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Polyculture of marine shrimp and giant freshwater prawn in Thailand. p22.

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From the editor

- 2 Ten Points in our 'To Watch List' for 2024

Industry News

- 4 US investigates antidumping and countervailing duties on frozen warmwater shrimp
6 New appointment and MOU on shrimp welfare

Hatchery and Nursery

- 8 Feed supplementation with a *Bacillus* probiotic blend for control of pathogenic *Vibrio* in cultured shrimp
Rex Ferdinand M. Traifalgar, Rowena E. Cadiz, Emelyn Joy G. Mameloco, Fredson H. Huervana, Carmelo del Castillo, Mark R Napulan, Ramir Lee and Craig L. Browdy report on trials in the Philippines
13 Commercial production of all-male giant freshwater prawn post larvae in Thailand
LST produces uniform all-male post larvae and next is genetic improvement of the Thai strain.
By Zuridah Merican
17 It all starts at the hatchery level
Critical for profitability and future success in farms are the basics and adapting management protocols to genetic lines, says the panel at TARS 2023

Shrimp Aquaculture

- 22 Polyculture of marine shrimp and giant freshwater prawn in Chachoengsao Province
The astonishing success with vannamei shrimp, say Zuridah Merican and Soraphat Panakorn
24 What does it take to produce sustainable Asian shrimp?
Navigating the wave of sustainability in shrimp aquaculture by the TARS 2023 Hard Talk panel

Feed Technology

- 30 Field application of a synergistic blend of organic acids to promote growth performance of fish and shrimp
I-Tung Chen, Martin Guerin, Gilberto Hernández, Mèrce Isern | Subich and Waldo G. Nuez-Ortín investigate.
34 'You are what you eat': Enhancing fish gut health for optimal feed performance
Mikael Herault and Kyeong- Jun Lee discuss the potential of marine protein hydrolysates in red seabream
38 The power of nutrition for the industry in Asia
Report on dsm-firmenich's 28th Aqua Conference Asia Pacific on assessing ingredients and towards consistent quality shrimp feeds

Interview

- 42 Revolutionising global shrimp aquaculture with precision diagnostics
Dedicated on reducing risks by reshaping health and disease diagnostics, Genics' Melony Sellars talks to AAP.

Industry Review on Marine Shrimp

- 44 Asian marine shrimp in 2023: Reflections with lowest prices in a decade
Zuridah Merican reviews how low prices started the 'stop and start' trend.
48 Marketing amidst resurgence in supply for Asia's black tiger shrimp in 2023
An exploration of market trends and strategies for this "pride of Asia"
52 Trade, supply, and consumption at the second Global Shrimp Forum

Show Review

- 55 Aquaculture Europe in 2023, August 2023
The people, science and products.

Company & Event News

- 60 Appointments
62 Humane stunning of shrimp



Zuridah Merican

Ten Points in our 'To Watch List' for 2024

The aquaculture outlook for 2024 will be highly dependent on the state of the global economy. Economists have forecasted the US Federal Reserve to start cutting interest rates in the 2nd half of the year while China is expected to face deflation. The US, China and Europe are our 3 largest markets and hence will determine the demand side. Will these actions lower the market prices of aquaculture products and increase consumption? What will drive aquaculture's growth in Asia?

To be concise it may be best to look at Asia-Pacific's aquaculture position from the following perspectives:

Shrimp

1. Shrimp already faces an oversupply situation with Ecuador expecting to reach 1.4 million tonnes production in 2023, a 12% increase. China is expected to import a million tonnes of shrimp, albeit, at much lower aggregate prices on a per kg basis. The latest 3rd quarter 2023 shrimp imports in the US have shown to be robust ie. showing y-o-y increases and may finish the year close to 800,000 tonnes, again at lower per kg prices.
2. These low prices will cascade to farmgate prices putting pressure on farmers to skip cycles in order not to lose money. AAP's Sep/Oct23 quick review of farmgate prices shows Ecuador with the lowest prices. Will Ecuador increase its market share as a low-cost producer, and will we see more consolidation in-country?

3. The US Department of Commerce has announced the initiation of antidumping duty investigations on Ecuador and Indonesia and countervailing duty investigations on Ecuador, India, Indonesia and Vietnam. The case calendar has listed June 17 and April 2, 2024, respectively, as dates for final determinations. Arguably, Indonesia faces the biggest challenge as more than 70% of its exports is bound for the US and pivoting to other markets may not be happening so quickly.

Fish

4. Tilapia from China still faces a 25% import duty into the US which places Central American countries and Brazil at an advantage.
5. Pangasius production in Vietnam will achieve 1.6 tonnes in 2023 but the export value is expected to fall 25% compared to the previous year. 2024 will see continued price pressure and China will be the largest buyer.
6. Although marine fish aquaculture has been targeted as the third leg for expansion in Asia, this has not taken off as expected. TARS 2024 Finfish Aquaculture: 'Steering an Industry into Focus' on August 14-15 will review the challenges and look for strategies for growth.

Feed

7. Both soybean meal and corn prices have fallen nearly 30% over the past 12 months. The price outlook will remain subdued as the US government offers incentives to produce renewable energy like ethanol from corn. The co-products will have to find a market in the feed sector. Conversely, fishmeal prices have increased 25% over the past 5 years. The recent increase has been due to El Niño affecting the fishing quotas off the coast of Peru. According to Rabobank, this will persist for the 1st half of 2024.

8. Overall, feed prices are expected to fall. Faced with lower shrimp farmgate prices, many countries in Asia are promoting lower crude protein feeds at lower prices to help farmers maintain margins. Together with smart feeding, the benefits could be reduced sludge accumulation and hence the threat of disease.
9. There will be a push for sustainable feeds coming from sustainable ingredients which carries with it a cost. Certification bodies are working along the supply chain to create this pull from the retail end.

Supply chain

10. Freight rates from Asia to Europe have doubled to USD4,000 and will continue to remain high as ships avoid the Suez Canal route. Due to low water levels, the Panama Canal has capped the daily number of vessels traversing this channel. The traffic jams at Panama together with sailing longer distances around Africa will tighten the availability of ships.

As often said, the industry in Asia is resilient and will continue to provide seafood to the world. After all, 2024 in the Chinese Zodiac is a Wood Dragon year, making it the perfect time for rejuvenated beginnings and setting foundations for long term success!

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If you have any comments,
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Antidumping and countervailing duty investigations of frozen warmwater shrimp from Ecuador, India, Indonesia, and Vietnam



On November 15, 2023, the US Department of Commerce (Commerce) announced that it will initiate antidumping duty (AD) investigations of frozen warmwater shrimp from Ecuador and Indonesia and countervailing duty (CVD) investigations of frozen warmwater shrimp from Ecuador, India, Indonesia, and Vietnam.

On December 8, 2023, in a press release, the USITC announced that it has determined that there is a reasonable indication that the US industry is materially injured by reason of imports of frozen warmwater shrimp from Ecuador and Indonesia that are allegedly sold in the US at less than fair value and subsidised by the governments of Ecuador and Indonesia and imports of frozen warmwater shrimp from India and Vietnam that are allegedly subsidised by the governments of India and Vietnam.

The petition

This latest development came about after the American Shrimp Processors Association (ASPA) filed trade petitions on October 25, 2023, seeking antidumping duties on imported frozen warmwater shrimp from Ecuador and Indonesia and countervailing duties on imported shrimp from Ecuador, India, Indonesia, and Vietnam. The claim was that the US shrimp market has been overwhelmed by massive quantities of underpriced shrimp imports, resulting in unsustainably low dockside prices, falling domestic market share, significantly lower profit margins, and historically high inventory levels.

Imports from the four countries were valued at over USD6.6 billion in 2022, accounting for over 90% of all imported frozen warmwater shrimp. ASPA estimates dumping margins for Ecuador ranging as high as 111% and dumping margins for Indonesia ranging as high as 37%. In addition, ASPA documented dozens of government subsidy programs benefitting shrimp farmers and processors in Ecuador, India, Indonesia, and Vietnam, including subsidised loans, tax concessions, grants,

export credits, and the provision of land, water, and other inputs. This should bring a measure of market correction and needed relief to the entire domestic shrimp industry.

ASPA said that shrimp imports from the four countries increased by more than 200 million pounds (90,909 tonnes) from 2020 to 2022, taking market share from an already vulnerable domestic industry. Imports also deeply undersold domestic shrimp, driving down prices to historically low

levels in 2023 for both fishermen and processors. As a result, the domestic industry's profit margin has all but disappeared, threatening the future viability of an industry that is critical to the Gulf region's economy and cultural heritage.

Dates to follow

Since two determinations are affirmative, full investigations at both agencies will last into the fall of 2024. Henceforth the dates in 2024 will be as below.

	AD	CVD
Commerce Preliminary Determinations	April 2, 2024	January 18, 2024
Commerce Final Determinations	June 17, 2024	April 2, 2024
ITC Final Determination	August 1, 2024	May 17, 2024
ITC Final Determination	August 8, 2024	May 24, 2024

Subject of this investigation

The products are certain frozen warmwater shrimp and prawns whether wild-caught (ocean harvested) or farm-raised (produced by aquaculture), head-on or head-off, shell-on or peeled, tail-on or tail-off, deveined or not deveined, cooked or raw, or otherwise processed in frozen form and sold in any count size.

Responses

Indonesia

The Aquaculture Directorate of the Ministry of Marine Affairs indicated in local news outlets that it is prepared to handle AD and CVD cases, especially in preparing explanations for policies or programs that are deemed as subsidies, especially in the fisheries sector, such as facilitating financing for the fisheries sector, and insurance for small-scale farmers, explained the Director General of Strengthening the Competitiveness of Marine

Ecuador	2020	2021	2022
Volume (kg)	120,784,034	177,592,689	191,336,456
Value (USD)	751,319,529	1,319,205,859	1,435,206,138
India	2020	2021	2022
Volume (kg)	270,489,085	339,249,031	301,665,803
Value (USD)	2,327,252,331	2,952,490,962	2,735,705,599
Indonesia	2020	2021	2022
Volume (kg)	145,914,035	150,599,111	139,538,956
Value (USD)	1,320,948,672	1,400,354,851	1,400,352,373
Vietnam	2020	2021	2022
Volume (kg)	54,045,058	73,355,461	51,200,829
Value (USD)	599,425,277	851,362,219	645,170,500

Source: U.S. Census Bureau, accessed through S&P Global Trade Atlas (Harmonized Tariff Schedule of the United States (HTSUS))

and Fishery Products (PDSPKP), Budi Sulistiyo in a written statement on 6 January 2024.

India

The Seafood Exporters Association of India (SEAI) and Marine Products Export Development Authority (MPEDA) will be providing the required data to the US to counter allegations by ASPA. The vice president of MPEDA and president of SEAI, Jagdish Fofandi said, "ASPA claimed that the export from India is subsidised by the Indian government. The RoDTEP scheme for the exporters is according to the compliance of WTO (World Trade Organisation)." If India fails to convince the US not to impose the AD and CVD, the export of Indian shrimp exports to America will become costlier by 6 to 10%.

Vietnam

Responding to this lawsuit is considered arduous and difficult, requiring the consensus of relevant businesses

and ministries. Trinh Anh Tuan, Director of the Trade Remedies Department (Ministry of Industry and Trade) said that now Vietnam is being investigated for the second time with many charges. "Over the past 10 years, the current investigation has had a number of changes, including investigating new alleged subsidy programs and changing the list of related businesses."

Accordingly, the US is investigating frozen warm water shrimp under the HS codes 0306.17, 1605.21, 1605.29. Although Vietnam's frozen warm water shrimp products were only investigated for anti-subsidy, the number of plaintiff's alleged programs in the US was much larger, so the DOC decided to investigate all 40 programs. Many of the alleged programs have new and complex content, involving several ministries, branches, and localities at various levels. The alleged subsidy programs include provisions of goods or services for less than adequate remuneration, preferential lending, export credit programs, tax programs, grant programs, and other subsidies. A notable point is that DOC also investigates a series of programs under the fisheries development strategy and fisheries industry development program.

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- Initiation of AD and CVD investigations of Frozen Warmwater Shrimp from Multiple Countries <https://www.trade.gov/initiation-ad-and-cvd-investigations-frozen-warmwater-shrimp-multiple-countries>
- Trade petitions, including public copies of ASPA filings, <https://americanshrimp.com/trade-case/>.
- Information regarding the antidumping and countervailing duty petitions on Frozen Warmwater Shrimp from Ecuador, India, Indonesia, and Vietnam. <https://www.whitecase.com/insight-alert/information-regarding-antidumping-and-countervailing-duty-petitions-frozen-warmwater>

Sunset review for current AD petition

In the latest sunset review for the existing AD orders on frozen warmwater shrimp from China, India, Thailand, and Vietnam on June 1, 2023, the USITC affirmed determinations. As a result, the existing orders on imports of this product from these countries will remain in place. The next sunset review on these antidumping duty orders will be in June of 2028. https://usitc.gov/press_room/news_release/2023/er0601_63963.htm

Chronology of events

- December 31, 2003. The US Southern Shrimp Alliance (SSA) filed a complaint with the U.S. Department of Commerce (DOC) and the US International Trade Commission (USITC) to impose antidumping duties on shrimp imports from Ecuador, Brazil, India, China, Thailand, and Vietnam.
- February 17, 2004. USITC determined that there was enough evidence to support the claim made

by the SSA that the six countries are unfairly selling their shrimp in the US market.

- November 30, 2004. DOC announced final duties for China and Vietnam as: Brazil - 4.97% to 67.80%; China- 0.07% to 112.81%; Ecuador-1.97% to 4.42%; India-4.94% to 15.36%; Thailand -5.29% to 6.82% and Vietnam -4.30% to 25.76%.
- June 4, 2007. DOC eliminated the AD on frozen warmwater shrimp imported from Ecuador after the World Trade Organisation (WTO) ordered a recalculation of the duty rates.
- May 2, 2017. In the 5-year sunset review USITC revoked the AD order on shrimp from Brazil.

Reference

- Owusu-Kodua, Derrick. (2016). Anti-Dumping Measures on Shrimp Imports –: A Case Study of the Dispute between the U.S. Southern Shrimp Alliance (SSA) and Shrimp Exporters from China, India, Thailand, Vietnam, Ecuador, and Brazil. 10.13140/RG.2.1.4131.8488.

Castex to succeed Le Treut as Lallemand Animal Nutrition President, General Manager

In December, **Lallemand** announced that **Mathieu Castex**, PhD., will succeed Yannig Le Treut, DVM, as President & General Manager of Lallemand Animal Nutrition on Feb. 1, 2024. Castex comes to the position after serving as the company's Director of Research & Development since 2014.



Le Treut successfully led Lallemand Animal Nutrition since 2012. To ensure a seamless transition, he will take on the role of Senior Vice President & Special Advisor at the Lallemand Group level, while supporting Lallemand Animal Nutrition's management team and leadership transition over the next several years.

"I am extremely pleased that, in Mathieu, we have a leader with a strong scientific background, aligned with the product offerings we have for our customers around the world. In addition, his product management and commercial experience make him an excellent choice to build on the success Yannig achieved over the past decade leading the Lallemand Animal Nutrition

team," said Bill Nankervis, Executive VP and COO of the Lallemand Group.

Castex added, "I am delighted to be able to continue to channel my fervour for microbiology, animals and animal breeding in the service of the Animal Nutrition business unit. I am honoured to be entrusted with succeeding Yannig in leading this remarkable team and business, which he played an integral role in establishing and strengthening. I am confident that our specialised teams – when coupled with science-based products, innovation, and our dedication to customer satisfaction – represent a winning formula for success for us, our partners, and our industry."

Castex joined Lallemand Animal Nutrition in 2009 as the product manager leading the yeast derivatives and aquaculture portfolio. He graduated from AgrosParisTech in Paris, France, now part of the University Paris-Saclay, and holds a doctoral degree in microbiology and physiology of nutrition. Castex's experience includes research and development, product management and business development within animal nutrition and health. www.lallemand.com

Partnering Can Tho University to enhance shrimp welfare in Vietnam

This groundbreaking partnership promises to shape the future of aquaculture practices in the region. FAI Farms has joined forces with Can Tho University to advance shrimp welfare in Vietnam. Welfare remains poorly understood despite the extent and importance of shrimp farming to Vietnam and other Asian countries. Through this pioneering collaboration, both parties aim to progress the science, set new standards, and foster sustainable practices in the Vietnamese aquaculture industry.

The partnership was formalised during a dedicated welfare session at the 11th International Fisheries Symposium (IFS) held in Bangkok in November. FAI Farms signed a Memorandum of Understanding (MOU) with Can Tho University, outlining a comprehensive plan to evaluate and improve how shrimp welfare is assessed and managed in Vietnam.

"The focus is on whiteleg shrimp *Penaeus vannamei* welfare in Vietnamese trial farms, using our industry-leading welfare assessment protocol," explained FAI Farms Aquaculture Project Manager, Marius Nicolini. "By involving Vietnamese scientists, we are using the strength of collaboration to increase understanding and influence practices related to shrimp welfare. It will play a pivotal role in promoting sustainable and ethical farming methods within the aquaculture industry in Vietnam.

"Engaging farmers in discussions about welfare is not always straightforward or easy, and it requires them to view their animals from a new perspective. It is vital for them to remember when animals are living their best lives, they also achieve higher and better quality levels of production."

The dynamics of the fish farming market in Asia differ significantly from other regions globally, and FAI Farms believes cooperation between countries is crucial to improve welfare. "By tailoring welfare practices to the unique conditions in Asia, the region can emerge as a leading advocate for exemplary fish and shrimp care on a global scale," added Marius. www.faifarms.com



Marius Nicolini (third left) with the team from Can Tho University: Researcher, Huynh Phuoc Vinh (left), Vice Dean Tran Minh Phu (second left) and Dean Vu Ngoc Ut (third right) and from FAI Farms CTO, Ralf Onken (second right) and Project Manager, Pau Badia (right).

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Feed supplementation with a *Bacillus* probiotic blend for control of pathogenic *Vibrio* in cultured shrimp

An effective strategy against mass mortalities caused by *Vibrio harveyi* and *Vibrio parahaemolyticus* infections in cultured *Penaeus vannamei*

By Rex Ferdinand M. Traifalgar, Rowena E. Cadiz, Emelyn Joy G. Mameloco, Fredson H. Huervana, Carmelo del Castillo, Mark R Napulan, Ramir Lee and Craig L. Browdy

The farming of *Penaeus vannamei* is a billion USD industry. However, with the intensification of culture systems to meet a growing market demand, the farming is challenged by emerging pathogens, threatening the economic viability and sustainability of this industry. To date, the industry has been stricken with serious economic losses due to the outbreaks of bacterial pathogens that include *Vibrio parahaemolyticus* and luminous *Vibrio harveyi*. *V. parahaemolyticus* is known as the causative agent of the early mortality syndrome (EMS), technically known as acute hepatopancreatic necrosis disease (AHPND). This disease is caused by a strain of *V. parahaemolyticus* (VpAHPND) with insect neurotoxins that are highly pathogenic to shrimp. It has been associated with mass mortalities in shrimp farms across the Asia-Pacific region. Luminous vibriosis disease caused by *V. harveyi* is an important bacterial pathogen in cultured shrimp and is known to cause shrimp mortalities of up to 100% in hatcheries and grow-out operations.

The efficient control of bacterial fish pathogens with the application of probiotics is well established. Similarly, there have been some reports on the application of lactic acid probiotic bacteria to control AHPND infections in shrimp. However, information on probiotics that are effective in controlling both pathogenic luminous *V. harveyi* and VpAHPND is very limited or non-existent. Also, the effectiveness of an applied probiotic consortia to control disease-causing *Vibrio* in shrimp has not been fully evaluated.

This article describes work conducted to evaluate the effectiveness of a mixed-species *Bacillus* probiotics

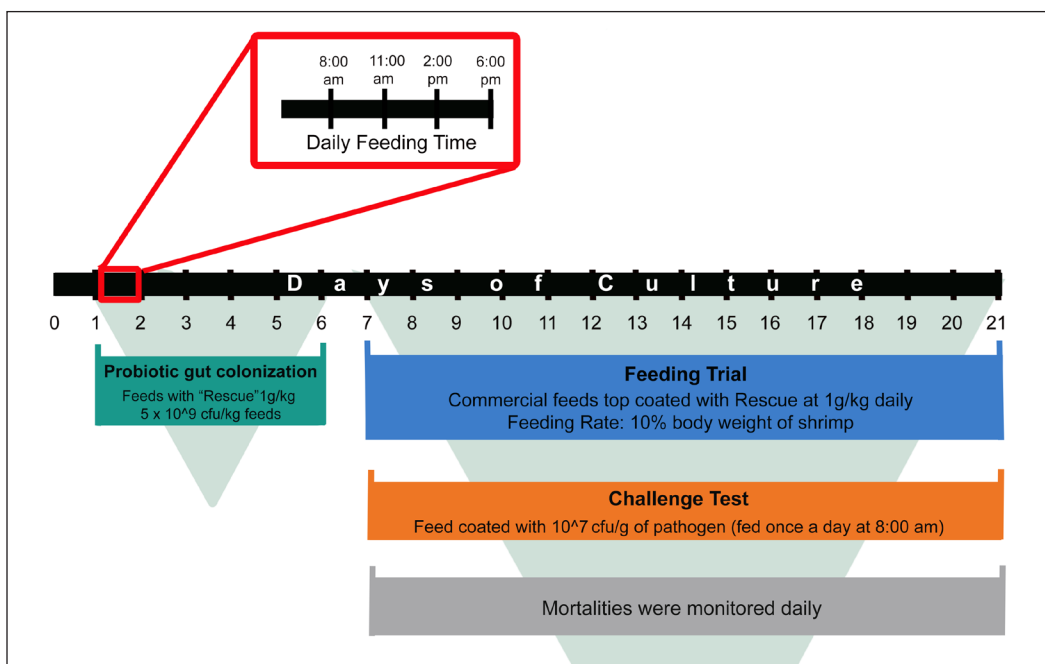
to prevent infection caused by luminous *V. harveyi* and VpAHPND in cultured juvenile *P. vannamei*.

Feeding trial

To evaluate the efficacy of the mixed *Bacillus* species probiotics, a feeding trial was conducted using groups of *P. vannamei* that were maintained with diets supplemented with the test probiotics and a control that received no probiotic supplementation. The probiotic blend evaluated in this study was a selected mixed *Bacillus* species probiotic (Rescue™ Zeigler USA) that is known to exhibit inhibitory properties against *Vibrio*.

The test juveniles (mean weight, 1.0g) were obtained from a local hatchery in Panay Island, Philippines. The trial had five treatments in triplicates. Experimental shrimp were randomly distributed in 15 plastic tanks of 135L capacity at a density of 80 shrimp per tank. The treatment group includes the negative control (one group), the positive controls (two groups, one for *V. harveyi* exposure and one for *V. parahaemolyticus* exposure), and the two treated groups receiving the Rescue supplemented diets (one for *V. harveyi* exposure and the other for *V. parahaemolyticus* exposure).

The negative control group was maintained with diets without probiotic supplementation and was not exposed to the pathogens. The positive control was maintained with diets without probiotics supplements but was exposed to *V. harveyi* and *V. parahaemolyticus* pathogens. The treated group was maintained with probiotic supplemented diets and was exposed to the test bacterial pathogens.





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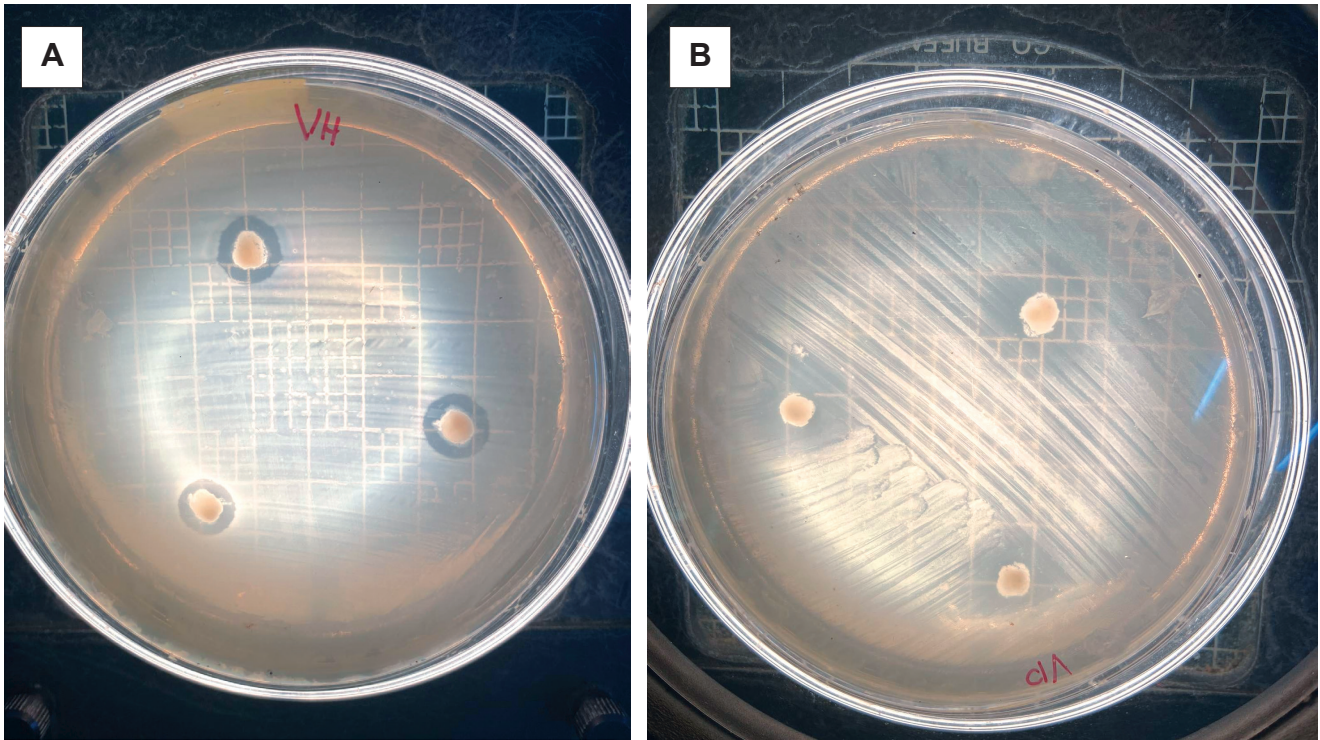


Figure 1. *Vibrio harveyi* (A) and *Vibrio parahaemolyticus* (B) bactericidal activity of Rescue™ probiotics. Spot in Lawn Assay, Mueller Hinton Agar with 2% NaCl, 24-hour incubation.

The experimental animals were fed daily at 10% of their body weight. The feed allocation was divided equally into four feed rations given at 8:00am, 11:00am, 2:00pm and 6:00pm. Before the start of the pathogen exposure test, the treated groups (two groups) were fed with probiotics-supplemented diets (Rescue, 1g/kg, 10^9 CFU/kg feeds) for 6 days to initiate probiotic gut colonization. Following the 6-day pre-feeding period, the pathogen exposed groups were challenged during the 8:00am feeding only, with diets top coated with *V. harveyi*, and *V. parahaemolyticus* at a LC50 concentration of 10^7 CFU/g feed.

During the trial, dead shrimp were recorded and collected daily in each experimental group and the mortality rates between the control groups and the experimental groups were calculated. The trial was terminated on day 21, 15 days after pathogen exposure.

To confirm the mechanism of *Vibrio* inhibitory activity of the probiotic, an *in vitro* plate inhibition assay was also performed to evaluate the bactericidal activity against *V. parahaemolyticus* and *V. harveyi*. Direct bactericidal activity of the probiotic was evaluated as a clear zone of inhibition when the probiotic was spotted in the lawn of the pathogens plated in a solid media.

Results were analysed using SPSS16 with a significance level set at 0.05. Bacterial counts were log-transformed before being subjected to a one-way analysis of variance (ANOVA) to determine if there were differences among the treatments for each sampling time. The results with significant differences were subjected to post-hoc analysis using Tukey's Test.

Inhibition of pathogenic *Vibrio*

Results from this trial confirmed that Rescue probiotics exhibited potent bactericidal activity against the test pathogens, *V. parahaemolyticus*, and *V. harveyi*. Direct bactericidal activity of the probiotics manifested as a clear zone of inhibition when the probiotic was spotted in the lawn of the pathogens plated in a solid media (Figure 1 A and 1B).

Total gut *Bacillus* counts

Results indicated that dietary supplementation of the mixed *Bacillus* probiotics influenced the total gut *Bacillus* counts in the treated shrimp group as compared to the control groups (Figure 2). Total *Bacillus* counts in shrimp gut in the Rescue treatment group showed a significant increase starting from day 3. The significant increase in gut *Bacillus* contents during the early phase of the rearing indicated colonization of the applied probiotics on the shrimp gut. *Bacillus* species are known to be surface colonizers and are also known to effectively colonize the digestive tract of aquatic animals.

However, in the present work, the level of gut *Bacillus* counts was found to be similar in all the treatment groups in the last weeks of the trial. The data suggested that endogenous *Bacillus* were also present in shrimp gut specifically in the negative control group. *Bacillus* species are known to comprise the natural gut microflora of aquatic animals and have been documented to be also present in shrimp gut. The increase in the control group gut *Bacillus* counts could be attributed to the growth of this normal bacterial flora in response to the nutrients coming from the feeds.

Lower total counts for *V. harveyi* and VpAHPND

The total *V. harveyi* colony counts in the gut of the probiotics treated group were lower than the counts in the positive control group in all the sampling periods (Figure 3A). However, the difference in counts was not statistically significant among the treatments. The enhanced *Bacillus* gut colonization in the group receiving the mixed probiotic strains could account for the trend towards lower counts of luminous *V. harveyi* in the shrimp gut. No *V. harveyi* was observed in the gut of the negative control group.

In contrast to *V. harveyi* gut colony counts, *V. parahaemolyticus* colony counts in the shrimp gut were similar in all the treatments and no clear influence of

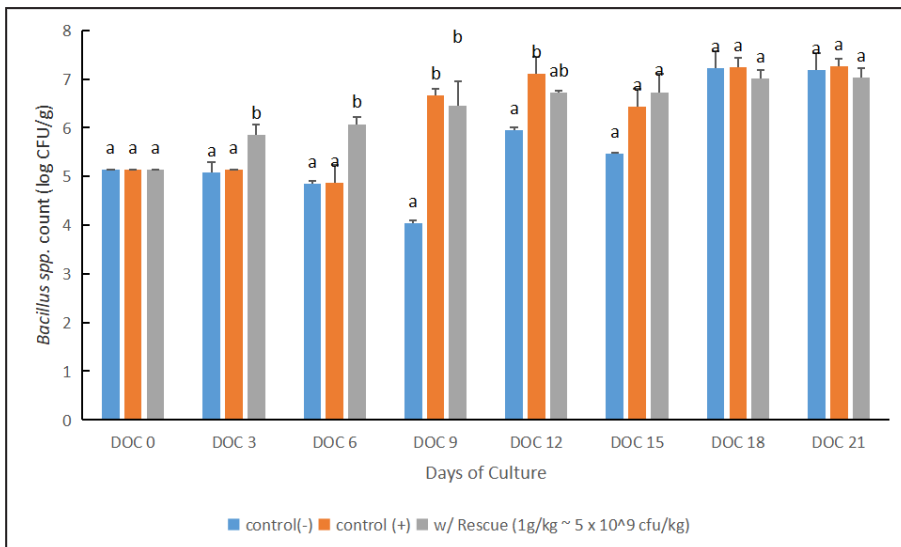


Figure 2. *Bacillus* spp. count in the gut of *Penaeus vannamei* fed with Rescue™ probiotics.

the probiotic addition could be observed (Figure 3B). However, the *V. parahaemolyticus* colony counts in the hepatopancreas suggested that the probiotic-treated group had significantly lower colony counts of *V. parahaemolyticus* in almost all the sampling periods.

These data indicated that dietary application of the probiotic blend promoted the active colonization of the *Bacillus* probiotics in the shrimp gut and in effect might have inhibited populations of pathogenic *V. harveyi* and *V. parahemolyticus* in the shrimp gut.

Efficacy of mixed *Bacillus* probiotics in preventing mortality

The infection challenge test results indicated that the treated group fed Rescue probiotics, exhibited a 33% improvement (Treated, 60%) in survival as compared to the control group (Control, 46%) when exposed to infectious luminous *V. harveyi*. Similarly, supplementation of the mixed *Bacillus* probiotics showed a 40% improvement in survival (Treated, 66%) as compared to the control group (Control, 47%, Figure 4) following exposure to pathogenic *V. parahaemolyticus*.

This improvement in survival could be attributed to the efficient gut colonization of the *Bacillus* strains in the



Demonstration farm in Cebu, Philippines using Rescue™ top coated in shrimp feed.

probiotic blend that might have inhibited the gut tissue entry, infectivity and or pathogenicity of luminous *V. harveyi* and the AHPND causing *V. parahaemolyticus*.

The significantly higher survival observed in the treated groups could probably be associated with the lower numerical counts of the bacterial pathogens in the shrimp gut. These results might further support the hypothesis that suppression of the pathogenicity of *V. harveyi* and *V. parahaemolyticus* due to Rescue supplementation could be linked to the high gut colonization activity, indicated by higher *Bacillus* counts in shrimp gut. The efficient colonization of Rescue *Bacillus* could have

reduced *V. harveyi* and *V. parahaemolyticus* gut populations inhibiting the infection and/or the pathogenicity in the hepatopancreas.

The hepatopancreas is considered the main target tissue of *V. harveyi* and *V. parahaemolyticus*. It has been known that *V. parahaemolyticus* manifests its pathogenicity by infecting and damaging the hepatopancreatic cells of shrimp. The efficient colonization of Rescue probiotics might have prevented the entry of these pathogens in the hepatopancreas and/or reduced their pathogenicity, hence resulting in the significantly higher survival in the treatment group as compared to the positive control group.

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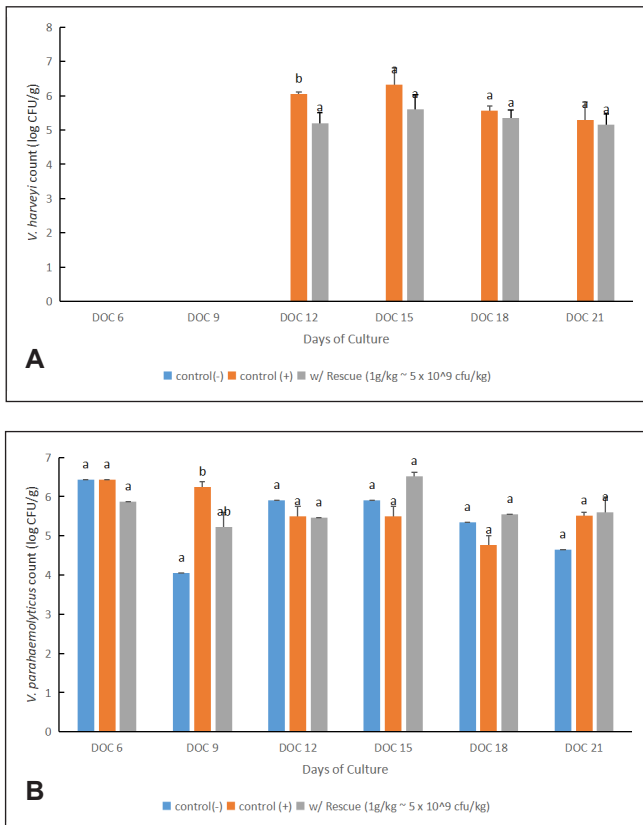


Figure 3. *Vibrio harveyi* (A) and *Vibrio parahaemolyticus* (B) colony counts in the gut of *Penaeus vannamei* fed with Rescue™ probiotics.

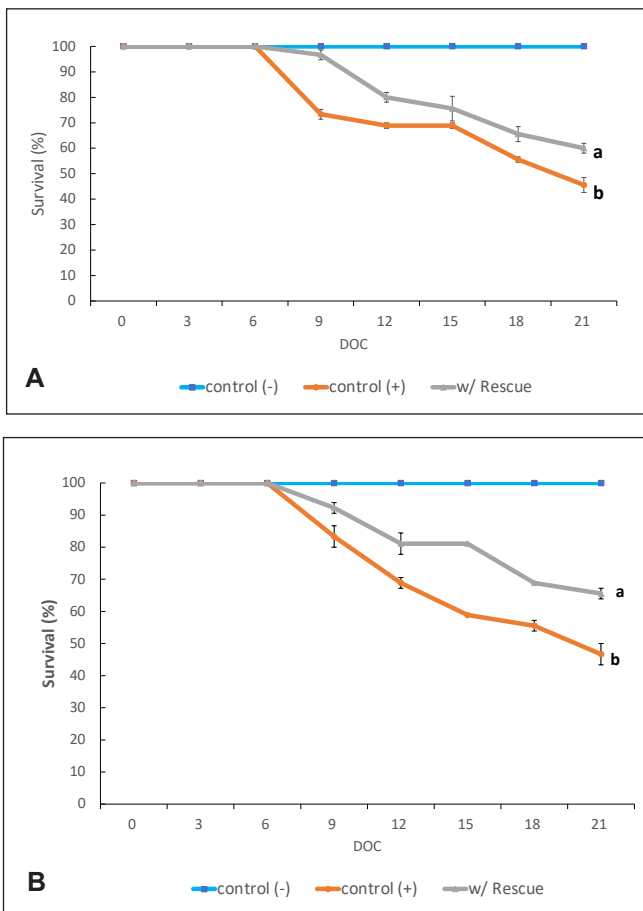


Figure 4. Survival of *Penaeus vannamei* fed diets supplemented with Rescue™ probiotics and exposed to *Vibrio harveyi* (A) and *Vibrio parahaemolyticus* (B) in an infection challenge test over 21 days.

Collectively, the present findings showed that dietary supplementation with the mixed *Bacillus* probiotics could reduce the populations of pathogenic *V. harveyi* and *V. parahaemolyticus*, lessen the virulence of the pathogens, and/or enhance the resistance of *P. vannamei* against these bacterial infectious agents. Additional research will be needed to further elucidate the mode of action of the observed reduction in mortality. Dietary supplementation of Rescue probiotics was shown to be an effective biocontrol approach to minimise mortality and associated economic losses caused by luminous vibriosis and AHPND in the commercial farming of *P. vannamei*.



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Above authors are with Zeigler Bros., Inc

Commercial production of all-male giant freshwater prawn post larvae in Thailand

LST in Chachoengsao Province has an ambitious plan for genetic improvement of the Thai strain after developing SPF broodstock and hatchery rearing for high survival and uniform all-male post larvae

By Zuridah Merican



Lukkungsetthi Company, or LST, in Amphoe Ban Pho, Chachoengsao Province, is the only broodstock multiplication centre and hatchery in Thailand able to consistently supply all-male giant freshwater prawn *Macrobrachium rosenbergii* post larvae for grow-out farms. At the AIT-organised international conference on the giant freshwater prawn, Giant Prawn 2023 (GP2023), in November, Somprasong Natetip, LST Founder and Director, described his journey since 2017. Next is to expand on his closed biosecure system for the genetic improvement of the Thai strain of this crustacean in terms of phenotype.

In Thailand, similar to other Southeast Asian countries, the giant freshwater prawn sector faces issues with supply of post larvae due to several failings, either because the larvae do not reach post larvae stages or there is a delay. Common too are the non-uniformity in post larvae size, low survival rates and incidences of white tail disease.

Challenges in grow-out ponds

Grow-out using the conventional post larvae will result in different proportions of the morphotypic stages of the male prawn: 5% blue claw, 20% strong orange claw and orange claw and 25% small males. Some 50% of the population are females, which grow slower than male prawns. This combination usually results in growth by hierarchy behaviour, low survival rates, slow growth and low average daily growth, high feed conversion ratios (FCR) and more females with lower growth rates than males. Some of these have poor market prices. Khun Somprasong also added that there is a demand for prawns with big tails, short heads and small and orange claws in Thailand.

Consequently, farming an all-male population is preferred. Males generally exhibit faster growth rates and are 2–3 times bigger and heavier than females of similar age. The

traditional practice is manually selecting males for culture during the grow-out, but it is labour-intensive and generally unsuccessful in producing an all male prawn monoculture.



Somprasong Natetip, LST Founder and Director, wants to corporatise his hatchery to expand work on genetic improvement of the Thai strain of *Macrobrachium rosenbergii* in terms of phenotype.

Commercialisation of all-male technology in Thailand

In 2006, Dr Wikrom Rungsin at the Department of Zoology, Faculty of Science, Kasetsart University, developed the technology to produce all males of the Thai strain of *M. rosenbergii* using a neo-female technology. This is ablation of the androgenic gland in 45-day post larvae (PL45). The androgenic gland is essential for sexual differentiation in prawns and the development of male primary and secondary sexual characteristics (Tan et al., 2020). Done at the right time, this delicate procedure causes the post larvae to develop into neo-females with chromosomes ZZ. Neo-females are mated with local males to produce all-male progeny theoretically. Neo-females are males functioning fully as females.

As part of the “Talent Mobility” program of Kasetsart University, National Science Technology and Innovation Office of Thailand, LST is commercialising this technology. Dr Wikrom acts as a consultant at LST. Following a market survey and developing a vision for the freshwater prawn hatchery segment in Thailand, the company developed a prototype hatchery in 2017. However, for Khun Somprasong, it was not just adopting the process. It was more to do with the genetic improvement of the species.

It has developed closed biosecure systems for a breeding program, targeting the production of fast-growing all-male post larvae from specific pathogen-free (SPF) broodstock. Since 2019, LST has a nucleus centre comprising separate facilities for quarantine, maturation, spawning and genetics selection and breeding. Then, there is a broodstock multiplication centre and hatchery. Nursery and grow-out ponds complement these facilities to conduct field trials.

Samples were collected as founder stocks. One might think that large broodstock are required for good post larvae, but Khun Somprasong said, “It is only necessary to have a broodstock, even though small, which has been through the reproduction process until fertility is complete.”

The criteria for SPF status required assurance of the absence of 5 major pathogens over a two-year period. These included white spot syndrome virus (WSSV), yellow head virus (YHV), *Macrobrachium rosenbergii* nodavirus (MrNV) and extra small virus (XSV), both causative pathogens for white tail disease. There is also the monitoring for decapod iridescent virus 1 (DIV1) which has not been recorded in Thailand but is on the Department of Fisheries Thailand (DOF) monitoring list. “We cannot use live feeds for broodstock maturation to prevent contamination from pathogens,” said Khun Somprasong.

Essentially, the game changer for Thailand's *M. rosenbergii* industry is the closed biosecure facilities to keep pathogens away and control rearing conditions.

Quality and uniform post larvae production

During a post-conference visit for GP2023 participants, LST hatchery staff explained some practices. At the pre-spawning stage, each male and female broodstock is held in one cubicle. In the mating tank, there is one male to 10 females. After moulting, prawns will mate very quickly; within a 15-minute interval, the females will allow entry of spermatozoa. Following hatching, nauplii are transferred into the closed indoor hatchery.

“We have developed the precise standard operating procedures to mass produce post larvae. We are proud that we can harvest nauplii daily, reach the post larvae stage in 14–15 days and complete in 4 days much faster than conventional post larvae produced with undomesticated broodstock. Our post larvae are of uniform sizes without going through a selection process. Post larvae are pathogen-free, and for every batch, larvae develop to post larvae well. We do not need to use antibiotics,” said Khun Somprasong.

In the hatchery, there is a well-controlled feeding regime. LST produces its own pathogen-free instar 1 artemia (500µ) which can be kept in ice for 48 hours. The first feeding of nauplii is with this artemia at 100g/million nauplii. In later weeks, larvae are fed egg custard (300µ) with added astaxanthin and artemia, alternated at specific intervals to prevent water pollution. The hatchery team discussed the sources of artemia available in Thailand with participants and their pros and cons. They also indicated that when using GSL artemia, each gram contains 250,000 to 260,000 cysts.



In-house production of pathogen-free instar 1 artemia is used for feeding nauplii and subsequent feeding of larvae.

Post larvae are fed pelleted feeds. After PCR testing (PL4), they are sold to farmers and cultured in nursery ponds to gather growth performance data as feedback for the genetic improvement work.

Success rate in an all-male production

In the case of LST, the current success ratio is > 90% male progeny. In his presentation, Khun Somprasong showed how for some post larvae the delicate ablation procedures can fail, indicated by a white shadow in the gland of the head (Figure 1).

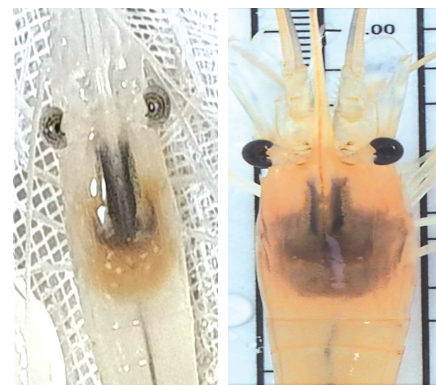


Figure 1. Post removal of the androgenic gland. (Left) the point on the head shows a successful removal and post larvae can develop into a neo-female. (Right) the line on the head indicates an unsuccessful procedure.



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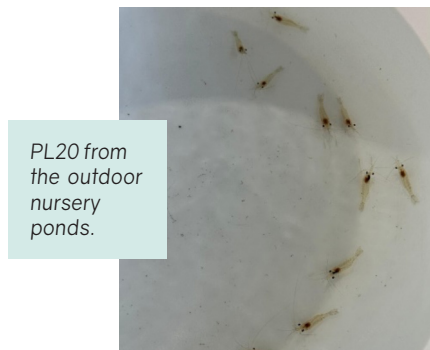
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50,000 (31)	200-250	140-180	65	28.88%
70,000 (44)	270-320	180-220	95	32.20%
100,000 (63)	300-350	200-250	100	30.76%
200,000 (125)	380-450	220-250	175	42.16%
200,000 (125)	900-1000 (40 days)	580-620 (40 days)	350 (40 days)	36.84% (40 days)



PL20 from the outdoor nursery ponds.

Table 1. Comparison of LST post larvae with conventional giant prawn in nursery culture at 60 days at different stocking densities.

“In the pond, one can find this combination: >90% males, higher survival rates, fast growth with low FCR and ultimately higher profit margins with lower costs of production.”

Nursery and pond grow-out

Harvests at nursery level and grow-out ponds justified the progress with LST’s post larvae. In Table 1, Khun Somprasong explained the growth of PL4 in outdoor nursery ponds compared with conventional stocks of post larvae available in Thailand. While LST’s stocks grew to size 120-125/kg, conventional stocks grew 34% slower to reach only size 170-200/kg after 60 days when stocked at 19 PL/ha (Table 1)

Field trials

Khun Somprasong described experiences in the field in the monoculture of his post larvae. This started with a nursery phase of 2 months to grow to 4g or 200-300 juveniles/kg. In the grow-out phase, the stocking was 7,000 to 10,000 juveniles/rai (1600m²). This translated to 5-6 juveniles/m². At days of culture (DOC) of 80-100 days, and after three times culling, the production totalled >2 tonnes/ha. (Related article: Polyculture of vannamei shrimp and giant freshwater prawn in Chachoengsao Province pages 22-23)



The new hatchery in Amphoe Ban Pho, Chachoengsao Province.

Into the future

In 2020, LST worked on increasing production, from 50 million post larvae in 2017 to 300 million post larvae in 2020. In 2021, in cooperation with Kasetsart University, the plans included building up more farms. Khun Somprasong is now looking at a corporate image for the company, increasing production and reducing production costs, in parallel to developing a full-fledged genetic centre for Thailand’s *M. rosenbergii* and investing around THB 100 million (USD 2.85 million). It already has the permit from DOF to export post larvae. Meanwhile, the R&D cooperation with Kasetsart and NRTC will continue.



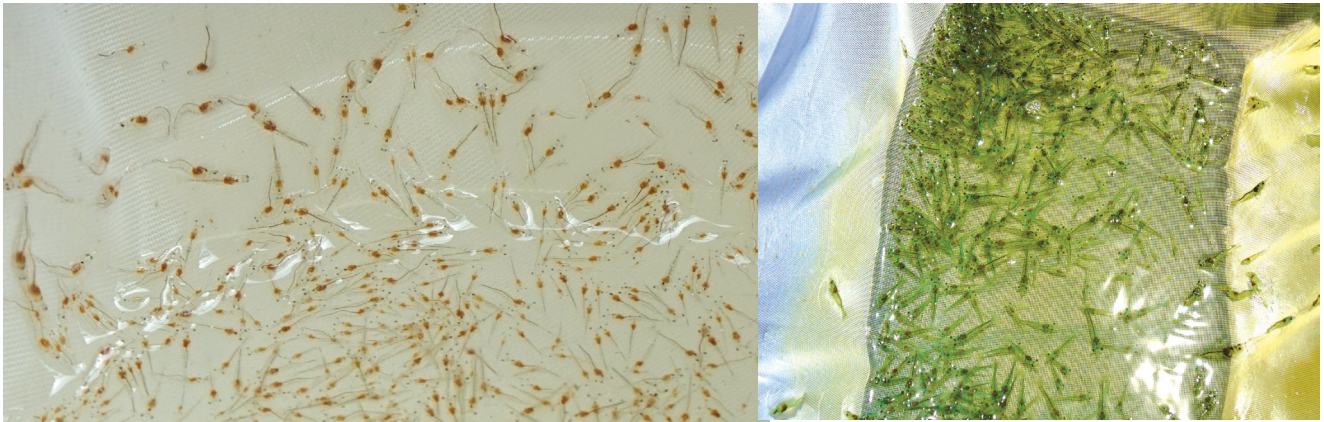
Inside the hatchery.

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It all starts at the hatchery level

Critical for profitability and future success in farms are the basics and adapting management protocols to genetic lines



Hatcheries and nurseries deliver good post larvae and juveniles from various genetic lines of broodstock. Entering this equation are manufacturers of early-stage feeds. How can all three come together to address the concerns of hatcheries and farmers? Over the last 10 years, breeding companies have marketed a range of genetic lines for the vannamei shrimp to meet the needs of an industry where there is no standardisation of culture systems but beset with changing environments and disease challenges. Are quality post larvae products of merely good genetics, hatchery management or their combination. These were the issues discussed in a panel led by Rizky Darmawan, CEO, PT Delta Marine Indonesia, at TARS 2023 on Shrimp Aquaculture, held on August 15-16.

Genetics and environment – What next?

Dan Fegan, Chief Impact Officer at SyAqua Group compared shrimp with poultry production. Nutrition is well understood in the latter, while in shrimp, it is less well understood. For example, body temperature in chickens is consistent so there is less variation in digestion than in cold-blooded animals such as shrimp. The variety of conditions in shrimp culture (intensity, salinity, and temperature) is also much more variable and less controlled than in commercial poultry production.

Genetics is responsible for between 10 and 40% of the variation in performance. “Overall, genetic influence on performance is generally less than 20% with water quality, nutrition, stress, pathogens, and management, which is one component of the environment, having a strong influence on genetics” said Fegan.

Which genetics?

At SyAqua, the genetic selection process involves the annual evaluation of 400 families, looking at growth and followed by disease challenges such as acute hepatopancreatic necrosis disease (AHPND) and followed by DNA sampling to create the database for breeding values. This information is then used to select the best families to produce the next generation for commercial production. “Genetics is not a silver bullet. It will not make a bad farm good or a bad manager successful.”

Genetic lines can be selected for growth (“speed” lines), resistance (“resistant lines” or a combination of both (“balance” lines). Speed lines show fast growth under the right conditions but tend to be less resistant to environmental or disease challenges. Resistant lines may be more tolerant or resistant to disease or environmental challenges but show low growth. Balance lines provide a combination of good growth and resistance.

When selecting genetic lines, it also important to consider the health status. There are four descriptions used in the market: specific pathogen-free (SPF), specific pathogen-resistant (SPR), specific pathogen-tolerant (SPT) and “all pathogen-exposed” (APE). SPF shrimp are only free of specific pathogens and a list of these should be available if requested. Fegan clarified that SPR is only resistant against the specific pathogen(s) for which resistance is selected. SPT means shrimp can be infected but can withstand a higher pathogen load without any health issues. APE is not a real definition of health as it is highly unlikely that the shrimp have been exposed to all pathogens and since exposure does not guarantee tolerance or resistance, it is meaningless from a health standpoint.

Currently, the threats to genetics are diseases, rising costs, low prices, and climate change. “With higher competition and low prices, it is important to understand and manage costs when farmers have no control over the selling price” said Fegan.

Environmental triggers such as water quality, overcrowding, biosecurity and health status can affect gene expression in positive and negative ways. Additionally, poor post larvae production practices can negate any genetic improvements. Therefore, the balance line approach aims to achieve the best results from the widest range of environments and culture conditions.

Fegan reminded that the days of fast innovation, low costs and high prices have ended. Future areas for improvement are related to the production environment, management, and resource use. Genetic improvement will continue to support improved production efficiency, but it is not enough on its own. “The industry requires data to make decisions

to improve production efficiency and maximise profits, but unfortunately few producers collect and use data routinely. Nowadays, we are in the new era of “big data” where information can be collected from a large number of farms and a wide range of conditions. Automation of data collection and analysis also holds promise for better understanding and management of resources for greater profitability.”

Crafting the foundation for farming efficiency in the first 30 days

Dr Olivier Decamp, R&D and Business Development Health Director at INVE Aquaculture, part of the Benchmark group, said that shrimp production costs vary with farming models and local conditions and currently range between USD2.2 and USD5/kg. For all the main shrimp-producing areas, the production cost is equal to or higher than farmgate prices. An important metric is the failure rate, high in Asia, such as 50% in Vietnam, compared to less than 5-10% in Ecuadorian farms. This impacts the profitability of a farm.

At only 8-10%, post larvae represent a small component of production cost but a critical investment for a farm’s profitability. A study of 4,000 crops by Grobest showed that the performance of farms operating under similar stocking densities was impacted by the hatchery supplying the post larvae (Figure 1, Decamp & Azpeitia, 2023). Hatcheries can control inputs from genetics, nutrition, and management systems. Their rearing protocols can be adjusted depending on genetics and nutrition.

Hatchery protocols

The expression of the potential of selected animals requires the correct rearing protocols and inputs. However, Decamp said the strict nursing measures either in the nucleus or broodstock multiplication centre can be compromised when moving broodstock to the hatchery. Without biosecurity procedures and the use of correct

feed, the health and disease-free status of post larvae are impacted. Algae, live food, and water exchange can be a point of entry for potential pathogens.

“In the last 20 years, we have been looking at the microorganisms in the hatchery. These are the k-strategists, i.e., slow-growing, and dominant bacteria in a stable system, and r-strategists, harmful and fast-growing bacteria, such as *Vibriosis*, that are dominant under unstable conditions. Regarding factors impacting the composition of the microbial communities, it is now known that 30-50% is associated firstly with algae, artemia and water inputs. There are new tools to reduce these disruptions. Emphasis should be put on making the system more stable.”

The message is to look at the inputs of products and get the best balance between feed and live food. In a fragmented industry such as shrimp farming in Asia, a hatchery needs to deliver post larvae which perform well in the farm and yet be profitable. Best Balance is an approach to shrimp hatchery culture in where the use of high-quality products is adjusted to the local culture conditions. Applying this approach in Thailand resulted in a higher number of harvested post larvae, which, in turn, has a cost-reducing effect on all the other cost contributors (evaluated as the cost per 1,000 post larvae produced). Benefits include a higher EBIT of hatchery operations and a further strengthening of the hatchery’s reputation through the supply of high-quality post larvae.

Decamp discussed the economics of using artemia in the hatchery. A Boston Consulting Group report gave data that artemia accounts for 5-30% of the total cost in the hatchery. There is a direct link between the total artemia used and larval biomass at 3.15kg per million artemia. A reduction in the use of artemia leads to a reduction in the larvae’s biomass, which indicates that artemia is still a critical live food. There are commercial hatcheries that

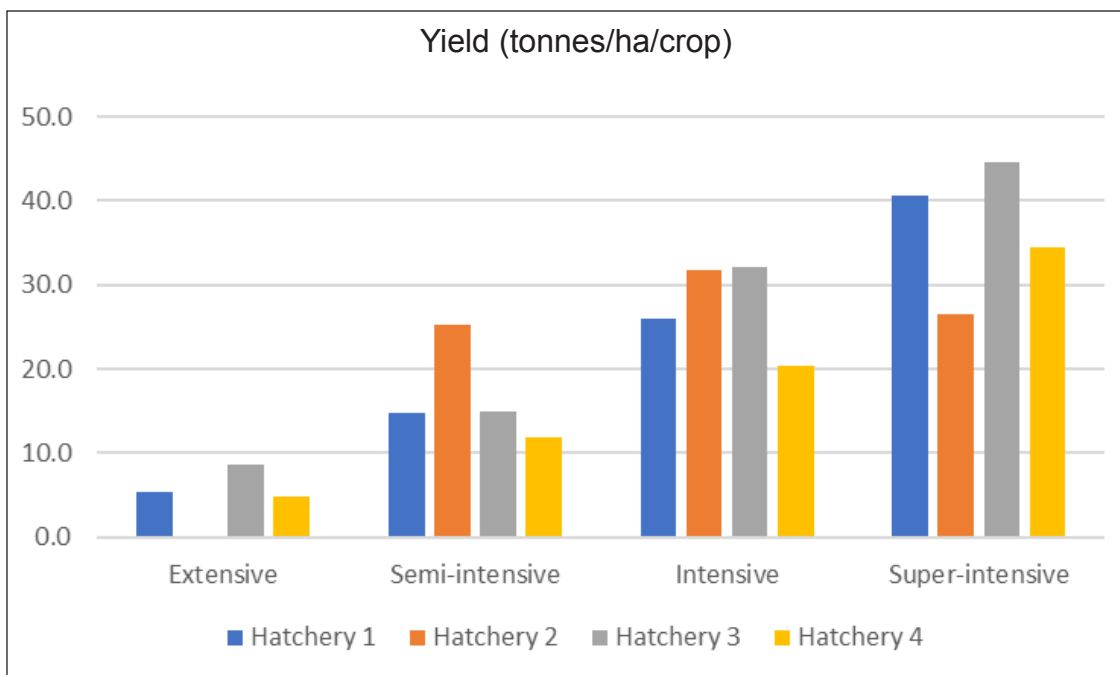


Figure 1. Yield achieved at Vietnamese farms operating under a range of stocking densities (extensive: <math><50\text{m}^2</math>; semi-intensive: 50-100/m²; intensive: 100-200/m²; super-intensive: >200/m²) and stocked with post larvae from four different sources. Number of crops included in the analysis >4,000. Source: Decamp & Azpeitia. 2023. Hatchery Feed Management 11(2)15-19

have dramatically reduced the inclusion rate of artemia in their feeding protocol. But the issue is to produce quality post larvae in a cost-efficient way," said Decamp, while highlighting some back-to-basics approaches. The simple actions to be carried out in the hatchery when using artemia include disinfections, preparations and maintaining conditions.

Artemia feeding is a major source of pathogens in the system. Nutrients released during artemia hatching support the growth of *Vibrio* that are found in the hatchery environment. The idea is to reduce risk by preventing a bacterial bloom during the hatching and separating the cysts from the hatched artemia, as these cysts act as a substrate for *Vibrio*'s growth. Another INVE study, using a standard line of genetics, showed the relationship between the age of post larvae and tolerance to *Vibrio parahaemolyticus* loads. This work justifies that larger post larvae are more resistant to pathogens. A compromise must be found between the robustness of the older post larvae and their ease of transport to the pond.

The conclusion was that 'no one hatchery rearing protocol fits all,' and all procedures must be continuously optimised according to the latest conditions and new technological developments. The transfer of larger and stronger post larvae helps to cope with disease challenges. A well-managed nursery phase, including biosecurity measures and optimal nutrition, will support the grow out performance. A crop's success depends upon actions taken in the first 30 days of the life of a shrimp.

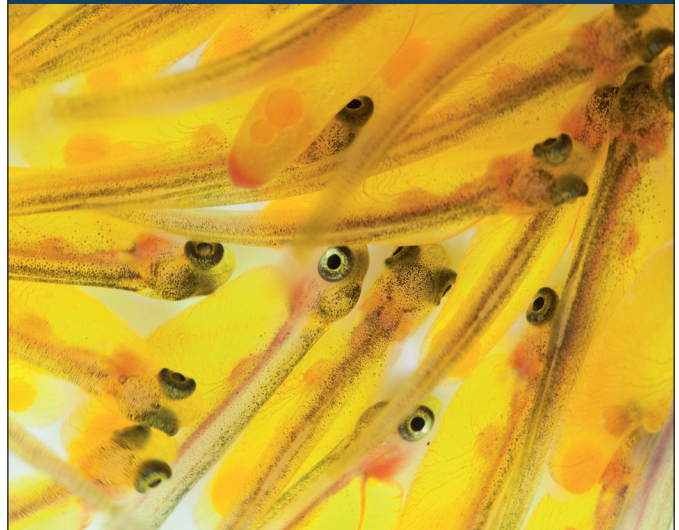
Genetics is a tool and not the solution

Further discussions at the panel included the participation of industry leaders active in shrimp genetics and hatchery management and travelling extensively in Asia; **Dr Craig Browdy** is Director of Research and Development at Zeigler Bros Inc, USA, and **Steve Arce**, Director of Technical Services, Kona Bay Shrimp-Hendrix Genetics Aquaculture, USA.

It all starts with the hatchery providing high-quality post larvae and then the appropriate management to be successful. Arce said that genetics can only contribute approximately 30% to farm performance, and 70% is influenced by management and the environment. The feeding rate and management systems should fit to the genetics. Genetics-wise, it is difficult to select for specific targets. Arce would like to see some standardisation of systems used and where their application will help geneticists develop the most appropriate strains.

Browdy expects the use of data to revolutionise and promote a better understanding of farm performance. He emphasised the importance of taking care of early life stages and differed on the absolute need for artemia in the hatchery for quality larvae production. Artemia usage has been successfully reduced and the successful replacement of artemia has been demonstrated. It is important to understand that larvae need good nutrition, not a particular ingredient or live feed. The driver of profitability in the hatchery is survival, with the most successful hatcheries investing in the efficient use of effective feeding and production technologies. *Vibrio* outbreaks have been increasing in Asian hatcheries. It is essential to work to reduce *Vibrio* loads to get the highest survival possible.

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Rizky Darmawan, PT Delta Marine Indonesia (left) with speakers and panellists, from right, Dan Fegan, SyAqua Group, Thailand; Steve Arce, Kona Bay Shrimp-Hendrix Genetics Aquaculture, USA; Dr Olivier Decamp, INVE Aquaculture, Thailand and Dr Craig Browdy, Zeigler Bros Inc, USA.

Sentinel testing

Since India is very much dependent on imported broodstock, how important is sentinel testing, such as the performance of 5-6 genetics lines in varying environments, asked S Santana Krishnan, India. According to Fegan, genetics companies already assess the suitability of their genetics under local conditions before suggesting the preferred genetics for farms in a particular country. Arce believes that sentinel testing, although easier said than done, can be useful when structured properly under standard conditions. But they need to generate large enough data sets to be useful. Arce cautioned that proper methodology and standardisation are critical.

Challenges with pathogens

Decamp said that breeding companies have been making massive progress with new disease challenges. "We look at new solutions for the farmer. Genetics-wise, it is to make sure the farmer receives a homogenous genetic line to stock in ponds. However, I do see that transparency in a fragmented market such as in Asia is difficult. There are reports of post larvae supplied by specific hatcheries performing better despite *Enterocytozoon hepatopenaei* (EHP) challenges."

The farmer can choose genetic lines being offered to match the seasonal conditions and the seeding pattern, but Arce emphasised the need for management guidelines focused on biosecurity and nutrition. There will always be pathogens in the system, but with no apparent disease. Unfortunately, sometimes, genetics becomes a method to get away from analysing the effectiveness of management protocols.

Clearly, genetics can only offer the potential to reach a target when coupled with the proper management systems. Browdy said that different lines are suitable for different systems such as fast growth lines worked well in achieving growth rates that often exceed 4g per week in recirculation aquaculture systems (RAS) in the US, which are free of pathogens. Such lines may not work as well in other culture systems.

It was emphasised that pathogens change very often. "SPT and SPR lines selected for tolerance and/or

resistance to, for example, white spot virus, will not work in the presence of background pathogens in the pond such as those causing AHPND. Fegan added that it is difficult for genetics companies to work with every pathogen to develop lines. "Neither can we be anticipating all new pathogens as we know that new diseases will always come along." Arce added that selecting for stronger immune response (rigour/resilience) may be a path forward.

Dr Manoj Sharma, India, gave the example of genetics, environment and carrying capacity. The same genetic lines have performed well in new areas, such as Punjab, even with better feed conversion ratio (FCR) and high survival rates at 95%. However, in older areas such as Gujarat, performance was poor. Fegan agreed that this shows that genetics is a tool and not a one-size-fits-all situation.

Ultimately, we need to find the best genetics to match the situation; genetics is a tool with potential that can only be exploited with good management. It is important that farmers understand the role of genetics in maximising and realising their own performance potential.

Ablated versus non-ablated broodstock

Browdy said, "Over the past 20 years, as we select each generation, we have been directly or indirectly selecting for fecundity, as the best spawners typically pass their genes on to the next generation. Today, we have females with higher productivity in terms of mating rates and spawn size. Increased fecundity has enabled the use of non-ablated broodstock. Moreover, SPF broodstock are expensive, driving hatcheries to develop strategies to maximise output



Fauzan Bahari, Skretting, Indonesia said that farmers are now asking for genetic lines which can help them against diseases.



"What are the differences in performance between ablated and non-ablated broodstock during the cycle," asked William Kramer, Philippines.

in terms of fecundity in the short term and productivity in the long term. Fegan offered information on a University of Stirling disease challenge with WSSV, which showed that post challenge survival was higher in post larvae from non-ablated females, showing that ablation could also impact post larvae quality.

While there is a move for market acceptance for no ablation in hatcheries due to animal welfare concerns, the panel noted if large markets are not too concerned with ablation, the future uptake of no ablation will be slower.

What would they ask hatcheries?

Moderator Rizky Darmawan challenged the panel to wear the hat of a farmer and ask questions on post larvae quality.

Browdy: Hatcheries tend to apply feeding protocols that use a cocktail of higher and lesser quality feeds to reduce input costs. However, these strategies are detrimental to the output. Whereas a small rise in survival raises output and profitability. I would ask the hatchery manager, "How good are your post larvae? How much have you invested in them and how can higher survivals and more robust post larvae improve your profitability while helping the farmer?"

Decamp: I would query the number of post larvae produced, the quality control using standard methods and how digital tools are used to assess variability in batch quality. I would want to visit the hatchery and get data on my batch of post larvae in production.

Arce: I would ask what the hatchery's failure rate and their farmers' success rate is. If the reply is hit and miss, as a farmer, I would go with the hatchery with consistent batches and a solid client base, a good level of adaptability of management protocols regarding seasons and genetic lines. Flexibility and being open-minded to evolve are crucial.

Fegan: I would also ask the hatchery to provide evidence of the source of their genetics as there have been several cases of "fake" genetics in the market.



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Polyculture of marine shrimp and giant freshwater prawn in Chachoengsao Province

The astonishing success in farming with vannamei shrimp

By Zuridah Merican and Soraphat Panakorn



Grow-out ponds are stocked with both species and the aeration is provided 24/7.

The farming of the giant freshwater prawn *Macrobrachium rosenbergii* is popular in Thailand, mainly because of the high demand in local markets, such that the country even imports the prawn from India and Bangladesh. Many new farms are being developed in the coastal and inland provinces of Thailand. Recent biotechnological advancements, particularly with the supply of monosex (all male) post larvae is pushing for more intensive farming of prawns in monoculture or polyculture.

In Chachoengsao Province, Khun Monchai Yokboonyatikarn runs the 15-year-old Monchai farm - Thailand's most advanced giant freshwater prawn farm. This large farm of 60ha has 500 ponds and the specialty is the polyculture of vannamei shrimp *Penaeus vannamei* with giant freshwater prawn. This is no ordinary prawn farm, since there are several techniques adopted from shrimp farming and applied to ponds stocked with both species. The area is inland where the water salinity is 2ppt, pH 8 and alkalinity is more than 100.

Nursery culture

The all-male fast growing prawn post larvae is from Lukkungsetthi company or LST as described on pages 13-16. As Khun Monchai stocks a combination of male: female at a ratio of 70:30, he

buys another 50% of a combination of males and females from another hatchery.

It all starts with a nursery phase where the PL14 post larvae are delivered by LST. Stocking is 140,000 PL/rai (1,600m²) and the post larvae are grown to 4g juveniles (size 200-300/kg) over 60 days. During this phase, survival rate is high at 90% for LST PL and around 60-70% for post larvae from other sources. Feed conversion ratio (FCR) ranges from 1.0-1.2. Transfer into the grow-out ponds is carefully programmed in the early morning before 10am, by reducing the water level.



Monchai Yokboonyatikarn (second left) with Somprasong Natetip, Lukkungsetthi Founder and Director, the supplier of the all-male post larvae to the farm (middle) and GP2023 participants.



A nursery pond for the giant freshwater prawn at Monchai Farm, Chachoengsao Province, Thailand.

Grow-out

Polyculture with vannamei shrimp starts with the stocking of 7-8 prawn juveniles of 4g per m² in ponds of one acre and 1.2 to 1.5m deep, depending on the season. Immediately after stocking, the prawns are fed with marine shrimp feeds #3 (usually are 3-3.5mm length), which cost USD1.3/kg. After 20 days, vannamei PL12 are added at a density of 12PL/m². The cost of shrimp post larvae is USD12.5/1,000PL while the cost of *Macrobrachium* post larvae is USD1/80 PL.

An interesting feature at this farm is that aerators run 24/7 even though the day can be sunny, and the total stocking is not more than 25 animals/m². During the post conference tour by participants of GP 2023, Soraphat Panakorn, Novozymes who was at the farm to help explain farm operations said that this is a unique practice at this farm, usually reserved at most for semi-intensive marine shrimp farming. He added that this is the secret to the success of this farm. The farm uses a general *Bacillus* strain of probiotics on a weekly basis.



Dr Julin Yuan, Deputy Director of Zhejiang Institute of Freshwater Fisheries holding a recent harvest of giant freshwater prawn at the Monchai Farm, Chachoengsao Province, Thailand.



Harvest of prawn and shrimp



Soraphat Panakorn, is Shrimp Culture Specialist, Novozymes (left) with Khun Monchai Yokboonyatikarn and Department of Fisheries Thailand's Malasri Khumsri, Head of Aquaculture Research and Business Group.

The total grow-out period is 4 months. Harvesting, carried out by the buyer comprised male prawns at size 12/kg (83g) and female prawns at size 20/kg. The farm practices total harvesting and prawns are sold at THB250/kg (USD 7.15) whereas the cost of production was THB100/kg (USD2.86). The harvest size of vannamei shrimp was 40/kg (25g).

Survival was 80% for the giant prawn stock and for vannamei shrimp, it was 50%. The reason for the lower shrimp survival is because of cannibalism at the final stages by the larger prawns when at low salinity, the moulting shrimp takes a much longer time to harden the shell. Using 38% crude protein feed of size #3, FCR was 1.2 for the total harvest.

What does it take to produce sustainable Asian shrimp?

Navigating the wave of sustainability in shrimp farming by the TARS 2023 Hard Talk panel



The Hard Talk panel at TARS 2023 discussed "What does it take to produce sustainable Asian shrimp?", from right, Prakan Chiarahkhongman, Charoen Pokphand Group, Thailand; Andreas von Scholten, Grobest Group, Hong Kong; Wan Nadhri Wan Fauzi, Blue Archipelago Berhad, Malaysia; Fred Hsi Chung Kao, SyAqua Group, Thailand; and Lourdes Chingling Tanco, MidaTrade Ventures International Inc, Philippines. Ronnie Tan, USGC, Malaysia (left) led the conversation.

A diverse group of industry leaders shed light on the complexities of producing sustainable Asian shrimp. They offered insights into the challenges and their subjective opinions on shaping the path towards producing sustainable shrimp for global markets. TARS 2023 on Shrimp Aquaculture was held in Bali, Indonesia from August 15-16.

Ronnie Tan, Aquaculture Consultant at USGC, began by introducing the panellists, chosen to represent the different segments in the shrimp aquaculture supply chain - farming, genetics and hatchery, feed and aquatic health and processing and marketing.

The panel

Wan Nadhri Wan Fauzi is CEO, Blue Archipelago Berhad, a leading shrimp integrator in Malaysia covering 480 ponds which started operations in 2009.

Fred Hsi Chung Kao has recently joined as CEO, SyAqua Group, Thailand, a leading shrimp genetics and hatchery feed company. With 23 years in poultry genetics, Fred contributed some practices and experiences from this sector.

Dr Prakan Chiarahkhongman, Vice President, Aquatics Animal Health Care Products Specialist, Solutions Provider (AAHCPS), Charoen Pokphand Group travels widely to communicate conceptual ideas to farmers, customers,

clients, partners, industry experts, associations, societies, the government sector and general public.

Lourdes Chingling Tanco, Managing Director, MidaTrade Ventures International Inc, Philippines established in 1990, represented the processor and marketing segment. Chingling has been vocal on how industry in the Philippines and Asia should position themselves.

Andreas von Scholten recently joined as Group Chief Commercial Officer, Grobest Group Holdings Limited, Hong Kong. Previously as CEO of the Barramundi Group, Andreas developed premium markets for sustainable barramundi *Lates calcarifer* from Asia.

What does sustainable shrimp farming mean?

The fundamental question was: "What do you understand by the term sustainable shrimp?"

For Prakan, sustainable shrimp farming is the need for practices that can be passed down through generations, while underlining the importance of environmental friendliness and cost-effectiveness. "At CPF, we believe that we can help farmers reduce their environmental impacts. This is what we have done to promote sustainable shrimp in the future. We educate farmers to understand that products that are good and environmentally friendly

will benefit all, on diversifying products from farm to food and incorporating technology across the shrimp farming process.”

The company prioritises technology and innovation to promote sustainable practices such as genomic selection, changing starch: protein ratio in feeds to reduce water pollution and excessive nitrogen output, diversification in shrimp products, holistic management systems and possibly, in the future, producing shrimp with high selenium content.

From farm to marketing

Chingling, adopting a multifaceted perspective and aligning with views of farmer, buyer, and processing plant, contends that sustainability, from a farmer’s viewpoint, entails enduring practices that ensure generations of growers can maintain profitability. She traces the evolution of sustainability definitions, emphasising their entwinement with market dynamics, particularly in the US.

“I believe certification begun with US buyers wanting assurances that products were safe and produced responsibly at social and environmental levels without having to travel to origin and see it themselves.” While highlighting the proliferation of certifications, Chingling added, “Some buyers have expressed scepticism on the perfunctory nature of annual farm evaluations”.



Lourdes Chingling Tanco says, “There are also hopeful signs as efforts are being made to make certifications more affordable, potentially paving the way for more farmers to join the sustainable movement.”

Chingling underscores the credibility of the Aquaculture Stewardship Council (ASC) due to its focus on the main part of the production chain. Within Asia, she expresses reservations about the narrow focus on consumer safety, highlighting broader concerns for environmental impacts and social responsibility. She highlighted the potential increase in animal welfare requirements, suggesting a clash of developed country thinking imposed on Asia.

There is a pivotal role of governments in promoting sustainability. The Indian government helps the farms with tests for certification. Vietnam’s government supports industry with environmental assessments such that almost all the processing plants are deemed sustainable.

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On the emergence of “fair trade shrimp” as a marketing strategy, Chingling said, “There is a degree of scepticism in evaluating impacts. Here the story is that when a customer buys a bag of this shrimp, a poor farmer in Asia benefits.” (Note: Fair Trade is a global movement that aims to make trade fair by improving prices, working conditions and the deal for farmers and workers in developing countries).

Views from a shrimp integrator

Wan Nadri was pragmatic in his definition of sustainable shrimp production. “The reality prevails with steady financial gains. Sustainability revolves first around earning margins consistently and supporting the local community. The next step is to consider the benefits for the good of the planet. Meaningful environmental initiatives are, realistically, contingent upon financial resources.”

Is there a lack of a compelling sustainability narrative for Asian shrimp?

This was a key question posed for panellists. Is there a sustainability story for Asian shrimp? If there is, how can it be enhanced or, if not, how can one be built?

In Andreas' opinion, there is no sustainability story. He asserted three negative points with the industry in Asia, “While there is progress in efforts across the value chain in Asia, the public image remains a significant challenge. Factors contributing to this image problem include the conversion of mangroves to farms, environmental pollution, antibiotic use, and concerns around labour conditions.”

Secondly, an absence of a unified branding effort for the Asian shrimp industry stands out as a major hurdle. There are successful examples in Latin America, particularly Ecuador, where associations and collaborative efforts have effectively built a brand representing sustainability.

Thirdly, Asia's industry is notably fragmented which not only complicates outreach efforts but also poses challenges in obtaining broad-scale certifications. These issues require structural changes, and the idea of an umbrella organisation covering all Asian farmers to facilitate industry-wide development was raised. “While I acknowledge the difficulty of an easy fix, there is a growing awareness among farmers about the importance of sustainability,” said Andreas.

Wan Nadri believes that Asia does have a sustainability story but unfortunately is not selling the story well. “There is a lot of awareness on social and labour issues and there is no lack of capacity to produce sustainable shrimp. He raised the issue of profitability and the challenge of convincing buyers to pay the fair price for shrimp.”

A consensus emerged that the industry was not doing enough to communicate its strengths effectively. Wan Nadri suggested a one-stop centre and a collaboration among industry players to take control rather than depend on a government to government (G2G) approach to pitch the industry's story.

Countering the negative image

The conversation digressed to the negative impact of documentaries, in particular Netflix's ‘Seaspiracy’, deemed as “the worst publicity ever for aquaculture”. Andreas acknowledged the difficulty of countering such narratives on social media, emphasising the challenge of gaining a shared voice amid billions of global consumers.

He noted the need for an effective response and reiterated that perhaps the suggested umbrella organisation could play a crucial role in addressing misinformation and advocating for the whole industry.

A question raised was: who should represent the industry and counter such negative narratives? Andreas highlighted that while there were advocates discrediting certain adverse narratives, their voices did not gain much traction. The dialogue unfolded into an exploration of Asia's strengths, with the panel underscoring the importance of storytelling to highlight the region's strengths.

The Ecuador versus Asia dynamics became a focal point, with Ronnie questioning if there is a need for collaboration to develop shrimp consumption worldwide. Fred believes that there is a lack of advertising positive aspects and it is the industry's collective responsibility to tell its story. “Every FCR gained, and every ADG improvement is a sustainability metric. We need to advertise these small steps. It is not



“Every FCR gained, every ADG improvement is a sustainability metric. We need to advertise these small steps.”

– Fred Hsi Chung Kao

about comparing Ecuador and Asia or India, it is just that Ecuador is doing a better job for its industry.”

Since the industry is in an oversupply situation, does working together mean some farms should reduce production? For Chingling, when linking buyers and sellers, it is imperative to have a convincing story. “Today, young Indonesian shrimp farmers have started to make a difference by telling the story of Indonesian shrimp. They are looking at niche markets such as small size shrimp into the high-end market in the UK. Pricewise, those for the small shrimp have not moved down as much as for large shrimp (USD0.5/kg versus USD2.5/kg). The message is to find the niche.”

Creating a sustainable story

Fred commented, “The need for collective effort is beyond genetics to enhance farm efficiency. Genetics is not a silver bullet. We try to give best genetics to farmers, but this contributes to only about 25% of growth



“The dilemma is to remain sustainable financially. We need to sell what the market needs, but our tight spot is how can we do it cheaply”.

- Wan Nadri Wan Fauzi

potential. The rest is nutrition from feeds, environmental conditions etc. Even though we are in a fragmented industry, if all players focus on farm efficiency and improve productivity, they can make a big difference.” When prompted on the challenge of getting diverse players to work together, Fred simplified it to a common motivator - making money.

Chingling emphasised the usefulness of certification as a standard operating procedure (SOPs) in entering some markets but brought in the factors: confusion, impracticality, and expense they might cause. Considering the associated costs, the question was consumers would be willing to pay for traceability and certification.

The response from the producers highlighted a dilemma between financial sustainability and market demands. As a producer, Wan Nadri said that he does not have a choice. “The dilemma is to remain sustainable financially. We need to sell what the market needs, but our tight spot is how can we do it cheaply”.

For producers, there is no choice but to align with consumer demands. Andreas, in advocating for sustainable shrimp production that does not excessively burden producers financially, urged industry leaders to focus on profitability through sustainable practices, emphasising the potential for increased viability and profits. “Better performing feeds will deter farmers from using supplements. It is really up to industry leaders to help make farmers to be more profitable.”

Low shrimp survival rates and use of antibiotics

On low survival rates hovering around 55-60%, Fred drew parallels with his experiences in the poultry industry. He highlighted the need for everyone to do a better job at coming up with better environmental, genetic, and nutritional management so the animals can survive longer.

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Use of antibiotics in Asian shrimp farming is tarnishing industry's reputation. Prakan highlighted Thailand's success in reducing antibiotic use and said that all credit goes to the Department of Fisheries (DOF). "DOF has created an electronic traceability system to track shrimp through the supply chain with an electronic Aquatic Purchasing Document (APD). It is a mandatory system for traceability. Farmers need to use this system to buy post larvae and other supplies. It holds information on origin and details of shrimp harvests."

The dialogue then shifted to the viability of self-regulation in countries like Malaysia. Wan Nadri expressed optimism but requires strong political will to shift the focus from quantity-based metrics to quality benchmarks. Weighing in, Chingling proposed an educational approach to regulations such as the example of Thailand.

Insights from sustainable barramundi production

Drawing from his experience at Barramundi Asia, Andreas stressed the importance of advanced vaccines, certified feeds, and transparent supply chains. However, he admitted that more investments and incentives were needed for widespread success in the shrimp industry.



Andreas von Scholten says, "I think sustainable practices is a continuous journey, and not to stop or to start based on the market conditions."

Investing towards sustainability

Finally, Ronnie introduced a notion borrowed from the construction industry, suggesting that with low shrimp prices today, it could be an opportune time to invest in sustainability to be ready to take advantage of the upturn at a later date.

Fred emphasised the continuous journey of improvement, "At SyAqua, similar to other genetic companies, we are investing to be better year on year. For the small or commercial farmers, it is always striving to be better and

not necessarily with the extra amount of dollars until they hit a plateau such as density wise."

"I think sustainable practices is a continuous journey, and not to stop or start based on the market conditions. Now, we have skyrocketing ingredient prices and farmers are squeezed with low prices, it is important to innovate and do things sustainably. We are developing zero fishmeal and low fish meal products with the same farm performance. Proper husbandry is the way to be more sustainable and more profitable which is the way we need to go," said Andreas.

Chingling suggested the need to continue exploring avenues like ASC certification to command premiums in the market. She highlighted their influence on ensuring compliance with regulations too. She shared her struggle to get suppliers ASC certified with high costs being an obstacle. "An upcoming ASC feed standard that will be enforced in about 12 months is not helping late entrants into the standard as if prometheus' mountain just gets steeper and steeper. However, there are also hopeful signs as efforts are made to make certifications more affordable, potentially paving the way for more farmers to join the sustainable movement."



Dr Prakan Chiarakhongman says, "When we talk about investments to the farmer, I tell them that they need to have the 2Ms: monitoring and maintenance."

Prakan said, "When we talk about investments to the farmer, I tell them that they need to have the 2Ms: monitoring and maintenance. Many farmers allow ponds to deteriorate or pond liners remained unrepaired, and I advise them that when 50% of crop is lost, the cost of production will be 200% and each day the damage is left untended it is USD500/day. Imagine with white spot disease, farmers can lose 10 ponds in the same day."

Wan Nadri said, "I believe in making changes through interventions, in three ways- financial, mechanical and process interventions. Since the latter is free - that is what we need to look at."



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Field application of a synergistic blend of organic acids to promote growth performance of fish and shrimp

By I-Tung Chen, Martin Guerin, Gilberto Hernández, Maria Mèrce Isern-Subich and Waldo G. Nuez-Ortín

Infectious pathogens such as bacteria, viruses, parasites, and fungi threaten production in aquaculture. These threats manifest with various symptoms, from asymptomatic to reduced growth performance and severe infections. Even individuals without symptoms can spread diseases among cultured ponds, slowing growth and increasing production costs. These pathogens often go unnoticed but can further lead to significant outbreaks when multiple contributory factors come together. For example, tilapia lake virus (TiLV) has been reported in Thailand, affecting both healthy adult tilapia and fingerlings, but does not display any clinical signs or cause mortality (Senapin et al., 2018). Similarly, the white spot syndrome virus can remain asymptomatic in shrimp for an extended period but trigger outbreaks under specific stressors such as spawning or environmental changes like temperature and salinity (Lo and Kou, 1998; Hsu et al., 1999).

In the past, antimicrobial agents such as disinfectants and antibiotics to control the growth of pathogens have been commonly used during disease outbreaks. However, the disease had already spread by the time farmers noticed the symptoms or mortalities. This has led to the emergence of antibiotic-resistant bacteria due to the overuse of antibiotics. As regulations become stricter, the use of antibiotics is being reduced. Instead, various strategies, such as improving pond management and reducing pathogen loads through nutritional strategies, are gaining popularity and becoming the preferred methods to prevent disease and improve farm efficiency.

Evidence supporting the benefits of organic acids

Dietary supplementation of organic acids has shown promising potential in enhancing disease resistance and growth performance in aquatic animals. Synergistic effects in disrupting bacterial cell walls and altering cytoplasmic pH, have been shown to effectively inhibit the growth of both gram-positive and gram-negative bacteria (Batovska et al., 2009; Defoirdt et al., 2009). Furthermore, the combinations of organic acids have contributed to energy generation in multiple metabolic pathways, including ATP production (Lim et al., 2015). The beneficial effects of including organic acids in the diet have been documented in several commercially important farmed aquatic species, including tilapia and shrimp (Ng et al., 2009; Nuez-Ortín et al., 2020)

Bacti-Nil®Aqua is a blend of organic acids designed specifically for aquatic species. It effectively combats the clinical and subclinical presence of pathogenic bacteria, which in turn promotes growth, particularly in high-density farming environments. Research under controlled infection conditions has demonstrated the efficacy of the health additive in reducing the impact of

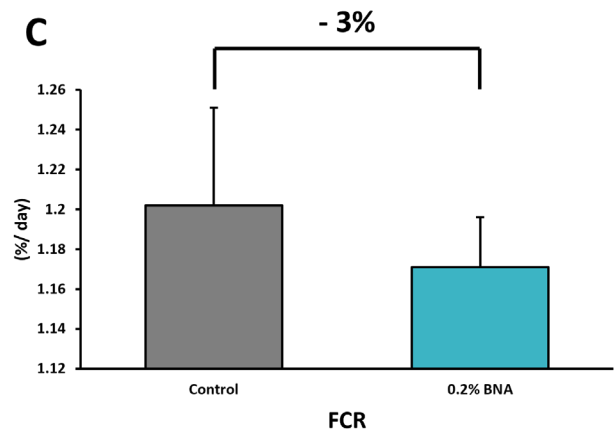
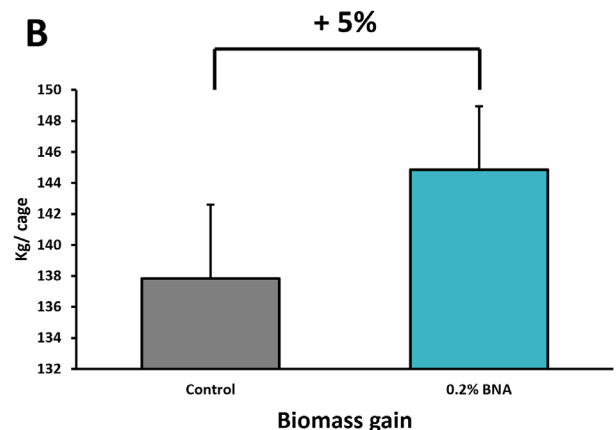
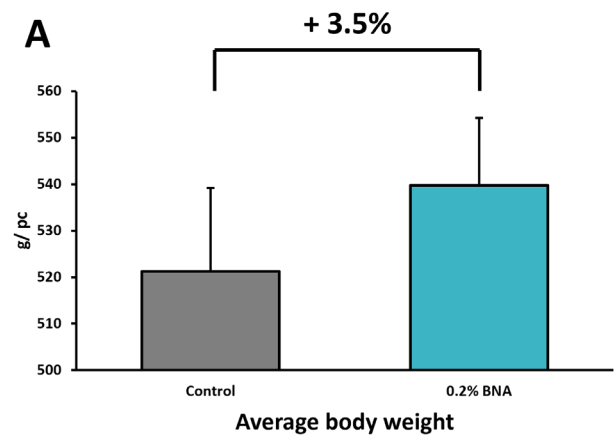


Figure 1. Effects of 0.2% Bacti-Nil®Aqua on average body weight (A), biomass gain (B), and FCR (C) of tilapia after 12 weeks of feeding.

francisellosis and streptococcosis in tilapia (da Silva et al., 2023), or vibriosis in shrimp (Morales-Covarrubias et al., 2022; Eissa et al., 2022).

This article presents two studies, one in tilapia and the other in whiteleg shrimp, that further corroborate the efficacy of Bacti-Nil®Aqua to control subclinical infections and promote growth in farm conditions.

Promoting health and growth performance of tilapia

The tilapia experiment conducted in the central region of Thailand, aimed to assess the impact of Bacti-Nil®Aqua on health and feed performance of tilapia in a farm trial setting. The study evaluated a control feed and a treatment 0% fishmeal feed both formulated to contain 32% crude protein and 4% fat. This blend of organic acids was supplemented at 0.2% in the treatment feed.

Tilapia were housed in cages within a reservoir pond, with each cage measuring 4 x 3 x 1.2m. A total of four replicates were used for each treatment, with 300 red tilapia fingerlings in each cage. The average initial weight of the fish was 56.5g, and the culture period spanned 12 weeks, involving two daily feedings.

At the beginning of the trial, a comprehensive health assessment was conducted, including general necropsy

and pathology examinations, to ensure that the fish were healthy and free of specific pathogens. Regular sampling occurred every four weeks, involving weighing and counting the fish to adjust feeding and monitor mortality and abnormal behaviours.

After 12 weeks of feeding, all the fish in the control and supplemented groups remained healthy, with no signs of infection as per the health assessments. Negative results were obtained for all tests conducted for *Streptococcus*, parasitology, and the TiLV PCR test. The survival rate exceeded 99% at harvest in all groups, which can be attributed to cooler water temperatures (i.e. around 28°C and on average 3°C lower than the previous year) and the subsequent lower risk of streptococcosis.

Despite the lack of environmental challenge, the use of Bacti-Nil®Aqua improved growth performance, evidenced by an average increase of 3.5% in body weight, 5% gain in total biomass, and a 3% reduction in the feed conversion rate (Figure 1). A recent study found that tilapia fed diets supplemented with Bacti-Nil®Aqua for 21 days showed a change in the fish's gut microbiota, reducing harmful bacteria like *Vibrio* spp. and increasing beneficial probiotics like *Cetobacterium* and *Bacillus* spp (da Silva et al., 2023). These are known to produce beneficial metabolites that support fish health and growth.

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The functional additive increased feed cost, but this investment was paid off by the biomass gain and economic returns. The return on investment (ROI) calculation indicated that for each USD invested in the additive application, there was a gain of USD3.5.

In summary, this farm tilapia trial demonstrated that incorporating a preventive dose of 0.2% Bacti-Nil®Aqua in feed has the potential to positively impact farm profitability even when production conditions are more optimal than expected.

Improving the performance quality of extensive shrimp feeds

A shrimp trial was conducted in a farm located in southern-central Mexico during May–July. The main objective of the research was to improve the performance of an extensive feed to reach that of a semi-extensive feed under a semi-extensive culture system. Three feeds were tested: a semi-extensive feed as positive control, and extensive feed as negative control, and an extensive feed supplemented with 0.2% Bacti-Nil®Aqua.

The extensive feed was formulated to the same protein and fat levels (35% and 6%, respectively) than those of the semi-extensive feed, but included less fishmeal and lower-quality protein sources. The cost of the extensive feed supplemented with the additive was lower than that of the semi-extensive feed.

Healthy juvenile shrimp of approximately 3g were stocked in submerged cages (3 x 3 x 1m) at a density of 25 shrimp/m². Feed was provided twice daily, and the feeding ratio was adjusted based on feeding tray consumption and weekly biometric measurements.

Results show high survival rates of around 90%. This was attributed to the period during which the trial was conducted; May–July is considered an optimal period in terms of environmental challenges and disease outbreaks in the area. Results also confirmed that 0.2% Bacti-Nil®Aqua improved the performance quality of the extensive feed. In relation to the extensive feed without supplementation, the additive significantly increased survival by 6% and numerically increased biomass gain and conversion efficiency by 7.8% and 8%, respectively (Figure 2). More importantly, biomass gain and conversion efficiency achieved by the additive in the extensive feed were numerically similar to those achieved by the semi-extensive feed.

Such improvements resulted in an ROI of 18.1, indicating that the supplementation strategy, by improving the performance quality of extensive shrimp feed, can potentially bring a noteworthy positive impact on the profitability of semi-extensive farms.

Conclusion

Organic acid-based additives are commonly used in aquafeeds as a preventive strategy to reduce the impact of bacterial infections. Animals that receive Bacti-Nil®Aqua under an optimal culture environment have been shown to have improved survival and growth rates. This is likely attributed to better control of subclinical levels of pathogens and to a better use of energy resources towards growth promoting mechanisms. These studies validate the efficacy of Bacti-Nil® Aqua as an additive to ensure the performance and profitability of functional feeds.

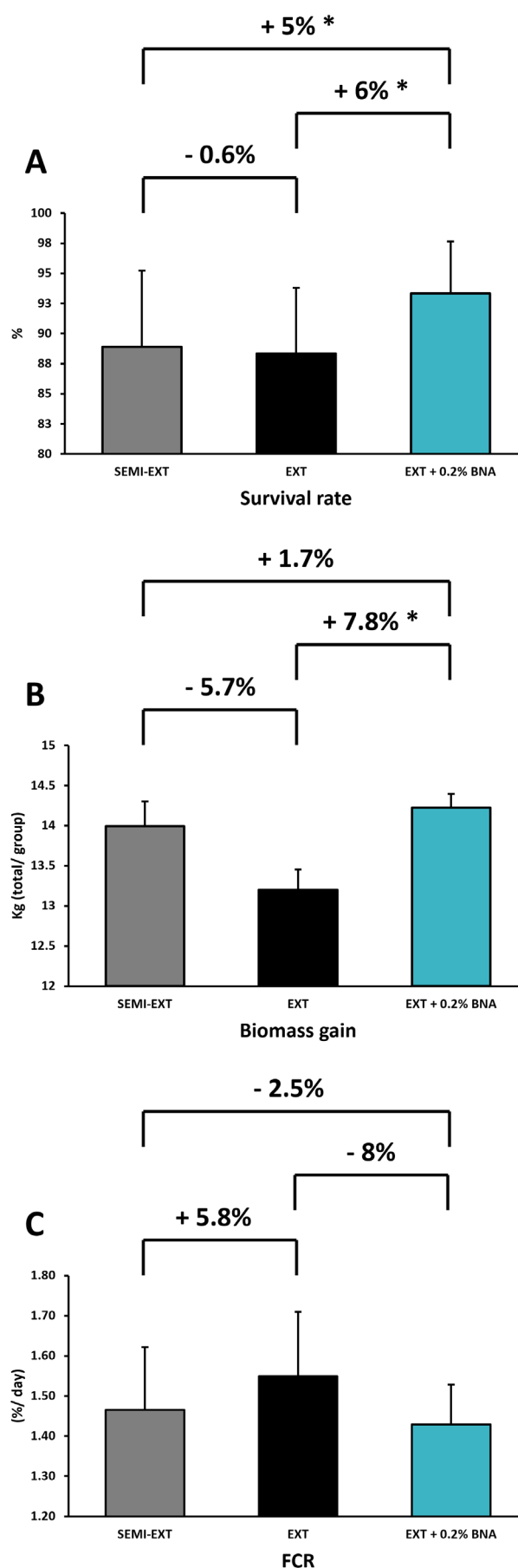
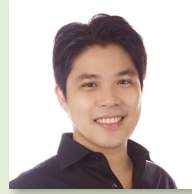


Figure 2. Effects of the extensive feed +0.2% Bacti-Nil®Aqua diet on survival (A), biomass gain (B), and FCR (C) on shrimp in comparison to semi-extensive and extensive control diets after 70 days of feeding. The results show significant differences ($p < 0.05$) compared to the control feeds.

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‘You are what you eat’: Enhancing fish gut health for optimal feed performance

The consolidation of 16 trials conducted on red seabream demonstrates the potential of marine protein hydrolysates to enhance gut health in marine fish species, leading to a significant improvement in feed assimilation.

By Mikael Herval and Kyeong-Jun Lee



Figure 1. a. Jeju University fish testing facilities, b. Red seabream *Pagrus major*

The benefits of using marine protein hydrolysates (MPH) in aquafeeds have been widely documented. Previously, our team has demonstrated the advantages of incorporating a shrimp and tilapia powder hydrolysates (SPH and TPH, respectively) to restore the performance of olive flounder when fed diets with reduced levels of fish meal (Herval, et al., 2015). Additionally, the health benefits resulting from SPH supplementation in both marine fish and shrimp species were also presented in 2018, with an indication on improved resistance to bacterial diseases (Soller et al., 2018). Both studies utilised cost-effective, optimised dietary formulations that outperformed high fish meal formulations (HFM). After these publications, numerous clinical trials were conducted on red seabream *Pagrus major* using SPH and TPH for internal reference purposes. Their consolidation provides further insights to better understand their potential for improving feed assimilation and the underlying modes of action.

A meta-analysis of MPH uses in different dietary contexts

Between 2014 and 2019, 16 trials were conducted at Jeju University, South Korea (Figure 1a and 1b) to assess the nutritional and health performance of new dietary solutions in red seabream, with SPH and TPH as our internal benchmarks. Both MPH were incorporated at 5% to facilitate the substitution of approximately 50% of the initial fish meal with plant proteins, primarily soybean protein (Table 1.) depicting typical high fish meal (HFM) and low fish meal (LFM) formulations for red seabream. These designs provided the opportunity to evaluate the benefits of MPH in both dietary fish meal substitution and supplementation (LFM + 5% MPH vs HFM diets and LFM + 5% MPH vs LFM diets, respectively).

After 12 to 15 weeks of feeding trials, fish were sampled to collect and measure an extensive array of zootechnical, physiological, and immune parameters. For the purposes of this study, we will specifically focus on the following parameters: specific growth rates (SGR in %/day), feed conversion ratio (FCR) and its mirror parameter; feed

efficiency (FE, calculated as $1/FCR$); villi length (VL in μm); enterocyte height (EH in μm) and goblet cell density (GC, number per cross section). Simultaneously with these feeding studies, apparent digestibility coefficients for dry matter (ADC_{DM} in %) and crude protein (ADC_{CP} in %) were assessed with fish from the same batch over a period of 3 weeks. The same dietary formulation was used, and chrome oxide (Cr_2O_3) served as an inert marker for ADC assessments.

SPH: Versatility when substituting fishmeal with plant proteins in carnivorous fish

The red seabream is a marine carnivorous fish species that requires a high level of dietary crude protein, which must be of good nutritional quality and palatable. SGR and FCR indicators, as illustrated by Figures 2a and 2b, clearly confirmed that it was possible to effectively substitute 50% of fish meal with plant proteins as long as 5% MPH was used to compensate for the missing soluble protein, associated bioactive peptides and dietary palatability.

It is important to note the differences in observed benefits based on the context and the source of MPH inclusion. When it comes to dietary supplementation, we observed higher SGR and FCR gains compared to fish meal replacement (p -value < 0.05). In less challenging nutritional conditions, both TPH and SPH are equally effective, with approximately 9% higher SGR and 13% lower FCR to be expected compared to the control diet (LFM).

Additionally, in the case of dietary application, the use of TPH in the LFM diet successfully restored the growth and feed conversion performances observed in the HFM diet, but dietary SPH outperformed it with a 5% higher SGR and a 10% lower FCR when compared to the LFM diet.

Ingredients	Experimental diets		
	HFM	LFM	SPH/TPH
FM FAQ65	30.00	15.00	15.00
SPH/TPH			5.00
Soy protein concentrate	15.00	26.40	21.40
Corn gluten meal	12.00	12.00	12.00
Wheat flour	30.00	30.00	30.00
Fish oil	4.65	6.00	6.00
Soybean oil	4.65	4.20	3.90
Mineral / vitamin Mix	2.00	2.00	2.00
Starch	1.20	1.20	1.50
Choline chloride	0.50	0.50	0.50
L-Lysine	0.00	0.50	0.50
L-Methionine	0.00	0.20	0.20
Taurine	0.00	0.50	0.50
Di-calcium phosphate	0.00	1.50	1.50
<i>Proximate composition (% dry matter)</i>			
Crude protein	45.4	45.7	45.4
Crude lipid	16.6	17.1	16.8
Crude ash	5.76	5.00	5.26
Gross energy (MJ.kg ⁻¹)	21.78	21.59	21.65
Moisture	5.37	7.25	6.63

Table 1. Feed formulations (dry basis)

The use of MPH led to higher feed efficiency, and this improvement was in part attributed to enhanced ADC for dry matter and crude protein. In the context of fish meal replacement, 5% MPH dietary inclusion allowed to maintain the observed ADC values seen in the high-level FM diets (Figure 2c and 2d). When used as a dietary supplement, it resulted in a significant increase in ADC by 6% (SPH) to 8% (TPH).

These improvements far exceeded what would typically be expected when replacing only 5.0% of dietary dry matter, or 7.8% of dietary crude protein considering 75% average protein content for MPH. This suggests that, in addition to promoting increased growth rates, there are other physiological changes associated with the use of MPH in diets, which contribute to improved nutrient assimilation and, consequently, feed efficiency.

MPH: “same same” but different*

The study of fish gut histology will help us to better understand how the dietary use of MPH enhances dietary nutrient assimilation. The Spearman correlations (Table 2) indicate strong and significant relationships between FE and ADCs, with ADCs themselves being correlated with VL and GC. Notably, VL was found to be highly correlated with EH.

While there could be additional mechanisms of action not described in this study (such as modulating intestinal amino acids and/or peptides transporters like Pept1), we can reasonably infer that the functionality of MPH promotes the development of enterocytes (EH), affecting the size of gut villi (VL) and the density of goblet cells (GC, see Figure 3a).

After undergoing an enzymatic hydrolysis process, a large proportion of the protein amino acids from MPH is found in the free form. These free amino acids are known to have a direct trophic effect on the enterocyte layer. Antioxidative and antimicrobial peptides, commonly found in MPH, also play a role in maintaining gut cell integrity and their defense against stressors such as anti-nutritional factors in plant protein or disruptions in gut microbiota.

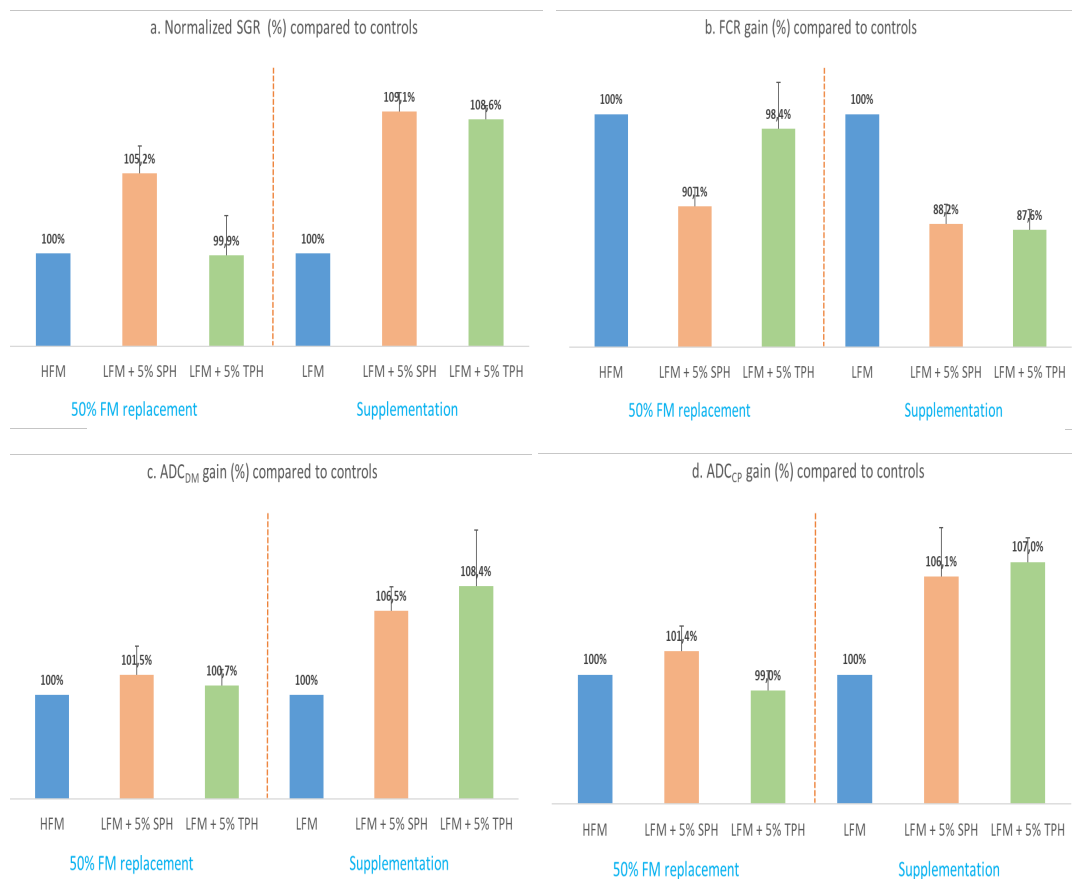


Figure 2. Normalised feed assimilation and ADC gains over controls (LFM + 5% MPH vs HFM diet for FM replacement topic and LFM + 5% MPH vs LFM diet for the supplementation one) a. Specific growth rate, b. Feed conversion ratio (FCR), c. Apparent digestibility coefficients (ADC) for dry matter, d. ADC for crude protein.

	FE (1/FCR)	ADC _{DM}	ADC _{CP}	VL	EH	GC
FE (1/FCR)		0.7055 p < 0.05	0.7059 p < 0.01	0.3588 p > 0.10	0.1647 p > 0.10	0.5618 p < 0.05
ADC _{DM}	0.7055 p < 0.05		0.8374 p < 0.01	0.6220 p < 0.05	0.4154 p > 0.10	0.5165 p < 0.10
ADC _{CP}	0.7059 p < 0.01	0.8374 p < 0.01		0.6471 p < 0.05	0.3971 p > 0.10	0.5618 p < 0.05
VL	0.3588 p > 0.10	0.6220 p < 0.05	0.6471 p < 0.05		0.8500 p < 0.001	0.1735 p > 0.10
EH	0.1647 p > 0.10	0.4154 p > 0.10	0.3971 p > 0.10	0.8500 p < 0.001		0.0706 p > 0.1
GC	0.5618 p < 0.05	0.5165 p < 0.10	0.5618 p < 0.05	0.1735 p > 0.10	0.0706 p > 0.10	

Table 2. Spearman correlation coefficients between fish gut morphometrics, FE and ADCs for DM and CP (n=16 individuals, p-values are mentioned below the coefficients). FE= feed efficiency, VL= villi length; EH = enterocyte height; GC = goblet cell density; ADC_{DM} = apparent digestibility coefficients for dry matter; ADC_{CP} = apparent digestibility coefficients for crude protein.

This is how dietary changes at the molecular level (the change of MPH native protein form and resulting functionality) significantly impact animals at the cellular and tissue levels, with bigger enterocytes and gut villi. Numerous references demonstrate that the size and shape of vertebrate gut villi modulate nutrient absorption and feed assimilation.

In parallel, goblet cells play an important role by secreting protective mucus, reducing the risks of gut inflammation or infection, while increasing the nutrient bioavailability. Enhanced fish gut physiology ultimately leads to improved ADC for both macro and micro-nutrients. It is important to note that the modes of action vary

when using different MPH; SPH demonstrates higher values for villi length (VL), while TPH exhibits higher values for goblet cell densities (GC, as shown in Figure 3b, 3c and 3d). These differences may partially explain why SPH was found to be more effective than TPH with regards to fish meal replacement.

Conclusion and perspectives

Marine protein hydrolysates, as functional ingredients, are widely recognised for their palatability and high digestibility. However, there is a limited number of references indicating their potential to enhance fish gut health and subsequent nutrient assimilation. Through

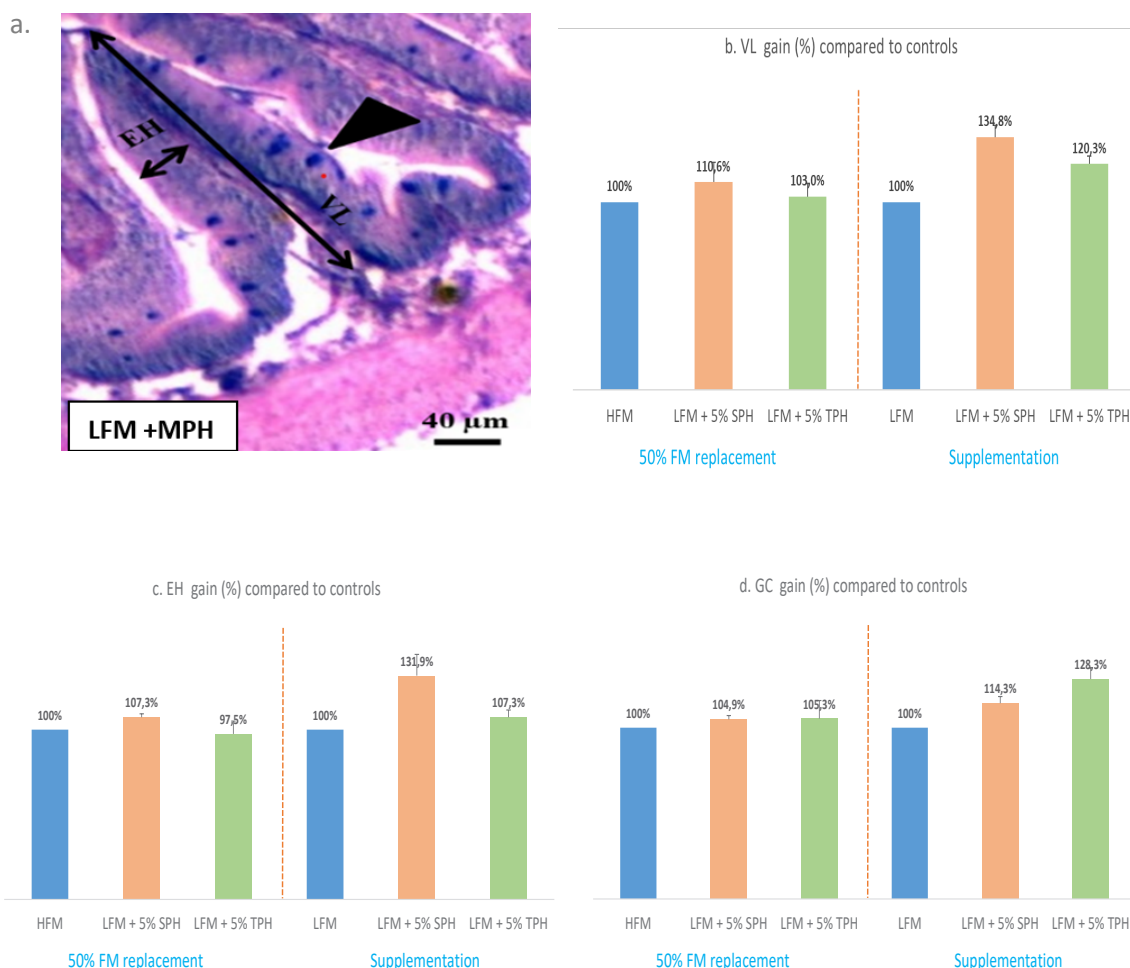


Figure 3. Normalised red seabream gut morphometric gains over controls (HFM diet for FM replacement and LFM diet for supplementation) a. microscopic details; b. VL gain, c. EH gain and d. GC gain.

the consolidation of data from several trials conducted on red seabream with dietary MPH, we have brought to the forefront this potential and have elucidated some of the underlying modes of actions.

Our findings illustrate the practical applications of dietary MPH, showcasing the effective reduction of fish meal usage in marine fish species, and offering advantages both in terms of feed efficiency and growth performance. These benefits become more pronounced when opting for MPH dietary supplementation.

Our analysis also showed that the raw material origin of MPH affected the functional benefits of the finished product. The hydrolysis of protein coming from fish or shrimp can lead to the production of different peptide profiles and AA peptides sequences carrying various biological activities and thus affecting different tissues and functions.

Taking a holistic approach to MPH dietary supplementation to enhance feed and nutrient assimilation can lead to additional advantages, such as improved water quality and reduced environmental eutrophication. Simultaneously, besides the decreased environmental impact on feed production (life cycle analysis), the industry can anticipate enhanced Fish In Fish Out (FIFO) ratios when using MPH for reducing fish meal in diets.

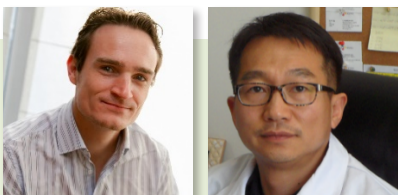
Further research concentrating on the influence of MPH on the assimilation of crude fat in marine fish species, ideally with detailed apparent digestibility coefficients (ADC) for critical fatty acid components (PUFAs), holds promise in reducing the reliance fish meals and oils in current dietary formulations.

** Note: The expression 'same same but different' is an informal phrase of Asian origin that signifies two things are similar in many ways, but there are still notable or subtle differences between them. It is used here to illustrate the similarities and differences revealed in the effects of MPH."*

Authors notes: SPH and TPH refer to shrimp powder and tilapia powder hydrolysates which are known in the feed market as Actishrimp and Actifish, respectively

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The power of nutrition for the industry in Asia

Nutrients, ingredients, postbiotics and back to basics at dsm-firmenich's 28th Aqua Conference Asia Pacific.

Setting the scene for an audience of 150, comprising mainly of feed millers, aquaculture producers and industry leaders around Asia, dsm-firmenich's Achyut Iyengar, Regional Marketing Director, Nutritional Products APAC, analysed the competitive forces shaping the shrimp industry in Asia.

"Traditionally, it has been the power of suppliers, but in the last three years, an imbalance has happened. It is now the power of buyers. While major suppliers, Ecuador, India, Southeast Asia, and China, bring in 3.5 million tonnes, demand from North America, Europe, China, and Japan is only at 3 million tonnes. Within suppliers, there is intense competition, the CAGR of 25% in Latin America and shift of exports to China markets, from 100% to 80%, is significant from a strategic perspective," said Iyengar, adding that new entrants bring new challenges for Asia's top producers - India, Vietnam, and Indonesia.

The message was that the industry cannot control much but can act on what it can and utilise technology before being caught unaware in this current VUCA (volatility, uncertainty, complexity, ambiguity) environment. "The poultry industry is using expanders more and more, as well as the power of enzymes in their operations for better digestibility. With post-pelleting liquid applications, dsm-firmenich is testing out pilot-scale applications to match the pelleting operations in the feed mill before commercial adoption. There is also Sustell™, the data platform to accurately measure the environmental footprint of farming and feed production. This is the differentiation tool for your operations, which helps to realise your targets such as carbon and footprint reduction."

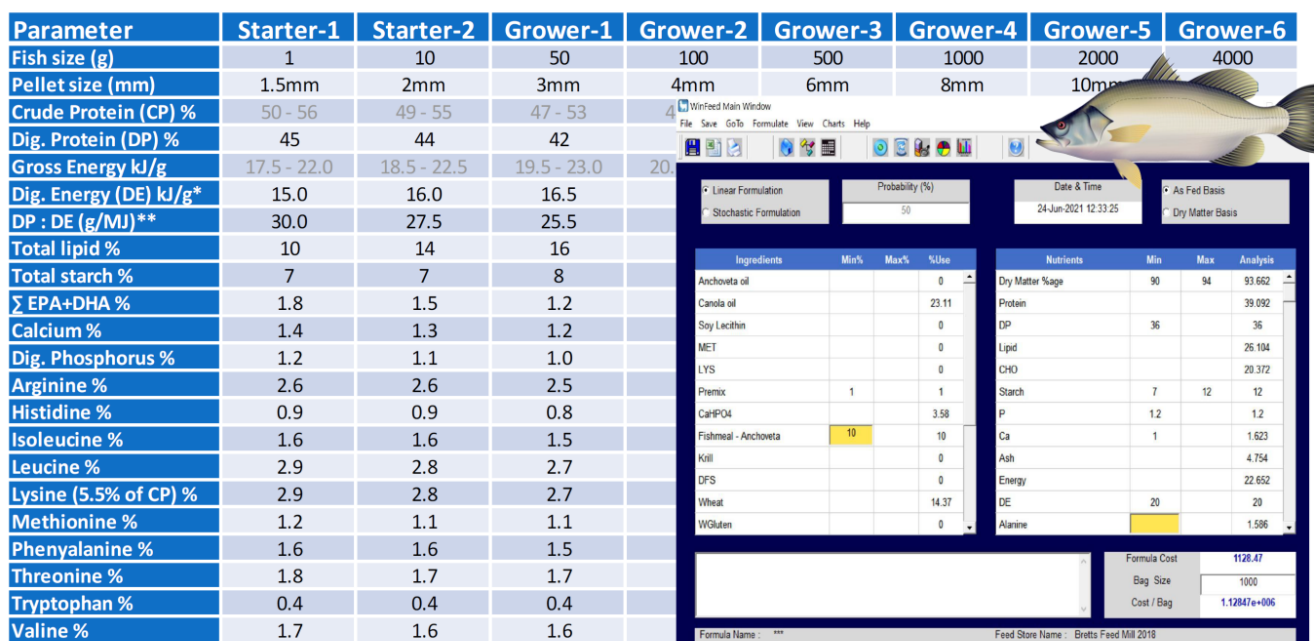
Revolving around the "Power of Nutrition", this one-day conference, held in Bangkok, Thailand on November 21, 2023, covered industry developments, from shifting priorities in ingredient assessments, quality shrimp feed production and back to basics on carbohydrates and anti-nutritional factors and gut health with postbiotics.

Shrimp protease matrix calculator

There was a launch for the shrimp protease matrix calculator. In introducing this innovation, Chiow Yen Liew, Regional Marketing Aqua, asked the audience to visualise the environmental benefits when there is a cleaving of protein and hydrolysis of the peptide bonds with the protease Ronozyme® ProAct, which increases protein digestion across a range of feed ingredients and reduces adverse effects of anti-nutritional factors, thereby reducing feed costs.

She added that the matrix value allows the quantification of the contribution from protein digestibility. The benefits include the least cost and innovative multi-objective formulations, which provide efficient utilisation, digestion, absorption, and assimilation of protein. The reduction of nitrogen in feed waste is crucial for the environment. This is also part of the quality control process for raw materials.

This user-friendly platform allows for inputs on raw material information, such as digestibility data for essential amino acids (EAAs) and non-essential amino acids digestibility (NEAAs). It then tabulates values automatically based on the dietary protein content of different diets and processing conditions. Some examples of shrimp protease matrix values were 30-31% protein digestibility improvements for soybean meal and 26% for full-fat soybean meal.



Derived from: Glencross et al. (2013). *Lates calcarifer* nutrition and feeding practices. *Biology and culture of Asian seabass Lates calcarifer*, 178-228.

Figure 1. Using this slide, Glencross demonstrated that modern nutrition is based on nutrients not ingredients. Derived from: Glencross et al. (2013). *Lates calcarifer* nutrition and feeding practices. In *Biology and culture of Asian seabass Lates calcarifer*.



Brett Glencross says, "Growth studies are never the starting point in any ingredient evaluation. You might get differences, but then separating out feed intake from nutrient supply effects becomes difficult."

Evolution of ingredient assessment: Shifting priorities in the 21st century

Dr Brett Glencross, Technical Director IFFO (Marine Ingredients Organisation) and Honorary Professor at the University of Stirling, Scotland, approached the above, first by looking at diet formulations. This requires knowing the requirements and then to design specifications in terms of feed composition. "We then marry that up with an ingredient database. In a feed formulation interface, we manage two sets of information: nutrients and ingredients."

Important too are the different types of constraints, such as raw material tolerances, processing parameters, quality expectations and prices. "Fundamentally, the art and science of the formulation process is how can I deliver the best feed at the least risk."

Precision nutrition approach

Diet formulations are no longer based on ingredients but on nutrients. Glencross illustrated this with a modern formulation for the Asian seabass (Figure 1). In precision nutrition, specifications change for different stages and pellet sizes and eight different specifications can be applied over the production cycle of this fish (from first feeding to 5kg harvest size). Secondly, digestible levels are fixed but crude or gross levels vary. Thirdly, as the animal's size changes and there is a different feed size and the protein: energy dynamics will also change.

"For every ingredient used, we need to have digestibility data. Then we need to understand the requirements for all (amino acids and fatty acids) and not just a generalisation of protein and energy."

Understanding the requirements

It is essential to understand the requirements for all nutrients. This is a Pandora's box, as there are many ways we can consider this. Glencross discussed the classic requirement curve of response criteria (growth or feed efficiency) for maintenance to adequate supply. He stressed that requirements will never be a constant and will always change with age, size, and condition. Back to the Asian seabass model, Glencross quoted an example of digestible protein demand for a 1000g fish at 19g/MJ DE. When translating this into the specification, Glencross cautioned against using a "one size fits all" across the whole life cycle. "This means that you will lose growth in the early stage from inadequate nutrient supply and at the end, cost the business money, by over supplying nutrients which are wasted while damaging the environment. A degree of conservatism is usually applied since it is less risky to up the specifications than to undercut them."

Managing ingredients

While precision nutrition is based on nutrients, critically it is ingredients that supply nutrients, and how we manage them is a hallmark of precision nutrition. By using an ingredient to their best capabilities, we can optimise its value and minimise its risks. There are lots of ingredients used in aquafeeds and Glencross discussed ways to evaluate them and then interpret the results. Before 2000, with AquafeedsV1, the ingredient base was limited, and the evaluation process depended on information from suppliers. "As aquaculture grew, formulation became much clearer, but the need was to control cost. With Aquafeeds V3, the focus has moved to what is most sustainable for the business and planet."

Glencross discussed the situation with marine feed ingredients. Fishmeal supply is constant at 5 million tonnes/year and fish oil is at 1 million tonnes. Today, with 55 million tonnes of aquafeeds, 80% of fish meal and 65% of fish oil are used in aquafeeds. In the 1990s, it was only around 20% of fish meal. Globally fish meal use has increased from about 2.9 million tonnes in 2000 to 3.9 million tonnes in 2020. Fish oil use by aquaculture on the other hand has decreased from 836,000 tonnes in 2000 to 791,000 tonnes in 2020.

All ingredients have SWOT's - strengths and weaknesses, opportunities, and threats. There is no such thing as the perfect ingredient, said Glencross. He added that all ingredients have risks and formulators need to be aware of the ramifications and impact they create on formulations.



The dsm-firmenich team, Benedict Standen, Head, Aqua Marketing Global (left), Mongkol Kaewsutas, Precision Service, GAPAC (third right); Chiow Yen Liew (second right) and Dr Rutchanee. Chotikachinda, Technical Expert, GAPAC, with speakers, from second left, Dr Dean M Akiyama; Dr Philippe Tacon, Product Manager - Microbials - dsm-firmenich; Dr Artur Rombenso, Senior Research Scientist and Animal Nutrition Team Leader, CSIRO; Dr Brett Glencross and Dr Trond M. Kortner, Associate Professor, Faculty of Veterinary Medicine, Norwegian University of Life Sciences.

Tacon presented on postbiotics in aquaculture; Kortner on antinutrients and adventitious toxins in fish feeds and Rombenso on carbohydrates. A report on these presentations will be published in the next issue.



Preecha Bangnokkhaek, Thai Union Feedmill PCL, Thailand (middle) with Anuj Tyagi (left) and Korupu Venkata Raju (right), Avanti Feeds, India.

There are ingredients that are easier to work with than others. “It is essential to understand the negatives and positives of any ingredient you use as this will increase adaptability and flexibility and what we can and cannot do with our formulations. Importantly, the methodology that we choose to assess an ingredient affects our understanding of a particular ingredient. It is critical to understand, re-evaluate your process and be very objective about it.”

Ingredient assessment

There is a logical hierarchy to assess an ingredient. There is a large influence of the feed intake parameter, followed by digestibility and their absorption. The greatest variability is at the start, said Glencross, although typically most will look at the end point such as growth. His 4-step approach to methodology to assess ingredients is given in Figure 2.

- The minimum data for characterisation of the ingredient is proximate analysis, amino acids, and fatty acids. The gold standard is chemical analysis while complete technical data sheets are useful.
- Palatability is the way an animal interacts with its feed and is indicative of the nature of the attractiveness of a feed. There is a “window of sensitivity” for feed intake which in during a period of 10 days (day 4 to day 14 after feed introduction), the animal can signal feed intake trends and allowing the formulator to decide on the ingredient’s utility quite rapidly. Too short and the risk escalates. Too long and it all becomes lost in the noise of other feed intake drivers.
- On quantitative ingredient digestibility, an example of research comparing various sources of marine meals against SPC, SPI and corn gluten is Glencross & Bachis (2021) in *Aquafeed* 13, 21-25). On digestibility across species, the message is that sometimes there is good commonality, but not always. Trophic levels and ecological niches are good indicators of similarity in digestibility.

- Growth can be used as a measure of ingredient utilisation but there is no right way, but lots of wrong ways. Some strategies are better for answering certain questions.

“The key is to be clear on the question being tested and then choose the most appropriate strategy to answer the question. As a general rule, when diets are formulated on an equivalent digestible nutrient/energy basis, then growth correlates to feed intake. However, growth studies are never the starting point in any ingredient evaluation. You might get differences, but then separating out feed intake from nutrient supply effects becomes difficult”.

Into the future ingredients

Glencross sees an increasing trend in ingredient diversity. In the fish meal market, different species, pricing, biogenic amine levels as well as how the carbon footprint story is positioning things as becoming increasingly important. Whether a product is certified and made at low or high temperatures, they give industry choices. As an example, TASA, from Peru has eight fish meal products: a clear diversification strategy for different applications in different markets.

The ability to use circular products is increasing. In 2022, by products from fisheries and aquaculture totalled 2.483 million tonnes (38% of global supply). That included 680,000 tonnes of fish oil and 1.8 million tonnes of fish meal, of which 25% and 27% of total supply came from fisheries by-products, respectively. While by products from aquaculture comprised 28% of fish oil and 7% of fish meal supply. As we increasingly rely on plant protein meals, hydrolysates are also becoming increasingly important ingredients. These ingredients give the flexibility to control palatability in a way that few other ingredients can.

Finally, Glencross said, “The importance of sustainability will grow and become more objective. To better manage things, we need to measure them better. Putting the sustainability story into a quantitative metric is where we can make choices by comparing values against each other. Using lifecycle assessment (LCA) information as a formulation parameter will provide some clear benefits for the future.”

Consistent quality shrimp feed production

Dr Dean M. Akiyama, Aquaculture Advisor, Indonesia, stressed that focusing on feed consistency is all about minimising risks. “The shrimp aquaculture industry is changing, while always encountering more constraints and challenges, it is always adapting. Despite the problems

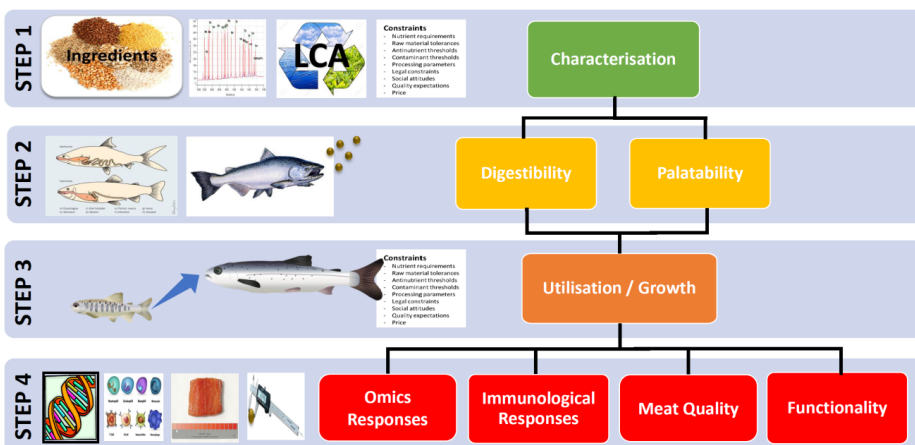


Figure 2. The 4-step approach to methodology to assess ingredients.



Dean M. Akiyama says, "Today, we strive to improve technology to reduce the cost of production but need to constantly up efficiencies."

faced by the shrimp industry, such as today with low prices, we continue growing by 5-8% yearly; always meeting production goals is getting harder," said Akiyama, while linking aspects of shrimp feed quality to farm management and water quality.

Variance component analysis

This looks at how different components (farm management, post larvae and feed quality) affect pond production in outdoor ponds. Biomass is critical as it determines profitability. Akiyama gave the results of the VCA conducted over three years covering 32,000 ponds in integrated operations from 2011-2014 (Table 1).

Variance Component	Biomass (g)	MBW (g)	SR (%)	FCR
Feed	15	22	16	10
Post larvae quality	19	23	24	15
Pond management	66	55	60	75

MBW = mean body weight; SR = survival rate and FCR = feed conversion rate.

Table 1. Results for variation component analyses for harvest shrimp production performance.

"The VCA gave some interesting results. The influence of feed quality on biomass was 15%, post larvae quality was 19% and pond management was 66%. Interestingly, pond management had a 75% influence on FCR. It was not feed quality but, more importantly, when, and how much to feed. In a fully integrated system, when post larvae were below specification, they were flushed out, and when feed was below specification, it was rejected. Our feed standard and consistency was better than in the open market."

Akiyama added that specifications for current outdoor ponds have not changed significantly in over 20 years. "The same ponds are being used to produce shrimp with modifications in production technology used. I believe that farm infrastructure and management are the major limitations to future production consistency."

The importance of consistency in feed quality

In his opinion, current shrimp feed quality standards exceed the production facilities (outdoor ponds) and farmer capability. While 10-20 years ago, feed quality made a difference in farm production since there was a lot of variability.

Protein in feed	FCR	Feed nitrogen (g)	Phosphorus (g)	Shrimp nitrogen (g)	Phosphorus (g)	Nitrogen loss to environment (g)
40%	1.5	86	20	22	4	66
35%	1.5	76	20	22	4	56
30%	1.5	65	20	22	4	45

"Today, across producers, nutritional standards are consistent and feed quality is comparable. Market leadership is based on reputation, technical services, and credit. Any differences in feed performance come from several biological and farm technology constraints which cannot be controlled in outdoor ponds. Each degree of change in temperature affects growth by 8-10%; a lower salinity from 25ppt reduces nutrient digestibility and availability, and dissolved oxygen lower than 6mg/L lowers shrimp appetite.

Three factors affect feed quality consistency: quality of feed ingredients at 60%, feed processing quality at 30% and nutrition based on formulation at 10%. On raw material assessments, Akiyama listed some guidelines and said that raw materials with low-quality specifications should be rejected, and that consistent quality of all raw materials will result in more consistent quality shrimp feeds.

With regards to shrimp feed nutrition, shrimp feeds need to have consistent palatability. The emphasis was on establishing the palatability enhancer as a minimum nutrient restriction for formulations. The most common aquafeed palatability enhancers are fish meal, other marine animal meals and hydrolysates.

Feed and water quality

Feed influences pond wastes. A 40% protein feed has 25% more nitrogen than a 30% protein feed (Table 2). Phosphorus from fish meal has low availability compared to MCP. To improve water quality, there are three options: reduce feed rate (which means reductions in nitrogen), phosphorous inputs and increase aeration and water exchange. Probiotics are helpful, but their results are inconsistent.

Akiyama gave an example of some findings at the farm where a 30% crude protein feed performed better than a feed with 40% CP. This is a testament to the effects of water quality measured in terms of transparency. With 40% protein feed, the water transparency went down to 20cm, and it was difficult to manage the water quality. This demonstrated that shrimp grew better because of water quality, not nutrients.

His message was, "Today, we strive to improve technology to reduce the cost of production but need to constantly up efficiencies."



Charing the Q&A panel, Benedict Standen (right) with speakers, from left, Dean M Akiyama, Trond M. Kortner and Brett Glencross.

Table 2. Variation in nitrogen and phosphorus in feeds with different % CP at a constant FCR.

Revolutionising global shrimp aquaculture with precision diagnostics

Melony Sellars discusses reshaping health and disease diagnostics in shrimp farming to reduce risks



Dr Melony Sellars, Founder and CEO of Genics Pty Ltd has 25+ years of experience in aquaculture, with an in-depth background in shrimp aquaculture breeding, health, biosecurity and high-density production.

In an era defined by the intersection of biotechnology and aquaculture, Genics reshapes the narrative of disease diagnostics in shrimp farming. In an e-interview with **Dr Melony Sellars**, the Founder and CEO of Genics Pty Ltd, we unravel the story of innovation, strategic pivots, and the competitive edge that sets the company apart.

From research to entrepreneurship

Sellars takes us on a retrospective journey, tracing the origins of Genics to her tenure at Australia's Federal Research Agency, CSIRO. Fifteen years ago, she was running breeding programs for shrimp producers; researching ways for reproductive sterility in *Penaeus monodon* and *Litopenaeus vannamei* and implementing shrimp gene regulation using RNAi. With the inherent problem of multiple pathogens, the cost of running several real-time PCR tests (required to realise the potential of their breeding programs) was prohibitive. This spurred the concept of a revolutionary solution, a super-plex PCR.

"I wondered if I could solve the multiplexing challenge to super-plex PCR. This would still be highly sensitive but reduce the cost to be affordable for farmers. They could also take a statistically significant sample size to make data even more powerful. Initial pilot studies were very promising, but research was stopped due to budget limitations at the time," said Sellars.

Fast forward to 2016, and Australia confronted a devastating white spot syndrome virus (WSSV) outbreak, propelling Sellars and her team to revisit their earlier work on quantitative pathogen detection. Sellars

seized the opportunity to transition from research to entrepreneurship. Genics was born in late 2018, driven by the mission to deliver a sensitive, affordable, and globally accessible super-plex PCR for quantitative pathogen detection.

"Personally, I was ready for a change and offered to start a company to get our biotech solution to global markets to improve shrimp production and food security."

A blessing in disguise amidst the pandemic

In late 2019, just as Genics began to market its multiple pathogen detection services (MultiPath™), the COVID-19 pandemic derailed the traction towards setting up local laboratories for two years. This was on the back of already successfully supporting 10-15% improvements in production in ponds in Ecuador.

However, Sellars recounts a strategic pivot that turned an adversity into advantage. A collaboration with DHL allowed it to streamline a delivery service, a swift sample collection from farms no matter where farms are located and a timely 3-4 day delivery to their accredited laboratory. The turnaround is 4-6 days, no matter how small or large a submission.

"When you think that this technology is detecting pathogens 2-4 weeks before animals are sick (when a point of care (POC) or industry standard PCR is run), we are keeping farmers ahead of their risks with trustworthy data to make smart management choices that genuinely change the outcome of their crop. Today, nothing makes our team prouder than seeing and hearing from our happy clients. Customers using our services continue to stay with us for every crop."

A distinctive competitive edge

On the notion of a crowded marketplace, Sellars asserts that Genics stands with its technology and industry experience as well as with accreditation. The core differentiator lies in its ability to achieve true early pathogen detection of multiple pathogens simultaneously, in a highly sensitive two to six copies per PCR, specific and quantitative assay at around the USD50 mark.

On copy-cat marketing prevalent in the industry, Sellars cautioned on often incorrect advice "At the end of the day, farmers need the best in class accurate and quality data that they can use to mitigate risk from pathogens. This is our commitment which extends across grow-out farms, hatcheries, and breeding programs. When combined with the comprehensive suite of health, biosecurity, and breeding solutions, no one gets close to what our team of experts delivers for our customers."

Transformative strides in shrimp aquaculture

Sellars unveils a series of achievements over recent years and announced that the R&D and commercialisation team

has developed Shrimp MultiPath2.0, a diagnostic tool featuring a spectrum of 18 pathogens. Set for commercial release in January 2024, this innovation promises to revolutionise disease detection in the global shrimp industry.

Beyond diagnostics, the venture into the digital realm, has led the introduction of the MyGenics portal, a year ago. This secure online platform facilitates safe sample submission, data tracking, and customer interaction.

"The Digital Solutions Team has taken a leap into the future by developing the world's first shrimp Artificial Intelligence (AI), to capture shrimp phenotypes in their natural habitat. The Global Client Success team's collaboration with clients worldwide highlights our dedication to maximising the potential of our products and services. One example is our dedicated biosecurity work in Vietnam, particularly with Viet Uc grow-out, as we have presented at several international conferences," said Sellars.

Genics has been busy supporting industry's shift towards genomic selection. It introduced to markets, the *L. vannamei* 60,000 Single Nucleotide Polymorphism (SNP) DNA marker system, a 7,800 SNP DNA marker system for *P. monodon* and an 8,000 SNP DNA marker panel for the pangasius. These tools promise gains, especially when combined with health and digital AI phenotyping solutions.

In terms of tangible impacts, Sellars said, "There was the doubling of nauplii output at Texcumar, Ecuador in 2023, a significant achievement using our application of shrimp health knowledge and technology. Similarly, the practical application of our technology has translated into profitable and stable shrimp production at Viet Uc in Vietnam."

On its global reach, the clientele base has expanded exponentially. Today, it is servicing customers in over 45 countries. In 2021, they had customers in 15 countries and expanded to 28 in 2022.

"We have an incredibly talented team of experts with an excellent team culture and a drive to deliver industry-relevant solutions. The team has expanded to 18 experts. Coming on board in early 2023, was our cornerstone investor and logistics expert Richard White."

Accolades were garnered in 2023 such as the Premier of Queensland Small Business Export Award, Lord Mayor's Product Innovation Award and Australia's InnovationAus Translational Hero Award.

The need for proactive disease management

A critical challenge, said Sellars is that no two farmers produce shrimp in the same way. "However, consolidation in some countries might help to lead to some consistency in production methods evolving over time. Intensification of production comes with pathogens and then disease challenges. Farmers seek solutions but unfortunately, with very few scientifically validated solutions to pathogens, there is a demand for unvalidated products sold as miracle cures."

Prescriptions for progress

Sellars maps out a prescription for industry enhancement. Firstly, she champions biosecurity, advocating for a global

education drive on its significance. Biosecurity, she insists, need not be intricate or costly, but rather "a journey of continual improvement" and ideally every shrimp operation should have a biosecurity plan in place. Secondly, breeding programs should develop tolerant, robust, pathogen-free lines which are affordable and globally accessible. "We see many small "pop-up" breeding programs run regionally in different countries with inadequate infrastructure facilities and sometimes with staff who have inadequate animal husbandry skills."

Thirdly, she advocates for the adoption of a statistically significant and properly designed proactive health surveillance, bringing together farmer observations, multiple pathogen PCR data from a sensitive, accurate, and affordable platform and histology. The latter if required.

Bridging disparities between Asia and LATAM

According to Sellars, divergences between the Asian and Latin American (LATAM) shrimp farms are primarily driven by varying densities, genetic lines, and risk mitigation awareness. "Farmers growing different genetic lines with different health statuses also have different needs in terms of early pathogen detection and risk mitigation."

Customisation and optimisation of solutions for early pathogen detection and early management over time emerge as the crux of addressing these divergent needs. "Overlay these with animal husbandry skills and experience, varying biosecurity knowledge, and different farmers having different needs for pathogen management based on knowledge and training."

Addressing WSSV

This is a longstanding conundrum. Sellars advocates an adherence to pond carrying capacities, good biosecurity practices, and stocking of genetically suitable post larvae while documenting good operating procedures. Following stringent dry-out and pond preparation procedures before the next crop will also set a farmer up for another successful season. She also acknowledges the challenges posed by neighbouring farms operating at different standards, thus presenting a risk of horizontal transmission.

In late 2022, Genics' early pathogen detection technology proved pivotal in detecting a new WSSV incursion in Australia, safeguarding the industry against emerging threats. In Indonesia, its technology serves as an early warning system, distinguishing between successful harvests and potential losses.

Future trajectory

Sellars has a bold vision for Genics and anticipates a doubling growth trajectory. The recently unveiled suite, combining health and digital AI phenotyping is poised for global adoption.

"Fundamentally, we will remain closely focused on delivering value for our clients, improving farm production and global food security. We will be transforming our industry by establishing sophisticated breeding programs that deliver high-quality broodstock and post larvae suited to solve our industry's biggest challenges."

Beyond shrimp, Genics is exploring other aquaculture species that would benefit from highly accurate and multiplexed disease surveillance testing platforms.

Asian marine shrimp in 2023: Reflections on the lowest prices in a decade

Drastically low prices started the 'stop and start' trend.

By Zuridah Merican



Earthen ponds and small greenhouse farms in China. Photo credit. Soraphat Panakorn, Novozymes.

At the end of 2022, most farmers worked with the expectation that post pandemic, demand will rebound and with this comes better prices. Buying had started in China in late 2022 and the first half of 2023 saw record high imports in China, going over the half a million tonnes mark but consumer demand and imports in the western markets of North America and Europe were down. Imports also declined in Japan and Australia (Globefish, 2023).

Since early 2023, farmers grappled with lower farmgate prices, (Figure 1). According to Globefish, in June 2023, the benchmark farmgate prices of vannamei shrimp for 60/kg were record lows at USD3.83 in Vietnam, USD2.88 in India, USD3.62 in Indonesia and USD2.20 in Ecuador. Thailand started well with a high price of USD5.37 in January 2023 but fluctuated downwards to end at USD3.88 in December, drastically low compared to that in 2022 at USD4.65 (Source: Vinij Tansakul).

By December 2023 prices were better at USD4.58 in Vietnam, USD 3.20-3.43 in India and USD2.65 in Ecuador but lower at USD3.52 in Indonesia. The highest farmgate price at USD4.84 was in Malaysia, where shrimp are mostly for the domestic market.

Vannamei shrimp supply in 2023

With falling farmgate prices, the question was whether the global vannamei shrimp supply in 2023 will contract. The Global Seafood Alliance (GSA) and Rabobank global shrimp aquaculture production survey and forecast report (presented at the Responsible Seafood Summit 2023 in October) gave a modest supply decline of 0.4% for 2023 at 5.6 million tonnes. During TARS 2023 in August, Robins McIntosh, Charoen Pokphand showed data for 2022 at

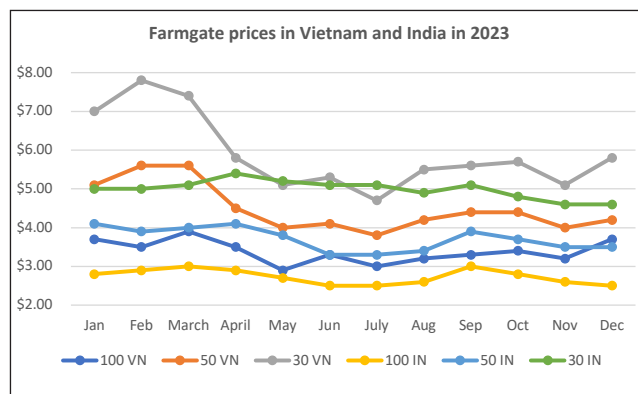


Figure 1. Average monthly farmgate prices for vannamei shrimp in Vietnam (VN) and India (IN) for sizes 100/kg, 50/kg and 30/kg. Source: Wei Che Wen, UniPresident, Vietnam.

5.34 million tonnes and in 2023, only 5.10 million tonnes. However, when Kontali considered the growth in volumes by Ecuador, the projection was 6.3 million tonnes in 2023 (Visch, 2023; Bussel, 2023).

As early as January 2023, India's industry leaders were pessimistic and projected drops as much as 10-12% for 2023. Rabobank (Sharma, 2023) also gave some projections of 2023 production: Vietnam to be less -15.1%, Indonesia, -5.1% and Thailand -2.2%. However, data from the Department of Fisheries Thailand (DOF) gave a 1.27% growth in production to a total of 260,268 tonnes with more volumes for both vannamei and black tiger shrimp (Table 1). Production from China is expected to increase by 8.8%.

	India	Vietnam	China	Indonesia	Thailand	Philippines	Malaysia	Bangladesh
Total shrimp production	788,800-835,200	723,000	2,070,000 *	310,000-320,000	256,832	89,247	32,000	70.219 *
Vannamei shrimp	748,800-795,200	570,000	1,890,000*	265-275,000	241,526	-	22,000	-
Black tiger shrimp	40,000-50,000	153,000	180,000*	45,000-50,000	15,306	-	10,000	70,219 *
Sources:	Sharma (2023)	Industry source	Guo (2023); McIntosh (2022) *2022	SCI	DOF	PSA & BFAR (actual data for Q1-Q3 & estimate for Q4)	Industry source	Das (2023) * data for 2022

Table 1. Estimates (tonnes) of shrimp production in major countries in Asia in 2023. DOF - Department of Fisheries, Thailand; SCI - Shrimp Club Indonesia; Manoj Sharma, Mayank Aquaculture, India; Philippines Statistics Authority & Bureau of Fisheries Aquatic Resources.

Farmed shrimp trade in 2023

Until July 2023, Chris Bussel, Kontali, at TARS 2023 reported a supply of 6.25 million tonnes of live weight equivalent (LWE) and out of this only 3.5 million tonnes entered the global trade, with 57% exported and 43% consumed locally. In a November review on export data up to Q3 2023, Willem van der Pijl, Shrimp Insights said that in Q3, the average prices of exported shrimp remained low. Despite a price slump, export volumes, mainly from Ecuador and India, continued to grow while others dropped. In Q1-Q3, the top six producers, Ecuador, India, Vietnam, Indonesia, China and Thailand exported 1.8 million tonnes (Shrimp Insights, 2023).

In a presentation on export statistics for the global shrimp market at the second Global Shrimp Forum 2023 (GSF 2023), van der Pijl noted that within 6 months in 2023, Ecuador had reached 600,000 tonnes of exports raising a possibility that exports would reach 1.2 million tonnes for the whole year.

"The total export value for Ecuador decreased, reflecting the negative price trend that Ecuador's exporters have been experiencing in China and other markets they supply to," said van der Pijl. Similarly, India's export value is on the decline. This is reflected in the negative price trend that exporters have experienced in the US and China, India's two largest export markets.

China was absorbing most of Ecuadorian shrimp. There are also exports of Ecuadorian shrimp via Vietnam to China as the final destination. China was also absorbing shrimp from India, followed by Vietnam, Indonesia and Thailand. With regards to other markets, volumes into the US dropped 18% y-o-y with an average retail value of USD9/kg. In 2023, while Ecuador's exports to the US dropped by 4%, other countries - India, Indonesia and Vietnam showed drops ranging from 20-28%.

Eyes on Ecuador

Industry in Asia continues to be intrigued by the success of Ecuador in growing its shrimp production and marketing. Sandro Coglitore, General Manager, Omarsa S.A shared some factors responsible for this success, during the Shrimp Summit 2023, among which were: low failure rates, technification with automatic feeders, aeration, and genetics and larval rearing. Production is within the same area of 220,000 ha. Thankfully, China is absorbing its production. Robins McIntosh added that Ecuador's advantage is the post-harvest handling which Coglitore added that Ecuador

has large integrators unlike the many 3-5 ha farms all over Asia. In the past year, large farms have been absorbing smaller farms too. Industry in Ecuador has enjoyed years of profits and is also more capitalised than their Asian counterparts.

Manoj Sharma, Mayank Aquaculture, India noted that Ecuador, albeit one-tenth the size of India but produced 1.3 million tonnes, surpassing India. Sharma attributed Ecuador's success to their efficiency. "Ecuador's farmers are far more efficient than us, at 15% less than India's cost of production".

Asian farmers realise that Ecuador has the better advantage especially when their market prices are low and the US market is nearby. Seabina.com said that Ecuador can sell up to USD2/kg lower than Vietnamese shrimp. It added that Ecuador has 40,000 ha of ASC certified farms allowing them to easily access the EU markets. With record low prices (USD2.80/kg for size 40-50/kg dropping from USD4.10/kg in April 2022), supply chain challenges, rising prices of fishmeal, pending El Niño etc, Coglitore sees the only way to lower costs is through increasing yields.

At GSF 2023, Gabriel Luna, Gluna Shrimp, Ecuador, and other industry experts estimated a 10-15% growth for Ecuador's production to 1.5 million tonnes in 2023. On the contrary Rabobank gave a less optimistic 6.3% growth.

Industry and production trends in 2023

India

There was a slow start in 2023, with farmers not stocking. It was a wait and see situation, either harvesting size 100/kg when prices were low or in anticipation of prices rising, keeping shrimp in ponds to reach larger sizes. Many large integrators managed to cope with low prices while pessimism with the second crop pushed others to give up leases for farms.

Most pond sizes are large and unlined. As farmers are challenged by disease outbreaks, Ravi Kumar Yellanki, Vaisakhi Biomarine said, "The route opted was to improve cost efficiency which was to lower stocking density from the current 40-50 PL/m². There is also the realisation that carrying capacity is constrained by the concentration of farms in a few areas. The trend of not taking a break between cycles and using the same water and probiotics is changing too. Some farms take crop holidays to break the pathogen cycle. Ultimately, production volumes in

2023 is expected to go down.” To access markets in Europe, some farms are pushing for ASC certification. “The current landscape presents a dichotomy. Despite India’s ascent as a global shrimp producer, boasting a capability to reach the one-million-tonne output and as one of the leading exporters of shrimp, the industry grapples with a stark reality – a diminished farm success rate hovering around 40-50%, compared to a success rate of 85% in 2010,” said Manoj.

Vietnam

It was confirmed by industry that production declined in 2023. However, data presented in Table 1 on black tiger shrimp only reflected production from intensive/semi-intensive farms. Globefish reported that Vietnam’s average farmgate prices for June 2023 was the highest in Asia at USD3.83/kg for size 60/kg. However, similar to India, there is a waiting game for higher prices such that at Vietfish 2023, Ho Quoc Luc, Fimex, expected a shortage of raw materials in the third quarter of 2023. He added that there was a lot of inventory in Vietnam. The current strategy is to work on value adding. Key is also to have a larger domestic market to absorb production. Vietnam has a free trade agreement with the EU but for better access, such markets require traceability.

For several years, industry leaders lamented on the high cost of production (COP) in Vietnam at almost USD4.00/kg. Bringing down COP is a support mechanism by aquafeed producers such as CP Vietnam, Sheng Long, Grobest and Skretting as well as Minh Phu, the leading integrator which have been developing models to increase yield and lower COP.

At GSF 2023, Dr Loc Tran, Shrimp Vet stressed that farmers need to reduce the risks of disease to achieve better profitability. He promotes a farm concept where the focus is on survival rate and COP and shrimp farming as a business. The minimum production is 2,000 tonnes which will require farms to consolidate. At Vietfish, Jesper Clausen, De Heus Vietnam said, “Some in Vietnam expect 2024 to be a transition year but industry will need to work hard at lowering the impact of disease and improve on efficiency.”

Indonesia

The Industry estimates production of 265 -275,000 tonnes of vannamei shrimp and 40-45,000 tonnes of black tiger

shrimp in 2023. Farmgate prices fluctuated and prices for size 50/kg shrimp ended the year at USD3.54, much lower than 2022 at USD3.96 (Figure 2, JALA Tech.)

According to Aryo Wiryawan, JALA Tech, at TARS 2023, “Today 60% of the farms are no longer operating showing disease is impacting the industry.” In contrast, Denny Leonardo, Pandora Aquatech, Indonesia, believes that the fear of low farmgate prices is the major factor deferring production. Indonesia has one of the lowest COP at USD3.00-3.50/kg and some well managed farms can secure a lower COP such as USD2.50-2.90/kg. At TARS 2023, Bussel had anticipated some issues when a new regulation PP36 takes effect in August 2023 which may likely affect the cash flow of processors and buying of harvests.

Indonesia, together with Ecuador, India, and Vietnam are subjected to antidumping duty (AD) and countervailing duty (CVD) investigations for imports of frozen warmwater shrimp to the US. This is a first for Indonesia and for industry players, it is particularly challenging when the US is the major market. Indonesian shrimp exports reached 130,776 tonnes, which was 17% behind the 2022 third quarter. Some 76% went to the US and other markets are Japan (12%). Malaysia is the third largest market this year with 3,581 tonnes (Shrimp Insights, 2023).

China

In recent years, there have been changes in China’s production landscape with the push to meet domestic demand by setting up small and large green houses. Guo (2023) gave an estimate of 1.49 million tonnes from seawater farms in 11 provinces and calculated 300,000 tonnes from freshwater ponds based on a success rate of 80%, bringing production to 1.89 million tonnes. At GSF 2023, Fang Qing, Aquaculture Stewardship Council China, countered that a success rate of 20% is more likely as farmers faced poor farming conditions, disease challenges and poor market prices. Another point raised was that such systems, using ground water may not be in line with the government’s program on ecological methods of farming.

Visch (2023) said that there is increasing competition between domestic production and imported shrimp. Farmgate prices are usually much higher in China, compared with those in other countries, but in July,



Figure 2. Data on monthly farmgate prices for vannamei shrimp in Indonesia for sizes 30/ kg, 50/kg, 70/kg and 100/kg. Source: JALA Tech, Indonesia

prices dropped 30% because of quality issues. Shrimp production in recirculation systems (RAS) is gaining momentum and Guo reported on plans by leading feed companies (Tongwei, CP and Evergreen) to expand their investments in RAS. Live vannamei shrimp are sold at USD40/kg.

What's next in 2024

Responsible Seafood Summit 2023 expects global production to grow by about 4.8% in 2024 to close to 5.88 million tonnes (Dory, 2023). Rabobank's Aquaculture Update 1H 2024 expects mild growth and mild contraction in Ecuador. However, an industry insider predicted a supply increase of 8% for 2024. While some in Ecuador's industry expect some effects from El Niño which was due to start in December 2023, particularly to 110,000 ha out of the total of 225,000 ha, Kontali's shrimp analyst, Erwin Temaats, is convinced that large integrators are well prepared to mitigate risks with little effects on Ecuador's production.

In India, Rabobank says that the expected contraction may not occur in 1H 2024. Another scenario is a contraction as prices are still very low and farmers will continue to skip cycles. Vietnam is the most expensive producer in Asia and production is expected to drop. In 2023, export volumes declined 23% but value went down 40%.

The curve ball for 2024 will be the US AD and CVD investigations, which will only take effect in 2H 2024. Before that we may see importers stocking up in 1H 2024.

The comeback with black tiger shrimp

The GSA/Rabobank survey featured a chart on the comeback of the black tiger shrimp with a CAGR of 7.6% in 2022, 9.3% in 2023 and a further 7.8% is expected in 2024 (Figure 3). Asian black tiger production is estimated at 520,000 tonnes in 2023 and is expected to increase to 580,000 tonnes in 2024 (Robins McIntosh, pers comm.) with growth in India and China.

According to Shyamal Das, MU Seafoods, Bangladesh produced 70,219 tonnes in 2022, with 1,229 tonnes from semi-intensive farms. Thailand and Malaysia are small producers targeting the niche and live markets. There was more production in 2023 in Thailand according to DOF data, as well as in Malaysia. A Malaysian insider expects more production in 2024.

At TARS 2023, Manoj said, "Understanding the world market for the black tiger shrimp is critical. India can hardly achieve an annual production of 40,000 to 50,000 tonnes since price realisation will be difficult when volumes increase."

Shrimp Insights reported that India's black tiger exports in 2023 almost doubled to 22,315 tonnes from that in 2022. Exports went to Asian markets in 2022

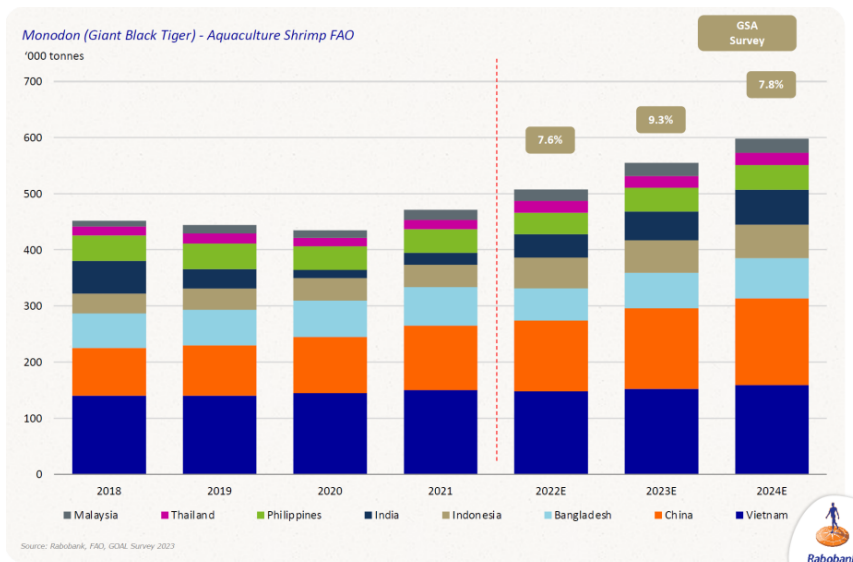


Figure 3. Production of black tiger shrimp. Presented at the Responsible Seafood Summit 2023, October 2023 by Global Seafood Alliance (GSA) and Rabobank.

and 2023, moving away from the focus on EU markets. Bangladesh exported 17,409 tonnes of black tiger shrimp and its major market is the Netherlands (Das, 2023).

In 2023, the major setback was depressed prices, often close to that for large size vannamei, such as in India, Vietnam and Malaysia (Table 2). Recent data on farmgate prices in Vietnam showed a farmgate price for size 30/kg black tiger USD6.95/kg) compared to USD 5.93/kg for vannamei shrimp (Table 2). There is a premium of MYR1.50/kg for live black tiger in Malaysia (MYR26.50/kg (USD5.62) versus MYR25/kg (USD5.30). Within Malaysia and also internationally, the market is small and very competitive. "Quality matters for buyers, such as offering Malaysia's black tiger USD2.00/kg more over those from India," said Catherine Lee, GST at TARS 2023.

Country	Vietnam	India	Malaysia	Indonesia	Ecuador
Black tiger	6.95	4.69	4.95	-	-
Vannamei	5.93	4.81	6.13	4.42	3.45

Table 2. Comparison of farmgate prices in USD (size 30/kg) between black tiger and vannamei shrimp in major producing countries in January 2024.

Conclusion

During the panel on shrimp production at the Shrimp Summit 2023, Robins McIntosh said that the price cycle with shrimp farming will always be there. Lower prices at retail may increase consumption but ultimately, it is about managing costs. Farmers always need higher margins to compensate for the high failure rate, hovering at 20-30%. Managing costs is critical, which farmers can control. At TARS 2023, he said, "In an oversupply situation, it will be the lower cost producers that will stay alive." When prices recover, he predicted that Indonesia and India will be ready.

References are available on request

Marketing amidst resurgence in supply for Asia's black tiger shrimp in 2023

An exploration of market trends and strategies for this "pride of Asia"



Harvest at Mayank Aquaculture, Gujarat, India. Picture courtesy of Manoj Sharma.

Producers in Asia still reminisce the black tiger *Penaeus monodon*, the species which spurred commercial shrimp farming in Asia from the mid-1980s. Production was decimated mainly due to white spot syndrome virus (WSSV) since 1996, and replaced with the domesticated specific pathogen free vannamei shrimp since 2002. A resurgence in the farming of the monodon shrimp in Southeast Asia, China and India came with the availability of specific pathogen free (SPF) broodstock in 2021.

With more production and a depressed market demand, power was in the hands of buyers, namely from China, Japan and Europe. Marketing issues dominated the discussion at the panel on "How to maintain the resurgence of the black tiger" at TARS 2023 in August.

The panel chaired by Dr Dean M Akiyama, Aquaculture Technical Advisor, Indonesia had two invited industry players - Catherine Lee, Shrimp Export Lead, Goh Siong Tee Marine Products (GST), Malaysia and Dr Yufan Zhang, China Aqua Business Development Manager, Alltech. Providing the background for discussions were two presentations. Dr Manoj Sharma, Director, Mayank Aquaculture recounted the challenges and costs of producing monodon shrimp in India, citing the dire situation with low ex farm prices for the shrimp. Regis Bador, Founder and CEO of Innov'Aquaculture from New Caledonia showed how monodon from Madagascar and Mozambique gained a foothold in Europe's high end market.

Farming the monodon in India

Manoj has been in shrimp farming for 30 years, initially with the monodon shrimp and then changing to producing large vannamei and now reverting partially to produce monodon shrimp. He described the trajectory of both vannamei and monodon shrimp productions in India. He

described 1985 to 2009 as the monodon era; 2009-2021 as the vannamei era and now we are seeing the resurgence of monodon farming with the new SPF monodon.

"A transformative phase was from 2011 to 2017, characterised by a remarkable surge in production. We called this the 'vannamei tsunami'. Post-2017, the euphoria subsided, giving way to formidable challenges within the aquaculture sector. The industry is now grappling with a stark reality – a diminished farm success rate hovering around 40-50%, compared to a success rate of 85% in 2010," said Manoj.

Internal challenges

While oversupply from Ecuador is a major challenge, in India, there is the rise in diseases, lower production success, and a 28% rise in input costs and all-time high costs for feeds and diesel. At the same time, farmgate prices have dropped by 30%. Manoj said, "In 2017 it was a party mode, everyone was making money in vannamei. But today, farmers are facing these major issues, and unable to reach break-even"

A predominant factor is the onslaught of diseases, with WSSV wreaking havoc across both vannamei and monodon shrimp farms. The high prevalence of *Zoothamnium* in low density monodon farming was attributed to years of high-density farming of the vannamei.

"The first crop of monodon in 2021 was very encouraging but there were WSSV outbreaks even in the summer months, when temperatures rose to 32-33°C. For both shrimp species, the high stocking density, high salinity, high temperature and higher organic loads, all combined leading to disease outbreaks."



Dean M Akiyama, Indonesia (left) chaired the panel comprising from second left, Manoj Sharma, Mayank Aquaculture, India; Yufan Zhang, Alltech, China; Regis Bador, Innov'Aquaculture from New Caledonia and Catherine Lee, Goh Siong Tee Marine Products, Malaysia.

Production cost

While he conceded that the new SPF monodon is good on the production side, the issue is that it can only truly be sold above 25g. There is no value for emergency harvests. "Comparing costs of production, for counts/kg 30/40, be it vannamei or monodon, it is close to USD4/kg. Survival and feed conversion ratio (FCR) are crucial, and we are at the mercy of nature in terms of production and market in terms of price," added Manoj.

Monodon post larvae cost significantly higher at USD12-14/1,000 PL than that of vannamei at USD3.5/1,000 PL. There is a call for indigenous brood stock and genetic lines to bring down the cost of post larvae.

Within India itself, infrastructure imbalances lead to challenges in cost efficiency. "Andhra Pradesh can sustain any industry shock due to better prices for small counts and lower cost of production. Post larvae prices are double in Gujarat, feed price 12% and electricity 6X higher," said Manoj.

Large size for monodon

At farmgate prices of 20C of vannamei at USD7.3/kg versus monodon at USD6.5/kg (Table 1) the situation has been dire for monodon farmers who will then suffer from losses. However, in 2023, Manoj managed to make gains by pushing to size 12C/11C at very high prices. He explained that he managed to produce 100g shrimp which took 200-300 days and obtained a good margin when selling at USD16/kg. Quoting challenges such as carrying capacity and diseases, this was a one-off crop success.

The market crisis and a slow approach

A market crisis with low prices beckons a measured approach to monodon marketing. The suggestion is to offer branded, traceable, and certified monodon products.

"If India were to produce more monodon it would cause an oversupply. In contemplation of the future, we should increase domestic demand and augment per capita shrimp consumption. If we work together, even increasing 100g extra per capita, 1-2 million tonnes of shrimp will be consumed," suggested Manoj.

There is a huge potential for domestic marketing in India. A market for sizes 16 to 25g should be developed in India itself as an insurance to emergency harvests.

Strategies for the monodon in India

According to Manoj, the maximum production in India as per current market situation is 40,000 to 50,000 tonnes of monodon. At more volumes, prices will fall.

Another suggestion is to "plan monodon culture in creek-based systems or other areas where vannamei culture is failing". However, he cautioned that farmers will have to balance their production between vannamei and monodon and sustain species diversification. The advice is to farm monodon in high saline and high temperature conditions.



"If we work together, even increasing consumption by 100g extra per capita, 1-2 million tonnes of shrimp will be consumed annually," said Manoj Sharma on developing domestic markets.

Vannamei shrimp		Monodon shrimp	
Count/kg	USD/kg	Count/kg	USD/kg
		10	11.6
20	7.3	20	6.5
30	4.6	30	4.65
40	3.65	40	4.2
50	3.3	50	3.0
60	3.0	60	2.7

Table 1. Prices in USD/kg between vannamei and monodon in India in August 2023.

Call for unity in markets

Manoj said, “My appeal to all Asian shrimp farmers is to create a separate market platform for monodon shrimp – let’s market it as pride of Asia.”

Brand marketing the monodon: A lesson from the Colombian Coffee success

As global shrimp production surges, declining global prices particularly affect the livelihoods of Asian farmers as they face increasing production costs. Bador compared the current situation as strikingly similar to that of Colombian coffee, in the 60s–70s. This historical success story in a different industry was directed to the young farmers in this conference in marketing the monodon shrimp.

In the post-World War II era, Colombia had a huge stock of unsold coffee and in the 1960s prices plummeted due to oversupply. Bador explained that “Only less than 5% of US consumers knew where their coffee was coming from. Furthermore, they were always using a blend and taking the cheapest sources”. The National Federation of Coffee Growers of Colombia (FNC) ordered an advertising campaign. There was a visionary marketing journey, creating the iconic Juan Valdez character and emphasising the unique qualities of Colombian coffee.

Brand identity

The success lay in brand identity, using a logo that showcased not just the product but the region where it was grown. This marketing strategy aimed to educate consumers on the distinct features of Colombian coffee, specifically Arabica which is known for its superior quality. The campaign effectively convinced buyers and consumers to choose progressively, 100% Colombian coffee.



The successful logo depicted Juan Valdez, a typical Colombian producer harvesting by hand, emphasising 100% Colombian Coffee. After years of effort, and video campaigns, other American brands started to sell only 100% Colombian Coffee validating the success of the campaign. For FNC, this “origin differentiation strategy” boosted the demand for Colombian coffee.

They communicated their uniqueness not just through claims but by leveraging on gastronomy by working with famous chefs. One striking example involved a claim of respect for mangroves, low carbon footprint and shrimp welfare, rebranding shrimp as “le bijou or jewel” instead of just “shrimp.”

Madagascar’s and Mozambique’s monodon shrimp

In marketing into niche markets, two noteworthy success stories emerged – Madagascar’s and Mozambique’s shrimp. The two producers differentiate themselves in a competitive market with specific farming rules and limited stocking density. They invested in multiple certifications and told a real story about efforts and achievements on community welfare and environmental issues.



Marketing cooked monodon in a seafood market in Malaysia. Picture courtesy of Catherine Lee.

In Mozambique, it is a family story which intertwines with a commitment to community and environmental responsibility. By showcasing their dedication beyond mere inspections and committing to long-term trust-building with buyers and consumers, these shrimp producers set themselves apart.

In a world dominated by social media, storytelling has become pivotal. It is not just about being different but about fostering a human connection through community and environmental narratives. The key takeaway is clear—commitment, storytelling, and continuous communication are essential to building trust, not just with wholesalers and processors but with the end consumers. “Be fully trustworthy, strictly respect the chosen rules to be different and communicate all the required information on a regular basis.”

In a market where trust has waned, these success stories remind us that being distinct, ethical, and committed are not only possible but also profitable. Whether it’s through a familial narrative, environmental commitments, or unique branding, the shrimp industry in Asia has much to learn from the triumphs of Colombian coffee.

Market strategies for the monodon: Mass vs unique markets

The success in marketing monodon from Madagascar and Mozambique in high end markets, may not work for mass volume markets. “The point of my presentation was to give inspiration to some producers and stress the importance of niche markets. There are many places in the world such as in Dubai, where consumers are willing to pay a lot for special dishes with monodon shrimp produced under unique and different conditions.

Monodon producers in Malaysia, as well as other countries are dealing with pricing pressures. Lee does not see the prices going down and echoed the importance of selling the shrimp as a brand and exploring niche markets. “Recently, our value proposition is to sell cooked shrimp.



“Be fully trustworthy, strictly respect the chosen rules to be different and communicate all the required information on a regular basis.”
– Regis Bador.

There is close proximity from farm to processing plant and we harvest live. We also have a unique project with Chinese buyers offering freshly peeled monodon shrimp with no soaking to Michelin starred high-end restaurants, targeting a premium market segment. The quantity and volume might be small. This is niche market for Malaysia that allows us to remain as active suppliers.”

More supply and domestic markets

China produces around 150,000 to 200,000 tonnes of monodon shrimp and almost 95% is consumed domestically. Zhang said, “I agree that it is imperative to know how much the market wants and the state of demand, which Chinese and other producers must figure out. Some 70% of monodon comes from Fujian province. Monodon farming used to be a goldmine with prices 5 times higher than vannamei shrimp. The cost of production is so high that it is mostly sold in tier-1 cities. For the consumer, monodon is just a bigger shrimp and with vannamei cheaper, monodon is losing out to vannamei.”

Trust is so critical for branding

With social media, people are always critical of misleading content, misinformed or is fake. “You also have to appreciate that this is the only form of content that people trust and it is the only way to reach the final consumer who will finally purchase the seafood. We cannot have the brand destroyed by a few,” said Bador.

Lee concurred that branding and perception is invaluable. One example was how the perceived value of monodon dropped with images of shrimp injected with gel in Vietnam which damage its reputation in China.



Madagascar's cooked monodon at the Seafood Expo Global 2023

Expectations of markets

Akiyama asked the panel on their experiences with European, Asian and Chinese buyers. “In the European market, the emphasis is on certification and quality although it is still price sensitive,” said Lee. The premium can be USD30 cents/kg more when these standards are met. There are challenges exporting to Europe due to stringent requirements. Chinese buyers are extremely price conscious and wait for a market downtrend.

“Japanese buyers rely on direct relationships, trust-building, and frequent visits to ensure quality, rather than being particular about certifications. Internally they've done testing to determine freshness, and its correlation with taste. They know how to differentiate quality and would be willing to pay a premium price, such as for shrimp from New Caledonia. In my experience, they will pay USD30-50 cents/kg more because they believe that Malaysia produces higher and better quality.”

Zhang described how shrimp are consumed in China. “Large frozen shrimp is for barbecue and after applying strong soy sauce, everything tastes similar. Small shrimp is used for frying so it does not matter whether it is monodon or vannamei. Lastly, there is a demand for live shrimp where most restaurants still prefer to steam to keep the meat quality which gives the monodon a better chance to show its quality advantage. However, despite the demand for live shrimp, we cannot expect high prices to be linked to meat quality. When low-priced shrimp from Ecuador or India is available, I think even the live shrimp market will be significantly affected.”

NEXT ISSUES

March/April 2024

Issue focus: Health & Disease Management

Industry Review: Marine Fish

Fishmeal/ Oil Replacements/Industrialisation

Deadlines: Articles/Adverts – January 30

May/June 2024

Issue focus: Sustainable & Responsible Aquaculture

Industry Review: Aquafeed Production

Hatchery Technology

Deadlines: Articles/Adverts – March 20

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Trade, supply and consumption at GSF 2023



The three-day second Global Shrimp Forum (GSF 2023) opened on September 5 with an inspiration on how shrimp is perceived and a presentation on the findings on global shrimp consumption. It was a huge success with an attendance of 530 delegates, representing over 300 companies from more than 40 different countries, said the organiser, the Global Shrimp Forum Foundation (GSFF).

The opening also featured a leadership panel comprising Guillaume Smeets, Cargill Animal Nutrition and Health; Novel Sharma, Rabobank; Rajagopal Choudary Chitturi, Devi Fisheries, India and Sandro Coglitore, Omarsa, Ecuador, sharing their vision on the state of industry.

In his 2-minute take on the state of the industry in Ecuador, Coglitore cautioned that it is already a race to the bottom with low prices, and many farmers are already quitting. In the long term, it is survival of the fittest while in the short term, it is to expect lower production volumes. He urged the global industry to come together and promote a demand for a generic shrimp. He reckoned that if consumption is increased by 1lb/capita in the established US market, consumption will be an extra 350 million lbs (159,000 tonnes) for the 350 million population. The goal is to sustain the livelihood of farmers and all those in the supply chain.

In response to “how to keep the fragmented industry in India robust and resilient”, Rajagopal said low prices have deterred farmers from continuing to farm and volumes from the second crop will be drastically lower. The only way out is to lower the cost of production although it is difficult with rising input costs. Disease outbreaks come with higher stocking density as well as lower success rates. National campaigns to increase domestic consumption are showing some results. Sharma added, “From an investment standpoint, production over the carrying capacity and high failure rates carry a high biological cost and reduce the predictability level.”

It was an interactive opening on “We Talk Shrimp” with Melanie Siggs (Global Seafood Alliance and The Center for Responsible Seafood) asking the audience on the role of shrimp in nutrition and health, its versatility (easy to portion, barbecues, curries etc) and sustainability (70% reduction in GHG by 2030), which is increasingly important among Chinese consumers when choosing foods.



The attributes of shrimp consumption on these cards allowed the audience to select their choices during the opening session: Versatility, Convenience, Nutrition and Health, Sustainability and Positive Associations. (Photo credit: GSF 2023)

Raising shrimp consumption

Using surplus revenue from its event in 2022, GSFF commissioned a study on the most effective ways for shrimp consumption to be better promoted. The aim was to empower the industry to clearly define its narrative and demonstrate what sets shrimp apart when compared with other more common proteins, highlighting factors such as the nutritional value, versatility and sustainability of shrimp. Independent Marketing and Brand Consultant, Arnd Jan Gulmans discussed his initial findings. The complete report is now available at the GSF website (<https://www.shrimpforum.com/publication/gsf-report-promoting-shrimp-consumption>).

Shrimp trade statistics

Willem van der Pijl, Board Member, Managing Director of GSF and owner of Shrimp Insights, presented on trends in the global shrimp trade up to July 2023. The overall export trend was clearly driven by India and Ecuador. While Ecuador's export volumes dropped in July, the total volume had already exceeded almost 600,000 tonnes in six months. When the second half matched that in 2022, Ecuador might

reach 1.12 million tonnes of exports in 2023. Since 2022, China is back and is really absorbing most of Ecuador's growth in supply particularly head-on shell-on (HOSO) and headless shell on (HLSO). Some 60% of Ecuador's production comes from the four top producers (Santa Priscilla, Omarsa, Songa and Expalsa). Volumes should rise to 900,000 tonnes of exports to China alone (Table 1).

	2022	2023 estimate
Ecuador	1,052,758	1,158,467 (+10%)
India	704,029	633,802 (-10%)
Vietnam	379,193	284,395 (-25%)
Indonesia	231,413	202,262 (-13%)

Table 1. Global shrimp supply (from export data and HS codes) from the top four countries in tonnes.

YTD April Ecuador's shrimp exports reached 390,000 tonnes of which 64% were destined for China. With the removal of diesel subsidies for farm areas above 30ha, the cost of production increased by USD0.35/kg. Comparing prices in July 2023 vs April 2022, these have fallen by USD1.54 /kg for size 60, from an estimate of USD6.50.

India's farmed shrimp export in 1H 2023 was marginally down at 295,667 tonnes as compared to 1H in 2022. Broodstock imports at less than -30% confirmed the drop in the first crop production and a possible further drop in Q3 2023. Higher (137%) exports of the black tiger shrimp (12,308 tonnes) went to Asian markets. Using mirror data for Vietnam, van der Pijl said that Vietnam's exports were 31% down year-on-year in Q1 and 39% down in Q2. Export value went down 30%. In H1 2023, Indonesia's vannamei exports were down by 19% Y-o-Y.

With regards to markets, India, Ecuador and Indonesia are the three top exporters to the US. But India's H1 drop in farmed shrimp exports to the US, was compensated by other markets such as the EU, Vietnam and Russia. Japan is Indonesia's largest market after the US, at 32% of exports in 2022.

In terms of imports, China and the US absorbed most of the global shrimp supply in 2022; 945,791 tonnes for China and US, 837,622 tonnes. EU was third with 556,048 tonnes. China's real consumption is 2,500 containers per month and they prefer brine frozen shrimp and therefore, their preference is Ecuador. LATAM countries supplied the majority at 65% of the total in 2022.

There were some comments from the panel. Gabriel Luna, Owner, Glunashrimp SA, expects that some farms in Ecuador will push boundaries to 6 tonnes/ha with partial harvesting, moving from the average productivity at 2-3tonnes/ha. In India, Sree Atluri, Devi Sea Foods Limited expects production to be less of larger sizes but more of small sizes. Real time data from BBIPM Indonesia showed an export decline by 20% in July. Aris Utama, PT Bumi Menara Internusa (BMI) said that with current market prices, the trend was lowering stocking density. Cost of production is USD3.50/kg. "Vietnam is moving towards more value adding, and expects 30% less production," said Liem Nyugen, Minh Phu Seafood Group, Vietnam. Van der Pijl summarised a downtrend in global supply at 15% for 2023, arising from reduced production by 15% both in Indonesia and India and 25% in Vietnam.



Willem van der Pijl (left) presented on trends in the global shrimp trade up to July 2023. Denny Leonardo, Pandora Aquatech, Indonesia participated in the panel Farmers x Tech.

Vannamei shrimp production

Kontali's Sander Visch with IDH's Lisa Wageningen led panel discussions, ranging from: whether Ecuador will continue to grow its shrimp production; Chinese domestic production versus its imports; and strategies of Asian producers to remain competitive and find their niche in the marketplace.

In a one-on-one conversation with Yahira Piedrahita, Chamber of Aquaculture Ecuador (CNA), Visch asked how much production will grow in Ecuador, on the current challenges with the security situation and how will El Niño affect production. Piedrahita said that the effect of the low prices is that small and medium farmers do not have the profit to invest in technification (aeration, auto feeders etc). Productivity will depend on the market situation. Growth will be mostly from the larger companies. The industry spends USD18 million or USD 6 cents kg of production on implementing security. On growth in 2023, the expectation is between 10-15% more than in 2022. El Niño is forecasted to be devastating. Flooding will affect logistics and infrastructure. Fishmeal and fish oil prices are expected to rise and droughts to affect soybean production. Feeds wise, it will be seeking protein alternatives.

Dr Fuci Guo, Royal Agrifirm, Canada set the stage with a presentation on unmasking vannamei shrimp production in China. A panel of Chinese industry insiders jointly reflected on supply from domestic production and imports. They agreed with Guo's assessment that there is a demand gap of one million tonnes to be fulfilled by imports. "This could be more when the economic situation improves, or when consumption in inland areas is explored," said Fang Qing, Aquaculture Stewardship Council, China. He added that domestic production for live/fresh shrimp in RAS farms around the top tier cities have increased by 30% since 2018. Imports and domestic production from earthen ponds are for frozen, ready to eat and shrimp meat markets. Qing also highlighted a market for high quality shrimp meat for expectant mothers and infants.

Dr Ronnie Jin, Aqua-One expects a rapid growth of super intensive RAS supplying top tier cities with live/fresh shrimp. Requiring high investments and skilled technical staff, RAS currently supplies only 3% of this demand for live and fresh shrimp. He quoted a demand in Beijing at 500 tonnes/day. Fred Kao, SyAqua, Thailand, said that hatcheries import 250,000 pairs of broodstock, mainly robust and balance lines to counter disease challenges, aside from using F2 and F3 broodstock.



Black tiger shrimp at the welcome reception

The panel on how to remain profitable in the current shrimp farming landscape in India, Vietnam and Indonesia, was preceded by a presentation by Alex Farthing from DELOS, a science-based aquaculture company in Indonesia using technology and research to change farming practices and to be more cost conscious along the production cycle. He described the components to run enterprise farms in Indonesia towards better profitability with investments in technology and fully fledged labs. There is a focus to predict pathogens 10 days before an outbreak.

Both Farthing and Dr Loc Tran, Shrimp Vet (Vietnam) would like to see the industry in Asia develop farming into a business and focus on consistency. Loc said it is putting good practices in terms of design and protocols and combine with a comprehensive risk management. Loc has developed a model bringing down COP from USD4.00 to USD2.40/kg and next is scaling up this model. In India, Ravi Kumar Yellanki, Vaisakhi Biomarine, discussed some steps being taken to improve production efficiency. Bangladesh, traditionally a producer of only black tiger shrimp now wants to shift to vannamei shrimp production. Shyamal Das, MU Seafoods discussed the

push by the industry to farm vannamei shrimp, since the processing segment have been operating only at 30-35% capacity.

GSF 2023 ended with a panel discussing retail trends and consumption promotion. RaboResearch Global Economics & Markets' Jan Lambregts gave a bigger picture on the current macroeconomic situation and how this is impacting markets and decision-making in the shrimp sector. Linda Lai Cornish, President and Founder of the Seafood Nutrition Partnership (SNP), a U.S. based non-profit organisation with a mission to inspire a healthier America said that post pandemic, people are seeking health. Through this coalition of corporate members and NGOs, there is unity to increase seafood consumption twice a week, increasing from 14lbs/person to 20 lbs/person. A guide on shrimp nutrition was scheduled for the end of 2023. It was clear that industry knows a lot about production but too little on consumption.

The Global Shrimp Forum 2024 will be held on September 3-5 in Utrecht, The Netherlands.



At the trade show, Thailand based Ocean Aquaculture, from left to right, Filipe Pereira, Erik van der Brande and Chatpet Pongdabpet. The company markets Artemia cysts, enrichment and microencapsulated diets.

Feeds and feed ingredients

Ronnie Tan, US Grains Council, Malaysia and Esther Luiten, ASC chaired this session which started with an update on the global commodity market, presented by Carlos Mera, Agri-Commodities Markets Research, Rabobank. The respective challenges feed companies in Ecuador and India face and their outlook were detailed by Carlos Miranda, Skretting Ecuador and Ramakanth Akula, The Waterbase Limited, India. Shrimp feed prices are expected to remain firm due to feed ingredient prices. With El Niño and fishing bans in the East Pacific, fishmeal and oil supply will be reduced, thus increasing prices. Shrimp feed demand is expected to remain in Ecuador.

The ASC feed standards and implications for the supply chain were presented by Michiel Fransen. These standards will have implications for sustainable feed ingredients and likely to affect plant-based ingredients more compared to marine based as the marine side has reached a higher level of certification. Supply chain downstream will have to follow but Tan said the question of 'who will pay for it' remains unanswered. The industry admits that it



Ronnie Tan, US Grains Council, Malaysia (second right) and Esther Luiten, ASC (left) with Jesper Clausen, Royal De Heus Animal Nutrition, Vietnam (second left) and Lukas Manomaitis, USSEC (right).

is a difficult time as costs are elevated for everyone and it is unlikely that the consumer is willing to pay more. Innovations featured smart feeding systems, development of a single cell protein as a feed ingredient and the progress toward a fish free shrimp feed formulation.

The people, science and products at AE23

Aquaculture Europe 2023 (AE23) was held in Vienna, Austria, from September 18-21. This is the annual meeting of the European Aquaculture Society with the theme 'Balanced Diversity in the Aquaculture Environment'. Diversification in aquaculture should be well balanced taking into account: area specificities, available natural resources, social realities and needs of circular economy. Diversification should be appropriately maintained for local conditions, market access and resilience. Balance between small and large-scale aquaculture enterprises and activities of various water users for example are salient issues in future aquaculture development.

The event had a total of 2,293 participants, from 80 countries, attending 52 sessions throughout the 3-day conference and trade show. There were 378 students attending and around 50 joined a visit to dsm-firmenich's Animal Nutrition and Health R&D facilities in Tulln.



Laszlo Varadi with Bente Torstensen and Alistair Lane

Honorary Life Membership

EAS, organisers of AE23, gave its highest award - Honorary Life Membership - to **Dr László Varadi**, who has dedicated his life and professional career to the recognition and development of pond aquaculture in central and eastern Europe – and well beyond. Bente Torstensen EAS President 2022-2024 introduced and presented the award.

László has been involved in aquaculture development since 1974 when he started to work in the Research Institute of Fisheries, Aquaculture and Irrigation (HAKI) in Hungary. Besides R&D, for the development of sustainable freshwater aquaculture systems and technologies in Hungary, he was also involved in various aquaculture development projects in Asia, Africa and Latin America, mainly as an expert for the FAO.

Technology and innovation are key words for László and the processes aimed at strengthening aquaculture innovation in Hungary have developed in parallel with the European ones. The Hungarian Aquaculture Technology and Innovation Platform (HUNATiP), of which László is Chief Technical Advisor was a milestone, which in close

cooperation with the European Aquaculture Technology and Innovation Platform (EATiP) contributes to the harmonisation and coordination of Hungarian aquaculture innovation programs and independently carries out innovation activities. He was also the President of the Hungarian Aquaculture Association.

László received the FEAP Award for Excellence in 2015 for his contributions to freshwater aquaculture, by playing a key role in developing the Hungarian sector as well as for his strong involvement and cooperation with less developed countries.

Hungary and Laos

Over recent years, László has split his time between Hungary and Laos. Cooperation in aquaculture development with Laos started in the 1980s and was supported by FAO at that time. One recent milestone was the establishment of a Hungarian-Laos joint venture company (ADC), which is producing high quality tilapia fingerlings. Fish culture was the "entry point" for other projects (e.g. feed manufacturing, livestock production, plant cultivation, irrigation) in the production of healthy and safe food in Laos.

Highlights at the plenary sessions

József Popp, John von Neumann University Hungary discussed "Balanced diversity and the responsible use of global resources to produce healthy food." On climate change, the message was to act with biodiversity and renewable energy. This is coupled with sustainable intensification by increasing land use and aquatic productivity while sustaining natural resources.

"Breeding for Resilience – Are we ready?" was covered by two speakers; **Antti Kause** who leads the genetics and genomics of the fish breeding programmes at the Natural Resources Institute (Luke), Finland and **Morten Rye**, Benchmark. The message was that genetic progress is driven more by accuracy of selection and selection intensity than by genetic variation and generation interval. Kause listed perturbations in aquaculture which include climate change, disease, multiple production systems,



Japan's Nagase Sanbio Co team, Nobumitsu Sato and Shinobu Sawada with Ingrid Lupatsch, Ab Agri Ltd, UK.



Giving a career talk in Tulln, Benedict Standen (right) with, from left, Eduardo Yamashita, Lorrán Gabardo, Ronnie Tan and Eva Binder.

novel feed and changes in fish welfare. For a geneticist, these also present opportunities. With regards to novel feeds, selection of fish reared with novel feeds makes them adapt to the feed. He also showed changes on feed utilisation in European seabass selected for 4 generations.

Discussing disease resistance, Rye said that the genomics toolbox is rapidly expanding, demonstrating the applications in several species – useful for complex traits, increased accuracy and reduced inbreeding. On the horizon, is gene editing which could be a game changer for disease resistance as it is faster than selection breeding. However, there is no uptake on gene editing in Europe.

Lissy Smit, CEO Aqua-Spark discussed “Moving aquaculture to more sustainable, healthier and affordable production, an investor viewpoint.” Aquaculture is still a sector which is under invested, said Smit, and explained how Aqua Spark invests for scale.

- Validated ideas and innovative R&D;
- Resilient teams such as eFishery in Indonesia, which has a diverse field team with local knowledge;
- Strategy for scale is business plans around scale such as Calysta in China;
- Alliances and collaborations;
- Market and industry adoption is talking to retailers etc.

Student career talk in Tulln

Dr Benedict Standen, Head, Aqua Marketing Global organised an afternoon visit to **dsm-firmenich's** Animal Nutrition and Health R&D facilities in Tulln for around 50 students attending AE23. This was an opportunity to observe firsthand the strong in-house research to develop innovative solutions for the aquaculture industry. The centre in Tulln, sited among universities and leading scientific institutions, has around 120 researchers in various biotech-focused teams. Some areas of research are using –omics technologies for a better understanding of antibiotic resistance, mycotoxin degrading enzymes as well as using AI to determine the mycotoxin contamination of harvests, genomics to understand microbiota and

metabolome, and finally before going to markets, intensive product testing and developing prototypes.

Standen was glad to support and inspire the next generation of aquaculture scientists and stakeholders. There was also a career talk with dsm-firmenich's diverse team, Eduardo Yamashita, Aqua Technical Manager, Latin America based in Brazil; Lorrán Gabardo, now Regional Product Manager Asia Pacific, and Eva Binder, Head of Translational Science, Animal Nutrition and Health. Joining them was Ronnie Tan, US Grains Council, Malaysia.

The team recounted the early days when they themselves were seeking their first jobs. The advice given by Yamashita was to never give up on aquaculture. Gabardo advised that they should not wait for the most suitable option but to just pursue whichever comes first. Binder believes that with a science background it will be possible to pursue whatever job they wish. Representing industry, Tan had these messages: Be open to the whole value chain in aquaculture; don't focus only on R&D and technical but to leverage them for the business side and look at your own start up as there is sufficient funding out there.

Euroshrimp

The interest in shrimp farming in Europe came about because of the negative associations with imported shrimp and an increased preference for locally produced shrimp - fresh and of high quality and available in inland markets, said Dr Philip Buike, CEO Island Shrimp, Spain in his presentation on the history of shrimp farming in Europe. The future challenges are technical such as cost control, optimum production scale and effluent management. Commercial-wise, it is whether shrimp farming in recirculation aquaculture systems (RAS) in Europe is a viable business model and can the production be consistent. What is clear to the group is that shrimp production in Europe is not going to compete with imported shrimp. In the next five years, some objectives are Made in Europe shrimp as well as a widely available Made in Europe post larvae. Friedrich Tietze, Suburban Seafood, Germany, suggested a closed loop farming with 'hatch your own shrimp' which gives better control on production and costs.



Gareth Giles (left) and Kazutoshi Utsunomiya. Ireland-based Pacific Trading Aquaculture distributes high quality hatchery feed products such as the Japanese manufactured Otohime range of larval fish diets, very popular in Asia and Sparos' WinFast which is a premium weaning microdiet for fast growing marine fish larvae.



The INVE Aquaculture team at the launch; from left, Dr Peter De Schryver, Innovations Director, Mario Hoffmann, Regional Sales Director EMEA; Geert Rombaut, and Fernando Garcia, Global Commercial Director Benchmark Advance Nutrition/INVE Aquaculture.

Product Launch: Ultra-precise artemia and rotifer quantification

INVE Aquaculture launched a game-changing solution for aquaculture hatcheries worldwide. This is SnappArt, a revolutionary automated live food counting tool, setting new standards for optimal feed management and enhanced production quality. The launch began with Mario Hoffmann, Regional Sales Director EMEA detailing some challenges in hatcheries. SnappArt simplifies live food counting in hatcheries, from small-scale to large commercial operations, ensuring accurate feeding practices. In larviculture and fry production, the innovation will optimize feeding protocols, improving production efficiency, and reducing wastage in larviculture and fry development. A roll-out in additional regions across the globe will follow swiftly. More details <https://bitly.ws/3awyE>



Geert Rombaut, Product Manager Artemia and Live Feed demonstrated the features of the SnappArt live food counting system.



Alvaro Rodriguez (left) and Dario Cleofe from Liptoqua, Spain which markets feed additives with immunomodulatory effects on fish and shrimp production.

BioMar was Gold Sponsor at AE23. It also sponsored the session on nutrition-alternative ingredients. Kiranpreet Kaur, Aker Biomarine ASA reported on enhancing feed utilisation of nutrients and growth of gilthead bream *Sparus aurata* using krill meal, as a functional raw material which could enhance bioavailability and fish health. Kaur reported better growth and utilisation coupled with economic benefits after 12 weeks of feeding.

Marta Carvalho from the University of Las Palmas, Spain presented on the impact using novel diets in gilthead bream selected for fast growth. In her experiment, she used diets containing 15% fish meal and 5.0% fish oil to mimic current composition of commercial feeds for this fish with some plant meal and oils as protein and lipid sources. In two diets, fish meal was replaced by an insect meal or a single cell protein. Fish oil was replaced with a blend of poultry and algal oils. There were positive effects of genetics to support the use of insect meal and algal oil as replacers of fish meal and fish oil, respectively. Algae oil increases omega 3s PUFAs of fish fillets, improving the nutritional value of fish final products for consumers.

Accurate biomass estimation is crucial for efficient feeding planning and reducing environmental impacts. In the Innovation Forum, Bruna Guterres, Federal University of Rio Grande, Brazil, discussed how deploying an off-the-shelf AI solution may be an important ally for biomass estimation within aquaculture applications. The presentation detailed the setup for data acquisition using a camera set within the rearing tank. The main challenges and advantages were discussed from a user and technological perspective. The work highlighted that computer vision and deep machine learning are useful tools to perform biomass estimation even when reliable data collection from tanks becomes challenging because of high water turbidity.

RAS and grouper farming

Sweden based **Veolia Water Technologies** promoted its Hydrotech Value series of drum filters which gives maximum filtration performance at a minimum operational cost. The company believes that to be a market leader is to give customers a quality that meets their exact requirements at the best possible price. Ireland-based **Aquamonitorix** has a new version of its RAS analyser which give precise readings of ammonia, nitrate and nitrite levels, in real time, simultaneously and autonomously.

The global company **Desmi** has high-quality industrial UV systems for intake and recirculation water to address the constant challenge of disease outbreaks. The AquaShield UV systems effectively eradicate pathogens and reduce mortality rates while ensuring safety and peace of mind of aquaculture professionals.



Will Conn at the Hydrotech booth.

Giant grouper farming in Germany

A team from Alfred Wegener Institute, Germany presented on trials to test the feasibility of farming the giant grouper, *Epinephelus lanceolatus* in RAS in Europe. This is part of the OPTIRAS (short for 'Optimising RAS) to promote the adoption of cutting-edge technologies and best practices in RAS across Europe. They used juveniles imported from Australia and fed 3 commercial floating feeds to reach 100–200g. There were several goals: to identify the formulated feeds available in Europe that meet the requirements of the species, determine an optimal rearing density which is economically viable yet meet animal welfare norms. The stocking density trial with 437g fish stocked at 60kg, 80kg and 100kg/m³ showed no difference in growth. The bio economic comparison with European seabass and seabream and yellowtail (*Seriola lalandi*) favoured the giant grouper which grew the fastest at 30°C to reach 2kg in a year, at a high stocking density of 80–100kg/m³ and highest productivity of 170–230kg/m³. The retail price for fresh fish was around €30/kg, comparable to yellowtail and turbot.

Microalgae and copepods

In the EU, Spain, Germany, France and Italy lead with the highest number of microalgae companies. Aquaculture is a market for these companies aside from food supplements, nutraceuticals and cosmetics.

Belgium-based **Proviron** offers freeze dried forms of marine microalgae produced using its ProviAPT technology to hatcheries to reduce or eliminate the risk of contamination and to ensure a healthy production. Proviron suggested Nanno Prime and Iso Prime microalgae for finfish and additionally ChaetoPrime, TetraPrime, ThalaPrime for the various stages of the crustacean, bivalves, echinoderms and live feeds. It recommends the use of its Tetra Prime C (freeze dried *Tetraselmis chuii*) as a choice to fight zoea syndrome in penaeid shrimp larvae as it suppresses the growth of *Vibriosis*.

Spain based **Aqualgae** is a 10-year-old multidisciplinary company which combines engineering, biology, and biotechnology expertise to develop tailor made solutions. It has automated bioreactors to produce volumes of algae under biosecurity systems which gives hatcheries the required volume of algae on tap. Portugal based **Newton** has been in the algae production business for 25 years. It has *Nannochloropsis*, *Tetraselmis*, and *Isochrysis* etc as dried powder, liquid and frozen.

For feeding marine fish larvae, Norway-based **CFeed** has live copepods of 100–200µm ready in three steps and after 24 hours at 26°C, copepods are ready for harvesting. A first at AE23 was China's **Tianjin Ranova Petfood** which focusses on supplying markets freeze dried petfood and frozen fish food. It has a newly constructed factory with large and advanced freeze-drying technology. Dr Liu Fengqi from the College of Life Sciences at Nankai University, now its CEO, set up this company in 2000

and selects copepods high in protein and lipid with high levels of EPA and DHA from the Bohai Bay. These are used in larviculture of red seabream, halibut and vannamei shrimp. At this trade show, the team displayed their high quality freeze dried polychaetes.



Dr Liu Fengqi (left) and the team, Linda Meng and Yunyun Xiao.

Immune modulating capacity of seaweed

In a technical seminar organised by Olmix, France, Professor Johan Schrama from Wageningen University presented on healthy diets for fish. Part of his work is to valorise seaweed's immune modulating capacity. However, the immunological effects of seaweeds depend on species and on the extraction technology.

Discussions at this seminar included the benefits of MFeed+[®] which is based on a patented technology OEA[®] or Olmix Exfoliated Algoclay to extract green and red seaweed. These exfoliated layers offer a very large contact surface to boost enzymatic activity.

Olmix has developed MSP[®] extracted via a fully macroalgae biorefinery process. It has highly active sulfated polysaccharides specifically 100% from cell walls of macroalgae. Raquel Pereira, Product Manager, Yes Olmix explained that Alгимun[®] is based on a combination of two biologically active microalgal extracts; MSP[®] immunity and MSP[®]Barrier for the promotion and maintenance of mucosal barrier function. The product promotes better disease resistance of seabass and gilthead seabream under a bacterial challenge. Survival improved by 75% in fish farms in Turkey affected by heat stress. To demonstrate strengthening of the mucosal barrier integrity, Pereira reported on results of fish survival after a pathogen challenge with different bacteria species, when fed diets with Alгимun. Survival improved 49% in olive flounder in Korea, and 50% in tilapia in Vietnam.



Olivier Biannic, Key Account Strategy Manager (second left) and the Olmix team, from right. Hasan Hüseyin Özçiftçi, Technical and Sales Manager, Türkiye; Raquel Pereira, Olmix Yes, Brazil; Sylvain David, Area Manager North & West Europe and Anne Cecile Jutten, Feed Product Manager (left).



Nabil Hamid, Chairman Grand Fish Feed (middle) with Joe Kearns (right) and Scott Snyder.

Fish feeds from Egypt

Grand Aqua, based in Egypt is the largest aquafeed producer in the Middle East. The annual production is 90,000 tonnes per year of a large range of floating and sinking feeds for freshwater and marine fish and shrimp. Pellet size ranges from 2 to 12 mm and crude protein from 25% to 55%. The team led by Nabil Hamid, Chairman Grand Fish Feed organized a seminar on fish feed production. The target audience was fish feed users as well as others interested in methods used to create a wide range of high-quality aquaculture feeds and their use. After an introduction by Nabil, speakers, Dr Scott Snyder of Zeigler Brothers, Dr. Mohamad Said and Joe Kearns of

Grand Fish Feed reviewed the nutritional, production, and final product characteristics.

Kearns said, "We want to share our experiences in fish feed production and the outcomes from Grand Aqua's feeds. We will follow that up with the discussion on the process itself how we make these feeds. We were in Saudi Arabia earlier this year, where they were getting a feed conversion ratio (FCR) above 1.6 but we have achieved 1.1 which means a tremendous difference in cost of raising the tilapia. We are already selling in Europe. Our biggest market is still Egypt, but we are already exporting our feed to 40 different countries."



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Business and Partner Development Manager for the Aqua Feed division in China

In a strategic move to further solidify its presence in the Chinese market, **Symrise Aqua Feed** has announced the appointment of **Richard Liu** as the Business and Partner Development Manager for the Chinese market, effective December 2023. Liu holds a master's degree in food quality management from Wageningen University, The Netherlands. His academic background and industry experience position him as an asset to the strategic aqua feed objectives of Symrise in the Chinese market.

In terms of sales and development, Liu will build upon the momentum of the past three years, ensuring the ongoing success of sales and development initiatives in the Chinese market. In product innovation, he will address the unique needs of the China aquafeed market, leading the launch of new products, aiming to meet current demands, and to expand the market presence of Symrise in aqua feed solutions. Liu will establish key partnerships with



Chinese entities, contributing to the development of new products made in China.

Liu said, "It feels exciting to join a world leading company by working in an increasing and promising market. The demand for high quality proteins grows constantly to meet our human food

consumption requirements. In this area, we can contribute to the aqua market of China with our expertise."

Symrise Aqua Feed specializes in developing, testing, and manufacturing sustainable ingredients and palatability enhancers. They help aquafeed manufacturers produce high performance diet and feed with low carbon footprint." www.aquafeed.symrise.com

Group Director - Sales Domestic & International



Goud Dhanunjaya (right) with U Dushyant Kumar, Managing Director of Devee Group

Hyderabad based **Devee Group** has announced the appointment of **Goud Dhanunjaya** as the Group Director - Sales (Domestic & International), effective from January 1, 2024.

"With over 20 years of experience in the aquaculture and livestock sector in Asia, Dhanunjaya brings valuable expertise in managing feed additive businesses and establishing strong distributor networks in South and Southeast Asian countries. His track record includes driving sales, managing distribution networks, implementing business strategies, and spearheading new product developments in healthcare products for shrimp and fish culture," said U Dushyantkumar, Managing Director.

The Devee Group is making significant strides in the livestock and aquaculture industry in India, delivering advanced healthcare solutions that cater to the evolving needs of farmers. With a solid foundation spanning two decades, the group has established itself as a pioneer in providing innovative and sustainable solutions to the aquaculture, poultry, and ruminant sectors. Its success is built upon the unwavering commitment to understanding market dynamics and delivering value-driven products and services. Devee takes immense pride in its state-of-the-art plant, certified by GMP+, ISO, and Fami-QS*, which ensures the production of high-quality offerings. By prioritising customer satisfaction and nurturing strong relationships, Devee Group has become a trusted partner in the livestock, ruminant and aquaculture healthcare industry.

Its dedication lies in driving the growth and development of these sectors and empowering farmers for a prosperous future. Through a relentless pursuit of excellence and focus on cutting-edge solutions, Devee Group continues to lead positive change within the industry.

The group is proud of its achievements and remain steadfast in a mission to revolutionise livestock and aquaculture healthcare. It is excited to expand its presence to international markets through strategic partnerships.

Fami-QS: Feed Additives and Premixture Quality System is under final verification phase. www.deveegroup.com



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Humane stunning of shrimp with semi-dry electrical stunners



Mårten Jørgensen at the booth of Optimar AS during the Global Shrimp Forum. The team brought with them the electric stunner for shrimp.

Norway based **Optimar AS** is a seafood technology company with leading innovations on fish handling and processing for aquaculture and fisheries. During the Global Shrimp Forum, held from September 5-7 in Utrecht, The Netherlands, Mårten Jørgensen, Sales Manager discussed the humane stunning of shrimp, other crustaceans and farmed/wild fish species including yellowtail kingfish, tilapia, salmon, trout, European seabass and seabream, lobster, crab, langoustine etc using its electrical stunner. "We developed the new electrical stunner in 2005 and commercialization began in 2007. Making any species unconscious in 0.5 second, we have sold more than 700 stunners around the world. It is not only for fish farming but also included in these numbers are 140 stunners for fishing fleets."

The focus on farmed shrimp only started a few years ago when Optimar began a cooperation with some large supermarket chains, Tesco and Marks and Spencer. The cooperation is still ongoing, and the Optimar shrimp EI-stunners are now being used by shrimp farmers in Honduras, Ecuador, Vietnam, and other countries farming shrimp *Litopenaeus vannamei* and *Penaeus monodon*. Jørgensen said that they are also working with different NGOs to supply stunners to shrimp farms around the world. The Shrimp Welfare Project (SWP) buys shrimp stunners from Optimar and distributes these amongst shrimp farmers for free.

In January 2023, SWP and Optimar signed an MoU to collaborate to promote more humane slaughter practices for shrimp. Both parties recognise the need to minimise the suffering of shrimp in the farming industry and commit to doing so. For farmed shrimp, in general, it is estimated that around 400 billion individuals are killed each year. The most widely used method of slaughter for shrimp is

thermal shock through immersion in an ice water slurry. Unfortunately, there are growing concerns that immersion in ice may not adequately stun decapods during slaughter with this process and may even be detrimental to their welfare. Andrés Jiménez Zorrilla, SWP co-founder and CEO has acquired Optimar's electrical stunner which he will use at MERSeafood, a shrimp producer in the Honduras which supplies large global buyers.

In terms of pricing, Jørgensen said that it depends on the capacity, but at this forum, Optimar was offering a special price such as the one which can process 5 tonnes/shrimp per hour which is a common capacity for most farms. The mode of action is to have this at the farm on a truck and connected to a generator. This 5 tonnes capacity stunner uses 6-7 kWh and travels from pond to pond. The live shrimp harvest is pumped into the stunner. Alternatively, the farmer harvests the shrimp in baskets or using braille nets. The live shrimps are made unconscious and kept in slurry ice. "This is a human way to render any crustacean or fish unconscious safely and, in a stress, free manner," said Jørgensen.

The per hour capacity of these electric stunners dedicated to shrimp and crustaceans are graded into 1-5 tonnes, 5-10 tonnes and 10 tonnes or more. In the case of fish, the per hour capacity ranges from one to 25 tonnes. Optimar says that it is the world leader with these electric stunners which have been scientifically verified and in compliance with European and Norwegian standards.

Optimar expects to be back in the next Global Shrimp Forum 2024 (September 3-5) in Utrecht and present their latest version of their Semi-dry Electric Stunner for shrimp. www.optimar.no



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The US Grains Council will be exhibiting at the Seafood Expo Global (SEG) Hall 1 #1C503. SEG 2023 will be from April 23-25 at the Fira Barcelona Gran Via Venue, Barcelona, Spain.

Post show, it will be organising a one-day International Aquaculture Conference on **April 26, 2024** at the Catalonia Barcelona Plaza, Barcelona, Spain

The program for this conference will include an opening by Ramy Taieb, USGC, Regional Director for Europe, Middle East and Africa and Karisha Kuypers, USDA FAS Madrid, Agricultural Attaché.

The presentations will be as follows:

- US & EU Shrimp market: demand & supply by Willem van der Pijl, Shrimp Insights
- Global Tilapia and Catfish Outlook by Ragnar Nystoyl, Kontali
- Best practice of Mediterranean Seabass & Seabream culture & feeding by Kantham Papanna, ex Nireus Aquaculture
- Global Grain Supply & Aquafeed Demand: Outlook and Opportunities for DDGS by Ronnie Tan, USGC
- Aquaculture Stewardship Council's new feed standards for sustainability by Michel Franssen of ASC
- DDGS sustainability program by Carlos Suarez, USGC
- Searching for Synergies: How Marine Ingredients Improve Feed Grain Use in Aquaculture by Brett Glencross, IFFO
- Corn Fermented Protein and Applications in Aquafeeds by Kevin Herrik, POET
- DDGS adds value to trout feed by Deniz Coban, Department of Aquaculture Engineering, Adnan Menderes University

Panel moderators will be Caleb Wurth and Mohamed Salah Bouthour, USGC. More information: www.grains.org

33rd Practical Short Course on Feeds, Pet Food and Aquafeed Extrusion February 5-9, 2024 | Texas A&M University, USA (hybrid)

This is a one-week Practical Short Course on Feeds, Pet Food and Aqua Feed Extrusion at Texas A&M University in hybrid format by staff, industry representatives, and consultants.

The program will cover information on different extrusion systems such as dry extruder, single and twin-screw extruder, designing new feed mills and selecting conveying, drying, grinding, conditioning and feed mixing equipment. Current practices for production of pet foods, aqua feed, full-fat soy meal; recycling by-products, aqua feed nutrition principles; spraying and coating systems, digests and preservatives; use of encapsulated ingredients and preparation of premixes are reviewed. Reservations are accepted on a first-come basis.

For more information, contact: Mian N. Riaz E-mail: mnriaz@tamu.edu



larvi 2024 8th Fish & Shellfish Larviculture Symposium September 9-12, 2024 | Ostend, Belgium 1st announcement and call for papers

Interested contributors to the symposium programme are invited to submit to the Symposium Secretariat before **January 15, 2024**
More information: <https://aquaculture.ugent.be/larvi/>



XXI International Symposium on Fish Nutrition and Feeding 27-31 May 2023 | Puerto Vallarta, Mexico

Call For Papers:

The ISFNF2024 Committee invites participants to submit high-quality oral and poster presentations that are in keeping with the "Blue and Green Aquafeeds: Challenges and Opportunities for a Sustainable Aquaculture" topic. Deadline: **March 15, 2024**
More information: <https://isfnf2024.com>

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aquaprofessional.org

February 18-21

Aquaculture America 2024
San Antonio, Texas
was.org

March 12-14

Health & Nutrition Asia/Victam Asia 2024
Bangkok, Thailand
vivhealthandnutrition.nl/

March 20-22

VietShrimp
Camau City
vietshrimp.net

April 23-25

Seafood Expo Global
Barcelona, Spain
seafoodexpo.com/global

• **April 26**
• International Aquaculture Conference
• Barcelona, Spain
• grains.org

• **May 27-31**
• XXI International Symposium on Fish Nutrition and Feeding (ISFNF)
• Puerto Vallarta, Mexico
• isfnf2024.com

• **June 5-6**
• Shrimp Aquaculture Conference Bali, Indonesia

• **June 27-29**
• Shrimp Summit
• Chennai, India
• responsibleseafood.org

• **JULY 2-5**
• Asian Pacific Aquaculture 2024 (APA24)
• Surabaya, Indonesia
• was.org

• **August 14-15**
• TARS 2024: Finfish Aquaculture
• Bangkok, Thailand
• tarsaquaculture.com



• **August 21-23**
• VIETFISH 2024
• vietfish.com.vn/en

• **August 26-30**
• AQUA24
• Copenhagen, Denmark
• was.org

• **September 3-5**
• Global Shrimp Forum 2024
• shrimp-forum.com

• **September 9-12**
• larvi 2024
• Ostend, Belgium
• aquaculture.UGent.be/larvi

• **September 17-19**
• SPACE
• Rennes, France
• space.fr

• **September 24-27**
• Latin American & Caribbean Aquaculture 2024
• Medellin, Colombia
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• **November 20-23**
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• was.org

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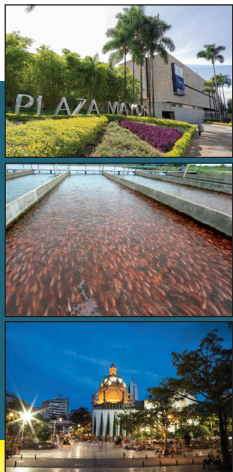


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