

URBAN SOLUTIONS AND SUSTAINABILITY R&D CONGRESS 2023

BUILDING SUSTAINABLE, RESILIENT, AND LIVEABLE CITIES OF TOMORROW

4TH - 5TH OCTOBER 2023



OVERVIEW OF CIRCULAR ECONOMY AND FUTURE TRENDS

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Urban Food Circular Economy

resource efficiency and safety considerations

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04 Oct, 2023



Summary

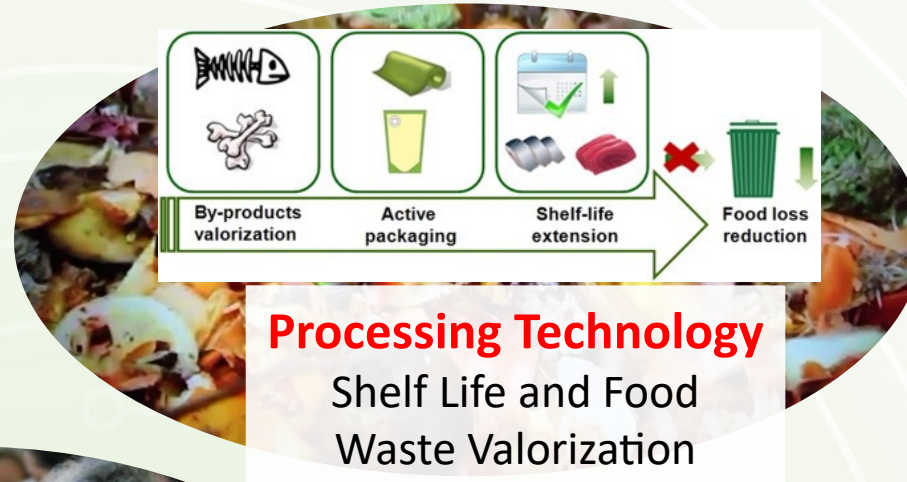
Food waste reduction is an important step in building an efficient food system. We have applied fermentation for nutrient recovery from food processing side-streams, and reintegrate these nutrients into food value chain. These include soybean residues, barley spent grain among others. In such resource efficient system, food safety assessment should be considered alongside nutrition profile as potential hazards also remain in the circular model.



Solutions for Singapore Food Security



Primary Production
Smart Farming



Processing Technology
Shelf Life and Food
Waste Valorization



Nutrition
Ageing Population and
Food Safety

II. Future Foods: Advanced Biotech-based Protein Production

Discovery



Computational Biology



Cell-Based Cultured Meat

Translational



Microbial Protein



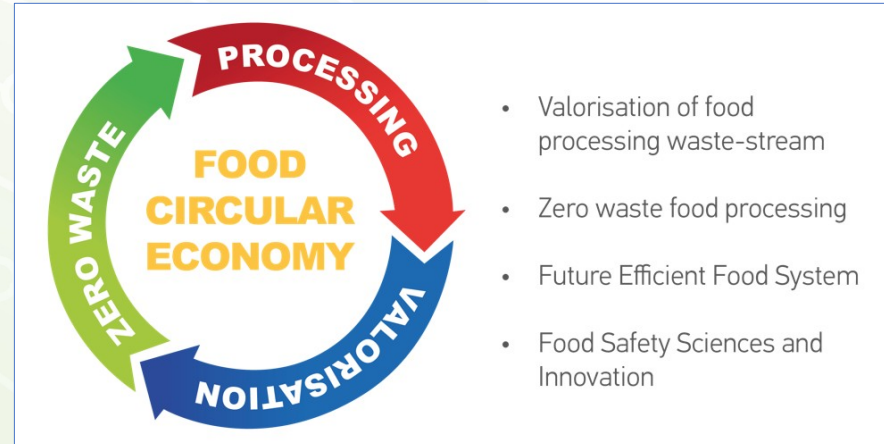
Plant Protein



Scale-Up

Innovations in Food Waste Reduction

- Adopt Existing Technology (Efficiency)
- Simple and Cost Effective (Scalability)
- Platform Technology (Adaptability)
- Zero-waste Food Processing (End Point)



FST NATURAL FOOD PRESERVATIVES

Precision Fermentation → **Green Extraction & Food**

FOOD PRESERVING

FST RESEARCH CAPABILITIES

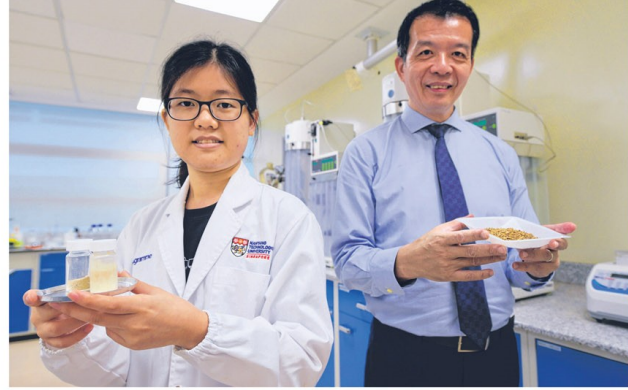
Fermentation technology for nutrient recovery

FST RESEARCH CAPABILITIES

Green processing

Biodegradable packaging materials from food for food

NTU scientists' plant-based emulsifier could replace egg in mayo



Protein-rich product could even improve plant-based meat, says prof who led project

Cheyl Tan

Finicky food lovers may soon not have to skip the mayo. Mayonnaise made entirely from plant-based ingredients – but richer in protein and antioxidants compared with the conventional product – could become a reality here.

Scientists at Nanyang Technological University (NTU) have developed a plant-based emulsifier that has the necessary properties to replace egg or dairy ingredients in food staples like mayonnaise, salad dressings and whipped creams.

Emulsifiers are crucial in food production as they help to combine ingredients that usually do not mix well, such as oil and water. For example, egg yolk is often used as the emulsifying agent in mayonnaise to ensure that the oil and water the mayonnaise contains do not separate.

To create the emulsifier, the NTU scientists used spent barley grains, a by-product of beer brewing and malt production that is rich in protein and antioxidants.

Current commercial processes of nutrient extraction involve the use of chemicals or high temperatures, which make them costly and

complicated, said Prof Chen. Once the proteins are extracted, they are freeze-dried into a solid form so that they can be used for producing foods such as mayonnaise.

The residue from the fermented grain can be upcycled to create sustainable packaging materials, noted Prof Chen. "The idea behind this is that every part of the process truly achieves our zero-waste goal," he added.

Already, the NTU team has received interest from two companies about its plant-based emulsifier. The first company is a start-up in the plant-based food space, while the second is a household brand looking to create a novel type of sauce.

In the meantime, the team is optimising its extraction methods to improve yield and quality. "For instance, at present, for every kilogram of spent barley grains, we can produce only 100g of emulsifier. However, we aim to maximise our output to 250g, as that is the maximum amount of protein that each kilogram of grain contains," said Prof Chen.

Being rich in protein, the emulsifier could be beneficial for the growth of the plant-based meat industry, he said.

"Some consumers have felt that the level of protein content in a low-calorie plant-based meat is lower than that of the real meat while others said that the taste is

Nutritional details

Compared with store-bought mayonnaise, Nanyang Technological University's plant-based version has a slightly higher calorie content as it has more protein and essential amino acids.

- Calorie content: 702kcal per 100g versus 680kcal per 100g for conventional mayo
- Protein: 6.6g per 100g versus 0.9g per 100g for conventional mayo
- The sugar and saturated fat content is similar for both types of mayo

Taste: (4.5/5)

The plant-based mayo has a more distinctive flavour compared with the conventional type, and has a slightly yeasty taste.

Resemblance to conventional mayo: (4/5)

The plant-based mayo is slightly pale orange in colour with a smoother texture, whereas the conventional product has a light cream colour and a fluffier texture.

Cheyl Tan

PhD student Chey Yi Ling with the plant-based emulsifier and mayonnaise made from spent barley grains, samples of which are seen in the tray held by Professor William Chen of Nanyang Technological University. ST PHOTO: NOR SHU LIAN

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Using soya waste in new ways for food production

They are also forming tie-ups to fight rising cost of farming and importing raw materials

Sophia Ines Klein

Efforts to reduce food waste have picked up pace among food producers in Singapore, driven by the rising cost of farming and importing raw materials, and an upcoming new law.

Some companies are forming new tie-ups to reuse one another's edible food surplus, by-products and discards, and expanding their recycling capacities. Others are investing in new ways to generate raw materials essential to industrial food production without producing more by-products that are thrown away.

Take artisanal bakery Baker & Cook and brewerz brewery. Said to be Singapore's first fully circular food pair, the firms have partnered to make use of each other's food surplus and by-products.

Specifically, Baker & Cook bakes its 'NWGrains' Sourdough with Brewerz's spent grains, while Brewerz brews its Earthbrew Sourdough Pale Ale with the surplus sourdough.

"To make circular food production work, parties have to come together – it is impossible to do it alone," said Mr Tan Wei Tuck, co-owner and managing director of Brewerz.

Mr Sean Bretschneider, founder of Baker & Cook, said the firm invests in research and development to ensure that the flavour and texture of its bread keep to a high standard despite incorporating spent grains in its dough.

A circular food production process ensures that by-products or food waste generated are repurposed. With 40 million tonnes of spent grains produced by breweries every year, equivalent to 80,000 Olympic-size swimming pools and 20 million slices of bread discarded daily

shopping malls and other companies involved in food processing segregate their food waste for treatment and recycling from 2024.

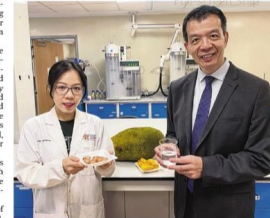
The new legislation under the Resource Sustainability Act proposed by the Ministry of the Environment and Water Resources and the National Environment Agency aims to reduce the amount of food waste sent for incineration, and upcycle waste into products to be used again. For instance, discards can be upcycled into animal feed, fertiliser, non-potable water or biogas for energy generation.

This legislation complements Singapore's '30 by 30' goal, which outlines plans to have Singapore produce 30 per cent of its nutritional needs locally by 2030.

In Singapore, 883,000 tonnes of edible food was wasted in 2022, with just 18 per cent being recycled. This includes leftovers from hotel buffets, restaurants and industry manufacturers, as well as food left past its expiration date.

Locally based biotech company Inno Industries is doubling the size of its facilities to 10,000 sq ft, to increase food waste intake by three to four times its current capacity of 30 tonnes to 40 tonnes a month.

It has worked with local food producers and farms such as restaurants, food manufacturers and central kitchens, such as P&N



PhD student Tan Anh Ngoc Le and Professor William Chen, director of the Food Science and Technology Programme at Nanyang Technological University, developed a method that extracts starch from jackfruit seeds and ferments it to produce lactic acid, which is crucial in the production of packaging materials, cosmetics and foods such as kimchi, yogurt and bread. PHOTO: NTU

Two separate projects are under way to use okara for cell-cultured meat and abalone

Shabana Begum

The team's fermented okara extract can cost \$2 per litre. The main cost driver for this novel food is the growth serum.

The research team is now reaching out to local cultivated meat start-ups to test the liquid extract. Singapore became the first country to approve the sale of a cell-cultured product last December.

Over at RP, researchers have concocted a cheaper feed for abalone, using okara as the main ingredient. Juvenile abalone fed on the okara-based food weighed about 25 per cent heavier than those sustained on commercial feed, and the abalone shells were a more vibrant purple.

Dr Chiradip Chatterjee, senior lecturer at the polytechnic's School of Applied Science, and his team developed the food pellets using a technology that included pre-treating the okara under high tem-

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ENVISION

CO-CREATING A CITY OF GREEN POSSIBILITIES
 EMBRACE AND INTEGRATE SUSTAINABILITY FOR A SUSTAINABLE FUTURE



THIS ISSUE:
 The Tase Neiras Integrated Waste Management Facility, SEA's biggest project will be Singapore's first integrated waste management facility with synergies and Autonomous Environmental Services to improve overall plant performance and optimise land use.

Amidst the backdrop of COVID-19, efforts in co-creating green spaces include NUS's iNCUBATE Partnership Programme and Autonomous Environmental Services in contributing to Singapore's environmental sustainability by a more sustainable future.

Through a shared vision and synergistic partnerships, individuals from different communities efforts to go green play a role with use of technology and innovation in contributing to Singapore's environmental sustainability by a more sustainable future.

ENVISION Magazine Issue 19 - Nov/Dec 2021 - A Publication of Singapore's National Environment Agency

Global Briefing

Novel Foods And Alternative Proteins For A Sustainable Urban Food System

With the world's population projected to reach 9 billion in 2050, food security is becoming an increasingly important global issue. The increase in population, over-changing consumer taste, climate change, water scarcity and COVID-19 pandemic make meeting the potential 60% increase in demand for food even more challenging.

Professor William Chen, The Michael Fum Chair Professor, Director, NTU Food Science and Technology Co-Director, Future Ready Food Safety Hub@NTU Director, Singapore Agri-Food Innovation Lab Nanyang Technological University (NTU) Singapore.

Climate change, COVID-19 pandemic and food security

The demand for food by the growing population would have a direct impact on the environment at various levels. The increase in production yield from traditional farming would be translated into deforestation, higher water usage, higher energy consumption in storage and transportation, thus contributing to global warming. The increase in global warming would in turn affect the production yield of traditional farming and with the extreme weather condition, even genetically modified (GM) crops would not be able to cope. For agricultural countries in Southeast Asia with large coastal farming areas, traditional farming land may well disappear when global sea levels rise as predicted in the recent intergovernmental panel on climate change (IPCC) report. Over time, the intensified demand in production yield and increased use of chemicals in farming would lead to the deterioration of soil condition and poorer nutritional quality of crops.

The added burden on traditional farming practices to feed the growing population would not be sustainable. It has been estimated that to feed 9 billion people

from the field to the consumer. The points of impact include the restricted movement of workers, changes in consumer demand, closure of food production facilities, restricted food trade policies, financial pressures in the food supply chain and a serious threat for public health. The overall impact has been across the entire food value chain (i.e. from food production to processing to distribution to consumer demand).

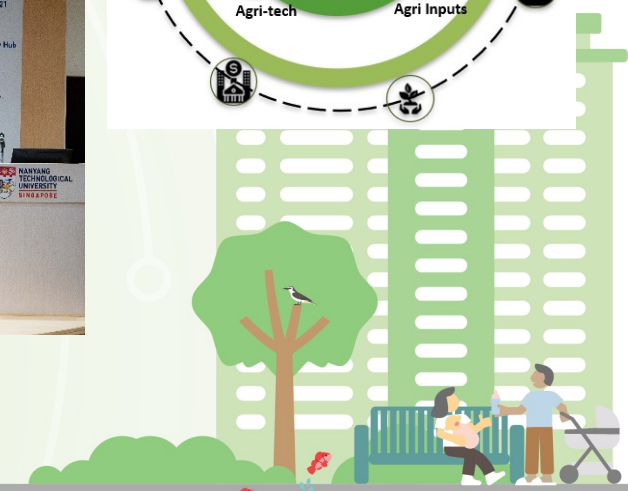
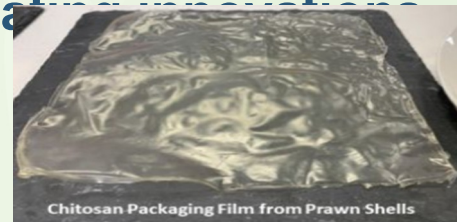
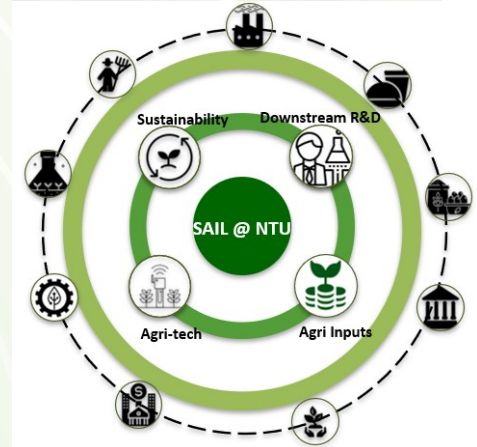
This interlinkage demands an integrated approach in dealing with food, public health and climate change to harness synergies and minimize trade-offs between food production, public health and climate mitigation.

Urban farming and efficient food system

With the increasing trend in urbanisation around the world, urban farming would provide a sustainable solution to complement traditional farming. Urban farming is resilient to climate change and other environmental hazards. It is also closer to consumers hence when compared with food produce from traditional farming, food loss would be lower and the nutritional value and freshness of food would be higher.

Food Safety Considerations for Urban Food System

- Food Circular Economy (*circular safety hazards?*)
- High Yield, High Nutrition (Higher Safety)
- Plant-based Proteins (*allergenicity?*)
- Insect Farming Substrate (*quality?*)
- Medium for Cultivated Meat (*safety hazards of replacement?*)
- Upcycling of Processing Side-streams (*mycotoxins?*)
- Enabling Platforms (FRESH, SAIL)
- Forward Looking Strategy: risk assessment with mitigation innovations



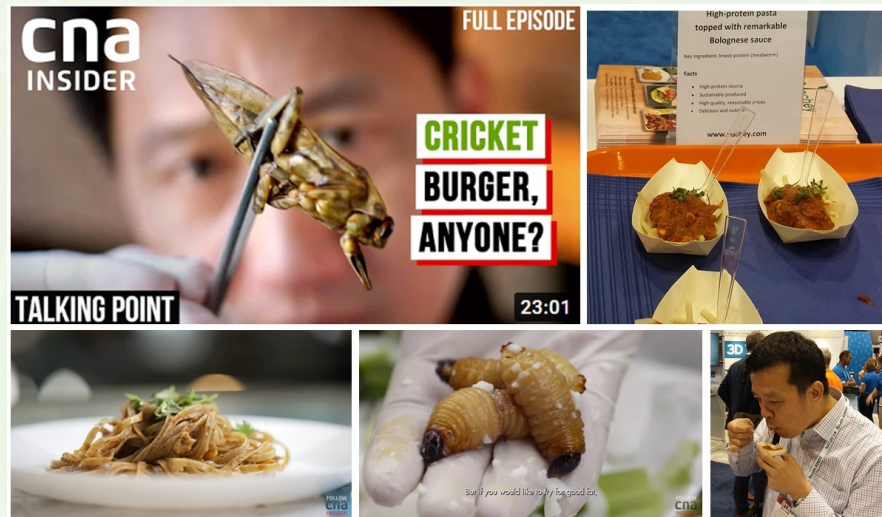
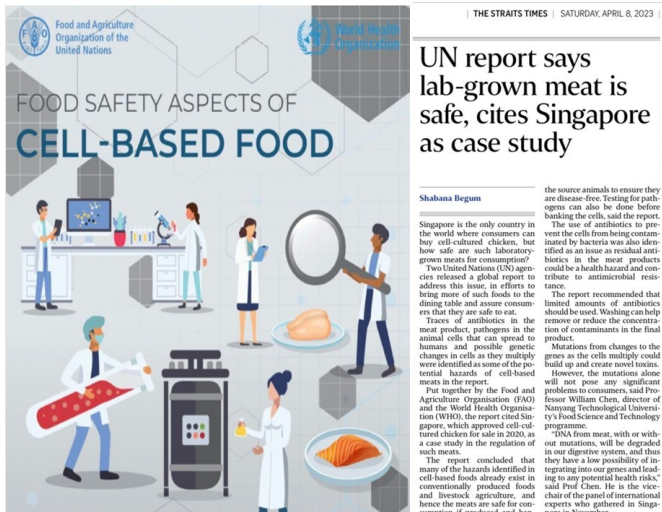
Conclusions and Future Directions

- Urban Food Systems are strong drivers of future food production
- Food Circular Economy makes Urban Food Systems more efficient
- Alternative foods from Urban Food Systems enhance Food Security
- Food Safety is integral part of Urban Food Systems
- Tech innovations improve Urban Food Systems, and make Food Safety assessment more progressive



Emerging issues in food safety

A health talk by Prof William Chen, Dr Steve Wearne, Dr Vittorio Fattori and Dr Mark Post
Nanyang Technological University Singapore, Codex Alimentarius Commission, Food and Agriculture Organization of the United Nations (FAO) and Maastricht University





Thank You