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Gauri Khanna · 6 days ago · 3 min read

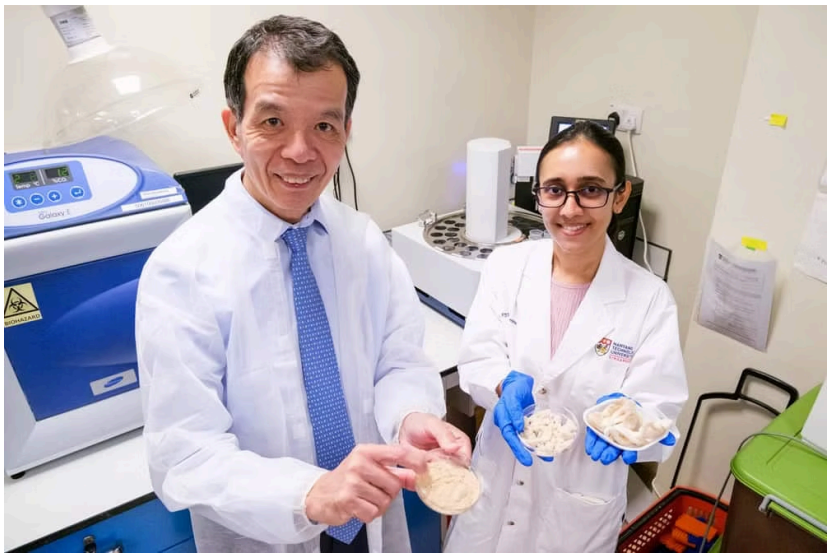
NTU Singapore Ferments Okara With Oyster Mushroom Mycelium Substantially Lifting Protein Levels

- Researchers at NTU Singapore, working with Ichimasa Kamaboko, raised the protein content of okara up 30% dry weight using oyster mushroom myceliumX.
- The team used solid-state fermentation, in which a fungus grows directly on moist solid material; over an 11-day incubation the mycelium broke down plant fibres and moved the taste from sour towards umami.
- The researchers say energy use, food safety, storage stability, human sensory response and production economics are still untested, so commercial viability remains unproven.

Researchers at Nanyang Technological University, Singapore (NTU Singapore) have fermented okara, the soybean pulp left over from tofu and soy milk production, with oyster mushroom mycelium. The treatment raised its protein content to between 27.7% and 30.2% by dry weight. The lab-scale study, carried out with Japanese food manufacturer Ichimasa Kamaboko and published in Food Chemistry: X, also found that fermentation shifted okara's flavour from sour towards umami.

A Perishable Side Stream

Soy food producers generate okara in large volumes, but its high moisture content means it spoils quickly. Its insoluble fibre, coarse texture and sourness keep it out of most food applications, and much of it is discarded or used as low-value animal feed, according to the study as reported by vegconomist.



Credits: NTU Singapore

The work belongs to a wider effort to turn agricultural residues into food ingredients with fungi, from carrot waste to starch waste. Okara adds a feedstock that is abundant wherever tofu and soy milk are made.

Solid-State Fermentation on Okara

The researchers used solid-state fermentation, a process in which the fungus grows directly on a moist solid substrate rather than in liquid. They compared fresh and dried okara with blends containing wheat bran and sawdust, two substrates common in commercial mushroom farming. Fresh okara produced the densest growth, with the mycelium fully covering it over the 11-day incubation.



Credits: NTU Singapore

As the mycelium grew, its enzymes broke the okara's plant fibres down into simpler sugars and amino acids. Nitrogen levels, an indicator of protein content, rose, while glucose concentrations increased between 2.8 and 6.4 times from a low baseline.

Taste Moves Towards Umami



To assess flavour, the team used an electronic tongue, a sensor device that scores taste traits. The fermented okara scored as less sour and more savoury. Laboratory analysis showed that the compounds behind umami increased several times over, with fresh okara giving the strongest result, while the acids responsible for okara's sourness generally declined.

The picture was not uniformly positive. Some samples also became more bitter and dry, and the researchers say the fermentation process will need adjusting to produce a balanced flavour.

NTU's Food Science and Technology Programme has related experience in this area. It partnered with Bunge in 2024 to develop alternative protein flavours from oilseed side streams, also using solid-state fermentation.

