Note

The Effects of Proteins and Phospholipids on the Mobility of Wheat Doughs

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Physical properties of wheat doughs are influenced by the amounts of proteins and lipids.¹⁾ Durum semolina and hard wheat flour, containing similar amounts of proteins, are different in their dough properties and are used for different foodstuffs: the characteristics of the latter flour are good for bread-making and the former are appropriate for pasta. We have already reported that protein-phospholipids interactions are closely related to this difference in characteristics.²⁾ In this study, the characteristics of these two wheat doughs are compared by mobility-water content plots obtained from farinograph experiments and ³¹P-NMR, and the effects of proteins and phospholipids on the physical properties of dough are discussed.

Durum wheat dough had a lower consistency in the farinograph than bread wheat dough which was prepared from hard wheat flour in this study, and then the mobility,

i.e., the reciprocal of the maximum consistency, at the inflection point of the mobility-water content curve was higher in the former dough than in the latter as shown in Fig. 1. Upon the addition of the extracted proteins to the original durum wheat semolina or the original hard wheat flour, respectively, the mobility-water content curve of the doughs shifted to higher water contents due to the increase in the capacity for immobilized water content. However, no significant change in the values of the mobility at the inflection point was observed for these two wheat doughs (Fig. 1). The results demonstrate that the mobility of wheat dough at the inflection point, where the gluten matrix may be saturated with water, was not affected by the kinds, gliadin or glutenin, of or the amounts of proteins. Before reaching the inflection point, the doughs with added glutenin required much more water than the doughs with added gliadin to give the same mobility value (Fig. 1). It appears likely that the quantity of immobilized water in the doughs might be controlled by gliadin, in other words, the interaction of gliadin with lipids, and that the capacity of the immobilized water might depend on the network structure of glutenin.⁴⁾ In the range of the higher water content above the inflection point, on the other hand, the doughs with added glutenin were more easily raised in mobility than the doughs with added gliadin. In this range of water content it should be noted that the mobility of wheat dough was affected predominantly by the interactions of proteins with proteins, proteins with lipids and lipids with lipids which occurred through the free water outside of the gluten matrix instead of direct interactions, since the gluten matrix was saturated with water.

By defatting with *n*-butanol, the inflection point of the mobility-water content curve is altered and great differ-

Fig. 1. Effects of Added Proteins on the Inflection Point of the Mobility Obtained from Wheat Doughs.

The experiment was done with a microfarinograph (Brabender RMS 65 NG) at 20°C. Glutenin and gliadin were extracted from wheat flours defatted with *n*-butanol by the method of Jones *et al.*³⁾

Figure A shows hard wheat dough and B durum wheat dough. (○), hard wheat dough (A) or durum wheat dough (B); (▲), with added gliadin (1 g/10 g sample); (△), with added glutenin (1 g/10 g sample).

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Fig. 2. Comparison of ^{31}P -NMR Spectra of Wheat Glutens.

^{31}P -NMR spectra A, hard wheat gluten and B, durum wheat gluten were obtained on a Hitachi R-90H spectrometer. Wheat glutens (water content 50 ~ 52%) were prepared by hand-washing with distilled water for 30 min. The composition of the dried glutens is as follows; protein 86 ~ 88%, total lipids 10 ~ 11%, residual 2.2 ~ 2.6%. The sample gluten was placed in a 8 mm round-bottom NMR tube and equilibrated to 30°C before accumulation. The spectrometer was operated at 36.438 MHz with broad band proton decoupling (decoupling frequency 22,400 Hz). The spectra were collected for 50,000 transients with a 7.3 kHz sweep width, a 27 μsec 90° pulse and a repetition time of 4 sec.

ences are noted in the changes in inflection point between durum and hard wheat doughs as shown in elsewhere.²⁾ This is intimately related to the interaction between proteins and polar lipids, especially phospholipids.

The state of phospholipids in the gluten matrix of these doughs was, therefore, investigated by ^{31}P -NMR. Wheat doughs were washed out with distilled water for 30 min and starch was removed thoroughly for enrichment of phosphorus content in the glutens. Hard wheat gluten gave rise to a sharp, symmetrical shape of signal as shown in Fig. 2. Such a signal reflected an isotropic motional averaging of phospholipids in hard wheat gluten. On the contrary, the ^{31}P -NMR signal of durum wheat gluten had a broad, asymmetric spectral peak with a slight shoulder in the higher magnetic field. Thus, phospholipids in these wheat glutens are considered at least to be in different states. It is suggested that the motion of phospholipids in the gluten matrix of durum wheat should be restrained due to the interaction of proteins with phospholipids, while the

phospholipids in hard wheat gluten should be expected to exist in a more mobile environment which resembles a pure phospholipid dispersion,⁵⁾ probably embedded in the gluten matrix in the form of stabilized microemulsions as reported by Marion *et al.*⁶⁾

References

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