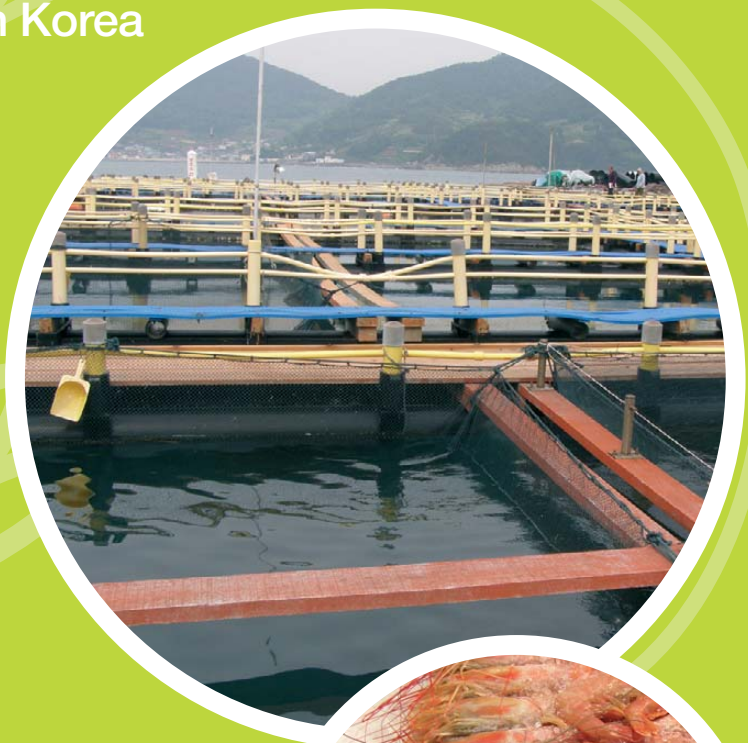
VOLUME 4 NUMBER 4 JULY/AUGUST 2008 MICA(P) 096/10/2007 ISBN 1793-0561

AQUA Culture AsiaPacific

Sustainable Aquaculture

- Guidelines for cage culture in the Philippines
- Recirculation system in Korea



SPF shrimp hatcheries in the Philippines and Vietnam

BT domestication in Madagascar

Application of phytase in the feed mill

Feeding for profit

Tilapia in 2007

Exporting farmed shrimp from Asia

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WRITE TO THE EDITOR
We want to hear from you. Write your comments on the industry to the editor.

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Letters may be edited prior to publication

From the editor

Whatever the market dictates?

History has shown that a strong economy can influence and, to an extent, control world trade. We are beginning to see this with aquaculture in the European Union. The EU, US and Japan have always been the major export markets for aquaculture products from Asia. In the 80s, with the strong Japanese yen, Japan dictated product specifications. In fact, it was the Japanese market that started Taiwan and the SE Asian countries on the road to black tiger shrimp aquaculture.

In the 90s, the strong dollar helped the US become a major seafood importing country which attracted products not only from neighbours such as Mexico and Ecuador but further afield from countries like Thailand and China. The US remains a dominant market but not as attractive as before with the dollar's depreciating value as producers are having trouble increasing prices in dollar dominated contracts.

Today, the strength of the Euro is creating the decade for the EU. We mentioned in our last editorial (May/June) that this region cannot be ignored. Jacques Gabaudan in his article (p33) notes that although the US and Japan import 71% and 86% of their frozen shrimp respectively from Asia, the EU only imports 31%. This is a market with 490 million people and an average per capita consumption of seafood of 24 kg. (Note: in comparison China's consumption is 25 kg/caput). This shows great potential for Asia to improve its market share. The frozen and processed shrimp market is also expanding. In 2007, the increase was 11% in Spain, 12% in France and 30% in Germany, according to Eurofish.

However, for many Asian producers (particularly for shrimp exporters), the process of exporting to the EU is a very different ball game due to the food laws and regulations that have come into play. For many years, Indonesia grappled with production conditions and food safety requirements equivalent to EU directives. The country is very proud that efforts have worked as now, the 100% testing for antibiotics residues have been lifted. China also had her dark period from 2002 to 2004. However, for some countries like Malaysia, the regulations seem to be akin to a train that has passed through their stations without the country being able to hop aboard on time (see page 7).

This has placed many stakeholders in a denial mode questioning such measures as non tariff barriers to trade. Those who have complied and met the requirements feel unfairly penalised in this countrywide blanket 'blackmark', claiming failure on the part of the competent authority for ensuring that everyone meets this requirement. Others go further to question the right of the EU imposing her rules and regulations outside her territory. The reality of the matter is that the food safety measures are demanded by the consumers of the EU and if we want to export to them, we have to meet their specifications.

The EU General Principles of Food Law came into effect in February 2002 and notice was given that compliance must be adapted by January 2007, in effect, giving 4 years to prepare for this. The best way to learn is from the leader who started preparing early. I am talking about Thailand and its Innovative Program on Food Safety Initiatives which was a project by the National Innovation Agency, a division the Ministry of Science and Technology, Thailand.

AAP has always advocated self-regulation and encouraged the industry to upgrade itself to meet new regulations, requirements and certifications. The EU regulations have shown us that government coordination in terms of a competent authority is equally important when it comes to meeting these requirements. However, satisfying the hygiene aspects of products and of production conditions does not end with the EU markets. Johan Suryadarma, President of the East Java branch of the Indonesian Cold Storage Association said that EU's standards have become the global standards. Tuan Syed Omar, President of the Malaysian Shrimp Industry Association said that it would have been easier if authorities apply these EU requirements to both local and export markets.

Regionally, adhering to these EU directives does have another plus point. Let us look at this proactively. It is levelling the playing field for all producers in Asia.

Zuridah Merican

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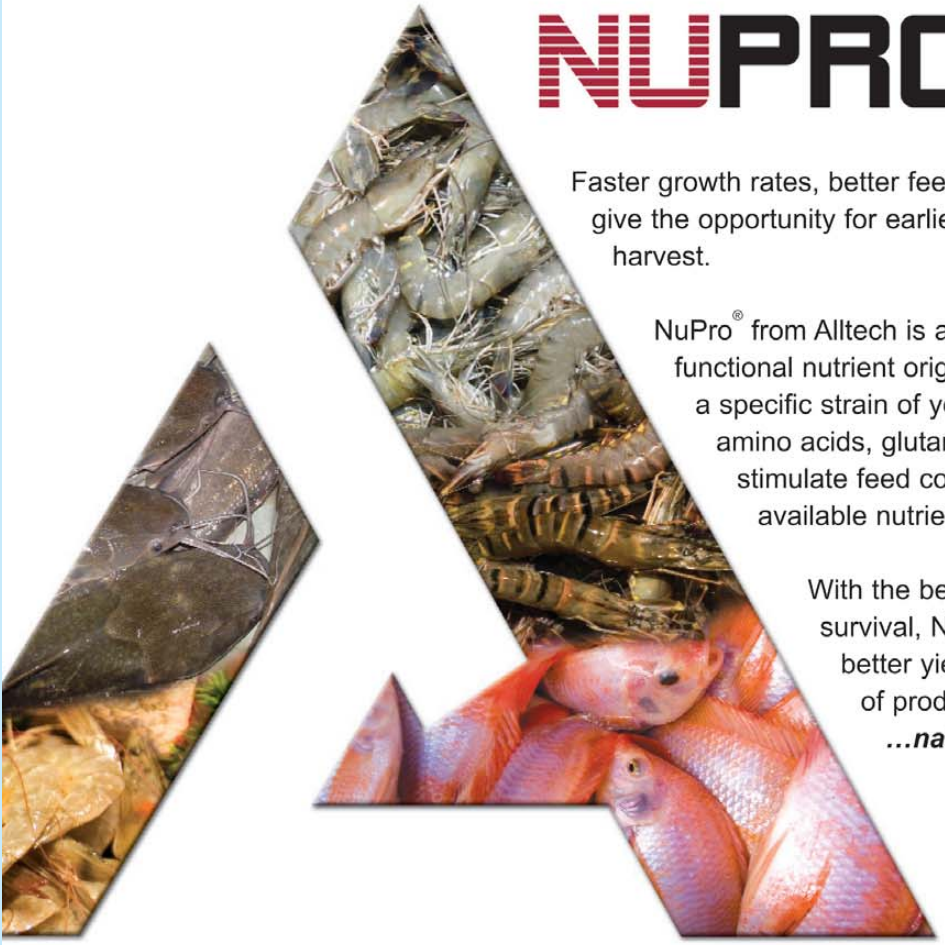

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Pangasius catfish in Vietnam

It is dire straits for the catfish farmer, according to several reports. A surplus of fish has lowered ex farm prices to VND14,200 to 15,500/kg, below cost of production which has escalated to VND 15,000-15,200/kg due to higher cost of feed and other inputs.

Low prices are cyclic

Around 170,000 tonnes of tra and basa stocks remain unsold. Stakeholders also blame banks in limiting credits. Processors are being accused of paying below contracted prices and delaying payments to farmers because of the lack of US dollar in the country.

"This situation with prices is repeated every two years, as demand increases, more farmers start farming the catfish, increasing supply and lowering prices. Then many stop production. Production starts again when prices increase. We go through this vicious cycle year after year," said **Dr Nguyen Huu Dzung** deputy chairman of the Viet Nam Association of Seafood Exporters and Processors (VASEP), in an interview during Vietfish 2008, 12-14 June 2008.

"Except, this year, problems are complicated by several other factors. Volumes are high from a rapid increase in production, selling prices have decreased but feed and other costs have increased, the Vietnamese Dong is depreciating against the US dollar, lack of foreign currency, high interest loans and producers do not have capital to start a new crop".

Dr Dzung described the current industry as mainly distributed in a ratio of 70:30 of old farms to new farms. The former are self-financing and less dependent on bank financing. They would have benefited from the high prices of VND 17,500/kg some two years and much lower costs of production of VND 12-13,000/kg. The newcomers of two years or so, usually dependent on bank financing will be affected by the commercial interest rates of 21%. Many of them would be from the construction industry, just starting to construct ponds and will need operating money. Exporters will be less affected by the financial situation and should benefit from the exchange rate of VND16,200 to one US dollar.

"Consolidation has already happening. Almost all of the large processing companies have their own farms and are even enlarging culture areas. This integration also includes addition of feed plants or working with private feed mills. Processors also get farmers to sign with them for the harvests. They discuss how to share differences in selling prices. Usually, it is medium scale farms that do this".

On the role of VASEP, Dr Dzung said, "Supply and demand are decided by markets. Most processing factories understand that the farmers need to survive. The new farmers need help and the factories can help with loans that will allow the farmers to buy feeds for the latter part of culture. They may agree to sell the fish to the factory. They can also help to buy oversized fish that the farms retain in ponds in anticipation of higher prices and put them in cold storage. The preferred market size is 1 kg per fish and fish of 1.3 kg are difficult to sell". Additionally seafood processors said that farmers are unaware that rating is based on colour of fish fillets after processing with four categories of preference-white>pink>pale yellow and yellow.

"We work for the farmer and processor and with the government. We have asked the government to bail out catfish farmers with insufficient funds. The Government has provided VND1 trillion (USD 57.14 million) to the Viet Nam Bank for Agriculture and Rural Development (Agribank) for this purpose. We also foresee that prices will pick up soon and request that banks provide some financing too but many are reluctant as they consider the special interest rate of 18% still too high. If borrowing is in foreign currency, the good news is that interest rate is low even though the exchange rate is high".

Better fillet prices

Over glazing has been used as a way to reduce offer prices for fillet. Dr Dung said, "We are working indirectly by asking processors to keep the water and protein content as natural as possible. The maximum glazing should be 20% and in this way, we can circumvent the problem of over glazing and lowering of prices. There is also a requirement to include the net weight, name and code of processor on the packaging. National Fisheries Quality and Veterinary Directorate (Nafiqaved) will not issue a health certificate for any processor violating this. We are also working on setting two floor prices based on quality. This is based on ratio of fish to fillet. The high quality fillet is from three 1 kg fish: 1 kg fillet ratio whereas in the lower quality fillet, two 1.3-1.4 kg fish: 1 kg fillet ratio with no skinning".

In 2007, Vietnam produced about 1 million tonnes of catfish. The target is 1.2 million tonnes in 2008 and for the first 4 months in 2008, 38% of this volume and 25% of value have been produced. There is, no doubt, that the country is still on track and the target can be achieved with exports of catfish of USD 1.1-1.2 billion.

Brainstorming "production, innovation and market access"

Two years ago, members of the shrimp industry in the Philippines examined the proposed culture of the white shrimp *Penaeus vannamei* as a way out of its malaise with the culture of only black tiger shrimp. The concerns centred on the possible introduction of diseases alien to *P. monodon*, the darling of the farmed shrimp industry. In January 2007, the government lifted the ban on white shrimp culture.

With this, the Bureau of Fisheries and Aquatic Resources (BFAR) began to certify hatcheries, allowed the imports of Specific Pathogen Free (SPF) *P. vannamei* broodstock from Hawaii and Florida only and set up the process for disease monitoring. Some farms began to culture vannamei shrimp, alongside *P. monodon*. However, with limited market access, coupled with inadequate processing, chilled shrimp, usually of 70-100pcs/kg size, are sold to markets in Metro Manila and other large cities. At the moment with few players in the markets, local prices are better than international ones. Production in 2007 was estimated to be 5,000 tonnes of vannamei shrimp and 39,000 tonnes of black tiger shrimp.

At this 6th Philippine Shrimp Congress held from 28 to 30 May, 2008 in Bacolod City, the three main issues affecting the industry were highlighted. At the hatchery level, how to meet requirements for certification and speed up production of *P. vannamei* post larvae from SPF brood stock. In the case of *P. monodon* post larvae, it was how to meet demand and overcome frequent incidences of WSSV infections. In market access, it was legislation and compliance requirements for processing factories.

Two pre-conference sessions tackled these issues. In the hatchery session, Oscar Henning, Kona Bay, Hawaii explained the value of SPF stocks and Fernando Garcia, Epicore USA showed how to maximise yields in larviculture, based on technology used in Belize and Ecuador. Matt Briggs, Vannamei 101, Thailand, discussed problems in the hatchery and outlined techniques and protocols in maturation and larviculture in Thailand. Shaun Moss, Oceanic Institute, Hawaii detailed the pathways in selective breeding programs and described OI's new commercial scale production of SPF broodstock, now commercially available.

From left, Gina Regalado, Intag Feeds, Anelyn B Jabile, Cruztacean Hatcheries, and Minvilu Casido, Cruz Aquaculture.

The Philshrimp 2008 team (from left), Engr Ramon Allegre, PhilFry, Mr Roberto A Gatuslao , President, Atty Jake Vergara, JLV Farms, Philip Cruz, Cruz Aquaculture Corp and Christopher Co, Overseas Feeds .

At the session for processors and traders, Rose Toledo-Mueda, University Philippines Visayas discussed the feasibility in niche marketing seafood from the Philippines. Lionel Dabbadie, CIRAD said that industry should add value to its products and look at organic aquaculture products and fairtrade marketing. At this session, traders and processors expressed the need for clearly defined and achievable best practices to meet international compliances for processing factories. The rest of the 3 day conference featured, 27 presentations on global, regional and national perspectives on industry such as in Vietnam, India, Ecuador and Thailand; advances in grow out technology such as in the cost efficient technologies, use of probiotics; biosecurity and water quality management and disease monitoring.

At the opening ceremony, Chairman of the organising committee Philip Cruz of Cruz Aquaculture and a major advocate of white shrimp culture in the country, said, "The hope among industry is that the tough ten years from the early 1990s when the main problems were luminous bacteria infection followed by white spot disease syndrome is over. Now, there is no doubt that the Philippine shrimp is moving up with *P. vannamei* and we can expect a production of 100,000 tonnes in five years".

Roberto A Gatuslao, President Philshrimp said, "The mission of the congress was to bring about synergistic fusion of the sectors in the country's shrimp industry as it faces production bottlenecks and inefficiencies. This is amidst unfavourable market conditions and pricing".

News in brief

EU eases imports from Indonesia

The EU will lift export restrictions on Indonesian seafood due to the sharp decline in cases of poor quality control. There were only 17 cases in 2007 from 49 cases in 2005. Up to May, only 2 cases were recorded. The EU has applied mandatory examination of seafood from Indonesia costing EUR 1,500-2,000 per container since February 2006. EU is the third largest seafood market for Indonesia taking 19% of seafood exports. In 2007, an estimate of exports of aquaculture products to the EU totaled 30,414 tonnes of which shrimp was 28,045 tonnes.

Lower prices for Thai shrimp

Seafood processors in Thailand have set weekly prices for shrimp based on farm production costs and export prices, according to the Bangkok Post. These will be used as median prices for food processors and cold storage operators to buy from farmers. The Thai Frozen Foods Association did not agree with the pledging prices set by the Ministry of Commerce which they said did not reflect genuine market prices. The ministry had set aside THB 300 million for 10,000 tonnes of white shrimp to prevent falls in prices from June to October 2008. This pledge is for THB 140/kg for size 50/kg, THB 130/kg for size 60/kg. The association has specified lower prices at THB120/kg for size 50/kg.

Hawaiian shrimp farm quarantined

The Hawaii Department of Agriculture has imposed an emergency quarantine on Limaloa Farm where shrimp tested positive for white spot syndrome virus. This is the second time the disease has been detected at Limaloa Farm, which is the former Ceatech shrimp farm. The disease was detected there in April 2004. The current quarantine prohibits the movement of shrimp from the farm. Limaloa Farms said it noticed a problem in one of its four ponds in June and sent tissue samples to be tested. The department said Limaloa Farms had voluntarily halted all shipments of shrimp since the symptoms were discovered. The quarantine will stay in effect until tests confirm the facility is disease-free.

Licence for barramundi in Khanh Hoa

Australis Aquaculture of Australia has been approved sea leases for more than 200 ha in Khanh Hoa Province, Central Vietnam for a 25-year period, said the Australian Business News. The company intends to develop a barramundi hatchery and offshore grow-out facilities for export to North America, Europe and other major markets. In 5-7 years, the target will be 10,000 tonnes/year of barramundi for the site.

New era in food safety

Global Food Technologies (GFT), a California based food safety company, and Tongwei Hainan Aquatic Products Co. Ltd., part of the Tongwei Group will introduce the iPura Food Safety Program at Tongwei's newest seafood processing facility, to be open in September 2008. GFT will apply its iPura program that includes pathogen reduction systems and daily on site services in the new Hainan facility. The target is to enter the US market with iPura labeled tilapia from this new facility in October. The Tongwei Group is the biggest supplier of fresh water fish feed in the world and it already manages every component of the supply chain with traceability and control from fingerling, feed and farming to processing and cold storage.

Now COOL of catfish in restaurants

As of July 1, 2008, it is mandatory for restaurants in Mississippi serving catfish to inform customers of the origin of the fish. Some 70% of catfish is consumed in restaurants. The law requires that the restaurant use informational materials offered free-of-charge by The Catfish Institute, the marketing arm of the US Farm-Raised Catfish industry in the case of domestic catfish but those serving imported fish must indicate so on the menu's dining options. Since 2005, COOL (Country of Origin Labeling) legislation is already federally mandated for all seafood in grocery stores. In SeaFood Business, James Wright said that although the law intends to protect consumers, but mostly it punishes restaurants that source catfish overseas.

Malaysia delists for seafood exports to EU

The EU commission is seeking a ban on fishery products and live fish imports from Malaysia. This follows the results of an EU inspection mission from the Food and Veterinary Office (FVO), from April 8 to April 18, 2008 to evaluate public and animal health controls and production conditions. The mission found serious deficiencies at the control level of the Competent Authorities (CAs) for Public Health for exports of fishery products and at the CA for Fish Health. The mission recommended urgent actions to be taken and the delisting of ten establishments. In mid-June, Malaysia took the step of a voluntary delisting of exports to the EU for six months.

According to Eurostat, Malaysian exports to the EU total 37,000 tonnes in 2006 of which 10,500 tonnes was shrimp, mainly frozen *Penaeus monodon* and *P. vannamei*. Industry estimated the total value of seafood exports was USD 461 million in 2007.

This mission followed an earlier one in 2005 which made recommendations on structures and provisions to facilitate Malaysian producers and exporters to comply with EU requirements. The aim of the 2008 mission was to assess how the respective CAs have addressed these. In Malaysia, three authorities comprise the CA for Public Health (Ministry of Health, Department of Fisheries (DOF) and Fisheries development Authority) and DOF is the CA for Fish Health.

The team found serious shortcomings at the CA level, which include the use of standards which are 'not at least equivalent' to EU requirements for the general monitoring on production conditions, lack of approval and official supervision of production establishments and a general absence of own checks and traceability. The inspection team identified deficiencies in animal health such as the absence of a targeted surveillance program which should be in place two years before Malaysia can be considered free of fish diseases notifiable to the OIE. Furthermore, not all farms are under the supervision of the CA and there is a lack of traceability as farms do not keep farm records.

At the production level, it specified deficiencies in layout, maintenance, hygiene and operations, cold chain and HACCP records in fishing vessels, landing sites and processing factories. Out of nine processing factories, six were not in compliance.

Industry leaders were outraged at this possible ban. They said that many seafood processors have invested heavily to comply with EU requirements are now penalized because country wide measures are not in place. Tuan Syed Omar, President of the Malaysia Shrimp Industry Association said, "The CAs were supposed to monitor the production process from start to finish, regardless of whether these contain bacteria or contaminants. Shrimp production is expanding and reinstating exports to the EU will take time". He added that at the same, the government is encouraging expansion with incentives to reach a target of 150,000 tonnes by 2010.

The next step is for the CAs to provide the commission with an action plan and timetable for the completion of recommendations of the mission. A follow-up mission is expected in July.

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SPF vannamei shrimp Hatchery: A new start in the Philippines

By Zuridah Merican

The Cruztacean Hatchery in Iloilo, Visayas is one of five accredited hatcheries in the Philippines currently producing vannamei shrimp post larvae using Specific Pathogen Free (SPF) brood stock imported from Hawaii. Previously producing black tiger post larvae, it had to undergo infrastructural changes to fit into the biosecurity requirement of the certification authority.

Algal culture tanks

Fry are transported to Negros in an airconditioned truck

Hatchery view

Some of the renovations required included reservoirs, UV, charcoal filters and cartridge filters for incoming water. It had to extend the water intake further out to sea and add additional tanks to hold treated water as well as to hold discharge water. A total separation into sections for the various functions in the production process with several disinfection stations was also required. The maturation building is separated from the area used for larval rearing. The whole hatchery is based on a partial recirculated water system.

The hatchery which was accredited only in early 2008 is still on a learning curve and is initially targeting 10-15 million/cycle to produce only vannamei shrimp PL, as the legislation (FAO 223) does not allow mixed species hatchery. It has already produced three cycles of production with an average survival rate of 40% from nauplii to PL. The current demand for vannamei PL for farms in the southern islands of the Philippines (excluding Luzon) was estimated at 200-250 million PL and Philip Cruz, owner said that there is a likelihood that this will double by the end of 2008 as more black tiger shrimp farmers shift to vannamei shrimp farming.

Only broodstock from Hawaii and Florida are allowed to be imported into the Philippines, according to Wesley Rosario from the National Fish Research Institute, Bureau of Fisheries and Aquatic Resources (BFAR), the Government authority in charge of issuing permits for imports and certification of hatcheries. More hatcheries will come on line soon as BFAR is expected to accredit more maturation and hatchery facilities in Luzon, Visayas, and Mindanao. In the importation of brood stock, BFAR and associated agencies check on the disease status of the brood

Broodstock

Postlarvae

stock at selected entry points. In the case of this hatchery, the entry point is Iloilo airport. The facilities at the Aquaculture Department of SEAFDEC, equipped with two PCR machines and one real time PCR are used to carry out these tests. A certificate is issued by BFAR which serves as 'movement papers' for the brood stock.

At the hatchery, male and female brood stock are kept together in the same tank for 3-4 weeks during acclimation. They are fed a commercial maturation diet, polychaete worms, and cold-water squid. Maturation is 3 weeks after eye stalk ablation. The hatchery is presently using a simplified feeding protocol with good results, feeding only the algae Thalassiosira and liquid feed from the zoea to PL5 stages. Excess nauplii are sold to other accredited hatcheries. Testing for diseases start at PL5 at SEAFDEC-AQD at the expense of the hatchery. Two follow-up tests are made by the buyer prior to harvesting in independent laboratories. In the case of farmers in Negros Occidental, samples are sent for PCR at the Negros Prawn Producers Marketing Cooperative in Bacolod City. The hatchery sells PL10 at around PHP0.21 each.

SPF shrimp hatchery: A good start to integration model in Vietnam

By Zuridah Merican

The ground breaking ceremony for a new shrimp hatchery in Ninh Thuan Province was done in mid 2007 and construction began in November. Some 100 million Penaeus vannamei post larvae from SPF brood stock imported from Hawaii have been sold to farmers. This was also the start of an integration model for Uni-President Vietnam, a market leader in shrimp feed production in Vietnam.

The demand for qood quality post larvae, both of the vannamei and black tiger shrimp has escalated in Vietnam. In 2007, shrimp production reached an estimated 350,000 tonnes comprising 270,000 tonnes of black tiger and 80,000 tonnes of P. vannamei shrimp. Jeff Jie-Cheng Chuang, Vice president said that the calculated annual nationwide demand will be 35 billion post larvae. He added that it is not only quantity of post larvae but quality that is lacking in the country.

"In the case of the vannamei shrimp, it is imperative that we train our farmers to use only post larvae produced from reliable specific pathogen free (SPF) brood stock to reduce risks from diseases. We provide these and follow up with disease diagnostic services to monitor diseases. This is the total package to reduce risks during the production cycle".

In the production of vannamei post larvae, the hatchery has a total of 80 larval rearing tanks. The target production is 240 million in one cycle and one billion post larvae annually. Brood stock from Hawaii and Florida are monitored for diseases at the Ho Chi Minh airport and then transported by road to the hatchery, five hours away. At the hatchery, during the acclimation period of 15 days, shrimp are tested for WSSV and YHV by the hatchery staff and provincial officials. Any infected stock will be discarded. Male and female broodstock are kept in separate tanks.

Monitoring of diseases with PCR in post larvae starts at PL3 -5. Diseases that are monitored are WSSV, TSV and YHV. The hatchery sells post larvae PL8-PL10 at prices ranging from VND 45 to 60, depending on volume, to farmers in the central province from Hue to as far south as the Mekong Delta. Health checks are carried out before the farmers receive the post larvae. However, they may also send samples to universities to counter check on the disease status of the post larvae.

Robert Chen I Ming, hatchery manager among the larval culture tanks in the P. vannamei section.

Uni-President also has a disease diagnostic laboratory in Tien Giang Province that provides services to the farmers in the Mekong Delta.

The distance to the Mekong is some 12 hours away but the stable sea water salinity and quality are the reasons for the location of the hatchery in Ninh Thuan Province. In the same location, are hatcheries belonging to several other feed and seafood companies such as CP, Grobest I- Mei, Viet Vc, Minh Phu, Hawaii Viet Thang and Thong Thuan.

In a separate area, the hatchery is producing post larvae of black tiger shrimp. The target production of post larvae of the black tiger is 5 billion by 2010. Brood stock are 8th generation domesticated stocks from Madagascar and Africa. Maturation work is carried out after a month of the arrival of brood stock.

Ponds in the Ninh Thuan area. All ponds are lined with PVC which are replaced every 2 years. Ground water with a salinity of 17ppt is used to hold vannamei shrimp, stocked at 100 to 220PL/m². Shrimp are usually harvested at 100pcs/kg and sold to processors or local brokers. Uni-President Vietnam has 70% of the feed market in the province.

Focus on the black tiger shrimp

There is still a lot of interest in the culture of the black tiger shrimp, despite the proliferation of vannamei shrimp culture in Asia. Mr Cheng Wen Chin, General Manager of Uni-President Vietnam, organizer of this session at the World Aquaculture 2008, Busan, Korea, said "Many farmers want to go back to the black tiger for its larger size and premium quality. Experts invited by the company will show us how to go about this".

It is apparent that interest in the black tiger shrimp is not waning as the session on 22 May 2008 attracted some 160 participants. It was chaired by Professor Shi-Yen Shiau, Taiwan and Dr In Kwon Jang, Korea and included various presentations from nutrition, culture, diseases to marketing. **Dr Timothy Flegel**, Centex shrimp gave an overview of the important disease of the shrimp in Asia. He said that to date, the viral diseases which pose the most serious threats to all shrimp farmers, is the white spot syndrome virus (WSSV) and yellow head virus (YHV). Other viral pathogens of concern for *P. monodon* are hepatopancreatic parvovirus (HPV) and monodon baculovirus (MBV). However, losses to these two viruses are usually not severe, and they can be effectively controlled by appropriate management of hatcheries to limit their prevalence in stocked post larvae derived from captured brood stock. Of the emerging shrimp viral diseases, Laem Sing virus (LSNV) has recently been described as a necessary but not sufficient cause of a condition described as monodon slow growth syndrome (MSGS) in *P. monodon*. MSGS probably ranks third behind WSSV and YHV in level of threat to *P. monodon*, Another threat to *P. monodon* that may be viral in origin is loose shell syndrome (LSS), frequently described from India.

The farming of black tiger shrimp in Vietnam continues to expand despite adverse conditions, said **Dr Nguyen Van Trong**, Deputy Director of Research Institute 2 (RIA2). In 2006, black tiger shrimp was farmed in nearly 70% of the total area used for shrimp farming. Production was 324,700 tonnes in 2006 in comparison to 6,000 tonnes of the vannamei shrimp. Some of the current weakness in the industry is in the weak control on post larvae quality. At the grow-out level, the culture period is longer and shrimp size smaller. The disparity between cost of production and selling prices has made the shrimp less competitive to culture than the white shrimp. There has been damage from WSSV, which affected 45,000 ha of culture area in 2007. Nevertheless, lessons learnt included more attention on quality of post larvae and disease checks with PCR at PL20. A sustainable stocking density is being practiced too at 20-30 PL/m^2 for intensive culture.
GAqp and BMP have been introduced in some farms.

Other presentations included a review on the semi intensive grow-out and pond management of the shrimp by Herve Lucien Brun, based on his experiences in farms. Dr Jacques Gabaudan, DSM Aquaculture Centre Asia Pacific in Bangkok gave an overview of the global production and trade of farmed shrimp (see pages 33-34). Dr David Smith outlined some protocols for the cultrure of the black tiger shrimp in zero water exchange production ponds. (More information: Jeff Jie Cheng Chuang email: jeff@upvn.com.vn).

Nutritional requirements of *P. monodon*

Professor Shi-Yen Shiau said that nutrient requirements for *P. monodon* have been studied extensively since 1990. Briefly,the optimum dietary protein level of *P. monodon* is 40-50%. Ten amino acids are essential for the species and their requirements have been quantified. The shrimp require 4-11% of lipid, 1% of cholesterol and 0.5-1% n-3 high polyunsaturated fatty acids in diet to maintain optimum growth. Complex carbohydrates such as starch are better utilized than simple carbohydrate (glucose) by the shrimp. The requirements of all the fifteen essential vitamins have been completely determined for *P. monodon*.

Energy is not a nutrient but if insufficient non protein energy is available, part of the protein will be used as energy. In contrast, excess energy may inhibit proper utilisation of other feedstuffs. The optimal P:E ratio has been calculated at two protein levels. The optimal protein for *P. monodon* reared in seawater is 40%. Data also suggested that when energy level reaches 330 kcal/100g, the dietary protein can be lowered from 40% to 36%.

Some of the recent work showed that the biopotency of different vitamin C sources for *P. monodon*. These were as follows; C2MP-Mg (100%)> C2MP-Na (84%)> C2PP (64%)>C2S (25%). In the case of choline which is important for methylated metabolites and as a precursor of acetylcholine, the requirement level was 6,200

The Uni-President team and guest speakers.
From left: Franky Lee, Aquatic Feed Business, Uni-President Enterprise Corp, Dr Wang, Prof. Grace Chu-Fang Lo, Prof Shi-Yen Shiau and wife, Dr Marc Le Groumellec and Jie-Cheng Chuang, Uni President Vietnam

mg/kg diet. In view of the importance of choline in lipid metabolism, would dietary lipid concentration affect the choline concentration? The answer is yes, as optimum levels differed with lipid levels.

For minerals, only copper and zinc have been studied.Copper is an essential trace mineral for the shrimp as they possess haemocyanin containing copper. Copper related immunotoxicity has been demonstrated with inhibitory effect on immune responses. Experiments to quantify the dietary copper concentrations for growth showed that the requirement is 15-21mg/kg diet. However, the immune indicators showed that adequate copper concentration for non specific immunity is about 10-30 mg/kg diet. Zinc functions as a cofactor for the enzyme system. The dietary requirements showed that for growth it is 32-34mg/kg diet and for non specific immunity, the requirement is 35-48 mg/kg of diet.

Title: Nutrient Requirements of Penaeus monodon, Shi-Yen Shiau, Department of Food Science, National Taiwan Ocean University, Taiwan.

Development, domestication and breeding of a SPF broodstock of *Penaeus monodon* from Madagascar

In this presentation, Dr Marc Le Groumellec said that the rearing techniques used in farming the shrimp in the Western Indian Ocean was a combination of those used in Latin America and Asia. In Madagascar, Unima has two farms, Mahajamba which started harvesting in 1992 and Besalampy which began in 1999. The strategy was total integration which will allows for easy production planning. The production scheme involves broodstock farms together with nauplii production, larval rearing, grow-out farms and processing plants in separate locations. Shrimp are cultured in semi intensive ponds with target biomass of 1.8 to 2.2 tonnes/ha. Grow out ponds are stocked with 1-2g shrimp, transferred from nursery ponds.

"As the markets for the head on shrimp are France, Spain, Portugal, Italy and Japan, specific methods of harvesting, transport and freezing to maintain quality. Costs of production are high because of bad logistics in Madagascar and high energy costs. Therefore maintaining high production performance is essential for us to be sustainable".

Some of the unique features of the farm were emphasized. These included separation of intake and discharge for a continuous water exchange, feed management with high quality feeds, surveillance program on shrimp and on food safety at the in house laboratory. The social responsibility aspect includes building hospitals, schools and provision of water and electricity. Environmental responsibility is the planting of mangroves trees and surveillance of the environment.

To address sustainability and biosecurity issues, the necessary challenge was to develope domesticated SPF broodstock. This has been the exclusive source of post-larvae for the farms since the beginning of 2003.

"It has given the farm independence from wild stock and a year round supply guarantee. More importantly, we have a safe source of post larvae, certified free of all economically important pathogens. The more consistent performance have allowed for more precise projection and budget calculations".

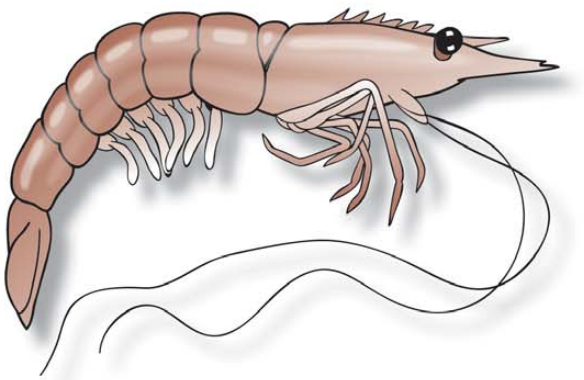
All broodstock were endemic to Madagascar. The broodstock centre has been designed with high biosecurity standards, and all founding populations have been passing through a primary and secondary quarantine phase. All OIE listed pathogens are tested and the selected population has been certified free from those pathogens. In addition, specific diagnostic tools for each endemic Malagasy pathogen detected since 1996 have been developed, and these are used for routine surveillance of Aqualma's shrimp stocks, along with the standard diagnostic tools for OIE listed diseases detection, and histology for detecting emerging pathogens.

More than 10.000 wild individuals have been collected along the West Coast of Madagascar from 1999 to 2002. The population has been established from 198 selected individuals, representing more than 99.5% of the genetic variability of the base population. From there, the breeding program was designed to keep as much as possible the genetic variability within this domesticated population (effective population size >300 at each generation). After the first five generations the estimated gain in growth rate was estimated to be 15% per generation, integrating domestication selection, mild directional selection for growth and improvements in rearing methodology.

"Quality management standards like ISO 9001 certification also helped us to achieve capacity building on best and safest management procedures. A complete traceability program has also allowed us to obtain the 'Label Rouge', a famous certification standard in France based on consistency of superior quality products. Adapted software and databases have been designed internally to record all measurable performance data, in order to closely follow the progress. However, biosecurity has become a major issue because of the inherently low level possible in our semi-intensive farms and because more projects are being developed in the zone. This is why we currently encourage biosecurity measures on a national or regional level."

"We would now like to evaluate the performances of our domesticated SPF P.monodon population under different rearing conditions. Our objective is to find reliable partners for a long term collaboration to develop that strategy."

Title: Development, domestication and breeding of a SPF broodstock of Penaeus monodon from Madagascar By Marc Le Groumellec, Vincent Rigolet, Olivier Rasoloniaina, Michel Rakotondrafara, Manavendra Vemulapalli Rao and Marc Vandeputte, Aqualma, Madagascar



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Feeding for profit

"The cost of feed often accounts for 50% or more of the operational expenses for an aquaculture facility. Nevertheless, too much emphasis is often placed on lowering cost of feed and not enough is placed on optimising feed costs ($ feed /kg fish produced) resulting feeds that are not always cost-effective for producers", says Pedro Encarnaçáo

Formulated aquaculture feeds are among the most expensive animal feeds on the market. The price of the feed varies with the type of feed (e.g., live, wet, moist, and dry feeds), the type and quality of individual ingredients incorporated into the feed, the manufacturing process and the method of delivery (i.e., bulk, bagged, or sacked).

The first consideration for formulation and production of cost-effective diets is the quality of the feed ingredients. The chemical composition (nutrient, energy, antinutrients, and contaminants) of the ingredient plays a determinant role on quality. However, biological aspects, such as digestibility and utilization of nutrients are important and often overlooked.

Due to the increasing cost of raw materials, fish nutritionists are being challenged to formulate feeds that not only meet the nutritional requirements of fish but also minimize production costs, limit environmental impacts and enhance product quality. These challenges not only add considerable complexity to finfish nutrition but also provide opportunities to avoid some of the mistakes made by other industries in the past.

Cost-effectiveness of Feed vs. Feed Composition

Reducing feed cost is often seen solely as the process of minimizing the cost of the feed ($/ kg feed) whereby the focus should be on minimizing feed cost per unit fish biomass gain (feed cost $/kg fish produced).

Consequently, improving cost-effectiveness of feed is not simply a least-cost formulation process (minimum cost per unit of weight of feed) but a process that should also take into consideration the amount of feed needed to more efficiently produce one unit of biomass or 1 kg of fish. This is especially meaningful for fish feeds, since their composition often varies significantly, not only as a function of species and life stages for which they are formulated (salmon feed vs. carp feed, fry feed vs. grower feed), but also as a function of the feed manufacturers preference or product lines, production environment and constraints (e.g. available raw materials), and economic climate (higher fish price, lower fish price).

The amount of feed required by fish to achieve a certain amount of weight gain depends primarily on the composition of the feed used. In general, a greater amount of a lower nutrient density feed will be required when compared to a higher nutrient density feed to achieve the same performance level (Table 1), assuming that the two feeds are similarly balanced. Feed with lower digestible nutrients will generally be less expensive per unit of weight than higher nutrient density feeds because grains and other carbohydrate-rich feedstuffs are often cheaper than higher protein and fat feedstuffs.

It is also important to note that an appropriate estimate for the final cost of the feed includes ingredient costs, manufacturing cost and other associated costs (shrinkage, bagging, shipping, profits, etc.).

Extruding and shipping one tonne of lower quality feed is as expensive as extruding and shipping one tonne of higher quality feed. This is often ignored in the industry. Total feed cost ($/kg fish produced) may be greater with a lower density, cheaper, feed since a greater amount of that feed will be needed to achieve the same level performance (Table 1).

Table 1. Performance of Atlantic salmon fed diets of different nutrient densities (but same protein to energy ratio) for 16 weeks and reared at 15°C.

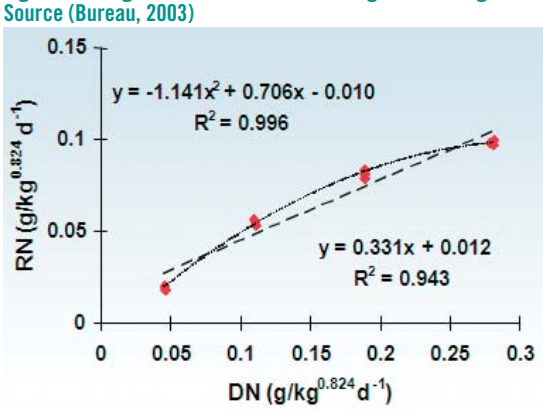
Diet	Grower	HND
Digestible protein (DP), %	37	44
Digestible energy (DE), MJ/kg	18	22
DP/DE, g/MJ	20	20
Ingredient cost, $/tonne	650	800
Manufacturing+shipping cost, $/tonne	150	150
Finished feed cost, $/tonne	800	950
Fish Performance		
Initial weight, g/fish	7.0	7.0
Final weight, g/fish	40.4	40.6
Feed served, g/fish	29.7	24.3
Feed Conversion Ratio (Feed/Gain)	0.82	0.67
Feed Cost, $/tonne fish produced	736	715

Source: performance data from Azevedo et al. (2002)

Improving animal performance

First of all we have to consider that the final target for the aquaculture industry is the production of high quality fish/shrimp meat (fillet). Lean weight gain (muscle growth) is mainly determined by protein deposition which is dependent not only on the protein level in the diet (Figure 1) but also the biological value of the protein (digestibility and amino acid balance) and also the DP:DE ratio in the diet. Most species of fish

Figure 1. Nitrogen retention in function of digestible nitrogen intake. Source (Bureau, 2003)



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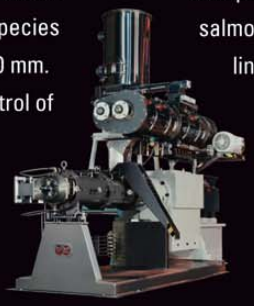

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derive energy from proteins and fats more efficiently than from carbohydrates, although omnivorous fish species, such as common carp, tilapia and catfish have a greater ability to metabolize digestible carbohydrates.

Nevertheless, the actual "value" of carbohydrates to support protein deposition and weight gain of fish is, however, not always clear in particular when the levels in the feed reach above 40%.

When feeds low in protein and high in carbohydrates and fiber are used, the capacity of the gut may be exceeded before the fish consumes adequate amounts of nutrients. This situation leads to a reduction in growth and/or the need for more feed to reach the growth potential of the animal, meaning higher FCR. If the feed is of poor quality and it is not being digested efficiently, it contributes to higher quantities of fecal solids in the water.

Even if the food is digested and absorbed, assimilation of the nitrogen (N), phosphorus (P), and other elements in a poor-quality feed may not be efficient, so these elements are excreted into the water. If the amino acid profile of the protein is unbalanced, the fish may use the carbon skeletons of the excess amino acids for energy instead of lean body tissue, and the excess N (in the form of ammonia) from the amino acids is released into the water. A low cost feed also may not be palatable, which may increase the amount of uneaten feed in the pond, again leading to an increase in FCR and affecting water quality.

With the increase reliance on less costly protein sources and low nutrient dense diets we are most likely increasing the levels of raw materials with lower protein digestibility and higher amino acid imbalance, higher carbohydrate and fiber content. This will lead to an inefficient utilization of the nutrients in the feed resulting in an increased feed usage and poor animal performance and increase costs to produce 1 kg of lean fish. This way we will not only be feeding the fish but also feeding the pond, which can be beneficial in terms of increasing natural food production in the pond, but still resulting in a less efficient process.

Therefore, the use of a balanced diet or more nutrient-dense feeds formulated to supply a specific nutrient concentration required for optimum performance at different life stages (life growth phases) would be the most efficient process. This is due to more nutrients being available and easily assimilated in a nutrient-dense diet, fish growth is improved and FCRs are lowered.

This approach was followed by the trout and salmon industry which focused on the production of feed with higher digestible/useful nutrient (mostly protein and fat) density and significant reduction in the amount of feed required to produce 1 kg of fish. Today, the use of higher digestible nutrient density feeds (e.g. 40-45% protein, 20-30% fat) allows a FCR of about 1.1 to 1.2. The significant improvements in feed quality and FCR were also accompanied by very significant reductions in waste outputs and relative cost.

A better understanding of nutrient and energy utilization may allow fish nutritionists, feed manufacturers and fish producers to look at feed cost under a new light.

Based on current knowledge on energy requirement and nutrient utilization, it appears that the use of low nutrient and energy density feeds are the main reason for the very poor feed conversion ratio (feed/gain, between 1.5 and 3) seen in most aquaculture operations. Production cost with such feeds may not be advantageous as often touted when one accounts for manufacturing (e.g. extrusion), transport costs and a poor FCR.

The potential negative impact on the productive capacity of the rearing environment which should be considered is the high organic waste output associated with feeding low digestible nutrient density feed. Improving cost-effectiveness is more than just a least-cost formulation. A complicated cost-benefit analysis based on ingredient characteristics (composition, limitation, and cost), manufacturing cost, fish performance (growth rate, FCR) and production constraints is necessary.

When presented with accurate nutrient and energy utilization data, the aquaculture industry in Asia may reconsider, for example, the use of low nutrient and energy density feeds (low cost feeds but not necessarily cost-effective feed) for the rearing of warm water omnivorous fish (catfish, tilapia, carp). (Photo courtesy of Ms Vo Thi Kim Hang, VietLong, Vietnam)

Phase feeding in fish, are we doing it correctly?

When formulating fish diets the nutrient-density can be increased or decreased simply by increasing or decreasing the percentage of one or more ingredients containing high concentrations of specific nutrient(s). Adjusting nutrient-density is a common practice as fish grow. For example, fingerlings and juveniles grow more rapidly than older fish. Since this growth is mostly addition of lean protein tissue, a higher percentage of protein is required in the diet to supply the essential amino acids that make up the lean tissue. As fish get older and larger, their overall growth rate and deposition of lean tissue declines, and the percentage of protein in the diet is usually decreased.

This concept of lowering the dietary protein content as the animal ages is the basis of phase feeding programs which were first implemented for the swine and poultry industry. Phase feeding is an efficient way to adjust the protein level in the feed and reduce the feed costs (by reducing costly protein rich ingredients), however, such programs should be implemented properly and according to the growth potential of the different fish species.

A common mistake observed in particular in the catfish industry in Vietnam is to follow a phase feeding program similar to those of the chicken industry. It is important to understand that fish have a different growth pattern when compared to a chicken or a pig, which will reduce their growth rate and almost stop growing (lean muscle) when reaching a certain age, normally close to the slaughter period (42 days). Fish normally grow for most of their life cycle, and the harvest weights for most commercially raised species are normally far below the maximum weight the fish can attain.

For the production of tra and basa catfish, we often see a reduction on the crude protein content of the diet from 30 to 25 and 20 % as the

production cycle reaches the final stages. However, a pangasius catfish with 1 kg body weight still has not reached is full potential growth of about 40 kg (fishbase.com) and as such, can still grow at a high rate.

This means that by reducing the nutrient density of the diet and in particular the protein content of the diet we are limiting the growth of the fish, in particular lean growth (muscle or fillet). The fish will have less amino acids available (the building blocks of protein for muscle growth) and excess carbohydrates. This can ultimately result in lower fillet yield and in an increase in visceral fat deposition. Furthermore, we are not only reducing the growth rate but we are also contributing to an increase in waste output which can reduce water quality and further reduce fish performance.

The use of suitable diets in aquaculture operations can significantly increase profitability by reducing feed costs, improving animal performance, maintaining water quality, and minimizing nutrient loads to the environment. The manufacture and use of feeds based on high quality and digestible feedstuffs, is highly recommended for the aquaculture industry as long as the use of such feeds is profitable and compatible with the environment.

Catfish harvest in Vietnam. The desired harvest size is 1 kg and it takes 3 kg of fish to produce I kg of fillet. Should feeding with higher protein diets (26-28 % CP) continue until harvest to increase fillet yield and reduce visceral fat deposition? (Photo courtesy of Ms Vo Thi Kim Hang, VietLong, Vietnam)

Dr Pedro Encarnaçáo is aquaculture specialist for Biomin. Based in Singapore and responsible for the Asia, Pedro has an extensive background in aquaculture and nutrition and has conducted several research projects focusing on the improvement of feed formulations for aquaculture species. He obtained his PhD in Animal Nutrition from the University of Guelph, Canada. Email: pedro.encarnacao@biomin.net

Phytase in aqua feeds: a focus on the application of phytase in the feed mill

By Dirk Lorenz-Meyer

Phytase application in fish feeds is well established. Phytase converts phytate phosphorus (P) into a bio-available form thereby reducing the need to supplement aqua feeds with inorganic P sources (Debnath et al., 2005 and Cao et al., 2007 for extensive reviews). A growing awareness of P pollution from pond effluents and recent price rises in feed phosphates, such as DCP and MDCP have created renewed interest in the application of phytases in aqua feeds.

However, a lack of application knowledge constrains phytase usage in the feed mill and thus hampers the potential to improve feed quality, reduce feed cost and P pollution. This article takes on the perspective of the feed producer and provides a foundation for decision making. As phytase usage concerns nutritionists and mill operators alike, phytase economics, post-pellet application technology and service capabilities of the provider are the key issues to be considered.

Common plant based feed ingredients provide sufficient total phosphorus (P) to meet dietary requirements but the majority is locked up in the form of phytate P which is indigestible to monogastric and agastric fish species. In addition, phytate has been shown to be a powerful anti-nutritive factor. It chelates with other nutrients including trace elements and proteins thereby reducing their bio-availability and may inhibit digestive enzymes such as pepsin, amylase and trypsin. However, the commercial practice of supplementing aqua diets with inorganic P sources leads to P pollution and may introduce unwanted substances to the feed.

Therefore, the idea of using a phytase enzyme is to utilize the P that is already present in the feed ingredients and to reduce the need for inorganic P supplements. This would ease input cost and improve feed quality because the enzymatic hydrolysis of the phytate molecule reduces its anti-nutritive effects. Feed quality also benefits indirectly as the space gained from replacing DCP or MDCP in the diet can be used for more valuable ingredients.

Selecting a phytase

Phytases from a variety of microbial origins (e.g. fungi, bacteria and yeast) have been identified and used as feed additives. While bacterial phytases (derived for example from *E. coli*, Bacillus or Klebsiella strains) have received a lot of research attention lately, no *per se* superiority of a phytase source can be postulated. Commercially available products vary widely in their properties, bio-efficacy, recommended dosages and price. All of this needs to be factored in when examining the economics of phytase usage.

The term phytase unit is misleading. Phytase activity is determined indirectly through the measurement of inorganic P released from the substrate. One phytase unit is then defined as the amount of enzyme that liberates 1 μmol of inorganic P per minute under the conditions of the assay, i.e. under the enzyme's optimum pH. However, assay conditions differ between phytase products and only in part resemble the actual milieu of the gastrointestinal tract of animals. As a result, different phytase products with the same declared activity of 5,000 units/g can vary greatly in their ability to release inorganic P under practical conditions.

Several factors have been suggested to impact phytase efficacy that can be grouped into three broad categories, namely phytase inherent factors, animal factors and feed related issues. Biochemical characteristics like temperature and optimal pH as well as inactivation by proteolytic enzymes are factors inherent to phytase products. Most phytases have their temperature optimum between 50 and 60°C. However, for the use in animal feeds the remaining relative activity at body temperature of the target species is much more revealing. At lower temperatures, fungal phytases of Aspergillus origin have a higher activity as compared to bacterial phytases (Elkhalil et al. 2007). This is especially important for ectotherms such as fish, where body temperatures in a subtropical climate might range from 23 to 32°C.

The pH stability profiles of phytases vary greatly. Intrinsic plant phytase and Peniophora based products are known for their narrow pH optimum at 5.0. *Aspergillus* and *Trichoderma* phytases have a wider pH range and are also active under the acidic conditions of the upper gastrointestinal tract where *E.coli* phytases display the highest stability.

PPLA technology in the mill: Two feed producing lines equipped with surge bins, enzyme applicators and downstream fat coaters (top). The feed flow to the spray chamber is regulated to create a stable feed curtain (bottom left) onto which the enzymes are sprayed (bottom right).

Bacillus based products on the other hand have their pH optimum at 7.5 making them a candidate for liberation of inorganic P in the small intestine. Whether pH stability is an advantage or a concern for a given product depends largely on the digestive systems of the target species. In agastric fish such as carps, acid phytases are ineffective and a neutral phytase (e.g. from a Bacillus strain) might be the option of choice.

Finally, phytase enzymes like all proteins are susceptible to inactivation by pepsin and pancreatin. In this respect, *E.coli* and Klebsiella based phytases show a higher resistance to proteolytic degradation than fungal sources. It again depends on the physiology of the target animal whether a phytase product can liberate sufficient amounts of inorganic P before coming in contact with protease enzymes.

While the relevance of phytase properties for its efficacy is obvious, their impact on practical results is related to the other two areas of animal and feed related factors. Genetics, sex and life stage influence P requirements and the response to microbial phytase supplementation, while the feeding behavior of aquatic animals will affect the amount of phytase that is actually ingested. Common freshwater fish such as tilapia and Pangasius catfish feed rapidly at the surface, whereas shrimp feed slowly on sinking pellets which increases the likelihood of nutrient leaching.

However, the main impact on phytase efficacy comes from the feed it is added to. Factors include feed components, additives and the manufacturing process. Enzymatic efficiency is largely dependent on the levels of total P, non-phytate P, and the amount and source of phytate P in the diet as this is the substrate for the enzyme to work on. While higher levels of calcium and mineral chelators have been shown to interfere with phytase, feed ingredients like Vitamin D, organic acids and synergistic NSP enzymes have the potential to increase its efficacy. However, it is the feed processing in the mill that has the biggest single effect on phytase as it determines the remaining enzyme activity in the finished feeds.

Formulating fish feeds with phytase

Fortunately for the decision maker, the phytase intrinsic properties crystallize into a P equivalency provided by the respective phytase manufacturer. A phytase with a broad pH spectrum and a higher resistance to proteolytic activity will tend to have a higher P equivalency. Table 1 illustrates how much P is made available by the enzyme at a given inclusion rate. A standard inclusion rate for monogastric animals including fish has been 100 g/tonne of a phytase product with 5,000 U/g. The resulting 500 U/kg of feed will replace between 0.8 and 1.3 kg of available P per tonne of feed, depending on the equivalency value of the respective phytase product.

Although this rather large range does reflect differences in the bio-efficacy of available phytase products, it is advisable to look into the details of the trials used to justify the claims. In diets with low total P, the response to phytase will be higher than with its addition to a P adequate diet. Therefore, it needs to be verified whether trials were done with diets resembling the commercial practice in the area of intended application before employing the particular P equivalency data.

Two questions often arise when formulating fish feeds with phytase. The first is whether or not to use matrix values that go beyond P. As phytase hydrolyzes the phytate molecule it liberates not only P but also other chelated nutrients which potentially improve performance. While any additional nutrient release will certainly benefit the aquatic animal, the question is whether the response to phytase addition would be consistent enough to be translated into digestible energy (DE) and amino acid (AA) values that could be captured in the feed formulation.

Literature on a potential growth response remains inconclusive. It is essential to scrutinize the underlying trial protocols. Growth responses are mostly documented with P inadequate experimental diets. When the effect of improved P availability is factored out, the performance seldom differs between phytase treatment and controls. The basically unchanged protein efficiency between fish fed diets with phytase or sufficient inorganic P points in the direction that a direct phytase effect might be limited. ME responses have mostly been reported with high phytate diets rich in wheat and wheat-byproducts, making it difficult to apply the same ME values in lower substrate corn/soy diets.

Overall, dietary factors play an important role in the potential to benefit the animal's growth performance and the lack of consistent results calls for caution in the use of any overly simplistic guidelines that ascribe ME and AA values to microbial phytase supplementation (Adeola and Sands, 2003).

The next question concerns the phytase dosage. While a standard dose of 500 U/kg feed has evolved over time, this level is arbitrary and might not be the economic optimum. With the current high prices of inorganic P sources it might be beneficial to use a higher inclusion rate of phytase. However, due to the limit of gastrointestinal transit time during which phytase activity can take place and the potential limit of dietary substrate the dose response function of phytase addition is non-linear. Doubling the amount of phytase in the feed might only lead to 30-50% increase in the P equivalency. Moreover, because of the different biochemical properties of phytase sources the dose response curve will also differ between products, diets and target species.

Ultimately, when price, P equivalency and most economic dosage of a phytase are known, the cost per tonne of feed can be compared with the replacement value of the inorganic P source used. The formulator then needs to take into account the cost of alternative raw materials needed to fill the space of the replaced DCP/MDCP to get to the net savings.

A Phlauer 2000L vacuum coater. A good vacuum coater manufacturer will ask the proper questions with respect to the number of liquids to be added and size the equipment properly to allow for a number of liquid additions either under vacuum or atmospherically (or both in one batch cycle) while maintaining the required production level. Picture courtesy of A&J Mixing, Canada.

Table 1. Comparing the economics of DCP replacement with graded levels of phytases with different P equivalency.

	Phytase A		Phytase B	
Phytase price (USD/kg)	9.00		12.00	
DCP price (USD/kg)	0.60			
Total P	18%			
Digestibility	75%			
Available P	13.50%			
Substitute raw material price (USD/kg)	0.20			
Phytase Dosage (g/tonne)	**100**	**150**	**100**	**150**
Phytase Units (U/kg feed)	500	750	500	750
Avail. P equivalency	0.08%	0.11%	0.11%	0.14%
Avail. P (kg/tonne)	0.8	1.1	1.1	1.4
DCP replaced (kg/tonne)	**5.9**	**8.1**	**8.1**	**10.4**
Gross replacement value (USD/tonne)	3.56	4.89	4.89	6.22
Phytase cost (USD/tonne)	0.90	1.35	1.20	1.80
Substitute cost (USD/tonne)	1.19	1.63	1.63	2.07
Net Saving (USD/tonne)	**1.47**	**1.91**	**2.06**	**2.35**

Applying phytase in the feed mill

Phytases like all enzymes are inactivated by heat treatment. Despite efforts to increase the thermo stability of phytases, results so far have been disappointing. Incremental improvements do not suit aqua feeds that are cooked for prolonged periods and then extruded. Enzyme activity is inevitably lost during the manufacturing process in the feed mill, limiting the use of powder products to the farm site.

Another option could be dephytinization which refers to the pre-treatment of raw materials with a phytase in order to release inorganic P before even entering the animal. This method has been used in research, but besides prohibitive costs, it would require major modifications in a feed mill to treat raw materials for the needed enzyme reaction time at the right pH, moisture level and temperature. In addition as phytate is present in all plant based ingredients, it is unlikely that specialized raw material providers would employ this technology.

This leaves the liquid application of enzymes as the only viable option for fish feed. Two distinct methods have been successfully used. After the extruded pellets have been cooled down and the fines removed post-pellet liquid application (PPLA) can be done with a vacuum coater or a dedicated spraying system. Vacuum coaters are typically used for oil application but can apply micro-ingredients too. The advantage of a vacuum coater is that liquids are sealed into the core of a pellet effectively eliminating fears of leaching. However, this process takes around 5 minutes per batch and might limit the throughput capacity of a feed production line.

The alternative is to apply enzymes with spraying equipment that can be tailored to each feed mill situation and avoid bottlenecks during production. Accuracy and uniformity of the enzyme application are the key concerns. Especially when inorganic P is reduced it must be assured that the phytase enzyme is sprayed evenly onto the pellets. To dose around 100 cc of a liquid phytase precisely onto 1,000 kg of feed requires sophisticated technology. The dry flow control which regulates the feed inflow to the spray chamber is the heart of a system. It determines the actual feed flow rate and triggers the pumps to deliver the matching amount of enzyme.

Apart from the spray performance, a state of the art system should be capable of handling up to four liquid ingredients and be able to recognize and correct density variations between different feed sizes. Therefore large numbers of feed profiles need to be calibrated and stored in the software.

Finally, a broad scope of after-sales-services is needed to make liquid application work and keep the system running. Key areas are the availability and dedication of local service engineers and the commitment of the supplier to assay feed samples on a regular basis. This will provide the confidence in the accuracy of the system and the assurance that all feeds contain the level of enzyme activity that the nutritionist and the end-user expect.

Conclusion

The benefits of phytase usage in aqua feeds are well known. It is important for the decision maker to realize that common phytase products which seem to have the same specification may indeed have very different potencies under practical conditions. This needs to be addressed in order to evaluate available phytase products against the intended area of application.

The loss of enzyme activity during feed processing leaves post-pellet spraying as the only way to use enzymes in fish feed. While it needs to be well planned and monitored, liquid enzyme application today can be done in an accurate, reliable and traceable way. Many equipment options are available and the decision for one PPLA system requires an entire selection process of its own. Expertise of the manufacturer and experience with the feed mill application must blend together with a compelling service offering to form a convincing package.

References are available from the author

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Selenium and immune function

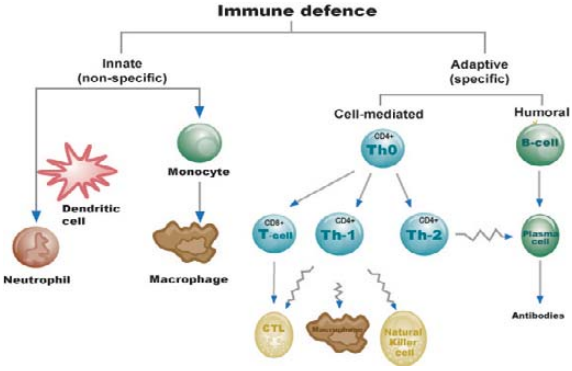
By Kate A. Jacques

Selenium has wide ranging effects on both innate and adaptive immunity. How the form of selenium can improve the defense by fish and shrimp against diseases in challenge tests, is explained.

Improving disease defense in animals, including aquaculture species, is increasingly important as farmers move away from therapeutic disease control to prophylactic strategies to improve immunocompetence. By improving defense against infectious diseases, concurrent improvements in welfare, performance and reproduction, efficiency, flesh quality and profitability can occur. One vital aspect of a prophylactic strategy is to consider diet ingredient composition and feeding management.

Selenium is known to have wide ranging effects, both direct and indirect, on both the innate (non-specific) and adaptive immune mechanisms as well as in protecting against certain types of tumours, although our understanding of the way selenium is essential in immunity is not yet complete. Selenium functions in defense against pathogens through two general mechanisms: the functional selenoproteins and the regulatory cytokines that regulate cell-mediated and humoral immunity. Figure 1 shows an overview of the immune system.

Figure 1. An overview of the immune system.



The form of selenium in the diet has a very large impact on its ability to fulfill its role in immune function. Substituting Sel-Plex, a selenium yeast, for the inorganic sodium selenite, reduced the impact of disease challenge with lower mortality and less pathology (tissue damage) and thereby improved efficiency, uniformity and product quality. The reason for this is fairly simple. The organoselenium compounds formed by yeast, like those in plants and phytoplankton, are more easily metabolized and can be stored to form tissue reserves against periods of increased demand such as immune challenge.

Selenoamino acid form in the food chain

Plants, certain blue-green algae, bacteria and yeast take up selenium ions from the soil or water and convert them to selenoamino acids, primarily selenomethionine (SeMet) and selenocysteine (SeCys). These are Se-analogs of the sulphur amino acids methionine and cysteine and are identical but for the replacement of sulphur for selenium. SeMet is the form in which the majority of selenium is stored in plant/algal protein. This is the main form in which selenium enters the aquatic or terrestrial food chain as animals are unable to form SeMet (just as they are unable to form methionine) (Schrauzer,2000).

When animals consume SeMet in vegetable feeds, it is digested, absorbed, transported, stored and metabolized by the same pathways as methionine. This means that unlike inorganic selenium, it can be taken up into tissue proteins such as muscle nonspecifically in place of methionine, which provides tissue reserves of this critical trace element. Normal cell and protein turnover releases needed selenium, a process which escalates during an immune challenge.

In contrast to SeMet, little SeCys is stored in plant or algal protein for transfer up the food chain. However, it is SeCys that exists at the active site of the selenoproteins, which are the biologically active forms of selenium. SeCys for this purpose is formed during synthesis of specific selenoproteins in response to the UGA codon for its insertion (Schrauzer, 2000). This is the only example of a trace mineral specified in the genetic code and underscores the importance of adequate amounts of metabolizable dietary selenium.

In immune defense: selenoproteins and cytokines

Currently there are at least 30 characterised selenoproteins in mammals and most homologues are also found in fish. These reveal that selenium is involved in virtually all aspects of cellular biochemistry, including antioxidant protection, thyroid hormone function and redox control of many cellular reactions. Any of the broad effects of selenoproteins on metabolism could be expected to affect some aspect of immune response. However, selenium has specific importance in innate, cell-mediated and humoral immune defense.

Se in innate immunity

The role of the antioxidant selenoenzymes in protection of phagocytic cells of the innate immune system is one of the best-characterised aspects of the essentiality of selenium in disease defense (Arthur et al., 2003). Phagocytic cells, neutrophils and macrophages, ingest and destroy pathogens using enzymatic processes or by the generation of toxic oxygen radicals. Preventing oxidative damage to the phagocytic cells is a balance between producing enough radicals to kill the pathogens and the activity of the radical-neutralizing enzymes. The antioxidant selenoproteins, particularly glutathione peroxidase (GSH-Px), must act quickly to neutralise the oxygen radicals to protect the immune cellular machinery and its 'killing ability'.

Phagocytic cells from selenium deficient animals have been shown to be less able to kill pathogens due to the reduced activity of GSH-Px (Arthur et al, 2003). Selenium deficiency has also been shown, by impairing the leukotriene B4 synthesis, to slow the chemotaxis of phagocytes to sites of injury/infection (McKenzie et al, 2006).

Selenium and adaptive immunity

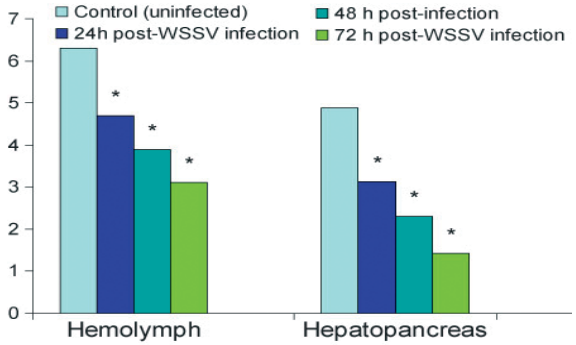
Selenium stimulates activity of both cell-mediated and humoral immunity through its regulation of IL-2, the cytokine responsible for the earliest and most rapid expansion and differentiation of T-lymphocytes into T-helper and cytotoxic T-lymphocytes (CTLs). This is brought about by an upregulation of IL-2 receptor expression (Baum et al., 2000).

While T-helper cell populations are critical to both cell-mediated and humoral immune response, the cytokines produced by Th-1 cells are of particular importance in defense against intracellular pathogens such as viruses. The effector cells of cell-mediated immunity recognize 'altered self cells', which cannot be reached by circulating antibody. Th-1 cytokines stimulate virus elimination by promoting activity of

CTLs, NK cells and activating macrophages. CTLs (specific) and NK cells (innate system) are cytotoxic, killing virus-infected cells. Activated macrophages have the enhanced ability to phagocytose affected cells as well as free virions (Tizard, 1996).

Improving selenium status by focusing on level and form has been shown to boost cell mediated immune parameters and defense against viral infection in many species, from humans to invertebrates. Sensitivity of immune defenses against viruses to selenium status is also a function of the impact of viral infections on oxidative stress. Oxidative stress, defined as an excessive production or accumulation of pro-oxidative compounds such as radical oxygen species (ROS). Oxidative stress is a hallmark of viral infection and is known to play a role in the progression of several viral diseases including HIV and hepatitis B in humans (Stehbens, 2004). Radical oxygen species are released from infected host cells and activated phagocytes. In addition, viral 'hijacking' of host synthetic processes disturbs the normal function of the endoplasmic reticulum and mitochondria, which increases ROS production and depletes cellular antioxidant components including micronutrients and glutathione (Allard et al, 1998; Schwarz, 1996). The result is reduced activity of antioxidant enzymes (Figure 2).

Figure 2. Effect of white spot syndrome virus on GSH-Px activity in hemolymph and hepatopancreas in Indian shrimp (from Mohankumar and Ramasamy, 2006).



Increasing selenium status of farmed aqua species

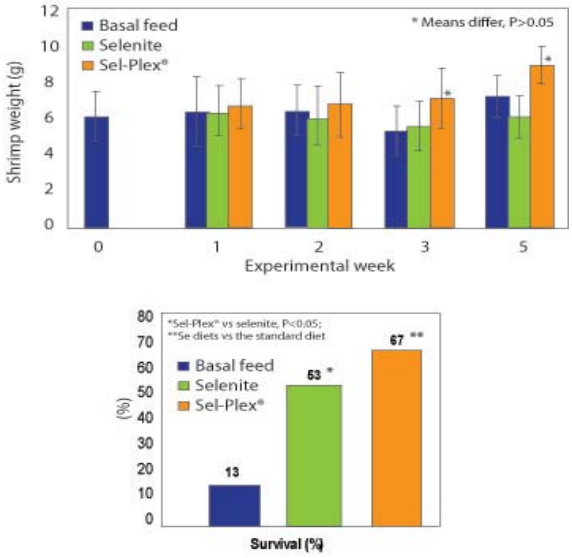
Given that there is a substantial amount of fish meal in most aqua diets, initially it is difficult to understand how adding additional selenium could be of value. However, considering that the form in which the selenium exists in fish meal is relatively unavailable and that the selenium content in the remaining vegetable ingredients will depend on soil selenium content and conditions where the crop was grown. In experiments with rainbow trout (*Oncorhynchus mykiss*) at the University of Plymouth, UK, trout given dietary Sel-Plex retained more Se in muscle than trout given selenite.

The practical impact of improved Se status on growth and health is illustrated in recent work by Sritunyaalucksana et al. (2008) with Pacific white shrimp (*Penaeus vannamei*). It was shown that the addition of Sel-Plex to the diet resulted in better growth (Figure 3). More importantly, higher survival after challenge with Taura Syndrome Virus was noted.

Conclusion

The selenium status is pivotal to the success of both innate and adaptive immune responses. This multifactorial role of selenium is

Figure 3. Effects of selenium source (added at 0.3 ppm) on the growth of Pacific white shrimp and survival after TSV challenge (Sritunyalucksana et al., 2008).



expressed through selenoproteins and regulatory cytokines. Many of the selenoproteins have antioxidant roles, which neutralize radicals produced by phagocytic cells of the innate response to maintain their effectiveness as the immune system's 'first responders'. Control over oxidative stress is also important in limiting the impact of viral disease. Low activity of GSH-Px due to Se-deficiency has been associated with increased viral virulence due to ROS-induced mutations of the viral genome. This role in viral evolution has been proposed to explain why so many emerging RNA viral diseases arise in Se-deficient regions of the world (Foster, 2003).

A large number and variety of pathogens important in food animal agriculture or aquaculture live or replicate inside host cells. Outcome of diseases caused by these pathogens is dependent on effective responses by the T-cell-mediated arm of adaptive immunity, which targets these 'altered self' cells. Selenium status is pivotal to cell-mediated immunity. Improvements due to providing this trace element in a form easily stored and metabolized has been shown to boost the animals ability to resist disease.

The ability of Sel-Plex, an organic selenium source to reduce the impact of disease and losses due to viral disease in a variety of species has important implications for the health management in the shrimp and fish farming. This contributes to increased food safety as well as improved farm economics.

References are available on request

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This article is adapted from a presentation given in Alltech's Asia Pacific Lecture Tour, Autumn 2007

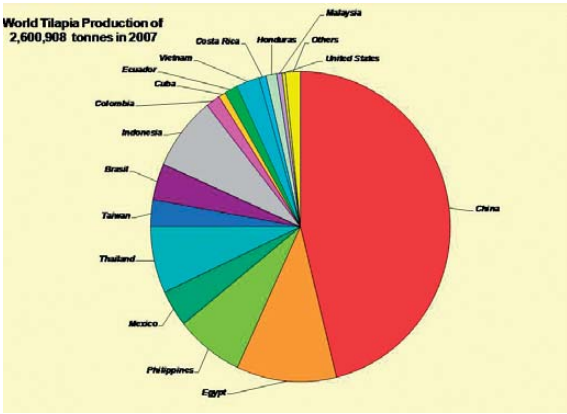
A good year for tilapia producers and consumers in 2007

By Kevin M. Fitzsimmons

The grand march of tilapia up the aquaculture and seafood ranks continued full-scale in 2007. Global production of farmed tilapia exceeded 2.6 million tonnes.

The number of product forms and packaging formats seemed to increase daily. Consumption in the European Union countries and US continued to rapidly increase. In the US, tilapia has become the fourth most popular food fish overall and represents the second highest volume of fish sales in supermarkets, after salmon. New farms and increased capacity kept prices relatively stable for another year. In fact, low prices for fresh fillets and rapidly increasing costs for feed and fuel did cause some farms in Ecuador to reduce stocks in late 2007. However, large tilapia losses due to winter storms in China and increasing fillet prices in early 2008 led most of the Ecuadorean producers to quickly restock. High feed and fuel costs are likely to finally force tilapia product prices up, but it is unlikely that producers and processors will be able to recoup all the increased input costs. Further increases in production efficiencies will be needed to maintain or improve profits.

Figure 1.



China leads

China again led all producers with roughly half the global production total. In November 2007, the China Aquatic Products Processing and Marketing Association hosted their Fourth International Symposium on Tilapia Production and Marketing in Hainan Province of China. The conference focus was on quality and food safety. This continued the Chinese government's strong attention to further improve the tilapia's quality and safety. The fact that tilapia avoided the mid -2007 warnings placed on several species of Chinese aquaculture products by the US, was a testament to the efforts of farmers and processors to grow and process better quality tilapia.

Tilapia markets in China remained strong with much of the fish being sold to live markets for restaurants and home sales. The international export trade consisted primarily of frozen fillets, although considerable amounts of frozen fillets are now beginning to appear in domestic Chinese markets as the middle class develops a taste for value added products and less interest in preparing whole fish at home. Markets for whole frozen fish appear to be stabilizing and were declining in the US. Taiwan's production has also moved upscale, with fewer whole frozen fish being marketed into international trade but increased amounts of higher value fresh and frozen fillets. Overall production increased slightly and was in the range of 75,000 tonnes.

ISTA 8 in Egypt

Egypt was the world's second largest tilapia producer. Production estimates range from 250,000 to 300,000 tonnes for 2007. Virtually all of the production in sold into domestic markets. In October 12-14, 2008, Cairo will host the Eighth International Symposium on Tilapia in Aquaculture (ISTA 8 http://www.ista8-egypt.com). This will be the latest in the symposia that bring the scientists, producers, processors, and marketers of tilapia together for technical talks on nutrition, genetics, breeding, diseases, processing technologies, and marketing opportunities. Farm tours, a trade show, restaurant competitions and social events are also important aspects. A special emphasis will be placed on how Egypt must upgrade its farming practices and processing capabilities to international standards in order to take advantage of their production capacity and proximity to European and Gulf Region markets.

As the home of the Nile tilapia (*Oreochromis niloticus*) the Egyptians feel that they should have one of the premier tilapia research, development and production programs and are putting additional governmental resources into the sector. Sub-Saharan Africa has significant populations of native tilapias and many small-scale producers. However, Lake Harvest Company's cage operations in Lake Kariba represent the only major producer and exporter. South Africa hosts several good research programs and some production, but very little if any reaches international markets.

Strong domestic markets

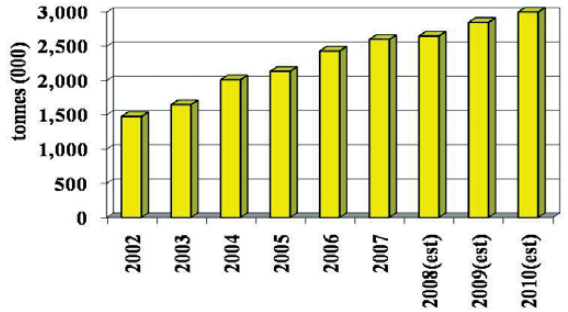
The Philippines are in the situation as a major producer but minimal exporter of tilapia products. Strong domestic markets and a leading role in breeding and genetics make the Philippines a hot bed of activity and potential. High quality processing and improved quality and greater average fish size will be required to have Filipino tilapia join the international trade ranks. With similar production levels between 150,000 and 200,000 tonnes in 2007, the Philippines, Thailand, and Indonesia fill the third and fifth largest producer positions. With both strong domestic markets and high quality producers and processors, Thailand and Indonesia provide significant production of frozen fillets for international markets. With strong attention to quality and food safety, these countries are actively seeking to increase their production.

The Latin American producers lead the world in the production of fresh fillets. Mexico and Brazil are the major producers of tilapia with production in the 100,000 tonnes range each. However, strong domestic markets have absorbed most of the production with little export business so far. Although each has great potential to rapidly increase exports to international markets. Ecuador, Honduras, and Costa Rica are the three major producers of fresh fillets for export primarily to the US and Europe. Colombia, Jamaica, Panama and other Central American countries are producing significant amounts of tilapia. Again, rapidly increasing costs for feed and fuel are their primary concerns and serve as an impediment to further growth.

Outlook

The common theme of rapidly rising costs for feed and fuel will be less of a concern for tilapia than many other aquaculture species and competing land-animal protein sources. Fish in general have better feed conversion ratios compared to warm blooded animals who also require relatively massive skeletons to move and remain upright. In addition, low trophic level feeders like tilapia and carps, require little if any fishmeal in a diet, lower protein levels, and consume significant amounts of algae and bacteria from their growing environment. The ability to digest a large array of agricultural by-products and thrive in very high densities further favors tilapia as a low cost aquaculture product.

A good future for the tilapia



The restaurants and grocery stores have seized on tilapia as the seafood equivalent to the chicken. It can be sold whole or in parts, can be processed into all kinds of value-added forms and recipes and cooks well with any type of apparatus (grilling, baking, broiling, steaming, microwaving, etc.). Interest in use of tilapia formed into blocks for the fast food industry's fish sandwiches, could drive another massive increase in demand.

Demand and production are likely to increase together by slightly more than 100,000 tonnes for each of the next three years reaching global production of 3,000,000 tonnes in 2010. Major sites of new production include Malaysia and Vietnam, which are developing big projects. The Philippines have been struggling to develop large-scale vertically integrated production in Mindanao.

The Chinese have also been hoping to encourage vertically integrated production, especially in Hainan Province. With the moderate decline in production expected this year, China will see increased market prices domestically, but production will fully recover within the rest of 2008. The Latin American companies will also significantly increase production. Mexican and Brazilian farms have plans to significantly increase exports, but keep turning increased sales to domestic markets.

Research and development in nutrition and feeds will continue to lower feed conversion ratios and moderate the cost increases. Additional genetic and breeding improvements will also improve efficiencies. Another bright spot for the tilapia industry are fish skin by-products. The top introduction in the last years had to be the tilapia bikini.

Of course wallets, belts, purses, vests, and other clothing and accessories are not as interesting, but probably more valuable in the long run. Overall it has been another strong year for tilapia and we anticipate better conditions for tilapia farmers and processors than most other aquaculturists can expect in the coming year.

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BFT for over-wintering of tilapia

By Yoram Avnimelech, Roselien Crab, Malik Kochva, and Willy Verstraete

It was reported that a harsh winter in Southern China had wiped out large population of tilapia, leading to a production reduction of about 80%. A bio floc technology approach to control water quality within the pond with minimal water exchange may be a solution to avoid such production losses during cold temperatures.

Tilapia is a tropical fish sensitive to cold temperature. Extended exposure to water temperatures below 10-13°C leads to death of the fish. Exposure to low temperature induces stress that may affect future growth of fish. A few cold spells during winter 2008 led to the mortality of about 50% of tilapia in Israel. Thus, thermal protection is needed to prevent damages, as described above.

One way to protect the fish is to cover ponds with plastic sheets (green house), in a way to effectively store solar heating. However, the investment in building the green houses can be justified only if we can stock a high biomass in the pond. Stocking with high fish biomass leads to the potential accumulation of high concentrations of ammonium and nitrite. Exchanging water to reduce the concentrations of the toxic metabolites is not feasible, since by exchanging water we discharge heat and introduce cold water.

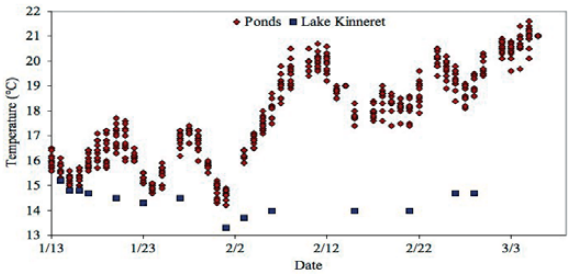
It is possible though to use bio floc technology so as to control water quality within the pond through the use of microbial activity, in highly loaded yet minimal water exchange ponds. This approach was tested during winter 2008 in the Genosar research station, by the Sea of Galilee, Israel.

Pond experiments

The pond experiments were carried out in 10 circular concrete ponds, one meter deep and an area of 50 m^2 each. A paddlewheel aerator of 1 hp aerated each pond and a 0.5 hp upward flow aerator was placed in the center of each pond to keep fine particles in suspension. Ponds were stocked mostly with 100 g tilapia hybrids (*Oreochromis niloticus* x *Oreochromis aureus*) at a stocking density of about 16 kg/m^3, three ponds were stocked with 50 g fingerlings at the same stocking density as the 100 g fish.

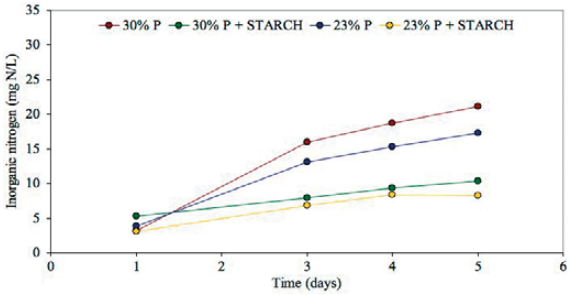
Water exchange was limited to 10% daily. Different formulations were tested in order to develop a protocol to rear tilapia over the cold winter season. As shown in Figure 1, the ponds maintained temperature higher than that of the water source. It was also higher than the air temperature which reached below freezing temperatures (for example, banana trees near the ponds were frozen).

Figure 1. Water temperature in all experimental ponds provided with polyethylene covers and in Lake Kinneret.



Water quality was maintained by either adding starch or giving low protein feed pellets. It was found that when C/N ratio of feed, or feed + starch was about 20, no ammonium build up was detected and all excreted nitrogen was assimilated into microbial flocs, serving as feed source to the fish. An example of the effects of feed (and starch addition) is given in Figure 2.

Figure 2. Ammonium concentrations in ponds during a week with zero water exchange using different feeds. (30% Protein pellets, C/N = 10.8; 30%P + starch, C/N = 20.4; 23% Protein pellets, C/N = 14: 23% P + starch, C/N = 20.5).



Water exchange of ponds was stopped completely for a week. During this period, inorganic nitrogen (ammonia, nitrite and nitrate) rose in ponds getting feed addition of C/N ratio of 10.8 - 14 from 5 mg/l to about 20. There was practically no rise of inorganic nitrogen when starch was added and C/N ratio was about 20. All the excreted nitrogen in these ponds was recovered as organic nitrogen in the bio flocs.

Fingerlings survival in the end of the winter was excellent: 97% in the 100 g fingerlings and 80% in the 50 g fish. Fish condition as evaluated by measuring the condition factor was also excellent.

Conclusion

It was concluded that over-wintering of tilapia in plastic covered ponds with limited water exchange is feasible. Water quality is controlled by using bio floc technology. Aeration was not a problem since feeding in the winter is limited and oxygen solubility in the water is relatively high. most probably, fish density used in the present study, 16-20 kg/m^3 can be exceeded. Using this technology one can avoid the damage of cold temperatures during the winter and get healthy fish in the spring.

Aerated pond for over wintering of tilapia.

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Bio floc technology

Bio Floc Technology (BFT) is a relatively new biotechnology means to control water quality in fish and shrimp ponds, to minimize water exchange and environmental pollution, to recycle feed materials and reduce production costs. This is all in accordance with the requirement of developing sustainable and environmental friendly aquaculture.

Today, this technology has caught the attention of aquaculturists all over the world and many companies and farmers have started to use this technology. Presently it is being successfully applied in fishponds (mostly tilapia culture in the US and Israel) and in shrimp ponds (Belize, Indonesia etc).

A BFT working group, headed by Prof. Yoram Avnimelech was established 3 years ago by the Aquacultural Engineering Society. The group is operating a web page (http://floc.aesweb.org) and has organized specific sessions in different World Aquaculture and other conferences. In Busan, Korea during World Aquaculture 2008, the session on BFT covered the principles of BFT and some applications.

What is it and how to use it?

Yoram Avnimelech, Dept of Civil and Environmental Engineering Technion, Israel Inst of Technology said that bio floc technology ponds can be visualized as built-in bio-filters. As fish and shrimp ponds are their own ecosystems with a rich microbial community, these can be used to control water quality as well as fish and shrimp nutrition and health. The inorganic nitrogen added into ponds through feed can be assimilated by these microorganisms and converted into microbial protein through an adjustment of C:N ratio. Shrimp, tilapia and other species can harvest the microbial flocs and utilize the microbial protein, doubling the feed protein efficiency. In these ponds, the effect of C/N ratio can be predicted and the amounts of carbohydrates demand can be computed. Present experimental and commercial results indicate that bio floc technology ponds achieve high yields in environmentally and economic sustainable systems. (Related article: Using the pond itself as a biofilter: A review of theory and practice Volume 4 (2) March/April 2008).

Super intensive systems and organic certification

Craig L. Browdy and the team at Waddell Mariculture Center, South Carolina Department of Natural Resources have been focusing on how to grow SPF stocks of *Litopeneaus vannamei* in rich microbial biofloc greenhouse-based, zero-exchange raceways. The systems rely on fast growing high health animals from specific pathogen free stocks of shrimp, biosecure engineered systems to maintain water quality, dense high quality feeds developed holistically to maximize growth and contributions from microbial productivity while minimizing use of marine products for eventual consideration of certification under USDA Organic Agriculture standards. The technologies aim to reduce environmental impacts and allow commercial shrimp farms to be sited close to large population centres.

Recent research has focused on management of bioflocs within the systems. At densities exceeding 500 shrimp per metre, feed inputs are high necessitating the cropping of biofloc communities and external waste treatment to maximize mineralization and nitrogen utilization efficiencies. Toxic metabolites including ammonia and nitrite are initially controlled through the careful addition of supplemental carbon to sequester nitrogen in heterotrophic bacteria. Once the microbial community matures, the carbon additions are discontinued shifting control of ammonia and nitrite to chemoautotrophic nitrifiers. The cropping of microbial biomass allows greater light penetration, encouraging algal productivity. The challenge at present is to better define management strategies to encourage beneficial microbes while eliminating harmful elements. All of these strategies are designed to reduce the need for supplemental oxygen while assuring maximum growth and survivability. Competitiveness of these systems is enhanced by maximizing outputs per unit area while controlling variable costs.

Stimulation of bacterial communities

According to **Angelito O. Abaoag**, Bionovar International Pte Ltd, Singapore, the most widely used pond management system relies on algae culture to provide water stability and nutrients to the cultures. Unfortunately, this system is very hard to maintain due to many interconnecting

variables. In recent years, a new model in aquaculture is gaining ground and the emphasis of this is the stimulation of bacterial population in pond ecosystems to provide nutrient transformation, waste utilization through flocculation or 'bioflocs'. However, operational issues such as cost and functionality provide hindrances to its adaptation.

By using mixed bacterial cultures, he showed how these can stimulate, maintain and manages a 'beneficial' algal based flocculation during every stage of the culture of *Penaeus monodon* and *P. vannamei*. Different mixed cultures were used in the commercial trials, such as 'biosoil' for pond remediation and 'biogreen' in the water. Changes in floc density and size with time were monitored. Microbial and algal profile were also monitored through time. Performance data at two farms indicated a sustained production of large size shrimp; 70-100g for the black tiger shrimp and 35-40g for vannamei shrimp. Major interventions in terms of protocol, microbial application and floc development were required at day 72 for the black tiger shrimp ponds and at day 67 for the vannamei shrimp ponds. Successive intervention points were every 10-15 days.

Launch of an Asian Chapter of the BFT group

Sessions participants agreed to establish an Asian chapter of the BFT group. Yoram said that due to the fact that these activities did not take place in Asia, involvement of Asian members have been minimal. The goals and planned activities of the group are:

- To serve as a contact point to individuals and institutions interested in the development of the field.
- To facilitate dissemination of relevant information a must toward the implementation of BFT systems.
- To keep a periodical coverage of BFT related information in Asian technical journals.
- To initiate specific sessions in aquaculture related conferences held in Asia.
- To organize training courses, seminars and specific workshop in order to provide the needed information to students, technical officials and farmers.
- To bring the existence of the BFT group to the attention of governments, universities and other related institutions and to seek cooperation.
- To place all relevant information in the BFT web page: (http://floc.aaesweb.org).
- To distribute the membership list and their e mail addresses to assist professional contacts.
- To work toward formal sponsorship of the WAS and AES.

The organising committee comprise

- Yoram Avnimelech, Technion Israel Inst of Technology; email: agyoram@tx.technion.ac.il
- Qiufen Li, Yellow Sea Fisheries Research Inst, China; email: liqf@ysfri.ac.cn
- Angelito O. Aboag, Binovar International Ltd, Singapore; email: lito.aboag@binovar.com
- Anil Ghanekar, Ecosecure systems, India; email: anilghanekar@yahoo.com
- Yuan-Nan Chu, National Taiwan University, Taiwan; email: ynchu@ccms.ntu.edu.tw
- Nyan Taw, PT. Luxindo Internusa, Indonesia; email: Nyan.taw@global2solve.com; nyantaw@hotmail.com
- David Smith, CSIRO Australia; email: david.m.smith@csiro.au

The group welcomes individuals or institution interested to join this group. They can contact Yoram Avnimelech, email: agyoram@tx.technion.ac.il or Qiufen Li, email: liqf@ysfri.ac.cn

BPGs to mitigate impact from aquaculture in cage and pen culture

By Patrick White

A recently completed project in the Philippines built capacity in the central and local governments to try and reduce the impact of aquaculture on the environment by helping them to plan, manage, monitor and control aquaculture development. One for the first steps was to develop better practice guidelines for cage operators as a way to manage and operate responsible and sustainable production.

The environmental sustainability of aquaculture needs to address the actual and potential adverse environmental effects on resources used in aquaculture, in particular, water, fry and farmed stock. In addition it needs to address the adverse effects of increasing aquatic pollution and habitat degradation, certain types of aquaculture practices and production and the related consequences on supply of fish as an affordable food commodity.

Given the diversity in aquaculture and the sometimes different perceptions of "sustainability", more balanced and informed approaches are required to address developmental and environmental issues in different countries. At the same time as resolving the environmental issues, it is equally important to identify those solutions that are viable in the wider context of poverty alleviation and the need to ensure sustained supply of food, particularly in areas where resource-poor segments of rural and urban populations are facing food security problems.

One solution to sustainability is for farmers to follow Better Practice Guidelines (BPGs) for sustainable production. BPGs are developed for fish cage and pen operators with emphasis on mitigating environmental impact. These BPGs cover both cages and pens in marine, brackish and freshwaters. The guidelines cover the culture practice from the purchase of fry or fingerlings until the point of sale.

Developing 'Better Practice Guidelines'

BPGs aim to give farmers sensible and practical guidelines to follow in the planning, management and operation of their farms. These guidelines are based on lessons learned from local and international practice or scientific research. These are useful to improve our ways of working (knowledge, skills, capacity and practices).

We do not yet know the best way to produce fish but we can improve the way we do it based on lessons learned, knowledge and research. By describing and sharing this, we hope to provide guidelines toward a 'better-practice'.

These guidelines are being developed as good practice guidelines that if followed, would encourage responsible and sustainable production. They incorporate many of the DA-BAFPS BAPS but are focussed on particular culture systems and mitigating aquaculture impact on the environment.

It is hoped that these guidelines will be taken up by producer organisations, mariculture parks, aquaculture parks, clusters of farmers and large farmers. It would be difficult for a farmer to implement all guidelines immediately but it is hoped that the farmers will start to implement some immediately and gradually implement the others as time goes by.

Within each section there are cross linked issues that need to be addressed

- Legal and regulatory
- Genetics and biodiversity
- Biosecurity
- Sustainable operation
- Environment

Care has been taken to ensure that these BPGs do not adversely affect the poorer small-scale farmers.

BPGs at culture system level

Different BPGs should be developed depending on species, culture system and geographical location.

It is recommended that the following BPGs are also developed.

- Hatchery and nursery
- Cage and pen culture
- Pond culture
- Mollusc culture
- Seaweed culture
- Post harvest

The PHILMINAQ project "Mitigating impact from aquaculture in the Philippines" is a recently completed project funded by the European Union. It had three main tasks.

1. Capacity building of the Philippine regulatory and enforcement agency for responsible and sustainable aquaculture development.
   This was undertaken by training Central and local Government staff in aquaculture impacts, preparation of a guidebook of aquaculture planning for Local Government Units (LGUs), Better Management Practices for LGUs, and a joint Administrative Order to rationalise the management of aquaculture by the 3 key agencies.
2. Development of tools for the planning, management, monitoring and control of sustainable aquaculture development.
   This involved the development of models for identifying suitable aquaculture zones and models to estimate safe carrying capacity for cages in those zones. Development of 3 categories of environmental monitoring surveys. Development of a GIS database for the identification of suitable areas and potentially conflicting issues. **Development of Better Management Practice** for local government regulators and **Better Practice Guidelines** for fish cage operators.
3. Development of recommendations to reduce environmental impact of aquaculture.
   These included recommendations on feeding practice, improved feed quality, changes to water quality criteria for aquaculture waters, etc. The guidelines are available at this web site www.philminaq.eu

Environment

- Farms should be sited in harmony with the ecosystem (away from sensitive habitats) andsurroundings and not conflict with other users of the coastal area.
- Retain buffer zones and habitat corridors between farms and other users and habitats.
- Fish cages, floating or stationary, should be installed and kept at least one (1) meter between units with a maximum of 10 in a cluster and at 20 meters between clusters to provide water exchange.

Cages in Taal lake that need better special planning

Feed management

- Efficient feeding practices will improve feed conversion efficiency (reduce FCR) and economic returns
- Use feed-back feed monitoring systems to ensure that there is no feed wastage

Training of trainers for teaching cage operators to construct feeding trays to prevent over feeding.

Water quality

- Monitor water quality around cages and pens
- Monitor sediments close to cages and pens
- Evaluate if impact on the environment is getting worse

Demonstrating water quality monitoring close to the cages

Patrick White is senior aquaculture consultant at Akvaplan-niva Norway. He has been the leader of 2 large research projects in the Philippines on developing techniques for monitoring and modelling aquaculture impact and assisting the government to develop ways for sustainable aquaculture development. Email: patrick.white@wanadoo.fr

The IBK RAS

Dr Jo with rearing tanks in the foreground and floating plants over the biofilter chambers in the background.

Tilapia from the tanks. Picture courtesy of Dr In- Bae Kim.

There are three main constraints for a sustainable aquaculture in Korea; limited land area, high cost of land use and high cost of production. In 1979, Dr In-Bae Kim saw the need for a simple yet effective system of intensive culture. He then developed a laboratory scale prototype and went on to commercialise this by the mid 1980s. The system is being sought after to this day.

The Intensive Bio-production Korean system (IBK) was developed as a modular recirculation system for the culture of freshwater fish such as the Korean catfish *Silurus asotus*, common carp *Cyprinus carpio*, tilapia *Oreochromis niloticus*, etc. The laboratory scale system is located in Pukyong National University in Busan. There is a total of 16 circular cement rearing tanks, each with a water capacity of $4m^3$. There are smaller square concrete tanks each measuring 1.5 m x 1.5 m x 0.7 m (deep) and 20 glass aquariums, each holding 200 litres of water . These tanks and biofilter are covered in a 600 m^2 greenhouse. Temperature is maintained at 18 to 30°C. With the exception of reproduction to nursery stage, water temperature adjustment in the production units must be reconsidered because of skyrocketing fuel costs.

During the opening ceremony, Dr In- Bae Kim received an honorary life member award from the World Aquaculture Society recognising his contribution to aquaculture in Korea.

The main concrete tank is designed for a carrying capacity of 150kg/m^3 of water in case of tilapia. Each group of four tanks is linked to a sedimentation chamber. This was calculated on the basis that the volume of water with solid waste is small.

"This IBK system is not a highly sophisticated system but it is a simple and effective way to produce fish intensively", said Dr Kim, currently Professor Emeritus of Aquaculture at the University. "Due to space limitations and the concrete structures, we could not make massive modifications. After running the system, we realised that one sedimentation tank is now required for two rearing tanks. We made this modification in the commercial farms which have adopted this system. For example, their rearing tanks are larger at 5-6 m in diameter."

The rearing tanks have a dual draining system. Water containing faeces and waste feed is drawn out through a bottom drain, with a very small amount of water, to the sedimentation chamber. Decanted top water in the sedimentation tanks joins the main flow channel directed to the biofilter. These open channels drain to the pumping station. Water is pumped to several sections of the biological filter.

Dr Jae-Yoon Jo, Professor at the Department of Aquaculture explained that only one vertical single axial flow pump is used with a one metre head in this system. For larger units multiple numbers of small pumps are used instead of one large pump to reduce the risks involved with pump failure.

"This is an extremely efficient system. There is only a one metre head for it to pump water from the tank drains to the bio filtration chambers. The pump station is designed so as to act for aeration, foam fractionation, degassing of CO_2 in addition to water movement. At the time of heavy feeding the organic load can be very high and dissolved organic matter is effectively removed by foam fractionation at the pumping station."

"We now grow water hyacinth *Eichhornia crassipes*, Water lettuce *Pistia stratiotes*, and Brazilian pennywort *Hydrocotyle leucocephala* at the top of biofilter to inhibit the accumulation nutrients, such as nitrates, etc. These plants grow very fast absorbing waste nutrients in the water very effectively. The first two plants are floating and the last is rooted if attached to soil substrate. The plants also protect nitrifying bacteria growing on the filter substrates by blocking light penetration. Growth of phytoplankton is also avoided."

The exchange of recirculating water is once per hour in the biological filter whereas it is 2-3 times/hour in the rearing tanks. The amount of top up water is less than 10 m^3/day, which is 5% of total volume of water in the system.

Nitrification of ammonia to nitrite and to nitrate takes place by the nitrifying microbes growing on the surfaces of filter elements of corrugated roofing plates. In addition to nitrification, this biofilter traps suspended solids very effectively and the details for this mechanism were presented by Poster #31, World Aquaculture 2008, held in Busan, Korea May 20-23, 2008.

The system has been deployed in several farms, such as at the Docheon Tilapia Farm, located some 60 km west of Busan. The original shape of sedimentation chamber has been changed from circular to square type with only minor modifications. The farmer constructed the IBK system recirculating farm in the 1980s, in addition to flow-though system tanks. The shape of rearing tanks is cut-corner square, and the size is 3.8 m x 3.8 m for 20 tanks and 3.2 m x 3.2 m for 32 tanks. The present standing crop ranges from 700 kg to 1,000 kg of near-marketable size of tilapia. In Korea marketable sizes are 1 kg or larger.

Aside from the above species, Dr Kim has tried the rearing of the eel *Anguilla japonica* and *A. anguilla* in this recirculation system. Here the feeding of the eel was continuous by a hand-made controlled feeder. In 2006, some British farmers showed some interest in the IBK system for the culture of cold water marine species. To date, Dr Kim has tried with success the rearing of the olive flounder in this recirculation system at an experimental station.

Dr Kim and Dr Jo also developed an effective micro-bead biofilter which is very compact and simple in construction and operation, and very effective in nitrification. When the size of IBK system biofilter is somewhat reduced this micro-bead biofilter should help fortify nitrification. The University has patented this biological filtration system.

Seaweed biofiltration in small-scale recirculating system

This was a presentation by Lilik Teguh Pambudi and Jae-Yoon Jo, Pukyong National University. They studied the biofiltration performance of three species of seaweeds in a small-scale recirculating system with three different seaweeds as biofilters. In this experiment, 9 aquaria (23 L) for seaweed biofilter reactor (triplicates) and 1 aquarium (23 L) as a control were used. Two reservoirs (288 L and 500 L) and submersible pump also were used to maintain water recirculating system at a flow rate of 1.095 L/min. Artificial wastewater was used as nutrient source for seaweed and a peristaltic pump was controlled to supply it into the system. Ammonia loading rate on this system was 20 g TAN/m^3/d. The photoperiod was 12 h light:12 h dark and irradiance was 100 μmol photons/m^2/s. Treatment temperatures were 10°C and 15°C to represent winter season. Concentrations of ammonium, nitrate, nitrite and phosphate were determined between inlet and outlet on each aquarium daily. The experimental period was 15 days for each water temperature.

The results showed that nutrients concentration of effluents between control and all biofilter reactors are significantly different ($p<0.05$) except for nitrite. Accordingly, it can be stated that Enteromorpha compresa showed the better biofiltration performance than, *Ulva pertusa*, and *Sargassum piluliferum*. *E. compresa* is suggested as a prime candidate as biofilter to maintain mariculture ponds effluent or will be used in seawater recirculating system at 10°C and 15°C.

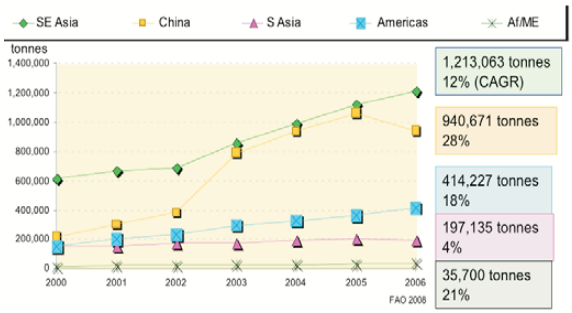
Farmed shrimp from Asia - Quo vadis

By Jacques Gabaudan

Studies on the global production and trade of farmed shrimp from Asia indicates that the future lies in markets in Europe.

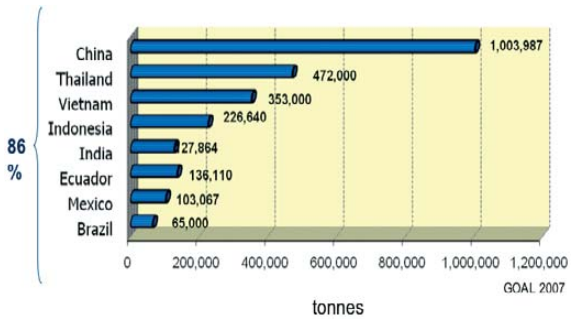
The global production of farmed shrimp, reached 2.8 million tonnes in 2006, tripling production in 1995. However, estimates showed a marginal decrease in 2007. In 2006, farmed shrimp production was nearly equal that of captured shrimp at 3,164,384 tonnes versus 3,460,003 tonnes for the latter, according to FAO statistics. The main contributors to production were SE Asia, followed by China, Americas and South Asia. However, between them, it has been China which has shown a tremendous growth from a mere 200,000 tonnes in 2000 to 940,671 tonnes in 2006.

Shrimp production from aquaculture by regions for 2000-2006



However, the estimates of production in 2007 (GOAL, 2007), showed a relatively slower growth of 4.2% to 2,917,158 tonnes. Countries in South East Asia dominated production at 43%, followed by China (34%), North and South America (15) and South Asia (7%).

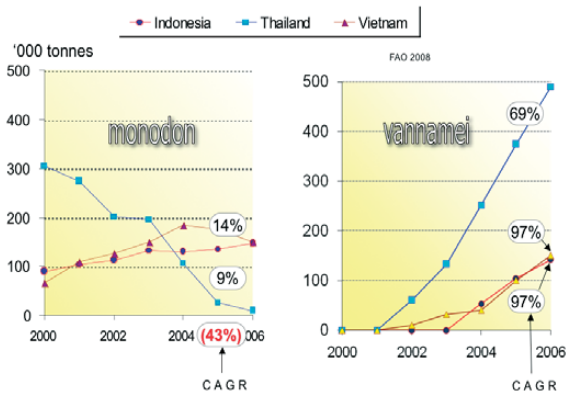
Shrimp production from aquaculture - Major producers in 2007e.



White shrimp versus black tiger

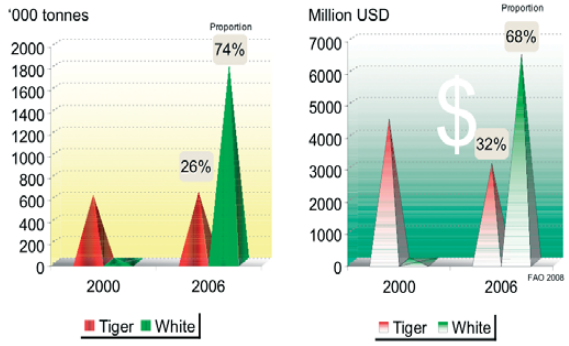
In 2007, it was apparent that the domino effect of white shrimp culture in Asia had reached its maximum potential. The CAGR of white shrimp for the years 2000-2006 was 56% but only 1% in the case of the black tiger shrimp. Globally, black tiger shrimp production was a mere 0.7 million tonnes in 2007, against 2.1 million tonnes in 2006. The evolution in the shift from monodon shrimp to vannamei shrimp for Thailand, Vietnam and Indonesia demonstrates the rapid change adopted by producers in these countries. The most significant change is in Thailand where monodon is now barely cultured. In Vietnam, the production of monodon shrimp is flattening although vannamei culture is increasing.

Evolution of the production of farmed shrimp in TH, VN and ID.



However, the proportion of value for vannamei and monodon in 2006 was 68 and 32%, respectively while the proportion of volume for vannamei produced was 74% compared to 26% for monodon shrimp. This reflects the lower price of the white shrimp and thus a loss of value for the industry.

Volume and value of black tiger and white shrimp in Asia

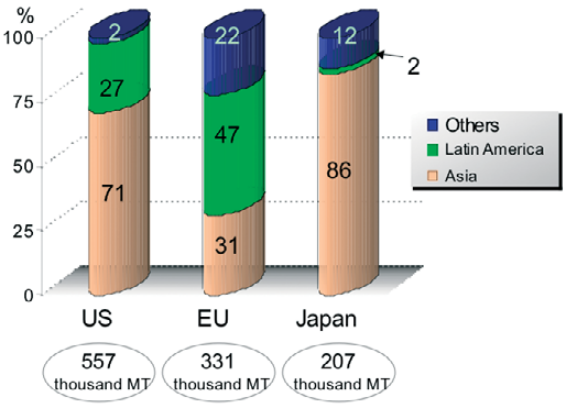


Global trade

Shrimp comprised 17% of the global trade in seafood in 2006, with 1.711 million tonnes of imports. In 2007, the volume was estimated at 1.671 million tonnes, a decrease of 2.3% of the volume in 2006. The significant changes are declining imports to markets in the USA and Japan whereas an increase was estimated for the EU. The pattern is clear as Asian producers dominate trade in frozen shrimp into the US and Japan at 71% and 86%, respectively in 2007. In the EU, 47% of the supply is from Latin American producers

In future, it is likely there will be changes in the pattern of trade because of changes in consumption. Demand indicators show that consumption has declined in Japan by 0.55% since 1995 whereas growth in consumption will be in the UK, Italy, France and marginally in Spain.

Frozen shrimp imports to the US, EU and Japan - 2007



Markets

US

Thailand was the top supplier at 33% of volume and USD 1.234 billion in value. Indonesia and Ecuador supplied 11%, respectively, although shrimp from Indonesia was valued at USD448 million as compared to USD308 million for Ecuador. The shrimp products into the US market were mainly shell-on at 43% which grew at a CAGR of 2.7%. Next was peeled at 32%. A remarkable growth was in the breaded shrimp which increased in volume by 52% since 2002. Breaded shrimp is not affected by the US antidumping duty issue.

The antidumping action on shrimp from Thailand, Vietnam, China, India, Ecuador and Brazil which was imposed in 2003 and is in fifth year, does not seem to have significantly affected imports. The CAGR of total imports was 2.5% for the period from 2003 to 2007 and total imports from the affected countries reduced by 1.2%. Imports from Thailand and Ecuador were apparently not affected whereas Brazil ceased to export to the USA.

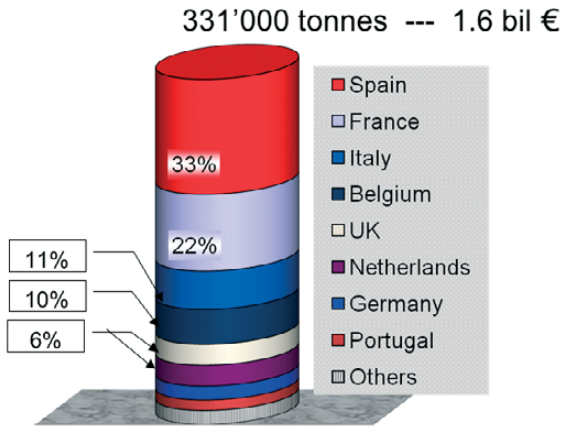
The purchasing preference for farmed shrimp in the US was influenced by country of origin>price> production method>refrigeration> size >product form. Brown et al (2007), said that the trends for monodon shrimp were limited supply and seasonal influx. Although imports of black tiger have decreased, there is still a strong market for this species. The vannamei shrimp however, has enough supply to meet demand but not for the larger sizes. However, the large supply resulted in a downward pressure on the markets in the first half of 2007.

EU

This is a large market with 490 million consumers with a high average per capita consumption of 24kg. The top importers are Spain, France, Italy, Germany and UK. However, consumption is characterised by its diversity. The seafood consumption in Portugal is 57 kg/caput whereas it is only 12 kg/caput in Spain to a low of 1.2 kg/caput in Germany. In Germany and France, seafood competes with animal products which has a per caput consumption of 90-92kg. In Europe, the concerns are on food safety and traceability.

Total shrimp imports totalled 330,000 tonnes valued at Euro 1.6 billion in 2007. Spain led with 33% of imports, followed by France, 22%, Italy, 11%, Belgium, 10% and UK, 6%. The exporting countries were Ecuador (18%) followed by India (8%) and Argentina (8%). Imports into Spain totalled 107,485 tonnes in 2007 and were mostly from Latin America (77%) and led by Argentina (capture fisheries). Asia only accounted for 6% of imports. Similarly, imports into France of 72,479 tonnes came from Latin America (44%) followed by Asia (22%) and these mainly came from India. Shrimp from Madagascar accounted for 12% of imports. The French hunger for shrimp was evident with an increase in volumes of 13.7% in 2007 as compared to 2006. However, the value declined as average prices declined from Euro 11.05/kg in 2006 to Euro 10.37/kg in 2007.

Shrimp imports into the EU-27: Top 8 importing countries - 2006.



Japan

Japan is showing a stagnating trend in seafood consumption. In 2007, the volume of imports was 276,000 tonnes which was 8% less than the volume in 2006. Japan imported 86% of its frozen shrimp in 2007 from Asia and in turn, the majority came from Vietnam (19%) and Indonesia (18%). For most countries, there has been a decline in volume of exports into Japan with the exception of Thailand which actually benefited when imports of value added shrimp from China stopped. The preference is still for monodon shrimp relative to vannamei shrimp but in 2004-2006, volumes of monodon shrimp declined 17% whilst volumes of vannamei shrimp rose 29%.

Conclusion

The shrimp market is characterized by its size and complexity, its large number of players, a relatively low level of integration and by disruptions due to antidumping cases and other trade barriers. In 2007, global shrimp trade fell behind 2006 with downward or stagnant trend for raw frozen and value added shrimp. Reduced exports from China appeared to have benefited principally Thailand. Interestingly, the cold water shrimp trade decreased at twice the pace of farmed shrimp. Demand remains strong. Europe is likely to continue to grow its imports of farmed shrimp in the years to come and China will most likely consume domestically a larger part of its production.

The article is part of the presentation "Global production and trade of farmed shrimp" at the P. monodon session of World Aquaculture 2008, 20-23 May, 2008, Busan Korea.

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Market potential for the giant freshwater prawn

By Shirlene Maria Anthonysamy

The giant Malaysian prawn *Macrobrachium rosenbergii* has its own niche market which remains to be tapped, in Malaysia and elsewhere.

The global production of the species was 274,000 tonnes in 2005. Aquaculture accounted for about 97% of this production. Though still small in volume, farming of the freshwater prawn is gaining popularity. This is evident from the rapid expansion in freshwater shrimp farming, in particular in Asia. The latest figure of 244 215 tonnes for production in 2006 indicated an increase by about 277% over the past ten years.

Asia is the production hub

Almost 98% of the global freshwater prawn production comes from aquaculture activities in Asia, namely China, India, Thailand, Bangladesh, Taiwan and Vietnam. However, accurate production data by species and country are yet to be reported. China is the largest producer of freshwater prawn with 132,000 tonnes in 2006. It also has the fastest growth rate of 257% for the period 1996 to 2006. Production was 37,000 tonnes in 1996. India ranks second with a production of 30,115 tonnes during 2006-2007. The bulk of production is exported as 'scampi'. During 2005-2006, India exported 6,191 tonnes.

In Thailand, production was 30,000 tonnes in 2005, up 203% from the year 2000 but down 8% from the previous year. There is a strong domestic market with a preference for larger sizes for the restaurant market. In 2006, exports of this species reached 8,094 tonnes but this dropped to 1,956 tonnes in 2007 due to increasing domestic demand.

Bangladesh is a big producer and consumer of the freshwater prawn with a total production of around 21,000 tonnes in 2006. Almost 60 to 80% of production is sold to processors while the rest is channeled to local markets as head-on fresh product. The larger wild caught varieties have a better demand because of its taste. The prawn is largely exported headless to the EU and the USA markets. The value added head-on and easy peel products are new introductions to the western markets.

The production of this prawn in Vietnam was previously classified under freshwater crustaceans in the FAO statistics and the volume totaled some 5,200 tonnes. Similar to Bangladesh, the domestic market for freshwater prawn is very significant and the preference is for larger sizes for barbeque and grilled recipes. Vietnam exports a substantial amount of head-on freshwater prawn to Germany and France for the Asian restaurants.

Export markets

The freshwater prawn from Asia is mainly exported to the US and Europe. The growing markets are in the Caribbean, Re-union Island and Middle East countries. Most of the freshwater prawn are marketed headless at sizes U/5, U/12, 13/20, 21/25, 26/30 pcs/lbs. A relatively smaller portion is sold head-on. The smaller sizes are also marketed as PUD (peeled undeveined) products. Most of the freshwater prawns are channeled to restaurants as headless product (tails) while the Asian restaurants require the head-on products. Easy to peel, barbequed style and marinated products are channeled to Europe and the USA.

The Malaysian domestic market

The production of freshwater prawn in Malaysia in 2005 totalled 485 tonnes, falling by 64% from its peak of 1,338 tonnes in the year 2000. Contrary to the increasing production trend from 1996 to 1999, supplies have been declining since 2000. Although production in Malaysia accounts for a very small percentage (0.3 %) of world freshwater prawn production, there is a good demand for this species in the domestic market.

Almost the entire production is consumed locally while only a small portion is exported live to restaurants in Singapore. Malaysia also imports fresh and frozen freshwater prawn from Myanmar and India. Hence, efforts should be concentrated on increasing domestic production as well as stimulating local demand.

In general, consumption of freshwater prawn is geared towards the middle to higher income group. A substantial amount of live prawn is channeled to seafood restaurants while the rest goes to retail markets (supermarkets and wet markets) as fresh products. Since 1996, prices of retail and wholesale prices of freshwater prawn have increased. Prices of live freshwater prawn in seafood restaurants can fetch as high as RM 140/kg (USD 44/kg) compared to RM30/kg (USD9.3/kg) for fresh product sold in supermarkets.

With quality improvement and promotional efforts, sales volume could be increased through the retail trade particularly supermarkets and hypermarkets. In addition, large and medium size head-on/claws-on freshwater prawn can be offered to retail consumers as tray packs at better prices.

In markets such as Hawaii, Jamaica and the Caribbean, the preference is for head-on products for barbequed and grilled shrimp recipes in holiday resorts. Most of the products are channeled to these markets via the USA. Since the head of freshwater shrimp makes more than 50% of the body weight of this animal, selling it as a live or head-on are the best options.

In the EU, the main markets are the UK, Germany, Belgium and France. In the UK, a large portion of headless products cater for the Asian consumers. Products into France are mostly head-on. Currently, the prices offered in the EU are higher than in the US market.

Domestic markets

Asia also consumes a significant amount of freshwater prawn. The species is marketed mainly as live or fresh product in the Far East. Seafood restaurants are the main users while those that are smaller and lower in quality are sold through retail outlets (wet markets and supermarkets). Demand for the freshwater prawn has been growing both in the domestic and international markets. With the depreciating US dollar, it has become more profitable to sell in the domestic market rather than export.

The article was presented at the Giant Macrobrachium Prawn 2008, Kuala Lumpur, Malaysia, 28-29 March 2008. A report on culture practices will appear in the next issue.

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Letter to the editor

Phospholipids, cholesterol and choline are among others essential additives for industrial crustacean feed. In this context, I refer to the contribution by Dr. Cruz-Suarez on ***'redefining the nutritional requirements of the white shrimp'*** in January/February issue (p 24).

Among others, the interaction between dietary phospholipids and cholesterol was reported. Unfortunately, it does not state the kind of phospholipids used in this experiment. The origin of phospholipids is very important for its degree of efficiency as reported by Kanazawa et al., 1985. In addition, there was no information on the fat content of the diet used. However, the higher the fat content, of the diet the higher the dietary phospholipids level has to be. And last but not least, the age and size of the animal is influence the dietary phospholipids requirement. Finally, it cannot to be overlooked that the interaction between dietary phospholipids and cholesterol in Kuruma shrimp *Marsupenaeus japonicus* which is very sensitive species to be cultured was already found in 1982 by Teshima et al. Due to the missing information, the proper interpretation of the reported experiment will be incomplete.

-De Joachim W. Hertrampf, Hamburg

Response by Elizabeth Cruz-Suarez and Denis Ricque, Monterrey, Mexico

We agree with the comments in the letter for the editor where he stated that details are missing. In fact this was an extract from a review presentation: New developments in the nutrition of *L. vannamei* in Latin America by L. Elizabeth Cruz-Suarez and Denis Ricque Marie, presented at 13th Aquaculture Conference Asia Pacific, DSM Nutritional Products, 23 November, Bangkok, Thailand.

Details for phospholipids studies and other topics treated in the extract are available at the proceedings of the international symposium on aquaculture nutrition held every two years in Mexico at http://w3.dsi.uanl.mx/publicaciones/maricultura/. Unfortunately the two first proceedings are not available in electronic format and most of the manuscripts are in Spanish. Nevertheless in the proceedings available there are at least 3 manuscripts of reviews on the phospholipids, cholesterol and lipid requirements on shrimp done by different authors at different years. They contain detailed information requested by Dr. Hertrampf and a complete reference list where the Japanese studies, mentioned by Dr. Hertrampf, have been cited as well as Dr. Hertrampf's own important review on the use of lecithin and phospholipids in aqua feeds.

And finally we would like to take the opportunity to announce that our IX International Symposium on Aquaculture Nutrition will be held at Ensenada, Baja California, Mexico, from 24 to 27 November 2008. For more information please visit this web page: www.sinaix.cicese.mx

World Aquaculture 2008

This year, the theme of the conference and trade show was "Aquaculture for Human Wellbeing- The Asian Perspective". It was planned that the conference located in Busan, Korea and held from 20-23 May will benefit the global aquaculture community as aquaculture in North Asia is very diverse and comprises both warm water and cold water finfish and crustaceans. Korea is also very strong in seaweed and shellfish aquaculture. The event attracted 2,300 conference and trade visitors from 75 countries.

At the opening ceremony, award winners and organisers

Aside from the usual technical technical sessions, additional ones included one on the culture of *Penaeus monodon* (see page 11) and on Korean Aquaculture. Several associations and feed companies in Korea were associate sponsors of WA2008. Below are reports on some selected presentations.

Shrimp culture management

Partial harvesting is a contemporary way to improve profitability in lieu of a single harvest said **Dr PingSun Leung** in his presentation on 'an optimal partial harvesting model for intensive shrimp culture'. Theoretically, partially harvesting the standing stock of cultured species over the grow-out cycle could reduce density and whereby to improve growth and survival.

"We need to consider the impact of the change in density resulting from partial harvesting on growth and survival and this is a more complicated decision than single batch harvesting. At the University of Hawaii, a soon to be released software will help the farmer make the right decisions on partial harvesting such as whether it is worthwhile to partially harvest the crop and how much to harvest for each target size category", said Dr Leung.

The team has extended the MS-excel spreadsheet developed earlier (Yu, Leung and Bienfang, 2007) into a decision-support system to demonstrate how farmer can take advantage of the density effects on growth and survival in the scheduling of harvests. Some basic assumptions in developing the model were made. These include that production cycle can be divided into several growout phases according to the target shrimp sizes; there is a linear relationship between density, growth and survival rate in each growout phase; and that feed is % of average biomass during a grow-out phase. Information can be stored and analysed so that the farmers will be able to compare with previous results and to maximise the net revenue for a single production cycle. The practical application of this model was tested with data from a commercial shrimp farm in Hawaii. In comparing cost/benefits of the alternative strategies, Dr Leung showed in an example that yields were higher at 16,825 lbs/acre for partial harvesting instead of 14,963 lbs/acre for single batch harvesting. The gain in net revenue was USD1,406. The various simulations demonstrate that the proposed model is robust in handling different managerial conditions and different managerial objectives and can be a useful management tool.

Title: An optimal partial harvesting model for intensive shrimp culture by Run Yu , PingSun Leung and Paul Bienfang, University of Hawaii at Manoa, USA.

Cages for the culture of rockfish, red seabream and black seabream for the the sea ranching project of Korean Ocean Research and Development Institute-KORDI. Dr Myuong Jung-Goo (centre) discussed the program with participants during the pre conference tour.

From Left: At the ASA Booth, Michael Cremer, Lukas Manomaitis, Hsiang Pin Lan and Catelina Valencia

Dr Dhanapong Sangsue (left) and Dr Preecha Ekatumasuit, Inteqc Feeds Co. Ltd, Thailand

Ng Siow Leng, Cargill Malaysia (left) with Dr Jae-Yoon Jo, Pukyong National University and wife.

Dr. Aneykutty Joseph, Dr. K.R. Salin, Dr CM Nair, Y.C.Thampi Sam Raj, India and Jeffrey Liu, Taiwan.

In China, wastewater discharged from intensive shrimp ponds are the cause of water pollution in coastal areas is a concern. A group from Hainan University, **Lai Qiuming**, **Yang Yi** and **Qiu Yunhao**, presented a simple purification system to improve water quality. A shrimp pond of 2,000 m^2 with 1.5m water depth and stocked with *Penaeus vannamei* at 200 pieces/m^2 was connected to a wastewater treatment unit consisting of a drum filtration tank and a foam separation tank. In the pond, there was a central drainage system from which pond wastewater flowed into the filtration tank passing through a 250 mesh filter, then pumped continuously at a rate of 100 m^3/hr to the foam separation tank which was installed with 4 sets of skimmers. Then the treated water flowed back to the shrimp pond.

A diagram showed the four sampling points to monitor dissolved oxygen, chemical oxygen demand, nitrite, nitrate and ammonia in the water for 5 days consecutively at 0700h. Results indicated that the shrimp feces and suspend organic particles were removed effectively from the filtration and foam separation tanks. It was concluded that The drum filtration reduced chemical oxygen demand by 1.88% - 4.57%, the foam separation reduced total ammonia nitrogen by 15.02% - 22.73% and increased dissolved oxygen by 39.3% - 60.6%. But the amounts of NO_3-N and NO_2-N were rarely removed by the process.

Title: Application of water purification technology in intensive shrimp culture by Lai Qiuming, Yang Yi and Qiu Yunhao, Hainan University, Hainan Province, China

Co culture of shrimp and tilapia

Under a CRSP funded program, researchers at the Asian Institute of Technology (AIT) in Thailand studied the effects of polyculture of tilapia *Oreochromis* spp and white shrimp *Litopenaeus vannamei*. In a previous study (Yang et al, 2000), there were mutual benefits with co culture of *Penaeus monodon* and the tilapia. Studies in Ecuador have established that shrimp yields increase with red tilapia which was deemed to have a probiotics effect in the pond. In their, presentation **Yuan Derun** and **Yang Yi** showed the effects on growth and survival of stocking shrimp with tilapia. They used 21 cement tanks (2 x 2.5 x 1 m) to stock shrimp postlarvae of 0.06 g at a density of 60 postlarvae/m^2. Two weeks later, red tilapia fingerlings of either small (13 g) or large (44 g) size were stocked into the shrimp tanks at the density of 0.4, 0.8, or 1.2 fish/m^2. Triplicate tanks with the monoculture of shrimp were used as the control. Commercial pellets were used to feed shrimp in treatment and control tanks. On the effects of co culture, they reported that increasing the stocking size and stocking density of tilapia negatively affected survival rate of shrimp. Shrimp yield was affected by tilapia stocking density. Feed conversion ratio for the shrimp feed increased with increasing density of tilapia.

Based on the monitoring of water quality parameters, the authors concluded that stocking tilapia into shrimp monoculture improved water quality and nutrient utilization and possibly the overall system production performances. However stocking large fish with high stocking density in early growth period of shrimp might negatively affect shrimp survival and growth. The experiment showed that a tilapia stocking density about 0.4 fish/m^2 of 12- 13 g might be suitable for such a polyculture system to ensure a superiority to shrimp monoculture in terms of economic performances and environmental concerns.

Title: Optimization of the stocking density and size of red tilapia in Intensive polyculture of white shrimp (Litopenaeus vannamei.) and red Tilapia (Oreochromis spp), Derun Yuan and Yang Yi, Asian Institute of Technology, Thailand.

Korean aquaculture

The challenges and prospects according to various presentations on the industry in Korea.

The Korean peninsula has the prerequisites for various types of aquaculture; a well developed tideland and tidal differences suitable for shellfish culture. The complex coastline with many islands and bays lends well for the culture of fish seaweed and shellfish. Accordingly, aquaculture production in Korea has continued on its upward trend to reach to 1,385,804 tonnes in 2007, said **Dr Jae-Hak Son**, Ministry of Food, Agriculture, Forestry and Fisheries, in his plenary presentation.

Production has focussed on four main areas. The culture of four main species of seaweed led with 792,553 tonnes in 2007 followed by shellfish at 478,646 tonnes and marine finfish production at 91,663 tonnes. Freshwater fish production totalled 15,373 tonnes comprising the eel, catfish, common carp and rainbow trout.

Oyster and abalone for export

The tidal flats and shallow seas with clean water have been utilised to develop a successful shellfish culture industry, said **Young-Je Park** and **Kwang-Sik Choi** of the West Sea Fishery Research Institute, Incheon and Jeju National University, respectively. The pacific oyster Crassostrea gigas at 321,276 tonnes in 2007,accounted for more half of annual shellfish production. The production is expected to increase. The new system of culture, set cage culture can produce 7-10cm of height with 70-150g of shell weight and 15-30g of meat weight in 12-20 months after settling. Production is in the export shellfish zone and the oyster has US FDA certification. Oyster exports are to 25 countries including the US, Japan, Canada and European Union.

Seock-Jung Han, Jeju Fisheries Research Institute said that abalone producers can have financial support from the government if they obtain certification from the government. Currently more than 10% of production is for export. He added that abalone culture technology is world standard but work on genetic diversity has just started. Development will need to be linked with the production of the kelp seaweed which the abalone feeds on.

Marine fish

The total production in 2007 comprise olive flounder *Paralichthys olivaceus* (41,171 tonnes), black rockfish *Sebastes schlegeli* (35,564 tonnes), mullet *Mugil cephalus* (4,921 tonnes) and red seabream *Pagrus major* (2,361 tonnes). The production of olive flounder showed an exponential increase from 20,000 tonnes in 2000 to 41,121 tonnes in 2007, whilst production from capture fisheries stabilised at 24,340 tonnes, according to Dr Jae. According to **Bu-Tak Shim** and **Hae-Young Lee** from the Korea Marine Fishculture Association and Aquafeed Research Center, respectively, the industry used 910,000 tonnes of trash fish and 62,207 tonnes of formulated feeds for land based tank and marine cage culture.

The culture of olive flounder is being threatened by bacterial pathogens, such as *Streptococcus iniae* and *S. parauberis* with mortalities of over 50% during the warm season, said **SB Park**, Gyeongsang National University. Cumulative mortality by VHSV -Viral hemorrhagic septicemia virus in the olive flounder is high at low temperature, said **Jin-Woong Kim** of Chonnam National University.

At the AquaInfo booth, KY Lee, Editor, HK Kim, Sung-Yoon Hong, In-Bae Kim, TK Chang, JJ Park and SI Kang.

Marine shrimp

Previously, the native species *Penaeus chinensis* (fleshy prawn) and *P. japonicus* were the main species but after the outbreak of white spot syndrome (WSSV), in 1993, the white shrimp *L. vannamei* was introduced, said **Jin-Ho Kim**, Pilkyong Fisheries Co and **In-Kwon Jang**, West Sea Mariculture Research Centre. Today, this species occupies 40% of production, the rest being the fleshy prawn. Ten shrimp hatcheries support with an annual production of 600 to 800 million post larvae (PL 8-12). These also produce larvae of the blue crab and finfish. The stocking season is from April to early June when temperatures rise to 15°C and harvesting season is from August to October. Stocking density is 25-35pcs/m^2.

Viral disease are HPV, BMN and WSSV. Korean scientists have developed technologies to control viral diseases such as specific IgY antibody against WSSV. SPF and HHS (high health shrimp) have been produced by NFRDI. The centre has also developed high density shrimp culture under limited water exchange.

Diseases and natural calamities

Dr Jae and several authors have attributed changes in production to a range of environmental problems, diseases and natural calamities. In the case of marine fish culture, increasing problems are from pollution of coastal areas, leading to eutrophication of these waters.

Disease occurrences have increased, attributed to bacterial infections leading to viral infections and high summer temperatures. The loss from disease was estimated to be USD 208 million.

Red tides and typhoons also cause considerable damage. The damage from typhoon Nari in 2007 was estimated to be USD 11 million. With shellfish culture, environmental degradation has led to poor natural spats. Korean scientists also discussed global warming and the changes in reproduction cycles and movement of bio resources but nevertheless concluded that production of shellfish will continue to increase as their producers have the competitive edge.

Abalone is cultured in coastal cages and fed with kelp. Picture is of 8 month old spats production at the Gyeongsangnam-do Marine Resources Research Institute.

Algal culture tanks at the Gyeongsangnam-do Marine Resources Research Institute.

Flounder at the wholesale market.

Directions for aquaculture development

By Mi-Seon Park

The role of aquaculture in Korea is not only to supply superior seafood to the domestic market but also to export good quality marine products. The focus on rock fish and seabream from the early 1990s had increased output but this was then challenged by imports from China and Japan when Korea opened its doors to imported marine products in 1997. This was followed by the liberalization of markets under WTO rules. With natural disasters and marine pollution, changes need to be made for a new aquaculture paradigm.

The industry in Korea has been nurtured through efforts to develop relevant technologies. However, little has been achieved in securing the industry's global competitiveness. The strengthening of the industry's competitiveness with up-to-date aquaculture technology and intensive investments is strategic for its future.

These issues and others have been taken up by the National Fisheries Research and Development Institute (NFRDI). These are aimed at developing environment-friendly technologies for the restoration and preservation of coastal ecosystems and the improvement of aquaculture productivity.

There are four major strategic projects to reduce aquaculture production costs. In addition, there is also the introduction of fish culture in the open sea, since 2005 to keep the coastal environment from deteriorating caused by the pollution. It is also to prevent aqua farms from damage caused by annually recurring typhoons and red tides. The industry needs to change from a small-scale household economy to a large-scale corporate one.

Quality extruded pellets

Farmers seem to avoid the use of extruded pellets because they believe it is not an efficient fish feed. This is in addition to the fact that they do not see the environmental damage brought about by the use of moist pellets. NFRDI has developed two types of extruded pellet for flounder (juvenile stage and adult stage), and one extruded pellet for rockfish (juvenile stage). These are being used in the industry.

The use of extruded pellets is now highly recommended because it prevents environmental pollution and overfishing of resources. The Korean government offers a direct-pay system for extruded pellets where it compensates fish farmers for the cost increment with the use of these pellets.

Fish vaccine development

The mortality rate of cultured finfish in Korea was 8.2% in 1996, but since then, this has increased every year to 16.8% in 2006. In the early 1990s, fish diseases were found to occur during warmer temperatures (above 20°C). Some 90% of infections were caused by single pathogens such as bacteria or parasites. However, in the late 1990s, diseases began to occur all year-round and some 30% of infections were complicated with more than two pathogens.

NFRDI has developed a Streptococcusis inactivated vaccine for flounder which has been transferred to two pharmaceutical companies. In addition, a Streptococcusis-Edwardsiellosis mixed inactivated bacterial vaccine was developed from flounder. A patent for the vaccine is pending. A recombinant vaccine for rock bream iridovirus was developed in 2005 and a patent for the vaccine was obtained in Korea in 2007. Future projects will be to industrialise the Streptococcusis-Edwardsiellosis mixed vaccine for flounder in 2008 and develop an RVID-Streptococcusis mixed vaccine for rock bream in 2009, a recombinant vaccine for flounder's viral nervous necrosis in 2009 and a triple multi-vaccine for Streptococcusis, Edwardsiellosis, and Vibriosis in flounder in 2010.

Genetic improvement for growth and disease resistance

The flounder has been cultured for more than 20 years but without R&D in breeding technology. Recent fish mortality caused by fish diseases and deformed farmed fish was presumed to be due to a lack of genetic diversity. While the culture of the flounder is sustainable with current stocks, industry may face a very grave situation in the near future.

A research project to develop stocks with attributes such as rapid growth and disease tolerance for the flounder and abalone species has begun since 2004. A mating scheme for family production has also been established and F1 was produced in 2005. A total of 287 families were produced, comprising a nucleus population that shows genetic diversity. In 2008, it is expected that the growth rate of flounder will be improved by 1.2 times.

Recirculated seawater systems

Water supply is a major cost in production. To resolve this, low cost and high efficient recirculating filter systems are being developed. Using the re-circulation system developed in 2005, flounder were cultured for 150 days. Based on results, average weight of cultured flounder in the recirculated system was 313.6 g, and it showed outstanding growth as compared to the cultured flounder in the raceway or running water system. The survival rate and feed coefficient in the recirculated systems were also better in comparison with other systems.

New challenges in offshore aquaculture

Industrialization of offshore aquaculture started with six offshore aquaculture cage sets in 2005 and 2006, under an agreement with NOAA, USA. The system was installed in areas 4.5 km away from the shore line of Jeju island. The economic efficiency was tenable in 2005 with a trial to farm 705,000 rock bream. In 2006, 1,200,000 rock bream were stocked to test the management of high density culture.

There was also the development of Korean-style in-closing nets in the open sea to rear tuna and yellowtail. For the continuous expansion of commercial scale offshore aquaculture system, fish species will have to be differentiated from the species cultured in the coastal areas by small family business fisherman. Thus, migratory fish species are highly recommended for offshore culture. These include species such as yellow croaker *Nibea japonica*, cobia *Rachycentorn canadum*, tuna *Thunnus thynnus* and striped jack, *Pseudocaranx dentex*.

Changing market trends

In Korea, most fish are consumed as sliced raw fish at restaurants and customers usually favour wild caught fish. To increase the consumption of farmed products, promotion activities are required to change the cosumers'perception. New demand can be created if packed fresh fish can be delivered to homes through cold chain logistics. Developing brands for marine products and introducing marketing concepts may be the way to expand marketing of products but a foremost prerequisite for this, is maintaining the freshness and safety of the products. Furthermore, in order to secure consumers' trust in the safety of aquacultural products, the traceability from farm to table should be emphasized.

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This article was extracted from 'The current state of aquaculture and the direction of its development in Korea', first published in AquaInfo Vol 2 No 5, pp 26-41.

Traceable tilapia

Trapia Malaysia Sdn Bhd was formed in December 2007 and is a subsidiary company of GenoMar ASA of Norway. The GenoMar group specializes in developing life science applications through technology driven sustainable development in order to meet and contribute to the increasing global food demand.

"Trapia" stands for "Traceable Tilapia", in reference to the unique Watermark™ DNA-based (non-GMO) traceability system utilized by the operation.

"The Verification of Origin System utilizes the GenoMar group's extensive experience in bioinformatics and breeding to create a new industrial standard in food safety. DNA profiles cannot be faked which means all Trapia products are 100% traceable and safer than any other seafood products available in the global marketplace today", said Richard Cook, Environmental Coordinator.

The Malaysia team comprises a dedicated team of expatriates and local Malaysians created to meet and solve the many logistical and operational challenges ahead. The concept is to create a fully vertically integrated operation in order to produce 40,000 tonnes of premium quality, sustainable, eco-friendly and safe seafood products by 2013. The operation requires that two thirds of the production is sourced from contract farmers operating under the Trapia Malaysia Contract Farming Scheme to further promote commerce and enhance livelihoods to the public sector.

Initial small-scale trials at Lake Temenggor, north Perak, Malaysia, has yielded excellent results with this fish displaying rapid and uniform growth.

"Trapia are found to have excellent taste, without muddy flavors or odours present, which can be seen as a result of the pristine rainforest-fed lake environment and effective husbandry practices applied. Microbiological, chemical and nutritional analysis of both the fish and the lake environment has also met with all of the required Food Safety Standards".

The dedicated and focused efforts by all involved in the GenoMar group have been rewarded with the company already entering the premium local markets of Malaysia. The recently Halal certified "Supply of Tilapia" has meant that "Royal Trapia" can now be purchased in 10

of the 14 Carrefour stores in Malaysia. Further expansion to all stores and entrance to the Carrefour Quality Line (CQL) is expected by the end of June 2008.

Presently, the team is in the process of setting up the first model farming unit to further define the production and logistical solutions required for the operation. This will also act as a demonstration and training component. The initial model will yield a production of 2,500 tonnes of raw product in 2009, delete primarily aimed at the expansion of the local market and development of the premium export market.

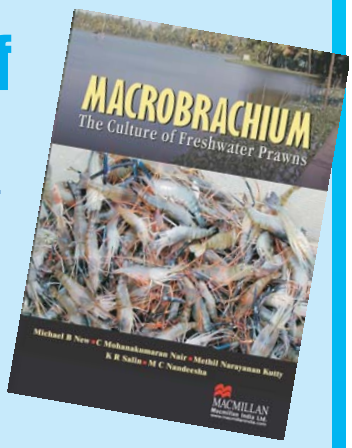
"There are many logistical challenges ahead still to overcome, although it is clear that the concept of producing a safe, nutritious and sustainable product is no longer a vision but fast becoming a reality for Trapia Malaysia", said Richard

More information: www.genomar.no; email: trapia.enquiry@gmail.com).

New Book release

Macrobrachium - The culture of freshwater prawns

By Michael New, C.M. Nair, M.N. Kutty, K.R. Salin and M.C. Nandeesha.
Publisher: Macmillan India Ltd.
Price: USD25, ISBN 10: 0230-63564-4; ISBN 13: 978-0230-63564-7



This is a new book on the farming of the freshwater prawn with special emphasis on the industry in India. According to the latest statistics (FAO Fishstat Plus, 2008), farmed production of all species of Macrobrachium reached nearly 444,000 tonnes in 2006, with a value exceeding USD 1.76 billion. In India, the annual production increased from 500 tonnes in 1996 to 43,000 tonnes in 2006. It is a large industry with nearly 6,200 tonnes exported from India alone with a value of USD 56 million.

Based on research and commercial experience over the past decade, the book highlights current practices in the freshwater prawn farming sector in India and also contains information on the current situation in some of the other leading producing countries. It is a valuable reference volume and practical manual for all concerned with freshwater prawns, especially academicians, farmers, policy makers and investors. The authors include Michael B New, with nearly 40 years of experience in aquaculture and who has contributed significantly to the global farming of the prawn. Dr C. Mohanakumaran Nair is Professor at the College of Fisheries, Kerala Agricultural University, Kochi, India with 27 years in aquaculture and is attributed with commercial culture of the prawn through hatchery production of seed stock. Dr Methil Narayanan Kutty was a former team leader and expert in various international organizations including FAO. Dr K.R. Salin is Assistant Professor at KVK Kottayam, Kerala Agricultural University and is an expert in seed production and farming of the freshwater prawn. Dr M.C. Nandeesha is Professor at the Department of Aquaculture, College of Fisheries, Central Agricultural University, Tripura, India. This book, priced at USD 25 plus P&P, is available from Dr. C. Mohanakumaran Nair (naircm@hotmail.com).

IAI
New additions to team

Integrated Aquaculture International (IAI) has announced the appointment of **Malcolm Smith** as Director of Breeding and Hatchery Operations. Mal, a professional aquaculturist with over 20 years experience in the industry began his aquaculture career at Seahatcheries Pty Ltd, where he helped develop technology for consistent spawning and larval production of barramundi. In 1992, he joined Seafarm Pty Ltd., and spearheaded the domestication program for *Penaeus merguiensis*. He was also instrumental in initiating domestication of *P. monodon* and has been a key figure in the Australian Domestication Program for the species. Mal will be located in Brunei Darussalam, overseeing selective breeding and hatchery production of specific pathogen free *P. monodon* and *P. stylirostris* in IAI's joint project with the Department of Fisheries of Brunei Darussalam. He will be responsible for managing quarantine, nucleus breeding, broodstock production, and hatchery facilities to produce large, fast growing *P. monodon*.

Thomas James has joined IAI as the Director of Pond Production. Tom started his professional career in aquaculture at Ecuadminsa, a fully integrated shrimp producer in Ecuador that operated a 1,600 ha farm. After twelve years of experience in pond management at the company, he moved to Granjas Ojai an agribusiness company with 1,000 ha of shrimp farms in Mexico. For 10 years, Tom was responsible for shrimp production operations in the company that involved extensive, semi-intensive and super-intensive production systems. His experience in managing intensive, aerated, and lined pond systems with probiotic cultures and bioflocs to produce head-on shrimp for premium market segments will be applied in managing the biosecure, intensive ponds in IAI's joint project with the Department of Fisheries of Brunei Darussalam. More information on IAI, www.integratedaquaculture.com

Biomin
COO for the Philippines

Christian Quimbo has joined Biomin Philippines on May 1, 2008 as Chief Operating Officer. He brings with him 20 years of hands-on experience in sales, distribution and business development in the Philippine feed industry, working for San Miguel Foods, Inc. Christian has managed aquatic feed sales (shrimp and fish) and animal feeds in Central Philippines, putting in place selling and distribution systems that have helped these businesses. He also handled the shrimp feed exports business of San Miguel Foods to India. He was also involved in understanding the regional markets of Vietnam and North China, assessing opportunities for investment and growth in the feed, livestock and food industries. He is a graduate in Agricultural Engineering from the Leyte State University (then Visayas State College of Agriculture) and hails from Cebu, Central Philippines. In his role with Biomin, Christian will work with distributors, business partners and the feed industry to maintain and grow Biomin's position in the Philippines.

Diamond V
Aquaculture business office in Bangkok

In May, the company celebrated the opening of its sixth office, located in Bangkok, Thailand and named it DV Asia. Diamond V is a supplier of fermentation metabolites and organic selenium headquartered in Cedar Rapids, Iowa, USA with 65 years of experience in the animal feed industry. The office will be headed by Dr. Brian Hunter, Director of Aquaculture Business and Technical Development and Manager of the Bangkok Office and Sulakkhana Pongthonpisut, Bangkok Office Resource Coordinator.

Dr. Mark Kujawa lighting a candle at the blessing ceremony

The office will serve as world headquarters for the aquaculture business and technical development, and regional headquarters for Diamond V's land animal business development. Other current offices are located in USA, China, EU, and Mexico. Distributors handle product sales in other countries. Products for aquaculture include DV Aqua, a unique fermentation metabolite product for fish and shrimp that promotes survival, disease resistance, non-specific immunity, growth, and feeding efficiency. SelenoSource is a highly bioavailable organic selenium source that contains a high level of seleno-methionine.

Part of the opening ceremony was a traditional blessing. In attendance were two top executives of Diamond V from the home office in Cedar Rapids, Iowa, USA. They were Dr. Mark Kujawa, Vice President of International Business Development, and Michael R. Goble, Vice-President of Operations. In addition, several managers from Diethelm Limited, Diamond V's Thai distributor were also present for the blessing, including Dr. Kitti Supchuken, Manager of Specialty Raw Materials for the Animal Care Industry, and Tavatchai Chidchomsrichantra, Aquaculture Products Manager for Specialty Raw Materials.

New contact details: Fifth Floor Pricha Building, 2533 Sukhumvit Road, Bangchack, Prakanong, Bangkok, 10260 Thailand, Tel: +662 730 3251, 730 3248 Fax: +662 332 8659 web: www.diamondv.com; email: bhunter@diamondv.com

From left, David Macdonald of Diethelm Limited, Dr. Mark Kujawa, Mike Goble, and Dr. Brian Hunter all of Diamond V.

Norel & Nature
Expansion in Asia Pacific

The company has opened its first representative office in Asia end June, with the purpose of strengthening its current business in the region and developing new activities. The new office is based in Singapore and Mathieu Cortyl, General Manager Asia Pacific is the first representative based in Asia and Pacific.

Mathieu Cortyl has been active in the feed business since 1991. He holds a Master of Science in Agronomy with a specialisation in Animal Nutrition. Prior to Norel & Nature Nutrition, he worked for different companies in the feed and feed additives industries, in Europe and Asia.

"The Asia and Pacific markets offer tremendous growth potential in our segment, and I am thrilled that this new position gives me the opportunity to provide their efficient and cost effective solutions to local and global customers."

Diana Pablos Velez, Business Development Director, said this decision is part of Norel & Nature Nutrition's willingness to strengthen its network on an international basis.

"Our new office will be primarily focused on offering technical support and is part of our worldwide effort to build up long term relationship with our customers. We are sure that Mathieu Cortyl's excellent knowledge of the feed industry at an international level, will help us to maximise business opportunities. His appointment and the opening of our Singapore office will allow our distributors and their customers to be in closer contact with us. We also will be better informed of market developments."

Based in Spain, the company operates in over 50 countries worldwide from 6 factories on 3 continents (Spain, Egypt and Mexico). Extensive research and development has kept the company at the forefront of the feed additive market with specific ranges of natural and nutritional products for swine, poultry and aquaculture markets.

More information: Email: mcortyl@norelynature.com

Vannamei 101

Technical service and training in vannamei shrimp culture

This decade has seen massive expansion of *Penaeus vannamei* culture in Asia, to a likely total of 1.7 million tonnes in 2008. This will be more than 80% of the global production of this species and more than 60% of the total world production of marine shrimp (of about 2.8 million tonnes).

Despite this rapid increase, techniques for culture of *P. vannamei* in all phases of its culture cycle are different from those used with *P. monodon*. One of the impediments to its further expansion in Asia is a lack of knowledge and understanding of these differences and the optimal management practices for their successful culture.

For this reason, a company registered in Phuket Thailand – Vannamei 101 was founded to offer a unique mixture of practical training, consultation, management and products to the Asian industry to assist development of the culture of *P. vannamei* in Asia.

Vannamei 101 was started in 2006 by David Kawahigashi and is the only company providing dedicated hatchery training and technology transfer as well as consultancy in Asia. The company provides hands-on training to hatchery managers and technicians in their joint venture Phuket, Thailand *P. vannamei* culture facilities. It has 2 broodstock multiplication centers, 3 maturation units, 25 larval rearing units, 1 algal culture laboratory, 1 PCR and disease diagnosis laboratory and a number of intensive pond farms, comprising close to 200 ponds.

David Kawahigashi

Matthew Briggs

The company's strength is with its technical directors and staff, with all of the Technical Directors having over 20 years of international commercial hatchery experience from both Latin America and Asia. The technical team includes: David Kawahigashi (USA), Dr. Matthew Briggs (UK), Gunnawit Ruchirawat (Thai), Khamron Waiyakruttha (Thai), Kelly Hegerle (USA), Alberto Bayas (Ecuador), Walter Briones (Ecuador), Chinh Pham (Vietnam) and Simon Loh (Malaysia). It also has >20 technical staff comprising experienced maturation, hatchery and grow-out technicians from Thailand and the Philippines working on various projects in the region.

Training Courses: The company offers hands-on training courses in most aspects of *P. vannamei* culture, in their dedicated commercial training facilities in Phuket Thailand. The courses include: Maturation (7-10days), Larviculture (7-10 days), Algae culture, microbiology and water quality (3 days), Disease diagnostics (1 day), and Intensive farm grow-out (7 days). They also offer customized training programmes. To date, it has received interest and trainees from companies from Malaysia, Vietnam, India, Japan, New Caledonia, America, Korea, and Kenya.

Consulting: This includes consultancy services on all aspects of *P. vannamei* culture worldwide and it has been involved in projects in Thailand, Malaysia, Iran, Indonesia, Philippines, China, Vietnam, Japan and New Caledonia.

Broodstock Development: Although the company does not provide training for breeding and broodstock multiplication programs, it does operate its own NBCs and BMCs with partners in Thailand. The broodstock produced at these facilities are 100% free of all Class I shrimp viral diseases and are certified by the Thai Department of Fisheries. Nauplius and post-larval *P. vannamei* are also available and can be shipped world-wide (depending on local regulations).

Results from grow-out ponds in Thailand using Vannamei 101 broodstock have shown >12%/year improvement in growth rates over the past four years. Target harvest size shrimp using its broodstock is 25 - 35 pcs/kg. Customer farms stocking 80-150 PL/m^2 are achieving 40 count/kg in four months and up to 28 count in 5.5-6 months (using partial harvests) for total productions of up to 35 mt/ha/cycle.

Joint Venture Projects: A number of JV operations are ongoing, especially in Vietnam (including some of the largest shrimp companies in Vietnam such as BIM Seafood, Minh Phu, and No. 1 hatchery) and Malaysia. The team has recently expanded into Iran, India and the Philippines.

Product testing: The company also conducts hatchery feeding trials for companies interested in testing their latest larviculture formulas as well as entering into the Asia shrimp industry market.

More information: www.vannamei101.com; email: mattbriggs101@gmail.com

Kiotech

Completes trials with Clarias catfish

Kiotech International has announced the successful completion of a seven-month trial of its Aquatice® attractant to enhance the rate of growth and feed conversion in catfish (Clarias sp.). The eight-pond trial was conducted in Southern Thailand. Treated ponds showed twice the number of large catfish, which command a premium price in the market and a significantly higher total yield and marked improvement in the feed conversion ratio compared with the control ponds.

During the last 18 months Kiotech has completed a series of successful trials to quantify the efficacy of Aquatice®. The catfish trial is the latest in this series. Further trials with additional species will be conducted, but the consistently good results already achieved now provide sufficient robust data to demonstrate the efficacy of this product and to allow positive steps toward the commercialisation of Aquatice® for these species. To achieve this objective Kiotech is in discussions with biotechnology companies for distribution of the product, especially for markets in South East Asia. In Vietnam, Kiotech has recently agreed to work with Bayer HealthCare.

More information: peter.scaramanga@scaracomms.co.uk

Review of the trade show at Busan

As the show returned to Asia, it was an opportunity for industry leaders in Taiwan and Korea as well as Asian offices of multinational companies to highlight their technology to the global aquaculture industry.

Some 11 companies from Taiwan participated under the umbrella of the **Taiwan Fish Breeding Association** (FBA, www.fish.org.tw). The association markets breeding and culture technology which Taiwanese farmers are several years ahead in comparison to their counterparts in the region. Among the companies at the show were **Hai Yu Enterprise** (www.ezone.com.tw/fish) and **GeneReach Technology**. The latter developed the semi quantitative IQ2000 PCR test kits and at the show demonstrated the newly developed i-screen WSSV (www.i-screen.com.tw) and TSV test kits. These will benefit farmers as not only is the cost extremely low in comparison to a PCR but the results can be available in three hours. Hai Yu, the first to manufacture larval feeds in Taiwan has continued to market this series of feeds. The latest development for the company according to Jeffrey Liu, is the production of organic kuruma shrimp *Penaeus japonicus* in Hainan, China and sold in Japan and Taiwan. It also produces mullet roe.

Gold sponsor **Uni-President** Enterprise (www.aquafeed.com.tw) introduced its new upstream activity of SPF *Penaeus vannamei* and *P. monodon* post larvae production at the new hatchery in Ninh Thuan in Vietnam (see page 10). The group is a major producer of fish and shrimp feeds in Asia. At its booth, it promoted feeds for the two species of marine shrimp, catfish and tilapia feeds manufactured in Vietnam and other feeds including aquarium fish feeds manufactured in Taiwan. The group which celebrated its 40th anniversary in 2007 is playing a larger role in industry with various sponsorship of conferences and industry activities, such as the forthcoming DAA7 Meeting organised by the Fish Health Section of the Asian Fisheries Society.

Korean company **Ahyun Aquadream Co Ltd** (ahyundream@naver.com) recently began to export its algal products to European countries (Belgium, Greece, Turkey etc). It is interested in the Asian markets and will enter the market through distributors. The products are Roticlo a concentrated liquid of freshwater chlorella which has 90% of the market in Korea since it was launched in the domestic market 7 years ago. Another product is *Dhachlo*, concentrated chorella with DHA. For marine hatcheries,

A new style of display for DSM's Aquaculture Centre Asia Pacific

From left, Bae Jong Chul, Shin- Kyung Jae and Baek, Seok Hoon, KOFEC

What to expect in AQUACulture Asia Pacific Magazine in 2008

Issue	January/ February	March/ April	May/ June	July/ August	September/ October	November/ December
Focus on current trends & challenges	Aqua Feed Production	Disease & Health Management	Food Safety	Sustainable Aquaculture	Organic Aquaculture	Cage Culture
Industry review	Marine shrimp	Marine fish	Catfish	Tilapia	Freshwater prawn	Hatchery
Features on success stories, best practices, new technology and developments						
Feed technology NEW	Enzymes & feed additives	Feed processing	Immuno-stimulants & Feed ingredients	Novel protein meals & amino acids	Nutrition & Formulation	Extrusion & Larval feeding
Technical	Culture technology	Recirculation technology	Product quality & markets	Biotechnology & diseases management	Pre & Pro-biotics	Health management/ Larval feeding
Shows	Victam & FIAAP Asia 2008	World Aquaculture 2008	Vietfish 2008	Australasian Aquaculture 2008	Indonesian Aquaculture 2008	Indaqua 2009

Mr Lee Chia-Ling, Director and Fenny Chen (second from right) with the Fish Breeding Association Taiwan (FBA) team

The Skretting team at the launch, from left, Philippe Dhert, Arjen Roem, Ng Hiang Chek, Eamonn O Brien, Yoshihito Ito, Tie Teck Lok and Kanae Watanabe

the product is *Seachlo*, a live green marine micro algae. Through partnerships with reliable manufacturers in USA and China, it will begin to market high quality GSL Artemia cysts as well as high quality Chinese artemia cysts, particularly to Asian countries.

Since 2007, the company has developed recirculation water modules for the high density hatchery and culture of several marine and freshwater fish species such as the sea bream and seabass. The modular design will accommodate any capacity and based on the requirements for water quality of the specific species, the company can customise systems. They have compared their recirculation systems with those already available in Europe. This system is compact, cost less and uses simple equipment. It uses only 10% of space occupied by a conventional farm with the same capacity. It is highly effective as there is high density of beneficial microorganisms in the cleaning media. These maintain a balance environment in the water tanks where the treatment of waste and water is ongoing. It is an easy and simple system with low maintenance. A patent is pending.

Jeju Marine Fish Culture Coop (www.jaf.co.kr) is an association of 268 producers all over Jeju island marketing quality flatfish of various species. The annual production capacity is 19,000 tonnes. Some 47 hatcheries support with a production of 21 million fry. Only fish which meet the standard specified by the cooperative is marketed. Those not meeting standards are used to produce fertiliser. **LG Life sciences** has Eltosil-fish (animalhealth@lgls.co.kr) which is a bovine somatotropin hormone to stimulate growth in fish and shortens the fish culture period by 1-2 months. Trials have showed higher CGR (comparative growth rate) for the rainbow trout, carp and flounder. **CJ Cheiljedang** has feeds for the flounder sea bream, bass, shrimp and trout. **Bowwow Aqua Feed Co.** has recently released a new type of soft pellets with 20% moisture. These have a shelf life of more than 6 months at room temperature. The pellets contained 47% protein in fingerlings diets and 45% in grow out diets for the rockfish. The company was founded in 2000. In AquaInfo, the Korean industry magazine, it was reported that the company tested the feed on rockfish and growth exceeded 80% of fish fed on raw fish and that feed conversion was 1.2:1.

A first for the industry in Korea is the vacuum packing or half vacuum packing after air removal of moist pellets (20% moisture) introduced by **Korean Feed Co** (**KOFEC**, www.ikofec.com), a new entrant to the aquafeed industry. The feeds have a shelf life of more than 6 months at a normal temperature of 30°C. The moist pellets are for the culture of the eel, seabass, sea bream and flounder and rock fish. In addition, it produces powder feed for the eel. Most of the feeds are marketed in the domestic market with small volumes of exports of eel feed to Fuzhou, China and Taiwan. The company is a market leader in eel feeds and the feed cost some 10% higher than equivalent brands from other companies. It also differentiates itself with a nano bio-fermentation process to produce 'herbal soft EP feed' which can provide enhanced immunity to fish. This uses microorganisms and includes local herbal products and fish meal with more than 75% crude protein.

At the **Skretting** booth, Eamonn O Brien and Philippe Dhert launched the new range Ori-go, culture and enrichment feeds for rotifers and artemia in marine hatcheries (see page 39, issue 2, Vol 4, March/April) for the Korean and Asian markets. Two products were launched, Ori Culture for live feed culture of rotifers and Ori Green, a live feed enrichment product (www.skrettingeurope.com). Both come as powders and have been designed with a wider range of particle sizes and shapes (0.2 to 20 microns) than traditional hatchery products to ensure an optimal live feed uptake. Ori Culture is based on a blend of natural algal proteins whilst Ori Green also contains a high level of HUFA. Main advantages of the products, according to Eamonn are the small amounts

Jan vanhoutte (right) and Wouter Van der Stichel (left), Sbae Industries and guest.

From left: Victor Suresh, IAI, Shery Kurian and Chris King, Alltech India and Hoon Lee, Korea

required and the tangible savings with the cleaner water, higher density culture and shorter enrichment process. The combination of Origo products and early weaning led to a 30% reduction in operational costs in large scale seabream tests (400,000 fry) in the Mediterranean.

The meal and oil from Antarctic krill produced by **Aker BioMarine** ASA made its debut. It is marketed as Qrill™ (www.qrill.no), (see page 41, issue 3, Vol 4, May/June). The company utilizes a unique and patented harvesting technology which prevents the krill from enzymatic degradation. As the harvesting of krill in the Antarctic region is governed by CCAMLR (Convention on the Conservation of Antarctic Marine Living Resources), this ensures the product is a sustainable resource. The oil is rich in marine phospholipids, a nutrient required in early life stages and for broodstock and is therefore recommended to boost enrichment of live food and to be included in starter- and brood stock feeds. Qrillô meal has strong palatability properties for both fish and shrimp and is therefore perfect during periods of stress in growth.

Also new to this series of trade shows is a **SBAE industries** (www.sbae-industries.com), a company established in 2006 in Belgium. It presented its unique solution for a more efficient and qualitative nutrition for fish and shrimp (see pages 34-35, issue 3, Vol 4, May/June). Some of the available micro-algal products for aquaculture include *Nannochloropsis, Isochrysis, Phaeodactylum, Tetraselmis, Thalassiosira, Chaetoceros* and *Skeletonema*. The international SBAE team, with over 20 years of experience in aquaculture and algae production, guarantees full cell integrity, leading to pure products, free of harmful organisms, with optimal fatty acids preservation. Ongoing tests in European hatcheries on production of rotifers and the use of green water technology, are showing significant positive results in larval survival, growth and health. Inclusion in pellets results in higher egg quality broodstock and adults. The products has fish, shrimp and mollusc applications.

At the show, **Ocean Spar**, US (www.OceanSpar.com) announced that it has the latest standard sea station version SS145 of submersible offshore fish pens with 14,500m^3 of culture capacity. The system is rated for operation with category 5 typhoon and has the new flip technology which will allow faster inversion of the fish pen. **Diamond V Mills**, USA has carried out several trials on the use of DV Aqua as feed additive in fish and shrimp. Brian Hunter from the newly established Asian Office in Bangkok (page 43) said that some trials have shown that DV Aqua supports good survival rates and feed efficiency in *P. vannamei*, Japanese flounder, catfish and tilapia. **Novus Aqua** (www.novusimt.com) offered products for nutrition and health to be used at the feed mill such as sources of methionine, organic calcium and organic acids.

At the Qrill (Aker BioMarine) booth, from left, Sjur Tveite, Gerry Mcguire, Chris McReynolds and Maja Bêvre-Jensen

Dr. Farshad Shishehchian (left) and Amornrat Boonchuay (middle) and Lim Huan Sein, AVA, Singapore (second from left) at the Novus Aqua booth

Training
Aquaculture Feed Extrusion, Nutrition and Feed Management

A one-week practical short course on Aquaculture Feed Extrusion, Nutrition And Feed Management will be presented on Sep. 28 - Oct. 3, 2008 at Texas A&M University by staff, industry representative and consultants.

This program will cover information on designing new feed mills and selecting conveying, drying, grinding, conditioning and feed mixing equipment. Current practices for preparing full-fat soy meal processing; recycling fisheries by-products, raw animal products, and secondary resources; raw material, extrusion of floating, sinking, and high fat feeds; spraying and coating fats, digests and preservatives; use of encapsulated ingredients and preparation of premixes, nutritional requirements of warn water fish and shrimp, feed managements and least cost formulation are reviewed.

Practical demonstration of sinking, floating, and high fat aquafeed, are demonstrated on four major types of extruders - (dry, interrupted flights, single and twin screw), using various shaping dies. Other demonstrations include: vacuum coating and lab analysis of the raw material for extrusion.

Reservations are accepted on a first-come basis. For more information, programs and application forms, contact: Dr. Mian N. Riaz, 2476 TAMU, Food Protein R&D Center, Texas A&M University, College Station, TX 77843-2476 Tel: +1 979/845-2774; Fax: +1 979/845-2744; Email: mnriaz@tamu.edu; Website: www.tamu.edu/extrusion

August 3-6
Australasian Aquaculture 2008
Brisbane, Australia
Email: sarahjane.day@aquaculture.org.au
Web: www.australian-aquaculturepportal.com

September 14-18
12th International Lupin Conference
Fremantle, Western Australia
Email: lupinconference@lupins.org
Web: www.lupins.org

September 15-18
Aquaculture Europe
Krakow, Poland
Email: mario.stael@scarlet.be
Web: www.easonline.org

September 28-October 3
15th Annual Practical Short Course on Aquaculture Feed Extrusion, Nutrition and Feed Management
Texas A& M, USA
Email: mnriaz@tamu.edu
Web: www.tamu.edu/extrusion

October 6-9
Aqua 2008
Guayaquil, Equador
Web: www.cna-ecuador.com
Email: ncely@cna-ecuador.com

October 12-14
8th International Symposium on Tilapia in Aquaculture
Cairo,Egypt
Web: http://ag.arizona.edu/azaqua/ista/ ISTA8/ISTA8.htm

October 23-25
Future Fish Eurasia 2008
Istanbul, Turkey
Web: www.future-fish.com
Email: mario.stael@eurasiafairs.com

November 4-6
13 Annual China Fisheries & Seafood Expo
Qingdao, China
Email: seafoodchina@seafare.com
Web: www.seafare.com

November 20-23
Aquafair Malaysia 2008
Kuala Lumpur, Malaysia
Web: www.aquafairmalaysia.com

November 24-26
IX International Symposium on Aquatic Nutrition
Ensenada, B.C. Mexico
Email: sinaix@cicese.mx

February 15-18, 2009
Aquaculture America 2009
Seattle, Washington
Email: worldaqua@aol.com
Web: www.was.org (IBC)

March 11-13, 2009
Aqua VIVAsia 2009
Bangkok, Thailand
Email:anneke.van.rooijen@vnuexhibitions.com;
Web: www.viv.net

May 25-29, 2009
World Aquaculture 2009
Veracruz, Mexico
Email: worldaqua@aol.com
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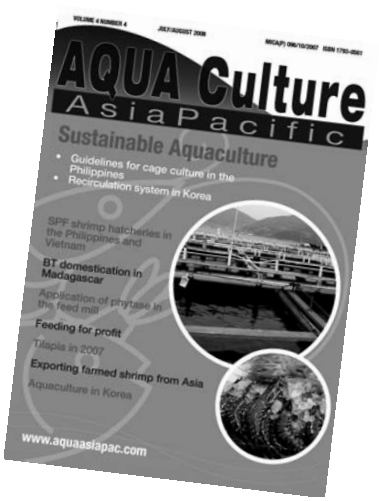

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