外国語要旨

Utility of various agricultural food particles in cooking and food processing

TANISAWA Yoko

Foods are complex, containing components and multiple phases. Dispersion and mixing of foods are important factors in the cooking process. When foods are mixed and cooked, an interface appears among them; by controlling this interface, foods with high palatability can be provided. Ingredient "dispersing and mixing" is an important operation that enables controlling the end-state of cooking. Micronizing foods is very important because it ensures their suitability both for the cooking process and for obtaining the desired products.

In recent years, it has become possible to make the ingredients very small. Foods are now available in the scale of a few microns to tens of microns, as a result of improvement in grinding technology in recent years. These fine particles can be utilized for cooking while maintaining the color and flavor of the agricultural food material. Despite the improvements of grinding technology, there are few reports on the cooking characteristics of microparticles.

Therefore, I investigated the cooking characteristics pulverized agricultural foods ranging from the several micrometers to tens of micrometers (fine particles) in size. In addition, it was examined whether new cooking functionality could be obtained for possible application in actual cooking. The application of food particles in cooking and food processing was considered in this research.

A total of 18 kinds of starchy and non-starchy agricultural foods were ground to fine particles using a dry pulverizer. The particle diameter, water content, color, appearance, density, and oil- and water-accepting capacity were investigated and considered as physicochemical properties of these particles. Most of the ingredient of samples were referred to in 'Standard tables of food composition in Japan 2015 (Seventh Revised Edition)'. The foaming, emulsifying, and thickening effects of these food particles were also investigated.

To investigate foam formation and stability, particles were dispersed in water and stirred. It was observed that Komatsuna and dried shiitake mushroom particles had effective foaming ability. To examine the potential use of particles in food processing and cooking, the particles were added to reduced-sugar meringues. The drip amounts from reduced-sugar meringues prepared with the particles decreased significantly compared to those from the control reduced-sugar meringue.

For emulsification and stability analysis, particles were dispersed and homogenized in water/oil. The shiitake particles had an effective stability in the emulsion. The particles were used to produce mayonnaise-like egg-free dressings and met the viscosity standard of mayonnaise dressings. Corn, adzuki bean, shiitake mushroom, and Hijiki

7.0-7.7% or glutinous rice 11% particles added to oil 57-59% and to the aqueous phase with NaCl 1.4%, produced a savory emulsion with mayonnaise-like viscosity (30 Pa・s, 1 s^{-1}) without the use of eggs. The stability of the glutinous rice particles in the mayonnaise- like dressing lasted for six months.

In order to investigate the emulsifying effect of the particles, the interfacial tension was measured. When measuring the interfacial tension between the oil and aqueous phases, I found that the interfacial tension of dried shiitake mushrooms rapidly decreased until 300 s, and the fine particles migrated from the oil phase to the aqueous phase. On the other hand, for glutinous rice, the interfacial tension gradually decreased. This indicates that dried shiitake and glutinous rice had different surface-active functions. To investigate whether glutinous rice-based emulsions were notably stable against oiling-off, which can be partially attributed to Pickering stabilization according to CLSM observation. The deproteinized glutinous rice- and shiitake-particles could not stabilize meringues and dressings, demonstrating that proteins within the particles might dominantly contribute to the stabilization mechanisms.

Furthermore, I studied the thickening effect of the particles. Thickening agents are used to improve the suitability of foods for swallowing. Chemically functionalized thickeners and starches are used as thickening agents in industrial cooking products. In this study, the fine particles of starchy food, including brown rice, pumpkin, lotus root, and ginger and the non-starchy food shiitake mushrooms had thickening properties. The particles were dispersed in water and heated to obtain a thickened liquid.

The thickened liquid of apparent viscosity, at a shear speed of 50 s^{-1} ranged from mildly thick (50 – 100 mP・s) to moderately thick (150-300 mP・s) and extremely thick (300-500 mPa・s), according to the classification in Modified Diet for Dysphagic Persons in the Japanese Society of Dysphagia Rehabilitation (2013), and more than to meat sauce or ankake viscosity (1000 mPa・s). Particles were used for 3 times concentrations of potato starch in the thickening liquid viscosity. The apparent viscosity of the particles was less dependent on concentration and temperature than those of potato starch and corn starch. The addition of salt did not affect particle viscosity; however, it significantly reduced the viscosity of potato starch. At a shear speed of 0 s^{-1}, the liquid thickened by particles had low flow characteristics. It was suggested both the starch and the dietary-fiber contributed to the thickening effect of the food fine particles.

In order to further the study, 14 types of commercial agricultural food powders were examined. Starchy food particles, such as brown rice, pumpkin, lotus root, and ginger, as well as non-starchy particles, such as lemon, yuzu, and carrot also had a thickening effect. These fine particles were sieved through an opening of 25 μm, and the correlation between viscosity particle size was examined.

In this study, it was shown that plant-based agricultural food particles are promising for producing new cookery products, such as foaming and emulsion cooking for its surface activity, and can be considered new thickening agents for cooking due to their thickness function.