factoring cost for the feed. Therefore, the aim was still to maintain a minimum of ingredients such as a combination soybean meal with fish meal as is practised in the poultry feed industry. But, for some time, there was still some necessity to maintain a certain level of shrimp meal at the grow-out phase at COP, Tahiti.

Fish meal

Ingredients were tested for their digestibility in order to fulfill the conditions of some complex indices set in Taiwan. These are total volatile basic nitrogen (TVBN), histamine, peroxide value (PV) and ammonia or in plant ingredients, phytate, conglycinin etc (Gaxiola and Cuzon, 2015). This is critical especially with the drastic reduction in fish meal availability in the market. A statement on ingredients will remain a priority to meet requirements or to minimize deficiencies as long as rearing conditions are not standardized. Due to the differences in environmental conditions and the location of culture in the tropical belt, differences in requirements will occur.

There is a kind of simplification in the world of shrimp farming with the fact that little by little over the past 40 years, farmers are beginning to concentrate on a few species for culture, among them *P. vannamei*. This is an advantage from the point of view of feed formulation but not necessarily from a diversity viewpoint. One question remains, which to focus on: complete feed (pellet or collet) or green pellet for "floc" culture?

Taking into account such specifications, it helped nutritionists to formulate least cost feeds and limit the number of ingredients, especially in the partial or total replacement of fish meal (Gaxiola and Cuzon, 2010). Fish meal remains a key ingredient; with knowledge on shrimp requirement for carnitine, vitamin B12 and calcium (all of these nutrients being easily obtained as a premix) fish meal can hence be partially replaced. On feed attractability, the industry solved this by using some premixes including betaine, or other commercial products to enhance acceptability by the shrimp.

Conclusion

In the 1970s, experimental diets gave preliminary results on shrimp requirements, and then feeds were manufactured with a specific objective on quality ingredients. These studies were carried out mainly in Japan where the availability of marine protein sources was not a constraint. The relationship between quality marine sources as a basis of formulating for shrimp grower feed was well established. Forty years later, the choice of ingredients to formulate grower feeds remain, perhaps with less intensity (due to rearing conditions such as bioflocs) but still an issue in shrimp feed formulation.

“ The paradox remains that globally shrimp nutrient requirements have been determined in clear water .. ”

Concurrent with the need to replace fish meal with plant protein sources, recent findings have unveiled the role of trace elements to sustain efficient trout feed with no fish meal. However, the paradox remains that globally shrimp nutrient requirements have been determined in clear water systems and produced values that are not adequate in culture systems such as in ponds with meiofauna and bioflocs (particulate biomass) and in cages (zooplankton blooms). The balance between feed composition and weight gain remains complex without any general guidelines available.

An absence of vitamin fortification did not give any negative effects (Lawrence et al., 1986) but protein wastage in semi-intensive culture can be an issue. High stocking density in bioflocs culture would necessitate a complementary feed, or the so called "green pellet". However, in ponds is a complete feed necessary at the start? It could be very much needed at least during the last 4-5 days of the growing phase (finisher feed).

Finally, what is the actual balance between feed composition and fulfilment of requirements? How can a feed manufacturer cope with the diversity of rearing conditions? By and large, a nursery feed can be complete, a grow-out and maturation feed could be less demanding than that indicated in requirement studies. Finally, a bottleneck exists due to a lack of efficiency in reproduction without live or fresh marine products.

The multiplicity of brand names in the market and few details on composition hinder the progress in ingredient selection to meet what is known on requirements to allow shrimp juveniles to exhibit maximum growth potential.

References are available on request



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Replacement of monocalcium phosphate with neutral phytase: Effects on growth and phosphorus utilisation in tilapia

By Shude Xu, Yubiao Lu, Qifeng Tang, Yangyuan Li and Qinghui Ai

This study in China suggests that dietary MCP can be partially replaced with neutral phytase and this also lowered phosphorus discharge into the pond environment.

Phosphorus is an important constituent of nucleic acids and cell membranes, a vital component of the skeletal system and plays an important role in energy and cell metabolism (NRC, 1993). Thus, it is an essential nutrient for growth, skeletal development and reproduction of fish (Asgard and Shearer, 1997). Calcium is directly involved in the development and maintenance of the skeletal system and participates in several physiological processes in fishes (Hossain and Yoshimatsu, 2014). Fish can absorb calcium directly from their environment, while the phosphorus uptake from water is negligible; therefore, fish need a dietary source of phosphorus to meet the phosphorus requirement. Meanwhile, phosphorus is a critical pollutant in the aquatic environment. Excessive phosphorus concentrations are the most common cause of eutrophication of rivers, lakes and reservoirs (Correll, 1999). The inclusion of exogenous phytases in fish diets was prompted by the need to reduce phosphorus discharge into the environment.

We conducted an experiment to investigate whether phytase could partially replace monocalcium phosphate (MCP), and thus reduce the dietary inclusion of MCP in diets of tilapia (*Oreochromis niloticus*♀ × *O. aureus*♂). The parameters measured were growth performance and phosphorus utilisation.

A 3-month growth trial was carried out using flow-through 200 L (70 × 60 cm) cylindrical fiberglass tanks in an indoor research laboratory belonging to the industry-college-research institute of Guangdong VTR Bio-tech Co. Juvenile fish weighing 42.13 ± 0.44 g were stocked at 25 fish per tank. There were three replicates for each dietary treatment. The fish were fed to satiation with the experimental diets twice a day (8:30 and 16:30 h).

There were three treatment diets; diet PP1.0, PP0.5 and PPO were supplemented with 1.0, 0.5 and 0% MCP, respectively, along with 300 mg (600 FTU) phytase/kg diet. There were three control diets. The positive control diet (P1.5) was prepared with 1.5% MCP. Two negative control diets were diet P1.0, containing 1.0% MCP and negative control diet P0.5, containing 0.5% MCP. All the control diets did not contain any neutral phytase (Table 1).

The weight gain, feed conversion ratio, protein efficiency ratio, feed intake, survival rate, apparent digestibility coefficient and phosphorus discharge were measured. At the last two weeks of the feeding trial, the fish were fed experimental diets supplemented additionally with 0.5% Cr₂O₃ as a digestibility marker. Faecal samples were collected separately by siphoning faecal strands at the bottom of each tank within 30 minutes to an hour after feeding. These samples were used for the determination of the apparent digestibility coefficients of phosphorus.

The results in Table 2 show data expressed as means ± SEM. Differences between the different dietary groups were tested using one-way analysis of variance (ANOVA) followed by Tukey's multiple comparison. The significance level was set at *P* < 0.05. Statistical analyses and figures were done using the software package Origin® Version 8.0 (USA).

Table 1. Formulation and proximate composition of experimental diets

Ingredients (%)	Experimental diets					
	P1.5 (+ve control)	PP1.0	PP0.5	PPO	P1.0 (-ve control 1)	P0.5 (-ve control 2)
Fish meal	3	3	3	3	3	3
Soybean meal	28	28	28	28	28	28
Rapeseed meal	18	18	18	18	18	18
Cottonseed meal	15	15	15	15	15	15
DDGS	8	8	8	8	8	8
Coconut meal	7	7	7	7	7	7
Wheat flour	16.45	16.45	16.45	16.45	16.45	16.45
Soybean oil	3	3	3	3	3	3
Mineral premix ¹	0.5	0.5	0.5	0.5	0.5	0.5
Vitamin premix ²	0.5	0.5	0.5	0.5	0.5	0.5
Others ³	0.05	0.05	0.05	0.05	0.05	0.05
Cellulose	0	0.47	0.97	1.47	0.5	1.0
MCP	1.5	1	0.5	0	1	0.5
Neutral phytase ⁴	0	0.03	0.03	0.03	0	0
Proximate composition (% dry weight basis)						
Crude protein	33.30	33.07	32.84	32.98	33.13	33.27
Crude lipid	4.65	4.47	4.42	4.52	4.53	4.60
Crude ash	9.53	9.41	9.32	9.24	9.40	9.33
Moisture	9.59	9.55	9.76	9.67	9.53	9.63
Phytate phosphorous	0.42	0.42	0.42	0.42	0.42	0.42
Total phosphorous	1.13	1.03	0.94	0.82	1.01	0.95

¹ Mineral premix (per kg of diet): MnSO₄, 10 mg; MgSO₄, 10 mg; KCl, 95 mg; NaCl, 165 mg; ZnSO₄, 20 mg; KI, 1 mg; CuSO₄, 12.5 mg; FeSO₄, 105 mg; Na₂SeO₃, 0.1 mg; Co, 1.5 mg.

² Vitamin premix (per kg of diet): vitamin A, 2000 IU; vitamin B1 (thiamin), 5 mg; vitamin B2 (riboflavin), 5 mg; vitamin B6, 5 mg; vitamin B12, 0.025 mg; vitamin D3, 1200 IU; vitamin E 21 mg; vitamin K3 2.5 mg; folic acid, 1.3 mg; biotin, 0.05 mg; pantothenic acid calcium, 20 mg; inositol, 60 mg; niacinamide, 25 mg; ascorbic acid (35%), 110 mg.

³ Others: choline chloride, 0.02%; antioxidant, 0.03%.

⁴ Neutral phytase: enzyme activity, 2000 FTU/g, supplied by VTR Bio-Tech Co. Ltd (Guangdong, China); phytase incorporated into diets prior to pelleting.



Tilapia in tanks

Growth performance

The results showed that partial replacement of MCP with phytase did not affect the weight gain of tilapia (Table 2). Compared with the positive control group, fish fed with diets PP1.0 and PP0.5 were not significantly different in weight gain, feed conversion ratio (FCR) and protein efficiency (PER) ($P < 0.05$). However, in the group fed the negative control diets (P1.0 and P0.5) or when diet with 1.5% MCP were completely replaced with phytase (PPO), the weight gain and PER decreased significantly ($P < 0.05$) and the FCR increased significantly.

The present study indicated that 0.5% dietary MCP together with 300 mg (600 FTU) phytase/kg diet did not adversely affect growth performance when compared to the positive control of

1.5 % MCP. Similar result was reported in grass carp feed where 1% MCP was replaced by 500 FTU/kg diet of phytase (Liu et al., 2012) and where 1% MCP was replaced by 400 FTU/kg diet of phytase in black sea bream feed (Lu et al., 2016) without affecting growth performance.

Table 2. Growth performance of tilapia fed the experimental diets for 3 months

Items	Diet No.					
	P1.5 (+ve control)	PP1.0	PP0.5	PPO	P1.0 (-ve control 1)	P0.5 (-ve control 2)
Initial body weight (g)	42.22 ± 0.56	42.35 ± 0.72	41.67 ± 0.64	42.16 ± 0.53	42.18 ± 0.28	42.25 ± 0.32
Final body weight (g)	592.52 ± 5.89 ^c	613.53 ± 6.32 ^c	598.79 ± 7.91 ^c	521.07 ± 4.56 ^b	522.31 ± 4.63 ^b	459.15 ± 4.86 ^a
Weight gain (%)	1304.06 ± 29.52 ^c	1348.71 ± 25.33 ^c	1337.79 ± 29.58 ^c	1135.53 ± 23.63 ^b	1138.82 ± 15.67 ^b	986.75 ± 22.04 ^a
Feed intake (g)	654.86 ± 11.57	662.57 ± 12.41	651.83 ± 12.17	636.95 ± 11.21	638.57 ± 12.11	621.18 ± 10.65
Feed conversion Ratio (fcr)	1.19 ± 0.01 ^a	1.16 ± 0.01 ^a	1.17 ± 0.01 ^a	1.33 ± 0.01 ^b	1.33 ± 0.01 ^b	1.49 ± 0.01 ^b
Protein efficiency ratio (per)	2.52 ± 0.03 ^c	2.61 ± 0.03 ^c	2.60 ± 0.01 ^c	2.28 ± 0.02 ^b	2.27 ± 0.02 ^b	2.02 ± 0.03 ^a
Survival rate (%)	100	100	100	100	100	100

Values are means ± SEM of three replicates. Values within the same row with different letters are significantly different ($P < 0.05$).



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Trial tanks at the college-research institute of Guangdong VTR Bio-Tech.

Phytase appears to counteract the negative effects on performance when dietary MCP is reduced from 1.5% to 1.0% and to 0.5%, probably by improving the availability of phosphorus, as phytate-phosphorus is converted to available-phosphorus by phytase which can be utilised directly by aquatic animals (Cao et al., 2007).

Table 3. Phosphorus utilisation of tilapia fed the experimental diets for 3 months.

Items	Treatment diets					
	P1.5 (+ve control)	PP1.0	PP0.5	PPO	P1.0 (-ve control 1)	P0.5 (-ve control 2)
Phosphorus intake (g)	7.39 ± 0.22 ^c	6.82 ± 0.16 ^{bc}	6.13 ± 0.16 ^b	5.22 ± 0.11 ^a	6.44 ± 0.17 ^b	5.90 ± 0.14 ^{ab}
Phosphorus retention (g)	2.97 ± 0.11 ^{bc}	3.08 ± 0.12 ^c	3.01 ± 0.13 ^{bc}	2.58 ± 0.08 ^{ab}	2.59 ± 0.09 ^{ab}	2.25 ± 0.06 ^a
Phosphorus discharge (g/kg weight gain)	8.03 ± 0.19 ^c	6.55 ± 0.18 ^b	5.60 ± 0.17 ^a	5.50 ± 0.17 ^a	8.01 ± 0.23 ^c	8.82 ± 0.20 ^c
ADC phosphorus (%)	55.15 ± 1.44 ^{ab}	60.24 ± 1.53 ^{bc}	64.06 ± 1.71 ^c	63.83 ± 1.90 ^c	53.22 ± 1.15 ^{ab}	50.36 ± 1.16 ^a

Values are means ± SEM of three replicates. Values within the same row with different letters are significantly different ($P < 0.05$).

Phosphorus utilisation of tilapia:

The apparent digestibility coefficient (ADC) of phosphorus increased and phosphorus discharge reduced when fish fed with the diets in which MCP was replaced by phytase (Table 3). The present experiment indicated that replacing MCP with phytase improved phosphorus utilisation and reduced phosphorus discharged into the water. Phosphorus discharge in the environment is of increasing concern in commercial fish production as it is the most important pollution source. The reduction in the phosphorus discharge is a critical factor in reducing environmental pollution from commercial fish production. These results on reduced phosphorus discharge from diet with the addition of phytase were in agreement with the findings of other studies (Forster et al., 1999; Vielma et al., 2002).

Conclusion

The present study suggests that dietary MCP could be reduced when phytase was supplemented in the diet of tilapia, and that the maximum reduction level of MCP was at 1% when phytase was supplemented at 300 mg (600 FTU)/kg diet. The results of this study indicated that partial replacement of dietary MCP with phytase not only reduced inorganic-phosphorus addition, but also lowered the phosphorus discharge in tilapia diets without compromising growth. The results therefore suggest that significant economical (cost reduction at USD2/tonne) and ecological benefits could be achieved by replacing MCP with phytase in commercial tilapia feeds.

References are available on request



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May/June 2017

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Industry review: Aqua Feeds in Asia

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Bio-processed protein concentrate as partial replacement for fish meal in shrimp farming in Indonesia

By Hyeonho Yun, Kyung-Hoon Chang and Seong-Jun Cho

Feed trials in ponds in Situbondo and Banyuwangi confirm that bio-processed protein concentrate can replace 30% of fish meal in commercial feeds for the white leg shrimp.

Indonesia is an archipelago with more than 17,000 islands and a coastline of about 81,000 km. The potential area for aquaculture development is 26.6 million ha (Fisheries and Aquaculture Department, FAO, 2016). The shrimp, *Litopenaeus vannamei*, is the most important farmed shrimp species in Indonesia with the highest value of all traded crustacean products. It has relatively low dietary protein requirements and adapts well to a wide range of environmental parameters, such as salinity and temperature.

In the last decade, an increasing demand for fish meal has led to price and world supply fluctuations. This situation highlighted the need for alternative protein sources for aqua feeds. However, in case of animal by-product meals, these have relatively lower protein digestibility for most of aquatic animal species (NRC, 2011). The protein digestibility in feather meal ranges from 62-80% and in poultry by-product meal, it ranges from 74-90%, as compared to herring fish meal which is from 91-96%. Plant meals are alternatives to replace fish meals but plant protein meals also have relatively lower protein digestibility than fish meal. The protein digestibility for soybean meal is 77-94% and for cottonseed meal, 76-88% (NRC, 2011). Although plant meals have anti-nutritional factors, they have stable pricing and supply than fish meal and animal by-product meals. Many processed plant protein sources such as soy protein concentrate, soy protein isolate and fermented soybean meal have higher protein digestibility in aquatic species and the processing have reduced anti-nutritional factors. Bio-processed protein concentrate, fermentation and enzyme treatments are solutions to the above problems and lead to improving the nutritional value of a plant protein.

AQUATIDE65 (AQ65, CJ Cheiljedang, Seoul, Korea) is a bio-processed (fermentation and enzyme treatment) ingredient developed to replace fish meal in aqua feeds. It is a mixture of soybean and corn gluten meal processed by incorporating *Bacillus subtilis*. The result of this process is a protein source with increased protein and peptide content, better digestibility and palatability, and minimum level of anti-nutritional factors.

Previously, we have conducted laboratory experiments on this bio-processed protein concentrate and confirmed that it could replace fish meal in shrimp feeds. This information was published in Aqua Culture Asia Pacific magazine (September/October 2016; Yun et al., 2016). In this article, we report on our field trials using AQ65 to replace fish meal in shrimp feeds in two farms in Indonesia.

Farms trials

Two field trials were conducted in Situbondo and Banyuwangi in Indonesia. For experiment 1, carried out in a farm in Situbondo,

Table 1. Experimental design of shrimp in Farm-A and Farm-B

	Farm-A (Economy- grade) Crude protein 32%		Farm-B (Premium- grade) Crude protein 35%	
	Control	Treatment	Control	Treatment
Ingredients	(CON1)	(AQ1)	(CON2)	(AQ2)
Fishmeal (CP65)	12	8	18.5	12.5
AQUATIDE65 (CP65)	0	4	0	6
FM replacement rate,%		33.3		32.4

shrimp of average initial weight 4.1 g were randomly distributed into four ponds of 3,000 m², with two ponds fed the control diet, CON1 and the other two fed the test diet AQ1, while for experiment 2 carried out in a farm in Banyuwangi, shrimp with average initial weight 8.7 g were also distributed into four ponds of 3,000 m², with two ponds fed the control diet CON2 and the other two fed the test diet AQ2.

In experiment 1, economy grade commercial feed containing 12% fish meal was used as the control diet (CON1). For the test diet, we replaced 33.3% of fish meal with AQ65 (AQ1). In experiment 2, premium grade commercial feed with 18.5% fish meal was used as the control (CON2). For the test diet, we replaced 32.4% of fish meal with AQ65 (AQ2). Water parameters during the trials were maintained at a temperature, 29-32°C, salinity, 20-25 ppt



Figure 1. Shrimp field test farms in Indonesia

Table 2. Trial results of shrimp fed Farm-A in Situbondo and Farm-B in Banyuwangi

Treatment	Farm-A (Trial period: 47-52 days)		Farm-B (Trial period: 40 days)	
	CON1	AQ1	CON2	AQ2
Initial weight(g)	3.9	4.1 ± 0.2	8.7 ± 0.0	8.8 ± 0.2
Final weight (g)	10.5	11.4 ± 1.1	18.1 ± 2.5	17.0 ± 0.3
Weight gain (%)	169.9	181.6 ± 12.4	108.2 ± 30.2	95.4 ± 2.1
ADG ¹	0.13	0.15 ± 0.0	0.23 ± 0.1	0.20 ± 0.0
FCR ²	2.40	2.22 ± 0.0	1.60 ± 0.3	1.69 ± 0.3
Survival rate (%)	50.0	42.0 ± 2.8	68.0 ± 11.3	69.5 ± 0.7

¹ADG: average daily gain, ²FCR: feed conversion ratio

and pH 7.7-8.4.

Situbondo farm (Farm-A)

In experiment 1, shrimp fed AQ1 diets showed higher average weight gain and average daily gain than those shrimp fed the control diets. With regards to feed conversion ratios (FCR), shrimp fed diet AQ1 showed improved FCRs as compared to shrimp fed the control diets. Meanwhile, the overall survival rates of all ponds were lower than normal (70%), because ponds in these farms were infected with white faeces disease (WFD), which commonly occurs in most Southeast Asian countries. The causes of WFD are not clear but generally high temperature, low salinity and increased organic matters followed by increased stocking densities are conducive environmental conditions for the spread of *Vibrio* spp, which are bacteria related with WFD outbreaks. Because of this WFD outbreak, ponds with shrimp fed control diets were harvested early at 40 days after stocking. The data for ponds with WFD outbreaks were eliminated. Recently, feed companies lamented on lower feed sales because of WFD. "With disease outbreaks and lower survival, FCR increases from

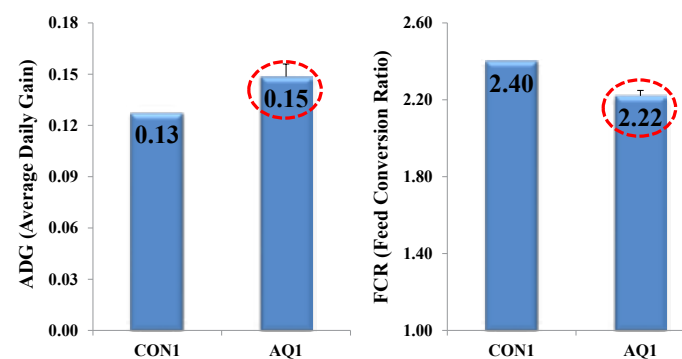


Figure 2. Farm-A in Situbondo. Average daily gain and feed conversion ratio of shrimp fed treatment and control diets

1.7 to as high as 2.3," said Haris Muhtadi, CJ Feeds (Merican, 2016).

Banyuwangi farm (Farm-B)

In experiment 2, shrimp fed the control (CON2) diet had higher average weight gain and average daily gain than shrimp fed diet AQ2. However, there were no significant differences. FCR of shrimp fed CON2 diets was lower than those of shrimp fed AQ2 diets, but again there was no significant difference. Survival rate of shrimp in trial ponds at farm-B was lower as the farm was also infected with WFD, but the farm eventually recovered from the

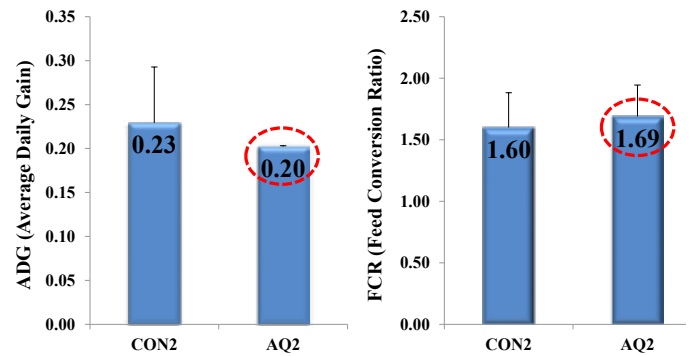


Figure 3. Farm-B in Banyuwangi. Average daily gain and feed conversion ratio of shrimp fed treatment and control diets

① Farm – A, Situbondo



② Farm – B, Banyuwangi



Figure 4. Harvesting of shrimp in the farms

disease. Survival rates of shrimp fed diets CON2 and AQ2 were recorded at 68.0% and 69.5%, respectively.

Conclusion

In these field trials, we show that Aquatide65 could replace more than 30% of fishmeal in commercial feeds for whiteleg shrimp under pond conditions and there will be savings in the feed costs of approximately 300 to 400 IDR/kg of shrimp diet. Consequently, field trials proved that this bio-processed protein concentrate can replace fish meal in shrimp feeds.

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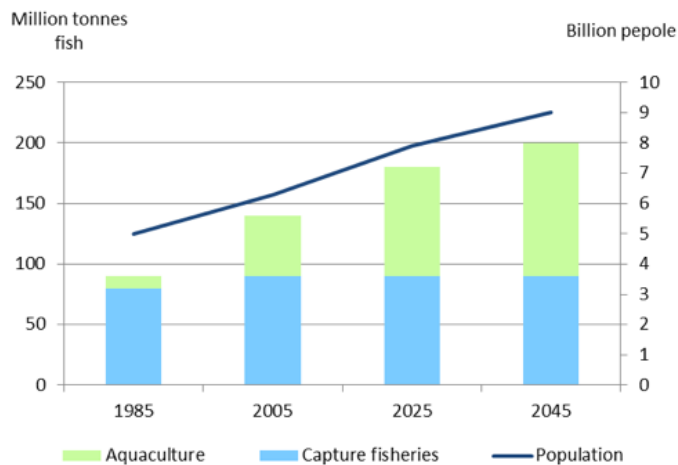
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The vaccine focus on fish health

By Maja Bævre-Jensen, Pham-Cong Thanh, Torill Widerøe and Are Klevan

Vaccination of fish is a way to ensure sustainable and profitable aquaculture as world demand for seafood spikes.

By 2045, The Food and Agriculture Organisation of the United Nations (FAO) estimates that our planet will have a population of 9 billion people (figure 1). The world will need to increase its food production by 70% in order to meet future demands, while simultaneously reducing the environmental impact by half. The global demand for seafood is expected to double by 2030. Since capture fisheries will not be able to meet the growing demand, further growth will have to come from aquaculture.



Gravningen, FAO Fisheries Proceedings 9, 2007



Demonstration on vaccination of juvenile pangasius at Vietfish 2016

An important part of the WHO (World Health Organisation) strategy is to fight antibiotic resistance by reducing antibiotic treatment in both humans and animals. Consequently, focus on fish health management and good farming practices is of great importance to overcome the disease outbreaks that lead to the extensive use of antibiotics today. Eventually this will lead to a more sustainable industry, protecting animal welfare, preserving the aquatic environment and finally increasing the product quality and profitability for the farmer.

“ Healthy fish is ...also the most lucrative for the aquaculture industry. ”

Sustainable fish disease control

Healthy fish is a prerequisite for sustainable and profitable growth in aquaculture, and a clear shift from medical treatment to prevention of diseases is needed.

Veterinary antibiotics (VAs) are commonly used in many countries worldwide to control bacterial infections when effective vaccines are not available; this is the case in Vietnam. Frequent use of antibiotics, mixing of antibiotics, suboptimal doses and short treatment regimes raise concerns about increased antibiotic resistance in microorganisms (Sarmah et al, 2006). This is a global concern related to both veterinary and human health issues.

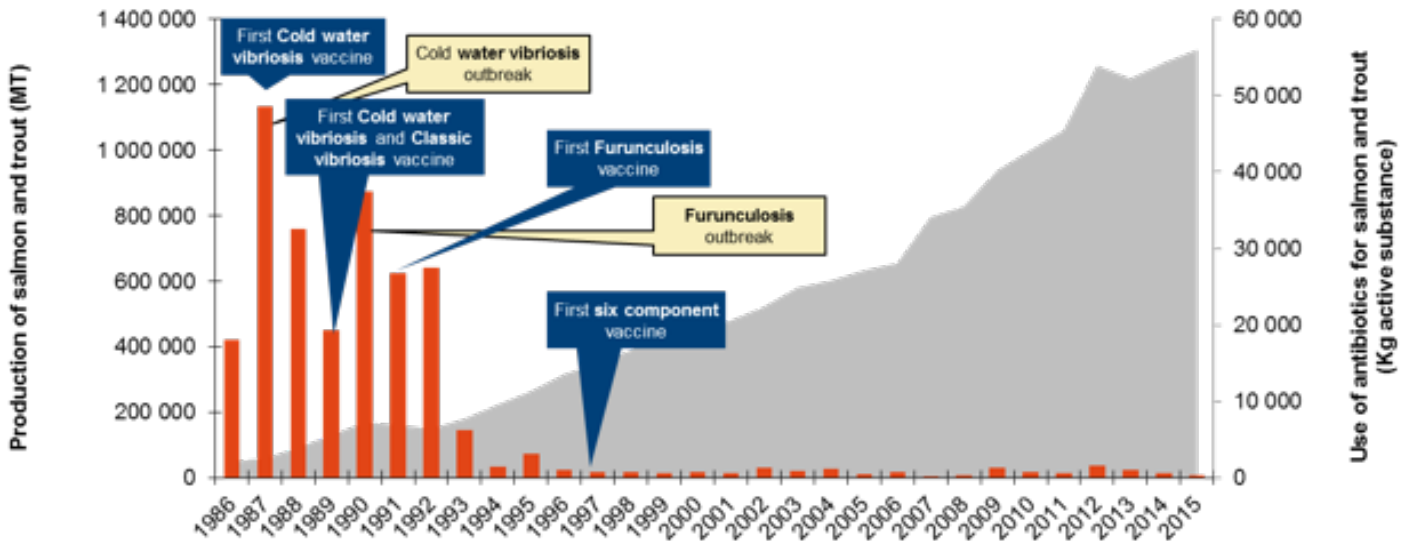
During profiling of a large group of *Edwardsiella ictaluri* isolates from the Mekong Delta (collected by PHARMAQ from 2011 to 2015), significant antibiotic resistance was observed. Only 1 out of 11 commonly used antibiotics was effective against all isolates. Also, most isolates displayed resistance towards multiple antibiotics. In fact more than 65 % of the isolates were resistant towards at least three antibiotics and several isolates were resistant towards seven different antibiotics or more.

Choosing vaccines for healthy growth in aquaculture

Healthy fish is not only the most environmental sustainable solution, but also the most lucrative for the aquaculture industry. This can be achieved by implementing a number of different farm health management practices, where vaccination is one of them. Vaccination reduces the risk of disease outbreak, and the spreading of disease from pond to pond, to other farms, and to wild fish.

Commercial fish vaccines in salmonids are today considered as the best tool to avoid diseases. Effective vaccines is a key factor in enabling the Norwegian salmon industry to grow from 65,000 tonnes in 1987 to more than 1.2 million tonnes in 2015. The result is impressive; lowering the use of antibiotics by 99.9 % to 549 kg in 2011 (Figure 2). Similar examples have been seen in other countries and for other fish species, e.g. seabass:

- Greece: Significant reduction in antibiotic use by 65–95 % for farmers that have implemented oil based vaccination



Source: CHIEAM, International Centre for Advanced Mediterranean Agronomic Studies, multiple scientific articles, PubMed

Figure 2. Production of salmon and trout and use of antibiotics in Norway.

- Spain: Significant reduction of antibiotic use and outbreaks of bacterial and viral diseases.
- Turkey: Three farms implementing oil based vaccination in 2013 reduced their use of antibiotics by 76, 82, and 85 %.

The introduction of vaccines has always been done stepwise (Figure 2). For the first salmon vaccine, Pharmaq started with a one component (monovalent) vaccine protecting against one bacterial disease. Today, standard vaccination includes six or seven components in one injection. The vaccines protect against virus and bacteria that used to be big challenges for salmonids.

Various fish species are susceptible to different diseases and exhibit different immunological responses. Fish health management is a continuous process. Surveillance, monitoring and sampling of diseased fish together with vaccination and control of different water quality parameters can make the difference between good and poor fish health. With the introduction of new and improved screening technology, this is done faster and more accurate than ever before. This work is essential in order to develop new tailor-made vaccines for pangasius in Vietnam.



Harvesting pangasius

Pharmaq is the global leader in vaccines and innovation for aquaculture and part of Zoetis, the world leader in animal health. The company provides environmentally sound, safe and efficacious health products to the global aquaculture industry through targeted research and the commitment of dedicated people.

The company strongly believes in the further growth of the global aquaculture industry, anticipating a significant increase in fish farming for both fresh water species and new high value marine species in the near future. The fish farming industry must be willing to invest in sustainable solutions like vaccines. The challenge in the years to come in Vietnam will be to implement safe and efficacious vaccination procedures together with customers in the pangasius fish farming industry. At the same time the company will develop new generations of vaccines against new diseases that currently are the main challenges facing the aquaculture industry. It believes that working together with its customers and partners, it will find solutions to overcome the challenges.



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Farming murrels in India

By B. Laxmappa, B. Sreenivas Reddy, Ravinder Rao Bhakshi and M. Gunakar

High demand in live fish markets but dependence on wild juveniles limits commercial farming.



Striped murrels

The murrels are the third most important group of freshwater fish after carps and catfishes farmed in India. Murrels are also known as “snakeheads” similar as in Thailand, Vietnam and China where they are one of the most popular food fish. The name is because of the shape and appearance of the head, which resembles that of a snake. On the roof of its pharynx, the fish has a pair of cavities with folded linings, which are richly supplied with blood vessels for taking in air. These organs enable the fish to survive out of water for a few hours or migrate from one pool to another. Indians often refer to the fish as “live fish”.

In India, murrels have good market value because of its taste and texture, low fat content and fewer intramuscular bones when compared to carps. They also have medicinal properties. For example, a century old practice is to give murrel fingerlings as “fish medicine” to asthma patients that gather from all over the country in Hyderabad City, in the month of June on the eve of *Mrigasirakarathi* Day. Additionally, murrels have a role in the biological control of mosquito larvae and aquatic insect population in stagnant water pools.

High demand and market value

The high demand and high market value, and their capacity to withstand adverse water conditions make them suitable for aquaculture. The most common type of culture practice is pond culture similar to practices in Southeast Asia. Out of the six species indigenous to India, three of them, the giant murrel *Channa marulius*, striped murrel *C. striatus*, and spotted murrel *C. punctatus*, are very popular as food fish in India and are important from a culture and economic point of view. Murrels are usually cultured by farmers together with the Indian major carps in several states, including Telangana, Andhra Pradesh, Karnataka, Tamil Nadu and Maharashtra.

The largest murrel species in India is *C. marulius*. The average length is 45 cm but it could attain over 1 m length and weigh more than 6 kg. It is cultured in ponds and irrigation tanks in some parts of India. The more common *C. striatus* is medium-size and is distributed widely from the Indo-Ganges plain to Peninsular India. Today *C. striatus* is widely reared in tank systems. It attains a length of about 90 cm and grows up to 2 kg. It breeds throughout the year except during extreme winters from December to February. *Channa punctatus* is a prolific breeder and is widely distributed. It is smaller in size than *C. marulius*, and prefers stagnant waters. The average length of an adult fish is about 30 cm and grows up to 0.25 kg weight.

Farming practices

The murrel breeds all year round in rivers, reservoirs, perennial tanks and other derelict water bodies. Juveniles under parental care move in shoals in search of food along the marginal areas of the breeding environment. Fishermen collect the entire seed stock using a fine mesh and sell them to farmers. Seed stock is available from May to August. This explains why the commercial farming of murrels is limited because of the lack of adequate seed stock.

Hardy fish

As murrels are hardy and tolerate overcrowding because they are air breathers, the stocking density is 20,000 to 30,000 fingerlings/ha. Fish farmers stock these murrel fingerlings in culture tanks and ponds alongside carp seed fingerlings such as catla, rohu and common carp. The culture period is 6-9 months or more. In carp culture, farmers stock 300-500/ha murrel juveniles (6.5 cm to 7.5 cm in length) to control the weed fishes, particularly tilapia. This gives additional income to the farmers in India. Production of murrels under the traditional culture system ranges from 50 to 150 kg/ha in 8-10 months. On average, marketable size can be obtained in 8-9 months. The yield is slightly more under semi-intensive culture along with carps where the carp seed stocking density ranges from 6,000-7,500 fingerlings/ha. In this system, water quality, feed and health managements are taken care off.



Releasing juveniles

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Farmers stock 300-500/ha murrel juveniles (6.5 cm to 7.5 cm in length).

Diseases

Murrels, irrespective of size are easily susceptible to the epizootic ulcerative syndrome (EUS) which usually results in large scale mortalities. However, infection occurs more often in the younger ones. Affected murrels with mild lesions may not show any clinical signs, whereas those with marked ulcerative lesions exhibit distinct abnormal swimming behaviour with frequent surfacing.

EUS is characterised by the occurrence of large haemorrhagic or necrotic ulcerative lesions on the base of the fins and other parts of the body, which later become large inflamed areas with acute degeneration of epidermal tissues. Initially, the disease appears as red coloured lesions, which are haemorrhagic in nature. These red lesions spread and enlarge, and gradually becoming deeper and ulcerative. With further advancement, scales fall off; ulcers become deeply necrotising and fish eventually die.

Marketing

Murrels account for 5% of the total inland fish production from rivers and reservoirs and 10 to 15% of fish harvested from other sources such as canals, tanks, pools and ponds. Murrels are quite popular among fish consumers particularly in the states of Telangana and Karnataka. Murrels have a high farm gate price ranging from INR 400-500 (USD 6-8/kg) in different markets. In general, prices of murrels are much more than those of carps and catfishes (Table 1). Heavy demand exists for murrels in Telangana and Karnataka states. The demand also arises because they are sold live in local markets.



Murrel effected with EUS



Dr B Laxmappa with an adult spotted murrel

Table 1. Local market prices of some fishes in India

Species	Market price per kg
Catla, Rohu	INR 120-150 (USD 2-2.5)
Common carp	INR 100-120 (USD 1.6-2)
Catfishes	INR 80-90 (USD 1.3-1.5)
Murrels	INR 400-500 (USD 6-8)

Future development

Despite vast fresh water resources, only a limited area is used for murrel farming in different states in India. The National Fisheries Development Board (NFDB) which was established in Hyderabad in 2006 plans to provide financial assistance for the development of breeding, feeding and culture technology of murrels particularly *C. striatus* in India. Murrels are the alternative species in aquaculture besides carps and catfishes in India.

The plan is to use underutilised water resources for its farming. These include water logged areas which are unfit for agriculture, and areas in the vicinity of canals and tributaries of rivers used for reservoir projects. Air breathers such as the murrels may have a significant advantage as they can thrive well in environments with low dissolved oxygen. More studies need to be initiated on murrel breeding and its nutritional requirements to further develop its commercial large scale culture.

References are available on request



B. Laxmappa



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The live freshwater fish market in India

The live fish food trade is a lucrative business in India. Generally live fish fetch higher prices i.e. almost double those of chilled or preserved fish. Within the live fish trade, there are certain types of fish, particularly the smaller- and medium-sized fish, which are demanded more often by consumers. Consumers directly purchase these fish species at landing spots, markets and stores. Because of the high profitability of this live fish marketing, there is a need to identify sustainable practices in this field.

Species		Marketing system	
Common name	Scientific name	Live	Dead
Magur	<i>Clarias batrachus</i>	Common	Rare
African catfish	<i>Clarias gariepinus</i>	Common	Rare
Singhi	<i>Heteropneustes fossilis</i>	Common	Rare
Striped murrel	<i>Channa striatus</i>	Common	Rare
Climbing perch	<i>Anabas testudineus</i>	Common	Rare
Nile tilapia	<i>Oreochromis niloticus</i>	Rare	Common
Catla	<i>Catla catla</i>	Rare	Common
Rohu	<i>Labeo rohita</i>	Rare	Common
Mrigal	<i>Cirrhinus mrigala</i>	Rare	Common
Common carp	<i>Cyprinus carpio</i>	Rare	Common

Aside from murrels described in this article, another air breather marketed live is the singhi or stinging catfish, *Heteropneustes fossilis*. Although the African catfish or Thai magur, *Clarias gariepinus* culture was banned in India under the Environment Protection Act, the fish is still farmed illegally in village ponds by some farmers in the states of West Bengal, Punjab, Tamil Nadu, Karnataka, Assam, Maharashtra, Andhra Pradesh and Telangana. Carps cater to



Marketing live murrel

the tastes of all classes of people ranging from aristocratic urban consumers to the rural poor. Carps contribute to more than 85% of the total aquaculture production and among them the major species are Indian major carps, catla, rohu and mrigal. Carps are sold live in some parts of India by keeping them in containers where oxygen is supplied from the oxygen cylinders in the trucks. Wild tilapia are landed from natural water bodies such as Godavari, Krishna, Cauvery, Yamuna and Ganga Rivers and from the Indian reservoirs and irrigation tanks. Certain fisher folks living near reservoirs are selling live fish which are kept in rectangular traps in water at the reservoir sites particularly in Telangana.

Future of live fish trade

Consumption of live fish is growing at a fast pace owing to improved preservation techniques, packing and transport. India has to develop strategies for marketing live freshwater fish in the coming years. There is a good market for live fish, but its potential has not yet been fully exploited. The live fish trade has the potential to provide employment opportunities to several thousands of the rural population including women. This appears a promising venture in the coming years. - **Dr B. Laxmappa**



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Smart solutions for farming shrimp in Vietnam

This year, Nutriad's distributor in Vietnam, Tan Sao A., chose Malaysia and Singapore as the destinations of its annual retreat for top clients and distributors. On February 22, the team conducted a half day seminar entitled "Smart Solutions for Sustainable Aquaculture in 2017" in Kuala Lumpur, prior to the group of 50 leaving for a tour of the city and onwards to historic Malacca and Singapore. Participants were owners, managers and technical staff from grow-out farms and hatcheries, sub dealers and distributors for Nutriad in Vietnam.

BK Chew, Regional Director, Nutriad Asia, described some recent development at Belgium based Nutriad. "Nutriad has a 50-year history in manufacturing state-of-the-art feed additives for aqua and livestock with sales in more than 80 countries. Nutriad's researchers continuously work on finding ways to improve farmer's production. Our focus is also on food safety issues and farming free of antibiotics. The aquaculture market is an important market for Nutriad. We conduct research in indoor facilities for species specific solutions and we have more than 15 years of research in aquaculture."

Allen Ming-Hsun Wu, Regional Manager, Aquaculture, Asia Pacific, Nutriad, referred to the success stories of Nutriad in Asia. "What makes Nutriad different is that we develop products specially for aquaculture. Ours is a truly aquaculture business. Several years ago, we realised that aquaculture is not just another species. It continues to be a very dynamic industry. The market is at times fragmented and feed formulations depend on farm conditions, species and genetics. It is thus a complex market which requires a highly specialised approach and support team.

"Nutriad aquaculture is focusing on two important programs. The Digestion program which is to reduce the costs of production by optimising nutrient utilisation; the other on Health, to reduce the impact of diseases and parasites on productivity. Vietnam is important to us. It is the only country where almost all Nutriad aqua products are registered."

Feed additives for protection and cures

Technical presentations at the seminar covered the company's range of solutions for aquaculture in Asia in areas of health, digestion, palatability, specialty nutrition and feed quality. The seminar emphasised how these solutions work in the shrimp farm and hatchery environment. Alexander Van Halteren, Business Development Manager Aquaculture Nutrition, discussed feed additives in functional shrimp feeds to improve disease resistance



The Nutriad team, from right, Allen Ming-Hsun Wu, BK Chew, Alexander Van Halteren, Ho Gim Chong and Diep Thanh Hai, Area Manager, Indochina, Nutriad.

and growth performance. At the grow-out stage, he discussed the mechanism for Sanacore® GM in the promotion of gut health and Aquagest®S to improve the lipid uptake in the hepatopancreas.

"Aquagest®S is a combination of natural emulsifiers and cofactors for fat digestion which improves the micelle formation and vacuolisation of the fat droplets resulting in better lipid uptake and augmented fat reserves in the hepatopancreas."

With regard to the mechanism of Sanacore® GM, Van Halteren explained "We have demonstrated the bactericidal effect against *Vibrio parahaemolyticus*, the causative pathogen for EMS, and many different species of bacterial pathogens. The mode of action is also linked to quorum sensing (QS) which is a mechanism allowing bacteria to activate pathogenicity only upon reaching a certain quorum. What we want to do is reduce pathogen counts and disrupt the QS signaling process. In the digestive system of shrimp, Sanacore® GM functions as a natural bactericide and inhibits QS depending on the dosage of the product in the feed. Although the product is focused on the microbial management in grow-out farms, we have also increasing interest for applications in post larval rearing. For example, in Vietnam, hatcheries struggling with luminous bacteria *Vibrio harveyi* and other *Vibrios* have developed successful preventive protocols in which post larvae larger than PL3 are treated with a daily dosage of Sanacore® GM between 10-15 ppm.

Alexander also discussed the protection and curative use of Bacti-nil Aqua, a mixture of short and medium chain fatty acids which have bactericidal properties. He showed the effect against *V. parahaemolyticus* as well as effects on *V. vulnificus*, *V. harveyi* and *Pseudomonas*. Similarly, a phyto-genic complex Apex® Aqua has broad spectrum bactericidal effects.

Tailoring nutrition for high saline farming

"A novel product introduced in Vietnam is HISAL, to help support shrimp reared in high saline conditions. The osmoregulation in the shrimp allows for it to be cultured in ideal conditions, ranging from 26-28 ppt. However, salinity often fluctuates during the production cycle. It is not rare to have fluctuations between 10 ppt and 40 ppt during the same culture cycle. In Vietnam, this is



an issue in the Mekong delta, when the shrimp is farmed between 15 ppt and 40 ppt. The farming conditions in central and northern regions are more stable. Shrimp need additional energy and nutrients to compensate for the osmotic stress.”

In general, HISAL allows the farmer to tailor the nutrition for high salinity farming. The product supports the shrimp by enhancing the feed intake, build up osmoprotective compounds in the haemolymph, reduce osmotic stress on cell membranes of gills and intestines and increase available energy required for osmoregulation.

White faeces syndrome in Indonesia and Malaysia

Over the past two years, Ho Gim Chong, Commercial/Technical Manager Aquaculture Southeast Asia, Nutriad, has been conducting field trials with Sanacore® GM in farms in Indonesia and Malaysia. Ho concluded that the farms have achieved relatively better harvests with relatively high survivals. In the case study in Malaysia, farms were affected by EMS and later with white faeces syndrome (WFS). EMS was not reported in Indonesia but WFS is a serious threat in farms throughout the country.

“We do not know the etiology of WFS but infected shrimp show reduced growth and gradual mortality. In one farm, the average growth rate (ADG) went down to 0.1 g. The protocol to use Sanacore® GM is 3 kg/tonne at days of culture (DOC) 30 and then reducing to 2 kg/tonne at DOC 80 and 1 kg/tonne at DOC 140. In the farm in northern Malaysia, we managed to make changes such as increasing feed conversion ratio (FCR) from 1.55 to 1.33, survival from 38% to 65.5% and ADG to 0.22g. The achievement was that the farm managed to continue culture until DOC 140 which gave harvest sizes of 30/kg. Yields were still limited but much better than those for the control pond where the emergency harvest resulted in shrimp of size 20/kg.

“In a field trial in Indonesia, WFS infected shrimp were present in all ponds at DOC 28 and as early as DOC 23. There was a need to develop curative measures and so we fed the feed additive at a dosage of 8 kg/tonne of feed for 3-5 days. We managed to stop further damage to the crop. During the recovery period, we fed commercial feeds and continued treatment with 3 kg feed additive/tonne of feed and reducing this to 2 kg feed additive/tonne of feed. We have observed that nowadays, WFS infected shrimp will stop growing whereas previously, shrimp continued to grow but at a very slow rate. Although in the trial ponds in



Le Huu Tinh (centre) with from left, Alexander Van Halteren, Allen Ming-Hsun Wu, Duc Truong Minh, Tan Sao A Ltd. Co, Vietnam, and Diép Thanh Hai.

Indonesia, shrimp was harvested at DOC 85 and sizes of shrimp in treatment ponds were larger than those in the control ponds, survival rate was only marginally higher (45% versus 40% in control ponds). The ADG recovered back to 0.2 g whilst the shrimp in the control ponds grew at 0.05 g/day at DOC 80.”

Ho summarised that by applying a full preventive protocol with the feed additive, shrimp can recover from WFS. In the audience, Phung Van Toan from the Fisheries Extension Centre in CaMau, requested for such trials in farms in Vietnam, so that farms in Vietnam can also benefit.

Success in Vietnam

Among the audience was Le Huu Tinh, CEO of Dac Loc Aquaculture Private Enterprise who operates a 50 ha hatchery complex located in Phu Yen Province. On the sidelines of the seminar, he described his recent success in his hatchery business.

“The momentum in Vietnam’s hatchery business has been picking up in recent years. I started in 2010 and since then my business has been good. Year 2016 was my most successful year and I have been applying new techniques (i.e. at the nursery phase) in the hatchery and commercial ponds. In 2016, I produced 1.2 billion vannamei shrimp post larvae (PL). The annual production capacity is 3.5 billion PL. My hatchery was GlobalGap certified in 2013,” said Tinh.

“In terms of volumes, shrimp farming in Vietnam has been increasing but we see only small increases in land area dedicated to its farming. More production is coming from new models such as farming shrimp and rice. I sell PL12 to PL 15 but also grow-out post larvae to PL40 and sell these at three times the price of PL15. Farmers however prefer PL15 and the average price for PL15 in Vietnam is about VND 80/PL (USD 3,800/million PL). I was the first to do nursery of post larvae in a greenhouse within a hatchery in Vietnam and required special feed supplemented with functional additives (Sanacore® GM, Apex®Aqua, Bactinil®Aqua) during the nursery stage until DOC 30-45.”

Finally, Tinh added that his focus is production of high quality post larvae and to brand his post larvae but at the same time, sell at a fair price.

More information: www.nutriad.com



Phung Van Toan from the Fisheries Extension Centre in CaMau (left), said that the group were excited with the results of the trials in Malaysia and Indonesia. With the cooperation of farmers, Nutriad can conduct similar trials in Vietnam and show the benefits to its farmers.

A new milestone in its sustainable development program



DIANA AQUA was recently awarded the IFFO Global Standard for Responsible Supply, Chain of Custody (IFFO RS CoC) certification. This award fully supports Diana Aqua's ambitions to become a leader for sustainable functional marine ingredients for the aquafeed and aquaculture sector.

Since 2010, Diana Aqua and TC Union Agrotech, a Thai leader in producing and supply aqua-industrial by products, have joined forces in a longstanding partnership with the common mission to add value co-products into performing solutions. With its unique know-how and scientific expertise, Diana Aqua has developed a leading position to deliver traceable, responsibly sourced and standardised marine ingredients with high functional value to aqua feed and aquaculture industry players.

On January 10 2017, Diana Aqua Thai subsidiary (SPF Diana Thailand), was awarded the IFFO Global Standard for Responsible Supply, Chain of Custody (IFFO RS CoC) certification. This certification recognises the full commitment of Diana Aqua of

providing its partners and customers with responsibly sourced raw materials, pure and safe marine ingredients with full traceability back to their source. It also reinforces its positioning as a sustainable reference partner in functional marine ingredients for the aqua feed and aquaculture sector based on responsibly managed factories and supply-chains.

Paul Seguin, Asia Sales Director said, "This certification marks our global and local commitment towards delivering trust to our customers and supporting their brands in aqua feed markets. The pressure on natural marine resources has become an imperative for all players of the value chain. Our role is to find innovative sustainable business models to keep on serving the growing industry of aquaculture without compromising the quality and the nutritional and healthy benefits of our products".

Diana Aqua's worldwide team works in close intimacy with a unique global network of technological and scientific experts to constantly deliver the highest quality standards in all its products along with an embedded top technology. With a proven performance based on ethically managed fish and shrimp panels, we develop sustainable functional marine ingredients meeting fish farmer's expectations around productivity, palatability health and bio nutrition.

The company manufactures natural and sustainable ingredients for the aquaculture feed industry, enhancing the health of farmed fish and consumers' well-being. Diana Aqua is part of Diana, a division of Symrise AG and relies on a unique global network of scientific and technological experts, a team of 130 passionate employees and 8 industrial sites. Its ranges of products are distributed under the AQUATIV brand. More information: pseguin@diana-aqua.com, www.aquativ-diana.com

A successful 2016 and further developments planned for 2017

The IFFO RS Standard has continued to expand its reach, with 118 certified marine ingredients producing factories located in 16 countries. Morocco is the latest country to join the program, strengthening presence in Africa. By the end of 2016, the program will represent almost 45% of the total world output of fish meal and fish oil, produced from both whole fish and by-products (heads, guts and frames) for the human consumption market. Besides that, the IFFO RS Certification Program is also recognised as a credible standard for responsible sourcing and production of marine ingredients by major aquaculture standards such as GAA Best Aquaculture Practices (BAP) and the Aquaculture Stewardship Council (ASC). It is expected that the production of compliant certified IFFO RS material will continue to increase over the years, and the development of the new version, the IFFO RS V2.0 Standard, should help with this increase.

To ensure the standard remains ahead of the curb, the IFFO RS Governance Board (GB) has decided to carry out a full strategy review during the course of 2017, involving a wide-ranging consultation of stakeholders, including industry and NGO's. The purpose of this review is to agree on a strategy for the standard

going forward into 2025. The IFFO RS GB has also decided to continue with the implementation of all ISEAL codes into the IFFO RS Certification Program.

The development of the IFFO RS V2.0 Standard has been carried out in two parts. The revised fishery criteria and proposed new assessment methodology (excluding mixed trawl fishery criteria) were opened up for a 30-day public consultation in August 2016. The factory audit criteria are under development and the aim is for the first full draft of the standard (excluding mixed trawl fishery criteria) to be ready and opened for a 60-day public consultation period from January 2017. The intention is to have this new version ready to be launched in June/July 2017, with a period of implementation of approximately 12 months for existing IFFO RS certificate holders.

The 60-day public consultation period will start on the 16 January 2017 and run until 17 March 2017. All the necessary information and templates to use for the consultation will be available on www.iffo.net/node/736

JV to boost industrial insect production

As the global population grows, so does the necessity for alternative, sustainably generated protein sources. Insects provide a natural and sustainable protein source that will contribute to closing the future protein gap. To address this potential, Bühler, the leading solution provider for the food and feed industry and Protix, the leading insect production company, founded Bühler Insect Technology Solutions. This joint venture will provide scalable, industrial solutions for the rearing and processing of insects to customers and insect producers worldwide.

Bühler Insect Technology Solutions has a global focus and has already begun operations. "By combining the knowledge and experience of our two companies, we can provide industrial insect processing solutions to address the alternative protein market," explained Ian Roberts, CTO, Bühler. "Together, we can develop both sustainable and cost effective solutions for large scale insect producers and processors that cover the whole value chain," added Kees Aarts, CEO of Protix.

Two-thirds of all vegetable proteins, including 80% of the soybean harvest are processed into animal feed for livestock. As more emerging countries prosper, meat consumption looks set to rise by nearly 50% by 2050. Adding to the challenge is the topic of waste. Today, some 30% of raw materials are lost or thrown away between the field and the plate. For these reasons, high hopes have been placed on alternative protein sources such as pulses or algae. One of the most promising sources to generate protein sustainably and with a low footprint is insects. Fly larvae or mealworms, for instance, are easy to breed and can be fed with organic waste. They are remarkably efficient at converting feed into protein and require little space to culture.

Protix was founded 2009 in the Netherlands. In just a few years, thanks to its dedicated team of highly skilled professionals, the company developed proprietary equipment and solutions gaining extensive operational expertise not only in the breeding and rearing cycle, but also in separating and extracting proteins and lipids from insects. In its industrial-scale demonstration plant in the Netherlands, the company produces large volumes of insect-based ingredients. The company was recognised as a Technology Pioneer by the World Economic Forum in 2015.



Kees Aarts, Founder and CEO Protix (left) and Andreas Aepli, CEO Bühler Insect Technology Solutions

"Protix is the most advanced insect company that has demonstrated industrial-scale production in a way that is scalable and multipliable. They have proven how to create a market in insect protein," explained Roberts. Now they are ready to take the company to the next level and needed a partner who understands the requirements of large, industrial processors. Switzerland-based Bühler is a technology and solution provider with more than 150 years of experience in developing scalable, cost effective, hygienic plants and processes for food and feed products. Bühler is also the recognised technology leader in milling, which is one of the key process steps for extracting protein from insects. Additionally, Bühler supports customers through its global service network.

"Bühler has a strong, established business providing technologies for animal feed, and protein from the insects can be used in pellets, or directly as animal feed. With our global market access, technology base, and engineering capabilities, combined with the deep knowledge, experience and entrepreneurial flair of Protix, we have the ingredients for a successful commercial partnership," said Roberts.

More information: www.buhlergroup.com/insects.

Cost savings with variable speed pumps

Pentair Aquatic Eco-Systems, USA, announced its new Taurus™ VS Pump which brings the exceptional energy cost savings of variable speed technology to aquaculture for applications that require up to a 1.5-HP pump. The company recommends the replacement of traditional pumps with Pentair's revolutionary variable speed technology to enjoy up to 80% energy savings. Electrical energy costs can be reduced by moving water more efficiently at lower speeds. Less work equals more savings when compared to conventional, single-speed pumps.

The pump is the most electrically-versatile pump on the market and is suitable for a wide range of applications; automatically recognises and adapts to 115- or 230-volt power, 50Hz or 60 Hz. The easy-to-access wiring compartment makes connection fast and simple. The Taurus VS pump comes with an advanced onboard digital display and a real-time, 24-hour clock which is easy to program and monitor. Three programmable speed settings plus



an override speed setting are available to meet specific pumping needs. It also includes external control and digital input modes; allowing all programmed speeds to be controlled remotely via 5-30V AC or DC inputs. More information: <http://pentairaes.com/taurus-vs-pump.html>

Chinese JV inaugurates new production line and warehouse

The Joint-Venture between the Danish BioMar Group and the Chinese Tongwei Group took another important step. On February 24, they inaugurated a new production line for extruded feed and a new warehouse at the Haiwei plant in Southern China.

BioMar Group was represented at the inauguration by Henrik Aarestrup, Vice President Emerging Markets and Niels Alsted, Vice Chairman of the board BioMar-Tongwei.

“The new extruder line is part of an upgrade of the factory where we have replaced older equipment with more efficient technology. Together with our Chinese partner Tongwei, we want to continue the growth of Haiwei and that requires a series of upgrades and also a new large warehouse. All together it will make us more flexible towards the customers and allow for continued growth”, explained Aarestrup.

He informed that BioMar-Tongwei has had a good start for the year at the plant, which continues the growth experienced in the last couple of years. “We expect to sell around 60,000 tonnes this year. We have a very strong team headed by our General Manager Mr Liu in place in Haiwei, and they have more than doubled their sales in the last three years.”

The Haiwei factory is located in the Pearl River Delta in an area with a large production of, among other species, Japanese sea bass and snakehead.



BioMar's Niels Alsted and Haiwei General Manager Liu paint the lions at the inauguration

“We estimate, that the farmers represented at the inauguration lunch all together produce more than 200,000 tonnes of fish annually, so we still have room for growth with Haiwei”, said Aarestrup.

The aquaculture production in the Pearl River Delta is competing with fast urban development. “Access to water and space suitable for fish farming is an increasing challenge. Our know-how in high performance environmentally friendly diets will therefore become more relevant in the years to come and we have already initiated several development projects targeting the species grown in the delta area”, concluded Aarestrup.

More information: haa@biomar.com (Henrik Aarestrup)

A fresh view on aquaculture

The BioMar Group has just launched a new website framing its ambitions for innovating aquaculture. The new website gives all users access to a significant knowledge base and makes it clear that the future of the aquaculture depends upon cooperation, innovation, performance and sustainability.

The company is now inviting all stakeholders to explore the new company website. While building it, one of the most important aspirations has been to enhance collaboration and partnership with stakeholders, sharing information and promoting long-term thinking. The new format gives easy access to a significant knowledge base on farming and feeding in aquaculture while telling the story about how BioMar for more than 50 years has been a significant player in building sustainable and efficient aquaculture.

Sif Rishøj, Corporate Communication Director of the BioMar Group, looks forward to giving new insights into BioMar and its activities. “At BioMar we are committed to innovating aquaculture. The website will ease communication and cooperation with our stakeholders. Actually we have designed and built a website that is extremely user friendly. I believe that it is very easy to find the right information despite the extensive volume of material available.”

In 2016, BioMar launched the company's purpose statement carrying the tagline “Let's Innovate Aquaculture” and a new ambitious strategy “Shaping the Future”. The guiding principles of the strategic initiatives - as well as the daily work in the company - are described by the four core notions: Innovation, Sustainability, Cooperation and Performance. These guiding principles are unfolded and described in depth on the new website.

“Our marketing and technical departments have worked hard in order to make a comprehensive webpage with the ambition of creating a truly interesting source of information. It will be constantly updated and developed with the aim of interacting with the aquaculture community being a proactive contributor to the development of a sustainable and efficient industry.”

The website is of course compatible with today's browsers and mobile devices. No matter the media the web page will open up for a user-friendly experience with easy navigation. It is available in fourteen languages allowing the users to easily access detailed information on products and product utilisation.

More information: sri@biomar.com (Sif Rishoej), Carlos Diaz, CEO, BioMar Group (cdiaz@biomar.com); www.biomar.com



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China Aquatic Products Processing and Marketing Alliance (CAPPMA)

Fujian Aquatic Products Processing & Marketing Association (FAPPMA)

China Great Wall International Exhibition Co. Ltd. (GIE)



New omega-3-rich canola

A new groundbreaking type of canola in development by Cargill could give aquaculture farmers a more sustainable way to farm fish rich in EPA/DHA omega-3 fatty acids.

The plant-based source of the nutrients, developed in collaboration with BASF, could provide an alternative to using fish oil in aquaculture feed and could ease harvest pressure on wild fish populations that currently supply much of that oil. In feeding trials it conducted with salmon in Chile, Cargill was able to completely replace fish oil in feed rations with oil from EPA/DHA canola.

“As a fish feed producer, we need to reduce our dependency on marine resources,” said Einar Wathne, president of Cargill Aqua Nutrition. “This new canola can create tremendous opportunities across the global food and feed markets, and we believe it is critical for the growth of aquaculture.”

At present, raising fish rich in omega-3s means supplementing their feed with fish oil. This new canola, which is genetically engineered to make long chain omega-3 fatty acids, will offer

a more sustainable alternative as it eases pressure on finite marine resources. Testing and regulatory approval for both the canola and the EPA/DHA enhanced canola oil is underway. The EPA/DHA enhanced canola oil is expected to reach the market sometime after 2020.

“Cargill’s EPA/DHA omega-3 plant based product is the only one we know of with a clear path to commercialisation in the industry,” said Mark Christiansen, managing director for Global Edible Oil Solutions-Specialties at Cargill.

This innovation may also broaden access to EPA and DHA omega-3s in consumer diets and make important nutrients more available and more affordable to people around the world. Groups such as the American Heart Association, Mayo Clinic and Harvard School of Public Health cite the heart health benefits and role in brain formation of EPA and DHA, but studies show most people are not consuming recommended levels of these omega-3s. As public awareness of the health benefits increases for omega-3s, demand for these nutrients is expected to rise significantly. More information: www.cargill.com

Mycotoxin risk management

There is an increasing trend to use more and more plant ingredients in aquaculture feeds. With this, the risk of mycotoxin contamination also increases. These toxins which are produced as secondary metabolites by molds, can have serious detrimental effects on fish and shrimp, ranging from mortalities, reduced growth, reduced immunity, increased feed conversion ratios (FCR), etc. They can be caused by a single mycotoxin, or as is more common, by more mycotoxins working together synergistically causing even more damage, even when present in small amounts.

To reduce the mycotoxin risk in feed, correct decisions concerning feed materials management can only be made if the mycotoxin concentration can be regularly determined with a high degree of accuracy. Olmix has developed the Myco’Screen package, helping feed producers, nutritionists and farmers to adapt their mycotoxin analysis strategy for feed or raw materials. This package is composed of 4 sections: sampling procedure, mycotoxin analysis, personalised reports and contamination overview.

The Myco’Screen sampling procedure section provides practical and realistic information to collect samples for mycotoxin analysis either on farm or in feed mills, this step being crucial for the accuracy of the analysis. The Myco’Screen mycotoxin analysis section then offers different types of mycotoxin analyses for Olmix customers.

Depending on the customer’s control plan and situation, Olmix partners can provide either rapid methods or complete screening with 45 mycotoxins analysed per sample thanks to liquid chromatography. The Myco’Screen personalised reports are detailed interpretations of mycotoxins analysis depending on the type



Myco’Screen package is composed of 4 sections: sampling procedure, mycotoxin analysis, personalised reports and contamination overview.

of sample and animal’s sensitivity. These reports also include a specific MT.X+/MMi.S recommendation for optimum protection. The whole of these analyses, run by Olmix during the last years, allows the editing of contamination overviews, which provide a view on mycotoxin risk level per area, per type of ingredient and per mycotoxin.

These data have been published in an International symposia worldwide, including the last World Mycotoxin Forum, held in May 2016 in Winnipeg, Canada. More information : www.olmix.com/animal-care

The Pearse Lyons Accelerator

In February, Alltech announced that a total of 183 startups from 38 countries applied to be a part of The Pearse Lyons Accelerator, a late-stage, agri-tech accelerator run by Alltech and Dogpatch Labs. The accelerator will commence with 10 startups that have been chosen to take part in a mentorship program for agri-business innovators with a proven technology that is ready for market. The 10 successful applicants will work with Alltech and Dogpatch Labs to accelerate their business development through Alltech and its global network.

The startups hail from Australia, Canada, China, Israel, Ireland and the US and have already collectively raised more than USD 30 million in funding. A full list of the successful 2017 applicants is available on the website. In aquaculture, a startup is eFishery (Indonesia) with a fish feeder that automatically senses the appetite of fish and adjusts the amount of feed accordingly.

The accelerator is a 15-week, mentorship-driven program aimed at collaborative learning and seeking new business and/or partnership opportunities. The program will culminate with the startups presenting on the main stage at ONE: The Alltech Ideas Conference in Lexington, Kentucky, USA, May 21–24, 2017, where more than 3,000 attendees from nearly 80 countries around the world will converge. This high-profile showcase will afford the startups the opportunity to present to future customers as well as investors and potential collaborators.

Startup participants will receive access to Dr Pearse Lyons, president and founder of Alltech, and the senior management of Alltech, a global animal health and nutrition company with a presence in more than 120 countries. In addition, participants will receive free space for three months in Ireland's leading startup hub, Dogpatch Labs, located in the heart of the Dublin Docklands, a €15,000 cash fund and mentoring covering a range of areas, from product development to strategy and international expansion. At the end of the program, the startups will pitch to the accelerator for business partners and investors. Additional benefits include software perks worth more than €300,000 from companies such as Google, Facebook, Softlayer and Amazon.

"We had a great selection week in Dublin, and I'm really impressed with the startups' ideas, their engagement and the talent," said Aidan Connolly, Chief Innovation Officer, Alltech. "We were especially looking for emerging technologies in agri-



The Pearse Lyons Accelerator interview panel select start-ups to take part in a mentorship program for agri-business innovators. From left to right: Jon Bradford, program advisor, Aidan Connolly, and David Hunt, CEO at Cainthus.

tech, such as drones, sensors, the internet of things and artificial intelligence, and I'm excited to see those are all represented within the 10 companies that were chosen."

The majority of the startup applicants are late-stage startups that have raised initial investment (known as the "seed round") and would now benefit from advice and support from Alltech to expand internationally. Startups were especially attracted to this accelerator due to the fact that Alltech is one of the few truly global agricultural companies positioned to assist in opening doors and advising on routes to market and global market access in the more than 120 countries where it is present.

"We're excited about working with these world-class accelerator applicants from across the world and assisting them on their internationalisation strategy," said Patrick Walsh, Managing Director of Dogpatch Labs. "This program will provide a unique environment for the accelerator applicants to drive sales and secure investment, and it underlines Dogpatch Lab's ability to provide mentoring and resources for founders due to our unique connection to the startup ecosystem."

The agriculture industry is beginning to be disrupted by new technologies. Agri-tech investment is growing at an exponential rate, with USD 9.65 billion invested in agri-tech startups since 2013 and USD 2 billion invested in the first half of 2016 alone. A clear route to market remains a challenge in the industry, and this program seeks to accelerate startups' access to this global market, with a comprehensive package of supports that helps them navigate the challenge of scaling their operations to service large corporate customers.

The accelerator applicants will arrive for their first core phase in Dublin on February 20, 2017, and will fly in for various core phases throughout the program. They will wrap up the program with a European demo day at Dogpatch Labs in Dublin and later will fly out to Kentucky to pitch their ideas at ONE: The Alltech Ideas Conference.

More information: www.Alltech.com/Accelerator or dogpatchlabs.com/alltech-accelerator,



The efishery team at the Asian Pacific Aquaculture 2016 in Surabaya, Indonesia

Commitment to sustainable aquaculture research, alliances and solutions

Aquaculture is the fastest-growing segment in the feed industry with a 12% increase in feed production in 2016 to 39.9 million tonnes, as per the 2017 Alltech Global Feed Survey (see pages 33-34). For many who are closely watching the aquaculture sector, this growth comes as no surprise. However, it presents a new set of challenges.

“The Fish to 2030: Prospects for Fisheries and Aquaculture’ report produced by the World Bank states that the projected growth in fed aquaculture over the 2000-2030 period, equivalent to an annual average growth rate of 3.9% per year, is much faster than the projected growth in fish oil use in aquaculture, which has an average annual growth rate of 1.7%,” said Dr Keith Filer, Project Manager for aquaculture research at Alltech. “This is why Alltech is committed to providing a sustainable alternative to fish oil with our algae.”

Alltech has been improving aquaculture performance through nutrition for 13 years, but recent developments have significantly strengthened the company’s efforts. In December 2016, Alltech received registration from the Canadian Food Inspection Agency (CFIA) for two of its algae products, ForPlus and All-G Rich™, and the company expects more regulatory bodies internationally to follow the CFIA’s decision. Alltech’s algae plant in Kentucky, USA was acquired in 2010 and is one of the largest commercial production sites in the world for algae. This traceable algae can provide a sustainable DHA omega-3 source as an alternative to fish oil.

It acquired Coppens International, an innovative Dutch aquatic feed and nutrition company, in 2016. This acquisition has enabled both companies to benefit from each other’s expertise, including the use of the sustainable algal DHA source, ForPlus, to replace

fish oil. Coppens has gained compliance with the Aquaculture Stewardship Council within the last year and has introduced a new range of feeds incorporating Alltech’s sustainable alternatives to fish oil and inorganic trace minerals in order to provide availability of these nutrients for optimum fish health and performance. A USD 1 million renovation of the Coppens Research Centre in 2017, will double its capacity while increasing the number of aqua species that can be included in this extensive research program.

There are formal research alliances with several universities and a research institute to demonstrate the impact of Alltech’s algae solutions in a variety of species

- Japanese yellowtail with Kochi University in Japan
- Turbot and shrimp with the Ocean University of China
- Tilapia with the Federal University of Santa Catarina, Brazil
- Largemouth bass and shrimp with the Kentucky State University, US
- Atlantic salmon with Nofima, Norway.

Filer noted that the research alliances’ findings to date have observed that All-G Rich could replace fish oil in the diets of marine, freshwater and salmonid species while maintaining performance as well as DHA levels in the fillet.

“What if we had a sustainable DHA source that was traceable and provided health benefits to fish?” said Dr Jorge Arias, Alltech’s Global Director for aquaculture. “We believe we have a real solution in our algae that will reduce reliance on fish oil while increasing the amount of DHA available to farmed fish and, ultimately, to consumers.”

More information: www.Alltech.com/aquaculture.

Appointments

Nutriad area managers in India

Multinational feed additive producer Nutriad announced the appointment of **Anand Srivastava** and **Rajaram Thiyagarajan** as Area Managers covering the Indian subcontinent.

India has recently emerged as one of the largest and fastest growing compound feed markets in the world. The feed industry is growing at a CAGR of 8%, with poultry, cattle and aqua feed sectors emerging as major growth drivers. The demand of animal protein and dairy products in India is expected to continue to increase and Nutriad aspires to play an important role in providing solutions for health and nutrition.

Driven by growth in demand for animal protein and dairy products, compound feed production is on the rise in India. Broiler feed is still the largest segment, but aqua feed is growing rapidly. Nutriad considers that there is strong potential for further growth of the compound feed segment if livestock challenges such as disease outbreaks, volatile livestock product prices and animal genetics are addressed.

BK Chew, APAC Director Nutriad, commented, “Asia Pacific is a focus region in Nutriad’s strategic growth plans. With the hiring of Anand and Rajaram we will seek to further increase our presence in India as we will provide increased support to our customers



Anand Srivastava

Rajaram Thiyagarajan

and partners in providing practical answers for their production challenges.”

Both Anand and Rajaram bring more than 20 years of experience in the feed additive business and have an excellent understanding of the industry dynamics.

Anand said, “I look forward to working with the Nutriad Asia team. Nutriad’s track record of converting technology into solutions is impressive. The wide range of high quality products in mycotoxin management, digestive performance and palatability provide a great basis for partnering with local customers.”

“On-going investments in the Indian subcontinent will drive ambitious growth plans that Nutriad has set in motion. Joining this team at this stage is an exciting next step in my professional career,” added Rajaram.

More information: www.nutriad.com

Acquisition of leading tilapia breeding company



The agreement on the acquisition of GenoMar Genetics was signed by Odd Magne Rødseth, Director of Aquaculture, EW Group (left) and Tor Vikenes, CEO Norway Fresh.

EW Group, a holding company with core businesses focusing on animal breeding, animal nutrition and animal health, has concluded an agreement to acquire 100% of the shares in GenoMar Genetics, the global leading tilapia breeding company.

GenoMar Genetics is a part of the Norway Fresh Group and the owner of the GenoMar Supreme Tilapia (GST) strain that has been developed through more than 25 years of professional and innovative selective breeding work in tilapia.

“As a leader in tilapia breeding, GenoMar Genetics has built a strong, scientifically based breeding program with well documented superior performance in the traits important to the industry,” said Odd Magne Rødseth, Group Director in EW Group. “Combining GenoMar Genetics R&D and portfolio of products with our strong capabilities in breeding and animal health and global reach will enable us to address factors impacting the development of the tilapia industry and reinforce our commitment

to the science of resource protection and sustainable global food production.”

“This transaction is positive for the tilapia industry because it makes advanced technologies, research resources, and best practices available horizontally across aquaculture industries around the world,” said Tor Vikenes, Chief Executive Officer, Norway Fresh. “I am pleased that GenoMar Genetics will be part of a team that has a long-term commitment to the tilapia breeding industry. The ability to share leading science, technology and animal husbandry practices among farmed aquaculture species will increase the rate of progress necessary to meet the need to feed a rapidly expanding human population.”

Globally, tilapia has emerged as the fastest growing aquaculture sector and has become a key commodity in the animal protein market. EW Group recently entered the tilapia genetics industry by acquiring Aquabel, a Brazil based breeding and distribution company. These acquisitions form the basis of a genetics and distribution network serving the major production centers in the Americas and South East Asia.

GenoMar Genetics, based in Oslo, Norway with a main operation in Luzon, Philippines has invested in a long term selection program to improve farmed tilapia. The program originated in the GIFT program and has a long term association with Central Luzon State University. With a total of 50 employees in Philippines, Malaysia and other countries, the company has an excellent reputation for its consistent investment in breeding and the quality of its products.

To strengthen their respective core businesses, Norway Fresh and GenoMar Genetics have entered into a Supply Agreement and a Cooperation Agreement on global supply of production stock from the GST strain and benchmark programs to document the performance of new product developments.

More information: tor@norwayfresh.com; odd.magne.rodseth@ew-group.de

Corrections*

In the article on “**The mycotoxin threat to yellow catfish**”, Issue January/February 2017, p27-28, there were printing errors in Table 2 (page 28). We reprint the corrected table below.

Table 2. Summary of growth parameters during the experimental period

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

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

In the article on “**Balancing the pond ecosystem in shrimp farming**,” the caption for picture on the left (page 10) should read, TCBS plate yellow *Vibrio* colonies.

In the report on **TIFSS 2016**, p 59, para 1, Line 3, should begin with Now, (i.e. delete 'In Thailand') Para 2, line 1, should begin with Grobest (i.e. delete 'In Taiwan') Para 3, line 6 should read, There are examples of farmers (vannamei shrimp in Thailand, Vietnam, China, India and Taiwan) doing well...

We apologise for these errors and any inconvenience caused.

*hardcopy version only



Asian Pacific Aquaculture 2017



Picture courtesy of Abdullah Rahim, Universiti Putra Malaysia

In 2017, the annual conference and trade show Asian Pacific Aquaculture (APA) will return to Kuala Lumpur, Malaysia. It will be from 24-29 July 2017 at the Putra World Trade Centre. APA 2009 was also held in Kuala Lumpur.

APA 2017 will be the gathering of global aquaculture stakeholders to update on the latest developments and technology for the farming of fish, shrimp and other aquatic species. The conference and trade show is organised by the Asian Pacific Chapter, World Aquaculture Society (WAS-APC), Malaysian Fisheries Society (MFS) and Universiti Putra Malaysia. It is hosted by the Department of Fisheries, Ministry of Agriculture and Agro-Based Industry, Malaysia.

The main features of the APA series are a conference with more than 10 technical sessions covering various species, aquaculture systems and technology and an exhibition featuring international companies showcasing the latest in products, services and all aquaculture related information. There will be a farmer's day targeted for the local farming industry and a special shrimp session organised by Gold Sponsor Sheng Long, Vietnam. These will address the everyday practical concerns and needs of aquaculture farmers. Other sponsors are Fishance for the President Reception, Blue Aqua International as premium sponsor and Evonik and Nutriad as session sponsors. A post conference tour to fish/shrimp farming activities around Kuala Lumpur is being planned by MFS.

Plenary

One of the key highlights of the conference program at APA 17 is the plenary session, led by leading experts. The session will start with presentation by Herve Lucien-Brun, Aquaculture & Qualite, France. The theme of APA 2017 is "Transforming for market needs" and he will present on "Marketing farmed seafood from Asia to global markets"



"In a lot of cases, producers in Asia do not have a clear idea of what the demand is and do not plan production to meet demand at that time. Knowing markets is indispensable for those farms wishing to optimise their margins. The real profit is to know and analyse carefully destination markets. This would permit farms to supply products which will meet exactly the demand," said Lucien-Brun.

Lucien-Brun is an independent consultant based in France. He has more than 30 years' experience in tropical marine shrimp and finfish aquaculture in major producing countries. He is an ADEME, France Carbone Footprint certified auditor and has the CRITT Ile France, France HACCP certification. In tropical aquaculture, he is involved in design studies, implementation,

and farm management, technical management of project and technology transfer. He has a Master's in Animal Physiology from the University of Paris, XI, Orsay, France.

WAS-APC Awards

WAS-APC is financing and awarding exceptional students and women within the field of aquaculture. There are three categories of awards.

- Pre-conference Student Travel Awards (judged on abstract,
- Presentation/poster awards for students (judged during the conference)
- Travel Award for Women's Participation

The Student Travel Awards proposed by WAS-APC are important to the whole aquaculture community because students are the future of this industry. All students submitting an abstract and presenting a poster or an oral presentation will be eligible and evaluated by the select committee, organised by WAS-APC.

WAS-APC is providing the opportunity for women involved in aquaculture to attend APA 2017. Funding for this opportunity is provided by WAS-APC, and Aquaculture without Frontiers is facilitating the selection process. There are two grants, each valued at USD 600 to assist with accommodation and travel. WAS-APC will organise and pay registration fees to attend the conference and trade show.

Applicants need to complete the application form and will be assessed on the following criteria:

- Knowledge and understanding of the role of women in the aquaculture industry.
- Capacity to contribute to the future development of the aquaculture industry,
- Potential benefits to the individual and the sector that they work in.

Applicants must be willing to serve and assist at the WAS-APC Booth. After the event, the awardee must prepare within 30 days a report, including photographs. Applications will close on 4 April 2017. For more information, Email: bibhak136@gmail.com (Dr Bibha Kumari, Student Director, WAS-APC)

**Technical sessions:
Abstract Submission Deadline
Extended to April 1, 2017**

Information and registration: Web: www.was.org / www.was-apc.org

Email: worldaqua@aol.com for conference, and mario@marevent.com for the tradeshow and sponsorships details.

2017 Shrimp Pathology Short Course on Disease Diagnosis and Control in Marine Shrimp Culture

July 17 - 22, 2017

The University of Arizona, USA

This short course will cover the major shrimp diseases listed by World Animal Health Organization (OIE);

- Baculovirus diseases: white spot syndrome virus (WSSV), monodon-type baculovirus (MBV), baculovirus penaei (BP);
- Parvovirus diseases: infectious hypodermal and hematopoietic necrosis virus (IHHNV), hepatopancreatic virus (HPV);
- RNA viruses infecting penaeid shrimp: taura syndrome virus (TSV), yellow head virus (YHV), infectious myonecrosis (IMNV), Penaeus nodavirus (PvNV), white tail disease (WTD);
- Bacterial diseases: acute hepatopancreatic necrosis disease (AHPND; caused by a unique strain of *Vibrio parahaemolyticus*), necrotizing hepatopancreatitis (NHP-B), *Vibrio harveyi*;
- Microsporidian diseases: *Enterocytozoon hepatopenaei* (EHP), cotton shrimp diseases.

It will cover methods of disease prevention and/or treatment and development of biosecurity and quarantine protocols. There will be labs and demonstrations which will cover sample

preparations for histology and PCR; PCR/RT-PCR for diagnosis of WSSV, AHPND, EHP, TSV; qPCR/qRT-PCR for diagnosis of WSSV, AHPND, TSV; Laboratory bioassay: AHPND and review of histopathology of viral and bacterial diseases. Lectures, labs and demonstrations will be presented by staff from the Aquaculture Pathology Laboratory.

Sponsored by the Aquaculture Pathology Laboratory, School of Animal and Comparative Biomedical Sciences, University of Arizona, Tucson, AZ 85721, USA, registration is limited to 30. Deposit and early Registration Deadline: USD 100.00 by June 1, 2017. The cost is USD2,000.00 if the deposit is received on or before June 1, 2017; USD 2,500.00 if the deposit is received on or after June 2, 2017.

More information: Dr Arun K. Dhar or Deborah Huie, The University of Arizona School of Animal and Comparative Biomedical Sciences, Aquaculture Pathology Laboratory, Tucson, Arizona, USA. Email: adhar@email.arizona.edu; dhuie@email.arizona.edu

Aqua Culture Asia Pacific in 2017

Volume 13 2017				
Number	3 - May/June	4 - July/August	5 - September/October	6 - November/December
Issue focus <i>Recent developments and challenges for the next step</i>	Sustainable & Responsible Aquaculture	Revisiting Shrimp Nutrition	Biosecurity & Disease Management	E-aquaculture & commerce
Industry Review <i>Trends and outlook, demand & supply</i>	Aqua Feed Production	Tilapia	Catfish	Genetics
Feeds & Processing Technology <i>Technical contributions from feed industry</i>	Lipids & Minerals Performance Feeds for Intensification	Extrusion & Processing Feed Additives	Sustainable Feeds Feed Safety and Hygiene	Functional Feeds for Health
Production Technology <i>Technical information and ideas</i>	Controlled systems/RAS	Disease Mitigation	Finfish Industrialisation	Aeration Technology & Waste Treatment
Aqua business Feature articles	Experiences from industry and opinion articles covering role models, benchmarking, health management, SOPs, social investments, CSR, ancillary services etc			
Markets	Developments in markets (live fish, product development, market access, certifications, branding, food safety etc)			
Company/Product news	News from industry including local and regional trade shows			
Deadlines for Technical articles	March 13	May 15	July 17	September 18
Deadlines for Advert Booking	March 20	May 22	July 24	September 25
Show Issue & Distribution at these events as well as local and regional meetings	*World Aquaculture 2017 June 26-30 Cape Town, South Africa	*Asian Pacific Aquaculture 2017 July 24-27 Kuala Lumpur, Malaysia The Aquaculture RoundTable Series, (TARS 2017) August 16-17 Bali, Indonesia Vietfish 2017 August 29-31 Ho Chi Minh City, Vietnam	Aquaculture Europe 17 October 17-20 Dubrovnik, Croatia	
*Show preview				



Asia-Pacific Aquaculture Expo 2017

June 2-4,
Fuzhou City, China

Asia-Pacific Aquaculture Expo 2017 will be held on June 2-4, in Fuzhou City, Fujian Province, South China. Fuzhou, is the capital city of Fujian, the leading aquaculture province in China. It will be co-located with the Fuzhou International Fisheries & Seafood Expo. Whilst the organisers of the seafood exposition will focus on processing and seafood production, the organiser of the Asia-Pacific Aquaculture Expo, China Aquatic Products Processing and Marketing Alliance (CAPPMA), will focus on aquaculture technology.

Together, the space for this exposition will reach 32,000 m². In 2016, the second time the show was presented, the trade show attracted 106 exhibitors; 16 from domestic provinces and 10 overseas covering 10,000 m². There were 12,000 visitors. China's leading enterprises such as Evergreen Feed, Yuehai Group, Liyang Aqua-Technology, Zonoco group, Da BeiNong Aquaculture, Dayouheng Aquaculture were present.

Accompanying the exposition is a themed conference; Global Aquaculture Summit (GAS). It will be held on June 1-4. The plenary session will be on Present and Perspective of Global Aquaculture Industry and will have presentations on challenges and opportunities for China's aquaculture Industry, industry trends and technology innovations. This will be followed by seven breakout sessions with the following themes:

- Trends in seafood consumption (consumption patterns, retail models, impact on the new US regulations, e-commerce etc).
- Practice and outlook of industrialised aquaculture (progress and experiences in China, RAS and new technologies in deep sea cage aquaculture, automation in near-sea aquaculture).
- Aquaculture technology innovations (technologies in aquaculture, breeding, ecological aquaculture, disease control and automation in aquaculture).
- China eco-friendly aquaculture development (trends of modern eco-aquaculture such as rice-fish paddy aquaculture systems, pond eco-aquaculture, marine ranching systems, intelligent aquaculture and aquaculture financial services).
- Marketing seafood meals (seafood for human nutrition, case study on student meal promotion in Japan and challenges with seafood meals in China).
- Trends in the aqua feed industry (status of the industry in China, competition, artemia markets and China's role, feed innovations, feed additives and global opportunities for aqua feed enterprises).
- China Fugu Summit (overview of the fugu industry and issues in its development).

More information: Dr Lisa Pang (lisa@apaexpo.com.cn), Nancy Li (cappmaexpo@126.com), Dorothy Si (apaexpo@chgje.com), GAS contact: Ping Yang (yangp@apaexpo.com.cn) Web: www.apaexpo.com.cn

2017

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

March 15-17

VIV Asia 2017
Bangkok, Thailand
Web: www.vivasia.nl

March 20-24

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

April 4-6

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

April 25-27

Seafood Global Expo
Brussels, Belgium
Web: www.seafoodexpo.com

May 31- June 4

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

June 1-4

Asia-Pacific Aquaculture Expo 2017
Fuzhou City, China
Web: www.apaexpo.com.cn

June 26-30

World Aquaculture 2017
Cape Town, South Africa
Web: www.was.org

July 10-13

Practical Short Course on Extruded Pet
Foods and Treats
Texas A&M University, USA
Email: mnriaz@tamu.edu
Web: www.foodprotein.tamu.edu/
extrusion

July 24-27

Asia Pacific Aquaculture 2017
Kuala Lumpur, Malaysia
Web: www.was.org

August 2 - 4

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

August 16 -17

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



August 29-31

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

August 28-September 1

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

September 27-29

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

October 17-20

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



World Aquaculture 2017

Sustainable Aquaculture
New Frontiers for Economic Growth
Spotlight on Africa

June 26-30, 2017

Cape Town International Convention Centre
Cape Town, South Africa

The Annual International Conference & Exposition of
World Aquaculture Society

Hosted by

Aquaculture Association of Southern Africa
Department of Agriculture, Forestry and Fisheries,
Republic of South Africa

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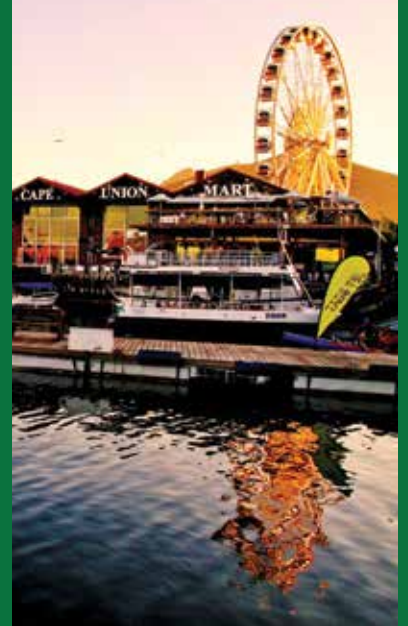


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