

BIOREFINERY

Many of us are probably not aware of how much food is wasted, or where and how it dumped. We also might think that given the fact that it is food, even if it is dumped it won't be doing much harm. Unfortunately that is not the case. Every year around 1.3 billion tonnes of food in the world is wasted or disposed of in landfills, posing a serious risk for the environment. Dr Carol S K Lin, a professor at the City College of Hong Kong led a team to develop what is called the biorefinery process that can put to use food that many of us don't give a second thought to while wasting. And none other than Starbucks in Hong Kong is collaborating in this venture by contributing their confectionary waste.

So what can we make out of these food items? Bioplastics and detergent ingredients – things we would never have thought of.

Why biorefinery?

Very large amounts of organic solids are discarded in food production and consumption and one of their uses is as carbonaceous raw materials for production of bioplastics. During her PhD, Dr Lin worked on the sustainable production of platform chemicals from renewable resources using green strategies. During this process, succinic acid was produced as a platform chemical using wheat. On joining the School of Energy and Environment at the City University of Hong Kong in July 2011, Dr Lin

explored the possibility of applying a similar approach for the production of platform chemicals and bioplastics from food waste.

What's the science behind it?

The food waste biorefinery process is based on the use of enzymatic hydrolysis to break down the macromolecules in food waste into simple sugars and free amino nitrogen. These can subsequently be utilized by bacterium for succinic acid fermentation. The process is as follows. Food items are blended with certain enzyme-secreting fungi which convert the carbohydrates in the food into simple sugars and accessible nitrogen source. These sugars go into a fermenter where certain bacteria break the sugar down to succinic acid – a colourless and odourless substance.

So, what all food can undergo this process?

Dr Lin explains, 'we tested that this technology can be applied to mixed food waste obtained from restaurant. Of course, the food waste hydrolysate obtained from homogeneous source (e.g. bakery waste, specific industrial food waste stream) will have more consistent glucose and nitrogen sources.' In Starbucks, it is the cakes and pastry's waste as well as coffee grounds that are converted into succinic acid. The good news? Dr Lin says



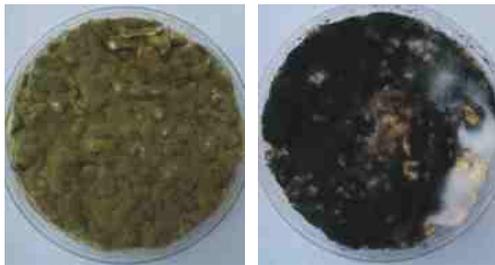
Bakery waste



Fungal fermentation



Bacterial fermentation



Solid-state
fermentation



Succinic acid

that this technology can be adopted by any food chain anywhere in the world. Definitely something to think about.

And what all can we make from these foods?

According to Dr Lin, 'This food waste hydrolysate can virtually make a spectrum of products using bioprocessing, such as, bioplastics, platform chemicals, biosurfactants.' In fact, a 2004 US Department of Energy report had suggested that succinic acid could be used to make products ranging from laundry detergent to bioplastics and even medicines.

How does this help the environment?

The biorefinery process provides an alternative to incinerating dumped food, a process that releases a lot of

pollutants into the atmosphere. In Hong Kong alone, it has been reported that an estimated 4500 tonnes of used coffee grounds are dumped or incinerated.

The biorefinery process itself, Dr Lin says is novel. 'Moreover', she adds, 'by the selection of a proper microorganism, solid-state fermentation of food waste for enzyme production would also become a novel research. This novel treatment strategy reduces the environmental burden of food waste, provides a partial solution to biochemical production requirements, and produces a potential income from a waste resource. Food waste is a major environmental problem in Hong Kong. Therefore, we propose the production of chemical and biodegradable plastic (succinic acid and poly-(3-hydroxybutyrate)) as a synergetic solution to both of these problems. Such a solution through the utilization of food waste for the production of value-added products can then be adopted by the Hong Kong Government as part of their strategy for tackling the food waste problem and for the environmentally friendly production of alternative platform chemicals.'