Small-angle neutron scattering study of wheat proteins

N. Sato, R. Urade, A. Okuda, M. Shimizu, K. Morishima, R. Inoue, M. Sugiyama

KURNS, Kyoto Univ.

The quality of wheat flour foods depends on the physical property of wheat dough and its component gluten, a composite of two major proteins gliadin and glutenin. Glutenin is a high-molecular-weight network polymer protein, while gliadin is an aggregated monomeric protein. This difference of the molecular structures may be relevant to the difference of their physical properties. However, the relationship is not clarified between the nanoscale structures of the proteins and physical properties of wheat dough. Small-angle X-ray and neutron scattering has been effectively employed for the structural analyses of various soft matter samples such as rubber, colloids, liquid crystals and hydrogels. Therefore it is also applicable to food materials.

In this context, we have been investigating the nanostructure of wheat protein mainly by small-angle X-ray scattering (SAXS) [1]. We found that, as gliadin concentration increases isolated gliadin monomers gradually associate together to form multimolecular domains with interparticle interference. We also found that gliadins become insoluble in water at much higher concentrations to form hydrated aggregates with density fluctuation inside and the correlation length of this fluctuation was smaller with increasing gliadin concentrations. However, the structure of gluten as a protein composite is little known yet. Contrast variation small-angle neutron scattering (SANS) is applicable to the structural analysis of multi-component proteins like gluten. A model gluten system composed of deuterated gliadin and hydrogenated glutenin provides structural information of gliadin alone in the gliadin/glutenin mixture when the SANS measurements are carried out in a proper composition of H_2O/D_2O solvent. In the previous work, we tried to measure the neutron scattering of deuterated gliadin, which is obtained from ripe seeds of wheat grown by hydroponics in heavy water. However, the result was not satisfactory because the yield of deuterated gliadin was too small and thus the amount for the SANS measurement was also too small (~10 mg). Hence, in this study, we made improvement of sample cells to obtain satisfactory results of SANS data with a limited amount of deuterated samples.

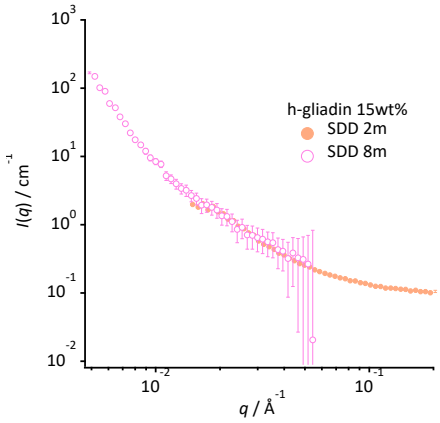

Fig. 1. The result of SANS measurements.

SANS measurements were conducted with SANS-U at JRR-3M reactor. The wavelength was 6 Å and sample-to-detector distance (SDD) was 2 and 8 m. The hydrogenated gliadin hydrates in 100% D_2O with a concentration of 15% were put into Al-cells with a path length of 1 mm sandwiched with quartz windows. To minimize the internal capacity of the cell, a 1-mm-thick PTFE spacer with a 5-mm hole at the center were put into the cell, where 5.7 mg gliadin is ideally needed to fill up the cell. The beam diameter was 5 mm. Typical exposure time was 1 h for SDD 2 m and 3.5 h for SDD 8 m.

Fig. 1 shows the result of SANS measurement. Only S10 mg gliadin was used for each cell, but reliable SANS profiles were available. From this result, it became evident that the cell in which a proper size of spacer is placed can be used for a limited amount of precious deuterated samples.

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