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Newly Developed Method to Extract Useful Proteins from Beer-Brewing Leftovers

The proteins could be used commercially to enrich human diets and cosmetic products

by Nanyang Technological University
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Researchers from Nanyang Technological University, Singapore (NTU Singapore), have created a method that extracts over 80 percent of the available protein in grain leftovers from brewing beer, commonly known as brewers' spent grain.

Brewers' spent grain (BSG) is the solid residue from malted barley after brewing beer. It is the most significant byproduct of the beer brewing industry, making up 85 percent of the total waste. Globally, about 36.4 million tons of spent grain are produced every year.

This spent grain is typically discarded after its primary use in brewing beer. While some

efforts are made to repurpose BSG in applications such as animal feed, biofuel production, or composting, a substantial portion still ends up in landfills, generating greenhouse gases such as methane and carbon dioxide.

After exploring new use cases for the BSG proteins, the researchers from NTU's Food Science and Technology program say their protein extraction method could help reduce waste. The extracted proteins could then be used to enrich diets and even for cosmetic purposes, feeding into growing consumer preferences towards sustainably sourced and eco-friendly goods, with 66 percent of global consumers expressing readiness to pay premium prices for products from sustainable brands.

The researchers extracted up to 200 grams of protein from one kilogram of BSG, indicating its potential as a protein source. The Singapore Health Promotion Board recommends that the average woman requires 40 grams of protein daily, while an average adult man needs 56 grams daily.

The researchers note that BSG proteins are safe for human consumption and of high quality, making them suitable for direct use in supplements and for enhancing the protein content of plant-based foods.

Given the importance of plant-based foods in providing essential proteins to our diets, incorporating BSG protein into these foods has the potential to enhance their nutritional value significantly. This addition could assist individuals in meeting their daily protein requirements more effectively.

This would also help mitigate a possible protein shortage due to a forecast 73 percent increase in meat consumption by the year 2050 following rapid global population growth, according to the Food and Agriculture Organisation of the UN (FAO).

The proteins extracted by the NTU researchers were found to be rich in antioxidants, which could not only protect human skin from pollutants but could also extend the shelf life of cosmetics like body lotions and moisturizers.

This could present an eco-friendly alternative to conventional cosmetic components

such as parabens, which disrupt hormone function in aquatic organisms, and petroleum-based ingredients, known to contribute environmental pollution during extraction and production processes.

Lead author Professor William Chen, Director of NTU's Food Science and Technology (FST) program, who led the study, said: "Our study, which presents more sustainable and efficient ways to add value to brewers' spent grain disposal, is a crucial step towards mitigating its contribution to greenhouse emissions and reducing environmental strain, while also enriching the global food supply chain. Demonstrating that the protein-rich qualities of brewers' spent grain could be successfully extracted and funneled into supplements and enriching plant-based proteins to make them more attractive to the consumer addresses two global pressure points—food wastage and food shortage." Prof Chen is also the Director of the Singapore Agri-food Innovation Lab (SAIL) and Director of the Singapore Future Ready Food Safety Hub (FRESH).

First author of the study, Dr. Chai Kong Fei, Senior Research Fellow at NTU's FST program, said: "The protein extracted from brewers' spent grain from the NTU-developed method has been shown to not only have potential to be included in our diets, but they could also serve in another industry—cosmetics. Due to their natural exfoliating properties and abundance of antioxidants, we feel they could be incorporated into various skincare formulations, from moisturizers to body lotions, offering an alternative to chemicals such as preservatives, which have been shown to cause damage to wildlife and the environment after being washed down our sinks."

Several NTU industry partners have received the NTU innovation positively. Ms. Mirte Gosker, Managing Director of The Good Food Institute Asia Pacific, said: "Innovative applications of underutilized grains like those being brewed up at NTU have the potential to reduce Singapore's dependence on raw-material imports, provide an additional revenue source for local producers, and help entrepreneurs craft more nutrient-dense plant-based meats. Amid rising food demand pressures, protein extraction from agricultural side streams is field primed and ready to be tapped."

The study, which presents an innovation that promotes a sustainable food tech solution that reduces waste, reflects NTU's commitment to mitigate our environmental impact,

one of four humanity's grand challenges that the University seeks to address through its NTU 2025 strategic plan.

The findings were **published recently in the peer-reviewed journal Innovative Food Science and Emerging Technologies**.

Unlocking the protein within

The NTU FST Program collaborated with Heineken Asia Pacific, the producer of Tiger Beer, using the brewers' spent grain in the study.

To extract the protein from the spent grain, the researchers first sterilized it before using Rhizopus oligosporus, a food-grade fungus commonly used to ferment soybeans to produce tempeh, a soy-based food popular in Southeast Asia. The three-day fermentation process helps break down the BSG's complex structure, making its protein content more easily extractable (see video).

The fermented BSG is then dried, ground into a powder, sieved, and spun in a centrifuge to separate the protein, which would float to the top from the rest of the mixture. Once extracted, the protein could be added to foods to boost their protein content or combined with lotions or creams to boost their moisturizing and antioxidant properties.

Prof Chen added: "Our method presents an innovative way to repurpose beer waste into a valuable protein source for global nutrition. Beyond mere innovation, our work embodies a narrative of turning what was once considered waste into a vital resource, a symbol of sustainability, and a solution to one of humanity's most pressing challenges: protein scarcity. Our endeavor underscores NTU's pioneering role in food technology science and our commitment to addressing real-world problems with ingenuity and foresight."

The NTU FST team will be in discussion with Heineken Asia Pacific to scale up their protein extraction method and plans to collaborate with several food and beverage and cosmetic companies to further implement their technology, with an eye towards commercialization.

- This press release was originally published on the Nanyang Technological University website and has been edited for style and clarity