

A team of scientists from Singapore and Japan have found that fermented soybean waste, or okara, could improve fat metabolism and mitigate the effects of diet-induced obesity.

Study co-lead author and Nanyang Technological University (NTU), Singapore, senior lecturer Dr Ken Lee 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, 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."

His co-lead author and Waseda University, Japan, professor Dr Shigenobu Shibata explained that: "*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."

The team had added a mix of *A. oryzae* and *A. sojae* – both food-grade microbes – to okara obtained from a Singapore beancurd manufacturer, and left it to ferment in the dark at 25°C for four days.

The fermentation process was important to enhance the nutritional profile of okara and increase its potential as a desirable

Soy waste to fight fat

Animal studies have shown that including fermented soybean waste in the diet can improve fat metabolism and lower cholesterol levels.



Adding fermented okara, seen here in powdered form in the test tube, to food could help improve fight diet-induced obesity. – NTU

ingredient in the human diet, the scientists explained.

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

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 high-fat diet supplemented with unfermented okara.

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

The mice that were fed ferment-

ed 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 fermented okara's potential to suppress diet-induced obesity, the researchers said.

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 also help bring down blood sugar levels.

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.

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.

"Tofu and soy milk are now widely accepted as health foods not only in Japan, but also around the world, and the effective use of okara, which is an industrial waste, is in line with the United Nations Sustainable Development Goals (UN SDGs)," said Prof Shibata.

With 14 million tonnes of okara generated every year 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 dual problems of food waste and obesity at the same time.

The study was reported in the scientific journal *Metabolites* last month.