ASCientia

AQUACULTURE

Innovative & Multidisciplinary Approach

Issue No. 10 (2015)

ASCientia is a combination of ***ASC*** (acronym for School of Applied Science) and ***scientia*** (Latin word for knowledge, science and skill)

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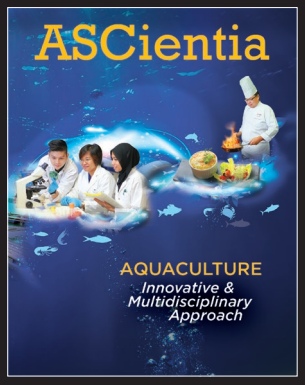

The editors wish to extend their appreciation to all who contributed to the production of this magazine, and to Apollo Aquaculture Group Pte Ltd for permission to feature the soft shell crab project.

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Director's Message

The Inaugural Institution of Aquaculture Singapore (IAS) Conference 2015 is a significant milestone for Temasek Polytechnic (TP) and the aquaculture industry in Singapore. In time to come, it shall also be an influential forum supporting aquaculture industries beyond our shores. The setting up of the IAS is an important collaborative effort between IAS and TP, and marks our commitment towards ensuring food security and safety. These are two issues of prime concern to Singaporeans and to all world citizens.

Our polytechnic is well placed to help the industry in two aspects. Firstly, we are committed to contributing to the national initiative of optimising local production. Secondly, we have been and shall continue to invest our resources to further develop expertise in this area.

Indeed, TP has been devoting her time and effort in creating a solutions centre for aquaculture. We are engaged in on-going research on feeds and formulations for better growth performance, development of on-site diagnostic kits for health monitoring and disease detection, as well as research on water technology and waste water treatment, to name a few.

We have signed an MOU with AVA in March this year to collaborate in research and training for the aquaculture industry. An example of such a collaboration was to conduct training to prepare about 70 farms for contingency planning to manage plankton blooms which are occurring more frequently. TP and AVA are also working with SPRING to assist farms in a proposed capability development plan which includes training and securing core farm equipment for managing plankton blooms. An agreement with MSD Animal Health Innovation Pte Ltd to perform pathogen detection in fish samples from both local and overseas farms has also been signed.

In the area of conservation, TP is the first and only polytechnic to be awarded the Conservation Fund to breed mudcrabs for conservation.

This conference is only an initial platform for those in positions responsible for ensuring food security and safety for our citizens to share their experiences and good practices. It is also meant to bring together experts in this area to share their technical know-how and leverage on each other through win-win collaborations. I am sure that the impact brought about by the gathering of some of the brightest minds in this industry from all over the world will continue to multiply in intensity, and spread to become a powerful and prevalent force behind the growth and well-being of our nations.

Dr Lee Chee Wee
Director
School of Applied Science

ASC Capabilities

We are pleased to present to you our school's capabilities in this short segment, highlighting some of our seven **Diploma-Specific Capabilities**. It will be evident to you, as you read about our various research projects, that we at ASC are bitten by the ***Research Bug***, whose bite is eagerly welcomed by our scientists and technologists.

As you take in the overview of our **Research and Development Clusters** (on page 9), you will catch a glimpse of our capabilities in Analytical Science being applied through consultancy services for a wide range of industries including Agri-Food and in particular, aquaculture.

Using Biochemistry to Develop An Organic Repellent

Chan Giek Far, PhD
Lecturer/Diploma in Biotechnology

At ASC, our Biotechnology research team used the principles of biochemistry to produce a 3-in-1 all-organic multi-pest repellent. This is the result of bringing timeless remedies to practical use. Named after our polytechnic, TPel is a repellent available as a simple gel. TPel keeps cockroaches, ants, lizards and mosquitoes away as it acts as a regular diffuser which can be left in a pest-infested room. The effusion of TPel, pleasantly fragrant to humans, is "disgusting" to the unwelcome pests.

The effectiveness of TPel is attributed to the constituents of its tri-layer gel of immobilised plant metabolites. In nature, plants produce many useful secondary metabolites of industrial importance. This includes the volatile metabolites that are widely used as flavour or aroma compounds. Some of the volatiles can function as repellents that induce plant defenses against a variety of insect pests. The initial preparation of TPel includes extraction of these volatile metabolites.

Currently, our research team is working on the stabilisation of plant metabolites, to increase the effectiveness and shelf-life of TPel.

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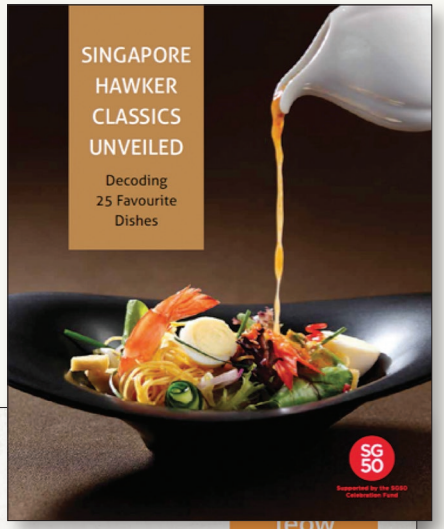
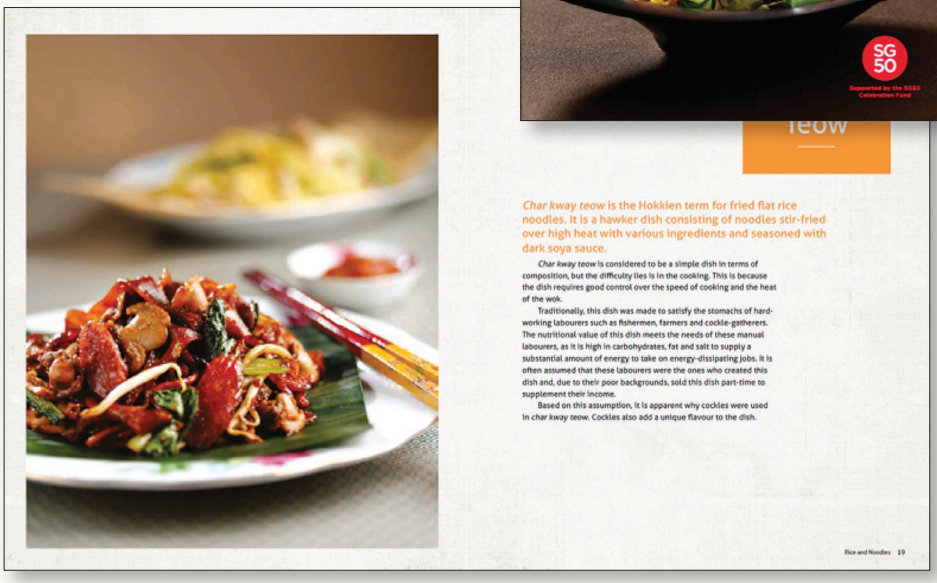
Commemorative Cookbook

Unveiling the Secrets of 25 Local Hawker Favourites





In conjunction with Singapore's 50th anniversary celebrations and Temasek Polytechnic's 25th anniversary in 2015, a commemorative coffee-table cookbook was developed by staff and students from the Diploma in Baking & Culinary Science. This project received support from both the SG50 Education and Youth Committee Collaboration Fund, and the Heritage Participation Grant from the National Heritage Board (NHB).

The book comprises 25 most sought-after hawker dishes that every Singaporean would have either seen or tasted in one form or another. It showcases a variety of main dishes and desserts, with the selection of hawker foods spanning the main ethnic and cultural groups in Singapore, truly reflecting our rich heritage and colourful multicultural society.

Our diploma team first conceptualised this cookbook in 2010, heeding the call by Professor Tommy Koh, the then NHB Chairman, for Singapore hawker culinary skills to be taught in culinary institutions to address the pressing need to preserve the integrity of our hawker culinary heritage. We embarked on this challenging journey to decipher 25 popular hawker classics, having considered the urgency to inspire today's youth on preserving our local food culture. Tapping on the diploma's technical capabilities in culinary science, the development of this book saw many hours invested by students, graduates, and staff to explore, rediscover and reignite our most favoured hawker dishes.

Each recipe begins with information on its journey from the place of origin to Singapore, to its variations which are available around Singapore or the region, as part of the Pan-Asian cuisine. The dish is then dissected into its sensory attributes, providing the reader with a sense of its aroma, flavour profile and mouthfeel, before the recipe is finally unveiled. The nutrient analysis of each dish is also tabulated for the health-conscious reader. There are culinary tips and facts of each dish or recipe as well as scientific explanations related to a recipe ingredient or cooking technique.

Understanding the past and moving towards the future, we have reignited these traditional dishes with a modern twist. While each dish is re-presented in an alternative form, it still preserves its essence, providing a novel appeal to both the modern cooking enthusiast as well as the young culinary explorer.

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GLYCEMIC INDEX OF COMPOSITE DISHES

from Research to Recommendations

Kalpana Bhaskaran
Manager/Nutrition Research

Determining the Glycemic Index (GI) of foods is, unfortunately, not a straightforward process simply because it involves human subjects. We are currently able to determine the GI value of common single foods. However, determining the GI value of local composite dishes such as Chicken Rice, Nasi Lemak, Fried Bee Hoon and Fishball Noodles could be challenging. As it would be beneficial to consumers to have readily available information on GI values of local composite dishes when preparing low GI meals, our GI research team set out to determine the GI of two popular hawker dishes: Fried Bee Hoon and Fishball Mee Pok Noodles.

Glycemic Index Chart

GI accounts for the quality of the carbohydrates consumed which affects blood glucose levels.
The lower the GI, the better!

In *vivo* GI testing of single carbohydrate (CHO) foods in our accredited GI research facility indicated that Mee Pok Noodles had a high GI, while Thick Rice Bee Hoon had a low GI. These two single CHO items (one of high GI and the other of low GI) were used to prepare the Fishball Mee Pok Noodles and Fried Bee Hoon. Cooking trials were conducted to develop the two recipes, simulating the ingredients, cooking method and the sensory attributes of hawker food.

Fishball Mee Pok Noodles registered a low GI value of 46.0 ± 4.2, while Fried Bee Hoon indicated a GI value of 40.0 ± 3.9. The GI value of Fishball Mee Pok noodles (composite dish) was much lower than that of plain Mee Pok Noodles (statistically significant). It is known that the addition of fat and protein to carbohydrates reduces the glycemic response by delaying gastric emptying. The increased amount of fat and protein in the gut induces a larger secretion of incretin hormones which increase meal-induced insulin response, and in turn results in a lower GI. The reduction in glycemic response might have been due to increased protein and fat content of the Fishball Mee Pok Noodles compared to the plain Mee Pok Noodles.

The GI value of Fried Bee Hoon, on the other hand, increased slightly compared to plain Bee Hoon. However, the GI was still low and the increase was not statistically significant. One of the possible reasons for the increase in GI of Fried Bee Hoon could have been due to the increased cooking time, which may have increased the GI.

Adopting a low GI diet translates into significant health benefits for consumers. Therefore, incorporating low GI carbohydrates such as rolled oats, quinoa, wholemeal pasta, brown basmati rice in the preparation of composite dishes will result in an overall low to moderate glycemic index meal plan.

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Efficacy Studies using Animal Models

Alvin Poh Lye Hin
Course Co-ordinator/Diploma in Biomedical Science
& Diploma in Pharmaceutical Science

The process of developing new products for the commercial market requires rigorous quality and safety assessment. This not only applies to products that are completely novel, but also to products that have been enhanced or improved with modifications made to their formulations.

Since the inception of consultancy projects using animal models in 2006, ASC has expanded its range of analytical and biological testing capabilities to different disciplines, helping numerous SMEs assess the efficacies of their health supplements and Traditional Chinese Medicine products. These collaborative projects can be specifically customised to the needs of the company, and leads to results in a relatively short period of time.

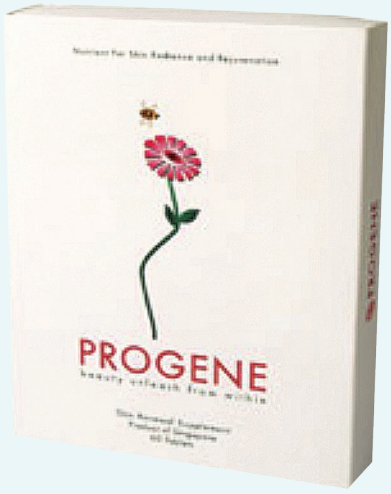
Dawyn International Pte Ltd (Dawyn) is a prime example of emerging healthcare companies leveraging on the scientific expertise of ASC and financial support from SPRING Singapore to improve their products. The company tapped on the expertise of ASC to perform efficacy studies on three improved formulations for their product, Progene. This is a well-established health and beauty product that has been sold in Singapore and other South-East Asian countries over the past decade. Dawyn's goal was to refresh their product line for marketing in different countries to consumers with different preferences for active ingredients in their formulations.

The efficacy study conducted by our research team on the improved formulations was primarily to compare the antioxidant efficacies of the three formulations with the original product using an animal model. We had, earlier in 2007, completed a similar study on the original Progene product; this second project was an indication of Dawyn's strong confidence in ASC's analytical capability.

For this study, our research team conceptualised an analytical methodology, based on reported studies performed on similar products. This involved the administration of Progene and assessing the antioxidant activity of the mice liver using a well-established superoxide dismutase (SOD) assay.

Moving forward, our research team will be designing animal models for a number of metabolic diseases for the evaluation of efficacy and safety of new formulations of health supplements. This will be supplemented with *in vitro* toxicology tests using cell culture systems and gene expression studies with known biomarkers, to provide a comprehensive suite of approaches and validation studies for the emerging nutraceutical, health supplements and wellness industry.

A. Animal models can be used to study the effectiveness of complementary health products.



B. Progene is an oral beauty supplement formulated to improve skin complexion and immunity through its antioxidant activity.

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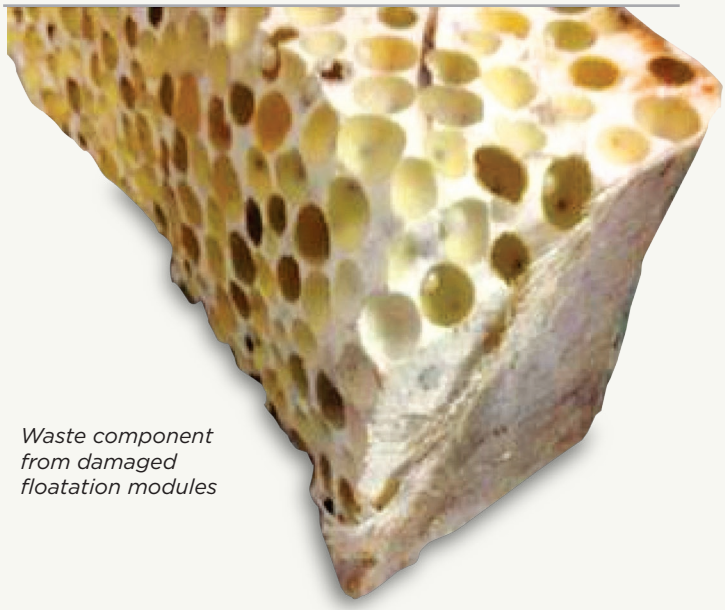
Recycling of Waste Components from Offshore Oil and Gas Industry into Building Materials

Wong Sook Fun, PhD
Programme Manager/Green Materials

ASC has collaborated with Dynaglass Reinforced Plastic Pte Ltd (Dynaglass) on a feasibility study to convert waste components from the offshore oil and gas industry into building materials. Dynaglass is a local small and medium enterprise (SME) with a strong technological base in engineered reinforced plastics.

Incineration and landfilling which are the current methods used to dispose of damaged floatation modules from the offshore oil and gas industry pose environmental hazards. Incineration is a major contributor of environmental issues as it causes air pollution and releases air-borne contaminants, while landfilling not only requires physical space, but the waste components may leach harmful chemicals into the native water supplies which endanger the native flora and fauna, and even human life.

Cementitious specimens incorporating the waste materials



Waste component from damaged floatation modules

This collaborative project therefore aims to recycle these damaged floatation modules as partial replacement of cement and sand in building composites. This reduces not only the environmental threat, but also the high dependency on conventional raw ingredients such as cement, sand and limestone.

Findings of this feasibility study have shown that mortar composites which incorporate contents of such waste components are potential materials that could be used for non-structural and structural applications. These green materials could be processed and used in the fabrication of various components in green buildings, which would effectively reduce high disposal cost, and potentially provide a secondary revenue stream for companies through the sale of recycled materials.

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Social Innovation Research on

Early Detection of Neurodegenerative Diseases

Leong Shu Xian Grace, PhD
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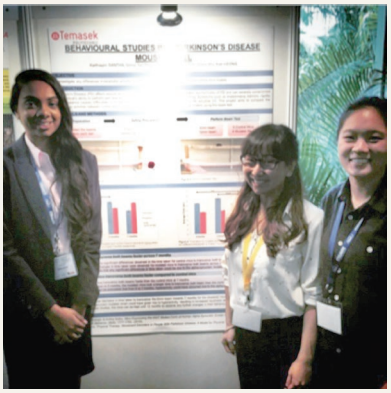
Our Pharmaceutical Science research team has found biomarkers that could lead to early detection of diseases. Early detection is critical in an ageing population where those 50 years and older are susceptible to neurodegenerative diseases like Parkinson's and Alzheimer's. The sufferer and his/her family would then be better prepared to cope with future inconveniences.

Early diagnosis would also mean a higher chance of slowing the disease progression through earlier treatment. Our research team's work towards improving the quality of life of such patients is supported by a 80K grant from TOTE Board's Social Innovation Research (SIR) Fund . This seed funding is for R & D in defined areas of social service and social environment.



PHS team at the SALAS-AALAC Annual Conference in January 2015

Our plan is to study a panel of biomarkers in the blood of mouse models before extrapolating results to humans. Sampling blood is the preferred choice for this research as it is not only cheap, quick and non-intrusive, but it is also an excellent source of biomarkers in relation to the potential signals and molecules released by various cells associated with the disease. Sampling of body fluids and secretions is most suitable and ideal when testing for Parkinson's Disease in the elderly, bearing in mind that testing for these patients should be as minimally invasive as possible.

Students have also been involved in this research as we have trained and equipped them with the relevant skills to run preclinical trials. To date, we have found a few interesting biomarkers showing differing expression levels in both normal and diseased mouse models. The results from this study were presented at a conference in January 2015 and we are preparing for another poster presentation at the Singapore Health and Biomedical Congress in October 2015.

Beam test using mouse model

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Animal Models in Preclinical Research

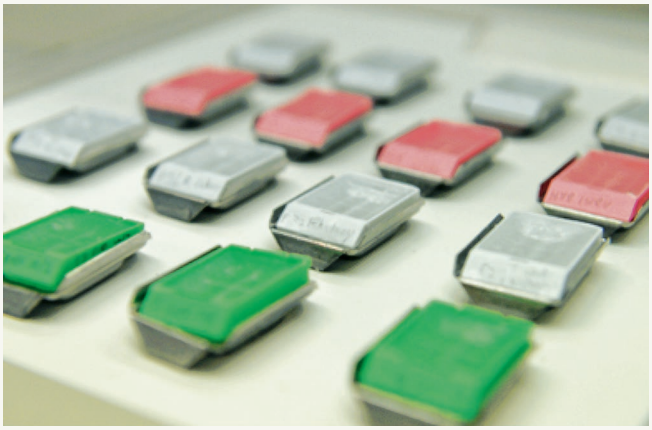
Chooi Kum Fai, DVM
Programme Manager/Preclinical Research & Drug Evaluation

With a rapidly ageing population, there is an increasing need to use animal models in the study of age-related disorders to find suitable treatments or cures. Under the preclinical research and drug evaluation programme at ASC, laboratory animal models are used for studying disease mechanisms and evaluating the efficacy of potential therapies for various diseases.

Currently, our veterinary research team is studying the mechanisms of liver fibrosis in rat liver. Following the induction of liver disease in rats, clinical tests are conducted to monitor the progression of the disease. Our in-house laboratories, which are well-equipped with the latest haematology and biochemistry machines, are designed for conducting such clinical tests. Our research team also has the expertise to study gene expression using quantitative Polymerase Chain Reaction (PCR). This has been used to study the molecular mechanisms in fibrosis development in liver tissue harvested from the rat model at different stages of liver disease.

Besides the application of molecular techniques, our team performs routine histological examination on tissues using haematoxylin and eosin, followed by special staining such as Masson Trichome to highlight collagen deposits. The pathologist on our team then examines the liver stains and scores them using the Ishak scale. In addition, an imaging software is used to quantify the fibrosis in the rat liver. These approaches provide an effective platform to study the mechanisms of liver fibrosis. This system has been used to test novel compounds simultaneously for their prophylactic and therapeutic potential. In addition to animal models, our research team is also trained in cell culture technology. We are currently using liver cell line to study gene expression in response to new antifibrotic agents.

Team members embed tissues in paraffin wax and fix 5μm sections onto slides.



Some of our other research projects using laboratory animal models are:

- developing potential therapies for diabetes
- studying disease mechanisms for Parkinson's disease
- studying beneficial effects of health supplements
- evaluating vaccines or probiotics for farm animals.

Embedded tissues on the cooling plate.

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School Of Applied Science

Research & Development Clusters

MEDICAL TECHNOLOGY

- Animal Model
- Diagnostics
- Proteomics & Protein Technology
- Trauma care

AGRI-FOOD TECHNOLOGY

- Applied Nutrition & Food Technology
- AQUACULTURE
- Plant Biotech
- Traditional Medicine

RENEWABLE RESOURCES TECHNOLOGY

- Biofuels
- Green Materials
- Water Technology

ANALYTICAL SCIENCE

Innovation Enabled by State-of-the-Art Analytical Capabilities

AQUACULTURE

An Innovative and Multidisciplinary Approach from farm to fork

NUTRITION
- Herbal Therapy
- Enriched Planktons
- Biofloc

DISEASE & HEALTH MANAGEMENT
- Disease Detection
- Disease Prevention

BROODSTOCK DEVELOPMENT
- Optimisation of Spawning & Rearing Conditions
- Molecular Approach

CULTURE SYSTEM
- Closed Containment Set-Up
- Urban Farming with Aquaponics/ Hydroponics

SUPPORTING TECHNOLOGIES
- Water Treatment (algal)
- Biological Testing
- Chemical Testing

APPLICATION & PRODUCT DEVELOPMENT
- Biomedical Application
- Innovative Recipe Development

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Herbal Therapy for Food Fish

Lim Choon Kwang, DVM
Research Scientist/
Technology Development

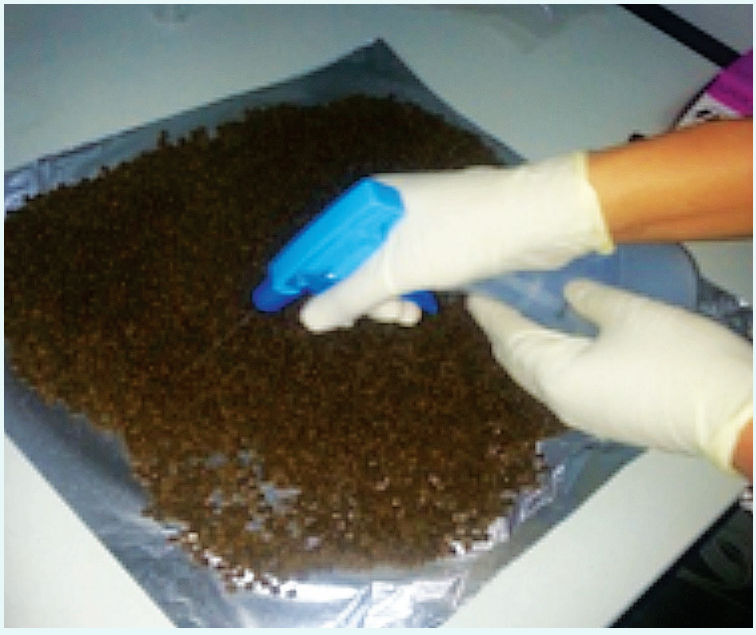
Tilapia
Oreochromis sp

Fish diseases caused by parasitic organisms, bacteria and viruses may affect the optimum yield resulting in dire economic consequences. Vibriosis is one of the most prevalent fish diseases caused by bacterium belonging to *Vibrio* sp. which has been observed in severe disease outbreaks in the Asian seabass cage culture.

The current method of controlling aquatic diseases depends largely on the use of antibiotics. However, frequent usage of antibiotics might lead to drug resistance and the presence of antibiotic residue in treated fish.

Our current project aims to study the efficacy of different herbal extracts from garlic (*allium sativum*), ginger (*zingiber*) and onion (*allium cepa*) on the immune response in tilapia at different inclusion rates incorporated in commercial pellets. These active compounds may have the potential to directly trigger the innate defense mechanism of fish through their actions on cell receptors, as well as through genes linked to the immune system, which could offer protection against the *Vibrio* species infections.

The findings of the three-month study showed that garlic supplemented feed at an inclusion rate of 0.5% to 1% had demonstrated positive growth performance with an improved Food Conversion Rate. On the other hand, fish fed on onion extract supplemented feed showed positive immune response compared to the control, throughout the three-month study. Elevated levels of anti-protease, myeloperoxidase and lysozyme levels were observed when humoral assays were conducted, which indicate that herbal extracts at appropriate concentrations could help in boosting the immunity in fish against pathogens. Plans are in the pipeline to conduct a disease challenge using bacterial pathogens.



Top dressing of commercial pellets with herbal extracts

Bio-enriched Planktons for Sustainable Fry Survival and Growth

Glendon Teo and Nadiah Sata
Technology Development

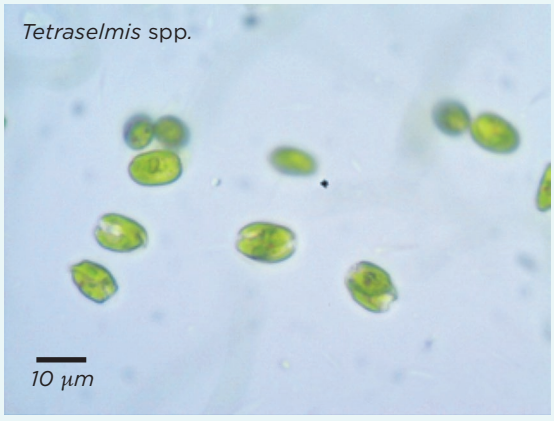
Nutrition plays an important role in the growth and development of frys (hatchlings) and their survival. Upon depletion of their yolk sac, the frys would need a rich source of nutrients for the different stages of their development into healthy juveniles. Frys usually have very small mouth aperture that can take in feeds of a few microns in size.

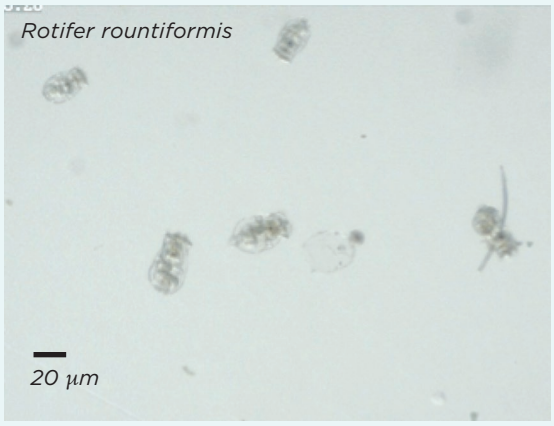
Live feeds provide the desired nutrition and are an important integral component in the stages of fry growth and development. As there is no local commercial production of quality planktons for feeding frys, farms have turned to imported live (or frozen) zooplanktons or powdered feed.

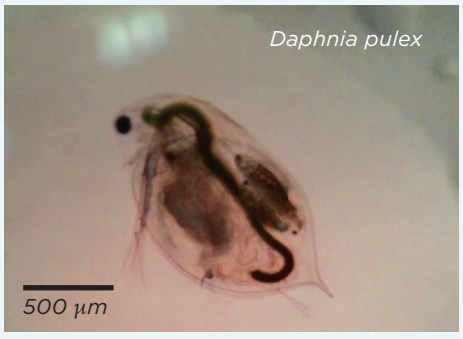
Our Aquaculture team at ASC has been working on ways to help the local aquaculture industry reduce their reliance on imports. Our research focuses on improving the production and nutritive value of zooplanktons as live feeds for larval nutrition of foodfish and crustaceans such as the mud crab.

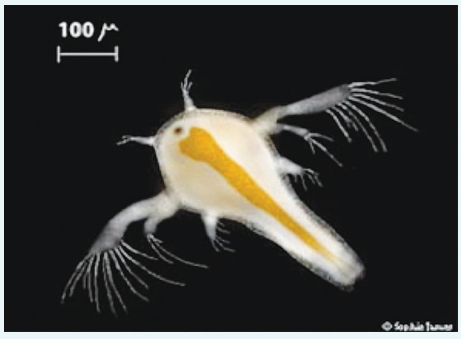
We have successfully cultivated various types of zooplanktons under optimised growth conditions. Although there are no known recorded commercial pond densities, our zooplanktons were produced consistently at high densities of up to 500 pieces/l for *Daphnia pulex* or *magna* and 10,000 pieces/l for *Moina* in a basic culture set-up at ASC. Furthermore, our research team has enhanced the nutritive value of these live feeds through bio-enrichment using low cost ingredients. While most live feeds are naturally high in protein but low in lipid content, our bio-enriched planktons have higher nutritive value particularly in the fatty acids DHA and HUFA. These fatty acids are important for boosting the motor and immune system of fish frys.

Currently, our research team is conducting larval growth trials at a commercial fish farm using *Moina*, one of the enriched live feeds.









Biofloc Technology

Alternative Feed for Sustainable Freshwater Foodfish Production

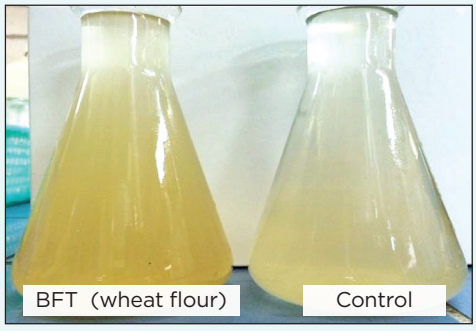
Christopher Marlowe A. Caipang, PhD
Research Scientist/Technology Development

Less than 10% of the local fish consumption needs is supplied by our local aquaculture food fish farms annually. With the increasing need to become self-sufficient in foodfish production for food security and food safety, urban farming through land-based aquaculture farms is expected to intensify. This would lead to more fish wastes produced which could cause environmental pollution if waste discharge is poorly managed. As a result, there is a need to develop a sustainable aquaculture technology for intensive land-based farming. One such environment-friendly aquaculture technology is Biofloc Technology (BFT).

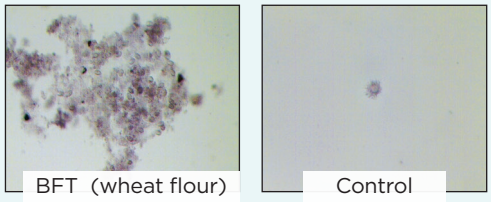
Biofloc refers to a collection of macro-aggregates including diatoms, macroalgae, fish faeces, uneaten feeds, remains of dead organisms, bacteria and minute invertebrates that are suspended in the water column. Biofloc supports self-nitrification within the culture system with zero or minimal water exchange, therefore enabling it to provide stable and sustainable aquaculture production particularly for freshwater Tilapia aquaculture. Tilapias are efficient filter feeders and they eat almost anything in the rearing environment.

Through our research findings, wheat flour has been identified as a suitable carbon source for developing good bioflocs that could enhance Tilapia growth. This indicates that biofloc is able to augment the nutritional requirements of the fish and it can partially substitute the use of commercial feeds for Tilapia aquaculture thus resulting in cost savings for the farms. The rearing water from the BFT tanks also showed that biofloc could inhibit the growth of *Vibrio* sp., a bacterial pathogen of most fish species.

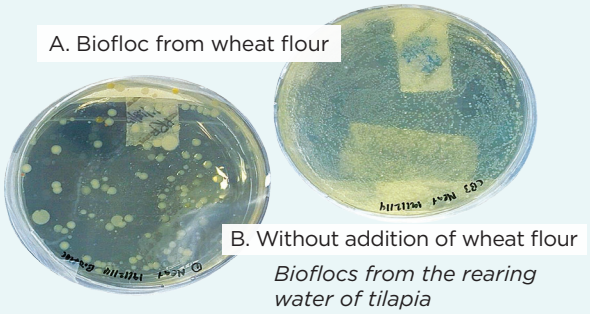
Further research on the composition of bioflocs and its viability for large-scale Tilapia production is in progress. Bioflocs have also been successfully shown to enhance the production of zooplankton as live feed for fish juveniles.



Rearing water of a tilapia grown in a BFT system using wheat flour as carbon source



Microbial population in the rearing water of tilapia grown in BFT system using wheat flour as carbon source.

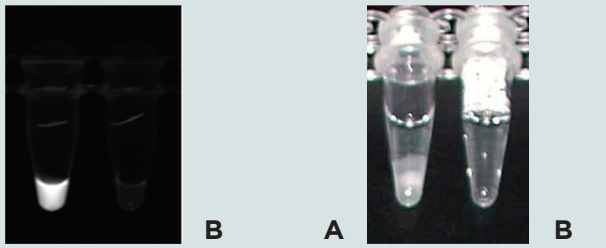


Bioflocs from the rearing water of tilapia

LAMP Assays for Early Detection of Fish and Shrimp Pathogens in Aquaculture

Christopher Marlowe A. Caipang, PhD
Research Scientist/Technology Development

Infectious disease is one of the most serious threats to the success of commercial aquaculture. Accurate diagnosis during the early stages of infection is crucial to ensure proper management procedures to avert mortality and economic loss.



Viewed using UV light | Viewed using normal light

Visual detection of samples during the LAMP assay. Positive samples (A) had bright coloration when viewed using UV light and a white precipitate after centrifugation, visible to the naked eye

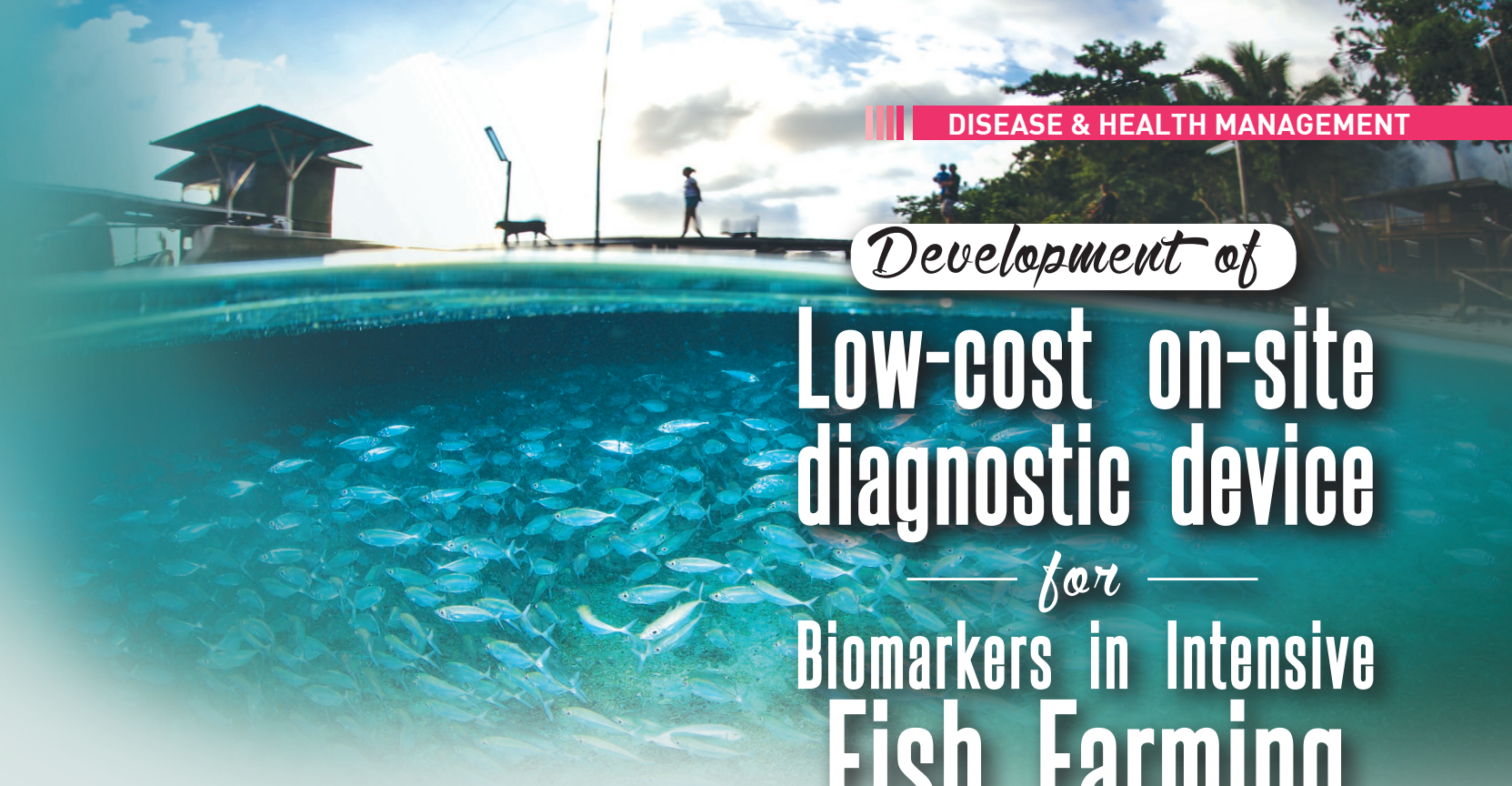
The current practice of fish farmers, once they notice a diseased fish, is to either send samples for time-consuming lab analysis or resort to therapeutic measures which may be harmful to the fish.

There are available point-of-care (POC) kits for on-site disease diagnostics of aquatic pathogens. Although these kits are helpful to farmers in detecting the cause of infectious diseases, most of these POC kits are antibody-based systems, which have limited sensitivity. On the other hand, molecular-based POC detection systems are cost-prohibitive, making them inaccessible to small- and medium-scale fish farmers.

A recent molecular detection technique known as the loop-mediated isothermal amplification (LAMP) system provides a platform for a rapid and sensitive detection of various pathogens of fish and shellfish. This diagnostic assay uses a single temperature and does not require expensive or sophisticated equipment. The reaction takes place in an hour, yielding results in a short time.

The presence or absence of the pathogen in the samples can be known visually through the formation of a white precipitate or a change in the colour after addition of a dye. A distinct advantage of this direct method of visual determination is the ease in training fish farm personnel to perform assays on-site. As the equipment is also cheap and readily available, this diagnostic technique is potentially viable as an on-site disease diagnostic tool.

At present, our Aquaculture research team at ASC has developed various platforms for detection of various pathogens in aquaculture. Tests are ongoing to standardise the LAMP detection assays for bacterial pathogens such as *Streptococcus* spp., and *Vibrio* spp. as well as viruses including iridoviruses and white spot syndrome virus (WSSV). As part of efficacy studies, field testing at fish farms will be performed soon.



Development of Low-cost on-site diagnostic device for Biomarkers in Intensive Fish Farming

Patel Kadamb Haribhai, PhD
Programme Manager/Biosensors

The application of biotechnology in aquaculture has contributed to the rapid increase in aquaculture production, providing a means to increase the intensity and capacity of fish farming. However, fish in culture are in a stressful environment and therefore highly susceptible to stress and infections. Growth of fish is affected and outbreak of diseases is common.

Currently, tests for detecting stress in fish involve microbiological, immunological and molecular biology. These are highly specific and sensitive methods for identifying and quantifying a specific pathogen. Molecular methods allow pathogenic detection of asymptomatic fish through polymerase chain reaction, restriction enzyme digestion and hybridisation. These tests are expensive and time-consuming. Well-trained professionals and well-equipped laboratories are essential for performing such diagnostic tests which in turn increase the cost and lengthen the therapeutic turnaround time.

DNA vaccines and antibiotics are also commonly used to solve the problem of disease. However, use of antibiotics and vaccines are restricted due to regulatory requirements set by local health authorities.

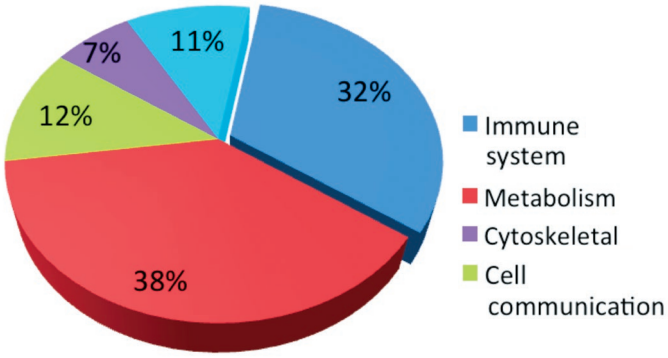
Our research team at ASC has developed a low-cost, on-site diagnostic device to detect stress in cultured fish. Using our in-house capability to immobilise enzyme chemistry and biochemical reagents on structurally modified paper, we have developed a multiplexed low-cost, on-site microfluidic paper-based device to detect liver enzymes (ALT, AST) and (GDH).

This device requires only a small volume of test sample (serum or blood) and no external supporting equipment or power. Semi-quantitative results are obtained within five minutes. While this diagnostic device can be used as a stress management tool, regular disease screening and monitoring is necessary in fish farms to avoid disease outbreaks.

Liver enzyme activities increase with induction of stress and disease outbreak. Fish cope with adverse conditions (stress) by synthesising glutamine, which is a product of ammonia detoxification through glutamate dehydrogenase (GDH). The GDH in *Misgurnus anguillicaudatu* is increased when the level of ammonia, an early chemical stressor in fish, is increased. Stress-related diseases also increase the activities of the liver enzymes, alanine aminotransferase (ALT) and aspartate aminotransferase (AST).

Non-invasive Monitoring of Fish Stress

Padmanabhan Saravanan, PhD
Course Manager/Biotechnology
Section Head/Medical Diagnostics



A. Classification of mucus proteins into categories based on biological processes

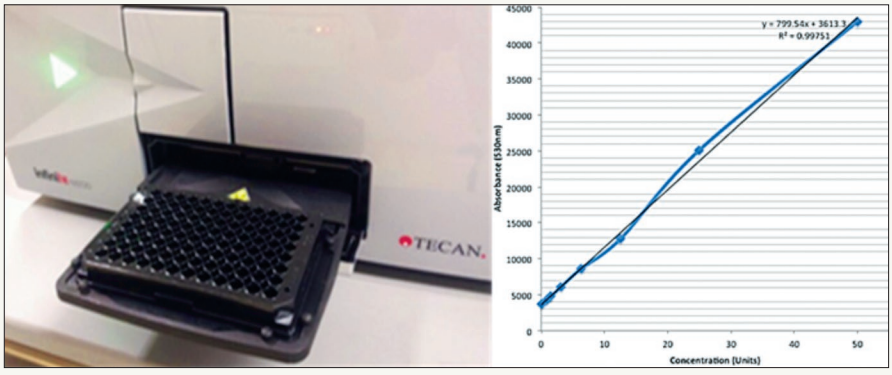
Fish have a complex defense mechanism to counter a variety of survival challenges in the aquatic environment: physical, chemical, biological and procedural stressors. Fish rely highly on their innate immune mechanism for protection against biological stressors such as pathogens. The layer of mucus on the surface of the fish is considered as a key component of the innate immunity system and the first line of defence. This layer of mucus, which is being continuously replaced, prevents stable colonisation by parasites, bacteria and fungi. The composition and rate of mucus secretion have been observed to change in response to external stimulus such as microbial exposure or poor water quality.

Fish mucus contains a variety of biologically active substances which provide immediate protection against potential pathogens. These protective substances include lysozyme, lectins, proteolytic enzymes, cathepsin-B, flavoenzymes, immunoglobulins, C-reactive protein, apolipoproteins and antimicrobial peptides (AMPs). The fish mucus also performs a number of other functions including respiration, ionic and osmotic regulation, locomotion, reproduction, communication, as well as feeding and nest building.

Therefore, fish mucus serves as a dynamic biological interface and could be a potential non-invasive source for prognostic and diagnostic applications. To better manage intensive aquaculture practices, there is a need to monitor fish stress. Our in-house aquaculture capability at ASC has successfully developed working protocols for non-invasive monitoring of fish stress using mucus samples. We have also developed turbidimetric, colorimetric, fluorimetric and electrometric assays for quantitative analysis of hormones (cortisol) and enzymes (lysozyme, carbonic anhydrase, alkaline phosphatase). Our modified cortisol ELISA of in-house fish standard has achieved a five-fold reduction in the cost of analysis for each sample compared to the commercial ELISA kit.

Our ongoing research is the development of point-of-care test (POCT) devices, with sample collection and processing gadgets to make the operations viable and user-friendly to the farmers. With our team of aquarists, veterinarians, and research scientists in ASC, we are able to provide consultancy services, customised diagnostics development and research solutions.

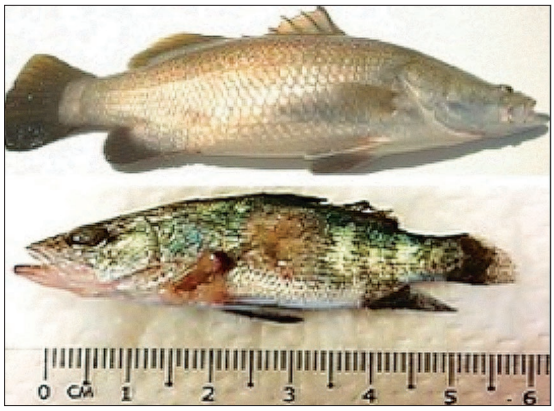
B. Classification of mucus proteins into categories based on biological processes



C. Fluorimetric measurement of lysozyme from mucus samples

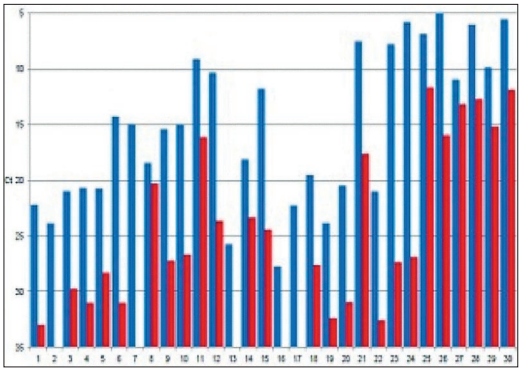
Tenacibaculum maritimum in Asian Seabass: Detection, Treatment or Prevention

Syed Musthaq, PhD
Research Scientist/Technology Development



Normal and T. mar infected Asian Seabass

T. mar colony



qPCR field data: Diagnosis Moritella viscosa (■) vs T. spp (■) - Cermaq

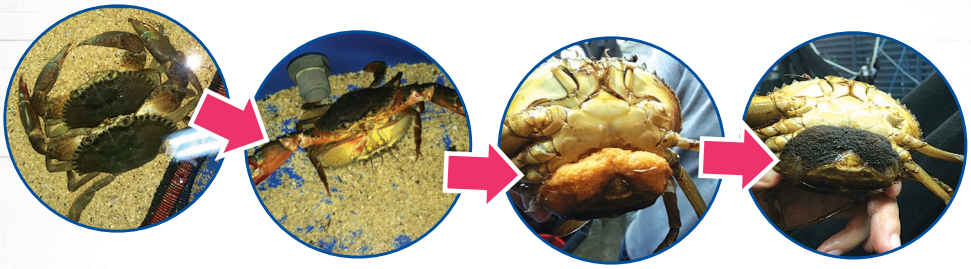
Worldwide, huge losses of wild and farmed fishes are caused by fish bacterial diseases. Among the bacterial species belonging to the family *Falvobacteriaceae, Tenacibaculum maritimum (T. mar)* is an important pathogen that causes *Tenacibaculosis* in marine fishes. The infected fish often shows typical gross lesions on the body surface with ulcers, necrosis, mouth erosions, frayed fins, tail rots. There is evidence of a constant mortality rate of 20-30% in each culture cycle; the mortality rate increases if either the disease is undetected or secondary infection develops. Since 2002, there have been several *T. mar* isolates found particularly in Indonesia, Malaysia and Singapore. There are also reports on the appearance of genetic variability in *T. mar* isolates among different fish species.

T. mar infects both young and adult fishes with the young suffering the most from the disease. *T. mar* transmission occurs through host-to-host interaction, through ingestion of infected fish and lastly, through jellyfish and sea lice which act as vectors for infection of farmed fishes. The virulence factors involved in *T. mar* infection are the toxins and enzymes present in the bacterial products, which have high protein degradation activity. This synergistic interaction of the toxins and enzymes leads to the hemorrhagic skin ulcerations in the fish. *T. mar* infection can be controlled by either antibiotic or chemical treatments. However, there has been an increased demand for non-chemical treatment methods.

The current microbiological methods used to diagnose *T. mar* infection are not only time-consuming, they are unable to distinguish *T. mar* from other similar species. An important step for the development of an effective treatment or a preventive methodology is: the isolation and characterisation of *T. mar* bacteria, followed by identification of bacteria via specific molecular biological method. Currently, we are looking into developing a rapid detection and treatment method against *T. mar* bacteria isolated from infected Asian seabass.

Development of Spawning and Rearing Conditions of the Mud Crab (*Scylla* spp.)

Terence Tan
Research Officer/Technology Development



Life Cycle of the mud crab. A) Male crab (top) guards a female crab (bottom) which is ready to moult. B) Male crab copulates with newly moulted female. C) Berried female crab. D) Developing eggs turns from orange to black prior to hatching.

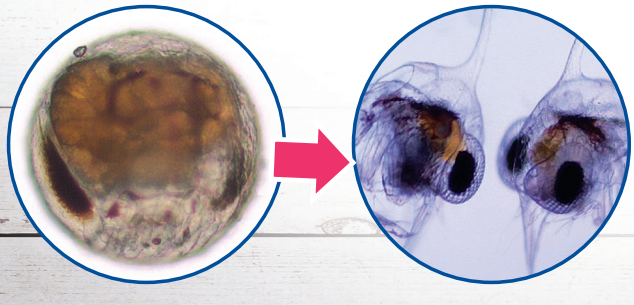
Chili Crab is considered by many as the national dish of Singapore. The key ingredient and star of this internationally famous dish served at seafood restaurants is the **mud crab** (also known as the *Sri Lanka Crab*). As a general term, mud crab refers to a group of crabs in the genus *Scylla* consisting of four species. They are widely distributed in the tropical and sub-tropical mangrove forests of the Pacific and Indian Oceans. Mud crabs from the wild are widely exploited by the seafood industry resulting in rapid depletion of wild stocks.

Worldwide, more than 146,000 tonnes of mud crabs were produced annually from wild catch and aquaculture (FAO, 2008). In Singapore, there is heavy reliance on imports of mud crabs: over 6,000 tonnes of crabs (including mud crabs) were imported in 2012 for local consumption (*Straits Times, 29 January 2013*). The global production of farmed mud crabs has not caught up with demand, being hindered by several challenges, one of which is the long and complex life cycle of the mud crab. It takes approximately 30 days for Z1 larvae to reach C1 crablet stage and another one to two years to attain maturity and market size. Seed productions from hatcheries are nowhere near industrial scale as the percentage survival of seeds rarely exceeds 1%. Therefore the farming industry still depends predominantly on seeds collected from the wild for aquaculture.

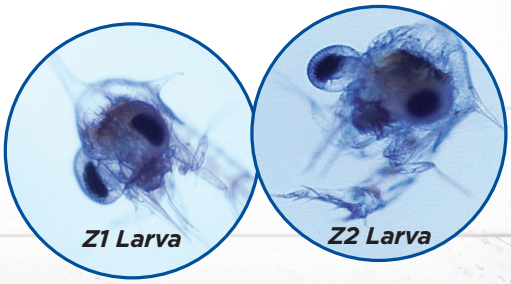
Recognising the demand for quality mud crab seeds for aquaculture and conservation of the species, our aquaculture research team at ASC has been actively working on establishing conditions for spawning of adult mud crabs in captivity as well as rearing conditions of adult and larvae including feed and feeding regimes. So far, spawning has been successfully induced and is reproducible. Larval culture conditions have also been established for three out of four *Scylla* species from eggs to Z5 stage, with significant improved survival rates (> 80% from Z1 to Z3). Research to close the lifecycle of the mud crab is on-going.

Developing egg

Eggs will hatch, releasing Zoea (the mud crab larvae) after 2 weeks



Mud crab Zoea looking very similar between developmental stages



Molecular Approaches to Boost Productivity *in local* Aquaculture

Stephanie Lee Ling Jie, PhD
Research Fellow/Technology Development

The local aquaculture industry currently falls short of the fish production target of 15% set by the Agri-food and Veterinary Authority (AVA), as only 8% of fish consumed in Singapore are farmed locally (AVA Vision, issue 1/2015). The challenges faced by fish farmers in Singapore are scarcity of quality seed stock, exposure to algal bloom and competition from regional players. They also have to deal with the same challenges faced by the global aquaculture industry which include slow growth and low feed conversion efficiency, disease susceptibility, and low environmental and stress tolerance of farmed fish.

Research and development have been identified as key drivers for improving productivity in local aquaculture. Molecular technologies have been used extensively for broodstock development in aquaculture species. Examples include the Atlantic salmon, Atlantic cod, tilapia and oysters. In Singapore, AVA and the Temasek Life Sciences Laboratory have used molecular approaches for broodstock development of the Asian seabass and tilapia. One of the approaches includes genetic improvement of aquaculture species for traits of economic interest. These traits include enhanced growth, better feed conversion efficiency, disease resistance and environmental tolerance. Fish with enhanced growth can reach the market sooner; fish resistant to common fish pathogens and environmental stresses reduce mortality and reliance on prophylactic antibiotics and therapeutics. These benefits translate into lower costs and higher productivity for the local aquaculture industry, a boon to both farmer and consumer.

The tools used for genetic improvement of aquaculture species at ASC are expression profiling of genes linked to traits of economic interest and the identification of quantitative trait loci (QTL). The identification of genes and genetic variants for traits associated with better performance can be incorporated into the development of genetically superior broodstock which can be used in breeding programmes.

Our aquaculture research team, in partnership with Oceanus Group Limited, a major player in the abalone aquaculture industry, currently focuses on the identification of molecular markers associated with growth rate in abalone. This involves screening for molecular markers (RNA, genes, quantitative trait loci and proteins) linked to fast growth in abalone with the overall aim of marker-assisted selection. The technical know-how for screening and validating potential broodstock for breeding performance is one of our research capabilities. We can also provide evidence-based advice regarding the setting up of breeding programmes for the production of better performing offspring.

Culture system

Closed Containment Set-Up

Saving Farmed Fish in Algal Bloom Crisis

Chan Pek Sian Diana, PhD
Assistant Director/Technology Development
Course Manager/Diploma in Veterinary Technology

Since 2009, harmful algal blooms have occurred regularly in the East Johor Straits particularly in the first quarter of 2014 and 2015. This has left an indelible and disastrous impact on about 60% of the 117 coastal and offshore fish farms, resulting in an estimated loss of 600 tonnes of farmed fish in February 2015 alone.

Although there are around 200 species of planktons in the seawater, an algal bloom would occur if the predominant plankton species grows faster than the rest, leading to a rapid and massive buildup of planktons. It is observed that these algal blooms usually occur during drastic changes in water temperature and water quality. Not all algal blooms caused by planktons are harmful to humans but they wreak havoc in the fish respiratory system by clogging up their gills or they release toxins that only affect fish.

With Singapore's growing population and increased dependence on fish as a source of protein, nearly all of the 100,000 tonnes of fish consumed are imported from our neighbouring countries, with only 7-8% produced by the local aquaculture industry. In order to have food security and less reliance on imported food fish, it is important that our local farmers have a mitigating measure for protecting their farmed fish against the algal bloom crisis.

Recognised by the Agri-food and Veterinary Authority (AVA), as well as the aquaculture farms, for our industry-oriented commitment in applied aquaculture research services, Temasek Polytechnic (TP) signed a Memorandum of Understanding with AVA, in May 2015, for development of training programmes for farmers. Together with AVA, our Aquaculture research team with its experience in setting up the canvas containment system for farms, conducted a one day hands-on Farm Contingency Planning (FCP) course for about 70 farms affected by the algal bloom. The team also shared pointers on what farmers could do to prepare themselves pre-, during and post-algal bloom crisis.

Farmers who are interested in building their farm capability, as part of the farm crisis management, can sign up for the FCP course at TP to learn about water quality monitoring and record keeping, fish health monitoring, farm risk assessment, basic good aquaculture practices, and canvas set-up, as well as pre- and post-crisis management.

During the algal bloom of February 2015

Dead foodfish

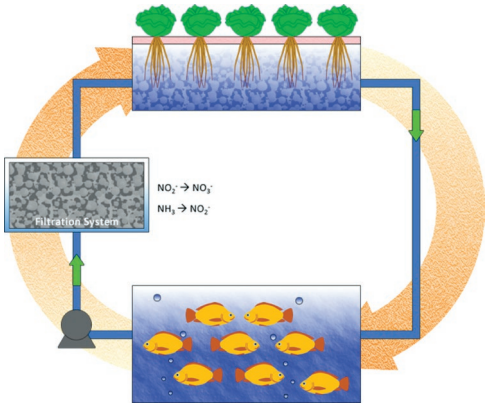
Canvas set-up for temporary holding of foodfish

Checking seawater quality in canvas set-up

Integrated Urban Intensive Farming

Aquaponics

Khin Mar Cho, PhD
Research Scientist/Technology Development



(Source: Aquaponics system sketch diagram by Loh Han Liat)

Agricultural land use in Singapore constitutes a mere 1%, of which 90% of leafy vegetables are grown from soil culture (41 soil culture farms, 3 organic farms, and 6 hydroponic farms). With the local vegetable farms currently supplying 10-12% of the local consumption needs, there is a need to enhance vegetable production for food security, as well as develop intensive and integrated farming systems conducive to urban farming.

Aquaponics is targeted at growing vegetables using recycled spent fish water containing faecal waste and uneaten feed via the recirculating aquaculture system (RAS). Tilapia fish is conventionally used in aquaponics. Water from the fish tank is filtered through physical and biological filtering processes in which nitrosomonas bacteria convert ammonia into nitrite. This is followed by bacterial nitrification where bacteria convert nitrite (NO_2-) into nitrate (NO_3-). The filtered, nutrient–rich water is circulated through the hydroponic growing units. Plant roots serve as a natural biofilter in the aquaponics system where nitrates in the water are taken up by the plants.

Our Technology Development research team is currently working on optimising fish stocking density, water quality and lighting conditions, as well as the optimum hydroponic conditions for growing Chinese leafy vegetables under intensive conditions. Once the conditions have been established for urban farming, there will be an environmentally friendly and sustainable food source of leafy vegetables.

Hydroponics

Mandar Godge, PhD
Research Scientist/Technology Development

Do you know that sweet potato (*Ipomoea batatas L. Lam*) is the sixth most important food crop in the world, and has been selected by NASA as a primary food source to be grown in space?

Cultivation of sweet potato has shown much promise in the area of environmental conservation in urban areas by reducing the urban heat island effect. In 2010, Agri-food and Veterinary Authority of Singapore (AVA) had planned to increase the self-sufficiency level of leafy vegetables to 10% by 2015. However, the local production has plateaued at 8% as of 2014. To meet the shortfall in local production, there is the need to potentially manipulate sweet potato for its nutritional value and disease resistance.

Our Technology Development research team is currently evaluating sweet potato cultivars for hydroponic cultivation. With the regulation of nutrients in the hydroponics culture system, the rate of growth and development was enhanced for all cultivars. We have also established the quantification methodologies of secondary metabolites for sweet potatoes.

Currently, we are exploring the Green Systems Biology approach (CRISPR/Cas system) which will enable us to increase the nutritional value and induce disease resistance in sweet potato, as well as other commercial crops and leafy vegetables.

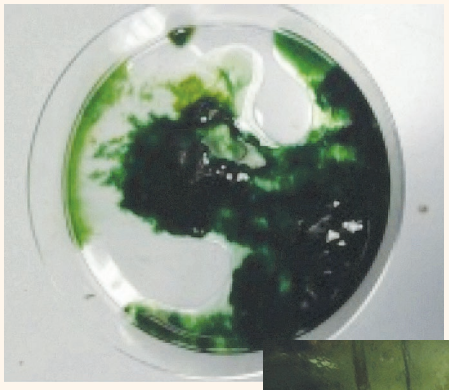
◀ *Slip culture initiation for sweet potato hydroponics*

Sweet potato hydroponics culture system

Supporting Technologies

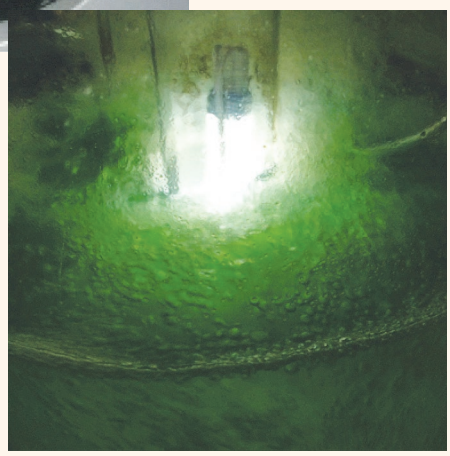
Water Technology

Algal Technology for Sustainable Aquaculture



Algae biomass

Algae bioreactor



Wuang Shy Chyi, PhD
Section Head/Technology Management

Plankton blooms are a recurrent problem worldwide, posing a real challenge for long-term coastal fish farming. Earlier this year, many local fish farms suffered massive fish deaths. To strengthen food security in aquaculture, the Agri-Food and Veterinary Authority of Singapore (AVA) provides assistance to affected fish farmers to recover and restart their operations, as well as enhance their resilience against environmental challenges.

ASC has also been making concerted efforts in finding a complete recirculating aquaculture system (RAS) to support sustainable intensive freshwater aquaculture. One particular innovation is the development of a microalgae system to treat fish wastewater (fish effluent). Algal technology has not been adopted in Singapore, and its application in intensive aquaculture is not widely explored. Due to the complementary requirements between algae growth and fish effluent treatment, algae can act as important bioremediation agents, capable of removing the nitrogen loads and producing biomass at the same time. The design of an integrated system of algae production with fish effluent treatment is a possible actualisation. The feasibility of the system depends on the fish effluent composition and the selected algal species.

Our RAS used Spirulina microalgae (also known as blue-green algae) to treat fish effluent and the results confirmed the capability and efficiency of microalgae in removing ammonia content, which is one of the main concerns about fish effluent. Besides, the accumulated biomass is currently being explored for various uses, including fertilizers, fish feed and biofuel production. Important parameters to assess the technical and economic feasibility of these uses will also be determined.

This work is currently supported by research grants from the Tote Board (Social and Innovation Research Fund) for an algae-based circulatory system for treatment of wastewater from fish farming as well as the National Research Foundation for the development of an intelligible solution for sustainable fish feed supply.

The environmental risks of fish farming

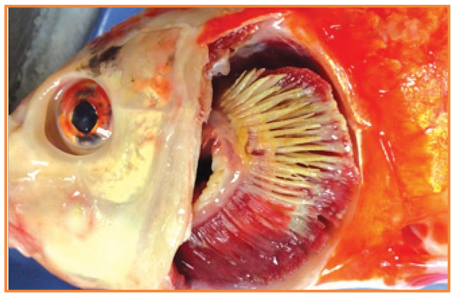
During decomposition,surplus feed and fish faeces reduce oxygen content, and increase ammonia and nutrient concentration in the receiving water, making it necessary to replenish the wastewater (fish effluent); extensive aquaculture uses large amounts of freshwater. Treatment of the water with chemicals such as chlorine and disinfectants may have undesirable effects on the water and fishes.

Such an integrated system using algal technology is expected to greatly reduce the water consumption of freshwater aquaculture as well as the energy cost per unit of fish effluent, thereby "greening" a sustainable aquaculture. The accumulated biomass is also expected to attract revenue to boost the profitability of aquaculture.

Biological Testing

Detection and Diagnosis of Aquatic Pathogens

Jomer Bo Lucanas, DVM
Section Head/Diploma in Veterinary Technology

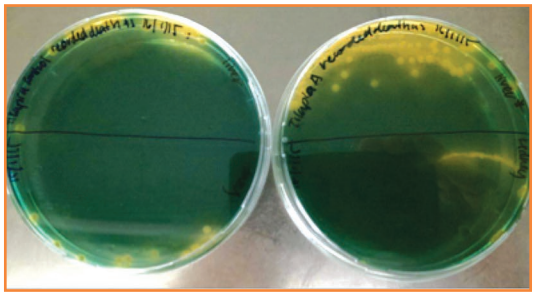


A. Diseased fish showing white (necrosis) gill and sunken eye

B. Microscopic examination

C. Gross lesion of fish with lump

Aquatic species such as fish and shrimps, just like humans, succumb to illnesses for a variety of reasons. These include drastic changes in living conditions, overcrowding, host-to-host transmission, as well as ingestion of diseased preys. Imported fish fry could also fall prey to opportunistic pathogens if they suffer from lesions due to poor handling and transportation.



D. Bacterial culture of *Vibrio*

With the nation's move towards intensive farming to enhance production for local consumption, fish and aquatic consumable species would probably be subjected to unnatural living conditions, such as high-stocking density in a smaller footprint. This could invariably lead to stress build-up in fish, which in turn results in illnesses and increased susceptibility to pathogen infection.

Currently, infected fish and crustaceans from farms and animal parks are sent to the animal health testing laboratories at the Agri-Food & Veterinary Authority (AVA) or other local and overseas diagnostic testing laboratories. At ASC, our Veterinary Technology (VeT) team has been working closely with farmers, AVA, research institutes, hospitals, Wildlife Reserves Singapore (WRS) and biotechnology companies in areas of aquatic and animal disease diagnosis. Our VeT team is a multidisciplinary team comprising molecular biologists, veterinarians, microbiologists, biological testing technologists and histology technicians.

In the pipeline are plans to further strengthen our veterinary and aquaculture diagnostic capabilities in research, training and testing services for both the aquaculture and veterinary industries.

The in-house laboratories at ASC are equipped to perform a myriad of common testing procedures such as:

- *faecal analysis*
- *urinalysis*
- *blood chemistry*
- *haematology*
- *immunology*
- *blood cortisol*
- *rapid antigen and antibody test kits*
- *necropsy*
- *histological processing*
- *microscopy*

Chemical Testing

Instrument-Based Analytical Science for Water and Food Safety

Matthew Kong, PhD
Section Head/Capability Development

Fish is an important source of protein for human beings, and is becoming increasingly popular as a healthier alternative to meat. In order to ensure that fish and related products are fit for human consumption, scientific analysis must be well integrated with the production processes of these products.

Capabilities of Analytical Science at ASC have grown significantly since 2013. Beginning with instruments capable of performing Gas Chromatography (GC) and High Performance Liquid Chromatography (HPLC) for analysis of simple organic compounds, the laboratories have gradually expanded their capacity to include more sophisticated instruments such as a Liquid Chromatography Time of Flight Mass Spectrometer (LC-TOF) and a Liquid Chromatography Triple Quadrupole Mass Spectrometer (LC-QQQ). These instruments provide increased sensitivity for trace-level analyses in complex matrices.

The most recent addition to the Agilent Partner Laboratory at Temasek Polytechnic is an Inductively-Coupled Plasma Mass Spectrometer (ICP-MS), which is used for the detection of inorganic elements (metals) at extremely low levels. This is particularly useful and applicable in the field of aquaculture, as trace-level heavy metal contaminants are common in water and fish products. ICP-MS is a highly sought after analytical technique that is used to ensure that such contaminants are maintained at an acceptable level throughout the production process.

Trial analyses of inorganic elements including zinc, manganese, copper and selenium have been conducted in aqueous matrices at extremely low levels. The state-of-the-art ICP-MS instrument offers extremely high sensitivity, allowing researchers to determine the quantities of these commonly occurring contaminants in water. This technique can also be applied to food testing. For example, batch testing of fish products can also be performed to ensure the safety of these food products.

Greater consumer awareness in this age of technology means that regulatory standards of food products are under increased scrutiny. As such, the development of more accurate, sensitive, and robust analytical techniques is critical to ensuring that products pose no health risks to consumers.

At ASC, the availability of sophisticated instrumentation, advanced scientific methods, and the requisite expertise ensures that Analytical Science can continue to support research and development over a range of fields including aquaculture.

Developing In-House Analytical Science Capabilities for Aquaculture Research

Matthew Kong, PhD
Section Head/Capability Development

As the number of projects in research areas such as aquaculture has increased significantly in recent years, the use of analytical science to enable and drive evidence-based research has become increasingly important. At ASC, the Analytical Science team is dedicated to providing access to equipment and technical expertise in order to facilitate the development of novel products and value-adding processes.

In 2015, the Aquaculture research team collaborated with the Analytical Science team in the analysis of fatty acids in enriched live feed. Currently, commercially available live feed for fish typically has high protein content but does not contain sufficient amounts of fatty acids that are known to increase the growth rates of fish fry and boost the immune systems of fish. The development of enriched live feed will therefore improve the survivability of fish and reap economic benefits for enterprises in the aquaculture industry. For the fatty acid analysis, High Performance Liquid Chromatography (HPLC) was used to identify and quantify more than 30 different fatty acids in each sample, with particular focus on Docosahexaenoic Acid (DHA) and Highly Unsaturated Fatty Acids (HUFA). This allowed the Aquaculture research team to evaluate and compare the nutritional values of several live feeds established.

Conventionally, research projects that require analytical services may involve the engagement of external testing laboratories. However, there are distinct advantages to engaging in-house analytical services offered by the Analytical Science team. One key advantage is that project-specific method development can be carried out to specifically cater to the needs of the research team. With a clear understanding of the research goals, the Analytical Science team can leverage on their expertise to suggest improvements to the analytical process and improve the quality of data obtained. Although routine testing services may be offered by external testing laboratories at a relatively low cost, non-routine analyses such as the development of novel testing methods may not be readily available.

As with the project involving live feed enrichment, collaborations between different teams at ASC also provide good opportunities for staff and student training. The knowledge and technical skills gained from developing these analytical test methods can be transferred to staff, enabling them to carry out further analytical tests in the future. Relevant analytical methods can also be channelled into the teaching curriculum in the form of student projects and practical lessons. This ensures that the curricula used across diploma courses at ASC remain highly relevant and applicable to the industry.

Shrimp Shells for First Aid

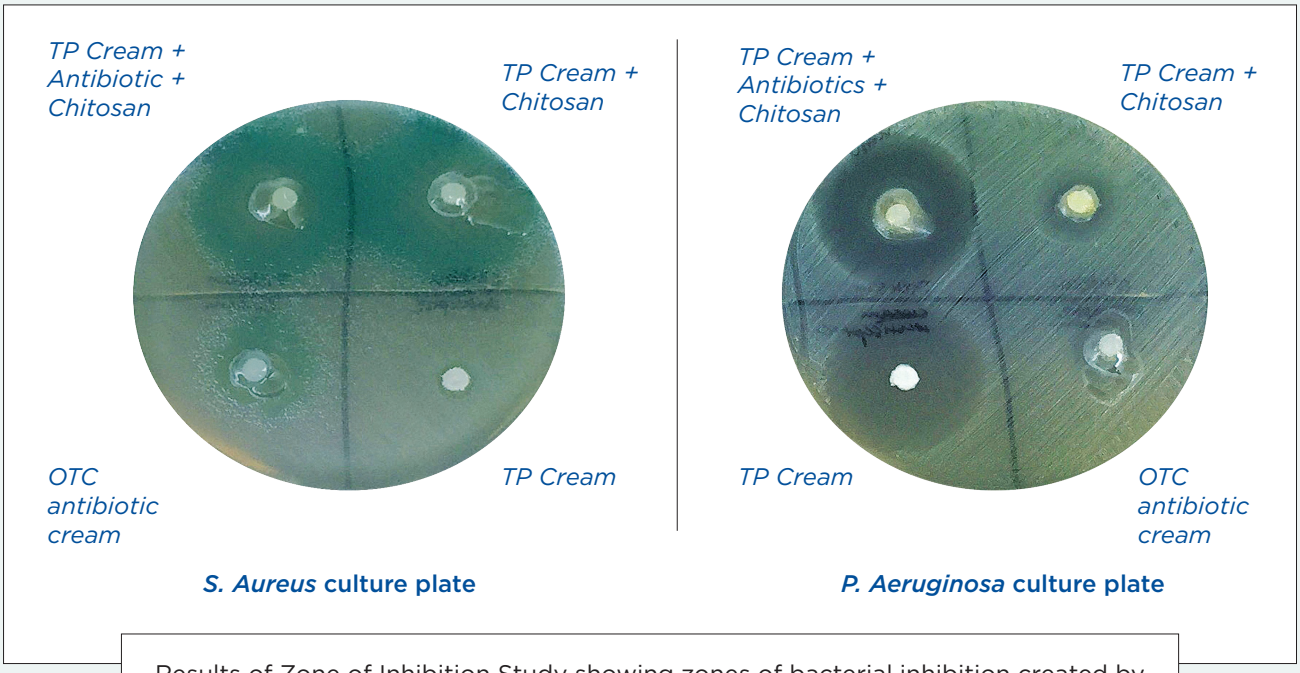
Lim Tse Loong Wallace
Course Manager, Diploma in Pharmaceutical Science
Section Head/Nanotechnology, Technology Management

The exoskeleton of shellfish is primarily made up of ***chitin***, which is considered aquatic waste. Through a simple deacetylation process, *chitin* can be used to manufacture ***chitosan***, a very useful bioactive polymer. A key attractive property of *chitosan* is its haemostatic ability (the ability to stop bleeding). Furthermore, it has been found that *chitosan* has some, albeit limited, antibacterial property.

At ASC, we have developed a haemostatic cream (named TP Cream, after our polytechnic) by incorporating *chitosan*. We have enhanced its antibacterial properties by formulating other actives into our product. Through months of testing, our formulation team has successfully developed a stable aqueous base cream with good texture, and which is pleasing to the eye.

More importantly, analytical tests have shown that the cream reacts with blood to form a gel-like material and thus aids in blood clotting. The results of the Zone of Inhibition Study also show that our cream has better antibacterial properties than any common over-the-counter (OTC) antibiotic cream, and that *chitosan* is bactericidal against *P. Aeruginosa*. However, the cream has limited efficacy and is not effective against a wide range of bacteria . Thus it is necessary to incorporate other actives. Currently, we are starting preclinical efficacy and biocompatibility testing.

We believe we have successfully utilised a readily available, inexpensive waste material from shellfish to create a very effective and invaluable product for biomedical application. We hope that our TP Cream will be stocked as an essential wound dressing item in all first-aid kits, everywhere.



Results of Zone of Inhibition Study showing zones of bacterial inhibition created by antibacterial capabilities of various formulations against *S. Aureus* and *P. Aeruginosa.*

Journey of the Soft Shell Crab from Sensory Evaluation to Recipe Development

Petrina Lim*/Course Manager, Diploma in Baking & Culinary Science*
Mabel Wang Rong, PhD*/Section Head/Food Research & Applications*

Sensory science is both an art and a science. Techniques in sensory evaluation are applied in R & D, quality control and product development. Any food with sensory characteristics perceived by human senses can be measured with the use of carefully designed questionnaires and sensory test techniques. The data obtained can be integrated to provide an insight into the product's sensory quality, to better understand consumers' tastes and preferences. This helps in product development and increases product success in the competitive market.

Acceptability testing of food is usually carried out among human subjects. Though human tasters are prone to biasness with their personal preferences, these variables can be minimised through use of equipment to ensure that the data are representative and valid. However, such data are single-dimensional, whilst the range of human senses is multi-dimensional. For a more meaningful interpretation, it is therefore necessary to correlate the equipment measures of sensory quality with the results from the human experience.

At ASC, our research team comprising food scientists and technologists have conducted evaluation studies on food textures using objective measures and correlated these results to the human senses for a range of foods. We worked alongside a team of culinary experts in baking, and Asian and Western cuisines, and translated this information into the development of recipes and food products. This unique joint expertise allows us to obtain optimal results in the food prototype or end product suited for both the F & B and food industries.

In a recent project sponsored by Apollo Aquaculture Group Pte Ltd which provided us with locally farmed soft shell crabs, our research team first determined consumer acceptability and preference of the crab's sensory quality. Our culinary team then followed up by developing innovative recipes using the soft shell crabs. These dishes include the Lemon Thyme Soft Shell Crab Pie, Soft Shell Crab Rolls with Thai Sweet Sauce and Soft Shell Crab Onion Rings with Tartare Sauce. The prototype products were then put through a focus group of expert panellists to evaluate their marketability and acceptability.

However, beyond these areas of consultancy, the food science and culinary teams are also experienced in evaluating and improving production processes for scale-up, thereby increasing efficiency and productivity. We are also able to complete the product development stages with the provision of food safety and HACCP consultancy, microbiological testing services for product quality and the environment.

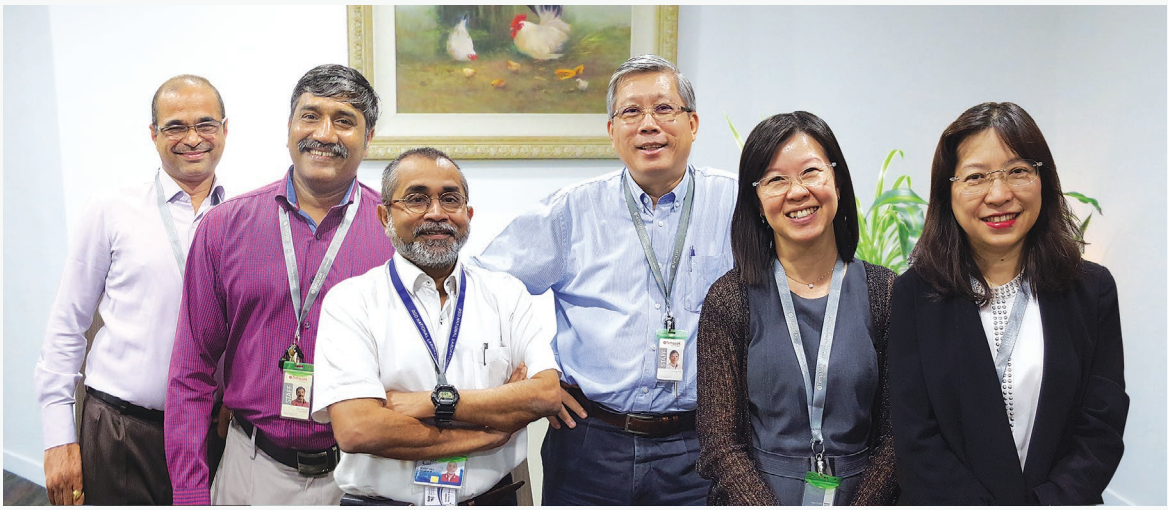
*Developing the new **Lemon Thyme Soft Shell Crab Pie** recipe*






Surge Research & Education

Goh Lay Beng, PhD
Deputy Director/
Enterprise Development
SuRE Pioneer Team



"Surge" is a mindset – staying updated always (just like our smart phone apps), ready to act and trained to mitigate in times of emergency.

At ASC, we initiated the Surge Research & Education (SuRE) Programme in 2014 to inculcate the surge mindset throughout the school. Under this programme, road maps have been set up to build capabilities in rapid detection of veterinary pathogens. Staff and students are also being trained to respond swiftly to threats coming through veterinary sources. The aim is to have a ready and deployable team, to help in environmental surveillance, and be able to support diagnostics, identification and mitigation of a biological threat when an emergency arises. We are in the midst of strengthening our capability, and working with established surge organisations, local and overseas, to acquire protocols and methods.

With the plankton blooms that resulted in massive fish deaths in February 2015, ASC's Technology Development team has started conducting workshops in conjunction with AVA, to prepare the local aquaculture industry in farm contingency planning (FCP). ASC has also recently signed an MOU with the Center for Environment, Fishery and Aquaculture Science from United Kingdom to conduct joint research and diagnostic testing for aquatic health monitoring and management.

Other partners under the SuRE Programme include Wildlife Reserves Singapore (WRS) and MSD Animal Health Innovation Pte Ltd. For both partnerships, ASC is involved in detecting the presence of pathogens in samples of both foodfish and exotic animal species. We are also partnering DSO Laboratories (DSO) and A*STAR Biopolis Shared Services (BSF) for research and analytical support.

With the intent of inculcating in public officers a holistic perspective of responding to public health issues, ASC in working closely with AVA, MOH and NEA, is offering a 1-year Specialist Diploma in One Health due to commence in October 2015. This will enable their officials to learn from each other, foster closer working relationships, and respond swiftly in a concerted effort on public health issues.

"Surge" is a mindset, and the ground is set for us to exercise it and sharpen our acumen for it. We welcome you to join us, and be surge-ready!

For more information, please contact the pioneer SuRE Team. Thank you.

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BioEnterprise

Goh Lay Beng, PhD
Deputy Director/Enterprise Development

Ever wondered what constitutes a biobusiness or bioenterprise? Some regard bioenterprise as a business designed to support and grow the healthcare industry, as well as to commercialise technologies in the bioscience space. However, bioenterprise is not confined to only life science companies. They can include engineering and information technology companies, even those specialising in telecommunications.

In a 2013 listing of the top 10 most innovative companies in the global healthcare industry, there was one that had designed bar coding for drug authenticity verification, while another provided a 24-hour doctor's hotline in an underdeveloped country. There was yet another that had created a pill-reminder app. Really, imagination is the limit ...

At ASC, we have taken the concept of bioenterprise a step further. Our vision of bioenterprise is to be a solution centre to support healthcare, wellness and sustainable living – aspects of Good Quality of Life! We have created a range of solutions for people and animals, as well as solutions to address environmental woes such as wastes. The school has also spearheaded the modular integration of technologies to create products and services in the bioenterprise space.

The opportunity to further our knowledge through research has enriched our scientific community as well as the industry, creating innovative projects that engage our students in the forefront of applied science.

In preparation for internship at bioenterprises, the school will be offering a new elective cluster, BioEnterprise, to final year students, with effect from 2016. It comprises subjects such as:

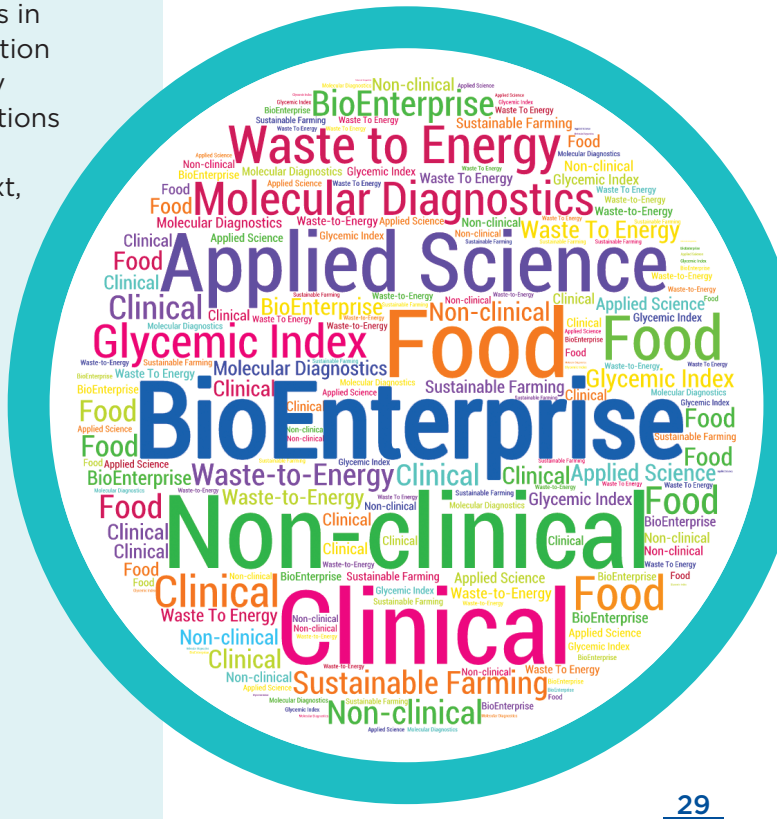
- BioEnterprise Communications
- Contemporary Issues in BioEnterprise Operation
- Life Science Industry Funding and Regulations

What will we think of next, in grooming students to be innovative, relevant, and ready to embrace challenges? Really, imagination is the limit ...

> *"Really, imagination is the limit ...*

To date, ASC has received government and industry funding to support research in many areas such as:

- clinical and non-clinical molecular diagnostics
- food and ingredient analyses
- traditional medicine analyses
- glycemic index
- waste conversion
- sustainable farming



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