JANUARY/FEBRUARY 2011
Volume 7 Number 1

AQUA CULTURE
Asia Pacific

Thailand leads in shrimp production

Rebound in aqua feed production

Recalculating amino acid requirements

Australian F2 progeny of the spiny lobster

Innovating the shrimp autofeeder

Show Preview -Aquatic Asia 2011

MICA (P) 008/10/2010 PP[illegible]1999/08/2011(020168)

www.aquaasiapac.com

Contents

Volume 7, Number 1 January/February 2011 MICA (P) 008/10/2010 ISBN 1793-0561

Spiny lobster picture courtesy of Lobster Harvest Ltd, Australia

Editor/Publisher
Zuridah Merican, PhD
Tel: +603 2096 2275 Fax: +603 2096 2276
Email: zuridah@aquaasiapac.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

AQUA Culture AsiaPacific is published bimonthly by **Aqua Research Pte Ltd**
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@aquaasiapac.com
Tel: +603 2096 2275 Fax: +603 2096 2276

Subscriptions
Online: www.aquaasiapac.com
Email: subscribe@aquaasiapac.com

Annual Subscription by airmail (6 issues a year)
Asia: SGD70
Other zones: SGD100

16th DSM Aquaculture Conference Asia Pacific

An interactive approach to aqua nutrition

Highlighting amino acid requirements for fish and the development of diets without fish meal and fish oil.

"The focal point of industry nowadays is sustainability. Aquaculture registered a 3.1% growth in 2009. Nevertheless, we need interactive approaches and those combining different disciplines. This is the objective of this conference, to lead industry into its next phase of growth," said **Dr Jacques Gabaudan**. Aquaculture Centre Asia Pacific, DSM Nutritional Products in his welcome to more than 300 participants at the 16th Aquaculture Conference Asia Pacific held in Bangkok on 18 November 2010.

"Since 2008, we have been focussing on fish meal and fish oil issues, be it in the commodity arena or in replacement studies. In general, prices of warm water fish have been low, although some species are experiencing better prices this year. The situation requires that the feed and culture sectors be innovative to remain profitable and expand production. In this conference, we cover topics related to changes in our industry. The price volatility and sustainability issues of feed ingredients require drastic formula changes incorporating ingredient substitutions and at the same time conserving the requirement levels of essential nutrients."

Leading the group of presenters are experts in fish nutrition and feed technology. Returning after three years to the same conference, Dr Sadasivam Kaushik, from the Nutrition Aquaculture and Genomics Research Unit, INRA, France, recounted recent achievements in fish meal and fish oil reduction in fish feeds conducted through an integrative approach of various institutions under the European Union's Aquamax programme. With regard to amino acid nutrition in fish, Dr. Dominique Bureau, of the Fish Nutrition Research Laboratory, University of Guelph, Canada, demonstrated to fish nutritionists in the audience the process to determine essential amino acids requirements in formulations and highlighting several common pitfalls in this process. Also in feed preparation, Dr. Jowaman Khajarern, from the Department of Animal Science, Khon Kaen University, Thailand, showed the effects on fish health and physiology of adventitious toxins, contaminants and adulterants present in ingredients. She also detailed out the use of several test kits developed in her laboratory.

Jacques Gabaudan (right) with Peter Blyth (left) and Dominique Bureau

A next set of presenters focused on the new regime in aquaculture which requires new ideas, particularly in feed management. Peter J. Blyth, from Business Development, AQ1 Systems Australia, related various technological advances in feeding shrimp and barramundi in ponds by using passive acoustics and adaptive control algorithms to determine the optimum feed ration. Meanwhile, Nguyen Hong Nguyen, from the WorldFish Centre, Malaysia, highlighted that through the genetic improvement of tilapia, we can see improvements in quality traits.

Several years ago, in this same conference series, Dr Chalor Limsuwan, Kasetsart University, Thailand discussed the devastation from diseases in the shrimp industry, then dominated by black tiger shrimp. At present, the industry consists of almost 90% vannamei shrimp and he focused on the white faeces syndrome occurring as a consequence of high summer temperatures. He also touched on the infectious myonecrosis virus affecting shrimp production in Indonesia.

The team from CPF, Thailand with Dr Chen Ming Dang (second from right).

Chalor Limsuwan (left) and Nguyen Hong Nguyen

White faeces syndrome in Thai shrimp

How water temperatures affect shrimp health

White faeces syndrome has been spotted in Thai shrimp farms since January 2010, affecting both black tiger and vannamei shrimp. **Dr Chalor Limsuwan** said this is common in ponds with very poor management with overfeeding and algal bloom. Ponds have poor soil bottom and low water quality, low dissolved oxygen and low alkalinity. Some 20 years ago, the white faeces syndrome was first reported in intensive shrimp ponds and *Vibrio* bacteria and protozoan gregarines were isolated. The solution for the latter was to use 10g of garlic per kg of feed.

"Current losses are moderate but I predict that we will not reach the expected high production. It was the unusually high water temperatures (33-34°C) in the afternoon which brought about the disease. In comparison, temperature was only 30°C last year. As the temperature rises, shrimp feed more and there is a tendency to increase feeds in the feeding trays."

The first signs of the disease are indicated by strings of white faeces in the water, followed by a decrease in feed consumption. This leads to loose shell syndrome and shrimp dying. Shrimp of 7-12g (50-70pcs/kg) were most affected regardless of salinity. Probiotics, immune stimulants or organic acids are suggested to overcome the problem.

Reports of the disease declined in July with the rains but its prevalence has continued. Limsuwan's advice is for farmers to stock at an appropriate density. Farms increasing stocking density to 90 post larvae/m^2 and using the same number of aerators have been more susceptible to the syndrome. Shrimp health improved when farmers were advised to stop feeding and use probiotics to improve water quality. He also recommended that the feeding rate be maintained at 30ºC and the feeding tray not be used to assess the demand for feed.

From year end until February 2011, white spot virus syndrome is expected again as the water temperature falls. This is more serious as mortality is chronic. His recommendation is for hatcheries to increase water temperature to 32±1°C for the last 7 days before stocking in grow-out ponds.

Title: New developments on white faeces syndrome and IMNV in shrimp culture by Dr.Chalor Limsuwan, Faculty of Fisheries, Kasetsart University, Thailand

Replacement of fish meal and fish oil

Using several analytical tools to derive not only best inclusion rates for growth but also healthy fish in terms of DHA and EPA levels.

Sadasivam Kaushik with Dr Mali Boonyaratpalin, DOF, Thailand (left) and Jowaman Khajarern (right).

Aquamax, an integrated EU project, was initiated in 2006 involving more than 32 research and industrial partners from 14 countries in Europe and Asia. Elaborating on the purpose of the project, **Dr Sadasivan Kaushik** notes, "There is recognition that fish is healthy and important for human well being. Aquaculture continues to contribute to the supply. However, of importance are the health and food safety aspects of seafood that we consume. Since the supply of fish meal (FM) and fish oil (FO) used in fish feeds has been stable for the past 20 years, it is crucial that we do not overly rely on fish meal and fish oil as sources of macro nutrients; and there should be a strong urge to develop feed with alternatives of a sustainable nature. An integrative approach is required to make the entire aquaculture chain sustainable in the long term."

Another aim of the project is also to see the balance between the risks and benefits involved in changes in feed composition. This is a major task which is too large for a single laboratory to carry out on its own. Different scientific groups integrated currently available tools such as metabolic, biochemical, molecular and physiological tools and looked at flesh and nutrients interactions to analyse findings. Life cycle analysis was used to assess the sustainability aspect.

Another major issue in Europe is also the welfare and health of farmed fish. Using molecular tools, the consequences on different metabolic pathways due to dietary changes were analysed to arrive at pertinent biomarkers of metabolic disturbances, health and welfare of the fish. The short and long term studies of the various species and validation of laboratory results were validated with commercial trials with feed manufacturers.

"At the end of the day, what is introduced is for the benefit of the consumers. There are four programmes: alternatives to FM and FO; benefits of fish to health; safety of fish feed on new diets and perceptions of farmed fish by the consumer. Ultimately, it is to tailor feeds to produce high quality fish."

…."Ultimately, it is to tailor feeds to produce high quality fish with very low levels of fish meal and fish oil."

The species covered were species important to European aquaculture: Atlantic salmon, rainbow trout, gilthead sea bream and cyprinids. Globally, salmonids consume 27% of FM and 67% of FO, respectively; and for marine fish the figures are 21% and 14% respectively. Carps are small consumers at 16 and 7% respectively. The targets of FM and FO in the Aquamax diets are detailed in Table 1.

Table 1. Status of fish meal (FM) and fish oil (FO) in feeds for fish farmed in Europe and Aquamax targets for fish meal and fish oil levels by 2010.

Species	2005 levels		Target levels	
	FM	FO	FM	FO
Salmon	35-47	25-33	12-16	8-12
Trout	30-35	20-25	5	5
Seabream	40-45	15-20	15	10
Carp	20-25	5-10	0	0

Feed intake and growth

In general, there was lower feed intake and growth during the first three months of the trial for Atlantic salmon fed lower fish meal and fish oils and it was not possible to catch up later in the trial. The trial showed that it was possible to grow Atlantic salmon from 70 to 1400g with feeds with 15% fishmeal. In rainbow trout, a reduction of 20% in growth was found with zero levels of fish meal and fish oil in diets.

In gilthead bream, there was no difference in growth. The fish can be fed with feeds with low FM and FO with no adverse effects on growth or feed utilisation. In Indian major carps, feeds without FM and FO performed as well as commercial feed used for common carp culture. It was not an issue as feeding fish with lower FM and FO diets is already a general practice.

Lipid metabolism

Lipid metabolism was variable in the Atlantic salmon and rainbow trout where increased body fat was evident. Fish fed decreasing FM and FO in diets modified fat metabolism but with no difference in oxidation capacities and transport mechanisms. However, feeding finishing feeds high in FO for three weeks can alter the fatty acid composition. In the rainbow trout, it was possible to tailor flesh EPA+DHA levels to meet the recommendation of w3 intake by the International Society for the Study of Fatty Acids and Lipids (ISSFAL) of 3.5g/week. After 3 weeks of finishing, 300g fish previously fed with plant feedstuffs, or even 210g of trout provide the same after 12 weeks finishing with FO-enriched feed.

Nutrient x genotype interactions

The programme also identified the genotypes with enhanced ability to utilise plant feedstuffs and those that maintain tissue n-3HUFA levels when fed diets low in n-3HUFA. The models are lean and fat (INRA)

strains of rainbow trout and One Commercial, a lean and a fat strain of Atlantic salmon. These were fed low FM and FO diets over long periods. The results indicated some heritability for flesh fatty acids composition.

Nutritional value of fish

It was reported that different salmon strains respond differently to high vegetable oil (VO) diets in terms of growth, tissue lipid distribution, lipid concentration and retention and deposition of fatty acids. For example, feeding 100% VO for 55 weeks reduced flesh DHA + EPA levels by 75%, 66% and 66% in the MH, Lean and Fat strains, respectively. However, feeding a 100% FO finishing diet for 16 weeks restored flesh DHA + EPA to 94%, 99% and 88% of values seen in fish fed FO throughout. This is already a common practice among producers and show significant savings in production costs.

Food safety

The use of plant meals and vegetable oils reduced the contamination levels of dioxin and dioxin-like PCBs load in the final fillet of the salmon. The loads of persistent organic pollutants (POPs) were reduced in the Atlantic salmon and gilthead sea bream fillet compared to current commercially farmed fish. However, the use of plant meals and oils increased levels of polyaromatic hydrocarbons (PAH, sum 16 EFSA PAHs) in the feed. The levels in fillet, however only increased marginally.

Flesh quality

To evaluate the flesh and sensory qualities, samples were sent to discerning consumer groups. Results indicated that these consumers could not detect any differences in taste and quality. Samples were then subjected to electronic nose analysis which showed distinct differences.

In the field trials, the farmer chose the feed manufacturer to produce the feeds and then carried out long term trials. The fish output were subjected to consumer taste panels. Greek consumer attitudes towards the gilthead sea bream fed on Aquamax formulations were encouraging as some even preferred the fish over wild caught fish.

FIFO ratios

When calculated using the most stringent method, post Aquamax feeds 'fish in fish out' ratios were reduced as indicated below.

Table 2. Change in fish-in-fish- out ratios.

Species	2006	Post Aquamax
Salmon	>7	3.6
Trout	6	1.5
Seabream	4.5	3.0
Carp	1.5	0.0

$$\text{FIFO} = \frac{\text{FM, \% in feed}}{\text{FM yield from wild fish}} + \frac{\text{FO, \% in feed}}{\text{FO yield from wild fish}} \times \text{Feed Gain ratio}$$

The conclusion was that in all species no serious issues as regards growth, feed utilisation or physiological well-being were detected. The aim of lowering FM and FO in fish feed was achieved despite specific constraints and addressing issues of importance in the European context, i.e. no terrestrial animal products and no genetically modified products. There were no issues on fish health and welfare, nutritional value and food safety as well as environmental sustainability. (Refer to www.aquamaxip.eu for the published formulation, information and publications).

Title: Recent achievements in fish meal and fish oil reduction in fish feeds: An integrative approach by S.J. Kaushik, Nutrition, Aquaculture & Genomics Unit, INRA, France. Email : kaushik@st-pee.inra.fr

Defining and meeting the essential amino acid requirements of fish

Are you using the right requirement levels of amino acid in fish feeds?

The mode of expression of essential amino acid requirements (EAA) of fish is a topic of disagreement between fish nutritionists. According to NRC, 1993, requirements are best expressed as a percentage of diet (% diet). The other two expressions relate to the diet energy content (g/MJ digestible energy (DE), Rodehutscord et al.1997) and dietary protein content (% protein or g/16 g N, Cowey and Cho, 1993; Mambrini and Guillaume, 1999), respectively.

"When we compare formulations, they may or may not meet the requirements according to these three modes of expression. Overall, we know that individual EAA levels deemed adequate in the diet may be different depending on: the mode of expression adopted, the composition of diet, and the amino acids profile of the ingredients," said **Dr Dominique Bureau**.

"For each of these expressions, there are certain assumptions, which can be contradictory. In % of diet, it is assumed that the diet composition has no effect on amino acid requirement (relative to the 'mass' of diet). In the g/MJ DE expression, the assumption is that the amino acid requirement is directly related to DE intake of the animal. Higher DE feeds will need to be formulated higher in EAA levels compared to lower DE feeds, since there is a lower feed intake with high DE feeds.

Finally, in the % of protein expression, it is assumed that any excess amino acid is catabolised for energy and that the first limiting amino acid is not spared compared to less limiting amino acids. It also assumes that if when the feed is formulated to amino acid levels in excess of the requirement, the excess protein must be 'balanced'.

As an example, the dietary requirement for arginine according to NRC (1993) is 1.5 % diet dry matter, whilst Rodethutscord et al (1997) gave 1.0g/MJ DE and, 4.4 % of the crude protein.

EAA values and evolution of aqua feeds

"For a long time, we have been trying to understand EAA requirements, how to meet them and formulate them into cost effective diets. In our experiments, when we express lysine in the three ways, we have up to 30% difference between the highest and lowest values. This is a large gap in my opinion. Researchers have been looking at refining estimates of nutrient requirements by using increasingly sophisticated techniques. However, they have largely forgotten that it is how this information is used in the field that matters most. Despite decades of research, we are still very much unaware of how the composition of the diet impacts EAA utilisation and requirements of fish and shrimp".

This is significant since the nutritional composition of aqua feeds has evolved quickly over the years. In the Atlantic salmon, fat levels have increased dramatically and protein levels have been reduced significantly. The composition of tilapia, carp and shrimp feeds has been evolving continuously.

Bureau's main question is how can we apply information derived from research done in the 1980s or 1990s and apply it to today's diets which have changed so much? The big questions are; how reliable are the estimates of requirement found in the literature; what is the best mode of expression and how does the composition of the feed affect the amino acid requirements of the animal?

Finding answers

Using reference values

In a study conducted to compare the effect of a high fish meal diet against those with a high corn gluten meal diet, it was found that lysine was deficient in the latter and needed supplementation. It was also shown that lysine was the limiting EAA in corn gluten diets and that the 1.8% of diet expression given in NRC was not a reliable reference value. Later results suggested that the lysine requirement was much higher. This demonstrated that feed formulators need to be more critical of published information and should refer back to the original research used to derive these reference values.

"When we look at published literature, we can find more than 300 studies conducted on EAA requirements of fish and shrimp. Rather than reinvent the wheel, these can be used to recalibrate the information on requirements. This work was initiated by researchers at INRA in France. However, it became apparent to us that only 25% of published studies could meaningfully be reanalysed to extract more information. Thus we need to foster the adoption of better experimental designs and better data analysis techniques by nutrition researchers. We need to do some training and foster dialogue between researchers and feed industry stakeholders so we can improve the quality of the experimental work done and the usefulness of results from research trials."

Broken line vs linear models

In order to generate information on the effects of diet composition on lysine utilisation and requirements in rainbow trout, Bureau and his team studied the effect of using feeds with different digestible energy levels. At two levels of digestible energy levels (16 MJ and 20 MJ) studied, the estimate of lysine requirement was identical. Using different models, the lysine requirement by the broken line method gave 1.8% of diet and with the nutritional kinetic model, the value was 2.3% of diet. This showed that the model selected for fitting the data is extremely important. Using the two estimates of requirements, the difference in weight gain was small at 10g for 120g fish but a gross 7-8% improvement in weight gain is nonetheless substantial. Feed formulators could be formulating cheaper feeds with 1.8% lysine level but the fish would not express their full growth potential. Optimising growth is essential since profitability of aquaculture enterprises is largely driven by product sales.

Lipids and lysine

A comparison with previous information confirmed that the protein level did not affect utilisation of the lysine and as such the expression of percent protein level is not recommended. When the digestible energy of the diet was increased by adding lipids, the utilisation of the lysine increased significantly but the lysine requirement expressed as a % of the diet did not change.

"This shows that fish probably catabolise amino acids for energy and that the catabolism of a deficient EAA can be further reduced by increasing lipid levels. Fish appear to be slightly different from pigs and chicken from this perspective".

Protein deposition and fillet yield

In deriving estimates of requirement, the team at the UG/OMNR Fish Nutrition Research Laboratory showed that lysine required for maximum protein gain of rainbow trout is slightly higher than that for maximising weight gain. With the exception of the broken line model, estimates of lysine requirement for protein gain appear to be 5-15% higher than those for live weight gain. However, the greater impact was with the model used for fitting the data (Table 1). From a practical point of view, a lysine level of about 2.4% of the diet appears to be adequate to maximise both weight and protein deposition in this species.

In turn, increasing dietary lysine levels appear to increase whole body protein and lysine concentrations. This could impact flesh quality and fillet yield.

"In our study, as we increased dietary lysine, the protein content and lysine gain continuously increased. In broiler chicken, yield of breast meat increases in response to lysine, more than weight gain and protein deposition. In aquaculture, integrated producers should look at the impact of amino acid composition of diet, not just on weight gain and protein deposition of the animal but also on marketable product yield and quality. To date, work has been limited on this," said Bureau.

Table 1. Varying estimates of lysine requirement using different models to fit data.

	Model			
Criteria	Four parameter logistic	Exponential	Polynomial	Broken line
Weight gain	2.11	2.68	2.23	2.19
Protein deposition	2.44	3.15	2.41	2.22

Factorial models

Bureau also discussed factorial models, increasingly used by feed manufacturers for estimating EAAs in shrimp and fish. These models are easy to construct and take into consideration water temperatures, life stages etc. Working backwards from sum of amino acid deposition for body protein deposition, maintenance, catabolism and faecal losses, the amount of amino acids is calculated based on predicted feed intake, weight gain and feed conversion ratio.

The downside of this is that these calculate requirement independently and do not take into account changes in amino acid efficiency and physiological condition as the animal grows and the impact of different components of diet on amino acid utilisation. Thus there is a need for better models.

Jacques Gabaudan and Chalor Limsuwan with participants after the conference.

Title: The challenge of defining and meeting the essential amino acid requirements of fish. By Dominique P. Bureau, UG/OMNR Fish Nutrition Research Laboratory, Department of Animal and Poultry Science, University of Guelph, Canada. Email: dbureau@uoguelph.ca http://fishnutrition.uoguelph.ca

Passive acoustics technology

A tool to regulate feeding and improve feed conversion ratios

It is through advances in mathematics and physics that this has emerged as a useful technology in monitoring and controlling feeding in ponds and cages, said **Peter Blyth**, AQ1 Systems Pty. Ltd, Australia. The company based in Hobart, Tasmania has been developing smart sensing, analysis and control technology for aquaculture production since 1990. It specialises in acoustic and optical technology for intelligent feeding systems and fish sizing technology such as hydrophone sensors and stereo video sizing, respectively.

In his presentation, Blyth said that the cost of feed is the biggest farm input (often >50%) but with the range of variables from water temperature, dissolved oxygen to lunar cycles and fish behaviour, it is impossible to predict exactly how much to feed and when. Additionally storms, rains and predators also affect feed intake. However, it is important to regulate the temporal and spatial distribution of feed accurately.

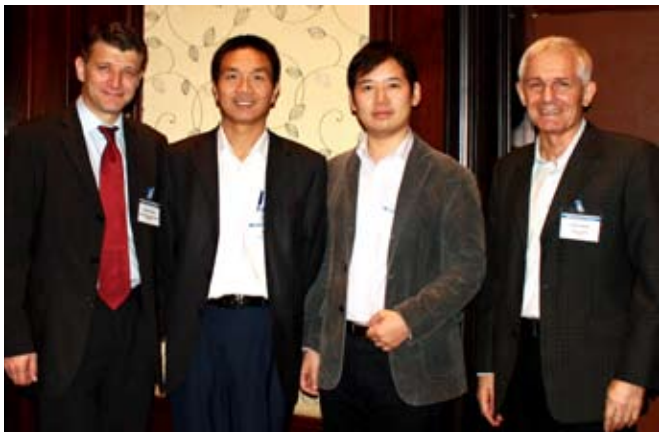
"Finfish aquaculture already uses feed sensor systems that detect feeding rate and have improved specific growth rate, feed conversion ratios, survival and reduced waste feed. Visual observation of feeding activity in ponds is not viable whilst feed trays are usually sampled well after the point of feed ingestion and can provide inaccurate feed intake data due to pellet degradation.

"In EU funded trials in Spain and Greece, FCR improved from 1.36 by manual feeding to 1.16 by sensor feeding for the sea bass. Similarly it changed from 1.86 to 1.6 for the sea bream. It is equally important that the sediment carbon input declined by 23.1% during the production cycle. The control feeding regime reduced waste output."

Sound feeding technology

Barramundi is a noisy feeder

In Australia, AQ1 began research on feeding by sound for the barramundi (*Lates calcarifer*) 5 years ago in co-operation with Australian Barramundi Culture Pty Ltd, Darwin. Currently barramundi farms in Australia average FCRs ranging from 1.5 to 2.5. The need is to control feeding by delivering feed when the fish wants to eat is key, as they are crepuscular feeders and consume food even in turbid water conditions. The system deployed in barramundi ponds and cages uses data from passive acoustic sensors to control feeding (hydrophone). At the same time, advanced algorithms identify feeding sounds and control feed. A detailed database for historical viewing and future modelling is also available.



The DSM Team, from left, Dr Christos Antipatis, Regional Marketing Manager Asia Pacific, Wen Ming, Technical Executive and Jack Wu, District Sales Manager, DSM (China) Limited, and Robert Redman, GM-Regional Manager, Indochina.

From left, Candra Yanuartin, PT Sinta Prima Feedmill, Suaedi Sunanto, DSM Nutritional Products Indonesia and Virnanda Hapsara, CJ Feed Indonesia

"Interestingly, the barramundi is a noisy feeder and showed a three stage feeding pattern; high feeding activity followed by relaxed feeding and cessation of feeding by most fish. The variation in feeding within the day and between days can be linked to environmental conditions. Controlled using passive acoustic feeding resulted in a 12% improvement in growth and a lowering of the FCR to 1.45 as compared to the previous farm average of 1.6 to 1.8 when fed by mechanical blower," said Blyth.

Shrimp feeds more during day

In conjunction with Gold Coast Marine Aquaculture, Queensland and CSIRO, a study was carried out in several 0.3ha ponds stocked with around 150,000 post larvae of tiger shrimp in late September which by January averaged 16g with a biomass of 13.3 tonnes/ha.

"In the shrimp, the need for sound feeding technology to control feeding is also because food intake is a key indicator of shrimp health status or other biological issues such as moulting, pellet palatability, disease etc. Measuring actual instantaneous intake is critical to shrimp growth (to avoid under or over feeding) and to pond health by avoiding waste."

Shrimp feeding sounds were generated in the 1-20kHz range. Feed intake occurred mainly in daylight and quickly during the first 10-20 minutes. Feed intake and noise generated post-feed input were linearly related (r^2=0.8236). Nutrient leaching from pellets is a real issue that should be considered in order to ensure feed is eaten rapidly when offered as shown by Smith et al, (2002) where 12% of dry matter was lost by 4hr of immersion in water and nitrogen loss was at 15% by 2 hours after immersion. At the end of the trial in April 2010, shrimp averaged 43g with a yield of 22 tonnes/ha and an FCR of 1.4.

Generally, these novel feeding technologies are needed to achieve productivity improvements. In ponds where visibility is limited, passive acoustics is one of the best methods to gather feeding data from this environment and use this data to effectively regulate subsequent intake. Adoption of the technology is progressing with further replicated trials commencing in Australia, South East Asia and the Americas with particular focus on the vannamei shrimp.

Title: Recent technological advances in feeding shrimp and barramundi in ponds –the use of passive acoustics and Adaptive© control algorithms to determine optimum feed ration. by Peter J. Blyth, AQ1 Systems Pty. Ltd., Australia. Email: pblyth@aq1systems.com

Adventitious toxins, contaminants and adulterants in fish and shrimp

Focussing on the effects of introduced contaminants

The limited supply and relatively high price of marine and animal feed ingredients are directing feed formulators towards plant meals. However, plant meals are associated with naturally occurring anti-nutritional factors (ANFs) and toxins. These toxins can have a wide variety of effects ranging from reduced growth to severe toxicity and death.

"Protein meals (soybean meals and fish meal) are often in short supply and exhibit a variation in quality aspects or nutrient availability. Additionally, since these protein sources have high unit costs, the company must establish not only quality standards for the purchasing unit but also a method for examining physical qualities, especially for foreign materials, moulds and toxins, which is fast, accurate and practical. Receiving operators need to be well trained to recognise the quality of raw material visually and carry out quick physical and chemical examinations as well as know the proper methods of sampling," said **Dr Jowaman Khajarern**.

Some of these variables in feeds and feed ingredients were discussed. Different processing techniques will yield products or by-products of different qualities. Meat meal produced from wet rendering has a different colour, odour and protein content when compared to meat scrap produced by the dry rendering process. Adulteration is another important introduced variable at the point of processing. Higher priced and higher quality ingredients are intentionally contaminated with cheaper and lower quality ingredients to reduce the cost and nutritive quality to just meet the specification.

The most common is melamine adulteration in squid meal, fish meal and soybean meal. Elaborating on the health effects of melamine contaminant in the marine shrimp and several species of fish, Jowaman finds that there is swelling and deposits of crystals in the intestinal tract in marine shrimp, as well as edema and swelling of the hepatopancreas and head. In fish, the effects are black skin and swelling stomach in catfish, and loose scale, pale skin syndrome, scale erosion and liver and ovary damage in tilapia. Histological examination shows crystalline spherulites and granuloma around the crystal deposits of melamine cyanurate in trout kidneys.

Aflatoxin (Aspergillus sp.) contamination in catfish results in necrosis in several areas and broken liver function poisoning when fed with 120 ppb and 240 ppb of AFB1 after 22 weeks. Aflatoxin contamination in the catfish showed haemorrhaging in the tail and the pancreas. In tilapia fed on a diet containing 100 ppm aflatoxin, the liver showed basophilic, spindle shaped cells surrounding necrotic hepatocytes.

Title: Effects of ingredient adventitious toxins, contaminants and adulterants on fish health and physiology by Jowaman Khajarern, Department of Animal Science, Faculty of Agriculture, Khon Kaen University/and Faculty of Veterinary and Animal Science, Mahasalakam University, Thailand

Genetics of flesh quality in fish

Genetic improvement has led to substantial increase in productivity in farmed animals and in tropical fin fish, this is evident in tilapia. The GIFT (Genetically Improved Farmed Tilapia) strain of Nile tilapia (*Oreochromis niloticus*) has been developed by the WorldFish Centre (formerly known as ICLARM), Norwegian Institute of Aquaculture Research and national research partners from Philippines (1988-1998) and from Malaysia (2000- present). Over many generations of selection, the fish show several favourable characteristics: fast growth, high fillet weight, good flesh quality, disease resistance and good adaption to various farming systems.

In discussing genetic aspects of flesh quality in the GIFT strain, **Nguyen Hong Nguyen** said, "Four groups of traits were studied. They included carcass traits (fillet weight and fillet yield), flesh composition (%protein, %fat and %moisture), flesh quality attributes (pH, colour) and fatty acid composition. Over a study period of three years (2006 to 2008), a total of 5322 individual fish at an average body weight of 530g was slaughtered. Fillet samples were randomly taken across families, selection lines, sex, batch of filleting within generations and were sent to a specialised laboratory for the analysis of flesh quality attributes."

The team at WorldFish found that in GIFT tilapia there was genetic variation in flesh quality traits which provides scope for genetic improvement. The heritability for fillet weight and yield was moderate (20-33%). Low to moderate level (0 to 24%) of genetic variation was observed for flesh composition (protein, fat and moisture contents) and pH and color were lowly heritable (4-5%).

"We also examined the effects of selection on flesh quality of GIFT tilapia. The selection programmes for high growth rate in GIFT has resulted in a significant increase in fillet weight. The accumulated response in fillet weight up to the latest generation of selection included in this study (corresponding to the spawning season in 2008) was 23%. In contrast to fillet weight, change in fillet yield was non-significant. There was very limited impact of selection for increased growth rate on flesh quality traits and fatty acid composition."

Nguyen and his colleagues at the WorldFish Centre concluded that there was a potential for genetic improvement for flesh quality. Selection for high growth rate increased fillet weight. There was no detrimental effect on flesh quality. However, a close monitor of correlated changes in economically important traits as a result of selection for high productivity is recommended in breeding programmes.

Title: Genetic improvement of fillet traits and flesh quality in aquaculture species by Nguyen Hong Nguyen and Raul W. Ponzoni, The WorldFish Centre, Penang, Malaysia. Email: n.nguyen@cgiar.org