NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE

# Food Science and Technology Global 2021

## Technology Innovations for Food Security

**27 - 28 April 2021**

# ABSTRACT BOOKLET

**In Partnership with**

Singapore Food Agency

Agency for Science, Technology and Research SINGAPORE

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# Chair's Message

Food security is a key national priority to many governments around the world. Singapore's vulnerability is compounded by our limited farmland and high dependency on imported food. Enhancing our food security is of critical importance as the global food production is under mounting pressure from the rapid population growth, an increasing impact of climate change and the ongoing Co-VID19 pandemic. Technological innovations, from modern farming technology to reducing food wastage through novel processing technology, are needed for our current food industry.

With its strong interdisciplinary teaching and research credentials in Science and Engineering, Nanyang Technological University (NTU) is best positioned to contribute to the national effort to strengthen our food security. NTU food technology innovations have attracted significant interest and recognition from government agencies and food industry, and are well aligned with our government's vision of achieving 30% of nutrition requirements from local food production by 2030 (30 by 30).

Food Science & Technology Global 2021 (FST Global 2021) aims to bring together FST experts from local and overseas institutions to share their research and innovation, and nurture new partnership and collaboration. The conference will be graced by the Guest of Honour, Ms Grace Fu, Minister for Sustainability and the Environment. The FUTURE READY FOOD SAFETY HUB (FRESH), a tripartite initiative involving Singapore Food Agency (SFA), Agency for Science & Technology and Research (A*STAR) and NTU would also be launched by our Guest of Honour at the start of the conference.

Being the first in its series, FST Global conference would take place biennially. For FST Global 2021, delegates would have the opportunity to listen and interact with distinguished speakers from Singapore government agencies (SFA and A*STAR), local and international academia, and food industry both physically and virtually. Jointly organised by NTU Food Science & Technology (NTU FST) Office and NTU-Institute of Advanced Studies (NTU-IAS), FST Global 2021 will take place April 27 - 28, 2021 at NTU, Singapore

Professor William CHEN
Conference Chair, FSTG 2021;
Host Principal Investigator, FRESH;
Director, Food Science & Technology (FST) Office &
Michael Fam Chair Professor in Food Science and Technology, NTU

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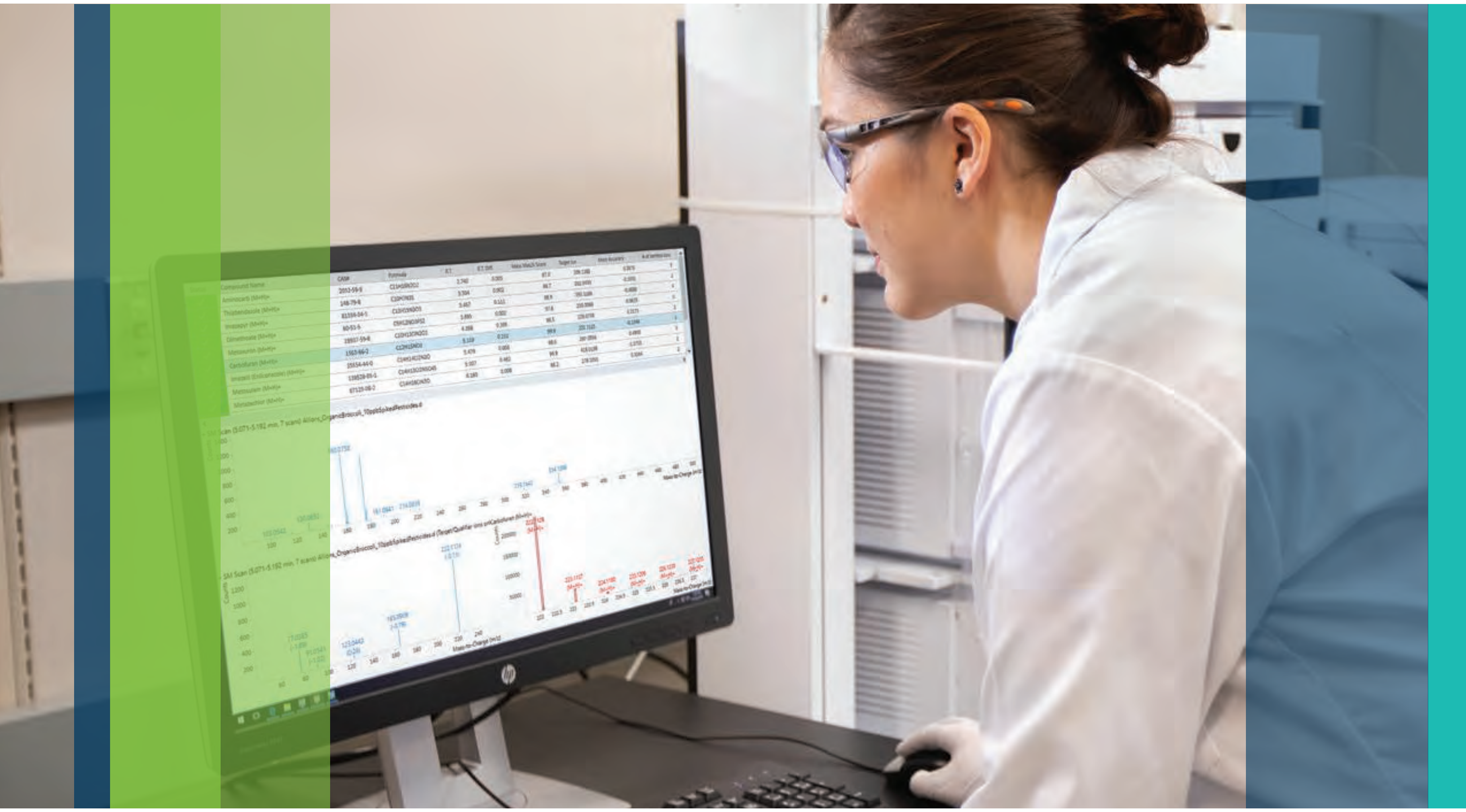



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## Program

| Time (GMT +8) | Conference Programme Day 1 (27 April 2021) |
|---|---|
| 0830hrs - 0900hrs | **Arrival of Invited Guests / Virtual Attendees' Login** |
| 0900hrs - 1015hrs | **Opening Ceremony** |
| | **Welcome by *Prof Willam CHEN (Host PI, FRESH and Conference Chair, FSTG 2021)*** |
| | **Address by *Prof Subra SURESH (President, Nanyang Technological University)*** |
| | **Address by *Mr Frederick Chew (Chief Executive Officer, A*STAR)*** |
| | **Address by Guest of Honour, *Ms Grace FU (Minister for Sustainability and the Environment)*** |
| | **MOU Signing Ceremony & Launch of the Future Ready Food Safety Hub (FRESH)** |
| | **Guest Presentation:**<br>***"To boldly grow where no plants has grown before - Growing crops on Mars and the Moon"***<br>by ***'The Martian' - Prof Wieger WAMELINK (Wageningen University & Research, The Netherlands)*** |
| 1015hrs - 1045hrs | **Intermission** |
| 1045hrs - 1110hrs | **Plenary Talk 1:**<br>***"Integrative role of science, innovation and digital technology to ensure a supply of safe food"***<br>by ***Joanne CHAN (Director, National Centre for Food Science, Singapore Food Agency, Singapore)*** |
| 1110hrs - 1135hrs | **Plenary Talk 2:**<br>***"Safety by "Discussion" - The role of Tripartite Partnerships in Furthering Novel Food Ingredient and Technology Safety (in SG)"***<br>by ***Benjamin SMITH (Director, FRESH & A*STAR, Singapore)*** |
| 1135hrs - 1200hrs | **Plenary Talk 3:**<br>***"Development of Platform Technology for Food Waste Valorisation and Sustainable Food Circular Economy"***<br>by ***William CHEN (Host PI, FRESH and Michael Fam Chair Professor in Food Science & Technology, Nanyang Technological University, Singapore)*** |
| 1200hrs - 1240hrs | **Intermission** |

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|---|---|
| | **Track 1 - Sustainable Food Systems**<br>**Co-Chairs:**<br>***A/Prof HUANG Dejian***<br>**(Deputy Head, Department of Food Science & Technology,**<br>**National University of Singapore, Singapore);**<br>***Prof Mely Caballero ANTHONY***<br>**(Head, Centre for Non-Traditional Security Studies,**<br>**The S. Rajaratnam School of International Studies,**<br>**Nanyang Technological University, Singapore)** |
| 1240hrs - 1300hrs | **Keynote Talk 1.1:**<br>***"Image-based Food Recognitionfor Nutritional Analysis"***<br>by ***MIAO Chun Yan (Nanyang Technological University, Singapore)*** |
| 1300hrs - 1320hrs | **Keynote Talk 1.2:**<br>***"Future of Sustainable Food"***<br>by ***Ralph GRAICHEN (Biomedical Research Council, A*STAR, Singapore)*** |
| 1320hrs - 1340hrs | **Keynote Talk 1.3:**<br>***"Plant geneticengineering for sustainable food production"***<br>by ***LUO Hong (Clemson University, USA)*** |
| 1340hrs - 1400hrs | **Keynote Talk 1.4:**<br>***"Materials Enhanced Agriculture and Remediation"***<br>by ***LAM Yeng Ming (Nanyang Technological University, Singapore)*** |
| 1400hrs - 1420hrs | **Keynote Talk 1.5:**<br>***"Redefining the Agriculture – Food Continuum for the 21st Century"***<br>by ***Paul TENG (National Institute of Education International, Singapore)*** |
| 1420hrs - 1440hrs | **Live Q&A Session by Conference Guest Speaker:**<br>by ***'The Martian' - Prof Wieger WAMELINK (Wageningen University & Research, The Netherlands)*** |
| 1440hrs - 1500hrs | **Intermission** |
| | **Track 2 - Food Safety / Consumer Education**<br>**Co-Chairs:**<br>***Asst Prof MA Wei***<br>**(Assistant Professor, School of Biological Sciences,**<br>**Nanyang Technological University, Singapore);**<br>***Prof DUAN Hongwei***<br>**(Professor, School of Chemical & Biomedical Engineering,**<br>**Nanyang Technological University, Singapore)** |
| 1500hrs - 1520hrs | **Keynote Talk 2.1:**<br>***"A Modern Approach for the Protection of the Food Supply: Smarter Food Safety"***<br>by ***MENG Jianghong (FDA-University of Maryland Joint Institute for Food Safety and Applied Nutrition, USA)*** |

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|---|---|
| 1520hrs - 1540hrs | **Keynote Talk 2.2:**<br>***"“Meat” the Future: Consumers' Perceptions of Nano-Enabled Food & Plant-Based Meat"***<br>by ***Shirley HO (Nanyang Technological University, Singapore)*** |
| 1540hrs - 1600hrs | **Keynote Talk 2.3:**<br>***"Antimicrobialactivity of defence phytochemicals: prenylated (iso)flavonoids andisothiocyanates"***<br>by ***Carla ARAYA-CLOUTIER (Wageningen University & Research, The Netherlands)*** |
| 1600hrs - 1620hrs | **Keynote Talk 2.4:**<br>***"Food Authenticity – Mitigating Emerging Risks and Threats"***<br>by ***Sterling CREW (The Food Authenticity Network, United Kingdom)*** |
| 1620hrs - 1640hrs | **Keynote Talk 2.5:**<br>***"Beechwood Xylan-DerivedDietary Fibers that are Produced by an Autohydrolysis Process Govern GutMicrobiome Responses and Metabolic Outputs"***<br>by ***CHEN Ming-Hsu (Nanyang Technological University, Singapore)*** |
| **Conclusion Of Day 1 Programme** | |

| Time (GMT+8) | Conference Programme Day 2 (28 April 2021) |
|---|---|
| | **Track 3 - Food Processing Technology**<br>**Co-Chairs:**<br>***Dr Ken LEE***<br>**(Senior Lecturer, School of Physical & Mathematical Sciences - Division of Chemistry & Biological Chemistry, Nanyang Technological University, Singapore);**<br>***A/Prof Susanna LEONG***<br>**(Assistant Provost (Applied Research), Singapore Institute of Technology, Singapore)** |
| 0900hrs - 0920hrs | **Keynote Talk 3.1:**<br>***"Food Processing for Future Foods"***<br>by ***Susanna LEONG (Singapore Institute of Technology, Singapore)*** |
| 0920hrs - 0940hrs | **Keynote Talk 3.2:**<br>***"Value Added of Baby Corn Blanching Water through Fermentation"***<br>by ***Warawut KRUSONG*** **(King Mongkut's Institute of Technology Ladkrabang, Thailand*)*** |
| 0940hrs - 1000hrs | **Keynote Talk 3.3:**<br>***"Production, Extraction, and purification of the high-value molecule phycoerythrin from Porphyridium purpureum: strategies and achievements"***<br>by ***Roberto PARRA-SALDIVAR (Tecnológico de Monterrey, Mexico)*** |
| 1000hrs - 1020hrs | **Keynote Talk 3.4:**<br>***"Handling Municipal Solid Waste by Conversion to Energy and Resources"***<br>by ***TONG Yen Wah (National University of Singapore, Singapore)*** |
| 1020hrs - 1040hrs | **Keynote Talk 3.6:**<br>***"Photo-fermentation of mixotrophic Chlorella pyrenoidosa as a new approach for high-protein biomass production"***<br>by ***WEI Dong (South China University of Technology, China)*** |
| 1040hrs - 1200hrs | **Intermission** |
| | **Track 4 - Industry**<br>**Co-Chairs:**<br>***Mr Gary LOH***<br>**(Founder & CEO, DiMuto, Singapore);**<br>***Dr Yuchu ZHANG***<br>**(Vice President (R&D), Cargill, Singapore)** |
| 1200hrs - 1220hrs | **Keynote Talk 4.1:**<br>***"Bridging the Gap between Research and Industry"***<br>by ***Dilys BOEY (Enterprise Singapore, Singapore)*** |

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|---|---|
| 1220hrs - 1240hrs | **Keynote Talk 4.2:**<br>***"The Future of Food Industry Post Crisis"***<br>by ***Rebecca LIAN (Center for the Spread of Affordable Wellness (CSAW), Singapore)*** |
| 1240hrs - 1300hrs | **Keynote Talk 4.3:**<br>***"Innovation in Alternative Proteins - Why are Consumers Making the Transition?"***<br>by ***Andrew IVE (Big Idea Ventures, USA)*** |
| 1300hrs - 1320hrs | **Waters-NTU Industry Lecture:**<br>***"Direct Mass Spectrometry for High throughput Food Analysis"***<br>by ***Simon HIRD (Waters Corporation, United Kingdom)*** |
| 1320hrs - 1340hrs | **Agilent-NTU Industry Lecture:**<br>***"LC/MS-based suspect and non-targeted screening of food contaminants"***<br>by ***Stéphane Bayen (McGill University, Canada)*** |
| 1340hrs - 1400hrs | **Keynote Talk 4.4:**<br>***"Growing Microalgae fora Sustainable Future - Why Single Cell Protein Is The Answer To Our Future?"***<br>by ***Eugene WANG (Sophie's BioNutrients Pte Ltd, Singapore)*** |
| 1400hrs - 1420hrs | **Keynote Talk 4.5:**<br>***"Shiok Meats: Cell-based crustaceans for sustainable future of food"***<br>by ***LING Ka Yi (Shiok Meats Pte Ltd, Singapore)*** |
| 1420hrs - 1430hrs | **Intermission** |
| | **Track 5 - Alternative Protein / Nutrition**<br>**Co-Chairs:**<br>***Dr Hazel KHOO***<br>**(Executive Director, Singapore Institute of Food and Biotechnology Innovation,**<br>**A*STAR, Singapore);**<br>***Prof Willam CHEN***<br>**(Host Co-Director, FRESH and Michael Fam Chair Professor in Food Science & Technology,**<br>**Nanyang Technological University, Singapore**) |
| 1430hrs - 1450hrs | **Keynote Talk 5.1:**<br>***"Meat-like Scaffold for Cell-based Meat Cuts"***<br>by ***Hanry YU (National University of Singapore; Institute of Bioengineering & Nanotechnology, A*STAR, Singapore)*** |
| 1450hrs - 1515hrs | **Keynote Talk 5.2:**<br>***"Challenges for Future Sources of Proteins"***<br>by ***Fariba DEHGHANI (The University of Sydney, Australia)*** |
| 1515hrs - 1540hrs | **Keynote Talk 5.3:**<br>***"Cell-based meat in anAotearoa New Zealand context"***<br>by ***Laura DOMIGAN (University of Auckland, New Zealand)*** |

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|---|---|
| 1540hrs - 1600hrs | **Keynote Talk 5.4:**<br>***"Translational Taste Research: Discovery of Molecular Targets for Flavor Innovations"***<br>by ***Corinna DAWID (Technical University of Munich, Germany)*** |
| 1600hrs - 1620hrs | **Keynote Talk 5.5:**<br>***"Anticipatory life cycle assessment and techno-economic assessment of commercial cultivated meat production"***<br>by ***Dean POWELL (The Good Food Institute APAC, Singapore)*** |
| 1620hrs - 1640hrs | **Keynote Talk 5.6:**<br>***"Food design & food digestibility"***<br>by ***Vincenzo FOGLIANO (Wageningen University & Research, The Netherlands)*** |
| 1640hrs - 1700hrs | **Keynote Talk 5.7:**<br>***"Towards Edible Electronics"***<br>by ***LEONG Wei Lin (Nanyang Technological University, Singapore)*** |
| 1700hrs - 1710hrs | ***Closing Remarks by Prof Willam CHEN***<br>***(Host Co-Director, FRESH and Michael Fam Chair Professor in Food Science & Technology,***<br>***Nanyang Technological University, Singapore)*** |
| **Conclusion Of FSTG 2021** | |

# Guest Presentation

27 April 2021

# To boldly grow where no plants has grown before - Growing crops on Mars and the Moon

**G.W.W. Wamelink[a], J.Y. Frissel[a], M.R. Verwoert[a] & N. Tack[a,b]**

[a]*Wageningen University & Research, P.O. box 47, 6700AA Wageningen, The Netherlands*
[b]*Reactor Institute Delft (RID), Delft University of Technology and Wageningen University & Research*
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## Abstract

When humans are going to live and work on the Moon and Mars, it is necessary to grow their food at the site. There are basically three option, aeroponics, aquaponics and the application of the present regolith ('soil'). We work on the application of the regoliths to grow the crops on. This will always be indoors given the harsh circumstances outdoors, both on Mars and the Moon, making crop growth impossible. We want to use what is available, regolith and water (ice) to cultivate the crops.

After the successful growth of crops on Mars and moon soil simulants (there is no regolith available for crop growth on Earth [1,2]) we are now focussing on the design of a sustainable agricultural ecosystem. We have identified several parts in this system, which includes: 1. The crops themself, 2. The recycling of non-eaten parts via earthworms and bacteria, 3. Nitrogen fixation because of the lack of reactive nitrogen, 4. Pollination and 5. The recycling of human faeces and urine. Additionally, the use of fungi for the acquisition of nutrients (phosphate) could be necessary.

So far, we have successfully applied earthworms on Mars and moon soil simulant and used nitrogen fixing bacteria in combination with peas. Recently we applied human urine in the form of struvite ($MgNH_4PO_4$) to the Mars (MMS [3]) and moon (JSC [4]) soil simulants and the control Earth potting soil and evaluated the production of green beans. In a fully random design ten pots of each treatment (three soils and addition of struvite or not) were placed in a greenhouse at 20 C and 70% humidity and lighted for 16 hours. Water (tap water) was given automatically once a day and moisture content checked once a week and when needed extra water was supplied to bring the pots back to original weight. Beans where harvested when full-grown and ready to eat, weighted and dried. The effect of struvite application was significant with a higher harvest for all soils with struvite addition (Fig. 1). Interesting was the harvest for non-treated moon soil simulant being higher than the other two soils. This was also higher in comparison with our earlier experiments. Struvite made from human urine can boost crop production and could be a key step in growing crops on Mars and moon regolith. Next step will be to apply human faeces as manure.

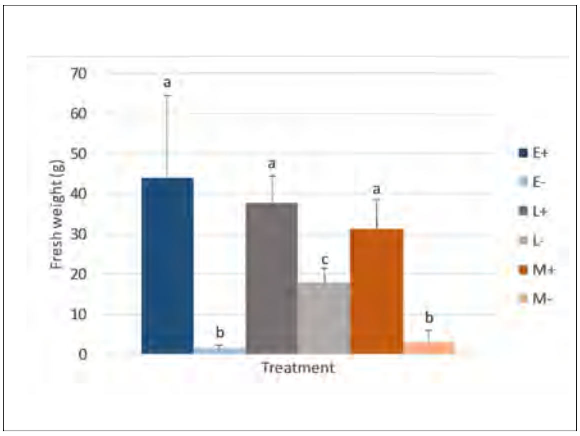


**Fig. 1:** Fresh weight of average total harvested green beans per pot grown on Earth potting soil E), moon soil simulant (L) and Mars soil simulant (M), with (+) and without struvite (-). Different letters indicate significant differences ($p<0.001$).

**References:**

[1] G.W.W. Wamelink, J.Y. Frissel, W.H. J. Krijnen M.R., Verwoert and P.W. Goedhart, "Can Plants Grow on Mars and the Moon: A Growth Experiment on Mars and Moon Soil Simulants". *PLoS ONE* **9**(8), e103138. (2014). doi:10.1371/journal.pone.0103138.

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[3] G.H. Peters, W. Abbey, G.H. Bearman, G.S. Mungas, J.A. Smith, R.C. Anderson, S. Douglas, L.W. Beegle, "Mojave Mars simulant—Characterization of a new geologic Mars analog", *Icarus*, **197**, 470-479. 2008

[4] D. Rickman, C.A. McLemore and J. Fikes, "Characterization summary of JSC-1a bulk lunar mare regolith simulant". (2007).

## Biography

Wieger Wamelink is an ecologist at Wageningen University & Research, The Netherlands. His main research areas include the effect of nitrogen deposition and climate change on plant species and ecosystems. This is mainly done by developing and applying plant and ecosystem models that indicate how biodiversity and connectivity is affected by anthropogenic pressures. He has worked for over twenty-five years on the relation between the soil and the occurrence of plant species. Based on field data Dr Wamelink and co-workers set up an indicator system that predicts the occurrence of plant species based on soil parameters such as soil pH, nitrate availability or ground water table. The field data were also used to do the opposite: setting up an indicator system that predicts soil parameters based on the occurring plant species. This system is widely used in ecological field work.

In 2013 Dr Wamelink started the first experiment on how to grow plants on Mars and moon, based on soil simulants delivered by NASA. Species selection for the experiment, fourteen in total, was based on the database about plant soil relations. After a successful first experiment, in 2015 the second experiment was started which led to the first ever harvest of garden cress, rocket, radish, pea, rye and tomatoes on both Mars and moon soil simulant. Nowadays the research focusses not only on the growth of crops itself but on the set-up of a sustainable agricultural ecosystem for Mars and the moon. This includes research on the application of human faeces, recycling of organic matter by earthworms and bacteria, nitrogen fixation but also food safety, since the Martian and moon regoliths ('soils') contain a lot of (heavy) metals.

# Plenary Talks

27 April 2021, 1045hrs - 1200hrs

# Integrative role of science, innovation and digital technology to ensure a supply of safe food

**Joanne Sheot Harn CHAN**

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*Singapore Food Agency, 10 Perahu Road, Singapore 718837, Singapore*
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## Abstract

Singapore imports over 90% of the food supply from over 170 countries and regions, making it vulnerable to food supply disruption. The Singapore Food Agency has a mission to ensure and secure a supply of safe food in a post-COVID-19 world which faces many challenges and opportunities globally such as climate change, food innovations, fake news, complex food supply chains, emerging food business model and a declining workforce. As food safety decision-making continues to evolve in response to emerging situation, the risk analysis paradigm remains the cornerstone, providing a framework for assessing food safety risks, managing the risks, and communicating both the risks and decisions taken to mitigate them. The modern food system needs to have a clear focus on risk analysis principles and in particular on risk assessment based on scientific evidence and insights that reflects Singapore's context in terms of food consumption patterns and food supply.

A robust system which allow for a timely response to food safety problems, moving from reaction to prevention can only be achieved through the integration of scientific discoveries, technical innovations and digital technology. A proactive, risk-based and data-driven food safety system will require multidisciplinary collaboration with all stakeholders in the food community which includes food industries, food research institutions, goverment agencies to realise synergies in strengths, resources and insights. Meaningful food policies and operations can be generated based on new scientific knowledge from toxicological sciences, innovation in novel methodologies such as novel analytical methods and rapid detection methods and digital technologies and methodologies to enable real-time risk assessment and early alert of any increasing trend and emerging risks by all stakeholders in the food chain to protect consumers.

**References:**

[1] FAO. 2020. *Climate change: Unpacking the burden on food safety*. Food safety and quality series No. 8. Rome

[2] FAO. 2017. *Food Safety Risk Management – Evidence-informed Policies and Decisions, Considering multiple factors*. Food Safety and Quality Series, ISSN 2415-1173.

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[4] Zwe, Y.H., Goh, Z.H.E., Chau, M.L. *et al.* Survival of an emerging foodborne pathogen: Group B *Streptococcus* (GBS) serotype III sequence type (ST) 283—under simulated partial cooking and gastric fluid conditions. *Food Sci Biotechnol* **28,** 939–944 (2019). https://doi.org/10.1007/s10068-018-0525-8

[5] Bryne, J., 2008. New tool offers rapid method of acrylamide detection, say developers. *Food Navigator*, [online] Available at: *https://www.foodnavigator.com/Article/2008/06/06/New-tool-offers-rapid-method-of-acrylamide-detection-say-developers* [Accessed 8 April 2021].

[6] EFSA CONTAM Panel (EFSA Panel on Contaminants in the Food Chain), 2015. Scientific Opinion on acrylamide in food. *EFSA Journal* 2015; 13( 6):4104, 321 pp. doi:10.2903/j.efsa.2015.4104

**Acknowledgements:**

The course of this work has been supported by the following staff in the National Centre for Food Science in the Singapore Food Agency :

1. Angela Li
2. Aung Kyaw Thu
3. Calvin Yeo
4. Johnny Yeung

## Biography

Adjunct Associate Professor Joanne Chan Sheot Harn is currently Centre Director of the National Centre for Food Science at the Singapore Food Agency (SFA) in Singapore and a WHO Collaborating Centre on Food Contamination Monitoring. She has contributed close to 30 years in building food testing laboratory capacity for Singapore's food safety system and ASEAN region through her role in the ASEAN Food Testing Laboratory Committee. She currently sits in the executive committee of the Future Ready food Safety Hub (FRESH) which supports the Singapore Food Story R&D Programme. She has a co-appointment as Adjunct Assistant Professor with the National University of Singapore as well as advisory roles with the polytechnics. Besides that, she also co-chairs the Council Committee testing of Laboratory under the national accreditation council (Singapore Accreditation Council) and chairs the advisory panel of the national chemical metrology's programme in chemical testing.

# Safety by “Discussion” – The role of Tripartite Partnerships in Furthering Novel Food Ingredient and Technology Safety (in SG)

**Benjamin P.C. Smith**

*Future Ready Food Safety Hub*
*A Joint Initiative of A*STAR, SFA & NTU;*
*Singapore Institute of Food and Biotechnology Innovation and*
*Innovations in Food and Chemical Safety Programme, A*STAR*
**E-mail:** ben.smith@ntu.edu.sg / smithbpc@sifbi.a-star.edu.sg

## Abstract

This presentation will look at the importance of collaborations across the Singapore food ecosystem to build food safety capabilities and talent. It will provide a brief overview of structures being developed within Singapore, including the newly established Future Ready Food Safety Hub (FRESH) based at NTU. The example of a collaborative study being undertaken between A*STAR, SFA and NTU to develop new tools for the assessment of local gut genotoxicity will also be provided.

## Biography

A/Prof Ben Smith is a risk assessor and toxicologist who has worked across industry, academia and government, Ben is a strong proponent of collaborative research and the importance of embedding safety across the entire food chain. He is particularly interested in the development of risk-benefit frameworks and the integration of human relevant and socially responsible safety methodologies into the regulatory approval processes for new ingredients and novel foods. His team is currently focused on the development of gastrointestinal models to assess genotoxicity, bioaccessibility and bioavailability of orally ingested materials, including nanomaterials considered for use by the food and consumer product industries.

# Development of Platform Technology for Food Waste Valorisation and Sustainable Food Circular Economy

**Jaslyn Lee, Kuan Rei Ng, Kong Fei Chai, Aaron Li Zhon Wei, Amanda Voo, Yi Ling Chin, Ting Shien Teng, Yun Nian Tan, Sachindra Cooray, Xiao Mei Lyu, Wei Kit Mok, Yong Xing Tan, Xi Cui, Jaejung Kim, Rita Mark, Sulagna Gupta, Gui Li Zhao, Ying Tong Yeo, Jianhua Zhang, Eleanor Soole, and William Chen**

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**E-mail:** wnchen@ntu.edu.sg

## Abstract

The key elements of Singapore's food security include availability of food from either domestic production or global market, accessibility of food by consumers, affordability, and safety as well as nutrition standards for consumers. Singapore imports over 90% of its food supply which leaves it vulnerable to trade and supply chain disruptions that can cause food prices to increase. The current COVID-19 pandemic acutely reflects Singapore's vulnerability in food security with severe disruption in global supply chain. Similarly, climate change may cause severe flooding and droughts in neighbouring countries, which can cause crop failure and in turn affect supply.

Technology innovations are needed to overcome these limitations and enhance food security in Singapore. Such technologies may include urban farming, technology-driven food waste management (zero waste food processing) as well as platform technology to develop alternative and unconventional food sources.


**Fig. 1:** Tech innovations for zero waste food processing and food circular economy

My presentation covers the development of platform technology from NTU FST (Fig. 1), focusing tech innovations for food waste upcycling leading to food circular economy. Examples may include: 1) sustainable natural food preservatives to extend shelf life of food produce resulting in reduced food waste generation; 2) nutrient recovery from food waste and the resulting wide spectrum of applications; 3) from-food-for-food biodegradable packaging materials resulting in food circular economy and solution for long term plastic waste reduction.

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## Biography

Prof. William Chen
Director of NTU Food Science and Technology
Co-Director, FRESH@NTU
Nanyang Technological University

Professor William Chen is the Michael Fam Chair Professor with NTU Singapore. His food research has a strong focus on development of food technology platform, which has resulted in his active joint R&D with food industry and government agencies. The F&N-NTU F&B Innovation Lab opened in 2019 is the first external lab in the company's 140 years of history. A number of his innovations have been developed into consumer products, and his research has been published in top food science journals. He is also actively engaged in various government efforts in enhancing food security. Prof. Chen's research in zero food waste processing and Circular Food Economy has been extensively covered by local and international media. He has been interviewed for his food tech innovations and his views on Food Security by international media. The ‘Going Green’ programme produced by CNN in 2019, based on his innovations, described Professor Chen as a Game-Changing Leader in the green revolution of the food system. Professor Chen is Advisor to government agencies, food industry, NGOs and overseas universities on matters related to food tech and food security.

# Keynote Talks

## Track 1 - Sustainable Food Systems

**Co-Chairs:**
**A/Prof HUANG Dejian**
(Deputy Head, Department of Food Science & Technology, National University of Singapore, Singapore)

**Prof Mely Caballero ANTHONY**
(Head, Centre for Non-Traditional Security Studies, The S. Rajaratnam School of International Studies, Nanyang Technological University, Singapore)

27 April 2021, 1240hrs - 1420hrs

# Image-based Food Recognition for Nutritional Analysis

**Chunyan Miao**

*School of Computer Science and Engineering (SCSE) &*
*Joint NTU-UBC Research Centre of Excellence in Active Living for the Elderly (LILY),*
*Nanyang Technological University (NTU), Singapore*
**E-mail:** ascymiao@ntu.edu.sg

## Abstract

A healthy diet is crucial for the prevention and intervention of various chronic diseases, especially for 3H: high blood glucose, high blood pressure, and high cholesterol. To enable users to keep track of their diet intake with ease and convenience, our research team from LILY, NTU, has developed a mobile app (see Fig. 1) for effortless diet management by automating food recognition and nutritional calculations [1]. To develop an AI algorithm for food recognition and recommendation for 3H prevention, we created a large labeled food image dataset, including many local cuisines in Singapore.

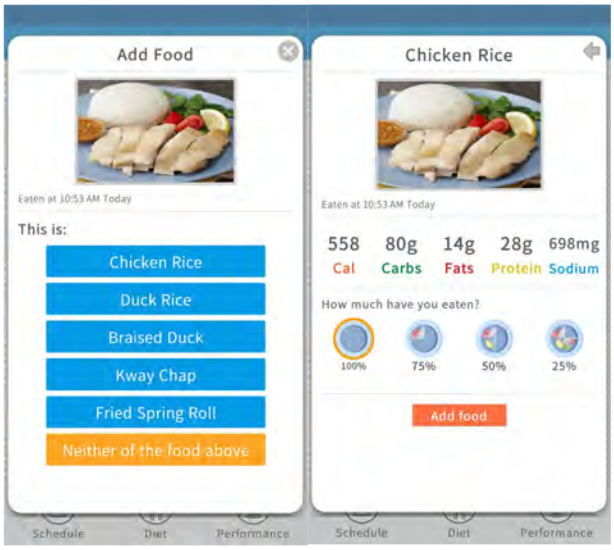


**Fig. 1:** The interfaces of a mobile app for users to upload their diet intake and view the nutritional composition.

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## Biography

Prof Chunyan Miao is a President's Chair Professor and the Chair of the School of Computer Science and Engineering (SCSE) at Nanyang Technological University (NTU), Singapore. She received her PhD degree in Computer Engineering from NTU and was an NSERC Postdoctoral Fellow at Simon Fraser University (SFU), Canada. She was a founding faculty member of the Centre for Digital Media established by The University of British Columbia (UBC) and SFU. She was also a Tan Chin Tuan Engineering Fellow at Harvard and MIT.

Prof Miao has received over 20 best paper/innovation awards in artificial intelligence (AI) and real-world AI applications for her impactful research in health, ageing, education and smart services. She is a recipient of the prestigious NRF Investigatorship Award 2018. She was awarded a Public Administration Medal (Bronze) from the President of Singapore in 2016. She also holds major research funding including MOH National Innovation Challenge (NIC) on Ageing award 2018 and NRF AI Singapore Health Grand Challenge Award 2019. She is the Founding Director of the Joint NTU-UBC Research Centre of Excellence in Active Living for the Elderly (LILY), Singapore's first centre focusing on AI empowered solutions to population ageing challenges. She is also the Founding Director of the Alibaba-NTU Singapore Joint Research Institute (JRI), Alibaba's first and largest JRI outside China.

# Future of Sustainable Food

**Ralph Graichen, PhD**

*Senior Director, Biomedical Research Council, A*STAR, Singapore*
**E-mail:** ralph_graichen@hq.a-star.edu.sg

## Abstract

Singapore is relient on imports for more than 90% of its food supply. It is therefore rather vulnarable to disruption in the food supply chain (e.g. COVID-19), global shortages and food safety risks. At the same time global food demand is projected to rise by 60%, as the global population will grow from 7.3b today to 9.8b by 2050 and climate change threatening harvests in many countries. The UN projected that two-thirds of people in the world will be living in cities by 2050. This will provide challenges for food supply chains and increase loss in the food system. Urbanisation and rising affluence are also driving a “nutrition transition” in developing countries towards higher consumption of animal protein which will require large increase in livestock production and intensive use of resources. Demand for protein will rise by 70%, and demand for fruits and vegetable will rise by 100%. On the other hand, global food production in the traditional way may not be able to supply sufficient food to keep up with global food demand. To meet the growing food demand, the world needs to develop more productive and sustainable food production systems. Technology innovation in multiple research disciplines can help overcome these challenges and turn these threats into potential opportunities for for the food system and specifically for Singapore.

## Biography

Dr Ralph Graichen is currently Senior Director, Food & Consumer at the Agency for Science, Technology and Research (A*STAR), Singapore. In this function, Ralph is leading his team to develop A*STAR’s strategy in food & nutrition, consumer care as well as human potential. He is responsible for driving activities across the public and private sector in Singapore, supporting economic activities, research funding and strategic national and international relations.  He has a co-appointment as Adjunct Associate Professor with Nanyang Technological University, School of Chemical & Biomedical Engineering. In his current position with A*STAR, Ralph is working with strategic partners to administer and develop new initiatives and programmes in the research areas of food, nutrition and consumer care.  Ralph is a board member of the Singapore Food Agency as well as a member of the Singapore Food Standard Committee.

Ralph has over 16 years of experience in the local and global biomedical and nutrition industry. He was previously Research Operations Manager for Abbott Nutrition in Asia, establishing the R&D infrastructure and managing the research portfolio for Asia.

Ralph graduated with a master in Biology from the Johannes Gutenberg University, Mainz, Germany and attained his PhD from the National University Singapore through the Institute of Molecular and Cell Biology. Ralph attended the Food System Leadership Institute, a program of the Association of Public and Land-Grant Universities (APLU) with support from the W.K. Kellogg Foundation.

# Plant genetic engineering for sustainable food production

**Hong Luo**

*Department of Genetics and Biochemistry, Clemson University, Clemson, SC 29631, USA*
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## Abstract

With the projected global population of nearly 10 billion by 2050 and the decreasing arable land and increasing environmental adversities for agriculture and animal husbandry as a result of climate change, it becomes incredibly more challenging to produce enough food to feed the burgeoning world. New strategies need to be developed to address this imminent urgency for a sustainable food future, of which increasing food production without expanding agricultural land through livestock and pasture productivity enhancement, crop breeding improvement and enhanced crop adaption to environmental adversities provides an effective solution. Plant genetic engineering using transgenic technologies offers the opportunity to incorporate into food and forage crops many agronomic benefits that are difficult or impossible to achieve through traditional breeding techniques. Beneficial traits such as high nutritional quality for cost effective food production, biotic and abiotic stress tolerance allowing plant growth in marginal land, better plant adaptation to adverse environment and less pesticide applications among a long list of others, can be improved. Biotic and abiotic stresses such as diseases, pests, drought, salinity, heat and nutritional deficiency are among the most important factors significantly impacting the productivity and quality of the food and forage crops. Using transgenic technology, we have developed various novel molecular strategies to genetically engineer perennial forage grasses targeting biological pathways involved in plant responses to biotic or abiotic stresses. Genes encoding structural, regulatory proteins and non-coding RNA molecules were manipulated in transgenic forage grasses, producing new cultivars with significantly improved plant tolerance to disease, pest, drought, salt, heat and enhanced nitrogen and phosphate use efficiency [1-15]. Simultaneously, we have also developed novel molecular strategies to mitigate potential transgene escape and to remove un-wanted DNAs in the final product allowing production of clean, environmentally friendly transgenic forages with significantly improved agronomic traits for commercialization [16]. The similar technologies can be easily extended to food crops, fruit trees and vegetables, significantly impacting modern agriculture and animal husbandry and contributing to environmentally friendly, sustainable food production.

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## Biography

Dr. Hong Luo is a professor in the Department of Genetics and Biochemistry at Clemson University. He holds a bachelor's degree in Agronomy, and master's degrees in Plant Genetics and Breeding, and Molecular Biology. After completing his Ph.D. at the Catholic University of Louvain, Belgium, Dr. Luo did his postdoc in the National Center of Scientific Research in France and Purdue University. Before joining Clemson University, he was with HybriGene, Inc. as the Director of Research. He is the recipient of the 2013 Clemson University Godley-Snell Agricultural Award for Excellence in Agricultural Research and has published more than seventy peer-reviewed journal articles and two books and has been awarded five patents. He serves as Associate Editor/Academic editor for *Frontiers in Plant Science*, *Grass Research*, *PLoS ONE*, *Genetics and Molecular Biology*. He is the member of American Association for the Advancement of Science (AAAS), American Society of Plant Biologists (ASPB) and the Society for In Vitro Biology (SIVB) and served as SIVB Plant Biotechnology Section Program Committee Co-Chair and Chair (2014-2016). He currently maintains several active research projects for both basic and applied research on genetic modification of crop plants. He has taught Advanced Genetics, Genetics and Biochemistry Senior Seminar, Principles of Molecular Biology and Plant Physiology.

# Materials Enhanced Agriculture and Remediation

**Lam Yeng Ming**

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## Abstract

Land is very important for food production to feed our growing population. As our world population continues to grow (currently ~ 7.8 billion), more strain is put on land resources both for economic development and food generation. There is a need to optimise and extend the use of available land for food production. In this talk, I will share with you some on-going work on soil conditioning, soil remediation, soil replacement for indoor farming work. Soil exposed to repeated wetting and drying in a tropical region are prone to develop hydrophobic coatings on the soil particles that results in hardness and water repellence. This condition limits the rate and capacity of water absorption leading to poor water infiltration and retention in soil. We have designed a super water absorbent nanosize gel particle and formulate a solution to combine both water retention and soil conditioning capabilities. In this talk, I will also take this opportunity to share some testbedding of this concept. Singapore is a land scarce country and this means that every inch of land is precious. As such throughout the history of Singapore, we also have to repurpose land use. We work closely with NParks and NIE to survey and using both phytoremediation and materials augmented phytoremediation way to reduce the contaminants in some areas. Last but not least, for a small nation like Singapore, it is important to ensure food security and as we are land-challenged, moving forward, we looked into using functional materials to help to enhanced food production in indoor farms.

## Biography

Prof Yeng Ming LAM received her Ph.D. degree in Materials Science and Metallurgy from the University of Cambridge in 2001. She is currently a Professor and the Chair of the School of Materials Science and Engineering, NTU. She is also the Director of the Facility for Analysis, Characterization, Testing and Simulations (FACTs). She is also the Founder for FytoSol Pte Ltd that is dedicated to deliver solutions to horticulture and agriculture needs. She sits on the governing board for International Symposium for Polymer Analysis and Characterization(ISPAC) and the National committee on Measurement and characterisation. She held a concurrent Senior Scientist position in RWTH University in Aachen, Germany, between 2011 and 2014 and a concurrent Senior Scientist position in IMRE, A*Star, from 2010-2011. She was awarded the Nanyang Award for Excellence in Teaching in 2006 and the L'Oréal Unesco For Women in Science National Fellowship and the Nanyang Outstanding Young Alumni Award in 2009.

# Redefining the Agriculture – Food Continuum for the 21st Century

**Paul Teng**

*Centre for Non-Traditional Security Studies, RSIS, & NIE International,*
*Nanyang Technological University Singapore*
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## Abstract

Agriculture traditionally has been the main source of food since the days when human communities started to settle along river deltas and domesticated plants and animals. Up till recently, farming in the countryside has been the main provider of food. However, in the second decade of the 21st Century, we are witnessing an increasing contribution of urban agriculture and aquaculture, augmented by "factory" produced raw food ingredients as well as edible food. There is therefore a need to redefine the agriculture-food continuum with a conceptual framework based on "Food Systems" which explicitly takes into account internalities and externalities and links all in a circular manner to support sustainability.

Different definitions exist for what constitutes "food systems". The High Level Panel of Experts on Food security and Nutrition of the FAO, UN states that a Food System comprises "all the elements (environment, people, inputs, processes, infrastructure, institutions, etc.) and activities that relate to the production, processing, distribution, preparation and consumption of food, and the output of these activities, including socio-economic and environmental outcomes" (1); the Economist Intelligence Unit considers it to cover "end-to-end activities, from production to consumption, and even disposal. More broadly, it also covers the governance and economics of food production, its sustainability, the degree to which we waste food, and how food production affects the natural environment" (2). Both these treat food systems as "end to end" inter-linked supply chains, with pre-production activities (including preparation of inputs like seed and fertilizer) at one end, and food consumption/waste at the other, going through components such as input supply, production (grow-out), post-harvest processing, storage and transport, etc. to food consumption and waste. In the past, agriculture stretched from production to post harvest processing, while food processing commonly encompassed processing to consumption, with various value-adding activities along the way. In the 21st Century, there is growing concern about the sustainability of food systems, with the concept of circular economy or circularity underpinning much of the discussion of food systems which are represented by this agriculture-food continuum. And embedded in the discourse is the desire to reduce food loss and waste. It is common to hear estimates of 30-50% food loss which implies loss of agricultural produce post farm gate. In the 1970's, the FAO,UN spearheaded a Global Programme on Crop Loss Assessment which focussed on pre-harvest losses. Many estimates put crop losses caused by abiotic factors (drought, floods, natural disasters) and biotic factors (mainly weeds, insect pests and plant pathogens), in contrast to food losses, at around 15-30%. Indeed if pre harvest crop losses and post harvest food loss and waste are added for any food system, the extent of usable biomass would only be a small fraction of production. This attests to the danger of not adopting a systems view of end-to-end agrifood systems and of treating separately what is otherwise parts of the same system. The pioneering 2011 FAO Report on Food Loss and waste showed that losses were higher in developing countries than developed, but waste was the reverse. A "whole of system" approach as represented by the agriculture-food continuum would suggest different priorities between developing and developed countries in terms of how to reduce overall biomass leakage from the system. This approach would also encourage governments and the private sector to develop appropriate policies and technological enablers to shorten supply chains and decrease the "food miles" of transporting food, e.g. through urban farming and novel food production such as laboratory-produced food in bioreactors and plant factories. Recycling agricultural and food waste through composting, etc. would be a circular way to provide inputs for growing plants while growing insects using food waste would provide new feedstock for animal feed or human protein. Growing algae or bacteria from food waste for food or industrial applications would add to system sustainability. Treating the agriculture-food systems as a continuum would also foster optimal application of disruptive 4th IR digital, mechanical and biological technologies to ensure circularity and sustainability. Ultimately, technologies such as "Blockchain" assure both farmers (agriculture) and consumers (food) that there is integrity in the identity and safety of food originating from any agricultural locale.

**References:**

[1] High Level Panel of Experts on Food security and Nutrition. Report no. 12. 2017. FAO, UN.
[2] The Economist Intelligence Unit. Separate Tables: Bringing together Asia's food systems. 2018.

## Biography

Professor Paul Teng is Dean and Managing Director, NIE International Pte. Ltd., and Adjunct Senior Fellow, Centre for Non-Traditional Security Studies, RSIS, Nanyang Technological University, Singapore. He is also concurrently Honorary Chair, International Service for the Acquisition of Agribiotech Applications (ISAAA), Adjunct Professor, Murdoch University, Australia, and Senior Fellow, Southeast Asian Regional Center for Graduate Study and Research in Agriculture, Philippines. His expertise includes food security, commercialization and biosafety of crop biotechnology, agritechnology innovations and bio-entrepreneurship, and sustainable development. He has over thirty years of experience from positions in international organizations (IRRI, Worldfish Centre), U.S. universities (Minnesota, Hawaii) and the private sector. Prof. Teng has won numerous awards for his work -- the Eriksson Prize in Plant Pathology (Royal Swedish Academy of Science), Honorary D.Sc. (Murdoch University, Australia), Fellow, American Phytopathological Society; Fellow, International Society for Plant Pathology and Fellow, The World Academy of Sciences (TWAS). He has published/ co-published nineteen books and over 200 technical papers.

# Keynote Talks

## Track 2 - Food Safety / Consumer Education

**Co-Chairs:**
**Asst Prof MA Wei**
(Assistant Professor, School of Biological Sciences,
Nanyang Technological University, Singapore);

**Prof DUAN Hongwei**
(Professor, School of Chemical & Biomedical Engineering,
Nanyang Technological University, Singapore)

27 April 2021, 1500hrs - 1640hrs

# A Modern Approach for the Protection of the Food Supply: Smarter Food Safety

**Jianghong Meng**

*Joint Institute for Food Safety & Applied Nutrition and Center for Food Safety & Security Systems, University of Maryland, College Park, USA*
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## Abstract

On April 30, 2019, the US Food and Drug Administration (FDA) announced a New Era of Smarter Food Safety. This new initiative is intended to build on FDA's efforts to implement the FDA Food Safety Modernization Act by leveraging, among other things, the use of new and emerging technologies as well as new approaches to some of the food system's biggest food safety challenges. This talk will introduce the new initiative that includes topics such as Tech-enabled Traceability and Foodborne Outbreak Response; Smarter Tools and Approaches for Prevention; New Business Models and Retail Modernization; and Food Safety Culture. Whole genome sequencing will be discussed as an example of technologies that have been applied to enhancing traceability throughout the food safety system and foodborne outbreak response. The FDA has established a first-of-its-kind network of laboratories that can sequence the genomes of foodborne pathogens and then upload the genomic sequence and the geographic location from which the pathogen was collected, into a publicly accessible database. Known as the GenomeTrakr, this new tool is a paradigm-changing development to facilitate foodborne outbreak investigations.

**References:**

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## Biography

Dr. Jianghong Meng, Director, Joint Institute for Food Safety & Applied Nutrition (JIFSAN, www.jifsan.umd.edu) and the Center for Food Safety and Security Systems (CFS3); and Professor, Department of Nutrition and Food Science, University of Maryland, College Park, USA. Prof. Meng received his veterinary medicine degree in China, and Mater of Preventive Medicine and Ph.D. from the University of California, Davis. He is a Fellow of American Academy of Microbiology, and a Fellow of Food System Leadership Institute of the US Association of Public and Land-grant Universities. He has conducted innovative and cutting-edging research to address major issues in microbial food safety and public health. He has published over 230 research articles, book chapters and reviews.

# “Meat” the Future: Consumers’ Perceptions of Nano-Enabled Food & Plant-Based Meat

**Shirley S. Ho[1,2]**

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[2]*President’s Office, Nanyang Technological University, Singapore*
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## Abstract

Changes in food properties can spark big questions and raise public anxiety. While the development of novel foods such as nano-enabled food and plant-based meat promises new benefits for the public, consumer groups have raised concerns about its potential health and environmental impacts. The increasing availability of novel foods to global consumers calls for a timely investigation of the current opinion climate towards novel food technologies. Based on public opinion studies conducted in Singapore, Dr. Shirley Ho will share key findings regarding the current levels of public acceptance of nano-enabled foods and plant-based meat, public attitudes toward regulations, and their willingness to consume the novel foods. Drawing upon theoretical approaches from science and risk communication, Dr. Ho will share insights on the mechanisms behind how socio-psychological and media factors shape public willingness to consume the novel foods. The talk will culminate with the discussion on the key communication strategies and directions for future research.

## Biography

Dr. Shirley Ho is Professor in the Wee Kim Wee School of Communication and Information at Nanyang Technological University. She is concurrently the Research Director for Arts, Humanities, Education and Social Sciences in the President’s Office at NTU. She is an expert in the area of science communication, in which she investigates cross-cultural public opinion dynamics related to science and technology, with potential health or environmental impacts. Her work emphasizes the roles of values, social media and other emerging modes of communication in shaping public attitudes toward science and technology. She is the Principal Investigator of several large-scale, interdisciplinary research projects that are funded by the National Research Foundation, the Ministry of Education, and the Info-communications Media Development Authority in Singapore. Her research has won many top faculty paper awards at major international conferences and her works have appeared in top-tier journals such as Nature Nanotechnology and Communication Research. She is the Editor-in-Chief of the journal, Environmental Communication. She is the recipient of the 2018 Hillier Krieghbaum Under-40 Award, given by the Association for Education in Journalism and Mass Communication to honor scholars under 40 years of age who have shown outstanding achievement and effort in teaching, research and public service.

# Antimicrobial activity of defence phytochemicals: prenylated (iso)flavonoids and isothiocyanates

**Silvia Andini, Carla Araya-Cloutier, Sylvia Kalli & Jean-Paul Vincken**

*Department of Agrotechnology and Food Sciences,*
*Wageningen University & Research, The Netherlands*
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## Abstract

Defence phytochemicals are produced *de novo* in the plant upon (biotic or abiotic) stress. Defence phytochemicals have been acknowledged for their promising bioactivity such as estrogenic, antibacterial and anticancer. These secondary metabolites can provide health benefits to animals and humans as medicinal natural products and/or food ingredients.

Prenylated (iso)flavonoids (those bearing a C5-isoprenoid moiety) are the main class of defence phytochemicals in leguminous plants (e.g. soybean). By simultaneous malting and fungal elicitation of soybeans the amounts of prenylated isoflavonoids and consequently their bioactivity, in particular antimicrobial activity, can be enhanced. Broad diversity in the (iso)flavonoid skeletons, the number of prenyl groups (one or two), and the prenyl configurations (chain or ring) can be found in nature. Evidence shows that these structural variations play a key role in their antimicrobial properties and spectrum of activity. Diprenylated (iso)flavonoids, bearing two prenyl chains, were among the most active antibacterials against Gram positive bacteria, such as *L. monocytogenes* and methicillin-resistant *S. aureus,* with minimum inhibitory concentrations (MIC) of less than 10 µg/mL. Furthermore, monoprenylated isoflavonoids, bearing a chain or a ring prenyl group, showed the best anti-yeast activity, with a MIC of ≤ 15 µg/mL against *Z. parabailii*. Gram-negative bacteria, such as *E. coli*, showed high intrinsic resistance towards these natural compounds, which could be overcome with the use of an efflux pump inhibitor. Regarding the mode of action of these compounds, it was shown that prenylated phenolic compounds can rapidly disrupt the integrity of the cytoplasmic membrane by permeabilization. Interestingly, some good antibacterial prenylated (iso)flavonoids showed good permeabilization capacity, whereas others did not (including the diprenylated molecules). Based on our QSAR studies, it is proposed that active prenylated (iso)flavonoids with different primary molecular properties might employ different mechanisms for cell uptake or interaction with the cytoplasmic membrane.

Isothiocyanates (ITCs) are another class of defence phytochemicals known for their antimicrobial properties. ITCs are released upon degradation of glucosinolates, as a defence response in the Brassicaceae family. Isothiocyanates bear an -N=C=S group, which makes them highly reactive towards (biological) nucleophiles. The antimicrobial properties of ITCs, mainly of allyl ITC (AITC), has been reported before, nonetheless, the antimicrobial properties and spectrum of activity of different ITC subclasses, bearing different side chains, have not been investigated before. Isothiocyanates (ITCs) with short chained methylsulfinyl (MS) or methylsulfonyl (MSo) groups represent ITCs with a good antimicrobial activity (MIC 25 µg/mL) against Gram negative bacteria (*E. coli*). ITCs with a long chained MS/MSo groups showed good antimicrobial activity (MIC ≤ 25 µg/mL) against Gram positive bacteria (*B. cereus, L. monocytogenes*) and fungi (*S. cerevisiae* and *A. niger* spores).

The quantitative structure-activity relationships and mode of action of antimicrobial prenylated (iso)flavonoids and ITCs will be discussed. New lead compounds for the development of novel natural antimicrobial compounds will be highlighted.

**References:**

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## Biography

Dr. Carla Araya-Cloutier is assistant professor at the Laboratory of Food Chemistry (FCH), Wageningen University & Research (WUR), The Netherlands. Her research is focussed on antimicrobials from plants. She completed her PhD at FCH on the antibacterial activity of prenylated isoflavonoids and stilbenoids from stressed legumes. She continued her postdoctoral studies at the same department and promoted to assistant professor after successfully securing a prestigious NWO VENI grant to support a novel project on phytochemicals as efflux pump inhibitors in bacteria. In her work, she integrates molecular modelling techniques for predicting and rationalizing the (quantitative) structure-activity relationships and the molecular mechanism of action of plant antimicrobials.

# Food Authenticity – Mitigating Emerging Risks and Threats

**Sterling Crew (FIFST, FCIEH, FRSPH, CEnvH, CSCi)**

*The Food Authenticity Network, Teddington, Greater London, United Kingdom*
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## Abstract

Food fraud is an age old problem that reoccurs periodically in global food supply chains. The prevention of food fraud is paramount to protect consumers and to maintain fair, sustainable business practices. No process can guarantee that our food and food supply chains are not the target of criminal activity. The purpose of this presentation is to guide viewers through approaches and processes to improve the resilience of supply chains to food fraud.

As well as the loss of confidence in food and economic disadvantage to the consumer, food fraud costs the global food industry an estimated US$40 billion a year.

Food fraud can harm consumers, causing illness and even death in some cases. This was true in 2008 when melamine was used as a nitrogen source to fraudulently increase the measured protein content of milk, resulting in more than 50,000 babies hospitalised and six deaths after having consumed contaminated infant formula.

Since the 2013 issue of the fraudulent use of horsemeat in beef products, there is world-wide consensus that as well as being better at detecting food fraud, more needs to be done to prevent food fraud from happening in the first place.

Sterling looks at the common factors in many of the recent cases and how risks can be mitigated to reduce vulnerability to fraud and assure the authenticity of food. In doing so, he will review various risk factors, which create vulnerabilities in a supply chain and examine selected risk mitigation measures aimed at preventing food fraud.

The effect of the COVID-19 pandemic are being felt across the global food supply network and could impact vulnerability to food fraud. Sterling reviews the potential food authenticity challenges created by the outbreak and the mitigation of the specific emerging risks and threats.

Sterling will also cover the role played by the Food Authenticity Network (www.foodauthenticity.global), an open access website that brings together global information on food authenticity testing, food fraud mitigation and food supply chain integrity in one convenient location.

## Biography

Sterling is Chair of the Advisory Board of the Food Authenticity Network. He is co-founder of Kitchen Conversation. Managing Director of SQS Ltd and is a Strategic Advisor at Dynamic Risk Indicator and the Shield Safety Group. Sterling is the Independent Scientific Advisor at Campden BRI and sits on its board. He is also on the audit governance board At Eurofins.He is Scientific Advisor to Olio the online food sharing business and City to Sea the plastic waste reduction charity.
He sits on the Editorial Board of New Food Magazize. He chairs the Institute of Food Science and Technologies Food Safety Group, sits on its Editorial Board and is it’s immediate past Vice President.

He has 35 years’ experience of working in the field of national and international food safety, authenticity governance, sustainability and regulation. He started his career in government before a successful track history in retailing with Marks and Spencer and Tesco. He has also worked in the branded environment for Coca Cola and Disney and two international food manufacturers.

Sterling’s experience as a regulator, retailer, brand owner and food manufacturer has given him a unique perspective of the authenticity challenges in the global food supply network.

# Beechwood Xylan-Derived Dietary Fibers that are Produced by an Autohydrolysis Process Govern Gut Microbiome Responses and Metabolic Outputs

**Ming-Hsu Chen** and **Sainan Zhao**

*School of Chemical and Biomedical Engineering, Nanyang Technological University. Block N1.2, 62 Nanyang Drive, Singapore 637459*
**E-mail:** minghsu.chen@ntu.edu.sg

## Abstract

Autohydrolysis is a pretreatment technology that utilizes hydrothermal treatments to fractionate the plant cell wall components. During this process, the lignocellulosic materials are incubated with saturated steam under elevated pressure and temperature conditions, and the acetyl substitutes released from hemicellulose reduce the solution pH and progressively hydrolyze plant xylan (Mosier et al. 2005). The intensity of the autohydrolysis treatments can be evaluated using severity parameters by lumping reaction temperatures and holding times (Pedersen and Meyer 2010). The produced soluble xylan fractions, with variant structural properties, can be recovered and used as dietary fiber and nutraceutical supplements.

Although xylo-polysaccharides and xylo-oligosaccharides derived from autohydrolysis are used for human consumption, there is limited information connecting the processing parameters and structural properties to the colonic fermentation of these nondigestible carbohydrates. Thus, to further clarify these relationships, beechwood xylan (BWX)-derived fiber substrates, prepared under five reaction severity conditions, were fermented with human gut microbiota using an *in vitro* model. Distinct fermentation kinetics were observed among the five BWX substrates. However, there were no significant differences in the glycosyl compositions. We found that the Firmicutes to Bacteroidetes ratio in the gut microbiota and the propionate to butyrate ratio in the culture media were altered by the BWX substrates. In addition, the relative abundance of specific microbial taxonomies, including genera *Bacteroides*, *Fusicatenicater*, *Blautia*, *Bifidobacterium*, and *Megasphaera*, were enriched after feeding with particular BWX substrates. In conclusion, we demonstrated that in addition to considering the yield and purity factors, it may be important to include the autohydrolysis process parameters used in the production of xylan-derived dietary fiber products.

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[2] M. Pedersen and A.S. Meyer, Lignocellulose pretreatment severity – relating pH to biomatrix opening. *New Biotechnology*, **27**(6), 739–750 (2010).

## Biography

Ming-Hsu Chen is an assistant professor in the School of Chemical and Biomedical Engineering, Nanyang Technological University. Dr. Chen received his PhD from the University of Illinois at Urbana-Champaign and gained his postdoctoral training at the Whistler Center of Carbohydrate Research at Purdue University. His research group is interested in the areas of sustainable food production, functional carbohydrate development, and gut microbiome engineering.

Sainan Zhao is a second-year PhD student in the School of Chemical and Biomedical Engineering, Nanyang Technological University. Ms. Zhao received her MS degree from the Harbin Institute of Technology. She is currently studying xylan-derived dietary fibers, including their production, fermentation, and the degrading microbial consortia.

# Keynote Talks

## Track 3 - Food Processing Technology

**Co-Chairs:**
**Dr Ken LEE**
(Senior Lecturer, School of Physical & Mathematical Sciences
- Division of Chemistry & Biological Chemistry,
Nanyang Technological University, Singapore);

**A/Prof Susanna LEONG**
(Assistant Provost (Applied Research), Singapore Institute of Technology, Singapore)

28 April 2021, 0900hrs - 1040hrs

# Food Processing for Future Foods

**Susanna S.J. Leong**

*Chemical Engineering and Food Technology Cluster, Singapore Institute of Technology*
**E-mail:** Susanna.Leong@Singaporetech.edu.sg

## Abstract

The development of future foods must be complemented by viable food processing technology that can produce new food products cost effectively and sustainably at scale. SIT offers capabilities in spray drying formulation and process optimization at different scales, crystallization and extrusion. Current research activities in spray drying include simulation of spray drying parameters, lab-scale formulation of food powder products, characterization of food powder properties and product/process scale up. SIT is also studying the use of high moisture extrusion to develop meat alternative products. Successful prototypes can be further scaled at SIT's small batch food production facility for market validation.

## Biography

Susanna Leong is an Associate Professor at the Chemical Engineering and Food Technology Cluster and Assistant Provost (Applied Research) at SIT. She did her chemical engineering undergraduate degree at UMIST (University of Manchester Institute of Science and Technology), and obtained her PhD (Chemical Engineering) from Cambridge University. Her research interests are in biochemical engineering and protein/peptide engineering.

# Value Added of Baby Corn Blanching Water through Fermentation

**Warawut Krusong**

*Division of Fermentation Technology, Faculty of Food Industry,*
*King Mongkut's Institute of Technology Ladkrabang, Bangkok 10520, Thailand*
**E-mail:** warawut.kr@kmitl.ac.th

## Abstract

Baby corn blanching water (BCBW), a massive waste water of processed baby corn product in hermetically sealed containers, contains high soluble protein and minerals. According to the zero waste concept, fermentation is an effective process to produce various value added product from BCBW. Bio-acetic acid is a product of interest. Commercialized production process has been successfully done using our developed technology with the target concentration of acetic acid of 8-12%. Two development issues are emphasized consisting of (1) a specifically designed bioreactor and, (2) an adaptation of acetic acid bacteria (AAB) on tolerance of high initial acetic acid concentration, a very severe environment. The first issue, high aeration system with abundant of fine air bubble is designed to provide high volumetric oxygen transfer coefficient (kLa) in the bioreactor. The high dissolved oxygen (DO) content is provided and sufficiently supported the activity of both membrane-bound enzymes, alcohol dehydrogenase (ADL) and aldehyde dehydrogenase (ALDH) of AAB cells for effectively converting ethanol to acetic acid. Our bioreactor is called as "Internal Venturi injector (iVi) bioreactor". The fine air bubble is supplied after pumping of the air through Venturi injector to fermentation medium. The details of this designed iVi bioreactor are indicated in the Petty Patent Inventions "Vinegar System with Fermentation Medium Mixed with Air in an Internal Venturi Ejector System" Intellectual Property. Additionally, it is awarded the Best Mechanical Technology Award, 1st prize in manufacturing machinery from the Ministry of Science and Technology, Thailand. Simultaneously, our screened culture of *Acetobacter aceti* has been adapted for acetic acid tolerance on the concept-"AAB can produce high concentration of acetic acid due to the ability to withstand high concentration of acetic acid in the fermentation mash". The success of these two developments has been passed down to entrepreneurs. There are six companies through the application of invention privileges from King Mongkut's Institute of Technology Ladkrabang. In addition, bio-acetic acid is commercialized in form of 5% acetic acid in liquid solution. It is also further developed as healthy drink. Moreover, the bio-acetic acid in the vapor-phase form is applied in food safety (such as elimination of *Klebsiella pneumoniae* contaminated on coriander leave) and postharvest technology (such as inhibition of mold *Botrytis cinerea* on strawberry). The satisfactory results are obtained. Nowadays, the baby corn silk is focused. The bio-acetic acid from the silk is more benefit and good for health.

## Biography

Warawut Krusong is Professor of Division of Fermentation Technology, Faculty of Food Industry, King Mongkut's Institute of Technology Ladkrabang (KMITL), Bangkok, Thailand. He graduated from Kasetsart Univeristy for his B.Sc. and M.Sc. and gained a Ph.D. from University of the Philippines at Los Banos. He works in development of commercial fermentation processes. His work in development of commercial bio-acetic acid production process is licensed for six companies.

# Production, Extraction, and purification of the high-value molecule phycoerythrin from *Porphyridium purpureum*: strategies and achievements

**Roberto Parra-Saldivar[1], Carlos Castillo-Zacarías[2], Laura Rodas-Zuluaga[1], Elda M. Melchor-Martínez[1]**

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[2]*Universidad Autónoma de Nuevo León, UANL, Facultad de Ciencias Químicas. Av. Universidad S/N Ciudad Universitaria, San Nicolás de los Garza, C.P. 66455, Nuevo León, México*
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## Abstract

The red marine algae *Porphyridium purpureum* is well known for producing interesting biopigments such as allophycocyanin, phycocyanin, and phycoerythrin [1]. Among these, the phycoerythrin (PE), a polar protein with interesting biological activities like antioxidant, anti-carcinogenic, anti-inflammatory, and fluorescent properties are produced [2]. Notably, the worldwide PE market is estimated to reach US $ 6.3 million by 2025 [3]. Several strategies for the production of phycoerythrin from the marine microalgae *P. purpureum* were performed to scale up (Figure 1). During this experiment, nitrogen concentration and light intensity were evaluated in order to obtain high biomass production and high phycoerythrin accumulation from *P. purpureum*. The range of nitrogen concentrations evaluated in the culture medium was 0.075–0.450 g $L^{-1}$ and light intensities ranged between 30 and 100 μmol $m^{-2}$ $s^{-1}$.

Surprisingly, low nitrogen concentration and high light intensity resulted in high biomass yield and phycoerythrin accumulation. Thus, the best biomass productivity (0.386 g $L^{-1}$ $d^{-1}$) and biomass yield (5.403 g $L^{-1}$) were achieved with $NaNO_3$ at 0.075 g L−1 and 100 μmol $m^{-2}$ $s^{-1}$.

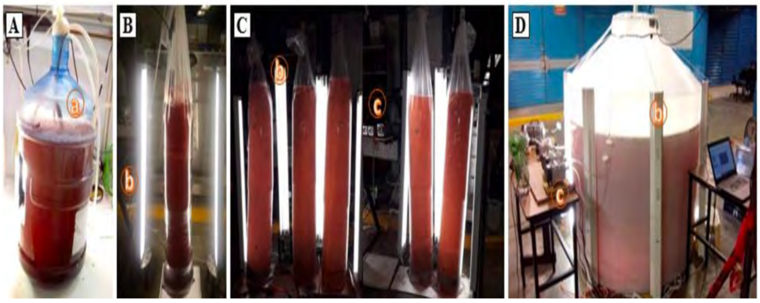

**Fig. 1:** Strategy for phycoerythrin production from *P. purpureum*. A) 16 L culture; B) 80 L culture; C) 400 L culture; D) 2000 L culture.

In addition, phycoerythrin production was improved to obtain a concentration of 14.66 mg $L^{-1}$ (2.71 mg $g^{-1}$ of phycoerythrin over dry weight). The results of the present study indicate that it is possible to significantly improve biomass and pigment production in *P. purpureum* by limiting nitrogen concentration and light intensity.

**References:**

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[2] Li, T., Xu, J., Wu, H. "Growth and Biochemical Composition of Porphyridium purpureum SCS-02 under Different Nitrogen Concentrations". *Marine Drugs* **17**, 124 (2019).
[3] Ardiles, P., Cerezal-Mezquita, P., Salinas-Fuentes, F. "Biochemical Composition and Phycoerythrin Extraction from Red Microalgae: A Comparative Study Using Green Extraction Technologies". *Processes*. **8**, 1–16 (2020).

## Biography

Visiting Professor at Massachusetts Institute of Technology at Langer Lab (2018), Visiting Professor at Harvard University (2017), Post-doctorate in bioprocess design for enzyme exploration (University of Westminster, London, UK, 2008); PhD in Biotechnology (Cranfield University. Silsoe, Bedfordshire. UK, 2004); Master in Food Science and Technology (Autonomous University of Querétaro); Biochemical Engineer (Morelia Tecnológico de Morelia, 1995); Adjunct Professor and leader of the Applied and Sustainable Biotechnology group of the Center for Biotechnology-FEMSA; has published more than 150 articles in scientific journals of strict arbitration (JCR) has more than 5,300 citations with an index H 39, index i10 of 102. It has 5 granted patents. He belongs to the national system of researchers (SIN III) and is a researcher repatriated by the CONACyT of England in 2008. He has taught more than 50 professional and postgraduate courses in the Department of Chemical Engineering and Biotechnology Engineering and in the Master of Systems Environmental, Master in Energy Engineering and Master and Doctorate in Biotechnology where he has directed undergraduate (15), master (20), doctorate (8) and post-doctorate students (12). In his professional career he has directed more than 85 national and international projects as Principal Investigator and is an evaluator of projects in Poland, Singapore, Poland, the Netherlands, the United States, Colombia and Mexico.

# Handling municipal solid waste by conversion to energy and resources

**TONG Yen Wah[1,2]**

[1] *Dept of Chemical and Biomolecular Engineering, National University of Singapore, Singapore.*
[2] *NUS Environment Research Institute, National University of Singapore, Singapore.*
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## Abstract

Technologies for waste treatment and conversion to energy have been around for more than 50 years. In particular, the most widespread and commercially viable process is anaerobic digestion of organic matter into biomethane, while gasification of biomass to hydrogen and syngas has also been commercialized in the last 10 years. However, these technologies and industries are almost always centralized and are of very large scales for the purpose of economies-of-scale. They are usually also located outside of the city or urban environments, and not even in the industrial areas in certain countries.

The scientific challenge and technological research is thus in modularizing and down-translating these processes, to enable them to be operated in a modular manner within a megacity such as Singapore and Shanghai, and to adapt them to a manageable urban system as potential distributed energy sources. In addition to enabling a local material and mass cycle to be closed loop, it also minimizes the need for transportation of wastes to centralized facilities, which is one of the major energy consumption activities that has not always been accounted for. In our programme, we are studying a hybrid waste-to-energy system comprising a compact anaerobic digester and a biomass gasification system for converting municipal solid wastes to energy. A crucial issue that arises in sustainable megacities is that of the cycle of energy, water and waste. The key research question: How can we attain security and resilience in these areas given global uncertainties, resource limitations, and the high-density living environment?

## Biography

Associate Professor Tong Yen Wah joined the Department of Chemical and Biomolecular Engineering at the National University of Singapore (NUS) in 2001 after graduating from the University of Toronto with a PhD in Chemical Engineering. His expertise is in biomaterials research for tissue engineering and in bioenergy from food wastes and biomass wastes, with over 130 publications and 6000 citations. His recent works in food wastes management has been successfully commercialized with distributed anaerobic digesters that can be effectively used in cities through a spin-off company from NUS. Dr Tong is currently the co-Programme Director for a NRF CREATE programme with Shanghai Jiao Tong University (SJTU) on "Energy and Environmental Sustainability Solutions for Megacities", E2S2-CREATE, a collaborative research programme between NUS and SJTU funded by the Singapore National Research Foundation for S$89 million on studying coupled problems in megacities related to energy, environment, health and waste.

# Photo-fermentation of mixotrophic *Chlorella pyrenoidosa* as a new approach for high-protein biomass production

**Qingke Wang, Zongyi Yu, Dong Wei**

*School of Food Science and Engineering, South China University of Technology, Guangzhou 510640, P.R. China*

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## Abstract

The alternative protein is a present hot spot for manufacturing and investing to face the fast increasing market demands of NEW protein for future food and feed ingredient. The green microalga *Chlorella pyrenoidosa* is regarded as the most promising species for high-protein biomass production by autotrophic growth in agriculture and heterotrophic growth in fermentation industry. Photo-fermentation (photo-heterotrophic or mixotrophic cultivation) is highly efficient for protein biosynthesis since light-driven fermentation could generate more energy and carbon skeleton to support the rapid cell growth in photosynthesis microalgae. Recently, we developed a novel strategy of photo-fermentation by mixotroph *C. pyrenoidosa* for converting high ammonium in wastewater to high-protein biomass. Firstly, the mixotroph cells was cultivated in high ammonium-high salinity wastewater medium for optimizing the initial cell density, glucose and ammonium concentrations, and light intensity in shake flasks. Then, a 5-L fermenter with surrounding LED (Light Emitting Diode) and a 50-L fermenter with inlet LED (patent issued) were employed for batch and semicontinuous cultivation. The results demonstrated that the highest contents of protein (56.7% DW) and total pigments (4.48% DW) with productivities of 5.62 g $L^{-1}$ $d^{-1}$ and 0.55 mg $L^{-1}$ $d^{-1}$, respectively, were obtained in 5-L photo-fermenter, while the maximum $NH_4^+$ consumption rate (1800 mg $L^{-1}$ $d^{-1}$) and biomass yield (23.6 g $L^{-1}$) were achieved in 50-L photofermenter.

Through the further study, *Chlorella*-mediated short-time acclimation was demonstrated that it could significantly improve $NH_4^+$ removal and biomass production in shake flasks. After acclimation through two batch cultures in 5-L photo-fermenter, the maximum $NH_4^+$ removal rate (1,400 mg $L^{-1}$ $d^{-1}$) were achieved under high $NH_4^+$ level (4750 mg $L^{-1}$) in batch 3. In 50-L photo-fermenter, through one batch acclimated culture, the maximum $NH_4^+$ removal rate (2,212 mg $L^{-1}$ $d^{-1}$) and biomass concentration (58.4 g $L^{-1}$) were achieved in batch 2, with the highest productivities of protein (5.56 g $L^{-1}$ $d^{-1}$) and total lipids (5.66 g $L^{-1}$ $d^{-1}$). This study provided a novel strategy for high-ammonium bioconversion to high-protein algal biomass, facilitating the algae-based "waste-to-treasure" process.

**References:**

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[2] Qingke Wang, Zongyi Yu, Dong Wei*, "High-yield production of biomass, protein and pigments by mixotrophic *Chlorella pyrenoidosa* through conversion of high ammonium in wastewater", *Bioresource Technology*, **313**, 123499 (2020)

## Biography

Dr. Dong WEI is the professor in School of Food Science and Engineering, South China University of Technology, Guangzhou, P.R. China since 2002. His main research interests focus on microalgal biotechnology for bioconversion and nutrition engineering, including (1) Physiology, biochemistry, omics study of microalgae for cell response to stress; (2) Cultivation system development and integration; (3) High-cell-density fermentation for bioactive compounds and biomass production; (4) Carbon capture, nitrogen and phosphate bioconversion and nutrients recycling through microalgal cultivation and further application of algal biomass.

# Keynote Talks

## Track 4 - Industry

**Co-Chairs:**
**Mr Gary LOH**
(Founder & CEO, DiMuto, Singapore)

**Dr ZHANG Yuchu**
(Vice President (R&D), Cargill, China)

28 April 2021, 1200hrs - 1420hrs

# Industry: Presentation –
# Bridging the Gap between Research & Industry

**Dilys Boey**

Assistant Chief Executive Officer, Enterprise Singapore
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## Abstract

Given growing demographic and environmental pressures and the heightened emphasis on food resilience, we need to accelerate the use of technology and innovation to increase the supply and sustainability of quality food, a point which has been exacerbated by the COVID-19 pandemic. To this end, we will need to seek out new opportunities in the agri-food tech sector in partnership with public, private and research entities. Within the food ecosystem, our Institutes of Higher Learning (IHLs) and Research Institutions (RIs) play critical roles in bridging the gap between research and industry outcomes. This presentation will discuss why and how IHLs and RIs can work to address this gap, ensuring a sustainable and resilient food system for today and future generations to come.

## Biography

Ms Dilys Boey is Assistant Chief Executive Officer of Enterprise Singapore, overseeing Lifestyle & Consumer and Food, Healthcare & Biomedical.

Enterprise Singapore is the government agency championing enterprise development. The agency works with committed companies to build capabilities, innovate and internationalise. It also supports the growth of Singapore as a hub for global trading and startups, and builds trust in Singapore's products and services through quality and standards.

Prior to joining Enterprise Singapore, Dilys was a Partner and ASEAN People Advisory Services Leader at Ernst & Young (EY) where she led the People Consulting practice across South East Asia. Dilys has dedicated her career of over 25 years to understanding and working with corporations and the public sector on people, culture and organisation priorities. At EY, she led the growth of the People Consulting practice across 6 key markets in Southeast Asia. Her team of Partners and specialists worked with clients on organisation restructuring, workforce capability development, change enablement, digital technology and automation, employment compliance, governance and risks.

Dilys has worked with a myriad of clients ranging from public sector organisations, professional services, food services, real estate and retail. In recent years, she worked with clients to address pressing issues facing the workforce with the accelerated adoption of digital, robotics and automation. This involved helping clients understand the impact of emerging technologies and jobs at risk, and define future jobs and future skills. In turn, this allowed organisations to prioritise a learning agenda, redesign jobs, manage change and wellbeing, and implement digital solutions – all while managing employment risks and compliance.

Dilys sits on the Boards of the Special Needs Trust Corporation and the Singapore Cancer Society. She contributes to various Committees, including the Singhealth Service Excellence Committee, the Singapore Accountancy Commission Professional Education Council, and sits on the Emerging Stronger Taskforce.

# The Future of Food Industry Post Crisis

**Rebecca Lian, PhD**

*Head of Applied Food Research Centre. Centre for the Spread of Affordable Wellness (MAV Holdings Pte Ltd), 41A, Amoy Street, Singapore 069867*
*Adjunct Associate Professor, School of Chemical and Biochemical Engineering*
*Innovation Advisor, IPI, Singapore*
**E-mail:** rebecca@csaw.co

## Abstract

After a non-stop run of some 50 years, the Food Industry today is confronted by increasing consumer concern on health, rampant increase in global obesity and its finanacial burden on healthcare cost, environmental and climatic changes. AI technology and digitalization, changes in meal consumptions habits, reduction of family size, increase in senior demographics, food security especially brought home by the COVID 19 pandemic are challenges on this list. The Food Industry whether MNC or SME are finding that they need to transforms to avoid declining market share. At the same time we are seeing such a steep rise in the numbers of Food and Agri Starts Up, which took place just 4-5 years ago but are gaining traction at a high velocity, spurred on by the swell of global liquidity espcially in Asia, that is looking for opportunities to invest.

Never before has planet Earth seen so many distraous weather conditions such as floods, droughts and wild fire taking place in every continent with huge devastations upon human life and economy. These and the ever increasing risk of the next pandemic lurking around the corner are real. As way back as 2004, in a joint WHO/FAO/OIE*( World Organization for Animal Health) report, it was highlighted that human activity, and especially the demand for meat was the main cause for the increasing escalation of infectious diseases. In 2020, the world was brought to a grinding halt by COVID 19. Besides responding to the impact of current COVID 19 pandemic, Authorities worldwide need to look further on how to address the root cause through education on healthy and sustainable eating with plant based food to mitigate the risk of more pandemics. Equally the Food Industry should rise to this clarion call and shoulder responsibilty to design healthy and sustainable food products, drive the education of consumers on healthy eating. Company needs to be measure by their contribution to the Share of Wellness besides Share of Mouth. Acadmic institutions should introduce education on food and health, which should be taught to all students irregardless of the course of study that the students are undertaking. Academic researches on food science and technology should prioritize those which supports the food and Agri sector to deliver technologies, ingredients and driving clinical research data that further support changes in dietary pattern so that we can transform to a healthy nation while at same time contribute to improving the environmental and towards building a sustainable and secured economy. Food is no longer just to statisfy hunger or pleasure of our taste buds but is intricately linked to Health, Environment, Climate, Politics, Economics and Pandemics.

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[2] https://www.mckinsey.com/industries/consumer-packaged-goods/our-insights/what-got-us-here-wont-get-us-there-a-new-model-for-the-consumer-goods-industry
[3] http://www.fao.org/newsroom/en/news/2004/36647/index.html

## Biography

Rebecca Lian PhD, graduated from of the University of Reading, United Kingdom with First Class Honours followed by a PhD ( Food Technology) in 1982. Upon graduation, joined Nestle R&D Centre, Singapore, heading New Product Development and later as Head of New Process Development until end of 1993. The

Nestle journey continued with an expatriation assignment to Nestle China in 1994 which lasted for 23 years until retirement at the end 2016 with Nestle. The 23 years in China coincidented with the huge economic growth of China, requiring innovative and differentiated products as well as building up manufacturing capability and factory operations in China.

Returning to Singapore, Rebecca joined one of the biggest Singapore Food and Agri company, Wilmar International taking on the challenge to help markets in Asia and Africa innovate new food products and setting up joint lab with NUS and A*Star ( CNRC), to establish clinical research projects addressing [Food Is the New Medicine]. This started a new journey, to drive transformation of food companies so that it is not just the share of consumer stomach but also the consumer's wellness. A Healthy nation requires Healthy citizens who understand Food and Health. An environmentally sustainable planet requires citizens to understand the impact that food habits has on the health of the planet Earth. This draws me join CSAW (Center for the Spread of Affordable Wellness) as Head of Applied Food Research Center,  to drive Food Innovation that helps Consumer eat Healthy, Company Transform, and Farmers Prosper.

# Innovation in Alternative Proteins - Why are Consumers Making the Transition?

**Andrew D Ive**

*Founder and General Managing Partner,*
*Big Idea Ventures, 88 Pine St, New York, NY 10005, USA*
**E-mail: andrew.ive@bigideaventures.com**

## Abstract

This talk will discuss why alternative proteins could be the next huge shift globally, as well as highlight examples of innovation in the space.

## Biography

Andrew D Ive is the founder of Big Idea Ventures. Its purpose is to solve the world's biggest challenges by supporting the world's best entrepreneurs. Our first fund + accelerator (NY & Singapore) invests in plant-based foods and ingredients to impact climate change, animal welfare and personal health. Investors include Tyson Foods, Temasek and Buhler. Advisory Board member for Tufts Nutrition Council. Friedman School Entrepreneurship Advisor. Harvard Business School graduate, Procter & Gamble brand management trained.

# Direct Mass Spectrometry for High throughput Food Analysis

**Simon HIRD**

*Global Food & Environmental Market Development, Waters Corporation, United Kingdom*
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## Abstract

Mass spectrometry, using ambient ionization techniques, combined with multivariate statistical analysis and real time recognition software, is an emerging technique for rapid characterization of food and animal tissues with no requirement for sample preparation. Here we focus on one of those techniques; Rapid Evaporative Ionization Mass Spectrometry (REIMS).

Due to their high market value, fish are often targeted for species substitution, adulteration, or mislabeling. REIMS has been successfully used as a fast profiling technique capable of achieving accurate species identification without the need for any sample preparation. REIMS can be used as a complimentary screening technique to DNA-based methods for detection of fish fraud. The utility of REIMS has also been explored for the direct analysis of meat samples from livestock treated with illegal growth promoters. The REIMS analysis generated specific lipid profiles which enabled differentiation of meat samples collected from pigs treated with ractopamine via their feeding regime. Lastly, there is a lot of interest in rapid tests that can screen out tainted boar carcasses without reliance on sensory analysis. Screening of samples of neck fat using REIMS, located at line in an abattoir, enabled discrimination between sow, tainted and untainted boars.

These case studies demonstrate that REIMS implemented in an untargeted-metabolomics workflow can be considered as a high-throughput and accurate strategy for real-time classification of fish and meat samples in relation to issues relating to food authenticity, safety, and quality.

Although REIMS is rapid and simple to use, the technology is coupled to a high-resolution mass spectrometer (HRMS), which may prove prohibitive for most point of control testing. REIMS has been installed and used effectively in an abattoir to detect boar taint, demonstrating that this is a technology that has practical potential to be used closer to the points of production and control if the costs can be reduced. However, there are innovative solutions, such as the RADIAN ASAP, being explored on the potential of other ambient ionisation techniques but fitted to a compact, easy to use nominal mass detector, which has greater potential for deployment away from the research laboratory environment.

## Biography

After earning his doctorate at University of Plymouth, Simon worked in a commercial mass spectrometry consultancy, M-Scan, before joining the Central Science Laboratory (now Fera Science Ltd) in the UK. He had various roles associated with residues testing and food authenticity before leading an LC-MS/MS team responsible for determination of residues and contaminants in food and environmental samples.

After almost 20 years, Simon left Fera in November 2014 to take up a role with the Waters Corporation, based in Wilmslow, UK, as a Principal Scientist. He is currently working in the Global Food and Environmental Market Development Team. In this role, Simon facilitates coordination with colleagues working on scientific projects, contributes to the commercialisation of new technologies and provides advice, training, context and technical marketing tools to various parts of the Waters organisation and to customers globally. He is responsible for the developing the Food Research market for Waters, including approaches to establishing the authenticity of food. He also contributes to activities linked to development of the Food Contaminants market, with responsibility for the areas of veterinary drug residues and natural toxins. The role provides opportunities to share his experience as a previous customer with colleagues in Waters and to demonstrate leadership in the field of food contaminants and authenticity. Simon continues to instruct on internationally recognised training courses, such as SARAF in France and for AOAC India, building upon his involvement with IFSTL whilst at Fera.

Simon continues to be invited to present at international conferences and has 21 peer-reviewed publications, including one of the most downloaded Trends in Analytical Chemistry articles, “Liquid chromatography-mass spectrometry for the determination of chemical contaminants in food”.

# LC/MS-based suspect and non-targeted screening of food contaminants

**Stéphane Bayen, Lan Liu, Lei Tian, Anca Baesu**

*Department of Food Science and Agricultural Chemistry, McGill University.*
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## Abstract

Suspect and non-targeted analysis, using high resolution mass spectrometry and advanced data processing tools, allows for the rapid characterization of thousands of never-before-studied chemicals in complex matrices. The novelty of the approach relies on the collection and the analysis of a large chemical fingerprint for each sample. In this presentation, key applications of LC/MS-based suspect and non-targeted screening for food safety will be detailed. This presentation will focus on how advanced data treatment strategies were deployed to: (i) detect and identify unknown or unexpected contaminants in food, (ii) understand the degradation/transformation of contaminants during food processing or (iii) identify differences in the contaminant fingerprints among groups of samples. Suspect and non-targeted analysis is now regarded as the next stage of surveillance tools for food and environmental contaminants.

## Biography

Dr. BAYEN is an Associate Professor in the Department of Food Science and Agricultural Chemistry at McGill University (website: foodtox.lab.mcgill.ca/). His research interests include (i) analytical chemistry applied to the detection of trace chemicals in agri-food matrices, (ii) the fate of contaminants (contaminant chemistry; bioaccumulation; behavior of contaminants during food processing) and (iii) ecological & human health risk assessments. He is building a research program at McGill University, concentrating on developing novel non-targeted approaches to monitor trace chemicals in agri-food matrices and to provide a more in-depth understanding of their behavior from field to fork. Dr Bayen has a proven history of research and collaboration with industry and food safety agencies on matrices including honey, seafood, dairies, or maple syrup on food authenticity.

# Growing Microalgae for a Sustainable Future - Why Single Cell Protein Is The Answer To Our Future?

**Eugene Y. Wang**

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## Abstract

The global population is projected to be over 10 billion around the year 2050. The consumption of food druing the last few decades has seen dramatic increase in many regions around the world. At this rate, we will run out of space to grow our foods if we continue to rely on conventional animal farming, agriculture, and even aquaculture. Global warming, deforestation, and lack of fresh water will make these conventional food production techologies more diffcult and cost prohibitive. We need a new set of technologies to grow our foods to cope with the looming crisis.

Among the new technologies to grow food, cell-based (or cultured) meat, seafood, and even plants make up the set of technologies that received most of the funding recently. However, there is still a lot of R&D work for these technologies to be commercialized. Microbe fermentation, on the other hand is more economical and available for immdeiate deployment. And among all the microbes we can use for food production purposes, microalgae really are superior when it comes to nutrition. They meet all of the nutritional needs for human beings to lead healthy lives. On top of that, many strains can grown in sea water which will substantially help alleviate the freshwater supply issues.

I am calling on an initiative to start a global effort in developing these microbe fermentation technologies to help solve our food supply issues in the future. And among all the microbes, I believe microalgae hold the most promising potential.

## Biography

Eugene Wang grew up immersed in the vegetarian food business. Since 2010, his vision for launching Sophie's Kitchen, the first Plant-Based Seafood Alternative, has manifested into a viable category innovation lauded by the press and social media thought leaders. Sophie's Kitchen had won numerous recognitions from companies like PepsiCo and Chipotle. In 2019, Eugene took the alternative protein to the microorganism level and started another new venture in Singapore, Sophie's BioNutrients Pte Ltd. He won the grand prize of $1 million SGD at The Liveabilty Challenge 2019 with this new project and started his first protein fermentation facility in Singapore.

# Shiok Meats: Cell-based crustaceans for sustainable future of food

**Ling Ka Yi, Ph.D. and Sandhya Sriram, Ph.D.**

*CTO/co-founder and CEO/co-founder of Shiok Meats*
*9 Chin Bee Dr, Innovate 360, Unit 05-01, Singapore 619860*
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## Abstract

The way the world eats at present is unsustainable and unhealthy for the environment, animals and ourselves. It is impossible to produce the amount of seafood required to feed the growing population by 2050. Hence the future of food will be meats grown in the lab, also known as, cell-based meats. By using stem cells, tissue engineering and food technology, Shiok Meats will bring crustaceans meats to your table, which are health-, animal- and environment-friendly. Shiok Meats is a cell-based crustacean company - the first of its kind in the world and the first cell-based startup in Singapore and South East Asia (Shiok in Singapore English means enjoyable and fantastic). In this talk, I will share the background and technology of cell-based crustaceans and also my journey of setting up Shiok Meats.

## Biography

Dr Ling Ka Yi is a developmental and stem cell biologist with over 10 years expertise in tracing and studying stem cells during development. Ka Yi received the prestigious A*STAR's National Science Scholarship and graduated with a Bachelor's and PhD from the University of Wisconsin-Madison. She worked closely with stem cell and developmental biology experts like James Thomson, Davor Solter and Barbara Knowles. Following graduation, Ka Yi did her postdoc at IMCB, A*STAR in Singapore. She is an active science communicator since her days in Madison; and frequently takes part in science outreach and speaks at food sustainability and career management events. She also did a podcast called "Science Now" and "Life after PhD" with fellow colleague/scholar. Ka Yi is passionate about marrying her experience in biotech research and her love for food to produce sustainable food products. In August 2018, she co-founded a cell-based crustaceans startup called Shiok Meats, along with Dr Sandhya Sriram. She was recognized as one of the MIT Tech Review's "Innovators under 35 in Asia" 2020, the "Women and the Ocean: Changemakers" challenge 2020", the Great Women Of Our Times 2020 by Women Weekly, and Gen T list 2020.

# Keynote Talks

## Track 5 - Alternative Protein / Nutrition

**Co-Chairs:**
**Dr Hazel KHOO**
(Executive Director, Singapore Institute of Food and Biotechnology Innovation, A*STAR, Singapore);

**Prof Willam CHEN**
(Host Principal Investigator, FRESH and
Michael Fam Chair Professor in Food Science & Technology,
Nanyang Technological University, Singapore)

28 April 2021, 1430hrs - 1710hrs

# Meat-like Scaffold for Cell-based Meat Cuts

**Shujian Ong, Larry Loo, Marion Pang, Russell Tan, Yao Teng, Xuanming Lou, Sze Khen Chin, Mihir Yogesh Naik, Hanry Yu**

*Department of Physiology, The Institute for Digital Medicine (WisDM), Yong Loo Lin School of Medicine, & Mechanobiology Institute, MD9-04-11, 2 Medical Drive, Singapore 117593;*
*Institute of Bioengineering and Bioimaging, A*STAR, The Nanos, #06-01, 31 Biopolis Way, Singapore 138669;*
*Ants Innovate Pte. Ltd., 7 Temasek Boulevard #12-07, Suntec Tower One, Singapore 038987*
**E-mail:** phsyuh@nus.edu.sg

## Abstract

Recent efforts for cell-based meat cuts focus on engineering edible scaffolds, neglecting visual cues which are key to enhancing consumer acceptance. Here, we employed artificial intelligence (AI)-based screening of potential plant materials and discovered that jackfruit (*Artocarpus heterophyllus*) has the natural structures to recapitulate marbling visuals of meat cuts. Plant tissue composition are exploited for its differential polyphenol adsorption to produce complex marbling patterns. A one-step colour control method by varying oxidation and incubation conditions of polyphenols was developed to produce permanent meat-like colours resembling chicken, pork, and beef. The scaffold exhibits a meat-like browning behaviour when cooked and is shown to support high-density porcine myoblasts culture without masking the marbled appearance. Surveys with 78 volunteers found that marbled jackfruit scaffolds improved consumer perception of cell-based meat by ~8 %. Our approach of combining AI, tissue engineering, and sensory science unlocks the possibility of creating a range of novel cell-based meat cuts with consumer focus.

**Fig. 1:** Plant-based bacon with appearance conferred by natural spatial control of colour

## Biography

Hanry Yu is Professor of Physiology (NUSMed) and Mechanobiology (MBI) at the National University of Singapore; and leads a Cell and Tissue Engineering group at the Institute of Bioengineering and Bioimaging (IBB), A*STAR; and co-leads a cell therapy manufacturing programme (CAMP) at the MIT research entity (SMART) in Singapore. He integrates biomaterials, tissue mechanobiology and engineering, biomedical optics and AI data analytics into solutions for pharmaceutical, environmental, and recently food industries. He has trained many students and staffs in leading universities in the US and Asia; built several institutions and companies, published >200 papers, delivered >250 invited talks, and is serving as a handling editor for Biomaterials; and the overseeing editor for the theme: Biomaterials for Future Food.

# Challenges for Future Sources of Proteins

**Peter Valtchev[1,2], Damian Frank[1,2], Roman Buckow[1,2] and Fariba Dehghani[1,2]**

[1]*School of Chemical and Biomolecular Engineering, The University of Sydney, Sydney, Australia*
[2]*Centre for Advanced Food Engineering (CAFE)*
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## Abstract

There are compelling reasons to move away from meats as main sources of protein: (1) animal farming is inefficient, using 83% of land for agriculture but producing only 16% of the food we consume; (2) it produces 60% of agriculture's $CO_2$ emissions, uses large amounts of water, and is the main source of fresh-water contamination; (3) consumption of meat leads to an increase of non-communicable diseases such as cardiovascular disease and cancer (red meat is classified as a class 1 carcinogen), and contributes to antibiotic resistance; (4) encroachments on arable land, and unsustainable fishing, are set to worsen as the global human population, increasingly middle class, marches toward 11bn by mid-century; and (5) there are increasing ethical concerns about the impact of industrial processes on farm animals. [1,2]

A number of plant-based meat substitutes have been developed and released into the global markets. These products are mainly patties from soybean isolate, potato and peas as a source of protein, and coconut or vegetable oil as a source of fat. While a few companies have produced signature products using empirical trial-and-error approaches, significant challenges still hinder development of this industry sector. These include, but are not limited to, (1) lack of dedicated raw ingredients for development of plant-based meat, (2) lack of technologies for creating the desirable texture, (3) no rational approach for recreating the flavour of meat varieties, and (4) lack of regulations concerning the use of non-traditional proteins and other novel food ingredients.


**Fig. 1:** The research pathway for future sustainable protein foods.

The centre for advanced food engineering at the University of Sydney in collaboration with food industries aimed to address these challenges and develop platform technologies for production of future sustainable foods as protein sources.

**References:**

[1] Protein Market: Size of the Prize Analysis for Australia, *FIAL*. 2019.
[2] Willett W Rockström J, Loken B et al, www.thelancet.com, 2019, 393(2) 447-492.

## Biography

Professor Fariba Dehghani is currently the director of Centre for Advanced Food Engineering and a former director of an ARC Food Processing Training Centre at the University of Sydney, Australia. She was recognised by Engineers Australia as one of the Australian's top 50 Engineers for innovation. Her research team collaborated with industry to provide pragmatic, cost-effective and environmentally sustainable solutions to a diverse range of issues, with the aim of improving human wellbeing.

After completion of her PhD degree at UNSW, she received the prestigious Australian Research Council Postdoctoral fellowship and continued working at UNSW as a senior research fellow and senior lecturer. She played a major role in the establishment of a R&D Company with Good Manufacturing Practice (GMP) facility and developed technologies and products that were sub-licensed to industries. Since joining the University of Sydney in 2006, she established a state-of-the-art bioengineering laboratory enabling multidisciplinary research collaboration. She promotes entrepreneurial engagement, resulting in four start-up companies being established by her research members.

# Cell-based meat in an Aotearoa New Zealand context

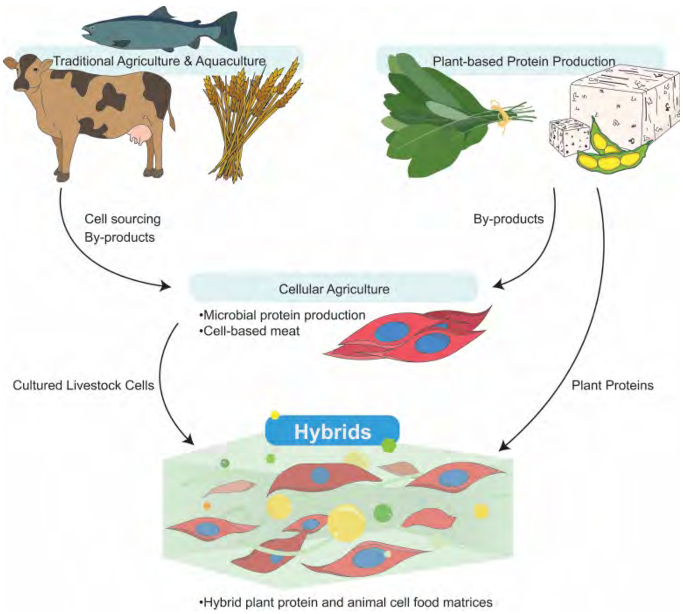
**Olivia Ogilvie[1,2], Vaughan Feisst[3,4], Sophia Roderigues[4], Warren McNabb[2,5], Renwick Dobson[1,2], and Laura Domigan[2,4]**

*[1]School of Biological Sciences, The University of Canterbury, New Zealand*
*[2]The Riddet Institute, New Zealand*
*[3]School of Biological Sciences, University of Auckland, New Zealand*
*[4]Department of Chemical and Materials Engineering, University of Auckland, New Zealand*
*[5]Massey University, New Zealand*
**E-mail:** l.domigan@auckland.ac.nz

## Abstract

The future of food is envisaged to include a variety of protein-rich foods for consumers, including those produced by culturing livestock cells in fermenters – termed cellular agriculture. In New Zealand, traditional agriculture is an essential link in the food system. New Zealand is geographically suited to pasture grazing, and it has one of the lowest input and most efficient livestock farming systems in the world.

At the heart of our research is the vision that future foods will combine ingredients from traditional agriculture, plant-based protein and cellular agriculture. In this presentation, we will discuss the unique opportunities and threats that cell-based meat has for New Zealand. This will include commentary on the inclusion and diversification of the existing New Zealand food industry, illustrated with some key examples of high-quality livestock cell sourcing, and by-product utilisation. As new protein foods come close to being ready for market, reliable technical and scientific data is essential to inform regulatory bodies and policy-makers about safety and efficacy. Towards this, we will discuss the current regulatory environment of cell-based meat as relevant to both the domestic New Zealand and export markets.




## Biography

Dr Laura Domigan is based in the Department of Chemical and Materials Engineering at the University of Auckland. Laura was born and raised in New Zealand and is a biologist by training. Laura's research is focused on sustainably sourced proteins - including formulating new protein biomaterials for surgical use, and cell-based meat production.

Prior to returning to New Zealand in 2015, Laura was a post-doctoral research fellow at Tufts University, USA. She enjoys spending time in nature, cooking, and home fermentation projects.

# Translational Taste Research: Discovery of Molecular Targets for Flavor Innovations

**Corinna Dawid, Sebastian Baur, Tara Duggan, Peter Gläser, Christoph Hald, Florian Utz, Karin Sebald, Thomas Hofmann**

*Chair of Food Chemistry and Molecular Sensory Science, Technical University of Munich, Lise-Meitner-Str. 34, 85354 Freising, Germany*
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## Abstract

The development of safe and at the same time healthier food products, for example, reduced in fat, sugar, or salt, respectively, are well-known to induce nonacceptable flavor defects in the products and has, thus, created unexpected flavor challenges for the food industry. In response to the consumers' demand for safe and healthy but tasty foods, novel ingredient discovery is essential to overcome such flavor challenges associated with the production of, in particular, sugar, salt or fat-reduced products.
Varying widely across the world, reflecting unique environmental, economic, and cultural traditions, various drying, fermentation, cooking and roasting procedures have been empirically developed during the last millenniums and, since then, the alluring flavor of the dishes prepared do attract consumers on a global scale. In particular, the food manufacturing techniques leading to the most premium tastes promise to contain essential taste compounds and/or taste modulators generated from sensory inactive precursors upon processing of the raw materials. This evolutionary refinement of food manufacturing procedures is, therefore, expected to open an interesting avenue towards the discovery of natural taste (modulating) compounds, which might be applied as natural solutions to overcome flavor challenges associated with the production of, in particular, sugar, salt or fat-reduced products. The presentation will highlight analytical strategies to identify key taste compounds and taste modulators in processed food by means of a Sensomics approach.

## Biography

Prof. Dr. Corinna Dawid is deputy head of the Chair of Food Chemistry and Molecular Sensory Science at TUM School of Life Science at the Technical University of Munich in Germany. After her studies of food chemistry at the University of Münster, Prof. Dawid started her doctoral studies with Prof. Dr. Thomas F. Hofmann in Münster. In 2007 she followed her doctoral supervisor to the TUM School of Life Sciences where she completed her doctorate and did a postdoctoral research. During a research stay at the Chulalongkorn University in Bangkok, she was instrumental in establishing the Institute for Molecular Sensor Technology. Back in Munich she began her habilitation with studies on stress resistance in plants. After the appointment of Hofmann as President of the TUM, Prof. Dawid took over the provisional leadership of the Chair of Food Chemistry and Molecular Sensor Technology. Since 2020 she is also a member of the ZIEL Institute for Food and Health and deputy director of the Bavarian Centre for Biomolecular Mass Spectrometry (BayBioMS).

# Anticipatory life cycle assessment and techno-economic assessment of commercial cultivated meat production

**Dean Powell**

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## Abstract

A life cycle assessment (LCA)[1] and techno-economic assessment (TEA)[2] modeling a future large-scale cultivated meat (animal meat produced by growing cells outside the bodies of animals) production facility show that by 2030, cultivated meat could have reduced overall environmental impacts, a lower carbon footprint, and be cost-competitive with some forms of conventional meat. This is generally true whether cultivated meat is produced using conventional energy mixes or renewable energy, but the reduction in environmental impacts and carbon footprint is greatest when cultivated meat is produced using renewable energy. In addition to the degree to which renewable energy is sourced at future facilities and the degree of decarbonization throughout the supply chain, the key factors that accomplish these outcomes are maintaining high-density cell cultures, efficiently using and sourcing cell culture media, and relaxing payback times for facility capital costs.

The LCA and TEA reports are the first of their kind to be informed by data inventories collected from active industry partners—over 15 companies involved in the cultivated meat supply chain, including five cultivated meat manufacturers contributed data and expertise. The study design, data analysis, and report writing was performed independently by CE Delft on behalf of The Good Food Institute.

The LCA accounts for uncertainty in the cultivated meat production process by conservatively assuming high energy use at the facility. Despite this conservative estimate, the LCA shows that even when compared to an extremely optimistic benchmark projecting reduced environmental impacts of conventional animal agriculture by 2030, cultivated meat produced using renewable energy:

- Reduces global warming impacts by 17%, 52%, and 85-92% compared to conventional chicken, pork, and beef production, respectively.
- Is 3.5x more efficient than conventional chicken at converting feed into meat, consequently reducing land use by 63%, 72%, and 81-95% compared to conventional chicken, pork, and beef production, respectively.
- Can be cost-competitive, with production costs modeled as low as $5.66 USD per kilogram.

These reports collectively highlight the enormous potential for cultivated meat as being a sustainable and affordable protein option for a growing population.

**References:**

[1] Odegard, I., and Sinke, P. "LCA of cultivated meat. Future projections for different scenarios" *(https://www.cedelft.eu/en/publications/2610/lca-of-cultivated-meat-future-projections-for-different-scenarios)*, (February, 2021).
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## Biography

Dean Powell is the Science and Technical Specialist for The Good Food Institute Asia Pacific. He holds a Ph.D. in molecular and cellular biology with a focus on poultry muscle development and a bachelor’s in Animal and Veterinary Bioscience, both from the University of Sydney. Dean has experience working for the

Australian Federal Government both as a scientific assessor for food safety regulations and as an international policy analyst focusing on the Asia-Pacific region.

# Food design and food digestibility

**Vincenzo Fogliano**

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## Abstract

The proper development of a food product should take into account all the quality parameters that will contribute to its success, therefore it is a very complex matter. To tackle this issue a food chain approach must be adopted. The various steps of product development, starting from the selection of raw material through the definition of suitable processing and the possible formulation, can be segmented and combined with several human factors such as the physiological effects, the consumers' perception and the decision taken by people working on the food chains.

This talk will focus on healthy foods targeting the food digestibility, which is an emerging aspect in food science. A number of recent scientific discoveries about the functioning of human gastro-intestinal system suggested several possible targets for healthy foods design. They can be aimed at triggering different biochemical pathways and physiological functions, but a proper understanding of the digestion kinetic is the basis to design proper foods for each target.

Smart feeding of gut microbiota is a number one nutritional priority and, the objective should be to provide the knowledge and the tools to design affordable and delicious foods for the benefit of the gut microbiota. In this lecture, some examples of how this can be realized by formulation, encapsulation and processing strategies will be provided.

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[3] Do DT, Singh J, Oey I, Singh H: Biomimetic plant foods: structural design and functionality. Trends Food Sci Technol 2018, 82:46-59.

## Biography

I'm a food scientist. After 20 years of career at the University of Naples as professor in Biochemistry, Food Chemistry and Functional Foods, from 2013 I became chair of the Food Quality & Design group at Wageningen University.

I published more than 400 publications on indexed journals covering many aspects of Food science. These papers received more than 16.000 citations and I have an h index of 63. I'm one of the few food scientists constantly listed in the Clarivate Reuter list of the "Highly Cited" from 2013 www.clarivate.com.

I worked for many years on the modification induced by food processing and in particular for the compounds formed through Maillard Reaction in coffee, cocoa, bakery and dairy products. Now the focus of my research is on the design of innovative healthy foods adopting a chain perspective and the focus on the gut health. My challenge is to use a food design approach to tackle the two main issues of the food sector: feeding the planed in 2050 and counteracting obesity.

# Towards Edible Electronics

**Wei Lin Leong**

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## Abstract

The natural and non-toxic materials form the basis of edible, biocompatible and transient electronics that completely disappears in a controlled fashion after fulfilling its duty. This is potentially useful in a wide range of applications, such as food sensors, medical diagnostics, therapeutics, and thus paves the way for ubiquitous electronics. My presentation covers the development of the new emerging field of edible electronics, developing a new approach to electronics that harnesses natural, edible electronic materials and degradable biopolymers, as well as less energy intensive manufacturing processes. We have focused on conductors, insulators and semiconductors from naturally occurring compounds or edible synthetic functional materials as well as utilization of the renewable natural sources as precursors. Our research work therefore present a beneficial approach for the development of various solution-processed and eco-friendly electronic devices.

## Biography

Dr. Wei Lin Leong received her Bachelor degree in Electrical and Electronic Engineering and Doctor of Philosophy in Materials Science and Engineering from Nanyang Technological University (NTU) in 2004 and 2009 respectively. She performed her postdoctoral fellowship under Nobel Laureate Professor Alan Heeger in University of California, Santa Barbara (UCSB), working on polymer and small molecule solar cells, where she was part of the team to achieve world record efficiency. In 2012, she joined Institute of Materials Research and Engineering (IMRE), Singapore, working in the area of photovoltaics and printed electronics. In July 2016, she joined the School of Electrical and Electronic Engineering (EEE) as an Assistant Professor. Currently, she is also the Deputy Director at the Centre for Micro- and Nano-Electronics at EEE NTU. Her research focuses primarily on developing nanomaterials (organic and hybrid) and implementing electrical device engineering for ubiquitous electronics and energy harvesting, such as flexible memory and tactile sensors.