Abstract

Fortification of wheat bread with various additives, such as fiber preparations and polyphenol extracts, is becoming increasingly common due to growing consumer awareness of healthy foods. In addition, wheat bread, being a popular food product, can act as a carrier to help deliver health-promoting ingredients to the human body. Bread contains proteins that form a continuous viscoelastic network in the dough, called gluten. Gluten is formed by two types of proteins: polymeric glutenins and monomeric gliadins. Gluten proteins contain large amounts of glutamine and proline, which allows them to bind to polyphenols, which are natural antioxidants.

The mechanism of interactions between gluten proteins and polyphenols is still poorly understood, especially during the dough mixing process. This process can lead to changes in the structure of the gluten network and its mechanical properties. The purpose of the research presented in this paper was to determine the effect of selected phenolic acids on the structure of the gluten network and its individual proteins in a model wheat dough, and to study the effect of phenolic acid fortification on the antioxidant properties of gluten. Phenolic acids used in the study were benzoic acid derivatives (4-hydroxybenzoic acid, protocatechuic acid, vanillic acid, syringic acid) and hydroxycinnamic acid derivatives (coumaric acid, caffeic acid, ferulic acid, synapinic acid).

The assays were carried out on a model flour, consisting of a mixture of wheat starch and wheat gluten in a ratio of 80:15 (w/w), in order to eliminate the influence of other components naturally present in wheat flour. Analyses were performed using spectroscopic methods such as infrared spectroscopy (FT-IR) and Raman spectroscopy (FT-Raman). In addition, the content of free phenolic acids extracted from phenolic acid-modified gluten by extraction with methanol was examined. The antioxidant properties of the extracts were investigated using ABTS and FRAP assays.

Spectroscopic analysis showed that both hydroxycinnamic and hydroxybenzoic acid derivatives affect the secondary structure of the gluten network and both gliadin and glutenin protein types. In modified glutenins, the predominant structural changes involve β-structures. In modified gliadin samples, changes in α-helix conformation were mainly observed. The study of antioxidant properties showed that enrichment of the dough with phenolic acids, especially hydroxycinnamic derivatives, improves the antioxidant properties of the gluten network. This ch ange is probably related to the presence of additional hydroxyl groups in the structure of the added phenolic acid.

Keywords: gluten network, gliadins, glutenins, phenolic acids, FT-IR, FT-Raman, secondary structure, antioxidant properties