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Functions of Sodium Chloride in the Formation of Wheat Gluten Networks

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Summary

The addition of sodium chloride to dough influences not only the taste of bread, but also the loaf volume and crumb structure. These effects may arise from the actions of the salt on yeast and wheat flour components. Differences between the microstructures of dough with or without sodium chloride are observed on a transmission electron microscopy. In addition, sodium chloride increases the strength, elasticity and stability of dough, and decreases its viscosity. These rheological changes are assumed to be due to changes in the interactions between gluten proteins. Gluten is formed with glutenins polymerized via intermolecular disulfide bonds, and gliadins, which are major wheat storage proteins, and associate with each other non-covalently on the mixing of wheat flour and water. Sodium chloride may cause changes on their interactions. However, the details of the mechanisms underlying the interactions of sodium chloride with these proteins remained unknown. Previously, we found that the yield of gluten from dough supplemented with sodium chloride was much lower than that from dough without sodium chloride. This suggested that the solubility of proteins in water increased in the addition of sodium chloride. Based on this finding, we determined the amounts of proteins extracted from the dough and analyzed them by SDS-PAGE. After 10-min washing, 10% of the total dough proteins was extracted from the dough independent of the presence of salt. These proteins may be water-soluble albumins. On continuous washing for 20 to 30 min, additional proteins from 30 to 45 kD in size were extracted from the dough supplemented with salt, but not from the salt-less dough. The extracted proteins increased in a salt-concentration dependent manner, reaching a plateau at 1.02 M sodium chloride. They were identified as α/β - or γ -gliadins on N-terminal amino acid sequencing. The elution of gliadins was predicted to occur only under the condition of a lower salt concentration of the dough on washing with water, since gliadins were not extracted on washing with 0.51 M sodium chloride. The effects of ions other than sodium or chloride on the extraction of proteins from the dough were examined. More chaotropic anions and cations other than lithium had stronger effects on the elution of proteins from the dough. On fluorescence emission spectroscopy, tryptophan residues of dough proteins were observed to migrate to more hydrophobic circumstances due to conformational changes in the proteins. In addition, it was shown on Fourier Transform IR spectroscopy that intermolecular β -sheet decreased, and intramolecular β -sheet, β -turn, random coil and extension of amino acid residues increased on the addition of sodium chloride to the dough.