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Functions of Sodium Chloride in the Formation of Gliadin-Aggregate in Dough

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Summary

The addition of NaCl to wheat dough increases the strength, elasticity and stability of dough, and decreases the its viscosity. These rheological changes are assumed to be due to changes in the interactions between gluten proteins. However, the details of the mechanisms underlying the interactions of NaCl with these proteins remained unknown. Previously, we found that the yield of gluten from dough supplemented with NaCl was much lower than that from dough without NaCl. Gluten proteins were extracted with distilled water from dough prepared in the presence of NaCl. We characterized the extracted proteins to be α/β-gliadin or γ-gliadin by N-terminal amino acid sequencing. Gliadins are thought to have extremely low solubility in water and neutral buffers. Hence, most studies on extracted gliadins have been performed in alcohol-water mixtures and acidic solutions. However, it is unclear whether alcohol- or acid-solubilized gliadins have the same properties as those in dough. The proteins extracted into water from the dough prepared using a NaCl solution are predicted to have properties similar to those in dough containing NaCl. In this study, we showed that the extracted gliadins were soluble monomers in distilled water by analytical ultracentrifugation. Extracted proteins were aggregated by the addition of NaCl at concentrations greater than 10 mM. The aggregation of gliadins was induced by various salts, but the effects were salt species-dependent. Therefore, gliadin aggregation may be induced by the interaction of a certain ion with the specific amino acid residues of a given protein, but not by an increase in ionic strength. Since there was little difference in aggregation among chloride salts and large differences among sodium salts, it is presumed that the interactions of anions with specific amino acid residues may be necessary for aggregation. The changes in protein-protein interactions induced by NaCl in the dough were clearly indicated by the cross-linking experiments. In particular, DST (6.4), with a spacer arm of 6.4 Å, cross-linked gluten proteins in dough only in the presence of NaCl, suggesting that the distances between the amino groups were shortened to less than 6.4 Å by NaCl. Most kinds of gluten proteins are cross-linked to macro-polymers that are insoluble in SDS. Therefore, a model is proposed in which the interactions of gliadins and glutenins are altered by NaCl, co-aggregating into protein complexes via intermolecular hydrogen bonds and/or ionic bonds. The formation of protein complexes may cause changes in the rheological properties of dough induced by NaCl, such as dough stability and optimal dough development.