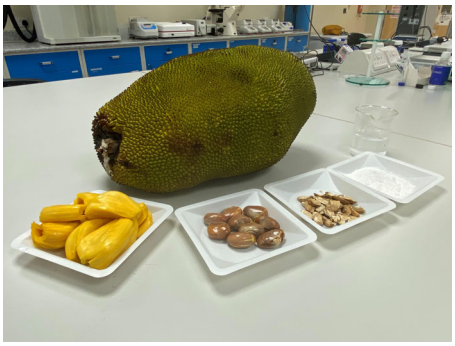
Singapore scientists upcycle jackfruit seeds to formulate lactic acid for F&B applications

02 Oct 2023 ---Researchers at the Nanyang Technological University (NTU) have developed a method to make lactic acid using once discarded jackfruit seeds, which they say is a sustainable and more effective technique for formulating the food additive compared to existing processes. Lactic acid is indispensable in the various manufacturing stages and preservation of bread, yogurt, cheese, kimchi, sauerkraut and pickles.

For the study, the scientists used jackfruit seeds as a nutrient substrate for lactic acid-producing bacteria to grow. They extracted jackfruit seed starch (JFSS) from fruit waste and discovered that the co-fermentation of *B. subtilis* and *L. plantarum* increased the amount of lactic acid produced.

Professor William Chen, director of NTU's Food Science and Technology (FST) program, who led the project, tells ***Food Ingredients First*** that the size of jackfruit seeds is significant and represents about 20% of jackfruit's total weight, which prompted them to use it for their study.

"Our motivation was to use it (jackfruit) as a cost-effective and sustainable replacement of the nutrient materials used in the fermentation process to produce lactic acid."



A side-by-side presentation of a jackfruit, its fruit, seeds, the powder from its freeze-dried seeds and lactic acid produced from the seeds in a beaker *(Image Credit: NTU)*

"A sustainable source of nutrient materials is needed for lactic acid production estimated to be 1.5 million metric tons annually and likely for other similar food additives produced at large volume through fermentation."

He further asserted that fermentation for the production of food additives needs to be reviewed for long-term sustainability and cost-effectiveness.

Preservation and flavor enhancement
The study states that lactic acid is one of the most relevant organic acids with a host of applications in the F&B industries, where it is used as a preservative, pH regulator and flavor enhancer.

In 2022, approximately 1.5 million metric tons of lactic acid were manufactured worldwide.

Lactic acid is also an integral contributor to sourdough bread's unique taste.

The FDA has classified lactic acid as generally recognized as safe (GRAS), which allows formulators to use it as a direct human food ingredient, an antimicrobial agent, a curing and pickling agent, a flavor enhancer, as well as a flavoring agent and adjuvant.

In dairy products, lactic acid confers a tangy taste. While in jams and canned fruits, it controls acidity. It also extends the shelf life of packaged meat products and conditions the dough for better texture and volume in baking.

Moreover, lactic acid helps emulsify dressings and sauces and maintains vibrant colors in fruits and vegetables.

Tackling waste, inflation and land scarcity
The study, published in the *Journal of Functional Foods*, aims to enhance the processing efficiency in the food supply chain while addressing two main pressure points for the food industry – rising production costs and waste management.

The cost of raw materials for lactic acid production is one of the significant difficulties, accounting for more than 34% of overall manufacturing expenses, it states.

Prof. Chen flags that the currently used nutrient materials for lactic acid production, sugarcane, cornstarch and beetroot sugar, have become costlier due owing to increasing scarcity of farmland, natural disasters and rising inflation.

Further, industrial methods also result in large amounts of by-products, such as gypsum, which release greenhouse gasses when not disposed of properly.

"Jackfruits are increasingly popular in diets worldwide, with their flesh, which resembles meat in both taste and texture, being made into meat substitutes. However, its seeds, which make up nearly a fifth of the fruit's total weight, are thrown into landfills," states the NTU.

Prof. Chen presenting jackfruit seeds that have been freeze-dried, a step that is a part of the NTU-developed method to use them to produce lactic acid. *(Image credit: NTU)*

Tram Anh Ngoc Le, a Ph.D. student from the FST program at NTU and first author of the study, states: "Who knew that the jackfruit tree that grows rapidly all over Southeast Asia could

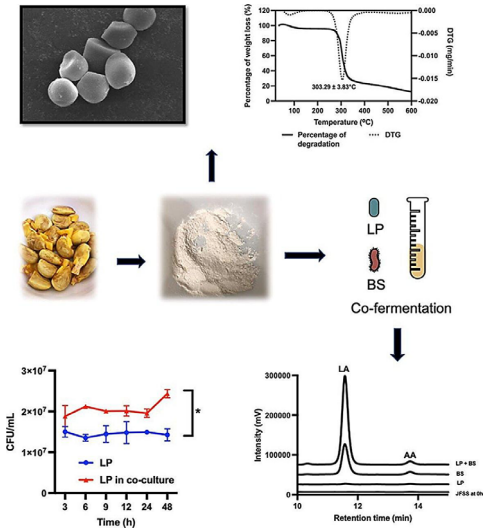
have the potential to address the world's current food issues, such as tackling food waste, food scarcity because of inflation and food insecurity."

"Not only is the jack fruit a nutrient-dense food product that could feed starving millions, but we have uncovered that its seeds hold even more promise in cutting down on the waste and chemicals in widespread industrial processes."

Utilizing the good bacteria

To produce lactic acid from jackfruit seeds, the scientists first washed the seeds and then added sodium hydroxide at room temperature.

"This is a common process to remove skins from fruits and vegetables for canning before freeze-drying the seeds and blending them into a powder," says NTU.



Graphic depicting how the scientists generated lactic acid from jackfruit seeds (*Image credit: Journal of Functional Foods*).

They then added *Lactiplantibacillus plantarum*, a "good" bacterium commonly found in probiotics, to the jackfruit seed powder. Breaking it down into sugars and lactic acid takes about two days and lactic acid is later extracted during a filtration process.

For this research, the scientists had to use co-fermentation of LAB with other microorganisms to aid starch saccharification for higher lactic acid yield.

Last year, scientists in Denmark, found that LAB with lactase can break down milk sugar and create natural sweetness in yogurt.

A "powerful tool" for manufacturing companies

According to Prof. Chen, the technique could become a powerful tool for manufacturing companies to produce lactic acid.

"On one hand, it already uses several common production techniques already in use in food processing facilities, such as freeze-drying, starch filtration and the extraction of lactic acid."

On the other, the feedstock is the low cost, "ubiquitous unwanted product—jackfruit seeds," which would reflect well on corporations' sustainability goals, he adds. Further, the hurdle of getting the jackfruit seeds to the lactic acid producers could be addressed by making some adjustments in the food supply chain.

The NTU team plans to optimize its lactic acid production method scale up their production process through collaborations with F&B partners.

Prof. Chen stated that the adoption of NTU's innovation would not be overnight, as it would need the optimization of large-scale production.

"Extending from our proof of concept, it is anticipated that other fruit seeds would be explored by industry or innovators for their potential use as a replacement of nutrient substrates for industrial fermentation to produce lactic acid and other food additives," he concludes.

By Insha Naureen