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AQUA CULTURE

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HEADQUARTERS - Gold Coin Holding Limited Sdn Bhd, Suite 9-6, Level 9, Wisma UOA Damansara II No.6 Jalan Changkat Semantan Damansara Heights 50490, Kuala Lumpur, Malaysia Tel: +603 2092 1999 Fax: +603 2092 1919 email: general@goldcoin-group.com

MALAYSIA (JOHOR) - Gold Coin Specialities Sdn Bhd/Gold Coin Biotechnologies Sdn Bhd, Tel: +607 237 0695 Fax: +607 236 1143 email: sp.koh@goldcoin-my.com

INDONESIA (NORTH SUMATRA) - P.T. Gold Coin Specialities Medan, Tel: +62 61 685 5127 Fax: +62 61 685 3452, email: p.zulkarnain@goldcoin-id.com

INDONESIA (WEST JAVA) - P.T. Gold Coin Indonesia, Specialities Division, Tel: +62 21 885 3668 Fax: 62 21 884 1947 email: p.zulkarnain@goldcoin-id.com

THAILAND (SONGKHLA) - Gold Coin Specialities (Thailand) Co Ltd, Tel: +66 74 483 600/5 Fax: +66 74 483 493 email: w.pradipat@goldcoin-th.com

INDIA JV - Godrej Gold Coin Aquafeed Ltd., 111a-135, IDA (Industrial Development Area), Kondapalli - 521228, Andhra Pradesh, India. Tel: +91 866 287 3071/73 Fax: +91 866 287 3066 email: viney.vatal@godrejagrovet.com



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Editor/Publisher

Zuridah Merican, PhD
Tel: +603 2096 2275 Fax: +603 2096 2276
Email: zuridah@aquaaasiapac.com

Editorial Coordination

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

Design and Layout

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

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

Editorial and advertising enquiries Request for reprints and articles

Email: zuridah@aquaaasiapac.com
Tel: +603 2096 2275 Fax: +603 2096 2276

Subscriptions

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From the editor

In 2010 - The Wish List

The beginning of the year is heralding in some good news. News reports say that global recovery in 2010 will ease the way for seafood exports. With better sales in the last quarter of 2009, both Thailand and Vietnam expect higher volumes of shrimp exports. Vietnam also expects to increase its pangasius exports to USD 1.2 billion/year.

Asia's two large integrators, Thai Union Frozen Products and Charoen Pokphand Foods Plc are bullish for 2010, with shrimp the main revenue earner. In February 2010 there will be the sunset review on the anti dumping duties imposed on shrimp exports to the US from China, Vietnam, India and Thailand. This will decide on whether the duties will remain or not. If removed, the benefits will, hopefully, translate to better prices for the farmer. In general, the outlook for 2010 seems positive.

However, 2009 was the year of falling prices and pessimistically, this can be expected to continue as production continues to rise. In 2009, Asia produced more than 2.8 million tonnes of shrimp versus 2.7 million tonnes in 2007. Tilapia production is also increasing. Demand in the US, the main consumer of aquaculture products from Asia, is not expected to increase in unison. As in any production industry, to compete, producers have to increase efficiency of production. They need predictability and the ability to manage health and diseases.

In 2010, our goal is to control diseases in fish and shrimp through biosecurity management. In livestock production, this is indispensable all along the production chain, even if vaccination is already a standard protocol. This was again emphasized at the Farmer's day session during the Asian Pacific Aquaculture 2009 conference. As we do not have the means to vaccinate against diseases, biosecurity management to prevent and control diseases is our only option.

In disease management, we have been focusing on SPF vannamei shrimp and automatically the next step is genetic selection for growth and disease resistance. In the case of the monodon shrimp, we can look forward to some developments with domestication. In India, the 3rd generation domesticated stock has been developed and is due to be commercialised in 2010. With new strains, we will soon need to unleash the full genetic potential by feeding a well balanced diet. This is the task of the feed manufacturers. According to nutritionist Dr Victor Suresh, "Once the constraints such as diseases and environmental stress are overcome, feed manufacturers should come forth and deliver feeds up to the desired performance standards".

Next on the list is meeting market demands. Changing the image that Asia can produce 'quality and clean' products is high on the list to create branding. In 2009, notifications on the RASFF for imports to the EU were too rampant and were mainly with nitrofurans residues in freshwater prawn and penaeid shrimp from India, Bangladesh and Sri Lanka. Other notifications were high levels of sulphite in shrimp and leucomalachite in fish. Korea which imports 86,435 tonnes of frozen shrimp found residues in shrimp from Taiwan, Japan, China, Saudi Arabia, Indonesia and Vietnam and imposed a 6 month ban. It has now lifted the ban for Thai imports, reported the Bangkok Post.

The sensitivity with how pangasius is produced in Vietnam creates uncertainty and significantly affects the margins of the small farmers. Thailand is leading this change after successfully registering 16,500 farms under its Good Aquaculture Practice and 320 farms under its Code of Conduct programs in 2009; it is now entering the next phase with new reforms which include social welfare and responsibility. However, there are countries in Asia still grasping with traceability from 'farm to fork'.

Our concern is not with integrators as traceability and certification is already part of the business. The worry is with Asia's small farmers as they face difficulties with compliance to standard practices, certification, market access and profitability. A push towards certification which incorporates food safety, control on the use of chemicals on farms and fish welfare will increase confidence in Asia, said Dan Fegan during the Tilapia session of the Farmers Day in Kuala Lumpur. It gives better access to markets and creates a level playing field. This requires government initiatives such as GAP and CoC, followed by industry derived standards such as the WWF tilapia, shrimp and pangasius standards.

This wish list is not exhaustive but provides food for thought for the industry.

AAP is entering its sixth year of publication. We will continue to share and update developments on aquaculture through its next phase of growth. We wish all our readers and stakeholders a 'HAPPY NEW YEAR' and a successful 2010.

Zuridah Merican

WRITE TO THE EDITOR

We want to hear from you. Write your comments on the industry to the editor.

Send by fax to Zuridah Merican at +603 2096 2276 or email: zuridah@aquasiapac.com

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Thailand's route during the downturn

Efficiency in production of white shrimp and presentation of composite products are driving the country's successful exports to the US and European Union, according to Dr Panisuan Jamnarnwej in Bangkok.

In September 2008, with the global economy in a downturn, the concern was that there would be effects on the Thai shrimp industry. This was the subject of a presentation by Dr Panisuan Jamnarnwej, President of the Thai Frozen Foods Association at the 15th DSM conference held in Bangkok in November 2009 (see pp 16). At the sidelines of this conference, Dr Panisuan donned his other hat as Managing Director of Thailand's largest seafood and ready-to-eat food processor and BEX listed Pakfood Plc, to give his views on how the industry in Thailand is managing itself out of the current downturn.

Recent reports indicated that Thailand increased by 3% its exports to the US to 73,367 tonnes, valued at USD 515.4 million for the first half of 2009. This was despite earlier predictions that shrimp exports will slow down with reduced demand in the US and EU as consumers lose jobs and homes, and move to cheaper seafood products. Within Thailand itself, estimates of production are now 520,000 tonnes in 2009, rising from 470,000 tonnes in 2008.

A different game from the crisis years after 1997

How the shrimp industry in Southeast Asia would cope with the reduced demand in the years from 2008 was often compared to how they exported themselves out of the Asian financial crisis in 1997. At that time, demand was high in the US and Europe but money was scarce in Asia. Back then, they faced the low value of the Thai Baht to the dollar but shrimp prices were high. Is the low dollar to Baht value today an obstacle to Thai shrimp exports? Dr Panisuan explains how this is now entirely different.

"In 1997 and the years before 2004, our margins for black tiger shrimp, which was our major production, were relatively high all along the supply chain. From the time we buy from the farmers, sell to the importer to when they are sold to the consumer, we calculated that all three had double digit profit margins. Now, overall in a good year, from the consumer to the farmer, we may manage a 10% profit margin which has to be divided three ways; farmer, processor and importer. The margin has become very slim. As a processor, we know that if we offer too low prices, farmers will not be supplying the shrimp. The importer needs to know how much the consumer is willing to pay".

"Before 1997, the dollar exchange rate was at THB 24-27 and then after 1997, it went up to THB 50. These were the few years when we enjoyed good margins in Baht terms. In dollar terms, it has remained the same."

"In 2006, when we were hit badly with the weak dollar, we tried several mechanisms such as hedging but we have eventually realised that it is efficiency of the farmers once we switched to farming the white shrimp. The size dispersion for the black tiger was very wide (possibly 8 sizes) and with this we would need to select and combine shrimp of a selected size range from many ponds to fill up one container. Now with the narrow size range in white shrimp farming, it has been easy to fill a container. A good farmer may have only 1-2 sizes. In my opinion, the genetic improvement of the shrimp has helped us too. If the efficiency had not gone up, the cost of shrimp production would be high; shrimp would not have been as affordable and popular as today and we will



not have such a large market. Efficiency from farm to processing is increasing too. This is how we have been able to compete".

Handling costs and prices

Since 2004, shrimp prices have been on a downward trend but costs of production including transport have been going up, mainly due to high oil prices. In November, the wholesale price for the mid range 70 pieces/kg white shrimp was THB 99.40/kg (USD 2.99/kg) and for the smaller 90/kg range, it was only THB 83.40 (USD 2.51/kg). How have farmers managed if they have been selling close or under costs of production?

"Farmers may sell below costs, once or twice at specific times but over the long term, they must be net positive otherwise, they will quit the business. The critical factor behind profitability is improvement in survival rate which is so much higher than for black tiger shrimp. In white shrimp, partial harvest has helped farmers increase stocking density. This allows them to cope with low prices, thin down the ponds, keep stock for another month and wait for higher prices. If the target is small size shrimp, the cost structure is entirely different and yields are better".

"In relation to current production costs, feed costs are high but feed millers have a clear cost structure and they cannot do much to reduce prices. Nowadays, the farmer knows that they can handle a price fluctuation of 10-15% provided that the feed is good and gives the growth performance that they are looking for. Of course, these have to be quality feeds and not too expensive".

Market positions and changing prices

The US and EU countries are the main markets for shrimp from Thailand and export volumes have not dropped. How does Thailand sustain these markets?

“In 2004, US antidumping duties were imposed on shrimp from Thailand and at the end of the same year we were hit by the tsunami. The EU then gave back to Thailand its GSP (Generalised System of Preferences) and with this we increased exports to 50,000 tonnes/year from only 3-4,000 tonnes/year when the GSP was removed. Our growth in the US market is only 1-5% per year but it has been phenomenal for the EU market. Next is that we have stabilised the market with composite products (those combined with other ingredients such as wanton shrimp). Exports are no longer limited to only head-on or headless shrimp. With composite products, farmers will know that they will be supplying a certain size shrimp for this market. We have managed to cope by evolving and to be competitive, we have become more efficient. Who knows, eventually, shrimp may be competing with chicken?”

Reducing production

In late 2008, the association asked producers to reduce production volumes by 20% to maintain prices. Apparently market forces overruled this as production has increased.

“As an association, we would like to influence industry. We had made an assessment of supply and demand and passed the information to farmers but it is entirely their decision to reduce production. We also know that we cannot dictate supply and control is through market forces. The best we can do is to provide a clear and accurate assessment of the market.”

“What is important is that if we have to allow for uncertainty, then we are less efficient and will not be able to compete”.

Room to grow in 2010

“Demand will be stable in 2010 and we may be able to manipulate this marginally by increasing or reducing the cost price. It is the supply side that we cannot fully control as this in turn depends on the weather, floods, temperature etc. Today, the advantage is that the turnaround time is only four months and if something adverse happens, prices may increase but four months later, will return to earlier levels. Only a freak year with abundant shrimp worldwide, will drive down prices, and in turn increase consumption. I believe that we will not get to the point where we have to throw away shrimp to stabilise prices. If we

look at the US, they consume 4lbs per person per year, there is still a lot of room to grow”.

Managing currency fluctuations

An ongoing debate is currency fluctuations and how to control margins and competitiveness.

“Our trade has been mainly in the US dollar but we may need to have a cut off point, that if the dollar becomes so weak, we will sell in Euro and Yen. There is talk to sell in the Chinese Yuan too, but only if there is opportunity for exchange rate or arbitrage. Japanese customers would like to shift between the Dollar and Yen as they calculate closely how much they can benefit with each currency. A stronger Yen against the US dollar means cheaper shrimp in Japan. Working in multi currency will reduce our risks”.

Effects of the removal of antidumping taxes

In 2004, the US Department of Commerce (DoC) imposed antidumping duties (AD) on shrimp from Thailand along with those from China, Vietnam and India in Asia. This remains in place although rates have been reduced over the years. Thailand is working to remove the AD but will demand for Thai shrimp increase subsequently and who will benefit from the removal of the AD?

“We need to get this settled and require an agreement from the whole industry: producers, importers, processors in the US and Thailand, the US DoC and Thai Ministry of Commerce. With the AD, there have been extra costs – the legal fees and financial burdens - that only benefited the lawyers and banks. The consumers have been absorbing the extra expenses. Without the AD, it will be easier to do business and we can either make shrimp more affordable to increase consumption or pass on higher profit to the shrimp farmers. Even with antidumping, we still sell at a profit and it has been the consumers paying more than they should have to. Without the AD, even if the demand improves, we will not be able to produce more because of limited farming area.”

“We have a clear understanding that the ex farm price to the farmers must be based on their cost plus sustainable profit. Any savings along the chain should contribute to a better margin down to the farmer level if the prices on the consumer side remain the same”.

Revised GAP with reforms in Thailand

A new version of Good Aquaculture Practice (GAP) has included shrimp welfare and social responsibility with a limit of 150,000 PL/rai.

The Fisheries Department (DOF) has drafted these into the GAP to raise the export standards and ensure shrimp meets the requirements demanded by buyers. This is also to upgrade the Thai shrimp export industry to keep ahead of her competitors, Indonesia and Vietnam. In the Bangkok Post, Director of DOF, Mr Pradit Chonchuenchob, said that issues of how to produce healthy shrimp with good welfare, environmentally sound culture methods and no employment of child or forced labour are some of the requests from buyers that Thai farmers will need to comply.

To reduce shrimp stress during culture, farmers will only be allowed to use not more than 150,000 PL/rai (94 PL/m²) to grow shrimp to 50-60 pcs/kg. For the larger size of 40-50 pcs/kg, the stocking density must be between 80,000 to 100,000 PL/rai (50-63 PL/m²) only. Among the 56 additional rules, are that farms must be equipped with appropriate

waste water treatment, no farming in mangrove areas and sites must be well irrigated. Currently, more than 17,000 shrimp farms comply with the Code of Conduct (CoC) and GAP. DOF will give three years for the farms to comply to these new rules as it expects that the smaller farms will need the time to change.

All these are part of the second strategic plan for the Thai shrimp industry in 2010 to 2012. The Department has targeted a 5% annual increase in production from 525,000 tonnes in 2010, 551,000 tonnes in 2011 and then 578,000 tonnes in 2012. Exports will expand only slightly as it will depend on demand. Export targets are 375,000 tonnes in 2010, 380,000 tonnes in 2011 and 390,000 tonnes in 2012. The plan also includes capping at 45% exports to a single market. Currently, the US market is the major market with nearly with 50% of exports.

News in Brief

More Pangasius from Vietnam by 2020

A Pangasius Production and Marketing Project in Mekong Delta will increase fish output to 2 million tonnes by 2020 from a maximum area of 13,000ha. The export volume will be 900,000 tonnes valued at USD 3 billion. The Ministry of Agriculture and Rural Development (MARD) will develop standards and tighten inspection over quality of fry, feeds, environment, hygiene and food safety. It will work with Vietnam Association of Seafood Exporters and Producers (VASEP) to manage fish quality and export prices. The aim is to enhance the competitiveness of Vietnam's pangasius industry and develop this into a key export industry. From January to mid November 2009, Pangasius exports were down 8.1% in volume and 10% in value, at 527,311 tonnes and USD 1.2 billion, respectively (Vietfish News, Dec 2009).

Salmonid farming in China

Canada based Agrimarine Holdings Inc, has built its first commercial farm near Shenyang, in southern Liaoning Province, to farm salmonids in China. The farm will use an entirely self-contained floating farming system, built by a Canadian R&D team and unveiled at the China Fisheries and Seafood Expo in November 2009. The first harvest of rainbow trout and salmon from this farm is expected in late summer 2010. In 2000, the British Columbian government contracted Agrimarine to solve fish escapes, disease and pollution problems common to traditional net cage farms. It developed a self-contained package that includes 10 tanks, each 79 feet (24m) in diameter and 20 feet (6m) deep. The AgriMarine system reduces local nutrient pollution of the water systems through the capture of waste feed and faeces. The company plans to install 4 more systems for salmon in cold-water regions and for yellow fin tuna in warmer waters.

Funding for Singapore farms

Singapore's Agri-Food and Veterinary Authority (AVA) has set aside SGD 5 million (USD 3.57 million) for a Food Fund to encourage local farms to use new technology to produce more quality products. The fund is for R&D and upgrade farming technologies in rice, chicken pork, fish, eggs and leafy vegetable production. The aim in the fish sector is to increase local production to 15% from 4% of demand. In 2008, 106 coastal farms produced 3,235 tonnes of marine fish. Singapore's largest commercial fish farm, Barramundi Asia is considering applying for funding to improve technology, according to the report in Asiaone business. Currently, the annual production is 500 tonnes of barramundi from a 7.2 ha farm and by 2012, the target is 3,000 tonnes. AVA said that with another 4 such farms, the fish supply will meet its target.

Concerns on residues in Indian shrimp

Following a biennial audit visit of Indian seafood testing laboratories, the Food and Veterinary Office (FVO) of the European Commission

was not satisfied with India's residue monitoring system. "Exports of farmed shrimp to the European Union (EU) are under threat", said Anwar Hashim, National president of Seafood Exporters Association of India (SEAI) in the Financial Express. "More than 50% of farmed shrimp exports from India go to EU countries and a ban would seriously disrupt aquaculture farms". The FVO report said that the Indian system of residue monitoring was ineffective and that the concerns raised by previous audit teams (2003 and 2006) were not addressed by the authorities. A ban might be imposed if the authorities fail to give a guarantee on issues raised by FVO. Many importers are now insisting that the Export Inspection Council of India (EIC) provide antibiotic-free and health certificates with every shrimp shipment.

Bangladesh to regulate fish and animal feed

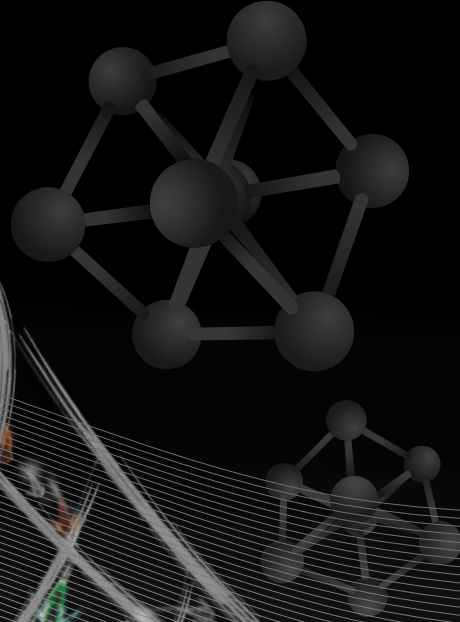
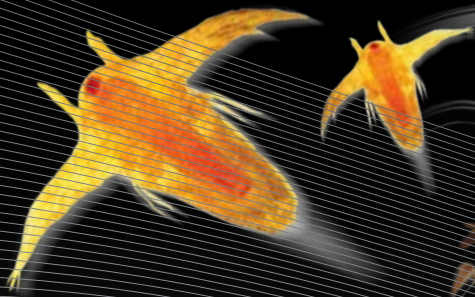
In 2008, the EU sent back consignments containing nitrofurans in fresh water prawn and shrimp. The government then imposed a voluntary ban on the shipment of prawns and shrimp in June 2009. A Bangladesh Quality Support Programme (BQST) study revealed that 11 out of 36 shrimp feeds, 10 out of 29 fish feeds, eight out of 23 poultry feeds and nine out of 72 feed ingredients were contaminated with nitrofurans metabolites and chloramphenicol. Feed ingredients such as protein concentrate and oil cakes were found to have been contaminated with harmful metabolites and chloramphenicol. Presently, local feed manufacturers and suppliers are not registered and they require no licenses. A fish and animal feed law to regulate fish and animal feed manufacturers in Bangladesh is expected to be passed in the current session of parliament. It is expected that imported feed ingredients such as protein concentrates, meat and bone meal, dried shrimp and oil cake would be free from banned antibiotics after the enforcement of the law.

Thai group asks for common shrimp export standards

Amidst growing concerns on the varying criteria used by Thailand's major shrimp export markets, the President of the Thai Shrimp Association (TSA), Somsak Paneetayasai has urged the government to enter into negotiations with other major world importers to set down a general system of standards for Thai shrimp. This is a cause for the rise in production costs. In Thailand, farmers follow 'Good Agricultural Practices' to ensure their products meet international standards on food safety and other issues such as levels of antibiotic residues. He added that the European Union now uses the 'Global Gap' criteria on shrimp imports and Australia has its 'Import Risk Analysis' to test shrimp imports. The US giant retailer Wal-Mart requires exporters to provide official recognition from its 'Aquaculture Certification Council' before exporting their shrimp to the US market. The value of the expected shrimp exports of 380,000 tonnes in 2009 will be USD2.8 billion.

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Marine shrimp in Asia in 2009: Production trends

An overall increase in production in Asia despite diseases, low ex farm prices and credit crunch.

Estimates of farmed shrimp production in 2009 totalled 2.83 million tonnes. In 2007, published figures showed that the global farmed shrimp production in 2007 was 3.19 million tonnes and Asia contributed 2.74 million tonnes. Below are some production trends in 2009 for main producing countries and a preliminary outlook for 2010.

China

In 2007 and 2008, China produced 1.22 million tonnes, comprising 88% of vannamei shrimp and 52% of this vannamei shrimp production was from inland waters. In 2009, the estimate was 1.20 million tonnes of vannamei shrimp. Dr Chen Ming Dang, Charoen Pokphand Foods Ltd, Thailand estimated 560,000 tonnes from coastal ponds. Another 100,000 tonnes comprised monodon and other penaeid shrimp. The average productivity of *P. vannamei* shrimp is now 8-10 tonnes/ha/crop in Guangdong from stocking 120-180 PL/m², said Jeff, Jie-Cheng Chuang, Zhongshan President Enterprises Co., Ltd, China. More production is expected in 2010 as China's Ministry of Agriculture said that it will increase shrimp culture areas by 20% in 2010. The estimate of total shrimp production in 2010 is 1.45 million tonnes.

Thailand

The production estimates for Thailand in 2009 ranged from 520,000-537,000 tonnes. Chen said, "Yields are high at 11.5 to 12 tonnes/ha at stocking densities of 80-85 PL/m². With biosecurity measures in place and use of disease free stocks, incidences of diseases have been reduced. We are constantly fine tuning culture management under the turbo shrimp program which uses fast growing post larvae. Better FCR is reducing costs of production but more importantly, the environmentally friendly approach is leading to more sustainable culture practices".

Thailand's DOF has announced a strategic plan for 2010 to 2012 and among these are new regulations covering social and shrimp welfare and a 5% annual increase in production to 525,000 tonnes in 2010. (see page 5).

Vietnam

The decline in production of the monodon shrimp, estimated at 40%, which began in late 2008 continued into 2009. Farmers stopped culture because of low prices, diseases as well as lack of capital. The stocking density was reduced to 10-20 PL/m² in the second crop in July/August 2009 from 10-30 PL/m² in the first crop, said Wu Ming Hsun, Uni President Vietnam. It was reported that short supply led to processors increasing prices by 20% to VND150,000/kg (USD 8/kg) for 20 pcs/kg and VND90,000 (USD 4.87/kg) for 40pcs/kg. Vannamei shrimp production in the north and central region continued as usual. In third quarter of 2009, farmers were stocking 100-130 PL/m² with a production of 8-12 tonnes/ha/crop.

Indonesia

Production in Indonesia was dragged down by a 40% loss in production in Lampung in mid year. The industry estimate was only 345,000 tonnes. In 2010, with the recovery from diseases in Lampung, Medan and East Java, production will increase to 265,000 tonnes of vannamei shrimp and 120,000 tonnes of monodon shrimp. The latter will be through the injection of funds to revitalise abandoned ponds in South Sulawesi. The target is a 10.42% annual increase in monodon shrimp production using extensive polyculture systems. Production averages 6-9 tonnes /ha/crop at 120 PL/m² for vannamei shrimp and 1.5-2.0 tonnes/ha/crop for 10-20 PL/m² of monodon shrimp.

Malaysia

Production in Malaysia was expected to rise to 85,000 tonnes in 2009. Another estimate was 78,000 tonnes with only 6,000 tonnes of monodon

shrimp (Chen, pers comm.). Average productivity of vannamei shrimp is 8-10 tonnes/ha with 80-120 PL/m². A return to monodon shrimp is planned using imported post larvae produced from SPF brood stock (see page 38).

India

Industry in India was pessimistic on the production in 2008 at 70,000 tonnes. In 2009, it was 80,000 tonnes. However, an optimistic estimate was 95,000 tonnes in 2009 (Chen, pers comm). Only 5,000 tonnes of vannamei shrimp was estimated, although the Coastal Aquaculture Authority has given import permits to 24 hatcheries (Fishing Chimes, Sept, 2009). The lower production was because of reductions in farming areas, stocking density (5-10 PL/m²), and number of crops as well as crops failures due mainly to WSSV. In Andhra Pradesh, the major shrimp farming state, shrimp ponds have been abandoned but activity may resume in future with post larvae from SPF brood stock of both vannamei and monodon shrimp, said S. Chandrasekar, Inve Aquaculture.

"In 2010, any increase in monodon shrimp production will depend on the availability of post larvae from SPF brood stock developed in Hawaii. However, we are optimistic that production of the vannamei shrimp can easily increase to 8,000 tonnes. A target up to 2012 would be 160,000 tonnes of marine shrimp, comprising monodon and vannamei shrimp in equal ratios".

Philippines

Only 35,000 tonnes of shrimp was expected in 2009 down from 54,000 tonnes in 2008. This will increase marginally to 37,000 tonnes in 2010 but with more vannamei shrimp. In December 2009, the Bureau of Fisheries and Aquatic Resources (BFAR) lifted an 8 year old ban on the importation of brood stock and postlarvae of monodon shrimp. BFAR wants the Philippines to be in the niche export market for locally grown monodon shrimp (Business Online). The monodon shrimp is sold at PHP 800 (USD 17.16) in comparison to PHP 200-250/kg (USD 4.29-5.36) for the vannamei shrimp.

References are available on request.

Table 1. Production trends for marine shrimp in Asia in 2007-2009 and outlook for 2010.

Country	Total in 2007 a	Total 2008b	2009b		Outlook in 2010	
			<i>P. vannamei</i>	<i>P. monodon</i>	<i>P. vannamei</i>	<i>P. monodon</i>
China	1,219,475	1,213,937	1,200,000	150,000c	1,350,000	100,000c
Thailand	501,100	494,000	537,000	3,000	522,000	3,000
Viet Nam	376,700	388,359	307,713	71,008	165,000	65,000
Indonesia	330,074	276,000	230,000	115,000	265,000	12,0000
Malaysia	35,173	51,047	72,000	6,000	75,000	5,500
India	107,665	70,000	5,000	80,000	8,000	80,000
Philippines	42,655	54,000	9,000	26,000	12,000	25,000
Bangladesh	63,600	64,000	-	71,000	-	-
Others	63,187	-	-	-	-	-
Total Asia	2,739,629	2,611,343	2,306,713	522,008	2,397,000	398,500
<i>P.vannamei</i>	1,719,237	1,956,915				
Latin America	453,199	454,000	500,000d			
Global total	3,192,828	3,065,343	2,806,713			

a Published production figures in 2007 (Fishstat Plus, 2009) and includes all marine farmed species. China data is from China Fishery Year book. Malaysia data, DOF; Philippines data, Bureau of Agricultural Research

b Estimates of production from industry in Indonesia, Office of General Statistics, Vietnam, Vietfish News, Jan 2010, Jeff, Jie-Cheng Chuang, Zhongshan President Enterprises Co., Ltd, China, Chen, M-D, CPF, Thailand and S. Chandrasekar, Inve Aquaculture, India based on a review presented to the All India Shrimp Hatchery Association.

c in China, includes *P. monodon*, *P. chinensis* and *P. japonicus*

d Andersen (2009)

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Retailing large black tigers

Better prospects with a change in focus to marketing only large size shrimp to the food service sector on Langkawi Island. By Zuridah Merican

In 2000, when the government was encouraging young entrepreneurs into shrimp farming, Mr Hashnoel Murshim, then 32, leased a 104 ha site with 10 abandoned shrimp ponds in Bukit Malut, 5 km from Kuah town. The farm is on the east coast of Langkawi Island, Peninsula Malaysia. The plan was to tap the food service sector in Langkawi which was fast becoming a major tourist destination. The luxury hotels on the island would be niche markets for larger size shrimp such as those of 50g and above.

After a massive renovation of the ponds, Hashnoel began operations in 2002 and created controversy with a successful harvest in 2003 of vannamei shrimp using culture technology from Taiwan and Thailand. At that time, farming of the vannamei shrimp was banned in Malaysia. The stocking density was 100 post larvae/m². In the original design, seawater with a salinity ranging from 28 to 32ppt was channelled directly into an inlet channel to supply all ponds. Freshwater was piped in to reduce salinity but with the prohibitive cost of freshwater, only seawater is now used.

“The survival rates were good at 80-90% and I was selling to several supermarkets on the mainland. Then in 2005, we were hit badly by the white spot syndrome virus. It devastated the company as shrimp were nearly ready for harvest. Ponds were then thoroughly cleaned and soil removed. For refinancing, I sought the help of my family who each

funded operations in one or several ponds and we restarted with both black tiger and vannamei shrimp”.

The company, Sumber Nadi Alam Sdn Bhd, Langkawi (SNA) now operates 40 ponds on the island and is expanding to a total of 60 ponds. On the mainland, through Langkawi Shrimpz Sdn Bhd, it has also begun construction of 31 ponds of a 65 pond farm in Jerlun, Kedah. Operations will start in early 2010. The company also has ponds in Thailand. The production target is 7 tonnes/ha/crop of the vannamei shrimp and 4.5 to 6 tonnes/ha/crop of the black tiger shrimp. The target annual production in the two locations in Malaysia will be 1,200 tonnes/year. In future, the seawater ponds will be also used to culture tilapia, milkfish, sea bass and tiger grouper.

Large black tigers

“Here on the island, I am focussing on the culture of only black tiger shrimp and only large sized ones of more than 50g. The annual production is between 160 to 200 tonnes. The hotels prefer the large shrimp which they likened to sea caught shrimp. We get extremely good prices for our shrimp as we sell direct to the hotel outlets which in turn sell cooked on a per 100g basis.” said Hashnoel.

At such low density of 8 post larvae/m², culture is deemed as extensive and ponds use only 4 short arm paddlewheels. Shrimp are fed the Supreme brand of monodon shrimp feeds from local company, Gold Coin containing 42-39% crude protein. Post larvae are sourced from various hatcheries on the mainland. Probiotics are used for pond remediation and aside from this, the use of chemicals such as lime is avoided. As the production protocol is almost natural, the next step for the farm will be to look at branding the shrimp as ‘natural and environmentally friendly’.

In 2010, the farm will start to use post larvae produced from the specific pathogen free (SPF) brood stock developed by Moana Technologies in Hawaii and imported from the multiplication centre in Thailand. In preparation, the farm is undergoing some reconstruction such as a drainage system for rainwater overflow from a nearby golf course, improving biosecurity with fencing and a reservoir pond for the storage of filtered water.



Hashnoel Murshim

Novel management

Over the years, Hashnoel has implemented some unique ideas. To take advantage of its location and help promote the island's tourism industry, SNA through Langkawi Shrimpz, started an ecotourism program in 2006. This half day tour includes horse riding, fishing at a pond containing sea bass and tilapia, farm tour and ends with lunch at the farm restaurant Shrimpz which was started in 2005.

The farm area is divided into four zones and two zones have been fully equipped with 5 cameras and close circuit television. From a desk at the office or anywhere via internet, the farm manager can observe the goings-on at the farm such as pond cleaning. This also helps Hashnoel, who lives in Kuala Lumpur and commutes to the farm for 10 day-durations, manage farm activities. It is also essential for farm security. An extension of this monitoring will be the addition of probes into the ponds to measure pH, oxygen etc on a regular basis and with the data input into a central data storage system. According to Hashnoel, this is important as 'farmers should always on the ball and know what is going on'.

Another innovation is Islamic music, played through six speakers at the pond complex. This is an adaptation of the treatment of the dairy cows in Japan which in addition to being fed well have classical music to help relax the cows. According to Hashnoel, growth has improved but he has no scientific data. Industry associates said that this is difficult to prove as stocking density is very low and culture is extensive.

"I found on the internet, that studies showed that air vibrations improved the water quality through agitation of the atoms in the water. We found that we could reduce aeration to 4 short arm paddlewheels instead of 6 long arm ones. Overall growth was impressive as we achieved 20-25 pcs/kg in 2.5 months. We have discovered that in ponds

nearest to the two speakers, some 95% were large shrimp whereas in ponds further away, it was only 60%", said Hashnoel.

Entrepreneurship program

"We employ 100 full time and part time staff and although we can say that we are contributing to the local community, this is not enough. We believe that we needed to do more community development and grooming new entrepreneurs in aquaculture will have more long term benefits".

SNA has built a hatchery within the complex for an entrepreneurship program in the breeding of sea bass. The Brackishwater Aquaculture Centre of the Department of Fisheries (DOF) assists with hands-on training from rotifer and green water culture to larval rearing. Entrepreneurs also visited the National Institute of Coastal Aquaculture (NICA) in Thailand for further training. Brood stock was supplied by DOF and SNA also provided some ponds for the grow-out of brood stock. The fingerlings are sold back to the farm for its fishing ponds.

A creeping threat

The strength for the farm has been its ideal location, rarely seen in other parts of Malaysia. It is away from any other shrimp farming activity on the island, close to the open sea and has a mangrove fringe along the coast. The inlet draws in clean and unpolluted seawater. The farm can enjoy a near monopoly in terms of markets for fresh or live and large black tiger shrimp. Bird carriers of diseases are swiftly taken care by the eagle population in the area. The problem is that as tourism has become a more significant economy, there is already competition for the use of this coastal area with easy sea access. The farm's location may pose a threat unless shrimp farming is seen as a regional economy equal in importance as tourism and SNA's success is recognised.

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Managing costs and improving feed performance

In 2009, with lower ingredient costs, feed producers in most Asian countries were asked to reduce feed prices to match the declining prices of marine shrimp, catfish and other freshwater fish respectively. As the feed industry matures with lower margins, the next step is managing costs and improving feed performance. AAP reports.

Estimates on aqua feed production in 2009, provided by industry and reports, showed marginal variations in volumes. Changes in shrimp feed production correlated with trends in shrimp production (see page 8). Fish feed production increased in Vietnam and Indonesia (Table 1).

Table 1. Estimates on aqua feed production in selected countries in 2009.

	Shrimp feed	Fish feeds*
China	1,500,000	10,160,000
Thailand	864,000	518,000
Vietnam	305,000	1,320,000
Indonesia	454,500	730,000
India	144,000	N.A
Malaysia	126,000	100,000
Philippines	58,600	N.A

In feed production, the key drivers are price of crude oil and feed ingredients. In 2009, the upside was lower crude oil prices and accordingly lower prices for several raw materials. Towards the end of 2008, commodity prices had just dipped and Asian feed producers were faced with calls to reduce prices but most were still holding stocks bought at high prices. The push to replacing fish meal with plant meals was to meet two objectives; managing costs and to show that aquaculture can be a sustainable production method.



Dr Chen Ming-Dang

Price sensitivity

The aqua feed market in most of Asia is distinctly separated into three groups, the small and medium scale farmers; large operators and aquaculture integrators - supplying feed to their own farms or contract farms. The first group is more sensitive to the feed price than technical characteristics of the feed. In Indonesia, the call to reduce shrimp feed prices of around IDR 9,000/kg (USD 0.95/kg) was

enhanced in 2009 as ex farm shrimp prices decline. Despite a 14% price reduction, producers asked the Government in Indonesia to force feed millers to further reduce prices. In most countries, selling prices are controlled by the Government. In Thailand, all of the shrimp feed companies reduced the price by 2.5% to 3.5%, said Dr Chen Ming-Dang, Charoen Pokphand Foods Plc, Thailand.

"This year, low prices for fish have astonished us as even during the festive season, prices of fish have not increased. In seminars, we are told to reduce fish meal with plant meals and animal product meals which can bring down costs but as prices of these raw materials rise, we do not make any gains in replacements. From the standpoint of using less marine resources, we know that meat and bone meal will work well in grouper and sea bass feeds and that poultry by products are good as attractants for shrimp. But if we use these, we cannot market into the EU and this is our dilemma", said an Indonesian feed miller.



In Vietnam, the extremely low prices for the catfish is affecting the supply chain, said Mr Philippe Serene of Proconco, Vietnam (see box). In Thailand, Dr Thomas Wilson, Thai Luxe Enterprise, Thailand, said that the feed formulator needs to be able to combine availability and changing prices with the nutrient profile when replacing fish meal with plant meals (see box).

Feed performance

The aim of EWOS in Vietnam is to seek a niche market for high performance feeds although price will be a major hurdle. In the marine fish production sector, Dr Dave Robb, said that the competitor is trash fish which retails at VND 2,000 to 8,000/kg. The farmer uses 10 kg to produce a kg of fish but this does not deter them even though pelleted feeds show an FCR from 2:1 and up to 4:1. Farmers need training on the intangible benefits such as reduction in disease and sustainability of production.

"Our R&D focuses on reducing costs and targeting the production of high quality fish for the higher price markets. Following the success with salmon farming in Europe, we also have to focus on food safety and traceability and assist in the long term sustainability of the sector. The experience from our 25 year R&D with salmon feeds will help the company with the work in Vietnam. From 1985 to 2005, it has managed to reduce production costs from USD 3.5 to USD 1.5 per kg by improving feed performance'.

In the newly developed sea bass farming sector in India, the government has proposed the use of only floating extruded feeds. However, there is insufficient feed supply from local producers. Thus, the government has reduced the 30% tariffs to 14% to encourage imports. As production costs range from INR 100 to 120/kg whereas selling price of fish is INR 150/kg, farmers seek lower cost feeds. Imported feeds costs INR 80-85/kg whereas a local feed costs INR 45-50/kg with a FCR of 1.8 to 2.0.

Industry factors Competition

In the shrimp feed market, competition is rife. Large integrators tend to bundle feeds with post larvae and are moving into the merchant market. In Indonesia, most of the 12 non integrated feed producers have joined independent hatchery operators to supply post larvae in order to compete. Margins are low for this group as profits are accrued



Small margins along supply chain strangling industry says Philippe Serene

Philippe Serene, a stalwart in the aqua feed industry in Vietnam since the 1990's and is now back again as General Manager of Proconco feeds, a leader in the catfish feed production.

Vietnam's catfish production has been growing. Feeds are sold at VND 7-8,000 and FCRs range from 1.4 to 2 with an average of 1.8. Feeds costs account for 70-80 % of production costs. It is dire straits for the farmer when selling prices drop to below cost or to a low of only VND 14,000/kg. Fish are exported as fillet and 1.5 to 2.9kg of fish is needed to produce one kg fillet (depend of cutting /dressing determined by the importer).

"In terms of functional feeds, nobody is spending enough to solve these issues in the industry. At the farm level, fish mortality remains too high, sometimes up to 30% and FCR is too high. These make production costly. Today, when we look at the salmon industry in Europe, the consumer pays Euro 10/kg and producers each get Euro 3/kg. Here is Vietnam for the catfish, when we sell USD 10/kg in the European market, the production chain (farmer and feed miller) shares only USD 1/kg. The industry cannot survive in this way".

"The supply chain and its sustainability can work well if at least USD 2/kg comes back to the production level in Vietnam. Here in Vietnam, we know that the processor is not making a lot of money and neither is the feed miller. We can make at least 1% margin or perhaps 2% if the feed mill has better machines such as modern dryers. For USD 100 million of feed sales (for 200,000 tonnes) and a million dollar of profit only, feed millers are exposed to USD 10-20 million risk, with their investments and the financial support to farmers such the 1 to 3 months credit or discount".

"If we say that this is due to the traceability, then the catfish industry in Vietnam and supply has to be more transparent and we need to brand our fish better. The panga is a good and versatile fish and it could be the solution for the lack of white fish in Europe, USA, and Middle East etc".

"I do not think that we need to go into complete integration to survive. I would say that partnerships are required where we all work to bring more money back to Vietnam. Sustainability needs a margin and that at 1% margin is too difficult to survive. Farmers can even lose what they have. At present, this is the weakness of the system and the balance needs to be corrected. We can look at decreasing FCR with higher protein levels and we can use nucleotides to strengthen the immune system. The feed becomes more costly, but efficient with better survival and FCR. Of course, we need to get people to understand this and it has to be done step by step."

"Vietnam's catfish feed industry is too competitive as for a 1.5 million tonnes annual production, there are 80 feed mills. For the salmonid feed industry in Europe. There are presently only 3 main players, Nutreco with one million tpy, Ewos with 0.9million tpy and Biomar with 200,000 tpy and few other small producers. In Vietnam, 2009-2010 could be the year for consolidation".

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Haris Muhtadi

only from feed sales. Their production was only 250,000 tonnes in 2009, which is 70% of the capacity of 350,000 tpy (Agrina Business, 2009).

CJ Indonesia Feeds, which started shrimp feed production in 2007 in Jombang, East Java, has attributed its success to the top three position within 2 years to its supply of quality post larvae, produced in collaboration with Global Gen. Haris Muhtadi, General Manager Aqua feed, PT CJ Feed Jombang, said, "Our new

technical service program whereby we deploy skilled and well trained technicians to jointly operate some farms has earned us market share. Here the farmers still have the capital but lack skills. We have also developed reliable standard operating procedures. In the future, we plan to have a training program for technicians who we will put in client's farms".

Among the top four shrimp feed producers in Thailand's 1.4 million tpy industry, CPF, Thai Union Feed Mill (TFM) and Grobest, have integrated operations. In 4th position is Thai Luxe Feeds which reported a 8-9% market share in shrimp feed – the best in the feed mill's 22-

year history. TFM expects to maintain its lead as it plans to expand production to supply farms in Malaysia, Vietnam, India and Indonesia.

Demand fell for tilapia fish feeds in Thailand and Malaysia as farmers faced major problems with bacterial diseases. In China, the aqua feed demand of commercially produced feed and farm made feeds is around 32.3 million tonnes and the capacity is only 41% of total demand (Wu, 2009). In Vietnam's catfish feed market, the competition is between Proconco, Viet Thang, CP Vietnam, Cargill, Uni President Vietnam and Green Feed Vietnam.

New entrants

However, there are opportunities for expansion with new demand for feed for the vannamei shrimp in India and Philippines. In early 2009, Thai Union Frozen Products (TUF) acquired a 14.99% of Avanti Feeds Ltd (AFL). The move is to support AFL with technical and marketing and its wholesale and retail network in the US. TUF through TFM will share its expertise in shrimp culture. In the Philippines, CP announced plans for a 114,000 tpy fish feed mill in Tarlac, Luzon and a 30,000 tpy shrimp feed mill in Cebu, both operational in 2011. In Malaysia, KPRC has begun to market floating feeds for freshwater fish since October 2009.

Power of suppliers and buyers

The feed industry has little control over feed ingredient suppliers as commodity prices are determined by demand and supply. Crude oil is a determinant factor as biofuel competes with feed and food for the commodity. The price movement of several commodities with a special emphasis on that of fish meal is discussed in detail in pages 16-22.

In 2009, soybean meal prices were weaker than that in 2008 and fish oil and soyoil were in the USD 600-1000/tonne range. The weak dollar is also a factor. Although the lower crude oil prices gave to lower prices in 2008 for most ingredients, there are indicators that in 2010 corn prices will rise with ethanol production and this will affect soybean supplies and prices too. Thus, it will be prudent to expect higher prices in the future as biofuel production is here to stay, according to Dr Robert Swick Linden Nutrition, Singapore. Nevertheless, alternative ingredients such as palm oil cake and waste from the brewing industry are sought after for low cost feeds.

Replacement with plant meals not any cheaper says Thomas Wilson



Dr Thomas Wilson is Vice President, Thai Luxe Enterprises Public Co. Ltd., Thailand. The company is a market leader in the production of fish feeds.

For several years, the feed industry has been under pressure to reduce marine protein and lipid sources and increase the use of plant meals and oils, deemed as relatively more sustainable resources. The target is to lower the cost of feeds.

"In terms of replacement of fish meal, in theory we can replace fish meal with vegetable proteins and lower costs, but over the last 18 months that has not been the case. In 2008, the cheapest protein was rendered meals from Europe, such as animal by product meals, whereas soy protein was very expensive. In the third quarter of 2008, soybean meal was THB 18-19/kg compared to THB 10-10.5/kg in early 2008. In January 2009, it came down to THB 11/kg but now (November 2009) it

is up to THB 17/kg. It has been a difficult task, when we are trying to remove fish meal. Meanwhile, our buyers are asking why is feed so expensive when you are not using so much fish meal?"

"I like to use corn gluten meal (CGM) but we were paying THB16-17/kg for US imported CGM in 2007. With the competitive use of corn

by the ethanol industry, prices went up to THB28/kg in August 2008. In 2009, as the price of oil came down and ethanol companies went bust, we expected CGM meal prices to come down but it went up to more than THB 30/kg in June. Thus, if we wanted to use CGM to replace some SBM, we have a problem of cost".

"No one plant protein can adequately replace the nutrients of fish meal by itself. From what I understand of the European strategy for replacing fish meal, plant proteins other than soy (rapeseed/canola, cottonseed, flaxseed, lupin, pea, peanut, sunflower) sourced from several plant meals in combination is best, as many plant meals have anti nutritional factors (ANFs). Using single plant protein sources at more than 10% inclusion rates will bring along effects of specific ANFs. Some plant meals are not readily available to us in Thailand, or as is the case of oilseed meals in general, competition with biofuels makes many of them too expensive. Here in Thailand, canola is more expensive than SBM, and lupin, although containing about 10% less protein than SBM, costs nearly 50% more."

Cheaper feeds

"How do we manage to have products cheap enough for the farmer? At Thai Luxe, we have 5 fish feed brands, each with 30% crude protein in grower feeds, covering a range of prices. High priced feeds will be those containing fish meal and perhaps no animal by product meal

and a set level of plant protein. The mid price product will have lower fish meal levels, animal by-products such as meat and bone meal (MBM), and a similar level of SBM and the lowest grades may have no fish meal but higher levels of animal and vegetable protein. However vitamin and mineral levels are constant across all grades. We want to reduce cost, not quality or performance. The price difference between grades is typically about THB 20 per bag (20kg)".

"The farmers looking for good FCR and performance will buy the top grade. Others may want cost effectiveness as opposed to performance and match the feeds. Typically Thai Luxe does not like to sell extremely cheap feeds which require the use of ingredients such as palm kernel meal, peanut meal, or coconut meal. Coconut meal is not recommended because of rancidity issues which can cause yellow liver diseases. Reducing feed costs is difficult and the only feed that is possible at THB 10/kg is vegetarian fish feed with very low protein. Thailand has companies selling vegetarian fish feed with 16% protein for as little as THB 180/bag while the lowest price we can manage is about THB 220/bag (THB 11/kg), because we will not use risky raw materials. Some smaller feed mills often produce low-cost feeds with crude protein and fat below the stated levels and customers do not have any way to check on this, but this puts pressure on ethical companies to reduce prices even further".

Debate on fat analysis

"Over the last few years, there has been a debate between feed manufacturers and the Department of Fisheries Feed Quality Control Section regarding appropriate methods of chemical analysis. The latter has asked for ether extraction for measuring fat levels in extruded fish feeds, although AOAC has determined that hydrolysis is essential to properly extract fat in extruded and expanded feeds. We know that there is a 2.5% difference in levels between the two methods. So if

a feed bag declares minimum 3% fat, actual levels have to be over 5.25%. If we continue to analyse by ether extraction, we need to add more oil to make up the required level, even for 'vegetarian' feed. In 2008, it was fat level which was controlling our raw material cost in vegetarian feeds, and not the crude protein level. We have asked that the fat level could be relaxed by 1%, since energy could be supplied by carbohydrates instead. This would have allowed us to reduce the cost of feed by THB 1/kg, which we could pass on to farmers".

"In 2008, we had a situation where fish oil prices were high but food grade soybean oil was even higher. In Thailand, most people will move away from soybean oil but towards cheaper products like palm oil and other vegetable oils. This is an ongoing issue as maintaining the oil level has been affecting costs more than maintaining the protein level".

Replacement and flesh quality

"Last year we did some studies on this. The key factor is maintaining Vitamin C and E levels. The benefit of these high vegetable diets is that you are not bringing in rancid oils in the fish meal and so there will be no ketones and aldehydes and fewer free radicals to promote further oxidation and affect taste. If you eat fish fed with low fish meal/high plant protein feeds on the day of harvest, there is no difference in taste compared with fish fed a high fish meal diet. However, after 4-5 days of storage in ice, the fish fed with lower fish meal diets will have better overall quality and taste. Our customers have said that using Thai Luxe feeds, the fish are more delicious. I do not have specific data to back this up but I would presume that this comes from better control of fish meal and fish oil quality, along with a good strategy to control oxidation. Because of the interest, I am planning to monitor taste quality in tilapia in the near future and benchmark against competitive products in the Thai market".

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15th Aquaculture Conference Asia Pacific

Economic indicators, nutritional approaches and calculating FIFO

Awareness of the changing commodity prices, functional feeds and being eco efficient with fish meal and fish oil usage contributing to sustainability is critical for feed producers.



Jacques Gabaudan (right) and speakers; Panisuan Jamnarnwej (middle) and Jean Francois Mittane.

The focus of the discussions at the annual Aquaculture Conference Asia Pacific organised by DSM Nutritional Products has taken new directions. Concurrent with the trend that feed producers have an extended role in the development of aquaculture, the sustainable use of fish meal and fish oil and use of by products from aquaculture was featured.

In his opening statement prior to introducing the speakers at the 15th Aquaculture Conference Asia Pacific held on November 19 in Bangkok, Thailand, **Dr Jacques Gabaudan** said, "In 2008, aquaculture feed producers were faced with historical high prices of feed ingredients whose price trends were closely monitored by the feed producers. Prices for the main ingredients may have dropped since then, but the knowledge on commodity trends remains important. With prices of shrimp and pangasius eroding, understandably growth is not what we would expect in the recent years. However, demand for seafood will continue to grow".

"Each year, we bring the feed producers together to help them understand the market situation and to prepare them for future challenges. This year, we have decided on topics that are related to the economy; we will review the shrimp industry in Thailand and examine how it has coped with the ever increasing price for feed ingredients in the commodity market. Other global experts will brief us on how we should look at nutritional approaches to fish health, including nucleotides. The latter is already a subject of DSM's research. And finally we will look into the future with a focus on sustainability issues and Dr Andrew Jackson, IFFO will discuss in particular the Fish-in Fish-out (FIFO) estimates, which many of us have been struggling with to illustrate the eco efficiency of fish meal and fish oil in diets and thus sustainability of our industry".

Economy: The Thai industry shows growth but...

Dr Panisuan Jamnarnwej, President of the Thai Frozen Foods Association (TFFA) presented 'The Thai shrimp industry and the 2008 financial crisis'. TFFA was established in 1972 and some 22 years ago, the Thai Government ruled that shrimp exporters to the US, EU and Japan must be members of the TFFA. Of the more than 200 members, 60-70 are shrimp processors. Two years ago, the Ministry of Agriculture issued a policy to promote contract farming, thus linking farmers and processors. The shrimp industry did well in 2008 with the high demand during the elections in the U.S. and the Olympics in China.

Issue is uncertainty

However, 2008 was also dominated with uncertainties. Two new variables (fuel prices and financial crisis) were added to the common 4Fs in shrimp production and processing (Fry > Feed > Farm > Factory).

"For us in the industry, it is how to quote prices with this constant change in exchange rate. As for fuel costs, the effect was felt all along the production chain, aeration of the ponds, pelleting feeds, raw material processing and in between all these, transport costs. In 2007, we estimated fuel cost to be 17.41% from fry to the processing plant but in 2008, it was 16.21%."

"There is a split in opinion on the price outlook for oil. The upward trend will see prices at USD 100-120/barrel or the down trend will see USD 80-85/barrel. The problem is the uncertainty. The silver lining is that high fuel costs will push seafood production towards aquaculture as it is a more efficient production method and uses only 20% fuel as compared to 60% with capture fisheries".

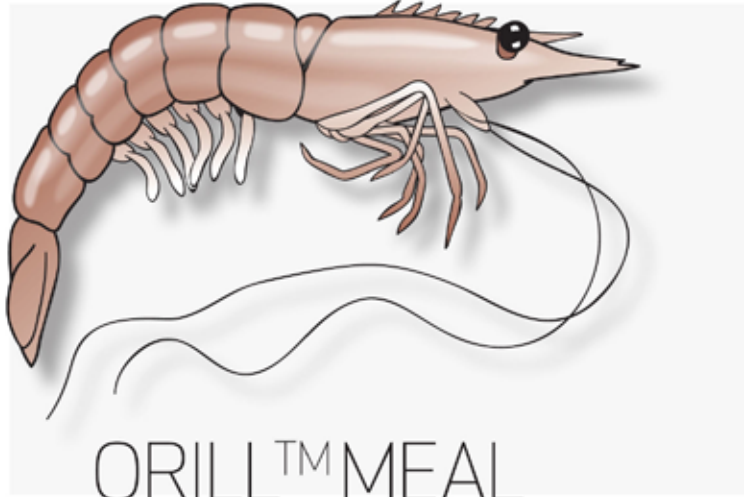
"**But banks love us.** The large size of the industry in Thailand at USD2 billion is attractive for bank financing as the industry pays USD10 million in monthly interest at 6% APR to banks during the 4 month period from grow-out to the time the shrimp is packed to the importer. The processing industry has a stable number of 12-year old processors", added Panisuan.

Future is good

World economic indicators at the end of 2008 showed growth of 0.5% in the US to only 1.4%, for Japan and the EU. In a simple market analysis of the future markets, Panisuan said,

"Earlier, we had observed that shrimp, usually consumed during special occasions would be left out when a family is on budget. The markets were expected to shrink by 30% if we calculated a 50:50 ratio of food service and retail markets. However, the ratio is actually 35:65 and if the food service sector decreased by 20%, retail markets increased by 12%, the overall change is a 0.8% increase in demand. It is this overall change which is helping growth in the Thai shrimp industry".

(Related article: Thailand's route during the downturn, page 4).



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Economy: A bullish trend for key aqua commodities

In this year's presentation "Are key commodity markets for aqua in a bullish trend?", **Mr Jean Francois Mittaine** referred to the IMF which reported that 'the global economy is recovering and that it is optimistic that the global recession is over and is on the rebound especially in the Asian economies. However, it warned of 'great uncertainty in general commodity prices'.

In his analysis of some items in the commodity markets, he showed that;

- From July 2008 to July 2009, the price index of 23 commodities ranged from 115 to 170. World freight market hit its lowest in five years in November 2008 but has recovered partly since then.
- Prices of soybean meal and soybean oil showed low levels in October 2009 but will likely strengthen during November 2009 to January 2010 due to tight supplies on the world market. One of the reasons lies with the potentially explosive situation in the EU which has blocked the imports of GM soybean meal whereas demand is high at 15 million tonnes. From March to September 2010, supplies are expected to increase resulting in potentially weaker prices with a good crop expected in South America (assuming Argentina's soybean crop recovers from the drought).
- The prices of the three vegetable oils (eg palm, soybean and rapeseed oils) have recovered partly from the low level at the end of 2008. In January to March 2010, prices for palm oil, soybean oil and rapeseed oil are expected to increase as consumption exceeds supply.

Fishmeal and fish oil

In 2009, fishmeal production declined to about 4.82 million tonnes worldwide. Other than Chile, Peru and Scandinavia, there are smaller production volumes which do not have an impact on the world trade but still present a significant contribution. Part of this comes from recycling of fish trimmings in localised areas.

"In general, consumption is significantly higher than production and production has only exceeded consumption in two years out of the past 7 years: in 2004 and 2007. It is expected that in 2009 consumption at 5.2 million tonnes will be higher than production (see figure 1). In 2009, ending stock is expected at about 0.7 million tonnes, sharply below that in previous years. Half of this will be Peruvian and 80% is already committed. As such, in reality, stocks are very low. Fish oil production is stable. As fish oil prices are the second lowest among oil prices, consumption in July-October 2009 is expected to exceed production".

In early 2009, Peruvian fishmeal FOB prices were around USD 800/tonne and by mid 2009, it had reached USD 1000/tonne and now in late November 2009, prices have moved up to USD 1300/tonne, close to its level in 2006. Fish oil is currently one of the lowest priced oils but it has the potential to rally, and may thus reduce its price discount with the price of rapeseed oil.

"This rise in fish meal prices will probably not continue. The fishmeal/soybean price ratio has been rising a lot at 3.84. The 2010 Peruvian supply will be delayed which means no new production will reach the 'end users' before January 2010. The demand for fish oil is picking up and unusually high physical stocks are declining. Prices will readjust to narrow its differential with rapeseed oil prices which in turn will increase with higher petrol prices as rapeseed oil is used in biodiesel production".

2010 Outlook

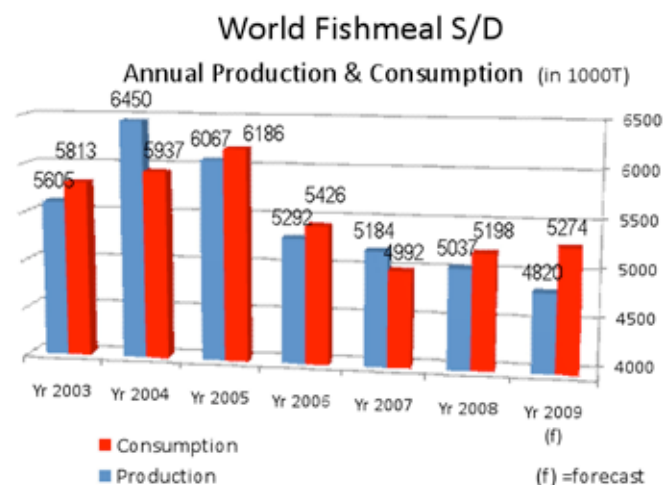
"The outlook remains uncertain. However, it is expected that stocks of fish meal will remain low and markets tight. In China, the largest consumer of fish meal at about 1.5 million tonnes/year, stocks are low in the ports and buyers will look towards domestic or other producing countries for supplies', said Mittaine.

"Some factors to note on the supply side are that the fat content in new stocks could be lower than the year before. The current 'El Niño' phenomenon does not seem to have an impact on the Peruvian anchovy resource but further warming of the coastal waters could potentially lead to lower supply during the second quarter of 2010".

"Fish, Oil & Meal World"

Mittaine also announced a new "vision" of the global fishmeal and fish oil markets. This arose from a three way partnership of Oil World, based in Germany, Fishmeal Experts Office, based in Paris and market analysts in China. "Fish, Oil & Meal World" will issue confidential information twice a month with independent and unbiased analysis and forecasting of the global fishmeal and fish oil markets. Ultimately, the aim is to put fishmeal and fish oil into the centre of the global protein and oil markets and the commodity markets. More information: Email: jfmittaine@gmail.com

Figure 1



Nutrition and health: leading to functional feeds

For the major farmed aquatic species, feeds that have been developed through continued research are technologically superior and are less likely to cause under nourishment, but the new dimension in farming of fish and shrimp is to maintain the health of the animal by feeding them with feeds based on sustainable ingredients and fortified with beneficial bioactive components. This was the message of the presentation on nutritional approaches to health management by **Dr Kiron Viswanath**, Bodø University College, Norway. He said that the feed industry and the farmer together have realised the importance of keeping the cultured animals in good health. Today, the basic mantra is 'feed right' and that good feed should not only deliver appreciable growth but also protect the animal from effects of stressors within the farm environment and diseases'.

There are several reasons why preventive health management is important and amongst these are intensification of culture,

Figure 2.



Delbert M Gatlin III (left) and Professor Boonsirm Withyachumnarnkul, Thailand

expansion of international trade in live fish and the slow awareness on emerging diseases. The importance for transparency in tackling disease situations was emphasized as illustrated in Figure 2. Besides infectious diseases, Viswanath highlighted that there should be greater awareness on diseases attributed to feed ingredients or additives or even feed storage. At the feed ingredient level, he referred to the findings of Norwegian and Dutch researchers that high amounts of soybean meal led to intestinal inflammatory problems in Atlantic salmon. Concerning the well-known issue of rancidity and shrimp feed storage; he cited the work of Thai researchers where it was shown

that ethoxyquin treatment of fish meal effectively prevented lipid oxidation when stored at ambient temperature for 4-5 months, though it affected the condition of hepatopancreatic cells. In another study on shrimp feeds, the fungal toxin, fumonisin B1 caused vacuolisation of hepatopancreatic cells and also affected flesh taste.

According to Viswanath, the performance of aquafeeds should be judged not only based on growth responses but also on health status including immune responses and disease resistance. He also spoke about the importance of the antioxidant micronutrients, non nutritive immune enhancers and pre and probiotics to protect from

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pathogens, with reference to some of his ongoing research. The future will see application of nutrigenomics to identify biomarkers that signal imbalances and in turn facilitate corrective measures. He concluded stating that future developments in the aquafeed sector would be functional feeds for targeted nutrition.

Nutrition and health: Dietary nucleotides

The modulation of immunity in fish and shrimp and disease resistance via non nutrient immunostimulation with glucans and other adjuvants was discussed by **Dr. Delbert M. Gatlin III**, Texas A&M University, USA. In his presentation, he focused on dietary nucleotides where initial research with the hybrid sea bass showed positive effects on growth, immune responses and disease resistance. These were then extended to the penaeid shrimp. In the red drum, the assessment included effects on intestinal health and immune responses.

In the penaeid shrimp, test diets used a final nucleotide premix containing 10% free nucleotide and 90% coatings materials, subjected to a triple microbinding process to prevent leaching of the nucleotides. When fed to the shrimp, Gatlin reported that final weight was particularly high in shrimp fed the nucleotide in a high protein diet (35% crude protein) although survival rate did not follow this trend. He showed that well-balanced free nucleotides can enhance growth of shrimp cultured in a recirculating system with very limited microbial load. An increased whole-body crude protein was also observed in shrimp fed nucleotide-supplemented diets, possibly due to their increased body size. The coating of commercial nucleotides resulted in a strong tendency ($P=0.1$) to enhance nucleotide efficacy in terms of growth, feed utilization, haemocyte phenoloxidase and haemocyte respiratory burst of shrimp.

The immune responses were shown to be high in red drum fed fishmeal-based diets supplemented with 0.5% to 1.0% of a commercial nucleotide. The structural changes noted in the intestine of fish fed 1% of the commercial nucleotide showed that nucleotide supplementation may influence nutrient utilization as well as immunological responses. Gatlin said that in general, the research pertaining to nucleotide nutrition of various fish species has shown rather consistent and encouraging benefits in terms of growth and health management although the suggested explanations remain hypothetical until further

insights concerning interactions between nutrition and physiological responses are available.

Sustainability: Turning by-products into co-products

The future in sustainable aquaculture is also in the utilisation of by-products from aquaculture. In Norway, by-products from the salmon industry comprising wastes from processing such as trimmings, fish heads and viscera, were a potential environmental problem in the 1990s said **Dr Trond Mork Pedersen**, Director of Nofima Ingrediens, in his presentation on 'Processing fish by-products for aquaculture feed'. Part of the role of the public owned Nofima Institute is in product development, i.e. the pilot scale processing of by-products from fish, animals and vegetables, crab, plankton, krill into fish oil, fish powder, hydrolysates, bioactive compounds, ingredients for use in health products, functional food, fish feed, pet food and traditional animals.

More than a third of by-product material from cod are discarded. In general, by-products are converted mainly into silage and meal. Through value adding, it was a Euro 160 million sector in 2007. The markets for ingredients such as fish meal, fish oil, fish protein concentrate (FPC) and bioactive peptides and lipids are fish feed and agriculture feeds. In the production of FPC using salmon wastes only natural enzymes present in the fish are used. There are a few companies that target products for the human markets, by adding enzymes in a continuous enzymatic hydrolysis of very fresh fish by-products.

Value of fish meal in feeds

Pedersen highlighted certain aspects of fish meal quality and its use in feeds. Digestible protein is often assessed with pepsin digestibility using different chemical methods such as the Torry method. To get the real biological digestibility value of the ingredient, digestibility trials with the target species (fish or shrimp), has to be done. Such trials are very expensive and time consuming and cannot be done as part of a commercial control of the raw material for feed production. At Nofima, scientist have documented a very high correlation (>0.90) between protein digestibility in mink with protein digestibility in several different fish species. The results from a number of trials over many years has proven that the mink test is a model method as it correlates



From left, **Dr Bikash Kanti Saha**, DSM Aquaculture consultant, India & Bangladesh and from Vietnam, **Nguyen Quang Hien**, Viet Thang, **Huynh Man Khoi**, DSM and **Huynh Duc Duy Linh**, Hung Vuong Tay Nam.



Dr Chen Ming Dang, Chareon Pokphand Foods Ltd (left) with **Dr Supis Thongrod**, Thai Union Feedmill, **Pradit Chonchuenchob**, Coastal Aquaculture Feed Research Institute and **Apisit Buranakanonda**, Feed and Livestock Magazine.



Andrew Jackson (right) with Philippe Serene, Proconco, Vietnam.

well with the biological digestibility value of the protein. This biological method is very reproducible, it is standardized, has a very low standard deviation and is cheap compared with other biological tests. It is a very good for commercial control of feed ingredients. Trials has also documented a very good correlation between protein digestibility in mink and the FCR and growth in several fish species.

Is the future with taurine and nucleotides in fish meals?

The successful replacement of fish meal with vegetable protein sources and oils has brought down the inclusion rate of fish meal in salmon

diets from 40% to 25%. In Chile trials, has been carried out where the inclusion of fish meal has been as low as 5 to 10% in salmonid feeds. In these diets there has been a high inclusion level of animal byproducts with concurrent reductions in ingredient costs from NOK 5.04/kg of feed to NOK 3.90/kg but with higher FCRs, from 1.05 to 1.15. However, with the consumption of fish fed on such feeds, what would be the effects, if any, on human health for instance on lifestyle diseases, such as fatty liver, cardiovascular ailments and diabetes?

“We then focused on taurine and nucleotides as relative to several plant proteins, hydrolysed meals produced from trimmings and viscera and other products of marine origin have high levels of nucleotides and taurine. Rats fed with hydrolysed protein stored less fat (abdominal) at the same energy level and the high taurine level in hydrolysed protein from by-products increases the production of bile acid. This is important for its positive effects on the blood pressure, cardiovascular disease and diabetes 2”, said Pedersen.

Scientists at Nofima has also focused on water soluble nitrogen compounds in marine raw material, as previously, the better growth performance of fish fed with increasing levels of water solubles has been attributed in part to the effect of some unknown growth promoting factors (UGF) in fish meal. Although more is known on the subject, the main trigger factor for the UGF remains elusive.

“In the continuous effort to develop fish feeds for tomorrow, it is important to learn more about the reason for all the positive effects of marine raw material which is not present in vegetable protein sources. In this context hydrolysed protein might be interesting, both from a nutritional and environmental point of view”.



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Sustainability of Fish Meal/Fish oil: Fish-In Fish-Out ratios

Dr Andrew Jackson, Technical Director of the International Fishmeal & Fish Oil Organisation (IFFO) discussed the eco-efficiency of fishmeal and fish oil. Since the 1980s, aquaculture has been increasing its usage of fish meal and by 2008, the percentage was 58.8%, mainly in feeds for crustaceans, salmonids and marine fish. The use of fish oil is now back in favour with the need to have foods enriched with omega-3 fatty acids. In 2010, aqua feeds will use 80% of supply. In 2008, the use of fish oil in aquaculture was mainly used in trout and salmon feeds (76%) and 15% for marine fish feeds.

However, the growing use by aquaculture has given rise to some concerns. The feed industry worries that the **“production of fishmeal & oil will not grow to meet demand and costs will just keep rising”**. On the other side the environmental NGO’s are concerned that **“fishing will just increase to meet demand damaging the marine environment”**.

Fishmeal/fish oil trap

With the growth in aquaculture, the issue of whether there is a “fish meal/fish oil trap” has been contested. Jackson said that with the use of fishmeal and fish oil in aqua feeds, every time prices rise, feed formulators seek ways to reduce its usage in the diets. When recently fish oil was cheaper even than palm oil, they reverted to using more fish oil. Also over the last decade, fishmeal inclusion in salmon diets has been reduced from 33% to 24% and fish oil from 23% to 15%. However, fishmeal is still averaging around three times the price of soybean meal and fish oil is the same price as rapeseed oil, the problem for feed formulators is that the price of all ingredients has risen.

“Aquaculture has therefore managed to keep growing by using substitution. For the major species, there is already sufficient nutritional information to allow substitution if the prices of marine ingredients rises too high. The substitution of fishmeal which may result in higher feed conversion ratios, but it is a balance between feed costs and growth performance’.

He added, **“There is no evidence that the growth of aquaculture is being limited by the availability of fishmeal and fish oil. The fishmeal/fish oil trap does not exist. There is no evidence that the price of marine raw materials is increasing because of the growth of aquaculture. There is little evidence that demand is driving overfishing in most countries because it is the interest of each country to manage its fisheries in a responsible way. Also it is not often realized that around 24% of global fishmeal production comes from fisheries by-products such as trimmings.”**

Critical review on Fish-In Fish-Out (FIFO) ratios

There is sensitivity on the feeding of fish to produce fish and many feel it should be discouraged. Therefore, industry has been asked to calculate the FIFO ratio in their farmed products to demonstrate their eco-efficiency. This measure is now starting to be adopted by some as a measure of “efficiency” such as the FCR. As part of the sustainability issue, the WWF aquaculture dialogues are discussing using FIFO ratios in their aquaculture standards. In addition, the Best Aquaculture Practices (BAPs) scheme promoted by the Global Aquaculture Alliance has adopted FIFO as a measure in their standards.

However, FIFO can be calculated in a number of different ways and they all give a different figure and it is important to choose the method that gives the correct figure for global aquaculture.

A simple model has been proposed by Tacon & Metian 2008. In the case of shrimp this shows that 1 tonne of wild fish is used to produce 225kg of fishmeal and 50kg of fish oil. At 20% and 2% feed inclusion rates respectively this goes to produce 662kg of shrimp at a FCR of 1.5. However, the wastage is 28kg of fish oil. Jackson argues that this method does not take into account this wastage and gives an incorrectly high value for the FIFO ratio.



IFFO is therefore suggesting the formula:

$$\text{FIFO Ratio} = \frac{\% \text{ fishmeal in the diet} + \% \text{ fish oil in the diet}}{\% \text{ fishmeal from wild fish} + \% \text{ oil from wild fish}} \times \text{FCR}$$

Using this method the excess oil produced in the shrimp example is not attributed to the shrimp production giving a FIFO of 1.3:1 instead of 1.5:1.

The global figure using this method for the amount of wild fish required is 16 million tonnes, in comparison with nearly 23 million tonnes with using the Tacon & Metian method (Table 1).

In his conclusion, Jackson reiterated that **“FIFO is based on a desire to measure and minimise the use of marine ingredients from whole fish in aquaculture diets. The IFFO method should be used to calculate FIFO ratios in order to give a true global measure. But more important than a false ratio is the question of the sustainability of all raw materials whether of a marine or land origin.”**

Table 1. FIFO for the different groups in Fed Aquaculture using the two different methods:

Data presented by Tacon & Metian with Wild Fish Used calculated using their method							
Species Volumes '000 tonnes	Fish Production	Feed Used	World FCR	FM Used	FO Used	FIFO Ratio	Wild Fish used
Salmon	1,465	1,831	1.25	549	361	4.9	7,220
Trout	632	790	1.25	237	109	3.4	2,180
Eel	266	379	1.42	209	19	3.5	927
MarineFish	1,536	2,072	1.35	663	166	2.2	3,316
Shrimp	3,164	4,948	1.56	990	99	1.4	4,399
Crustacean	1,066	1,030	0.97	155	15	0.6	687
Tilapia	2,326	3,203	1.38	192	16	0.4	854
Catfish	1,809	1,927	1.07	193	33	0.5	856
Milkfish	585	468	0.80	14	5	0.2	94
Carp	10,225	8,466	0.83	423	0	0.2	1,881
Misc FW Carn. Fish	777	249	0.32	100	12	0.6	442
Total Fed farmed fish & shellfish	23,851	25,363		3,724	835		22,858

Alternative Method for Calculating FIFO Ratios						
Species	FM in Diet%	FO in Diet %	Yield of FM from wild fish%	Yield of FO from wild fish%	FIFO Ratio	Wild Fish used '000 tonnes
Salmon	30	20	22.5	5	2.3	3,329
Trout	30	15	22.5	5	2.0	1,293
Eel	55	5	22.5	5	3.1	827
Marine Fish	32	8	22.5	5	2.0	3,014
Shrimp	20	2	22.5	5	1.3	3,958
FW Crustaceans	15	1.5	22.5	5	0.6	618
Tilapia	6	0.5	22.5	5	0.3	757
Catfish	10	1.7	22.5	5	0.5	820
Milkfish	3	1	22.5	5	0.1	68
Carp	5	0	22.5	5	0.2	1,539
Misc FW Carn. Fish	40	5	22.5	5	0.5	407
Total of Fed farmed fish & shellfish						16,631

Fresh fish for high quality fish meal

By Christian Lückstädt and Kai-J. Kühlmann

Update on the effect of potassium diformate on the quality of fish under tropical conditions.

The acid preservation of fish and fish viscera to produce fish silage is a common practice (Lückstädt, 2007) and its final product has been widely used in fish feeds with reported beneficial effects (Gildbert and Raa, 1977; Åsgård and Austreng, 1981). It is a widely used method in many European countries to extend storage or preserve fish-by-products as well as freshly caught “industrial fish” for further fish meal or fish oil production with formic acid, acetic acid or potassium diformate.

The present study examined the effectiveness of a liquid blend of potassium diformate, antioxidant and corrosion inhibitor (Fishform, Addcon) as a preservative for sardines, caught in the Indian Ocean. During preservation, a storage temperature of 12°C was chosen, which reflects the situation of the tropical fish storage conditions (on ice) on modern fishing vessels. The potassium diformate blend was added in one concentration (0.40%) next to a negative control. Samples (3 replicates) of the fish were taken after 24 h, 48 h and 72 hours storage time, for determination of Total Volatile Nitrogen (TVN), histamine and dry matter (DM) content of fish.

TVN

TVN is the most important quality criteria for the freshness of fish raw material (Haaland and Njaa, 1987). The main constituents of TVN are trimethylamine and ammonia. Its amount increases with the time of storage in the unfrozen state. Trimethylamine originates from bacterial decomposition. The presence in fish is therefore taken as an indication for bacterial growth as ammonia comes from decomposition of amino acids. High levels are indicative of a reduction in the quality of the available protein.

Levels of mainly 40 mg TVN per 100 g fish mass are regarded by the industry as limits for a good quality fish meal. Furthermore biogenic amines, such as histamine, are formed if the bacterial degradation of protein (amino acids) has started and is therefore an important criterion for the quality of the fish too. Histamine, for instance, is formed during the bacterial degradation of histidine, which is an essential amino acid in fish nutrition. Contamination with histamine can cause food poisoning and allergic reactions (Diel et al., 1997). Finally, the dry matter content (DM) of fish is an important economic criterion, since it indicates how much fish meal can be produced with the fish raw material.

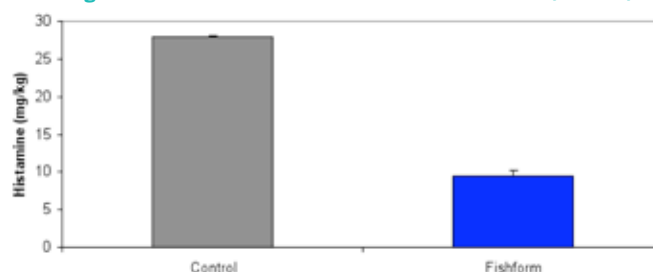
Delaying TVN and histamine development

The TVN values in the negative control increased rapidly and exceeded the above mentioned 40 mg already after 48 hours at 12°C storage temperature. The fast TVN development was significantly delayed by



Good quality sardines for further fish meal production.

Figure 1. Development of histamine levels (average ± SD) after 48 h of storage with 0 / 0.4% Fishform and without Fishform (control).



the addition of the potassium diformate blend. After 48 h the TVN-level in the group treated with Fishform was only half compared to the negative control (Table 1).

Table 1: Quality parameters of sardines for fish meal production (TVN and dry matter) stored with or without Fishform (potassium diformate blend) at different storage times (at 12°C).

Storage time (h)	24		48		72	
	TVN (mg/100g)	DM (%)	TVN (mg/100g)	DM (%)	TVN (mg/100g)	DM (%)
0.0%	26.0a	24.9	59.4b	24.3	52.4b	26.0
0.4%	25.2a	26.1	30.2a	24.9	37.5a	26.3

Values with a different superscript differ significantly (P<0.05)

Furthermore, the analysed values of histamine in the preserved fish was nearly 3 times lower than that in negative control after 48 hours of storage. This clearly proved the bacterial degradation of non-treated fish and that treatment improved quality of the fish raw material (Figure 1).

Finally, the average dry matter content over the whole experimental period of fish preserved with Fishform had an average dry matter content of 25.8%. In comparison, dry matter of the non-treated fish was 25.1%. A significant increase in dry matter of nearly 2.8% would lead to a more optimized fish meal production.

These results clearly indicate that the addition of Fishform improved the quality of the stored fish and that the yield of fish meal can be increased. This translates to a more economic and sustainable use of the limited resource fish meal.

References are available on request.



Dr. Christian Lückstädt



Dr. Kai Kühlmann

Dr. Christian Lückstädt is Technical Director of Addcon Asia since 2007. He is responsible, among others, for the aquaculture product range of the group. Dr. Kai Kühlmann who conducted the experiment is Application Marketing Manager at Addcon Asia Co Ltd, Thailand, Email: christian.lueckstaedt@addcon.net

Can krill meal feed an expanding aquaculture?

The major question to be answered before adopting this solution is whether using krill in aqua feed and other nutritional uses is a sustainable practice.

The rising global demand for food includes a rising demand for fish but fisheries are increasingly controlled to ensure stocks remain viable. This means that the total catch will not increase and that aquaculture must bridge the gap.

Aquaculture already provides around half of the fish for human consumption. Both the proportion and total production are expected to increase. The dilemma facing a large part of aquaculture is that fishmeal and fish oil are vital ingredients in feeds, where they provide proteins, energy and nutrients such as omega-3 fatty acids, vitamins and minerals that make fish a healthy food option. These marine ingredients are derived mainly from managed reduction fisheries, which means the supply cannot be increased. If anything, it is slowly declining for several reasons including a diversion of some supplies into more lucrative human consumption.

Krill, tiny shrimp-like crustaceans that exist in huge masses in the Antarctic seas, can make an important contribution to aquaculture. Feeding trials initiated by Aker BioMarine, a company involved in harvesting and processing Antarctic krill, show it can be a rich and nutritious ingredient in feeds for salmon, marine species and shrimp. Conservation organisations such as WWF Norway are cooperating with Aker BioMarine to ensure harvesting krill is sustainable.



Euphausia superba

The krill contribution

Krill, mainly *Euphausia superba*, offer rich, highly digestible nutrition with all the valuable characteristics found in fishmeal and fish oil, and are extremely low in persistent pollutants found in more northern waters. The major question to be answered before adopting this solution is whether using krill for fish feed, and other nutritional uses, is a sustainable practice. With the introduction by Aker BioMarine in 2003 of specialised catching methods and rapid processing to capture nutrients in a stable form, krill fishing has emerged as a genuine option.



Krill

The initiative has attracted worldwide attention. The icy waters of the South Polar Sea are probably the world's richest source of krill. Recent estimates suggest a total biomass of anything from 60–155 million tonnes (Eurofish, 2009) in the south Atlantic, to 125–750 million tonnes total for the southern ocean (Aker Biomarine). Swarms can extend over 450 square kilometres with a mass of two million tonnes.

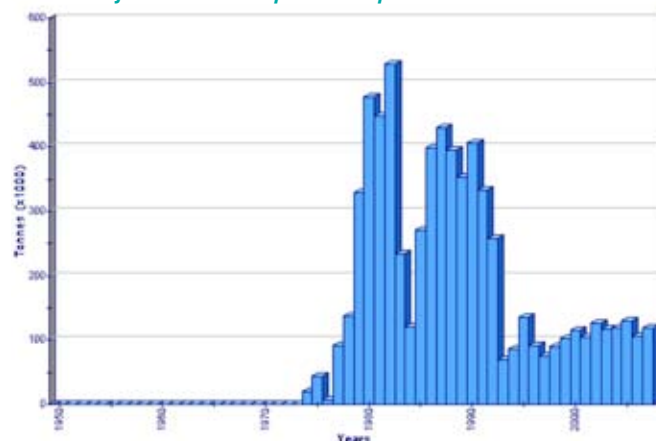
Krill and ecology

Krill perform a valuable action as carbon capture pumps, which is why any fishery should only have a negligible impact on the total biomass. These tiny crustaceans spend most of the daylight hours in deep waters, from 500 to 1,000 meters below the surface, rising at night to feed on plankton. When replete, they slowly descend again and only excrete their faeces when they have returned to the depths. The carbon contained is dispersed in the ocean depths rather than being released at the surface by bacterial activity. Krill are also well known as a vital food resource for animals such as baleen whales, seals, penguins and many fish species that in turn provide food further up the ladder to larger fish and birds.

Krill fishing and conservation

The concept of krill fishing is not new. The chart shows the recorded catches from the mid 1970s to the present. The peak of around 500,000 tonnes in the 1980s was during a period when the former Soviet Union subsidised krill fishing fleets. The distance and difficulty of krill fishing and the challenge of retaining the nutritional value of the krill meant that the activity was not commercially viable. It virtually ceased when the subsidy disappeared. The annual catch has stabilised at 100,000–150,000 tonnes shared between South Korea, Japan, Ukraine, Norway and Poland.

FAO Fishery Statistic for *Euphausia superba*



Krill stocks are monitored and fishing is controlled by the CCAMLR (Convention for the Conservation of Antarctic Marine Living Resources). Quotas in the areas where krill fishing is allowed are set on the precautionary principle at 620,000 tonnes a year. Current krill catches are around a fifth of this allowable total. Fishing for krill requires a licence, organised by CCAMLR and issued by national fishing authorities. As a member of CCAMLR, Norway for example has issued four licences, two of which are held by Aker BioMarine.

Nutritious and traceable

The krill harvesting method developed by Aker BioMarine uses a specially designed trawl to funnel the krill into a hose that takes them onto the vessel. This minimises physical damage to the krill while a special selection mechanism identifies unwanted by-catch for release unharmed. Rapid onboard processing preserves all the key nutrients in both krill meal and krill oil. Due to its position low in the food chain, this way of preserving the nutritional value makes krill a particularly efficient resource in ecological terms.

Processed krill products are collected by a second vessel and delivered to Montevideo on the coast of South America, for onward distribution. Close control over the entire sequence means that each product batch can be traced back to the coordinates of the vessel when the harvesting took place.

Protecting resources

To provide an independent record of krill harvesting, Aker BioMarine has a scientific observer permanently on board the harvesting vessel. Research facilities are provided on board the vessel, including the provision of sonar data, so that the observer can combine scientific research activities with monitoring the krill harvest and treatment of by-catch. In a further assessment of ecological impact, the krill harvesting, processing and distribution activities are being monitored and quantified in association with Dalhousie University in Canada.

WWF Norway has been working with CCAMLR for many years and is a member of the Antarctic and Southern Ocean Coalition, which is working to protect krill and other resources in the Southern Ocean. Aker BioMarine has established a formal cooperation with WWF Norway with three main focus areas. These are sustainable harvesting of fish and krill, combating illegal fishing and traceability of fishery products. Through this WWF Norway gets financial support for its conservation work and Aker BioMarine has a partner for constructive dialogue in the development of objectively assessed sustainable krill harvesting.



Sigve Nordrum, Aker BioMarine (right) and Nina Jensen, WWF.

Assessing sustainability

This important part of krill harvesting is being further assessed by the Marine Stewardship Council (MSC) for certification. MSC certification is based on the health of the stock and how it is managed and the effect of the harvesting on the wider ecosystem. Aker BioMarine has already successfully completed a pre-assessment by MSC for certification of its Antarctic fishing operations. Full assessment is scheduled for completion in the near future. Accreditation will enable Aker BioMarine to add the MSC eco-label to its krill products, thus endorsing its sustainability.

Worldwide fishmeal production annually is around 5.5 to 6.5 million tonnes and fish oil production is 900,000 to 1 million tonnes. They continue to be important ingredients because of the nutrients such as omega-3 fatty acids, minerals, vitamins and antioxidants they provide. Krill meal and krill oil are rich sources of these same nutrients as well as phospholipids and have been demonstrated to improve the performance of feeds for species such as Atlantic salmon, sea bream and shrimp. Harvesting krill within the sustainable limits set by CCAMLR brings krill meal into the category of a sustainable key ingredient for inclusion in targeted aqua feeds such as starter feeds, health diets and other speciality feeds.



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Probiotics in aquaculture operations

By Elisabeth Mayer

Bioremediation to relieve challenging pond conditions in shrimp and fish farming is a promising technology.

These naturally occurring live microorganisms improve the growth and survival of fish and shrimp. Fish pathogens such as *Vibrio* spp. and *Aeromonas* spp. cause diseases, frequently affecting growth and mortalities. Live bacteria are used not only in the intestine of the aquatic animals, but also to improve the water quality of their environment.

Probiotics are “live microbial feed supplements which beneficially affect the host animal by improving the intestinal microbial balance” (Fuller, 1989).

Although probiotics have been a topic of much interest and research in the past 30 years, the extensive application of probiotics in aquaculture is relatively recent and widely becoming recognized as important for disease control (Irianto and Austin, 2002). However, the aquatic probiotics differ from the use of terrestrial based probiotics.

In the aquatic environment, hosts and microorganisms share the same ecosystem. Potential pathogens are able to maintain themselves in the external environment of the animal (water) and multiply independently of the host animal. Surrounding bacteria are constantly ingested by the animal through osmoregulation and feeding. (Verschuere et al., 2000)

Therefore the definition of an aquatic probiotic differs from that by Fuller (1989) as there is no longer the precondition for the probiotic to be acting in the gastro-intestinal tract of the host. Modes of action can also occur in the culture water and an aquatic probiotic can have additional effects, including change of the water quality and interaction with phytoplankton. (Verschuere et al., 2000)

A diverse range of beneficial bacteria is used as probiotics in aquaculture, in some cases as alternative to the use of antimicrobial compounds (Table 1).

Table 1. Probiotic use in aquaculture species.

Probiotic strains	
Bacillus spp.	Paracoccus
Bifidobacterium	Pediococcus
Enterococcus	Saccharomyces
Lactobacillus	Streptococcus
Nitrobacter	Thiobacillus
Nitrosomonas	

Lactic acid bacteria (LAB) are potential probiotic candidates in aquaculture and are also known to be present in the intestine of healthy fish (Balcázar et al., 2008). The most researched and used LAB are the lactobacilli and bifidobacteria (Ross et al., 2005; Senok et al., 2005).

Other commonly studied probiotics or bio-remediators include *Saccharomyces*, *Pediococcus*, *Nitrosomonas*, *Nitrobacter*, *Paracoccus*, *Thiobacillus* and the spore forming *Bacillus* spp.

Probiotics can be provided to the host or added to its aquatic environment in several ways: addition via live food, bathing, addition to culture water or addition to any commercial diet.

Mechanisms of action

Various ways exist in which probiotics could be beneficial. They can act either singly or in combination (Kesarodi-Watson et al., 2008). Several studies have demonstrated certain mechanisms of action:

- **Competitive exclusion of pathogenic bacteria:** Adhesion and colonization of the mucosal surfaces are possible protective mechanisms against pathogens through competition for binding

sites and nutrients (Westerdahl et al., 1991). Different lactobacilli have reduced the adhesion of *A. salmonicida*, *C. piscicola*, and *Yersinia ruckeri* to intestinal mucus from rainbow trout (Balcázar et al., 2006).

- **Production of inhibitory compounds:** Recent studies by Biomin (2009) have demonstrated that various probiotic strains exhibited antibacterial activities against several common fish pathogens, including *Enterococcus durans*, *Escherichia coli*, *Micrococcus luteus* and *Pseudomonas aeruginosa*.
- **Enhancement of the immune response against pathogenic microorganisms:** The non-specific immune system can be stimulated by probiotics. Immunostimulants vary according to their mode of action and the way they are used. Certain derivatives, such as polysaccharides, lipoproteins, nucleotides and β -glucans, have the capability to increase phagocytic abilities by activating macrophages. Rengpipat et al. (2000) indicated that the use of *Bacillus* sp. provided disease protection by activating both cellular and humoral immune defenses in tiger shrimp (*Penaeus monodon*).

Benefits

Some possible benefits for fish and shrimp linked to the administering of probiotics have already been suggested:

B. subtilis and *B. licheniformis* fed fish displayed a significant improvement of feed conversion ratio (FCR), specific growth rate (SGR) and protein efficiency ratio (PER) (Merrifield et al., 2009). It has also been shown that survival rates of European eels (*Anguilla anguilla* L.) fed with *Enterococcus faecium* were significantly higher than in the control groups after challenged with *Edwardsiella tarda* (Chang and Liu, 2002). Furthermore, *Enterococcus faecium* was also found along the shrimp digestive system when fed diets containing this probiotic strain (Supamattaya et al., 2006). It was concluded that this probiotic strain have a positive impact on shrimp gut bacterial ecology and can reduce the number of *Vibrio* spp. through competitive exclusion (Supamattaya et al., 2005).

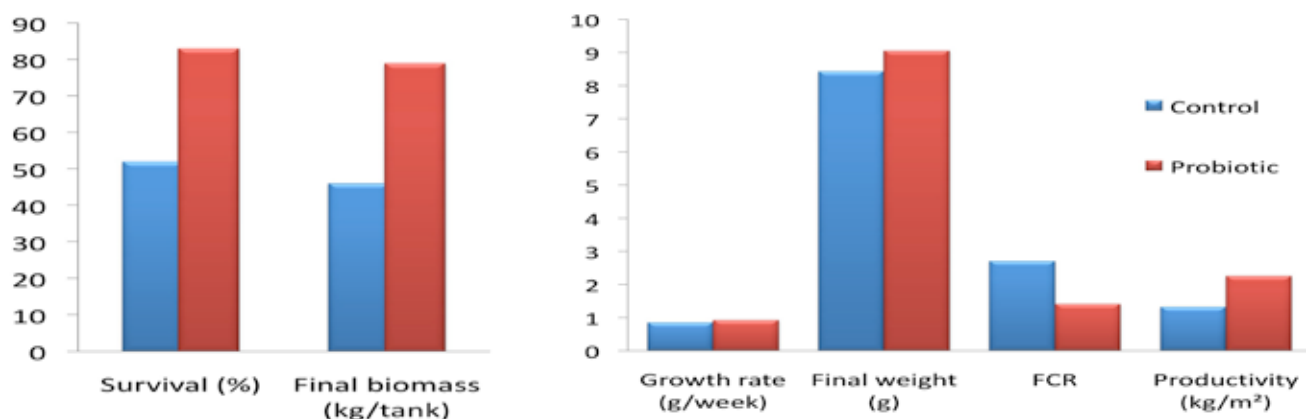
A trial with *Vibrio parahaemolyticus* infected shrimp (*P. vannamei*) resulted in excellent shrimp performance with a 30 % increase in survival and better growth and FCR after application of a multi-strain probiotic product (*AquaStar*[®], *Biomin GmbH, Austria*) to improve water and gut health (Figure 1).

Probiotics for the pond

A common procedure to improve water quality – and therefore the immediate environment of fish and shrimp – is the application of probiotics directly to the ponds. This type of biotechnology is equal to “bioremediation”, which involves manipulation of microorganisms in ponds to reduce pathogenic bacteria, enhanced mineralization of organic matter and removal of undesirable waste compounds.

The presence of high levels of ammonia or nitrites not only pollutes the water but also blocks the appetite of the fish well before causing fish mortalities (Guillaume et al., 1999). Removal is important for both reasons and can be carried out by addition of specialized nitrifying bacteria such as *Nitrobacter* and *Nitrosomonas* and denitrifying bacteria such as *Thiobacillus* and *Paracoccus*. (Beneficial pond) microorganisms present in the immediate environment of aquatic species also have a large impact on farmed fish welfare as well as on growth and health status. This is due to the fact that animals in an aquatic environment carry a bacterial flora, which is a reflection of the flora of their environment (Chandrasekaran, 1985). Recent research shows that the use of commercial probiotics in *P. vannamei* ponds can reduce concentrations of nitrogen and phosphorus and increase the shrimp yields (Wang et al., 2005).

Figure 1. Performance of *V. parahaemolyticus* infected shrimp (survival, growth rate, FCR and productivity) under intensive culture conditions (300 shrimp/m²) when combining probiotics in feed (AquaStar® Growout) and water (AquaStar® Pond). p < 0.05. Adapted from Krummenauer et al., 2009.



Conclusion

The pond environment is a complex system of inter-linking processes. Maintaining the balance of critical parameters is a fundamental requirement for successful aquaculture. There is already experimental evidence that the prophylactic use of beneficial bacteria can improve health and performance of cultured aquatic species. The use of probiotics to control pathogens by Competitive Exclusion is gaining acceptance in aquaculture and considered as alternative to antibiotics. Probiotics play important roles as biological control agents in pond culture, particularly with respect to performance of fish and shrimp, disease control, and water quality of the pond.

The application of probiotics for the improvement of aquatic environmental quality and for disease control in aquaculture seems promising. However the information is limited and sometimes contrasting. Due to these uncertain and incomplete results, there is no

standardized protocol to test the beneficial effects of these products and their impact on farmed fish welfare, growth and health status (Ringo and Olsen, 2008).



Elisabeth Mayer is Technical Manager for Biomin, Austria, and responsible for the probiotic product line. Elisabeth has an extensive background in probiotics and nutrition. Email: elisabeth.mayer@biomin.net

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Profiling amino and fatty acids in the orange spotted grouper

By Nguyen Van Nguyen, Le Xuan Hai, Nguyen Van Hao, Pham Duy Hai and Nguyen Thanh Trung

Information on the proximate composition, amino and fatty acid profiles of orange spotted grouper relative to size will contribute to the database for formulating efficient feeds.

The orange spotted grouper *Epinephelus coioides* (OSG) is now widely cultured throughout Viet Nam, in particular in Quang Ninh, Khanh Hoa and Vung Tau provinces. The culture models are generally floating net cages or abandoned shrimp farms. Attributes of the species such as its hardiness, fast growing and excellent characteristics for processing lends well to its culture. However, at the farm level, there are difficulties such as the lack of extruded feeds, limited availability of fingerlings, disease outbreaks and unstable prices in domestic and export markets. Farmers use trash fish for on farm feeds and this is a main cause of poor water quality, overexploitation of wild fish, disease outbreaks and low yields.

In the search for a sustainable and effective culture methodology, research has been conducted by SEAFDEC, NACA, ACIAR and other agencies to obtain more information on this species. This paper discusses some aspects of the biochemical properties of OSG, essential for the development of cost-effective feeds.



Fish samples

Samples of juvenile fish ranging from 8-12g, 50g and 75-85g were provided by the National Breeding Centre for Southern Marine Aquaculture. Fish were randomly collected, immediately killed and were used for analysis of whole body composition. Wild-caught groupers with an average weight of 750g were purchased in a local market at Long Dat district, Vung Tau province, Viet Nam. Twelve specimens were transported to the laboratory and muscle tissue was combined as one sample for the analysis of chemical composition.

Analytical methods

Samples of whole fish and tissue were analysed in triplicate. The nutrient contents of fish were determined by standard chemical methods. Moisture content was determined by drying in a dry oven at 105°C for 6 hours, crude protein was analysed by the Kjeldahl method (AOAC 984.13), crude lipid was determined by the ether extraction and Soxhlet method (AOAC 920.39), crude ash was determined by

incineration in a furnace (AOAC 1990) at 550°C for 4 hours, amino acids were analysed by HPLC- Picotag method and fatty acids were analysed using gas chromatography (GC-ISO/CD 5509:94).

Carcass analysis was used to determine the dietary essential amino acid (EAA) requirement at varying protein level of OSG juveniles. The dietary EAA requirement can initially be computed on the basis of the carcass EAA pattern present within 35% of the known dietary protein requirements of the fish species. In general, EAAs (including the NEAAs cystine and tyrosine) constitute about 35% of the total dietary protein required by fish. Based on the analysed result of amino acid profiles of the whole body of fish, the dietary EAA requirement was computed on a carcass EAA pattern of 35% of the dietary protein level following Tacon (1987).

$a_i = \frac{p \times 35 \times k_i}{10000} (\%) \text{ where}$
<p>a_i: Percentage of the i^{th} amino acid (EAAs and tyrosine, cystine) in diet, $i = (1-12)$. p: Protein content of diet. k_i: Percentage of the i^{th} amino acid (EAAs and tyrosine, cystine) in the whole body fish.</p>
$\sum_{i=1}^{12} k_i = 100 (\%)$

Proximate composition

The composition of the muscle tissue and whole body of fish is given in Table 1. These were different to that for muscle tissue of grouper *E. neivatus* (Beville and Hale, 1982) with moisture (79.7%), crude protein (19.10%), crude lipid (1.14%) and crude ash (1.21%). Tawfik (2009) reported that commercial size grouper *E. coioides* had the following composition: moisture (78.23%), crude protein (19.14%), crude lipid (0.75%) and crude ash (1.10%). The composition reflected high moisture, low lipid, ash and moderate protein content.

Table 1. Proximate composition of muscle tissue of 750g OSG.

Composition	% Wet weight basis
Moisture	77.94 ± 0.03
Crude Protein	19.22 ± 0.03
Crude Lipid	1.51 ± 0.02
Crude ash	1.27 ± 0.03
<i>Data represent mean ± SD (n=3)</i>	

The composition of whole fish of different sizes is shown in Table 2. Results showed a reverse correlation between the fat and water content, which is common for many fish species. Fish of smaller size had higher moisture and lower protein content in comparison with larger fish. Proximate composition of whole body and quality of muscle tissue has been shown to be affected by protein, lipid, carbohydrate, mineral and vitamin content in feed (De Silva and Anderson, 1995). Furthermore, a study by Le Anh and William (2007) for 57g *E. mabalaricuss* reported



that the proximate composition of whole body was moisture (72.64%), crude protein (7.07%), crude lipid (5.47%) and crude ash (4.42%).

Table 2. Proximate composition (% wet weight) of whole body of juveniles.

Composition	Fish size		
	(75 -85 g)	(50g)	(8-12g)
Moisture	72.11 ± 0.19 ^a	72.58 ± 0.22 ^b	72.93 ± 0.14 ^c
Crude Protein	19.01 ± 0.07 ^d	18.67 ± 0.21 ^e	18.31 ± 0.07 ^f
Crude Lipid	3.84 ± 0.11 ^{ab}	4.06 ± 0.07 ^{bc}	3.72 ± 0.13 ^{cd}
Crude ash	4.84 ± 0.07 ^{de}	4.63 ± 0.03 ^{ef}	4.88 ± 0.05 ^{gh}

Data are mean ± SD (n=3). Values with different letters in the same row are significantly different (P < 0.05)

The data on proximate composition indicated that there was a significant difference between whole body at different sizes of juveniles and with muscle tissue of wild-caught grouper. However, these differences were expected due to the fact that the chemical composition of fish also varies greatly among species and between individual fish of the same species depending on age, sex, environment and season (Hussy et al., 2004).

Amino acids

The composition of EAAs of OSG juvenile at fish size (50g) and fillet (750g) are listed in Table 3. Results showed the 10 EAAs in whole body and muscle tissue of fish. At 50g fish size, the EAAs composition was generally similar to the findings of Millamena (2004).

Table 3. Comparison of EAAs composition (% in 100g sample) in different fish sizes.

Amino Acid	Whole body of 50g fish	
	Data from Millamena (2004)	Present study
Arginine	1.02	1.34
Histidine	0.43	0.6
Isoleucine	0.75	0.86
Leucine	1.75	1.54
Lysine	1.59	1.77
Methionine	0.62	0.72
Phenylalanine	0.87	0.82
Threonine	0.98	0.96
Tryptophan	0.03	0.13
Valine	0.65	0.93

The EAA pattern of the whole body (Table 4) is similar to that in other fish species (Ogino, 1980, Wilson and Cowey, 1985). These results are in agreement with work by Wilson & Cowey (1985) which indicated

that EAAs composition of fish body does not differ greatly between individual fish species and therefore, the pattern of EAAs requirement for different fish species will also be similar. Furthermore, Meyer and Fracalossi (2005) reported that amino acid composition of whole body of the fish did not change with the size of the fish and dietary history.

Table 4. A comparison of EAAs composition (%) in whole body of juvenile fish in this study with published literature (Ogino,1980a) for common carp (*Cyprinus carpio*) and rainbow trout (*Oncorhynchus mykiss*) and species (Wilson & Cowey,1985) for rainbow trout (*Oncorhynchus mykiss*) and Atlantic salmon (*Salmo salar*).

EAA composition	50g juvenile (<i>E. coioides</i>)	EAAs pattern (Ogino, 1980a) for carp and rainbow trout	EAAs pattern (Wilson & Cowey, 1985) for rainbow trout and Atlantic salmon
Arginine	12.56	11.6	12.3
Histidine	5.62	4.8	5.2
Isoleucine	8.06	7.5	8.0
Leucine	14.43	13.5	14.6
Lysine	16.59	16.8	16.9
Methionine	6.75	5.4	5.5
Phenylalanine	7.69	9.5	8.3
Threonine	9.00	10.6	9.2
Tryptophan	1.22	1.7	1.7
Tyrosine	7.22	6.5	6.6
Cystine	2.16	2.7	2.0
Valine	8.72	9.5	9.5

The nutritional requirements for this species have been determined by several authors. Protein requirements have been reported by Giri, Suwirya and Marzuqi (2004), Lin and Shiau (2001, 2003), Toledo (2001), Eusebio and Coloso (2003), Millamena et al (2002, 2004), Wu (2002) and Niu et al., (2007). Generally, most of them reported that protein requirement for juvenile of 8-12g, ranged from 44 - 47%, lipid 8-10% and NFE 16-28%. Based on the EAAs pattern presented, and combined with data on protein requirement in the literature, the EAA requirement in diets at varying dietary protein level was established and is given in Table 5. These results are similar to the dietary nutrient levels reported by Tacon (1987) and Wilson & Cowey (1985) for carnivorous fish species.

Table 5. Requirement for EAAs in diets (%).

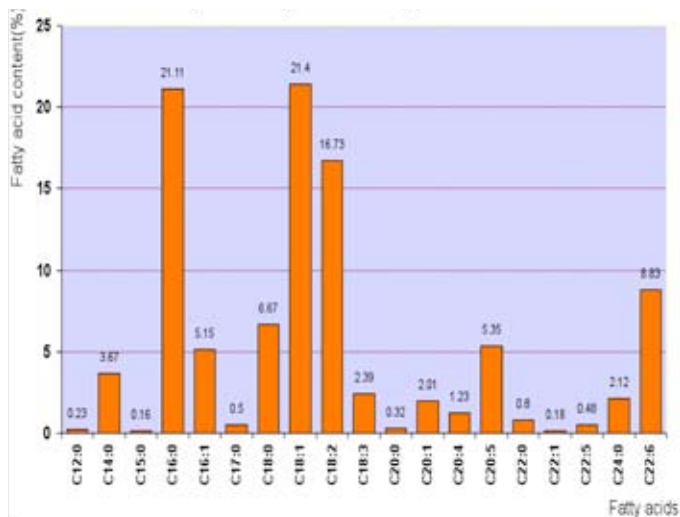
EAA composition	EAAs pattern of juvenile 50g	Dietary Protein level (%)				
		44	45	45.5	46	47
Arginine	12.56	1.93	1.98	2.00	2.02	2.07
Histidine	5.62	0.87	0.89	0.89	0.90	0.92
Isoleucine	8.06	1.24	1.27	1.28	1.30	1.33
Leucine	14.43	2.22	2.27	2.30	2.32	2.37
Lysine	16.59	2.55	2.61	2.64	2.67	2.73
Methionine	6.75	1.04	1.06	1.07	1.09	1.11
Phenylalanine	7.69	1.18	1.21	1.22	1.24	1.27
Threonine	9.00	1.39	1.42	1.43	1.45	1.48
Tryptophan	1.22	0.19	0.19	0.19	0.20	0.20
Tyrosine	7.22	1.11	1.14	1.15	1.16	1.19
Cystine	2.16	0.33	0.34	0.34	0.35	0.36
Valine	8.72	1.34	1.37	1.39	1.40	1.43

Values are expressed as percent of the dry diet

Essential fatty acids (EFAs) composition

A summary of fatty acid content is given in Figure 1. In general, the whole body of juvenile fish had 35.58% of saturated fatty acids (SFAs), 28.74% of monounsaturated fatty acids (MUFAs), 35.01% polyunsaturated fatty acids (PUFAs) and 15.89% of highly unsaturated fatty acids (HUFAs). In comparison, the SFAs of fish have been reported

Figure 1. Fatty acid contents (%) of total fatty acids in 8-12g juvenile fish.



to be low except for certain species. A high whole body SFAs of more than 30% was reported by Halver and Hardy (2002) which was probably due to rising water temperature of more than 30°C during the rearing period. Lopez et al., (2006) indicated that lipid content of whole body muscle increased with increasing dietary lipid levels and muscle fatty acid composition reflected dietary fatty acid profiles.

Although docosahexaenoic acid (DHA) is superior to eicosapentaenoic acid (EPA) as the essential fatty acid for growth of grouper, the levels of HUFA in whole body were 22:6n-3 > 20:5n-3 > 20:4n-6 (arachidonic acid) and ratio of DHA/EPA was 1.65. The levels of C16:0, C18:0, C18:1, C20:0 acids were similar with the findings of Beville and Hale (1982) for muscle tissue (100g, *E. niveatus*) and Tawfik (2009) for wild caught grouper (*E. coioides*). However, the levels of the rest of the fatty acids in the whole body of fish differed. This is possible as the amount of fatty acids in fish tissues vary mainly with their diet, size, age, reproductive status, geographic location and season. The high level in the whole body of the nutritionally important EPA and DHA was reflective of dietary levels of these HUFAs.

Conclusion

Results from this study showed a difference in proximate composition between whole body of different sizes of juvenile fish and with muscle tissue of wild-caught grouper. Based on the composition of EAAs, the EAA requirement at varying dietary protein level ranging from 44 - 47% was established and the data will contribute to the formulation of cost-effective diets.

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The full reference list is available from the author.



Nguyen Van Nguyen with experimental samples

Nguyen Van Nguyen is currently Vice Director of The Fisheries Post Harvest Center, Research Institute for Aquaculture No 2 (RIA2). His special field of research is in nutrition and aqua feed technology. Le Xuan Hai, PhD is professor of chemical technology, Ho Chi Minh City University of Technology. Nguyen Van Hao, PhD is Director of RIA2. Pham Duy Hai and Nguyen Thanh Trung are researchers at RIA2. Email: nguyenria2@gmail.com (Nguyen Van Nguyen).

A standardised white spot disease challenge test to evaluate the efficacy of a biocide

By Mathias Corteel, João José Dantas-Lima, Hans J. Nauwynck, Maurice B. Pensaert, Mathieu Wille, Patrick Sorgeloos, Victoria Alday-Sanz and Olivier Decamp

Many of the aspects of WSSV remain poorly understood, and management tools need to be experimentally evaluated with standardised, reproducible methodologies. The current study evaluated a biocide which was capable of inactivating WSSV at relatively low concentrations. However, outbreaks of WSSV cannot be controlled using this biocide alone and will require protocols combining improved water quality, enhancement of the shrimp's defence system and point application of biocides.

White Spot Syndrome Virus (WSSV) and other viral diseases have plagued the penaeid shrimp industry since the early 1990s. As reported in numerous publications, WSSV infections can cause a cumulative mortality up to 100% within 3 to 10 days. WSSV infections are characterized by loss of appetite, lethargic behaviour, reddish discolouration and white spots below the cuticle. As a consequence of WSSV outbreaks and their seasonality, farmers reduce stocking, either by lower stocking density or reduced number of ponds stocked, during the colder months of the year. During the cold season, the shrimp production is therefore reduced in either case, due to massive mortalities in ponds or due to the decision of farm managers to reduce stocking.

Both the farmer and scientist have been looking for ways of preventing or at least managing WSSV. Strategies include preventing the entry of the virus by stocking confirmed specific pathogen free shrimp (SPF), and applying a range of biosecurity measures (water treatment, disinfection of tools/trucks, nets above ponds, etc). Farmers have tried various pond management approaches during the production cycle, focussing on improved water quality, the application of ingredients with expected antiviral activity and the stimulation of the defence system of shrimp. In the case of viruses such as WSSV, the challenge lies in the difficulty of assessing the effect of a management measure, an ingredient or a biocide in the field. Evaluating these factors under laboratory conditions is thus required.

Two major limitations have hampered the scientific search for solutions:

- The absence of crustacean cell lines. This lack of continuous cell lines prevents the study of shrimp viruses and the fast screening and evaluation of antiviral compounds *in vitro*.
- The only option is to perform challenge tests with live animals. However, obtaining consistent and repeatable results from these challenge tests has been difficult. Earlier work was affected by the use of non-SPF shrimp, possible interactions with other pathogens and variable source of viral pathogen of doubtful titre due to inability to measure or observe the viruses accurately. This has led to wrong assessment of the efficacy of products.

Standardised WSSV challenge test

In 2005-2006, a standardised WSSV challenge test was developed by two laboratories at the University of Ghent, Belgium. These are the Laboratory of Virology from the Faculty of Veterinary Medicine and the Laboratory of Aquaculture and Artemia Reference Centre from the

Faculty of Bioscience Engineering (<http://www.vetvirology.ugent.be/research/researchtopics/wssv/wssv.html>).

For the first time, this shrimp virus was titrated and used in a highly standardised inoculation model. This model allowed us to compare the virulence of different virus isolates and the susceptibility of shrimp species, to test nutraceuticals, antiviral products and temperature to control the disease and to do a pathogenesis study.

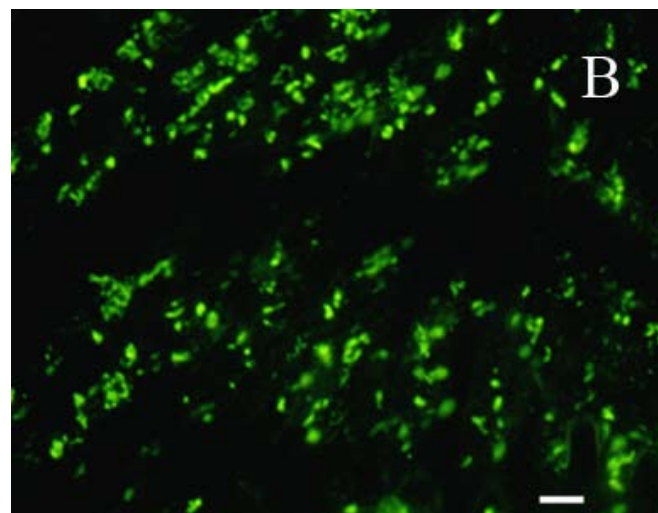
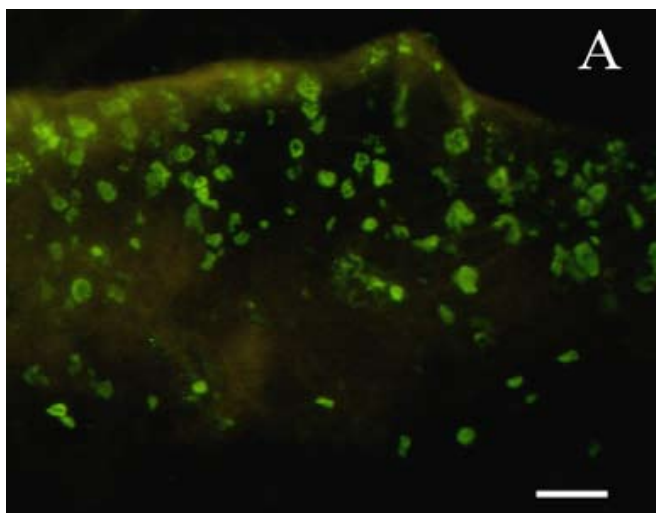
In the pathogenesis study, it became clear that WSSV replicates first in stomach epithelium, antennal glands and gills. After a transport in the haemolymph in a cell-free state, the virus reaches internal targets such as the cuticular epithelium, haematopoietic tissue and the lymphoid organ. In later studies, a correlation was found between virulence and the degree of replication of WSSV, especially in the gills.

The studies demonstrated that once replicating WSSV can be detected, it is impossible to help the animal to stop the infection and eventual death. The only exception to this was applying a high water temperature of 33°C for at least 18 hours per day which could effectively stop the replication of the virus. Other antiviral products such as Spirulina algae and cidofovir could only delay mortality in the standardised challenge test for a day or two at best.

Figure 1. Experimental setup of 10-litre tanks stocked with isolated shrimp to prevent transmission of the virus between experimental animals. Room temperature was kept at 27°C at all times during the experiment.



Figure 2. WSSV-infected cells in for instance a) cuticular epithelium and underlying connective tissue and b) gill tissue can be seen as green fluorescent signal, following immuno-staining and observation by fluorescence microscopy (scale bar = 50 μ m).



Efficacy of a biocide

Based on empirical findings, many shrimp farmers employ biocides to treat the water in shrimp ponds. As part of a collaborative project, the efficacy of a biocide (INVE Aquaculture) that had received positive comments from farmers, was evaluated for its ability to inactivate WSSV by an *in vivo* experiment.

In the project, *Penaeus vannamei* were supplied by Syaqua Siam Co. Ltd., Thailand. The shrimp were certified to be specific pathogen-free (SPF) by the Phuket Coastal Fisheries Research and Development Centre of the Thai Department of Fisheries. Batches of 10,000 shrimp arrived as PL10 and were reared in a recirculation system at the Laboratory of Aquaculture and Artemia Reference Centre (ARC), Ghent University, Belgium. For the viral challenge experiments, shrimp were transported to the facilities of the Laboratory of Virology, Faculty of Veterinary Medicine, Ghent University, where the experiments were performed under bio-safety conditions.

The WSSV Thai-1 isolate, which has been the standard isolate in all other work at Ghent University, was used in the present study. This isolate was collected from naturally infected *Penaeus monodon* in Thailand in 1996 and passaged in crayfish *Pacifastacus leniusculus*. Crayfish gill suspension containing WSSV Thai-1 was amplified in SPF *P. vannamei* juveniles. The infectivity titre of the stock was determined. The median infectious titre of the stock as determined by intramuscular inoculation in SPF *P. vannamei* was $10^{6.6}$ shrimp infectious dose with 50% end point (SID₅₀) per ml.

A toxicity test was performed to differentiate mortality induced by WSSV or the biocide itself. Different solutions of the biocide were prepared in autoclaved artificial sea water (15 g/l), and incubated at 27°C for 3 hours, after which a volume of 50 μ l was injected intramuscularly in 10 shrimp for each concentration (ranging between 0 and 1000 mg/l). After the injection, the groups of 10 shrimp were housed in covered 10 litre aquaria (Figure 1). Shrimp were observed for clinical signs and mortality every one hour during the first 6 hours, and every 12 hours thereon until 120 hpi (hours post injection).

The WSSV stock was then diluted in autoclaved artificial sea water (15 g/l) in order to make an inoculum containing 10^4 shrimp infectious dose with 50% end point (SID₅₀)/ml. This was either immediately titrated (t=0) or first incubated for 3 hours with different concentrations of biocide (including 0 mg/ml as control) inside endopods at 27°C and then the infectious titre of the mixture was

determined by *in vivo* titration. Serial 10-fold dilutions were made in PBS and 50 μ l was injected intramuscularly in shrimp, 5 for each concentration. After the injection, the animals were kept individually at 27°C, followed-up clinically. Dead shrimp were removed and processed for indirect immunofluorescence (IIF) to confirm infections with WSSV. The experiment was performed for five days post inoculation. At this time, all surviving shrimp were euthanized and processed for IIF.

For IIF-analysis, half the cephalothorax of each shrimp was embedded in methylcellulose and frozen at -20°C. Cryosections (5 to 6 μ m) were made and fixed in absolute methanol at -20°C, washed with PBS, incubated for 1 h at 37°C with 2 μ g/ml of the monoclonal antibody 8B7 specific for VP28, washed and incubated for 1 h at 37°C with 0.02 mg/ml of fluorescein isothiocyanate (FITC)-labelled goat anti-mouse antibody (F-2761, Molecular Probes) in PBS, washed with PBS, rinsed in deionised water, dried and mounted. Slides were analysed by fluorescence microscopy (Figure 2). Tissues of moribund shrimp infected with WSSV Thai-1 and uninfected shrimp were stained and used as positive and negative controls, respectively.

Results

In general, the observations included

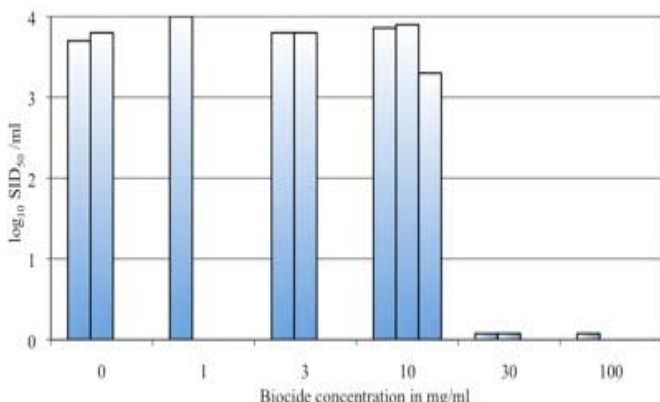
- No clinical signs or mortality were observed in shrimp after injection of 50 μ l of the biocide, up to a dose of 1000 mg/l.
- All shrimp which were collected dead/moribund, were confirmed to be infected with WSSV by IIF. All survivors were negative for WSSV replication.
- As seen on the inactivation curve (Figure 3), the minimal concentration for complete inactivation of 10^4 SID₅₀/ml WSSV was 30 mg/l (3 hours incubation).

Conclusion

The data confirmed the efficacy of relatively low concentrations of this biocide in inactivating WSSV. However, the dose required to destroy the virus in these laboratory tests is higher than the concentration used in the pond. Therefore, outbreaks of WSSV cannot be controlled using this biocide alone. The best results reported from commercial farms rely on protocols combining improved water quality, enhancement of the immune system and point application of biocides.

The standardised inoculation of known doses of a screened viral stock into SPF shrimp via intramuscular route allowed for a highly

Figure 3. Inactivation curve of WSSV Thai-1 isolate due to the activity of the biocide at different concentrations during 3 hours incubation. A concentration of 30 ppm was effective in completely inactivating infectious WSSV.



reproducible challenge, presenting equal doses of virus for the different concentrations of biocide to interact with in the hours before injection. However, this standardised challenge test does not allow the evaluation of longer contact time between the biocide and WSSV. In a pond, the contact time would be obviously higher than 3 hours.

Concurrent research carried out at Ghent University proved that shrimp are more susceptible to WSSV infection from the water in the period following moulting and that wounding facilitates infection (Corteel et al., 2009). This finding provides a scientific basis to justify the use of biocides in combating WSSV spread in shrimp farms as the

biocide can destroy virus in the pond water before it can reach another host. When combined with management measures which ensure the prevention of cuticle damage, biocides can help in preventing disease outbreaks or slow the spread of the disease. Ongoing research at Ghent University should provide some answers regarding the importance of the shrimp cuticle in WSSV transmission and allow the formulation of targeted management practices.

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Mathias Corteel

Mathias Corteel, João José Dantas-Lima, Hans Nauwynck and Maurice Pensaert are with the Laboratory of Virology, Faculty of Veterinary Medicine, Ghent University, Ghent, Belgium. Mathieu Wille and Patrick Sorgeloos are with the Laboratory of Aquaculture & Artemia Reference Centre, Faculty of Bioscience Engineering, Ghent University, Belgium. Victoria Alday-Sanz is a consultant with Aquatic Animal Health, Portal del Angel, Barcelona, Spain. Olivier Decamp is with Inve Aquaculture Health, Thailand. Email: o.decamp@inve.be

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'Ensuring a future for farmers'

The future is bright for aquaculture producers and the way ahead is to learn how to manage diseases successfully and focus on the market requirements for seafood.

This was the broad message to the audience at the Malaysian Farmers day session of Asian Pacific Aquaculture 2009 held in Kuala Lumpur on November 5 2009. The Department of Fisheries Malaysia sponsored 300 farmers and they were joined by other local and foreign farmers and conference participants. The morning session was chaired by Dr George Chamberlain and the Director General of Fisheries Malaysia, Dato Junaidi Ayub. The sponsor of the session was Uni President (UP) Vietnam.

In inviting experts for this session, Uni President's Wu Ming-Hsun, Director of Aquatic R&D, said, "It is apparent, that the industry in Malaysia as well as the region will need to improve on disease management and prevention, as this is the largest threat to consistent production which is within their control. There is some pessimism in the industry as we cannot control the lower demand during this economic downturn. However, we can use this opportunity to provide knowledge to farmers on biosecurity and disease management for the marine shrimp and fish. Aside from shrimp farming, the future is in sustainable cage culture."

Positioning aquaculture for the future

Dr George Chamberlain, President of the Global Aquaculture Alliance (GAA) started the day with his presentation "Positioning Aquaculture to meet the long term global demand for seafood". Aquaculture is the only way to meet the increasing demand for seafood and it is an efficient food production method with its low FCR and carbon footprint, comparable to poultry. However, consumers are confused by the media reports on social, environment and food safety issues. At the recent GOAL meeting, it was agreed that the "future is bright if we can eliminate the negative issues and focus on the health benefits of seafood", said Chamberlain.

Through a transparent multi stakeholder process, the Global Aquaculture Alliance has developed aquaculture standards and best management practices covering environmental, social food safety and traceability issues along the entire production chain; hatchery, farm and processing. Its standards and best management practices at the feed mill are under review. There has been market endorsement of the BAP in the retail, food service and distribution areas sectors in the US and Europe. In Asia, the strategy is to help small scale farms and as in the case of those in Thailand where a cluster system will help to reduce the burden of costs of certification which will only be imposed at the processing plant level.

Making the most of scientific information on WSSV

Dr Grace Lo Chu Fang and the team at the National Taiwan University have been working on the white spot syndrome virus in marine shrimp since 1994. This is the most serious disease in shrimp farming and their work covers not only the causative agents but also the viral transmission and control. In her presentation on "Control of Viral Diseases in Crustacean-Lesson learnt from WSSV", she focussed on the current understanding at the molecular level on what happens when shrimp is infected and how to use this information to control the disease.

Various technologies have been developed to control the spread of the virus, some more effective than others but in general, it is possible to overcome the virus. Vaccination against the disease can be effective through treatment with inactivated virions or with feed pellets coated with inactivated bacteria. Results are not consistent and protection only lasts a few days or weeks and is effective only when the infection is low.



Presenters and the UP team in Vietnam; from left: Misai Tsai, Grace Lo Chu Fang, George Chamberlain, Franky Lee, General Director, UP, Marc Le Groumellec, Wu Ming-Hsun and Hou Hsu Kuang (UP).



Her message was, “We may wish to eradicate the virus but do not have the practical means to kill all viruses. Shrimp cannot tell us when they are uncomfortable but we can use stress markers to detect this. There is a potential to use vaccines to prevent mortality to perhaps 60% but we need to wait for the development of a vaccine that can be used in the ponds. We have hope but need a lot of patience”.

Transmission pathways

What is known about WSSV is that it can affect most aquatic crustaceans and cause up to 100% mortality of shrimp and thus is a serious economic impact. Molecular diagnostic tests are now required to detect infection in brood stock and post larvae. Several screening methods that monitor shrimp populations and allow disease outbreaks to be controlled are available such as 2-step and real time PCR (polymerase chain reaction) for low level infection, isothermal amplification (LAMP) lateral flow dipsticks and fast and easy to use antibody detection strips to confirm acute infections.

Studies in the ovary showed that WSSV attacks egg cells and the transmission pathway is from female brooders to the offspring and from male brooders through spermatophores to the female brooders. Brooders are infected through water and food. In Vietnam, brooders, although in good condition, showed light infection after two days and two weeks later showed heavy infection. It was determined that the source of infection was hermit crabs which were heavily infected even though they looked healthy. The polychaetes were WSSV free.

“Farmers need to know this as transmission can continue as we still have farmers practising unsafe feeding practices. This also applies to clams and copepods which are potentially very dangerous food sources for shrimp. Our work showed that WSSV can replicate in copepods, earlier known as passive hosts. WSSV cannot replicate in clams but can concentrate in tissues of clams”, said Lo.

Monitoring stress levels

When shrimp with low infections of WSSV are subjected to environmental or physiological stress, replication is triggered and will lead to a full blown outbreak of WSSV. The commonest protein in the WSSV genome is ICP11 and it acts as a DNA mimic and it competes with cell DNA. Thus, it prevents DNA from binding to histone proteins leading to death of the cell. When this is expressed it is a losing battle as the infection will very quickly lead to the death of shrimp.

However, Lo said that we now know how to monitor stress. WSSV is a unique virus with 500 proteins of which the IE proteins are the key regulators of viral infection. These are involved in the outbreak of disease under stressful conditions. It is now known that physiological and environmental stressors activate shrimp STAT (signal transducer and activator of transcription), which is then annexed by the virus and enhances the expression of viral immediate early gene in WSSV-infected shrimp. This in turn leads to its rapid replication of IE proteins, involved in the outbreak of disease. Situations such as spawning and hypoxia (oxygen deficiency) are the stressors. An E3 ligase expressed by WSSV prevents apoptosis (killing itself). Real time PCR, protein

gel electrophoresis and western blot analysis of STAT can be used to monitor the transcription level of shrimp STAT.

In summary, if the WSSV genome is present in the cell, in response to stress it will rapidly replicate viral gene expression and result in a full blown outbreak. STAT and the downstream genes can be used as markers to monitor stress. By monitoring stress, it will be possible to remove or reduce environmental stress before they can trigger an outbreak of WSSV.

A moving target

“The threat of WSSV will continue, particularly if we continue to culture shrimp intensively. New outbreaks will likely occur. To stay ahead we need to be one step ahead and for this, an understanding of the pathogenesis of the viruses of shrimp and work at the organism, cellular and molecular levels. We need to know more to be better prepared”.

~ Lo

Biosecurity: from theory to practice

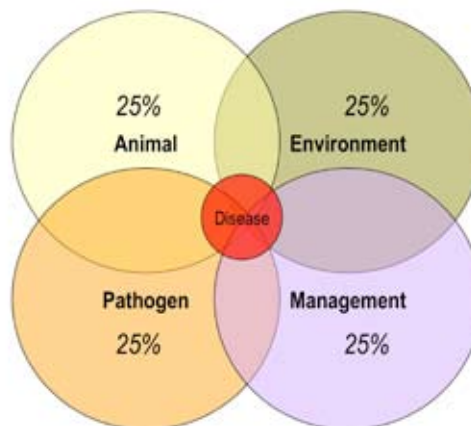
The concept of biosecurity continues to baffle farmers. In shrimp and fish farming, it is “management practices that reduce the risk that pathogens will be introduced to a facility and/or will spread throughout the facility”. It is also to ‘reduce the conditions’ that can enhance susceptibility to infection and diseases”, said **Dr Marc Le Groumellec**. “In Asian aquaculture, this knowledge on biosecurity needs to be improved. Farmers need to understand the transmission mode, multispecies pathogens and its vectors and hosts and take into account in its farm management”.

Biosecurity was explained in terms of a modified Sniezko’s diagram where there is an equal contribution of the four biosecurity factors; species, environment, pathogen and management (Figure 1). Le Groumellec, based his presentation on his scientific and managerial experiences in biosecurity, shrimp domestication and larval rearing at the Unima group of farms in Madagascar along with previous experiences in the Americas, Pacific Islands and Asia.

Environment and biosecurity

This deals with geographical location, water quality issues and seasons, proximity of other aquaculture operations and pollution. How this can be improved is by having the following goals: ensuring no stress by the environment on the animal, no impacts from outside sources to the farm and vice versa. The environment can induce stress to the animals through drastic physico-chemical changes that take them out of their normal physiological zone. This brings in extra biological risks that do

Figure 1. Biosecurity factors in a modified Sniezko’s diagram.





The Uni President team at their booth, front row, from left: Wu Ming Hsun, Vietnam, Jeff, Jie-Cheng Chuang, China and Maple Hung, Vietnam.

not exist originally in the ponds but these risks can be alleviated.

“Classical improvements include physical barriers to reduce impacts from wind and sun or minimising fluctuations in water quality by covering ponds. It is important to avoid salinity changes from heavy rains, or a drop in temperature due to strong winds. Changes can be buffered through the use of water bodies prior to release into culture ponds, liners to solve poor soil issues and effluent treatments to avoid auto-pollution. To be more independent from environmental changes, easily controlled biosecurity with indoor grow-out phases are good alternatives, similar to that practised in industrial production of land animals. However, there may be impacts on taste and general quality of the shrimp produced”, said Le Groumellec.

Pathogens and biosecurity

This requires knowledge of endemic pathogens, their virulence, transmission mode and whether these are multispecies pathogens. Exotic pathogens should be kept away through strong national sanitary regulations. The importance of sampling techniques and quality of diagnostic techniques was emphasised. At the farm, an essential protocol is record keeping and to recognise signs of early disease.

Le Groumellec echoed Lo’s emphasis on molecular biology techniques to ‘detect the presence of known pathogens, even at carrier stages with no disease outbreaks’. He also stressed to look out for emerging and unknown pathogens where histology is the only diagnostic technique available.

“Similarly, in dealing with pathogens there must be goals set such as avoid replication of pathogens on the population. Depending on the type of pathogen, the choice is an ‘All clean strategy’ or ‘Live with it strategy’. The first is only efficient in big companies or groups of small holders and works better with exotic pathogens than with endemic pathogens (vector and carriers). For endemic pathogens, looking for more tolerant or resistant animals could be an efficient alternative.”

Animals and biosecurity

The main objective is first to make sure animals are not bringing in unwanted pathogens into the farm. Farmers have tried to control that risk through extensive PCR testing of broodstock before entering them into hatcheries, and post-larvae before stocking.

“There are improvements, but still not enough to achieve a high level of protection, because of false negative results such as WSSV positive test results in post larvae sold as SPF. Also, we do not know how to test for carrier stages of emerging pathogens”, said Le Groumellec.

“Domestication has been key to our success with the marine shrimp and has allowed for better husbandry and sanitary control, notably through repetitive testing over several generations for major pathogens. This is still lacking in marine fish in Asia. The ultimate goal

will be to ensure the production of sanitary safe breeders with good growth and high fecundity, genetically and physically identified and traceable. Once that stage of full domestication is reached, genetic programs could then select animals that are more adapted to local culture conditions, such as resistant to some pathogens, better growth or able to better withstand specific environmental conditions.”

Management and biosecurity

These are best management practices for husbandry, nutrition, handling and pond management to reduce as much ‘man-induced’ stress as possible. A discipline and rigour in implementation of procedures are critical. Several manuals such as on best management practices (BMP) and standard operational procedures (SOP) are available on the web for reference.

A goal of a biosecurity plan is to show that biosecurity measures are working and to see that remaining risks are covered and put under the surveillance plan. Improvements can only work if all factors are under control and that the strategy is shared by other farms in the vicinity. The design is as such; define targeted diseases and the ways the disease could enter and identify preventive measures. In the field this translates into;

- pathogen exclusion from water through better filtration such as drum filters with down to 50 micron mesh to remove vectors from water intake canals. An alternative is a no water exchange strategy.
- Pathogen exclusion through water and soil sterilisation (physical rather than chemical)
- For shrimp culture, crab and bird exclusion devices to prevent natural transmission
- During production, a control plan and continuous improvement process to be undertaken.

“The overall success is dependent on manpower management. Using the ISO9001 management methods based on SOPS, records for CCPs (Critical Control Points, as used in HACCP) and continuous improvements are essential tools for capacity building and work supervision”.

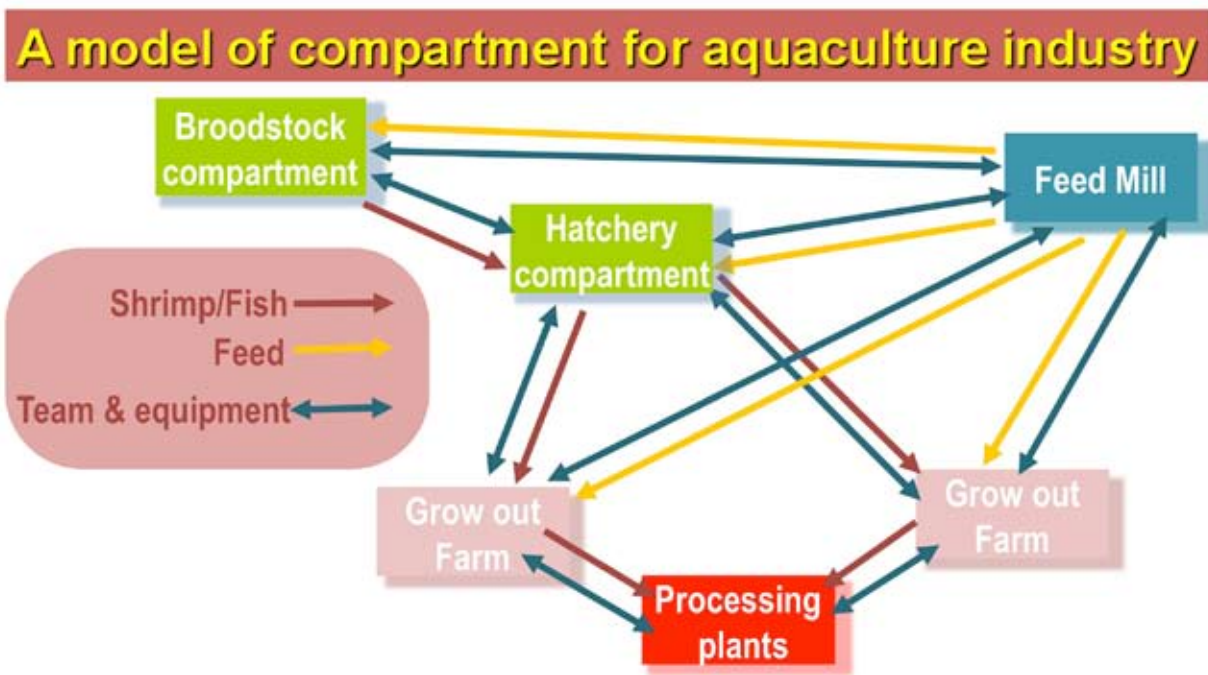
Biosecurity is more developed now in shrimp aquaculture than for marine fish, as there are fewer shrimp species reared, their pathogens and adequate diagnostic tools are better known, and specific prevention tools have been designed. However, marine fish should improve its biosecurity level too and it has the advantage of vaccination against major pathogens.

Moving up with a veterinarian: proposition of a new organization for the industry

Le Groumellec introduced this to the audience. “In order to be more efficient in its implementation, we should now look at biosecurity in aquaculture in the same way as in a livestock production facility. The veterinarian will play a central role in managing biosecurity in a farm or group of farms. The person will be independent from the farmer and ‘look more coldly’ at the situation and recommend the right actions even if economically painful”.

Among the responsibilities of the veterinarian, are to undertake a continuous improvement process with multiple farmers in a defined geographical zone and tailor biosecurity measures with current knowledge, implement adequate cost effective measures and most importantly, interpret diagnostic results. There is also coordination with other stakeholders and national authorities creating a “compartment” according to the OIE definition and ensure the coherence, cohesion, cooperation and coordination (4Co rule) is applied by all and ensure alert is communicated to all in case of non compliance for contingency plan implementation”. (Figure 2)

Figure 2.



Modern cage culture for traceable pompano in Indonesia

“The vision of each farmer should be ‘economic price and taste’. The first is via location and good management and the second is via good quality feed and processing”, said **Mr Misai Tsai**, who operates a pompano cage culture farm, PT Lucky Samudra Pratama in Indonesia. “As a farmer, my mission is to impart my experiences in farming pompano *Trachinotus blochii* in Pulau Kongsii”.

During the planning stages for the farm, Tsai used his engineering background in site selection. Other than a whole year round current survey, knowing the benefits of each physical parameter is important. He has optimised on the environmental conditions by locating the cages at a water depth of 25m but close to an upwelling where the current is constant and will bring high dissolved oxygen. He has identified that a light blue water colour and 6m transparency as excellent for cages and dark blue water colour and 4m transparency as good only. A stable temperature and good feed management will give a good feed conversion ratio.

Complete traceability

Traceability starts from fry with quarantine inspections to feed traceability at the factory and product traceability at the processing plant. Feed and product use one production code. During production, the farm record book keeps track of medications used for disease and parasites control during production. It also records harvesting data as well as management protocols such as washing nets every 2 weeks which was shown to improve survival rate from 40% to 70%. The average feed conversion ratio (FCR) for the pompano is 2.0 for fish up to 1kg and 2.5 for fish up to 1.4kg.

“We are very focussed on feed management and quality to improve feed conversion, reduce harvest times and improve fillet texture. By adjusting the moisture level in the feed from 10% to 20% for better digestibility, and coupled with better feed management, we have increased the 10 months growth from 0.87 to 1.05 kg.



Growth also improved when we added functional ingredients to the feed. The addition of organic selenium and zinc reduced harvest times by 20 days. Organic selenium improved texture, colour and taste. Probiotics with *Bacillus natto* and *Lactobacillus spp* improved digestibility and FCR improved from 2.27 to 1.97”, said Tsai. “However, all these are all conditional on using choice larval fish, improving feed management and fish size selection”.

The farm produces pompano of 800g to 1kg for the Taiwan market, 1-1.2kg for the Korean market and 1.2kg to 1.6kg for the Japanese market. Fillet size is 300-400g each and the Japanese sushi and sashimi markets require fish of 1.2kg. As the pompano is a migratory species, spawning is only from March to May and the company gets its fry supply from a Taiwan based hatchery which uses brood stock originally from Japan. The advantage of this farm in Indonesia instead of Taiwan or Japan is not only the costs of production but also the faster growth rate at 14 months for 1.2 kg fish. This would be 2.5 years in Japan.

“However, the stocking density is lower at 7kg/m³ for more natural growth as compared to 10-12kg/m³ in Japan”, said Tsai.

Return of the black tigers

A validation of SPF status during the grow-out for this commercially available post larvae. This is a prerequisite before industry in Malaysia can import and begin culture.

Whilst a large percentage of farmers in Asia have been focusing on the vannamei shrimp, in Malaysia, Thailand and Indonesia, there are pockets of farmers dedicated to the farming of the black tiger *Penaeus monodon* shrimp. Reasons for this are larger sizes and the higher value the species commands as well keeping commitments to their clients.

Similar to the vannamei shrimp, the way forward for black tiger shrimp farmers is to use post larvae produced from domesticated brood stock selectively bred for certain traits. Specific pathogen free (SPF) stock is a precondition. Domestication programs have been initiated by governments and large commercial farms in several Asian countries and results of their progress are now being seen (see box). The return to the culture of the black tiger shrimp is imminent.

Moana Technologies in Hawaii which started the domestication and selective breeding program, 8-9 years ago, has set up multiplication centres for commercial post larvae production in association with local hatcheries in Thailand, Vietnam and India. The company is a post larvae producer. In April 2009, Malaysian farm, Monodon Aquaculture Sdn Bhd, applied to the Malaysian Department of Fisheries (DoF) to import Moana post larvae from an associate hatchery, Siam Kuladum Co. Ltd, in Phuket, Thailand.

Their justification, according to Dr Mohd Fariduddin Othman, Head of the Brackish Water Aquaculture Research Centre, (BARC), Fisheries Research Institute in Gelang Patah, Johor, was that the post larvae are F6 progeny from Moana's nucleus breeding centre and wild brood stock from the Andaman Sea was used in their production line.

Randall Llyod Aungst, Managing Director, Monodon Aquaculture Sdn Bhd., said, "A few rounds of farm testing in Thailand showed excellent production results in comparison to post larvae derived from wild brood stock which originated from the same area. There are also other quality attributes in comparison with SPF post larvae from the Mozambique strain which currently dominates more than 80% of stock in farms in Malaysia".



T. Segar (left) and Mohd Fariduddin

Validation process

As the authority issuing import permits, the DoF decided that the post larvae should undergo a validation process in its own ponds, to determine the SPF status. Operational protocols follow closely those used in commercial operations. At the same time, information on its growth performance was gathered. In June 2009, 550,000 post larvae (PL15) were brought in and quarantined in a raceway at the pond site. The batch was certified as SPF for five OIE diseases (WSSV, TSV, IHNV, YHV and MBV) by the Phuket Coastal Fisheries Research and Development Centre. Specimens were screened for viruses at the centre in Gelang Patah using the IQ2000 PCR kit. Duplicated samples were sent to an independent laboratory.

Continuous screening

"We followed the usual procedures prior to purchase. When post larvae were in the hatchery, we tested samples of PL12 at the Thai DOF laboratory and at an independent laboratory in Thailand for the seven viruses (WSSV, TSV, IHNV, YHV, MBV, GAV and HPV)", said T. Segar, Technical Head and Farm Manager, Monodon Aquaculture Sdn Bhd.

"Prior to stocking, we kept the post larvae in a hapa and monitored them. Our procedure was that within 48 hours, if the survival was more than 95%, only then will we stock them into the ponds. We sent samples to the DoF laboratory and an independent laboratory. In the ponds, we again conducted monthly screening for these viruses. Since the arrival and up to 120 days of culture, samples were certified negative for all viruses."

Growth performance

The post larvae were stocked initially into four ponds at varying stocking densities of 17 to 25 PL/m². Juveniles of 10-15g were then distributed into 5 ponds at a density of 20-25 PL/m². Premium monodon feeds were used for these ponds. After a culture period of 120 days, the shrimp reached a size range of 30-35g. Short arm paddlewheels were used in the verification ponds. All ponds used zero water exchange.

Growth has been impressive, according to Segar. "We have stationed two experienced staff in the centre in Gelang Patah to monitor these ponds and they followed our culture protocols. We have not harvested the shrimp but based on our sampling and feeding rate, the average survival was estimated at 75% which was much higher than the survival rate of local stocks. The highest survival rate was in the pond with the lowest stocking density of 7 PL/m². This pond attained an estimated survival rate of 98% after a growth period of 2.5 months".

"Depending on the ponds, at 184 days, we had sizes ranging from 70g for stocking density of 17 PL/m² to 49g at a stocking density of 31 PL/m². We have calculated that stocking at 25 PL/m² will give us 32-35g after 120 days and an average yield is 5.5 tonnes/ha/crop. For the local stocks of monodon post larvae, we used to get 45 pcs/kg (22g) after 120 days and the additional problem of a 40% size variation".

"The feed conversion ratio (FCR) has not been calculated but we expect a production cost of MYR 13-14/kg at this farm, including costs of utilities. In our own farm, taking into consideration variable costs, I would estimate cost of production of MYR16/kg", said Segar.

Mohd Fariduddin said, "Overall, we are pleased with the growth performance of the shrimp which translated to a growth rate of 2-3g/



week. Interestingly, we noticed that the sizes were almost uniform and shrimp grew much faster than the Mozambique strain which we have in our other ponds. We also noticed a higher requirement for dissolved oxygen and because of this, additional paddlewheels were required. Based on this validation exercise, we will recommend that farms use a stocking density of only 25PL/m² to target 81% survival rate".

The BT shrimp domestication program

A simple program to jump start selective breeding and commercialise production of SPF black tiger shrimp brood stock.



Indoor brood stock tanks. Water from the main reservoir of 4 ha goes to a sedimentation pond and biological filter before being subjected to chlorine treatment, biological and mechanical filtration and finally is UV treated separately at the five modules of the centre.

Out of the 30 active marine shrimp hatcheries in Malaysia, only 5 hatcheries produce black tiger shrimp post larvae. These hatcheries will require SPF brood stock. In 2004, the Brackishwater Aquaculture Research Center, FRI, in Gelang Patah, Johor, collaborated with the former Black Tiger Hatchery an independent shrimp hatchery on a domestication program. The founder stocks came from Mozambique. The hatchery now produces post larvae

from its seventh generation SPF brood stock but production is mainly for its own farms with excess post larvae sold to independent farmers.

In 2007, the centre in Gelang Patah began its own domestication of the black tiger shrimp *P. monodon* and banana shrimp *Fenneropenaeus merguensis* project in collaboration with another centre in Kg. Pulau Sayak, Kedah in the northern part



Mozambique origin black tiger shrimp are kept in an open pond at the centre.

of Peninsular Malaysia. The latter carries out the selection and breeding work whilst at Gelang Patah, post larvae are grown for the production of a new generation of brood stock, to be distributed on demand. Currently, the centre has about 3,000 brood stock ready for spawning.

Mohd Fariduddin, Head of the centre in Gelang Patah, said that the production of brood stock is the first step in the preparation for a national SPF hatchery which will come complete with nucleus breeding and multiplication centres in Rompin on the East Coast of Peninsular Malaysia.

Initially on production aspects

“In our own program, we started with three founder stocks of the black tiger shrimp, from our own hatchery as well as from two other hatcheries. We have reached the third generation with the black tiger shrimp. In the case of the banana shrimp, we are starting with the 5th generation. Our focus is on production aspects to show results quickly for the benefit of the industry.”

“Our target is fast growth and high fecundity. If we were to concentrate on genome mapping, this will slow us down. Thus, geneticists at the University Putra Malaysia are helping us to do this. They have just completed the mapping for the banana shrimp”.

According to Mohd Fariduddin, procuring wild spawners from local waters is not easy, as fishing and keeping live shrimp is no longer profitable for fishermen. Furthermore, wild spawners from local waters are heavily infected with diseases. The final solution is imported brood stock from Mozambique. These were then cross bred to get new family lines.

“The facilities in Pulau Sayak carry out the selective breeding akin to a nucleus breeding centre. Brood stock are screened to be WSSV, TSV, IHNV and MBV-free and eye stalk ablation is used to induce spawning”.

They will supply us with post larvae of 2g or less to grow and further selection is carried out in our centre in Gelang Patah. Here, post larvae are first nursed to 3-5g in indoor recirculation water tanks and fed artemia biomass, produced at the centre. They are then transferred for grow-out for 8-10 months in 500 – 1000 m³ circular (40m diameter) cement tanks in a partially enclosed area. Adult shrimp are fed polychaetes and mussels as well as premium pelleted feed. We screen for WSSV, TSV, IHNV and MBV every ten days. The selected brood stock are sent back to the centre in Pulau Sayak for selective breeding work”.

Performance tests on the fecundity traits are carried out with the cooperation of Universiti Malaysia Terengganu in the east coast of the peninsula. Results showed that fecundity is moderate, at 200-300,000 eggs per production cycle. The next step in this program will be using commercial ponds for growth performance tests.



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Fish supply in the Arab states

Part 2: Can aquaculture in the Arab states bridge the fish supply gap?

By Izzat H. Feidi

In part one (Issue 6, November/December 2009), the author reviewed aquaculture's contribution to fish supply in the region. Demand for high quality products is increasing as consumers are more aware of the nutritional benefits of seafood. In this second part, he discusses the opportunities for aquaculture in the region as well as challenges in species selection and production methods.

The Arab states such as Egypt, Sudan, Iraq and Syria with significant fish supply from capture fisheries resources from inland water bodies have also resorted to aquaculture in order to increase local supplies of fish. Even the states with rich marine fisheries resources such as Morocco, Algeria, and Tunisia have also started to practice aquaculture in their fresh or marine waters. All Arabian Gulf States (GCC) have established fisheries research centres to conduct research in order to obtain technologies and know-how and also operate pilot projects in aquaculture.

Saudi Arabia has in addition established mega, state-of-the-art marine shrimp farms along its Red Sea coast not only to supply the local market with shrimp but also for the export market. Kuwait, Bahrain and U.A.E. are involved with the culture of indigenous commercial species to produce fingerlings for re-stocking depleting stocks in their marine fishing grounds and also to supply fish fry to other states. A tuna fattening project has been established along the Arabian Sea coast of Oman, and Yemen is currently considering such a project.

Challenges

Aquaculture is a major challenge to the Arab states. The two main constraints on aquaculture development are environmental degradation and the availability of land and water for aquaculture. It has not yet fully developed in the Arab states except in Egypt which has an aquaculture production that has in the last two years exceeded its capture fisheries. In order to sufficiently develop aquaculture in a sustainable and responsible manner, relevant governments and research institutions need to constantly increase and improve their research capabilities.

Research in aquaculture must address developments in ecologically sustainable technologies and reduction in production costs. Farming indigenous and popularly demanded species as well as possible introduction of new species should be achieved without endangering the ecological balance.



Fish pond at Saudi Fish Farming Centre



Shrimp farming in Saudi Arabia

Some of the challenges facing aquaculture in the Arab states include:

Natural resources: Sound utilization of water resources is required for fish culture; other problems include loss of ground water, contaminated water, shortage of suitable coastal waters and effects of urbanization in coastal areas.

Technical shortfalls: Lack of experience in fish culture especially in fish health management and in the culture of local species; shortage of scientific references and literature on the subject.

Management obstacles: Poor management practices and planning.

Economic shortfalls: High cost of operating farms, high initial capital investment, lack of concessional credit financing.

Feed shortages: Shortage of locally produced feeds.

Manpower shortages: Shortage of experts and local consulting firms and well trained manpower.

Legal obstacles: lack of aquaculture legislation to regulate activities.

Fish from aquaculture

Currently, freshwater and brackish water aquaculture, which may include polyculture, provides about 22% of its fish supply. Supply also comes from mariculture along the coastline of several states. Capture-based aquaculture is the latest form of aquaculture and involves the collection of 'seed' from the wild and its subsequent on growing to marketable size in captivity. In Oman, there are fish-fattening farms where stocks of small size finfish, yellow-fin tuna fish in particular, are collected from the wild and fed in a coastal cage farm to huge sizes for export to lucrative tuna markets, in particular Japan.

Another source of fish supply is aquaponics which combines fish farming with the production of higher plants, mostly vegetables, flowers

and herbs particularly suited to closed recirculation systems. Still under consideration is the innovative practice of farming of fish in the high seas that may insure sustainability and avoid pollution threats.

Suitable species for culture

The most suitable culture species in the Arab states are those indigenous to the region in general and to each Arab state in particular. These are well accepted by the consumers, environmentally suitable and marketable not only in the local markets of one Arab state but also in other Arab states. Tilapia is a good example and widely produced in the Arab states (Table 1). In 2007, the total production was 274,596 tonnes. Arab States in North Africa have also recently begun to farm the tilapia.

Table 1. Tilapia production in the Arab States: 2000-2007.

State	2000	2001	2002	2003	2004	2005	2006	2007
Egypt	157,425	152,515	167,735	199,557	199,038	217,019	258,925	265,862
Kuwait	30	16	16	202	275	185	557	293
Saudi Arabia	3,968	3,981	6,000	2,580	2,396	2,900	3,402	3,804
Sudan	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,350
Syria	2,626	3,195	2,571	3,439	3,650	3,363	3,460	2,921
Jordan	563	540	515	650	487	411	420	293
Lebanon	0	0	25	25	25	27	27	27
Libya	0	0	0	0	10	10	10	10
Oman	0	0	0	0	0	5	0	0
Qatar	0	0	0	0	0	11	36	36
Total	165,612	161,247	173,881	207,453	206,881	224,920	267,847	274,596

The Gulf States also conduct research in the farming of groupers and breams which are popular indigenous species. Bahrain also farms rabbit fish while Saudi Arabia farms local varieties of the marine shrimp. Projects for rearing the regionally popular sea bass and sea bream in cages along the Mediterranean Sea coast are carried out by Egypt and Tunisia. Some Gulf States are also experimenting on these species in farms along the Arabian Gulf.

The introduction of foreign exotic species should be carefully studied before commercial farming is introduced. *Barbus* spp. and Carp spp. are currently farmed in Iraq and trout is farmed in Lebanon. Saudi Arabia Fish Farming Centre (FFC) has experimented for several years with the Asian sea bass *Lates calcarifer* before disseminating its farming techniques to local private fish farms.

Farming seafood species other than finfish is also possible especially for the export market where they fetch high prices. Besides shrimp from Saudi Arabia, oysters and pearl culture are practised in the Arabian Gulf waters. High value species like abalone and sea cucumber which are available in local waters and are in high demand especially in China, Japan and other Southeast Asian markets, can be considered in future culture trials.

Expanding aquaculture

Opportunities for expanding aquaculture in the Arab states exist. Therefore, introducing and/or expanding aquaculture activities as a



Major fish species cultured in Arab States.

English common name	Arabic common name(s)	Scientific name	Where mostly cultured
Fresh, brackish water species			
tilapias	bolti, musht,	<i>Oreochromis niloticus</i> ; <i>O. Zilli</i> ; <i>Galilea</i> ; <i>Tilapia</i> spp.	Egypt, Sudan, Syria, Jordan, Saudi Arabia, Kuwait
carps species:	mabrook	<i>Cyprinus carpio</i> ; <i>Siluris glannis</i> ;	Egypt, Syria, Lebanon, Iraq
trout, rainbow	trout, truite	<i>Salmo gairdnerii</i>	Lebanon
barbus	binni, kattan, shabout, himri	<i>Barbus</i> spp.	Iraq
marine water species			
groupers,	hamoor, waqar, manani	<i>Epinephelus tauvina</i> ; <i>E.coioides</i> ; etc.	Kuwait, Bahrain, Saudi Arabia
rabbit fish	saffy, sigan	<i>Siganus canaliculatus</i> ; <i>S.rivulatus</i>	Bahrain, Saudi Arabia
sea bream	murjan, faskar, sobaiti,	<i>Sparidentex hasta</i> ; <i>Sparus aurata</i>	Kuwait, Bahrain
european sea bass	qarous	<i>Dicentrachus labrax</i>	Egypt, Tunisia,
gilthead sea bream	dinees, dorade	<i>Sparus sparus</i> , <i>Sparidae</i>	Egypt, Tunisia, Morocco
mulletts	bouri, maid, biah	<i>Mugilidae</i> spp. <i>Liza Oligolepis</i> , spp.	Egypt, Iraq
shrimps, prawns	rubian, gambari, quraides	<i>Penaeus indicus</i> ; <i>P. semisilcatus</i> ; <i>P. monodon</i>	Saudi Arabia, Egypt; U.A.E.

source of increasing production of popular fish species for the local markets and also farming other high value seafood products for the lucrative international markets seems to be a suitable alternative for all Arab states. It should also be noted that selection of species for farming should concentrate on those species which have high growth rate, easy to produce, acceptable to consumers, affordable in price to majority of the people and highly adaptable to various water salinities and temperatures. Tilapia offers such characteristics. The production of sufficient food for the population has many advantages in the short, medium and long term including purposes of food security, creation of employment, preservation of resources, and savings on foreign currency reserves.

On whether aquaculture can close the fish demand gap, it may be said that while it would not be able to close the gap completely, it certainly can substantially narrow it. Several issues have to be considered: human population growth trends, enhanced production from capture fisheries, availability of more natural resources for aquaculture, greater demand for fish proteins, government policies and legislations, domestication and genetic improvement of cultured species and environmentally sustainable culture technology.



Izzat H. Feidi

Izzat H. Feidi is Fisheries Development Consultant based in Egypt. He has served with FAO in several countries for over 30 years in various technical and managerial capacities. His last posting was Chief, Fish Utilization and Marketing Service, FIU, FAO, Rome, Italy. Email: ifeidi@thewayout.net

Trade show at Asian Pacific Aquaculture 2009

The most dynamic aquaculture trade show in the region demonstrates the vitality of aquaculture in Asia.

A constant flow of trade visitors, from Malaysia and the region kept exhibitors busy over the three days from November 4-6 2009 in Kuala Lumpur, Malaysia. Some 66 exhibitors occupied all of the 69 booth trade show. International, regional and local companies were marketing a large range of products and services, ranging from cage systems and materials, recirculation water systems, total aquaculture solutions, feeds, feed additives, post larvae to diagnostic services and training. Several local universities promoted their ready to commercialise research findings and academic programs.

Very satisfied with the response to products displayed at the Zeigler Bros., USA booth, Neil Jervais Jr, Technical Sales Manager-Shrimp Feeds said, "In the previous WAS trade show in Veracruz, Mexico, we had the chance to deal with visitors on a one to one basis. In some quiet trade shows, usually visitors were exhibitors visiting the booth of others. But here in Kuala Lumpur, it has been absolutely fantastic as we saw more people in the first hour than in the two other recent shows put together. All these were business related and also governments from all over the world. This is by far the most dynamic show. Even on the third day, we continued to have visitors to the last hour. It showed more than ever that Asia is the centre of aquaculture".

In the US and Latin America, **Ziegler Bros** markets a range of feeds for fish and shrimp at all stages of development as a well pond treatment services and products. In Asia, the focus is on hatchery and brood stock diets. The latest product is the new and improved EZ Artemia, a synthetic artemia feed formulated as a complete balance diet. It is designed to mimic the colour, taste and texture and nutritional value of artemia nauplii.

The trade show provided an excellent platform for networking with international aquaculture consultants, producers and suppliers, said S. Santhana Krishnan, SK Marine Technologies (India) Pvt. Ltd, who attended the show with Team Aqua of Taiwan. **Team Aqua** manufactures and markets paddlewheels and aerators. The new product at the show was the water breaking and power saving impeller series of aerators. At



Neil Jervais Jr

the **INVE Aquaculture** booth, it was also a hive of activity as the team introduced the new SepArt technology (see page 47). The company also held a meeting for regional offices and distributors in Kuala Lumpur.

Culture technology

According to **Don Bishop**, farmers visiting **TenCate Geosynthetics Asia** booth showed an interest to change from traditional systems. He added that judging from their questions, they want to make improvements on culture management. TenCate has manufacturing facilities in Kuala Lumpur, Malaysia and Zhuhai, China. At the show, there was a model of its containment system and aqua grid netting material. Bishop added that TenCate is interested in conducting seminars to explain modern cage farming technology as well as bring its innovative products to the attention of cage culturists in the region. At the booth of **Malaysian Olefins**, there was a display of the HDPE walkway in floating aquaculture systems.



Santhana Krishnan, (second right) with visitors. Ed. S. Lazo, Business Development Manager, Vitarich Corporation, Philippines (second left) and Matthew Tan, CEO, Singapore Aquaculture Group (right). Besides interaction with the international crowd at the show, Lazo sought information on advances in fish and shrimp nutrition and on disease diagnosis. Tan's interest at the show was an overall outlook of aquaculture needs for insurance and products.



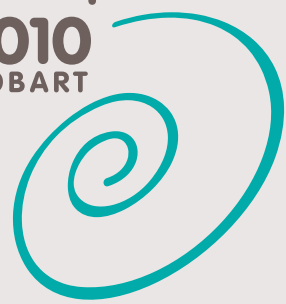
At the Inve Aquaculture booth, from left, Wim Martens, Oliver Decamp, S. Chandrasekar and guest Nayak Ramakanta Novozymes, South Asia Pvt. Ltd.



Photo courtesy of CSIRO

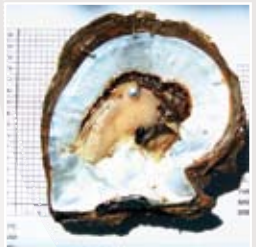
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At the TenCate Geosynthetics Asia booth, model of a containment system with the semi rigid aqua grid netting.

One stop solutions in fish and shrimp culture were provided by several regional companies. Malaysian companies, **Advanfis** has paddlewheels, water pumps to feed additives and **Aquatic Enterprises** markets brine shrimp eggs, feed additives and products for water treatment. **Super Artemia** also markets brine shrimp as well as products for the hatchery and shrimp culture. In Thailand, Angus McNiven has established a new company **Farm Aqua** to provide equipment and consultancy for tilapia culture. **Sepang Today Aquaculture Centre** displayed a model of the Goldbill recirculation system which was developed in China. There is the portable system for research purposes and a large commercial scale system with two 50 tonnes tanks. Each module can produce 1.5 tonnes of marine fin fish such as the grouper.

Marine shrimp

Kembang Subur is a Malaysian producer of nauplii and post larvae from SPF/SPR brood stock from SIS Florida. The total capacity is 1.5 billion post larvae, produced at 2 hatcheries in Sitiawan and Pahang and a joint venture hatchery in Kuching, Sarawak. It also provides 3 billion nauplii for 4 associate hatcheries, in Penang, Perak and Johor. The company is now pursuing an integrated business with local and foreign partners. Specific for farmers in Vietnam, feed company, **Uni President Vietnam** is also marketing its Unilarva, a new brand of SPF



Brajesh Kumar (left) and Abhilash Nair (centre), Zymonutrients, India



At Vannamei 101, David Kawahigashi (middle) and Matthew Briggs

shrimp post larvae produced by its aqua breeding subsidiary, located in Ninh Thuan, Vietnam.

Moana (Asia) Ltd is marketing its genetically improved and disease free post larvae of *Penaeus monodon*. There are multiplication centres in Thailand, India and Vietnam which supplies post larvae direct to farms (related article, page 38). Phuket based **Vannamei 101**, established by Dr. Matthew Briggs and David Kawahigashi has technical services, training, consultancy, brood stock, post larvae and other products to the vannamei farming industry in Asia. It provides hands-on training to hatchery managers and technicians through its joint venture vannamei farm in Phuket.

Disease diagnostics

Several exciting developments in this field were shown at the trade show. There was a live demonstration of intraperitoneal (IP) injection vaccination at the **Intervet/Schering Plough Animal Health** booth. Juvenile tilapia was vaccinated using AquaVac® Strep Sa, an oil adjuvanted *Streptococcus agalactiae* Biotype II vaccine which the company has launched in Asia and the Latin America. **Lab-Ind Resources** showed the new and exciting isothermal amplification endpoint and real time for disease monitoring at lower cost but with a high specificity. The Malaysian based company plays a major role in disease diagnostics in the region. Taiwan based **Rega Biotechnology** has two rapid test kits for Nervous Necrosis virus and Grouper Iridovirus awaiting patent applications. This simplifies testing procedures and reduces costs by replacing the need for a PCR.

Feeds and feed additives

At their respective booths, there were **Cargill Hoplite's** team with the new natural yeast product and **Cargill Corn Milling**, offering a new corn protein product. **Cargill Animal Nutrition**, the sponsor for the tilapia session of the farmer's day had the REVEAL software to help feed manufacturers make purchasing decisions amidst fluctuating market costs, manage nutrient variation of ingredients and support more precise diet formulations. **Uni President (UP) Vietnam** promoted its seabass and slow sinking grouper feeds as well as vannamei shrimp feeds to the region's farmers. New to an aquaculture trade show in Asia, was French company **Seppic**. At the booth, Claire Notin introduced recent findings by the company on the benefits of Promutase™ 200 in shrimp growth and survival. This is an innovative nutritional ingredient of plant origin which provides bioactive superoxide dismutase (SOP), a powerful antioxidant enzyme. As the first line of defence in an animal, SOP is seen as an alternative to antibiotic treatments.



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Aeration Industries International, Inc., the world's largest manufacturer of surface aerators is celebrating 35 years in business. The US based company has delivered over 62,000 aerators worldwide in over 92 countries.

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"When selecting an aerator for aquaculture usage, oxygen dispersion is the most important element. This involves thorough oxygenation and sub surface circulation to create a de-stratified pond environment so that temperature and oxygen levels are uniform throughout the entire pond. A de-stratified pond creates a healthier environment for increased size, increased survival and thus, increased profits. Shrimp thrive in the oxygenated and cleaner environments of ponds with complete mixing."



Pond with Aire-O₂ aerators shows the strong horizontal mixing.

Other technical advantages are low maintenance because of only one moving part, flexibility of use, lightweight and portable, water lubricated bearing with no artificial lubrication necessary, no gearbox design and ease of installation. (More information, Email: Brian.Cohen@aireo2.com; Web: www.aireo2.com)



New standards for responsible aquaculture

A new Artemia technology for a sustainable and efficient one-step separation of hatched nauplii from the cyst shells.

The brine shrimp Artemia is a well-known, convenient and indispensable live food for the industrial aquaculture of most marine fish and shellfish. What determines the success of Artemia is not only its availability as a nutritious live prey, but also the possibility of tailoring its nutritional value to the hatchery needs and its flexibility of use in an industrial hatchery environment. The use of Artemia requires the hatchery operator to separate the freshly hatched brine shrimp nauplii from the cyst shells. This complex process usually involves sedimentation or decapsulation.

In its press release, Inve Aquaculture said that it has made these steps redundant by launching an innovative product & process called SEPArt. The process yields pure Artemia nauplii without the use of chemicals or complex manipulations. The advantages are multiple and include: pure and highly vital nauplii separated from cyst shells without any use of toxic chemicals (decapsulation). There is no environmental

impact nor adverse health effect for the hatchery workers. There are high nauplii yields through the elimination of losses.

The use of the new Artemia technology does not require any structural modifications or changes in incubation or harvest protocols. Using the Inve cysts and the dedicated equipment (Tube separator or the high throughput CysTM unit) simplifies the process and excludes the need for any additional energy. The brine shrimp cysts are currently distributed to more than 150 customers in Asia and the Americas.

It has also been demonstrated at several main European marine fish hatcheries and has been enthusiastically received as a major step change in the hatchery operations. Inve Aquaculture is now ready to launch the products in the European markets. With this, the company highlights its commitment to innovating aquaculture to the highest standards and supporting sustainable and environmentally friendly practices. The SEPArt Technology is patent pending in all the major aquaculture countries of the world. (More information: Email: inveaqua_bu@inve.be)

NEXT ISSUE

March/April 2010 issue will feature

- Focus on Hatchery Management
- Industry Review-Marine Fish
- Larval feeds
- Feed additives

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Presidential Science Prize of Taiwan for 'Father of black tiger shrimp', I-C Liao

Professor I Chiu Liao, 73, academician of Taiwan's research institute Academia Sinica and Chair Professor, Dept. of Aquaculture, National Taiwan Ocean University was awarded the Presidential Science Prize of Taiwan in the applied science category in December 2009. This is in recognition of his prominent research and contribution to Taiwan's aquaculture industry, in particular in the breeding of shrimp and fish. Liao, known as the 'father of black tiger shrimp,' developed models and techniques for the larval rearing of *Penaeus monodon* which changed shrimp farming from 'tidal pond culture of wild-caught shrimp post larvae' to that using hatchery reared post larvae. This was a milestone for the global farmed shrimp industry and made Taiwan 'the shrimp and fish breeding centre' of the world.

He also developed artificial breeding of the grey mullet and milkfish and was responsible for introducing the tilapia into Taiwan. Liao began his research in aquaculture in July 1968 after obtaining a doctorate in agriculture from the University of Tokyo, Japan. He was selected as an Academician of the Academia Sinica in 1992 and has published more than 450 papers in national and international journals. He has received several honours including honourable life membership in the Asian Fisheries and World Aquaculture Societies and Fellow of the Third World Academy of Sciences in Italy. In recent years, Liao has been promoting collaboration between industry and academia to develop bio-products that may overcome the White Spot Syndrome Virus in shrimp.

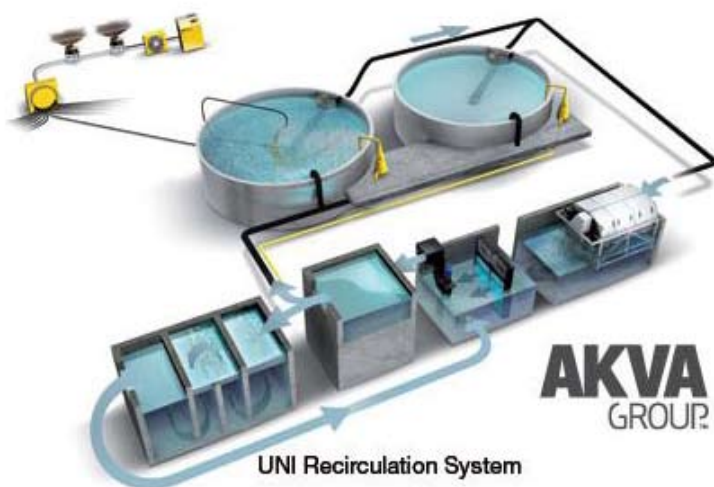
The Presidential Science Prize of Taiwan was established by the Office of the President in 2001 to promote Taiwan's position in the

international scientific community. The prize in four fields is awarded once every two years, through a selection committee to 'scholars whose works have had major impact on the development and applications of these fields in Taiwan'.



I-C Liao flanked by his wife Dr Nai-Hsien Chao (second left) and Dr. Shi-Yen Shiau (left).

Recirculation for greater amberjack in Saudi Arabia



aquaculture species. NPC also plans to establish production of 35-50,000 tonnes of yellowtail kingfish. The Akva group has already delivered a complete sea cucumber production unit and is currently constructing a biosecure brood stock system together with a shared water intake for the 5,000 tonnes production facility.

More information, Email: tseverinsen@akvagroup.com (Trond Severinsen, Chief Marketing Officer); www.akvagroup.com

The AKVA group has signed a new contract with the National Prawn Company (NPC) in Saudi Arabia for the delivery of a complete UNI-recirculation marine hatchery. The hatchery is for the culture of the greater amberjack *Seriola dumerili*.

The hatchery is located at the NPC's facility on the Red Sea coast, close to Jeddah. NPC is the world's largest fully integrated shrimp producer, and is embarking on a large fish farming project. The new hatchery will consist of brood stock facilities with egg collectors, incubation section, first feeding section and the unique Akva live feed production system operating on recirculation technology. It will be equipped with automatic dosing system for live feed, oxygen control and a back-up security system managed by a state of the art control system. It will be commissioned in early 2010.

This hatchery is part of a master plan to establish a complete land based production facility with an annual capacity of 5,000 tonnes of amberjack and other potential new



EFSA green light on human health claims for its organic selenium

Global animal health and nutrition company Alltech has announced that several human health claims relating to Sel-Plex® have been accepted by the European Food Safety Authority (EFSA). The EFSA Panel on Dietetic Products, Nutrition and Allergies (NDA) has accepted health claims linking its dietary intake to the 'protection of DNA, proteins and lipids from oxidative damage, normal function of the immune system, normal thyroid function and normal spermatogenesis'

This is the only FDA reviewed form of organic selenium and is the first to be EU approved for all animal species (Strain: *Saccharomyces cerevisiae* CNCM I-3060). Selenium is an essential nutrient for both animals and people, and plays a critical role in metabolism, normal growth, reproductive health, and immunity. Due to its specific organic form, this selenium is better absorbed and retained by the animal.

Marc Larousse, vice president, Alltech Europe, says: "Alltech has been the sole leader in submitting extensive data and research petitioning EFSA for this successful opinion for Sel-Plex. This confirms the role that this selenium plays in human nutrition and emphasizes the significance Sel-Plex has in the full food chain from the animal to the human. Alltech is committed to its pioneering role utilising nutrigenomics and gene expression profiling as an effective tool for improving nutritional strategies in both animals and humans."

(More information: Email: clombard@alltech.com (Christina Lombard); web: www.alltech.com)

International Irish Company of the Year in Asia-Pacific

Alltech was named International Irish Company of the Year in Asia-Pacific at the Business & Finance Asia-Pacific Ireland Business

Awards during the third annual Asia-Pacific Business Forum in Bangkok, Thailand. This is for its outstanding commercial success and sustainable growth over the last decade, as well as high levels of innovation, ethics and corporate social responsibility within the Asia-Pacific region.

Orla McAleer, Alltech's Asia-Pacific marketing manager said: "We are deeply honoured to be the first recipients of this prestigious award. Alltech entered the Asia-Pacific market in 1986 and since then the region has made a significant contribution to our global success. We look forward to ongoing expansion and growth in Asia-Pacific and continuing to work with our customers, colleagues and associates and to promoting science and education as well as constantly advocating safety, quality and traceability in our industry."

The awards were organised by Business & Finance magazine in association with the Asia-Pacific Irish Business Forum and the Ireland China Association. The annual Asia-Pacific Business Forum, coordinated by the Irish Thai Chamber of Commerce, serves as a business networking event for representatives from the 11 business groups in the region.

Alltech, founded by Irish scientist Dr. Pearse Lyons, has over 1,800 employees and operates in 113 countries. The Asia-Pacific market was entered through their first distributor in Japan and it opened the first Asian office in Beijing, China in 1994. Currently, it has offices in 16 countries throughout Asia-Pacific and the Asia-Pacific Bioscience Centre in Bangkok, Thailand. The 20% annual growth has been predominately organic with expected regional sales of over USD100 million in 2009.

People, Profits and Planet-The Triple Bottom Line

This is the theme for Alltech's 26th International Animal Health and Nutrition Symposium. The annual International Animal Health and Nutrition Industry Symposium gathers industry from around the world and invited speakers to learn about the latest industry technologies; their applications and implications. It will be held Lexington, Kentucky, USA from May 16-19, 2010. Attendance is by invitation only.

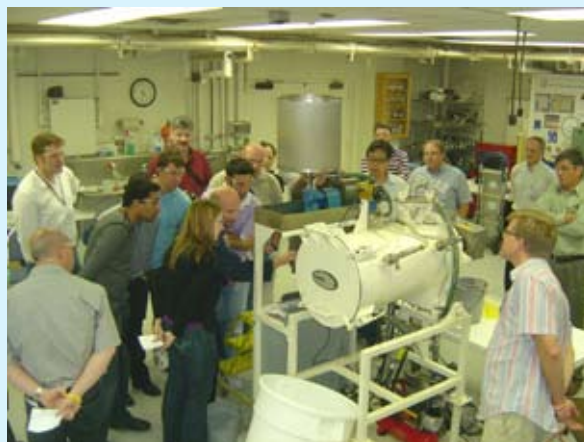
Successful FPRDC course

The 16th Annual Practical Short Course on Aquaculture Feed Extrusion, Nutrition, and Feed Management was held from September 20 to 25, 2009 on the campus of Texas A&M University.

This was a joint effort between the Extrusion Technology Program of the Food Protein R&D Center (FPRDC) and Texas A&M University's Wildlife and Fisheries Department. Dr Mian Riaz, course organiser said, "This course was truly international. We had 30 participants from 13 different countries for the demonstrations and practical instruction. These countries included Australia, Bangladesh, Canada, Ecuador, India, Jamaica, Mexico, Nigeria, Peru, Switzerland, Thailand, Trinidad and USA. American Soybean Association International Market sent 10 participants from India and Bangladesh".

There were more than 30 lectures during the course covering a wide variety of topics in the aqua feed industry. The emphasis was on four major types of extruders: dry, interrupted flight, single screw, and twin screw. Discussions also included in-depth information on how each type of extruder works and suitable raw materials. Other topics included setting up of new feed mills, feed mill organization, grinding and mixing materials, recycling wastes, coating systems, conveying, drying, conditioning, minimizing processing costs, odours in the production facility, nutrition and feeding practices, techniques for floating, sinking, and slow sinking feed and quick trouble shooting during plant operation.

"All of the FPRDC's courses are considered 'practical' and 'hands on' to allow for one-on-one interaction with qualified industry experts", added Riaz. In 2010, the course will be held September 2010. More information: Web: www.tamu.edu/extrusion; Email: mnriaz@tamu.edu (Mian Riaz).





Victam Asia bigger than ever

Victam Asia, to be held in Bangkok from March 3-5, 2010, at the Queen Sirikit National Convention Centre, is expanding its exhibition space in response to strong demand from exhibitors, said Mr Henk van de Bunt, General Manager of Victam International at a press conference in November 2009.

There are more exhibitors, larger stands and booths and more conferences as compared to Victam Asia 2008. The new event GRAPAS Asia 2010 is an exhibition and conference for rice and flour milling, industrial noodle processing and pasta processing. FIAAP Asia 2010 is the newly introduced event for feed ingredients, additives



Mr Henk van de Bunt

and formulation. These shows fit very well with Victam as it covers animal feed processing technology and ancillary equipment. Aquafeed Horizons Asia 2010 will focus on three key issues; protein sources, natural feed additives and processing efficiency in the aqua feed production sector. Additionally there will be the Thai Feed Conference, organised by the Thai Department of Livestock and the Thai Feed Mill Association.

Victam has developed a strong reputation throughout Asia as the region's foremost dedicated animal feed exhibition together with the series of conferences that run alongside it. More than 6,000 visitors and conference delegates from 65 countries is expected to attend.

Entrance to the event is free of charge for industry visitors. Registration is open at www.victam.com. Information on the current list of exhibitors together with conference programmes, delegate registration and fees are also available on the website.



Global aquaculture sustainability standards completed for tilapia

Tilapia standards represent the first set resulting from the Aquaculture Dialogues

The World Wildlife Fund (WWF) announced in December, that the WWGlobal standards have been finalised. This is the first set of completed standards produced through the Aquaculture Dialogues, a series of roundtables coordinated by WWF. The standards are the final output of the Tilapia Aquaculture Dialogue (TAD), a network created in 2005 of more than 200 people, including producers, conservationists and scientists. The standards and video are available at www.worldwildlife.org/tilapiadialogue

The tilapia standards are based on almost five years of discussion and research, as well as feedback from more than 50 stakeholders when the draft standards were posted for review. The steering committee that manages the TAD process used all of this information to develop the final product. The committee included representatives from Regal Springs Trading Company, Sustainable Fisheries Partnership, New England Aquarium, Aquamar, Rain Forest Aquaculture and WWF.

Dr. Aaron McNevin of WWF, Dialogue coordinator said, "There are other tilapia standards on the market but these standards have staying power because they were developed by a broad and diverse group of experts through a very transparent process. The standards also will

have a long shelf life because they are metrics-based, which is the only way to really know if the tilapia industry is reducing its environmental footprint. The standards will be amended over time to incorporate new science and to encourage continuous improvement on the farm."

"The certification costs will be low compared to most certification programs because the standards focus on reducing a set number of key impacts instead of a long list of issues. The relatively low cost will make it easier for small- and large-scale producers to adopt the standards", said McNevin.

The Aquaculture Stewardship Council (ASC), a new entity, operational in 2011, will be responsible for working with independent, third party entities to certify farms according to all of the standards created through the Aquaculture Dialogues process. In the meantime, this role will be filled by GLOBALGAP, a private sector body that sets voluntary standards. It will certify tilapia producers by supplementing its existing food safety, environmental and social requirements with the new standards. It will begin to offer this new certification option to tilapia producers in early 2010.

Pangasius aquaculture draft standards in last public comment stage

This is the final step in the process to create global standards for pangasius farming.

Pangasius Aquaculture Dialogue (PAD) of the WWF announced in November that it has posted on the web, the draft pangasius standards and the deadline for feedback is January 20, 2010. Feedback received during the 60-day public comment period will be used by PAD to finalise the standards in the first quarter of 2010. The process began in 2007 and includes more than 400 producers, conservationists, government officials, academics and others interested in pangasius farming. The draft standards are available at www.worldwildlife.org/pangasiusdialogue

Significant changes have been made to the PAD standards as a result of the input received from 140 people during the first public

comment period, discussions at the PAD meeting held in Vietnam in August, and meetings with small-scale pangasius farmers in Vietnam and Bangladesh.

"We welcome feedback because we know that tapping into the experiences and expertise of a broad and diverse group will make the standards more robust," said Dr. Flavio Corsin of World Wildlife Fund (WWF), who coordinates the PAD. "I am confident that, because of the open and transparent process we use, the final standards will help transform the pangasius farming industry."



Plenary on climate change and disease challenges

Australasian Aquaculture 2010 (AA2010) delegates can expect to hear from two world class plenary speakers who will talk on global issues affecting the Australian aquaculture industry. Senior Research Scientist at CSIRO Marine and Atmospheric Research, **Dr Alistair Hobday** will present a highly anticipated session on the subject of climate change.



Alistair Hobday

Hobday's research spans a range of topics including spatial management and migration of large pelagic species, environmental influences on marine species and the impact of climate change on marine resources.



Adolfo Alvia

Biologist from the University of Chile, Mr Adolfo Alvia will focus on the ISA outbreak in Chile. As Technical Director of Marine Harvest

Chile for two years, Alvia was in charge of conducting research and control measures for infectious salmon anemia (ISA) and Caligus challenges.

Mr Roy Palmer, Conference Chairman, said there are lessons that can be learnt from the ISA outbreak in Chile. "Disease can happen at any time despite all our best efforts and this can put the business in jeopardy. Adolfo Alvia has been involved all through this crisis so what a great chance to hear what occurred and maybe some solutions if the problem happens."

AA2010 delegates will be exposed to a range of relevant sessions including 'Efficient Aquaculture Production', 'Branding Strategies', 'Reducing Red Tape in Aquaculture Regulation' and a selection of other interesting topics pertinent to the conference theme 'keeping pace with change.'

AA2010 conference and trade show will be held at the Hotel Grand Chancellor Hobart from 23-26 May 2010. More information: Web: www.australian-aquacultureportal.com; Email: sarah-jane.day@aquaculture.org.au (Conference Coordinator Sarah-Jane Day) or mario.stael@scarlet.be (Mario Stael) for European companies.



Chennai to host global seafood show in February

The Marine Products Export Development Authority (MPEDA), in association with the Seafood Exporters Association of India (SEAI), is organising this three-day show at the Chennai Trade Centre from February 19 -21, 2010.

It is one of the largest seafood fairs in the Asia-Africa region. The biennial show offers a common platform for seafood processors, exporters, importers, aquaculture farmers, hatcheries, seed and feed producers to meet under one roof. The show consists of exhibition pavilions and technical sessions that offer a glimpse into the latest machinery and equipment. It will also showcase the latest technology available for the farmers as well as new insights for the processors and value addition for exporters.

The IISS offers opportunity for participants to network and exchange ideas and also to explore the possibility of strengthening trade relationships, said MPEDA. The previous shows had brought importers and exporters together and solved outstanding problems as well as created new markets for Indian seafood exports. As in previous years, there will be an exhibition with 100 stalls displaying a variety of products and machinery associated with fishery, processing and exports. Manufacturers of seafood equipment and machinery are expected to participate in the event. A large number of delegates from the importing countries such as the US, Europe, Japan and South Africa are expected. (More information: Email: premchandran@mpeda.com web: www.mpeda.com)

What to expect in AQUA CULTURE Asia Pacific Magazine in 2010

Volume 6 2010						
Number	1	2	3	4	5	6
	January/February	March/April	May/June	July/August	September/October	November/December
Issue focus <i>Current trends and challenges</i>	Aqua feed Production	Hatchery	Sustainable & Responsible Aquaculture	Health & Biosecurity	Cage Culture	Food Safety & Traceability
Industry review with <i>profiles and outlook</i>	Marine Shrimp	Marine Fish	Catfish	Freshwater Fish	Tilapia	Marine Fish
Feed Technology	Animal & plant meals	Larval feeds & processing Feed additives	Feed standards Feed enzymes	Pre and Probiotics Immunostimulants	Processing Technology Feed additives	Nutrition Novel meals & oils
Production Technology	Aeration & Disinfection Technology	Brood stock & genetic Improvement	BMP, Standards and Certification	Recirculation aquaculture technology	Feed management	Health management
Shrimp/Fish culture developments	Coverage on experiences from industry, including role models, benchmarking and opinion articles.					
Markets	Contributed reports on market trends, product development, issues and challenges.					
Show Preview/Issue	Victam 2010, Bangkok, Thailand 3- 5 March World Aquaculture 2010, San Diego, USA March 1-5	Bonus distribution: Ildex Vietnam 2010, Ho Chi Minh City, Vietnam, March 25-27 2010 ASAIM Aquaculture Conference, Bangkok, Thailand, March 21-25	Australasian Aquaculture 2010 Hobart, Tasmania 23-26 May Vietfish 2010, Ho Chi Minh City, Vietnam 12-14 June		Aquaculture Europe 2010, Porto, Portugal 6-8 October	



ILDEX Vietnam Aquaculture Conference 2010

The New Dimension for Aquaculture in Vietnam

March 26, 2010 - Saigon Exhibition & Convention Center, HCMC, Vietnam

The aim of the ILDEX Vietnam Aquaculture Conference 2010 is to discuss new dimensions in aquaculture in Vietnam as the country needs to move quickly toward sustainable aquaculture. It will be held on March 26, 2010 in Ho Chi Minh City, Vietnam.

This is a forum where leading aquaculture experts from around the region share views and visions on global aquaculture practices and trends. The conference will focus on three major issues: sustainability and certification; innovations in culture technology and feed management and development.

"We believe that a one-day conference offers a starting point for the industry to learn more about technical issues and industry challenges which should eventually translate into securing a brighter future for the entire industry," said Sirapat Kettarn, Managing Director, Spotmark, the conference secretariat.

Ildex Aquaculture Conference 2010 will be co-located with Ildex Vietnam 2010 which will take place on 25-27 March 2010 at the New Saigon Exhibition and Convention Centre (SECC), Phu My Hung, Ho Chi Minh City. Ildex Vietnam 2010 is Vietnam's leading International livestock, dairy, meat processing and aquaculture exhibition. The show is supported by the Department of Livestock Production, Ministry of Agriculture and Rural Development of Vietnam (MARD). It is organized by N.C.C. Exhibition Organizer Co., Ltd. (NEO). Well known for its emphasis on production technology for land animals, the show is now expanding to highlight technology and business solutions in aquaculture.

"Together with VNU Exhibition Europe, we can bring in international technology to satisfy local needs ranging from livestock, dairy to meat-processing and finally to aquaculture," said Ladda Mongkolchaivivat, General Manager, NEO. More information: LDEX Vietnam Aquaculture Conference 2010, Email: info@sptmrk.com; Web: www.sptmrk.com. ILDEX Vietnam 2010, Email: info@ildex.com (Lertwat Chanthatarath); Web: www.ildex.com

February 19-21

17th India International Seafood Show
Chennai, India
Email: premchandran@mpeda.com
Web: www.mpeda.com

March 21-25

2010 ASAIM Aquaculture Conference
Bangkok, Thailand
Email: organizer@soyevents.com
Web: www.soyevents.com

May 23-26

Australasian Aquaculture 2010
Hobart, Australia
Email: sarah-jane.day@aquaculture.org.au
Web: www.australian-aquacultureportal.com

February 24-26

Urban Aquaponics Conference
Brisbane, Australia
Email: wilson.geoff@optusnet.com.au

March 25-27

Ildex Vietnam 2010
Ho Chi Minh City, Vietnam
Email: info@ildex.com
Web: www.ildex.com

May 31- June 4

14 International symposium on fish nutrition & feeding
Qingdao, China
Web: www.isfnf2010.com

March 1-5

World Aquaculture 2010
San Diego, California, USA
Email: worldaqua@aol.com
Web: www.was.org

March 26

ILDEX Vietnam Aquaculture Conference 2010
Ho Chi Minh City, Vietnam
Email: info@sptmrk.com
Web: www.sptmrk.com

June 9-12

Global Conference on Aquaculture 2010
Bangkok, Thailand
Email: aqua-conference2010@fao.org
Web: www.aqua-conference2010.org

March 3-5

Victam Asia 2010
Bangkok, Thailand
Email: expo@victam.com
Web: www.victam.com

May 5-7

International Conference and Exhibition on Shrimp Aquaculture 2010
Jakarta, Indonesia
Email: donedwin@bimatama-inka.co.id

June 12-14

Vietfish 2010 – Vietnam Fisheries International Exhibition
Ho Chi Minh City
Email: quocthanh@vasep.com.vn
Web: www.vietfish.com.vn

March 3

Aquafeed Horizons Asia 2010
Bangkok, Thailand
Web: www.feedconferences.com

May 19-21

Offshore Mariculture 2010
Dubronik, Croatia
Email: iroberts@mercatormedia.com
Web: www.offshoremiculture.com

October 5-8

Aquaculture Europe 2010
Porto, Portugal
Web: www.easonline.org
Web for exhibition: www.marevent.com



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