Small-angle neutron scattering from deuterated wheat protein gliadin

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Since food materials are multi-component, condensed and opaque, nanostructural analyses of them is quite difficult. Quantum beam analyses, widely applied to various condensed materials such as gels, colloids and rubber, can be also applicable to food materials effectively.

Wheat flour is one of the most essential foods. The quality of wheat flour foods is much dependent on the physical properties of wheat dough, which are primarily attributed to gluten, a composite of two wheat proteins: gliadin and glutenin. It is attracting to reveal the relationship between the physical properties of dough and molecular structure of the proteins in the dough.

Within this context, we have been employing a small-angle X-ray scattering (SAXS) analysis to investigate the structure of aqueous solutions and hydrated sols of gliadin [1]. The SAXS study demonstrated that gliadin monomers are isolatedly dispersed in low concentrations, while gliadin becomes insoluble in water with further increasing concentrations, and forms hydrated aggregates with density fluctuations inside.

Another question is what is the structure of gluten composed of gliadin and glutenin. Little is still known about the real structure of gluten. In order to clarify gluten structure, SAXS is an insufficient tool because it cannot distinguish partial structure inside gluten. Instead, small-angle neutron scattering (SANS) combined with a contrast-variation method is a powerful alternative for examining protein complex structure. If deuterated gliadin and hydrogenated glutenin was mixed as a gluten model system and the neutron scattering of that mixture was measured in a proper compositions of D_2O/H_2O mixed solvents, we can observe the structure of gliadin alone in the model gluten. In this study, we carried out SANS measurements of deuterated gliadin in various compositions of .D_2O/H_2O mixed solvents as a first trial.

Deuterated gliadin was obtained from ripe seeds of wheat which was grown by hydroponics in heavy water. The wheat flour obtained by milling the seeds was kneaded with NaCl-containing water and then gliadin was extracted by washing with pure water [2].

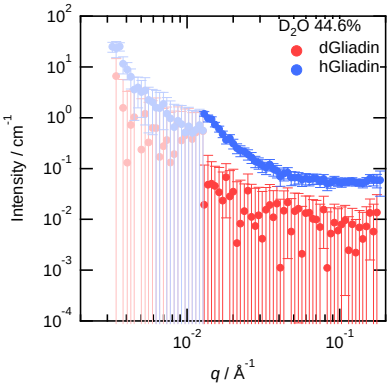

Fig. 1 SANS results for gliadin in 44.6% D2O

SANS measurements were conducted with SANS-U at JRR-3M reactor. The wavelength was 7 Å and sample-to-detector distance (SDD) was 2 and 8 m. The gliadin hydrates of 20 wt% were put into Al-cells with a path length of 0.5 mm sandwiched with quartz windows. The beam diameter was 5 mm. Typical exposure time was 1 h for SDD 2 m and 3 h for SDD 8 m.

Fig. 1 show a result for deuterated and hydrogenated gliadins in 44.6% D_2O. Unfortunately, all SANS results including this result had large experimental errors, subtraction fault, and lack of continuity between two SDD measurements which prevent reliable data analysis . The reason for these glitches is ascribed to too small amount of protein samples. The amount of deuterated gliadin obtained was very limited. Thus the packing of the samples in the cell could have been too uneven to give proper protein scattering results. It is required to improve cell design for small amount samples as well as to increase deuterated proteins for appropriate data acquisition.

[1] N. Sato *et al.*, *J. Agric. Food Chem.* **63**, 8715 (2015).

[2] T. Ukai *et al.*, *J. Agric. Food Chem.* **56**, 1122 (2008).