ASCIENTIA

GLYCEMIC INDEX

Why We Should Care

2014

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Our Director's Message

In today's rapidly changing global economic climate, Small and Medium Enterprises (SMEs) face significant challenges in terms of limited resources. Having to thinly spread resources over all the steps of the production process – from idea conceptualisation to product validation to product commercialisation – can be draining and have a negative effect on the enterprise.

This can be addressed by having SMEs collaborate with Institutes of Higher Learning (IHLs) that offer industry-specific innovative solutions, thereby retaining a durable competitive advantage over industrial competitors. In line with our national agenda, SMEs will then be able to leverage on established technologies and resources at IHLs and gain access to additional resources offered by SPRING Singapore, resulting in an improvement to the quality and reputation of local products.

The School of Applied Science at Temasek Polytechnic (TP) has significantly increased both the scope and depth of its capabilities, as demonstrated by obtaining laboratory accreditation in several key areas and the establishment of the Agilent Partner Laboratory at TP. It is our penultimate goal to establish mutually beneficial collaborations with SMEs across a range of industries. This is an effort to simultaneously improve the quality of products and services offered by SMEs, provide expertise training for staff of the SMEs, and help our staff retain industrial relevance.

Based on a core set of technical competencies, we seek to integrate various areas of expertise and work with SMEs in a cohesive manner to help them achieve their goals. This will ensure that the products and services offered by these SMEs will be of higher quality and value.

I believe that the School of Applied Science at Temasek Polytechnic is not only well-aligned to the goals of SMEs in Singapore, but more importantly, we possess the knowledge and capabilities required to help SMEs achieve these goals. I hope that the research articles featured in this publication will provide a better understanding of the scientific capabilities offered here at the School of Applied Science, and how we can help bring your enterprise to the next level and beyond.

Dr. Lee Chee Wee
Director
School of Applied Science

About Our Distinguished Advisor & Nutrition Consultant

Dr. Thomas Wolever MD, PhD, DM (Oxford) is President of Glycemic Index Laboratories Inc., a premier facility for testing the metabolic responses to foods and ingredients.

Dr. Wolever obtained a Bachelor of Medicine and Bachelor of Surgery from Oxford University, UK in 1980. He earned his PhD in Nutritional Sciences from the University of Toronto in 1986 and a Doctorate in Medicine from Oxford University in 1993.

His research interests are the effects of dietary carbohydrates on human physiology and metabolism. He is well known for his work on the glycemic index (GI) which was first developed by him and Dr. David Jenkins with other collaborators while he was a medical student.

Dr. Wolever's research expertise includes: the assessment of dietary intakes, especially of dietary fibre, glycemic index and glycemic load; metabolic assessment of human subjects, especially postprandial responses, insulin secretion, insulin sensitivity and colonic fermentation; determination of the glycemic index of foods; and clinical trials. He has extensive experience coordinating central laboratory facilities and organising international laboratory cross-validation programmes and multi-centre clinical trials.

Dr. Wolever founded Glycemic Index Testing, Inc. in 1997 to provide confidential research services of high scientific quality to industry in order to educate them about GI, promote the use of the GI and help develop low GI food products. In order to provide an expanded range of research services and cope with increased demand, Dr. Wolever partnered with Dr. Alexandra Jenkins and Dr. Vladimir Vuksan to form GI Labs in 2004.

Dr. Wolever has authored or co-authored over 280 peer-reviewed publications and over 50 book chapters and review articles. He is also the author of a scientific book entitled The Glycemic Index: A Physiological Classification of Dietary Carbohydrate published in 2006 by CABI.

Is GI a Valid Marker of Carbohydrate Quality?

By **Dr. Thomas MS Wolever**

Recently Health Canada joined other critics of the glycemic index (GI) by publishing its opinion that including GI on the food label would be misleading and not add value to nutrition labeling or dietary guidelines to help consumers make healthier food choices. Health Canada does not accept GI as a marker of carbohydrate quality on the following grounds: GI methodology is inaccurate and is too imprecise for labeling purposes, GI does not predict glycemic responses and GI does not predict what foods are healthy. This sounds like very bad news for nutrition professionals who believe GI is useful and want to teach people how to use the GI concept in diet planning and also for those in the food industry who are trying to develop and market healthy low GI foods.

Dr. Wolever with a teaching award he received recently.

However, those in favour of GI should not despair because none of the critics have been able to provide sound reasons for rejecting GI; some of their arguments are based on flagrant errors in understanding and interpretation, some are illogical and others are not supported by current data or are inconsistent with other nutritional recommendations. GI is valid for these reasons: GI methodology is accurate and precise enough for practical use, GI is a property of foods, and GI is biologically meaningful and relevant to virtually everyone.

Current dietary guidelines about carbohydrates, at least in North America, do not mention GI, but recommend reducing consumption of added sugars and increasing consumption of whole grains and dietary fibre.

Public demand for information about the added sugar content of foods is driven by sensational and often grossly inaccurate stories in the media about the harms of sugar. The scientific rationale for reducing intake of added sugars is that they cause weight gain and are empty calories. However, current evidence suggests that the weight gain caused by consuming sugar-sweetened beverages is due to excess energy consumption rather than a harmful effect of sugar or fructose per se. In addition, many foods containing added sugars are nutrient dense, and data from North America and Europe suggest that, compared to those with an average intake of sugar, the intake of key nutrients is lower not only in those with very high intakes, but also in those with very low intake of sugars. Since the GI of sucrose is less than that of refined starches, replacing sugar in foods with starch may increase diet GI. I am not suggesting that added sugars are healthy. However, sugar can make healthy foods more palatable and undue avoidance of added sugars may do more harm than good.

I agree with the recommendation to increase consumption of whole grains and dietary fibre. However, it seems illogical to recommend these without recommending low GI because the evidence that low GI diets improve health outcomes is at least as good as or better than that for whole grains and fibre.

GI is a novel concept from a regulatory point of view and a number of problems will have to be addressed to successfully translate GI knowledge into practice. The problems are not insurmountable but no progress can be made until bias and misunderstanding about GI can be overcome and there is better agreement about what is the actual state of knowledge on GI so that the real issues can be identified and addressed.

Your GI Guide to Eating Well

Glycemic Index Research Unit

Temasek Polytechnic set up the Glycemic Index Research Unit (GIRU) to conduct GI testing and research of single foods and meals. GIRU has received the accreditation for testing from the Singapore Accreditation Council (SAC), a first in Singapore and the region.

The research team at GIRU has made significant developments in the research area of low GI food products. In addition to offering highly consistent and reproducible GI analyses in our accredited laboratory, the development of functional food products at TP has expanded beyond single food products to full-fledged meals that are classified as low GI. This scaling up of functional food research has also led to the development of low GI foods ranging from staple carbohydrates, to desserts, and even to baked pastries. Currently, the GIRU here at the School of Applied Science is also conducting innovative research into how functional ingredients can be incorporated to benefit people in general.

What is “GI” and Why Should I Care?

Glycemic Index (GI) is a useful tool to help us choose the **right type of carbohydrates** that will benefit our health.

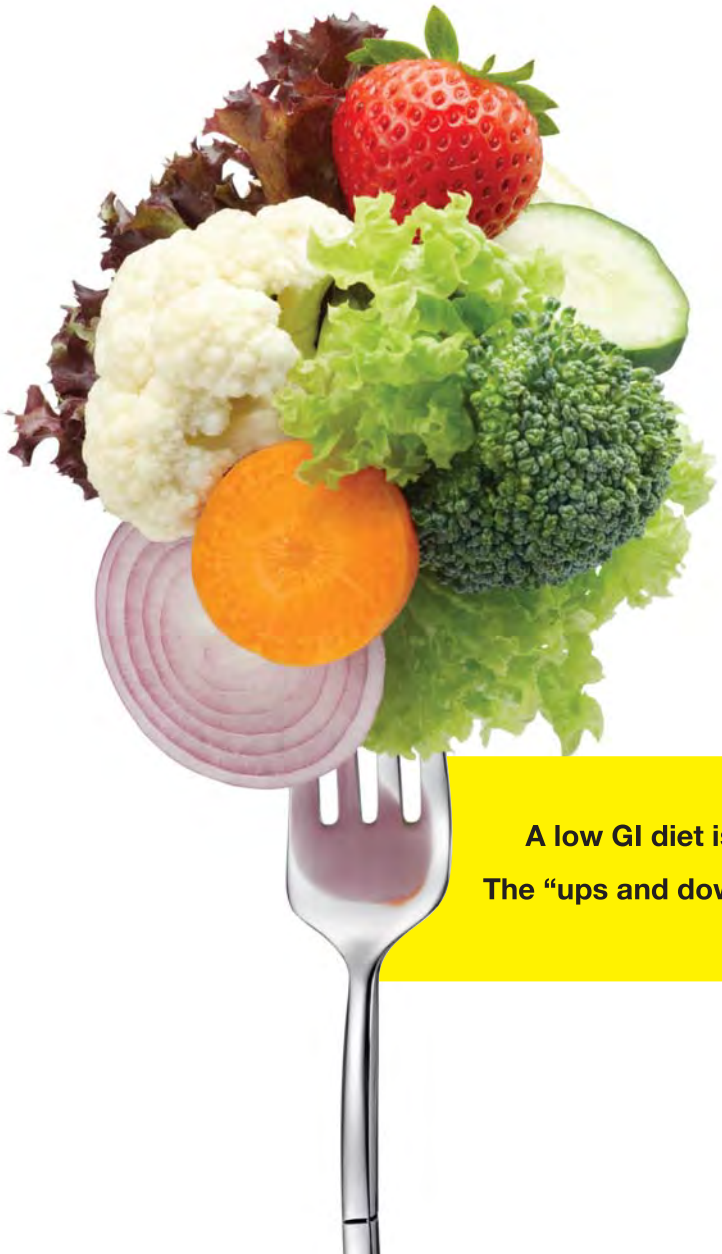
GI is a ranking of carbohydrate foods from **0 to 100** based on how quickly they raise our blood sugar levels.

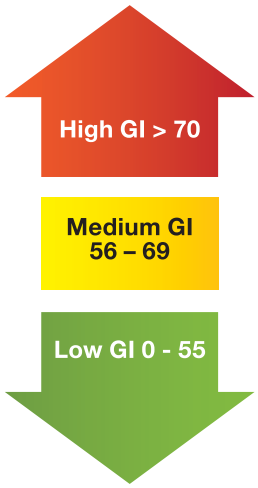
By **Kalpana Bhaskaran** Manager / Nutrition Research (Diploma in Applied Food Science & Nutrition)

Foods are classified as **low, medium or high** GI based on their individual GI value.

High GI foods are rapidly digested and absorbed causing a quick rise in blood sugar levels.

Low GI foods are slowly digested and absorbed causing a lower and more gradual rise in blood sugar levels.





BENEFITS OF A LOW GI DIET

- Improves blood glucose control
- Prevents & manages diabetes
- Increases the feeling of fullness
- Helps control food intake
- Facilitates weight loss
- Reduces blood cholesterol level
- Improves sport performance
- Improves sport endurance
- Reduces risk of heart diseases
- Reduces risk of certain cancers
- Improves acne

A low GI diet is the best way to make healthier food choices!

The “ups and downs” in blood sugar levels affect health adversely!

SWITCH TO LOW GI ALTERNATIVES

Most of our carbohydrates come from rice, noodles, breads, cereals and potatoes. Choose low GI foods where possible at every meal. Here's your guide:

Low GI Foods

Basmati rice (parboiled or brown)
Multigrain bread
Sourdough bread
Rolled oats
Bran
Wholegrain cereals
Unpolished rice
Tanghoon
Rice vermicelli
Soybean & other bean varieties
Most fruits & vegetables
Most beans & legumes

Medium GI Foods

Basmati rice
Brown rice
Laksa noodles
White pita bread
Chappati
Pineapple
Banana

High GI Foods

Thai Jasmine rice
Short grain rice
White bread
Cornflakes
Wheat flakes
Yellow noodles
Mashed potato
Dried dates
Pumpkin
Watermelon

WEIGHT CONTROL & SPORT PERFORMANCE

A low GI diet is advantageous for people trying to lose weight. When it comes to weight loss maintenance, healthy low GI diets work with the body's changing metabolism to stabilise blood sugar levels and appetite hormones and increase the feeling of fullness.

A low GI diet is good before a race or strenuous exercise while high GI foods will be good during and after such activities. Athletes who ate a low GI diet 24 hours following prolonged running increased their endurance capacity the next day.

TIPS ON HEALTHY EATING WITH LOW GI

Eat two or more servings of fruits and vegetables every day

Include more beans and legumes such as soybeans and chickpeas in your diet.

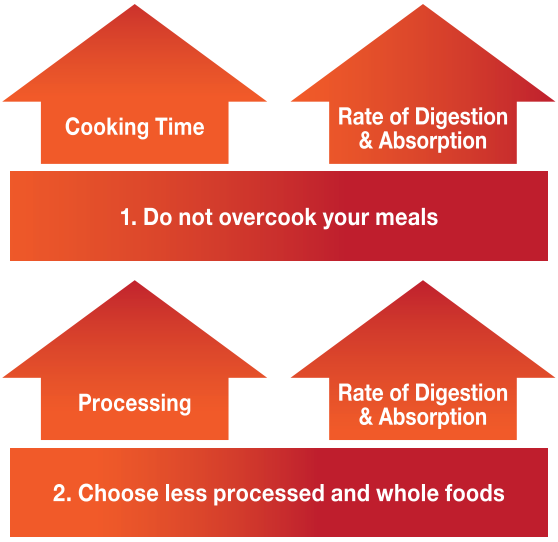
Substitute your high GI breads, rice, and cereals with low GI varieties.

Consume less processed food. Use rolled oats instead of instant oats.

Include at least one low GI food in every meal.

Consume lower GI staple such as wholegrain cereals (e.g. brown rice & barley)

WHAT INCREASES THE GI OF FOODS



- **The GI value is never meant to be the sole determinant when choosing foods!**
- **Pay more attention to the overall nutritional quality & quantity of the foods.**
- **You need not exclude all high GI foods from your diet.**
- **Instead, include more low GI foods.**

You need not exclude all high GI foods from your diet. Instead include a greater proportion of low GI foods.

Serving Singapore's First **Low Glycemic Index Meal**

By **Petrina Lim**
Course Manager / Diploma in Baking & Culinary Science

Having the nation eat healthily is tough; tougher still is encouraging the young, particularly teenagers, to make healthier food choices when dining out. The prime objectives of the Bistro Walk training café were to offer healthier menu choices and create awareness that eating healthily may not always mean compromising on flavour. With the mounting media attention on the health benefits of eating foods with low glycemic index (GI), Temasek Polytechnic (TP) seized this unique opportunity to create and launch its own low GI meals on campus.

Serving healthier meals would be meaningless without the nutrition education support that follows it. As such, the teams from both the Diploma in Baking & Culinary Science (BCS) and the Centre for Applied Nutrition Services (CANS) collaborated to simultaneously initiate a set meal promotion and print education materials on 'low GI and its benefits' to create awareness at the café site.

When developing the low GI recipes, the culinary team had to consider the food trends of teens, followed by working on the carbohydrates of the meal, particularly the quality of the starches. With the ultimate goal of a low GI meal, the team had to select and incorporate certain whole grains whilst ensuring that the right balance was achieved between texture and flavour. Rounds of sensory tests were conducted among the chefs and target audience to evaluate the acceptability of each baked rice meal in terms of their texture and flavour. Finally, four dishes were shortlisted: fish baked rice, sausage baked rice, vegetarian baked rice and chicken baked rice. These baked rice meals were then prepared and put through an in-vivo Glycemic Index testing protocol among some healthy subjects to determine the Glycemic Index (GI) of each meal.

All four baked rice meals indicated GI values of less than 55, thus categorising the meals in the low GI range. With these results, the meals were included in TP's Bistro Walk training café menu in January 2014. To complete the meal, the café launched a set meal promotion where customers could have a serving of low GI baked rice and a low GI beverage. Making these healthier meals more affordable, the set meal was specially priced as a buddy meal. This launch makes the café the first F&B outlet in Singapore to serve a complete low GI meal.

Since its launch in January 2014, the meals have received very positive feedback and are amongst the most popular items on the menu despite containing at least 30% whole grains.

Formulation of Functional and Healthier Noodles with Extended Shelf Life

By **Dr Mabel Wang Rong**
Section Head / Food Research and Applications
(Diploma in Applied Food Science & Nutrition)

In an increasingly developed world where information can easily be transmitted and received, consumers of food products are becoming more aware of the quality and nutritional value of the food products that they are choosing from. Consequently, consumers are constantly demanding more from their functional food products, and an example of this is the demand for functional foods with extended shelf life.

At the School of Applied Science, researchers from the Glycemic Index Research Unit (GIRU) have undertaken a project to formulate healthier, functional noodles that possess an extended product shelf life while still maintaining its "healthier choice" characteristics. Furthermore, this research project seeks to ensure that the taste and quality of the noodles will be attractive to consumers. The development of functional foods not only impacts consumers who are health-conscious, but also extends to consumers who can greatly benefit from functional foods due to diet-related diseases.

Although many research groups are also involved in the development of functional food products, a typical approach merely involves the incorporation of larger quantities or more varieties of functional ingredients into foods. As such, research into other practical aspects such as the shelf life has been very limited. When considering the shelf life of functional food products, processing conditions at every stage of the production process play a very important role in the quality and stability of the product. During the course of this project, researchers carefully modified the processing parameters and packaging conditions, while monitoring the impact that these modifications had on the shelf life and taste of the product. By carefully optimising the processing conditions, they were able to determine the combination of parameters that would yield a product of the highest quality. To date, laboratory prototypes of these healthier noodles have been developed, with preliminary studies conducted on them to ensure that all the required characteristics were retained.

Moving forward, the research team is working towards translating the laboratory prototypes to a commercial production line. In addition, a thorough shelf-life test can be performed on the scaled-up noodle products to ensure that the products consistently possess an extended shelf life.

This research area is of particular interest to SMEs in Singapore that are keen to export their food products overseas. If the functionality, nutritional value, and taste of these food products can be retained while increasing their shelf life, it will allow SMEs the opportunity to expand into markets beyond Singapore and South-East Asia. Also, this enabling technology is not limited to just noodles, and may benefit consumers all over the globe when applied to a much larger variety of food products in the future.

Aquaculture & Medical Technology Research

at Temasek Polytechnic

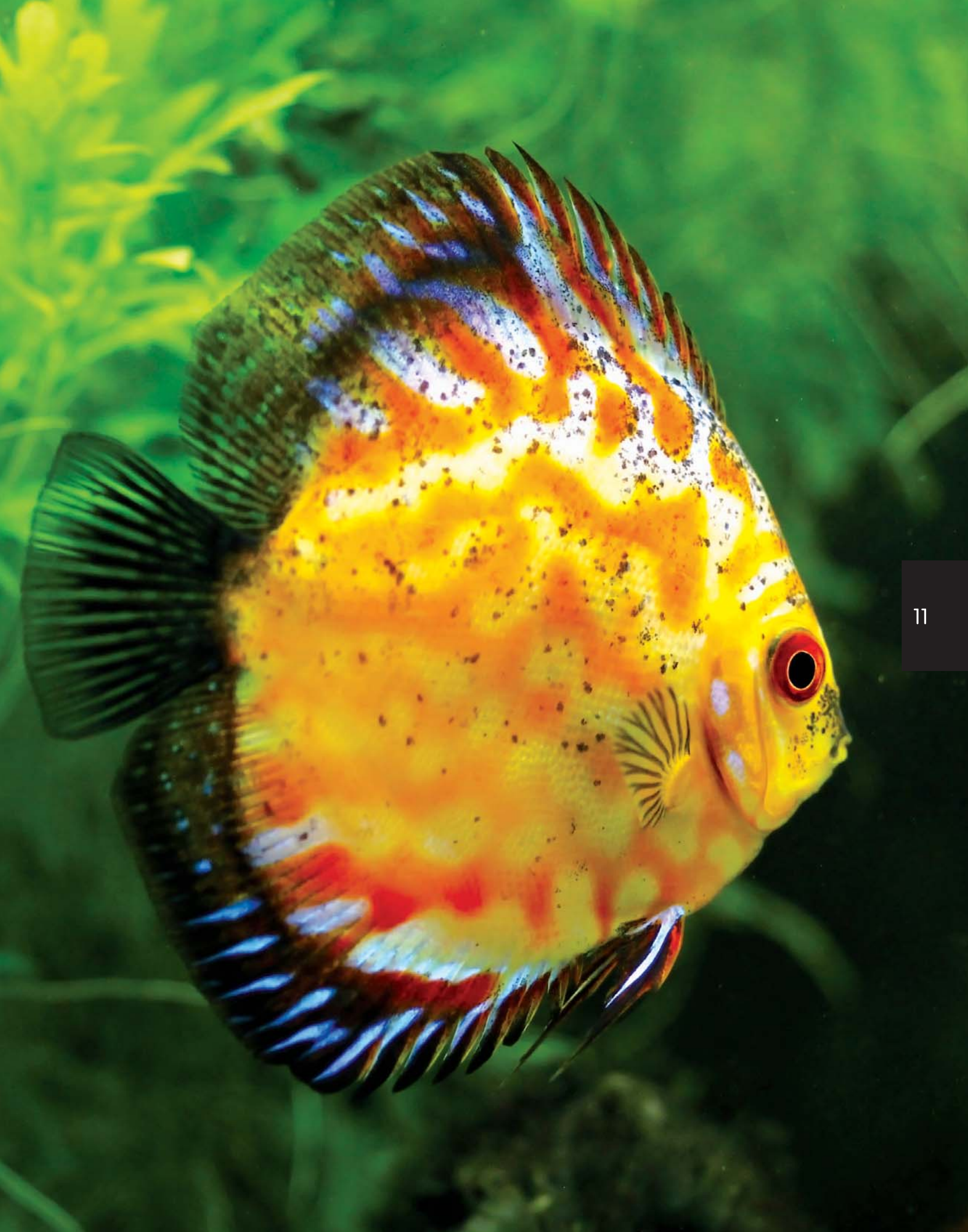
by **Dr Chan Pek Sian, Diana**
Assistant Director / Technology Development
Course Manager / Diploma in Veterinary Technology

AVA aims to enhance productivity of local marine fish farms so that there is a sufficient supply of foodfish for local consumption. Singapore is also the leading ornamental fish import/export country with many of the farms developing new varieties through breeding. In order to be more productive and competitive, local fish farms are now receptive to using science and technology in their production and farming practices.

At the School of Applied Science, research in this area of aquaculture is primarily focused on improving the nutrition and overall quality of the fishes at these farms. To achieve this, an in-depth study into the optimisation of growth conditions for live feed is being carried out at TP. By improving the quality and sustainability of live feed provided to the fishes at these farms, researchers not only expect to improve the nutrition levels of fishes, but also to improve the appearance of ornamental fishes. In addition, researchers are investigating the physiological effects of adding different supplements and additives into the live feed provided to these fishes. Results from this work will determine the types of supplements that have the highest efficacy, and afford maximum retention in fish larvae.

The School considers this area of research important because appropriate and proper nutrition is the key to the overall success for the cultivation of any aquatic species. Success is determined by factors such as optimum growth and development from fry to adult, good broodstock quality and reproductive performance, as well as the ability to tolerate environmental stress. Novel feed supplements could also enhance the digestibility of feeds for better nutrient assimilation into the fish body, potentially resulting in more attractive colour pigmentations. This area of research is also attractive for us as there is no local production and supply of quality live feed for the foodfish and ornamental fish trades in Singapore.

Research in this area of quality live feed is highly beneficial to SMEs in the aquaculture industry as advances could result in fishes taking a shorter time to grow and develop, increasing the efficiency and productivity of these fish farms. Also, costs to the SMEs can be potentially reduced if higher quality feed results in better feed assimilation in fish or in better fish survival rates if the fishes are less prone to diseases due to better nutrition. Developments in this area of research can lead to SMEs being able to take advantage of consultancy services or research collaborations with Temasek Polytechnic in order to improve the overall quality of their products.



Herbal Therapy to Enhance the Immune System of Fish

by **Dr Lim Choon Kwang**
Research Scientist / Technology Development

In modern aquaculture practices, outbreaks of diseases caused by a variety of parasitic organisms, bacteria, or viruses have the potential to destroy a significant portion of fish cultures, leading to severe economic losses for companies. In South-East Asia, the Asian Sea Bass is a commonly cultured species of fish, and is primarily used as a food source. Unfortunately, severe outbreaks of Vibriosis remain one of the major problems that fish farms in South-East Asia face. Vibriosis is one of the most prevalent fish diseases and is caused by several species of bacteria belonging to the *Vibrio* genus, with outbreaks reported in many cage culture farms throughout the region. To date, the accepted method for controlling these aquatic diseases is the administration of antibiotics to increase the resistance of fishes to these diseases. However, this has led to concerns regarding the presence of antibiotic residues in fish (particularly for human consumption), and regarding increased antibiotic-resistance in fish.

In previously reported studies, it has been demonstrated that herbal plants may contain immunostimulating compounds that could increase immune functions by affecting blood cells. For example, enhanced phagocytic activity was observed in both Rainbow Trout that were fed with ginger, as well as Asian Sea Bass that were fed with garlic.

With the eventual goal of using natural herbal therapy to improve fish's resistance to bacterial infections, a study is being carried out at the School of Applied Science to investigate the effectiveness of garlic extract, ginger extract, and onion extract for these purposes. In addition, the inclusion rates of these compounds are also being studied in a bid to optimise the uptake efficiency in fish. The research team is also performing in-depth studies into the mechanisms through which these active compounds function, in order to better understand how these compounds directly trigger the innate defence mechanism of the fish. To date, it is proposed that these active compounds function through their actions on cell receptors or genes that are linked to the immune systems of the fishes, thereby offering protection against the *Vibrio* species infections.

Preliminary results reported by the team are very encouraging – garlic extract has led to an increase in the specific growth rate of the fishes, as well as a decrease in the food conversion rate of the fishes. Current experiments involve batches of fishes being put on a strict three-month feeding regime consisting of the various herbal extracts, and will be followed by the introduction of the *Vibrio* species bacteria. This will allow the team to evaluate the effects of these herbal extracts in enhancing the immune systems of fish against Vibriosis.

If successful, these herbal extracts can be used as food additives in commercial feeds, and will greatly decrease the mortality rates of fishes in fish farms throughout the South-East Asia region. This will not only be economically beneficial for SMEs in the fish food product industry, but will also benefit consumers who are at risk of consuming these antibiotic residues through the consumption of these fishes and related products.

Renewable Resources Technology:

Making the Planet Cleaner

By **Tay Boon Keat** Assistant Director / Technology Management & Course Manager / Diploma in Chemical Engineering

Renewable resources technology refers to technology that gives waste resources a new lease of life. In general, it refers to the recycling of solid waste, water and waste heat. This field is especially important to Singapore as we do not possess any natural resources, and depend on the import of resources to sustain our daily activities. These renewable resources range from the natural aggregates (sand, gravel) that we use in construction, and crude oil that is processed into fuels, to a vast variety of other materials (plastics, lubricants, paints).

The renewable resources technology capability at the School of Applied Science is broadly divided into three capabilities: Green Materials, Water Technology and Biofuels. Over the past 5 years, the research group has garnered $1.8 million in industry and research funds over a broad range of environment-related projects.

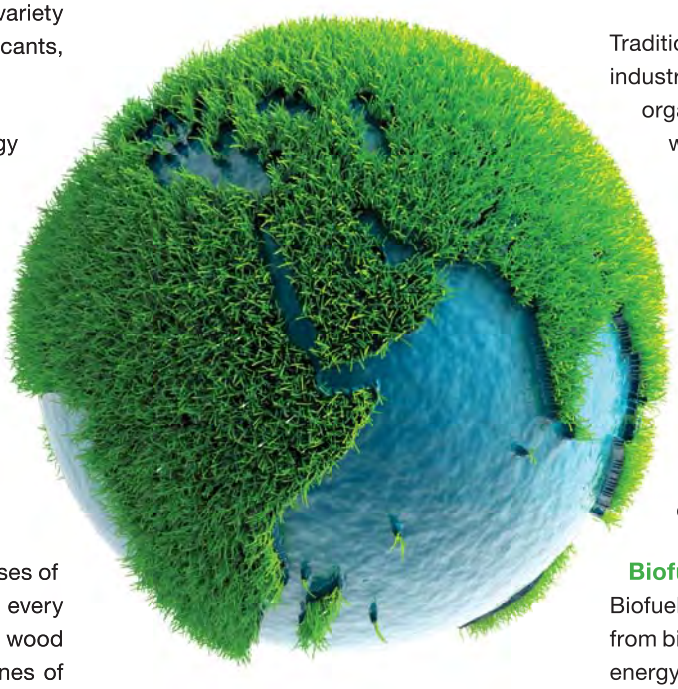
Green Materials

As a small island, Singapore disposes of a large amount of waste materials every day. About 500 tonnes of waste wood and horticultural waste, 2,000 tonnes of plastic waste, and 500 tonnes of sludge and ash are disposed of daily through incineration or landfills. However, some of these materials can be recycled by making use of available technologies. As a tariff can be collected for such waste at about $77 per tonne, any business that is set up to recycle solid waste into useful green materials can potentially be very viable as the business operates on a double revenue model.

We have developed material formulation that allows for the recycling of wood waste, incineration ash and plastics into building materials for walls, park benches and even souvenirs. We have also earmarked plans to use recycled plastics in hot mix asphalts, and to set up an accredited laboratory to conduct materials testing for green materials.

Water Technology

Water is another scarce resource in Singapore. To conserve water, Singapore has commissioned many initiatives, including the production of NeWater. There is also a need to move fish farming on land to improve yield, and for this to happen, water must undergo recycling through the recirculating aquacultural system (RAS).



Traditionally, fluidised bed bioreactors (FBR) and the moving bed bioreactors (MBRs) have been adopted by the industry to treat aquacultural wastewater. However, one of the main concerns for FBR is power consumption. Hence, TP currently focuses on kinetics studies of such reactors to allow for correct sizing, which will naturally lead to lower power consumption. Moreover, traditional FBRs or MBRs result in conversion of ammonia in fishwater into nitrates, which is also toxic to fish and prevents the complete recycling of fishwater. Therefore, we are also looking at incorporating algae, or the use of development phototropic reactors, for the removal of nitrates from water so as to enable complete recycling of aquacultural wastewater.

Traditional ways of municipal and industrial wastewater treatment removes organics through biomass growth, which are ultimately disposed of through incineration or landfills. Currently, we are developing a technology that allows for natural selection of microbes that produce bioplastics during the wastewater treatment process. This innovative process allows for the treatment of wastewater, and production of bioplastics to occur simultaneously.

Biofuels

Biofuels refer to fuels that are produced from biomasses. It is a form of renewable energy and the use of biofuels has a near-zero carbon footprint. One major concern, however, is in the use of food crops for biofuel production. Moreover, bioethanol, being a commonly used biofuel, cannot be used independently in engines but has to be blended with petrol. To alleviate these issues, the team of researchers at the School is currently investigating the development of biobutanol from lignocellulosic materials, e.g. wood waste and sugar cane bagasse.

Green products created and tested by TP include a park bench made from horticultural waste and Engineered Cementitious Composite (ECC) sandwich wall panels for the construction industry.

IMPORTANCE OF Green Materials Testing

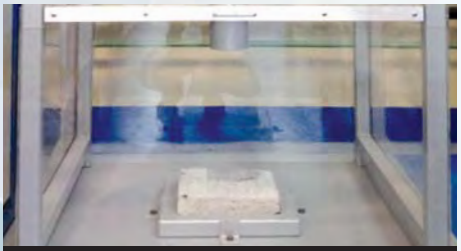
By **Dr Wong Sook Fun**
Section Head/Green Materials
(Technology Management)

It has been reported that green materials comprising composites with recycled byproducts (such as wood and horticultural wastes, plastics, fly ash, bottom ash, aggregate fines and newsprint) could potentially offer advantageous technical properties such as improved toughness, high impact resistance, durability and thermal insulation.

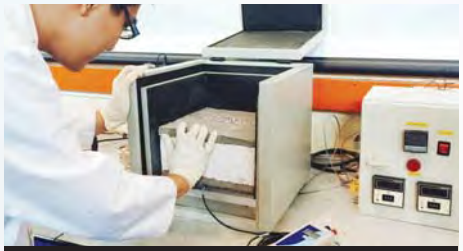
However, to date, there is still much to be learnt about these properties of green materials due to the limited and fragmented nature of reported works. Hence, the Green Materials team at the School of Applied Science has identified suitable test methods and equipment to carry out a wide range of characterisation and performance studies on raw materials and finished products.

For example, "drop weight impact" tests are performed to evaluate the impact resistance of green composites; ultrasonic pulse velocity (UPV) and rebound hammer tests to examine the quality of these composites; thermal conductivity tests to determine the thermal resistance of green insulation materials; permeability and surface resistivity tests to assess the durability of green composites against water and chemical attacks; as well as toxicity and leaching tests to ensure material and product safety.

Green materials testing is an integral part of the sustainable development of new materials and products. It can be used to offer consultancy and collaborative projects related to different areas of materials research. It is also conducted to ensure that the new materials and products so developed are fit for purpose, and to achieve certification for their commercialisation by complying with standard guidelines and regulations.



Drop Weight Impact Test



Thermal Conductivity Test

Ultrasonic Pulse Velocity (UPV) Test

Rebound Hammer Test

Air and Water Permeability Test

Surface Resistivity Test

Building Solutions for the Future

ENGINEERED CEMENTITIOUS COMPOSITE (ECC): A NOVEL MATERIAL TO FACILITATE A NEW CONSTRUCTION METHOD

By **Dr Wong Sook Fun**
Section Head / Green Materials (Technology Management)

The Green Materials team at the School of Applied Science at Temasek Polytechnic collaborated with Sembcorp EOSM* Pte Ltd to develop the 'ECC-Crete' sandwich panel in-fill wall system, through two successfully completed consultancy projects supported by SPRING Singapore under the Innovation Voucher Scheme (IVS). This system has many advantages over the conventional wall system such as faster construction, enhanced quality control, labour-saving benefits and better flexibility to meet changing needs.

The two projects involved the following research studies:

- Development of a new **engineered cementitious composite (ECC)** mix by incorporating reinforcing fibres and novel recycled materials (e.g. incineration ash such as fly ash and bottom ash), to produce an all-in-one pre-packed dry mix version. This product is used as the skin (outer layer) of sandwich wall panels.

- Utilization of **cellulosic insulation (CI)** material and **autoclaved lightweight composite (ALC)** as the core (in-fill) insulation materials.

ECC represents a unique group of fibre-reinforced cementitious composites with ultra-high ductility developed for applications in the large material volume usage, cost-sensitive construction industry. It is essentially a family of composite materials that behaves like a metal.

CI materials, produced from recycled wastes and byproducts (e.g. recycled newsprint, incineration ash) that may otherwise be dumped into landfills, can improve various properties such as thermal performance, fire resistance, sound insulation and air-flow resistance. These materials can be used in wall and roof cavities to insulate the inside and outside of buildings, both thermally and acoustically.

ALC consists of quartz (silica) and incineration ash. The silica, together with a mixture of cement and lime, reacts with aluminium to form millions of tiny air cells that give ALC its unique properties. ALC makes an ideal building material and thermal insulator due to its outstanding thermal properties and superior fire resistance. It has been reported that a 100-mm thick ALC wall could achieve a 4-hour fire rating.

Designing Better Walls with Prefabricated Modules

Sembcorp EOSM Pte Ltd is a construction company that designs and provides ECC-Crete materials and systems for both local and overseas customers (e.g. developers in India, Vietnam and Cambodia) to create a better living environment by offering various choices of prefabricated building assemblies known as 'e-modules', that are fast and cost-effective for mass housing.

The School's Green Materials team carried out the research and developmental work in the production of the mix formulations and materials used in the 'ECC-Crete' sandwich panel in-fill wall system.

Sembcorp EOSM Pte Ltd is currently commercialising the following products and systems to raise productivity in the building and construction industry, both locally and abroad.

ECC Mix Formulations

The successful development of green ECC mix formulations enables the company to reduce material wastage, reduce manpower and increase productivity, since the raw materials come as an all-in-one pre-packed dry-mix, just like your favourite 3-in-1 coffee mix.

ECC-Crete Walls

The ECC skins reduce the self-weight and at the same time improve the performance of the wall panels. The insulating layer is made of lightweight CI or ALC with a fine pore structure which gives it the superior thermal insulation properties and mechanical strength. This in-fill material is relied upon to replace conventional insulating foam, making it possible to build energy-saving, monolithic and solid exterior wall panels without any additional thermal insulation.

ECC-Crete Facades

ECC-Crete facades comprise ECC panels with and without insulation, which allow architectural finishes to be made into desired shapes and profiles for wall claddings, cornices and roof coverings.

ECC-Crete Pods (Bathroom/Toilet Modules)

ECC-Crete pods (bathroom/toilet modules) are built and completed totally in factory conditions. The shells are constructed of ECC materials, with good fire and acoustic ratings and complete with all accessories as per the client's specifications. All pods are produced in accordance with the current regulations in the countries of destination to ensure that every detail is compliant, especially for plumbing and electrical systems.

The finishing stage of the prefabricated shells begins with the installation of plumbing and electrical systems, followed by tiling, sanitary and bathroom accessories, before final testing, cleaning and quality control ensures that the prefabricated pods are ready for delivery and connection to site services.

Looking Ahead

In the pipeline is a collaborative project between the School's Green Materials team and Sembcorp EOSM Pte Ltd based on a study of blast and impact resistance, delamination resistance and incorporation of polymer mesh in ECC-Crete wall systems. The research will focus on disaster-proof housing and protective structures.

The name *EOSM originated from "e-OSM", an abbreviation for "e-Off Site Manufacturing", which means all the building components are manufactured off site (e.g. in prefabrication factories, precast plants), delivered to the site as modules and then assembled on site.

From Waste to Bioplastics

By **Dr Huang Zhi** Research Fellow / Diploma in Chemical Engineering

Plastics are part and parcel of our everyday lives, with about 260 million tonnes produced worldwide each year. Conventional plastics are made from fossil fuels, with the rate of plastic consumption far exceeding the rate of fossil fuel formation. After their use and disposal, large amounts of plastics typically end up accumulating in landfills and oceans, with no means for recycling or reuse. This has led to a global problem of rapidly diminishing fossil fuel reserves in order to maintain the global demand for plastics. As such, there is an urgent demand for the development of sustainable technologies in the area of plastics manufacturing.

Polyhydroxyalkanoates (PHAs) are a group of polyesters produced by microbial cultures, and can be seen as a new type of 'bioplastic'. These materials are fully biodegradable, biocompatible and possess thermoplastic properties similar to those of conventional polyolefins. However, the manufacture and commercialisation of PHAs is very difficult due to high production costs associated with the scaling up of manufacturing processes. Therefore, significant amounts of research in recent years have been dedicated to the development of alternative, cost-effective processes for the production of PHAs.

In the same vein, scientists at the School of Applied Science are conducting research to develop a mixed culture technology that will enable the growth of PHA-producing microorganisms by natural selection. This will offer the possibility of using waste streams, such as domestic wastewater, farm waste and food waste as the raw materials for the fermentation process. This enabling technology will significantly decrease the cost of PHA production and has immense potential to revolutionise the plastic manufacturing industry. In addition, the increased availability of bioplastics will have a positive effect on our environment, as the co-treatment of waste oil and grease by the proposed mixed culture system will also minimise the negative impact of current waste disposal methods.

Current established methods for PHA production require the use of expensive, specialised equipment and involve a high level of energy consumption. Another critical obstacle is that PHA production must be performed in batches, making it extremely difficult to produce on a large commercial scale. At Temasek Polytechnic, this research project is aimed at developing a sustainable mixed culture process to produce PHAs in a continuous manner while using treated waste oil and grease. To achieve this, advancements have been made and a bench-top PHA mixed culture generation system has already been developed, with detailed product characterisation and analysis on-going.

Due to the novelty of this project, G5 International Holdings Pte. Ltd. is currently collaborating with the research team at Temasek Polytechnic to carry out a pilot study, with the eventual aim of commercialising this technology. This exciting and innovative project using waste oil and grease to produce PHAs has the potential to ensure the sustainability of plastics and to create a greener and better environment for the entire world.

SUPPORTING LOCAL ENTERPRISES:

Facilitating Innovation with Analytical Science

By **Dr Ong Seng Poon**
Deputy Director / Capability Development

The field of Analytical Science is based upon the need to identify and quantify the components in any given substance. This field was developed in the mid-1800s and has made significant advancements through the 20th century. Today, the fundamentals of Analytical Science rely on the use of modern and sophisticated instruments capable of accurately determining the identity and quantity of chemical compounds. These analytical techniques are also routinely applied across fields ranging from environmental monitoring and product manufacturing, to medical testing and forensics.

At the School of Applied Science, the Capability Development Division focuses on advancing its analytical capability in several core areas, beginning with the area of Traditional Chinese Medicine (TCM). To date, a large number of studies to characterise and quantify active ingredients in TCM products have been carried out for industry partners, with the goal of ascertaining product quality, safety and efficacy. Since 2009, TP has also obtained the SAC-SINGLAS accreditation for food safety testing and alcohol testing. At present, the team is working closely with universities and hospitals in Pharmacokinetic studies and Metabolomics for the development of drugs and complementary health products.

By continually developing and increasing the scope of its analytical capability, the School is committed to helping local enterprises innovate to remain competitive and tap into new markets.

The field of Analytical Science is the heartbeat of any research goal or production process, which is why the School, with our strong team of Chemists working closely with our Biologists, is constantly upgrading our expertise in the area.

Stability Testing of Herbal Products

By **Lee Yian Hoon**
Section Head / Technical Support
(Capability Development)

Dr Tian Feng, Edmund
Manager / Analytical Science
(Capability Development)

Health supplements and medicinal products are usually marketed with their date of manufacture and expected date of expiry prominently displayed. These durations range from several months to several years, leading to the commonly posed question of whether these products retain their efficacy and original condition throughout the supposedly viable period. Unsurprisingly, consumers of these products are unable to ascertain if the amount of time elapsed between production and consumption affects the effectiveness or characteristics of the product.

In order to ensure the safety and viability of their herbal products throughout their shelf lives, a major Traditional Chinese Medicine (TCM) company approached the School of Applied Science to conduct a thorough investigation of their products. This is to ensure that consumers will still be purchasing a quality product some time after it has been manufactured. This is particularly important as many herbal-based products (especially in liquid form) are prone to microbial growth if left unconsumed over an extended length of time.

This study involves the products being placed in a stability chamber with stable conditions (temperature and humidity) designed to mimic these products being placed in a store for sale. With the conditions kept constant, samples of these products can be obtained at pre-defined time intervals and have their active ingredients assessed for functionality. In addition, the microbial analysis team at the School of Applied Science periodically evaluates the extent of microbial growth in the product.

This study is currently in progress, with the results intended for use by the company to ensure that all agency regulations are complied with. The results will also serve as a marketing tool as it will improve consumer confidence in their products, ensuring that their quality and safety are maintained at any time between manufacture and expiry.

"We are extremely pleased with the services provided by Temasek Polytechnic. Their support and expertise have enabled us to improve and innovate not just in our processes, but also our production techniques. We are also able to use the stability test report as a requirement for exporting our products overseas."

Mr Yeo Kay Yong
Managing Director,
H.W. Traditional Medicine Pte. Ltd.

Pesticide Analysis by Liquid Chromatography Coupled to a Quadrupole Time-of-Flight Analyser

By **Dr Xue Xuejia** Lecturer / Capability Development

Pesticide residues in food products have become an increasing concern for consumers in recent years due to increasingly competitive farming practices and manufacturing procedures. This can be observed from the rapidly expanding organic food market, which assures consumers that little or no pesticides were used in the farming process. However, accurately determining the amount of pesticide residues on food products is an extremely time-consuming process due to the large number of food products available, as well as the large number of pesticides that have to be screened for.

In collaboration with Agilent Technologies, researchers at the School of Applied Science are developing a rapid screening method for determining and quantifying pesticide residues. This method is based on a state-of-the-art liquid chromatography-mass spectrometry instrument that guarantees high accuracy and reproducibility of results. This technique allows researchers to determine the amounts of several hundred types of pesticides in food products with a single analysis, and will lead to the development of a comprehensive database of all regulated pesticides in Singapore.

Currently, the accepted standard for analysing different types of pesticides is based on Gas Chromatography. However, due to the relatively high temperatures required, these methods encounter significant obstacles when analysing thermally unstable pesticides. In addition, a single detection method may not be applicable to all the pesticides of interest. As such, coupling liquid chromatography (which does not require high temperatures) to mass spectrometry (applicable to all compounds) is an ideal approach to analysing pesticide residues in food products.

This research idea was conceptualised in 2013 when Agilent established a partnership with Temasek Polytechnic to develop enabling technologies that would be helpful for SMEs in the food industry.

Pesticide analysis of food products remains one of the most challenging problems for the food industry, and the development of a rapid screening method may prove to be revolutionary for the industry.

This pesticide screening technique makes use of liquid chromatography coupled to a Quadrupole Time-of-Flight (QTOF) mass analyser to determine pesticide residues extracted from food product samples. Using a QTOF mass analyser, the masses of the pesticides can be determined extremely accurately, which allows for greater confidence in the identification and quantification of these compounds. The identities and quantities of these pesticides can be determined by comparing the results with a database obtained from analysing pure pesticide standards.

In a preliminary investigation, a total of 252 types of distinct pesticides have been detected and identified at the parts-per-billion (ppb) level, indicating

good sensitivity and selectivity. Eight red wine samples were also analysed using this technique, and results showed that five common pesticide residues (Buprofezin, Diethyltoluamide, Fenamiphos, Enilconazole and Penconazole) were present in appreciable quantities in these wine samples. These preliminary experiments demonstrated the feasibility of using this technique to rapidly screen for an entire host of pesticides, without the need to use a variety of analytical methods for different pesticides.

By making use of the developed technology, regulatory agencies and SMEs will be able to significantly increase the throughput of pesticide screening for fresh and processed food products. This will not only improve the efficiency of quality testing processes in Singapore's food industry, it will do so while maintaining the accuracy, reproducibility, and overall quality of the results warranted from these tests.

Efficacy Studies on Upgraded Formulations of Progene

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

Quality assessment is a critical step in the process of developing new products to be sold on the commercial market. This not only applies to products that are completely novel, but also to products that are enhanced or improved when modifications are made to their formulations.

Dawyn International Pte. Ltd. tapped on the expertise of the School of Applied Science to perform efficacy studies on three improved formulations for their product Progene. Progene is a well-established health and beauty product that has been sold in Singapore and other South-East Asian countries for over ten years. The aim of Dawyn International Pte. Ltd., when developing these three new product formulations, was to refresh their product and to market it to potential consumers in different countries who had different preferences for active ingredients in the product.

This study was primarily to compare the antioxidant efficacies of the three new formulations with the original product using an animal model. This analytical methodology was conceptualised based on slight modifications to previously reported studies performed on similar products. After the administration of Progene, the antioxidant activity of the mice liver was assessed using a superoxide dismutase (SOD) assay, with SOD levels measured using a simple spectrophotometer.

Having completed a similar study on the original Progene product in 2007, Dawyn's second project with the school indicated their strong confidence in the analytical capability of the team at the School of Applied Science.

Since the inception of consultancy projects using animal models in 2006, the school has expanded its range of analytical capabilities to different fields and has helped numerous SMEs assess the efficacies of different health and medicinal 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.

This project is a prime example of industrial companies leveraging on the scientific expertise of Temasek Polytechnic and financial support from SPRING Singapore to improve the quality of their products.

COMMUNITY OUTREACH:
Promoting the Use of
Safe Medication Among the Elderly

by **Hor Mooi Sian, Magdeline** Senior Lecturer / Diploma in Pharmaceutical Science
Shahedah Bte Md Ali Lecturer / Diploma in Pharmaceutical Science

Staff and students from the Diploma in Pharmaceutical Science partnered with the North East Community Development Council (NECDC) in a project targeted at elderly residents. The project promoting the safe use of medications amongst elderly residents allowed students to apply their knowledge and skills, and expand their experience beyond the classroom. Staff advisors from the School of Applied Science are trained Pharmacists with a wealth of experience in the area of community healthcare education.

The outreach programme was conducted as a door-to-door community health education exercise. The teams conducting the education visits included students from the Diploma in Pharmaceutical Science, as well as alumni volunteers and adult volunteers identified by NECDC and associated community help agencies.

During the door-to-door visits, volunteers reviewed the seniors' current habits on the use, storage and organisation of medications, and their access to healthcare advice and medical supplies. The volunteers also provided education on the safe use of medications, encouraging timely referrals for professional healthcare advice.

Temasek Foundation - Temasek Polytechnic Public Health & Nutrition Intervention Programme in Cambodia

By **Ong Eng Gim** Section Head / Nutrition & Dietetics
(Diploma in Applied Food Science & Nutrition)

Having a baby is the happiest time in a woman's life, but in Cambodia, where 30% of the population live below the national poverty line, and 18% below the food poverty line, the journey towards becoming a mother can be a most trying time.

80% of the population in Cambodia live in the rural areas, and two thirds of rural households face seasonal food shortages each year because of floods and droughts. The problem of malnutrition amongst mothers-to-be is therefore common, and this is exacerbated by the limited access to education, health and other public services

The Temasek Foundation-Temasek Polytechnic Public Health & Nutrition Intervention Programme seeks to address this problem. 150 community health educators and officials from the Ministry of Women's Affairs in Cambodia were recently trained in maternal and child nutrition under the programme.

Mothers who are underweight before pregnancy & do not gain enough weight during pregnancy have inadequate nutrient reserves to support the critical period of organ formation & continued fetal growth & development. This leads to increased risk of birth defects, fetal growth restriction, pre-term, fetal & neonatal mortality, and maternal complications like antepartum haemorrhage & anaemia.

Cambodian health educators receiving training in maternal and child nutrition.

PART-TIME COURSES

We offer a range of part-time courses for adult learners.

New!

SPECIALIST DIPLOMA IN LABORATORY MANAGEMENT AND INSTRUMENTATION

Jointly offered by Temasek Polytechnic and the Singapore Accreditation Council (SAC) of SPRING Singapore, the **Specialist Diploma in Laboratory Management and Instrumentation** aims to prepare graduates for work in SAC-accredited and to-be-accredited laboratories. It also serves as a platform for individuals who are involved in analytical testing in laboratories to upgrade their skills and knowledge.

Upon successful completion of the course, participants will be able to:

- describe the management and technical requirements of laboratory accreditation standards (e.g. ISO/IEC 17025)
- describe and apply knowledge on method validation
- describe and apply measurement uncertainty and its determination
- apply knowledge and skills on the modern analytical techniques used in laboratories
- perform analytical testing in compliance with technical requirements of laboratory accreditation standards (e.g. ISO/IEC 17025)

TARGET PARTICIPANTS

This course is targeted at diploma graduates and PMEs who are keen to work in analytical testing in laboratories in various industries such as the chemical, pharmaceutical and food industries, research institutes, R&D companies and other testing sectors.

CAREER OPPORTUNITIES

Graduates will be able to take up technical positions and the skills learnt in this course would help the graduates in their career progression within their organisations.

MINIMUM ENTRY REQUIREMENTS

- Diploma in Applied Sciences / Engineering or equivalent
- Degree in Science / Engineering or equivalent
- Holders of other equivalent academic qualifications from foreign institutions will be considered on a case-by-case basis.

Scan to find out more about our courses

Other courses offered by the School are as follows:

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SPECIALIST DIPLOMA IN ENVIRONMENT AND WATER TECHNOLOGY

The School of Applied Science

BIOFACTORY

Providing Innovative Solutions for Enterprise

The Biofactory at the School of Applied Science is a one-stop applied science centre where project ideas are translated into products for commercialisation. The Biofactory consists of various Biostations where each station will apply their expertise to transform the idea, intermediate products and prototypes as they move along the value chain. The Biostations are built upon the existing three capability clusters of the School, namely Agri-Food Technology, Medical Technology and Renewable Resources Technology.

We are dedicated to helping your company achieve your business goals with innovative solutions and in a cost-effective manner. Each Biostation supports your products and services in a way that is customised specifically to your needs, thereby giving your business a competitive edge.

If you have an idea that would bring benefits to the industry or the society, we are here to help. By providing our expertise to match your need, leveraging on funding sources and industry partners, we shall take the project through to commercialisation.

TARGET INDUSTRIES

- Agri-Food
- Aquaculture
- Biologics
- Biomedical
- Environment & Water
- Food
- Nutrition
- Pharmaceutical
- Plant Biotechnology
- Renewable Resources
- Traditional Medicine
- Veterinary
- Education

KEY ACCOMPLISHMENTS

- More than 50 consultancy projects with SMEs completed.
- Approximately S$4.5 million research grants secured over 5 years.

CONTACTS FOR COLLABORATION

For enquiries on our services and collaboration opportunities, please contact:

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BIOSTATIONS

- Aquaculture
- Plant Biotechnology
- Renewable Resources Technology
- Food & Applied Nutrition
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