JOINT NEWS RELEASE

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NTU Singapore and Japan's Waseda University trial use of soybean waste to tackle obesity

An international team of scientists from **Nanyang Technological University, Singapore (NTU Singapore)** and **Waseda University** in Japan have found that fermented soybean waste, or okara, could improve fat metabolism and mitigate effects of diet-induced obesity.

Through laboratory experiments reported in the peer-reviewed scientific journal *Metabolites* in February, the scientists from NTU Singapore and Waseda showed that mice on a high fat diet supplemented with fermented okara gained less body mass and had lower levels of fat and cholesterol after three weeks as compared to mice on the same diet but not fed any fermented okara.

With 14 million tonnes of okara generated every year[1], and nearly a third of the world's population overweight or obese, the scientists hope their findings can pave the way for fermented okara to be integrated into health foods one day, addressing the problems of food waste and obesity at the same time.

Dr Ken Lee, senior lecturer at the NTU School of Physical and Mathematical Sciences and **co-lead author of the paper**, said: "Using a process akin to what is used to produce miso and soy sauce, we fermented okara and fed it to mice on a high-fat diet. Three weeks later, we found that these mice gained less weight as compared to mice on a high-fat diet but without fermented okara. The mice that were fed fermented okara also had less fat and lower cholesterol levels.

"Our findings suggest that fermented okara could help to mitigate the harmful effects of a high-fat diet, and could potentially be integrated in the diets of obese patients who find it difficult to make immediate lifestyle changes."

Dr Shigenobu Shibata, Professor at the Waseda University Graduate School of Advanced Science and Engineering and **co-lead author of the paper**, said:

[1] *An Overview of the Composition, Applications, and Recovery Techniques of the Components of Okara Aimed at the Biovalorization of This Soybean Processing Residue, 18 May 2021*

"*Aspergillus oryzae* and *Aspergillus sojae,* which are typical aspergillus fungi used to produce soy sauce and miso, were successfully combined to ferment okara. Compared to unfermented okara, fermented okara was found to be able to reduce obesity and improve abnormal lipid metabolism in mice. Tofu and soymilk are now widely accepted as health foods not only in Japan but in the world, and the effective use of okara, which is an industrial waste, is in line with the United Nations Sustainable Development Goals. I hope NTU and Waseda University, each with their unique strength, will continue to promote such joint research centred on graduate students and young researchers."

The okara study supports the goals of the **NTU 2025 five-year strategic plan**, which prioritises the University's commitment to sustainability, as well as its focus on health and society as one of the research clusters with potential for significant intellectual and societal impact.

Enhancing okara's nutrition

To enhance the nutritional profile of okara, the research team from NTU and Waseda first fermented okara collected from a Singapore beancurd manufacturer using a process traditionally used in Asian countries to make fermented soybean food products such as miso, soy sauce, and tempeh.

Enhancing the nutritional profile of okara increases its potential as a desirable ingredient in the human diet, the scientists explained.

For this study, the team added a mix of *Aspergillus oryzae (A. oryzae)* and *Aspergillus sojae (A. sojae)* – food-grade microbes – to okara and left it to ferment in the dark at 25°C for four days.

Compared to unfermented okara, the scientists found that fermented okara had more protein and a higher total phenolic content – an indication of higher antioxidant properties – and less insoluble dietary fibre.

Fermented okara improves fat metabolism

The scientists then investigated the anti-obesity effects of fermented okara on mice put on a three-week high fat diet compared to mice put on three other types of diet: a normal diet, a high-fat diet, and a diet supplemented with unfermented okara.

At the end of three weeks, mice that were fed fermented okara every day gained the least body mass (3g) as compared to other three groups of mice that gained between 6g to 10g.

The mice that were fed fermented okara also had less visceral and subcutaneous fat (30g and 19g respectively) than mice on a high-fat diet without any fermented okara (67g and 53g respectively).

The scientists also found lower triglyceride and cholesterol levels in mice on a fermented okara-supplemented diet compared to those without. Triglycerides are a type of fat in the blood that has been linked to an increased risk of heart disease.

Further investigation revealed that the reduction in triglycerides was in part due to a significant dip in proteins involved in fatty acid synthesis.

These findings indicate the fermented okara's potential to suppress diet-induced obesity, said the scientists.

The study builds on the NTU-Waseda team's earlier research on other uses for okara. For instance, the scientists showed that fermented okara could help to bring down blood sugar levels. They have also worked with a local brewery to integrate okara into modern dishes.

Working with collaborators in Singapore, the NTU team has also successfully repurposed okara into an eco-friendly 3D-printing ink, highlighting the potential use of 3D food printing to improve food sustainability[2].

The NTU-Waseda team is now reaching out to industry partners to translate this work into healthy snacks and exploring how it can be integrated into other food products.

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Notes to Editor:

Paper '*Solid-State Fermented Okara with Aspergillus spp. Improves Lipid Metabolism and High-Fat Diet Induced Obesity'* published in *Metabolites* on Feb 23 2022. https://doi.org/10.3390/metabo12030198

[2] *3D Printing of Okara Ink: The Effect of Particle Size on the Printability, 8 Nov 2021*

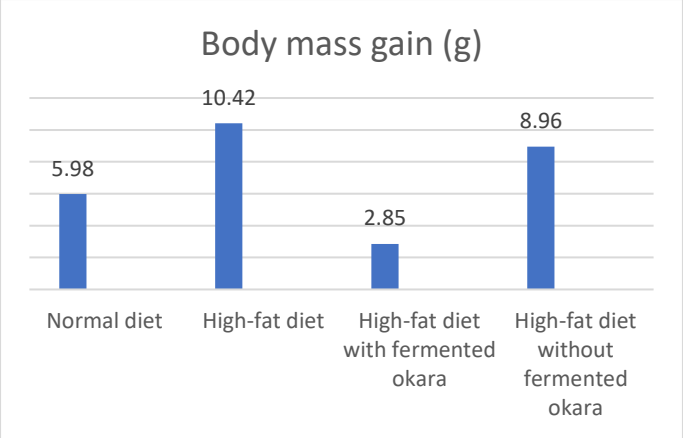

Chart 1: Gain in body mass in mice put on different diets after three weeks

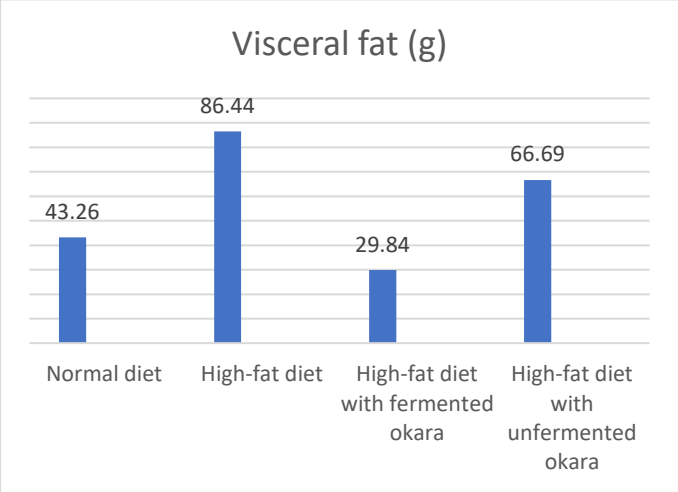

Chart 2: Visceral fat in mice put on different diets after three weeks

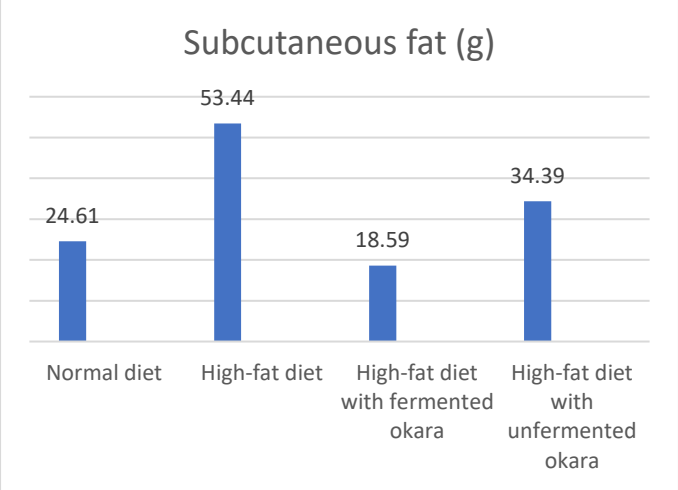

Chart 3: Subcutaneous fat in mice put on different diets after three weeks

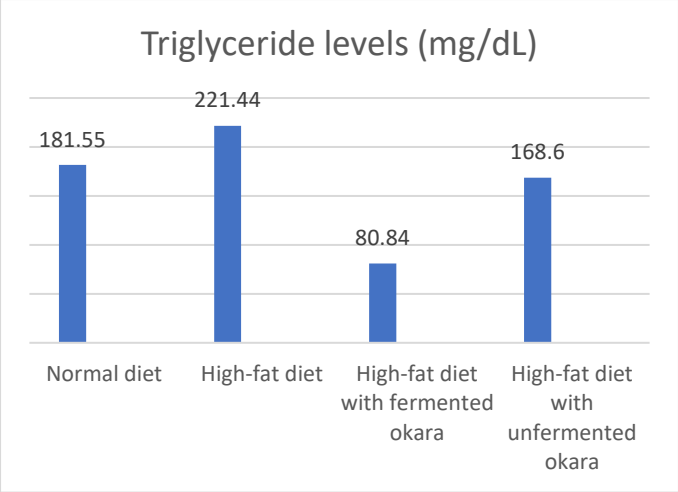

Chart 4: Triglyceride levels in mice put on different diets after three weeks

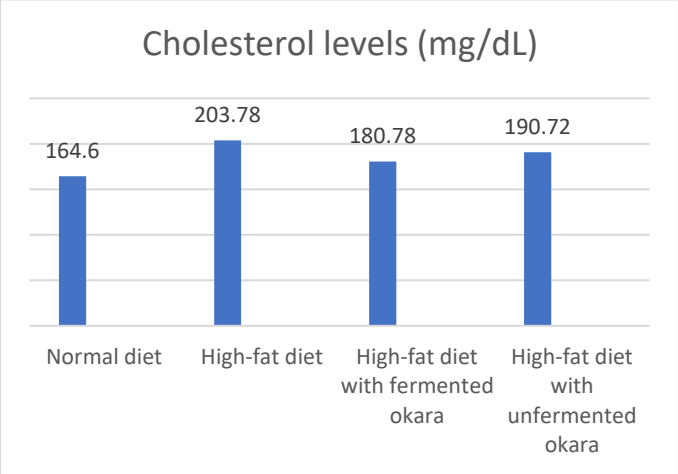

Chart 5: Cholesterol levels in mice put on different diets after three weeks

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About Nanyang Technological University, Singapore

A research-intensive public university, Nanyang Technological University, Singapore (NTU Singapore) has 33,000 undergraduate and postgraduate students in the Engineering, Business, Science, Humanities, Arts, & Social Sciences, and Graduate colleges. It also has a medical school, the Lee Kong Chian School of Medicine, established jointly with Imperial College London.

NTU is also home to world-class autonomous institutes – the National Institute of Education, S Rajaratnam School of International Studies, Earth Observatory of Singapore, and Singapore Centre for Environmental Life Sciences Engineering – and various leading research centres such as the Nanyang Environment & Water Research Institute (NEWRI) and Energy Research Institute @ NTU (ERI@N).

Ranked amongst the world's top universities by QS, NTU has also been named the world's top young university for the past seven years. The University's main campus is frequently listed among the Top 15 most beautiful university campuses in the world and has 57 Green Mark-certified (equivalent to LEED-certified) buildings, of which 95% are certified Green Mark Platinum. Apart from its main campus, NTU also has a campus in Novena, Singapore's healthcare district.

Under the NTU Smart Campus vision, the University harnesses the power of digital technology and tech-enabled solutions to support better learning and living experiences, the discovery of new knowledge, and the sustainability of resources.

For more information, visit www.ntu.edu.sg.

About Waseda University, Japan

Located in central Tokyo, Waseda University was founded in 1882 based on three principles: independence of scholarship, practical application of scholarship, and fostering of good citizens. Approximately 50,000 students are enrolled in one of the 13 undergraduate and 22 graduate schools.

Waseda has produced many changemakers in its history, including 8 prime ministers and many leaders in government, journalism, science, literature, the arts, and more. With more than 6,500 international students enrolled in AY2021, Waseda is proud to be the most global campus in Japan.

Students may choose to obtain their degrees entirely in English and learn Japanese in parallel to their major studies. They can also gain invaluable experience of living in Tokyo, one of the best global cities for students because of its safety, cleanliness, hospitality, convenient public transportation, and balance in traditional and modern culture.

For more information, visit www.waseda.jp/top/en/