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OPTIMIZATION OF WHEAT DOUGH RHEOLOGY AND BREAD QUALITY THROUGH THE ADDITION OF FLAXSEED FLOUR

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Abstract
The study investigates the impact of flax (linseed) flour on the rheological properties of wheat dough and the quality of bread produced using various technological methods. Incorporating flax flour at a level of 10% resulted in a 3% increase in the specific volume of the product and improved organoleptic quality compared to samples with 7% flax flour.Utilizing natural additives derived from domestic raw materials including wild-harvested sources and by-products from food processing enterprises enables the production of bakery products with enhanced nutritional value while offering significant economic benefits. The inclusion of these additives reduces the consumption of primary raw materials in the formulation of national bakery products, such as varietal wheat flour and solid animal fats.For this study, simple and enriched Uzbek flatbreads were produced using rose hips and peanut seeds (deformed, crushed, or unsold), as well as partially defatted flax seeds (cakes). These raw materials, despite their high nutritional value, are often used for animal feed or discarded.
The incorporation of these additives in the production of national bakery products provides tangible benefits by lowering material and production costs, reducing the consumption of flour and fat, and increasing the yield of finished products.

Keywords: Wheat dough, bread, flax (linseed) flour, rheological properties, nutritional value, bakery products.

Introduction

The quality and physico-chemical characteristics of bread are primarily determined by the fundamental properties of the dough [1–3]. Enhancing dough performance and its key properties is achieved through the incorporation of various biologically active additives and components into the raw materials [4–6]. Of particular interest is the study of the rheological

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properties of wheat dough when biologically active additives derived from powders isolated from seeds of agricultural crops are introduced into its formulation [7–9].

The aim of this study is to investigate the effect of flax (linseed) flour on the rheological properties of wheat dough and the quality of the resulting bread.

The objects of research included flax flour, wheat dough, its rheological behavior, quality indicators, and physico-chemical characteristics.

Research Methods

To analyze and evaluate the quality of raw materials, semi-finished products, and finished bakery products, standard physicochemical research methods used in the baking industry were applied [10–12].

In some cases, the latest advancements in this field have been applied [13,14]. The rheological properties of the dough were evaluated using an Alveograph [15].

Results and Discussion:

Dough samples were prepared with flax flour added at levels of 5%, 7%, 10%, and 12%, partially replacing premium wheat flour [16]. As a control, dough samples were prepared using only premium wheat flour without any additives. The rheological properties were assessed based on elasticity, extensibility, specific energy required for dough deformation, and the curve configuration ratio. The results of these measurements are presented in Figure 1.

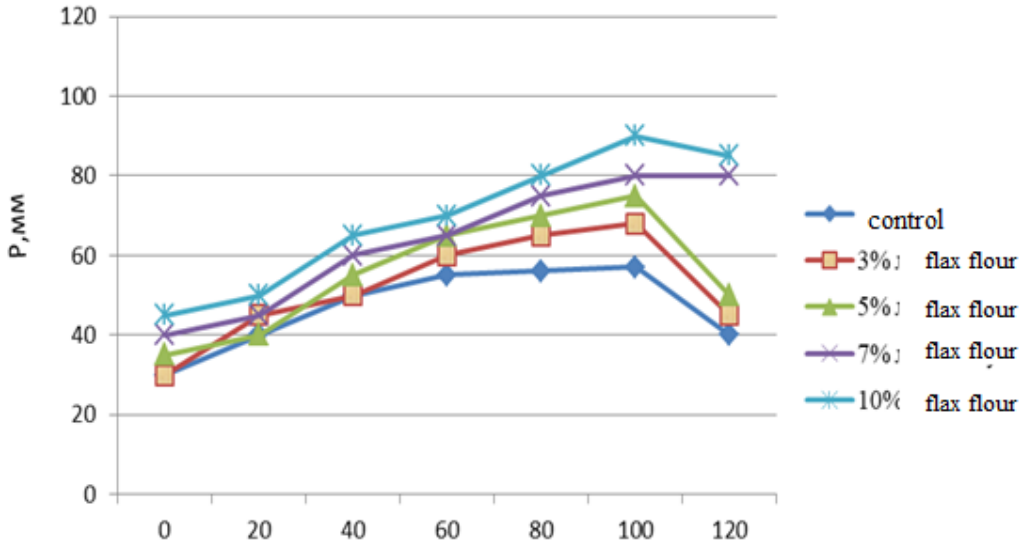

Fig. 1. The influence of the dosage of flaxseed flour on the rheological properties of the dough

The data presented in Fig. 1 indicate that the addition of flaxseed flour led to an increase in dough overpressure (P) by 54–173%, depending on the dosage applied, reflecting an increase in dough elasticity. At the same time, dough extensibility (L) decreased by 32–76%, and the specific energy required for dough deformation (W) decreased by 1–20%. Based on the curve

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configuration coefficient (P/L), the dough exhibited high elasticity but insufficient extensibility, indicating a reduction in overall dough flexibility. The most pronounced decrease in extensibility, specific deformation energy, and elasticity was observed at the highest levels of flaxseed flour addition.

In addition to these findings, the effect of flaxseed flour on the quality characteristics of bread was also investigated.

The objects of the study were bread samples prepared randomly with the addition of flaxseed flour at levels of 5, 7, 10, and 12%, replacing a portion of premium wheat flour. Bread samples without any additives were used as the control. The effects of flaxseed flour on the physico-chemical and organoleptic quality indicators of bread are summarized below.

Organoleptic quality indicators:

Appearance and shape: Control bread maintained a proper shape corresponding to the baking mold. With the addition of flax flour, the surface became slightly rough, though still free from cracks and ruptures.

Crust color: The control bread had a golden crust, while the color of the bread with flax flour ranged from light brown at lower dosages to dark brown at higher dosages.

Crumb condition: The control bread was baked properly, elastic, and not sticky. Bread with flax flour showed a reduction in elasticity, with the crumb becoming less cohesive and slightly denser at higher dosages.

Porosity: Control bread had well-developed, uniform porosity without voids or dense spots. With flax flour, porosity became slightly underdeveloped and less uniform, with medium to thin-walled structure.

Crumb color: The crumb of control bread was white, while the addition of flax flour gradually darkened the crumb to light gray or grayish at higher doses.

Taste and smell: Control bread had the characteristic bready taste. Bread with flax flour exhibited a pleasant light flaxseed flavor at lower dosages, but at higher dosages (10–12%), the flavor and aroma of flax became strongly pronounced, with a slight off-flavor observed at 12%.

Physico-chemical indicators:

The specific volume of bread decreased by 8–11% as the flax flour content increased from 3 to 10%.

Crumb porosity decreased slightly, by 1.3–2.5%.

The most pronounced changes in these parameters were observed at the highest flax flour addition.

Humidity, acidity, and shape stability of the crumb remained practically unchanged across all samples.

Overall evaluation: All bread samples retained relatively uniform porosity and an elastic crumb, though the crumb color darkened with higher flax flour content. At the highest dosage (12%), an intensified crumb coloration and the appearance of a noticeable off-flavor were recorded.

Further studies examined bread made with 7 and 10% flax flour using both uncooked, steamed methods and intensive "cold" dough technology. In these cases, flax flour replaced a portion of premium wheat flour during dough kneading. Bread quality was evaluated based on organoleptic and physico-chemical parameters, showing similar trends as observed in previous experiments.

The study evaluated the quality of bread with the addition of flaxseed flour at dosages of 7% and 10%, using both unpaired (steamed) and paired dough methods.

Unpaired (steamed) method: Bread with 7% and 10% flax flour showed similar physico-chemical characteristics. The specific volume ranged from 3.5 to 3.7 cm^3/g, crumb moisture was around 42%, crumb acidity slightly increased from 2.5 to 3 °H, and form stability remained stable at 0.6–0.7 H/D. Organoleptic analysis indicated well-developed porosity, an elastic crumb, light gray to gray color, and a subtle bready flavor with a mild flaxseed aroma. Increasing flax flour from 7% to 10% slightly improved the specific volume and organoleptic qualities.

Paired dough method: Bread prepared with 7% and 10% flax flour exhibited a specific volume of 3.4–3.5 cm^3/g, crumb moisture of 44–44.5%, and consistent crumb acidity at 2 °H. Form stability was 0.5 H/D. Organoleptic evaluation showed proper bread shape, smooth crust, elastic and non-sticky crumb, medium, uniform porosity, and light gray to gray crumb color. The taste and smell were bready with a subtle pleasant flaxseed flavor, with the 10% flax flour sample being slightly more elastic and softer.

Conclusion:

The best physico-chemical and organoleptic properties were observed in bread prepared using the steamed method with 10% flax flour, demonstrating improved volume, crumb elasticity, and overall sensory quality compared to other dosages and dough preparation methods.

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