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Effects of Atomized Okara on Obesity and Gut Microbiota in Mice

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Description

This study explored the effects of Wet-Type Grinder-Treated Okara (WGO) on obesity and gut microbiota in high-fat diet-fed mice. WGO supplementation reduced weight gain, improved glucose tolerance and altered gut microbiota composition, increasing beneficial *Ruminococcus* while decreasing harmful bacteria, highlighting its potential in preventing metabolic disorders.

Dietary fibers are prevalent components of food, categorized into soluble and insoluble forms based on their solubility, or into non-starch polysaccharides, resistant starch and resistant oligosaccharides based on their composition. Conversely, low dietary fiber intake, combined with high fat and sugar consumption, leads to dysbiosis, an imbalance in gut microbiota. Recent research indicates that the composition of gut microbiota is vital for host health and plays a significant role in preventing metabolic and immune-related disorders such as type 2 diabetes, obesity, inflammatory bowel disease and allergies. The health benefits associated with dietary fibers are influenced by their viscosity and their fermentation by intestinal microbiota. Well-controlled clinical studies have shown that the advantages of dietary fibers, including improved glycemic control and reduced cholesterol levels, are closely related to their viscosity.

Over the last decade, advancements in nanofiber technology have emerged, with nanocellulose capable of forming viscous solutions unlike traditional cellulose. Okara, a byproduct of soybean processing, is rich in dietary fibers, primarily in the insoluble form. Our previous study demonstrated that dispersions of water jet-treated okara formed a highly viscous slurry and inhibited α-amylase activity while increasing butyrate production by *Roseburia intestinalis*, a predominant human gut bacterium. Other studies have shown that nanocellulose consumption reduces postprandial insulin levels in a concentration-dependent manner in mice. The impact of added nanocellulose on viscosity, enzyme activity and glucose release during starch digestion has also been revealing that while nanocellulose increases viscosity and delays starch hydrolysis, it does not affect α-amylase or α-glucosidase activity.

Furthermore, the effects of dietary nanocellulose have been investigated in mice on a high-fat diet, indicating that it can modulate obesity and alter the gut microbiota structure. Specifically, the abundance of Lactobacillaceae increased, while Rikenellaceae and Streptococcaceae decreased. Nanocellulose supplementation also enhanced exercise performance and demonstrated inhibitory effects against obesity through its influence on gut microbiota composition. These findings suggest that atomized okara could be a favourable strategy for mitigating metabolic syndromes like diabetes and obesity by reshaping gut microbiota. However, the specific mechanisms through which atomized okara exerts its anti-obesity effects by modifying gut microbiota structure remain unclear.

In this study, we prepared atomized okara using a wet-type grinder and investigated the effects of this treatment on obesity in mice fed a high-fat diet. We analyzed gut microbiota composition and plasma metabolites through bacterial 16S ribosomal RNA gene sequencing and ultra-high-performance liquid chromatography-mass spectrometry, respectively, to elucidate the mechanisms behind the anti-obesity effects of the atomized okara.

Diets

The control fat diet, high-fat diet for the cellulose-treated group and high-fat diet with no added cellulose for the fiber-untreated and atomized okara-treated groups were sourced from Research Diets. The dietary compositions are outlined in the accompanying table. The atomized okara was produced from defatted okara, which contains a specific percentage of water, protein and fat.

Intake of feed and fiber

Over the 12-week study period, the average feed consumption, based on caloric intake, was recorded for each group. The cellulose-treated group consumed more feed compared to the control group, with no significant differences among the other groups. The average fiber intake for the cellulose and atomized okara-treated groups was also measured.

Our results indicate that supplementation with atomized okara significantly inhibited obesity in mice on a high-fat diet, leading to reduced body weight gain and fat accumulation. Additionally, improvements in glucose tolerance and cholesterol levels were observed. Notably, consumption of atomized okara prevented the decrease in muscle mass induced by the high-fat diet. Other changes included cecum enlargement, reduced pH and increased butyrate production.

In summary, the consumption of atomized okara effectively suppressed body weight gain and fat accumulation while improving glucose tolerance and lowering cholesterol levels in mice on a high-fat diet. Supplementation led to cecum enlargement, a lower pH and increased butyrate production.

Sequencing analysis revealed that atomized okara treatment increased the abundance of butyrate-producing *Ruminococcus* and decreased the populations of *Rikenellaceae, Strepto-coccaceae* and *Prevotellaceae*, which are associated with metabolic diseases.