FOOD SCIENCES

INVESTIGATION OF THE QUALITY OF DOUGH WITH GERMINATED GRAIN ADDITIVE

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Abstract

Germinated grains are added to wheat dough with the purpose to promote the biological value of bread. As a result, a new product was obtained with a higher content of protein, fiber, B group vitamins, and vitamins C and E. The task was to investigate gluten quality changes at grain germination time, wheat dough rheological property changes with various wheat, rye and barley amount additions, germinated for a different time. With the purpose to save maximum stability value of gluten, it was ascertained that the germination time of wheat grain could not be more than 24 hours. The best dough quality was obtained with germinated wheat grain additive. Germinated rye and barley grain additive (more than the experimentally ascertained amount) increases dough softening, decreases dough development time and dough stability. Only adding experimentally determined optimal amount of germinated grain, which promotes high quality bread, could produce dough with accepted rheological properties.
Key words: germinated grain, wheat, rye, barley, dough.

Introduction

Innovation in wheat bread technology is germinated rye, wheat and barley grain application (Холерская et al., 1998). Germinated grains have been added to the wheat dough with a purpose to increase its biological value. The obtained bread has a higher content of proteins, fiber, vitamins of B group, vitamins C and E.

Important factor is dough rheological properties: dough development time, water absorption, dough stability, and quality.

Baking properties of grain were reduced during germination time; therefore it is necessary to determine the optimum grain germination time, when grains have the highest biological value but structure of grains has not considerably changed. It is important to determine the optimum amount of germinated grain additive to dough.

Gluten is the main component characterizing dough quality. Gluten is a strong hydrolyzed gel, which mainly consists of albumen and carbohydrates, fats and minerals. The amount of gluten components depends on the variety of grain, flour type, preparing stage, and dough mixing and rinsing time. Wet gluten of wheat grain consists of *gliadins* and *glutenins* (their ratio is 1:1), rye grain – of *gliadins* and *glutenins* (their ratio is 2:1), *barley* – of *prolamine*, *glutenins* and *hordeins* fractions. *Gliadins* decrease dough mixing time, whereas *glutenins* – increases it (Казаков, 1989; Ruža, 2001).

The activity of enzymes increases during germination: endohydrolase enzymes (α; β-amylases), proteolytic enzymes, diphenoloxsydase, and catalyse were activated. Stability of gluten depends on the amount of formed *disulfide* bonds *(-S-S-)* and *disulfide* bonds correlation with *sulfhydryl* group *(-SH-)* (Казаков, 1989; Hugh et al., 1998).

Composition of amino acids is a very important aspect for wheat grain. In the central part of a grain, the amount of amino acids is higher compared with periphery: *isoleucine* is 6–7%, *leucine* is 8–9%, and *phenylalanine* – 3–4%. Albumin of aleurone contains more of *tryptophan, lysine,* and *arginine*. The aleurone albumin has a higher food value compared with albumen of endosperm (Казаков, 1989; Hugh et al., 1998). Therefore, in dough preparation technology it is important to use all grain ingredients.

The albumin content in rye grain composition is smaller, while maintenance of essential amino acids is by 1.5 times higher (*lysine* and *threonine*) compared with wheat grain. Rye grain starch gelatinization temperature is lower (+52 – +55 °C) compared with wheat grain; a viscous gel forms from starch, which provides the soft consistency and longer shelf life of rye bread. The amount of riboflavin and vitamin E in rye grain is higher. Physical properties of rye grain gluten are similar to that of wheat grain, it is with lower elasticity and stability. Gluten content in rye grain is 40% from the total amount of albumin. The biggest part of rye grain albumin dissolves in water and low-concentration salt dilutions. The increase of *glutenin* amount promotes strengthening of gluten (Казаков, 1989).

In food industry hull-less barley is acknowledged as more valuable and more economical compared with flaky barley. The hull-less barley flour has a little darker colour, because compared with flour from soft wheat it has a higher maintenance of ash value, higher protein and β-*glucans* content. Soluble dietary fiber, mainly β-*glucans,* provides the promoted viscosity; as a result, digestion, cholesterol and fat absorption were decreased (Bhatty, 1999; Bengtsson et al., 1990; Newman et al., 1991). A higher content of natural antioxidant tocopherol and tocotrienols, as well as maintenance of E vitamin, was established in barley grain, compared with wheat and rye grain (Holasova et al., 1998). The properties of barley gluten, similarly to rye grain gluten, are equalized to wheat grain gluten with poor quality. The

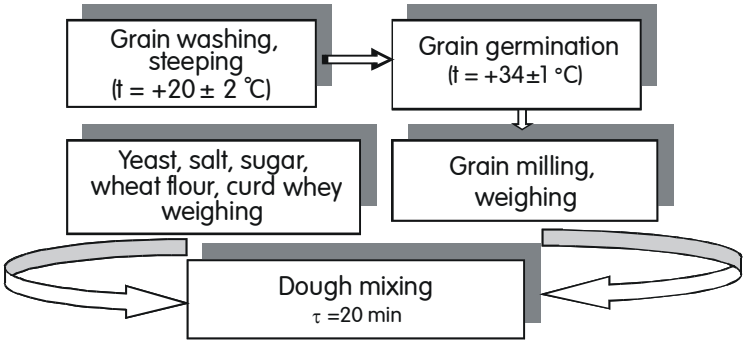

Fig. 1. Dough preparation technology.

proteolytic enzyme *paphain* activity deteriorates the quality of gluten (Казаков, 1989).

All-round complex rheological description of wheat dough can be extracted by the farinograph. Duration of dough forming, dough stability and influencing stage in a fixed period of the experiment is possible to control, as well as water absorption of flour is possible to define. The farinograph registers dough forming and its property changes in continued mechanical action time, describing it as continuous graphical representation (Козубаева, 2005*).

Methods and materials

In our experiments, as a germinated grain addition to wheat dough rye, wheat and barley grain with a different germination time (to 36 hours) and different added amount (25–50% from the amount of flour) were used.

The research was accomplished on grains of wheat (variety 'Kontrast'), rye (variety 'Voshod') and hull-less barley cultivated in Priekuli Plant Breeding Station in Latvia, water, yeast, sugar, salt, curd whey and wheat.

Gluten quality and maintenance were investigated by standard method *LVS 275*.

Dough rheological properties were investigated by farinograph *„Brabender"* using standard method *ICC – 115/1*.

Rye, wheat and barley grain were washed and dunked before germination. Grains were germinated in climatic camera at optimum germination temperature of +34±1 °C, relative air humidity – 82 ± 1%, germination time – 24 and 36 hours. Dough with germinated grain additive was made using new technology (Fig. 1).

Wheat dough without germinated grain additive was used as a control dough sample.

Results and discussion

Un-germinated wheat grains and germinated for 12, 24 and 36 hours were tested. It was observed that the amount of dry gluten (in germinated 24 hours wheat grains) decreased from 25.4% to 3.8%, gluten index from 96.14% to 38.00%, and gluten hydratation properties from 213.58 to 171.43% (comparing with control grains) (Table 1). After wheat grain germinating time for 36 hours, gluten was not detected. Gluten was found neither in germinated nor un-germinated rye and barley grains.

Germinated for 24h grains were used because, for example, comparing with bread without germinated grain additive the bread with germinated wheat grain addition has an elevated content of B_1 (by 75%), B_2 (by 88.5%), thiamine (by 67.5%), E (by 62.2%), and C (by 42.8%) vitamins.

It could be explained mainly by the existing higher amount of *gliadins*, as well as diminished correlation between *disulfide bonds* and *–SH-* groups in germinated rye grains and *paphain* activity in barley grains (Казаков, 1989; Hugh et al., 1998).

Analyzing dough properties by farinograph it was observed that the quality value of the control dough sample

Table 1

Gluten quality changes during wheat grain germination time

Wheat grain	Dry gluten, %	Gluten index, %	Gluten hydratation properties, %	Quality group	Gluten characterization
0 h	25.4	96.14	213.58	III	Unsatisfactorily strong
12 h	7.7	89.61	208.00	I	Qualitative - very qualitative
24 h	3.8	38.00	171.43	III	Unsatisfactorily weak
36 h	-	-	-	-	Gluten did not appear

**Козубаева. Изучение реологических свойств теста из диспергированного зерна пшеницы. (http:www.apk-inform/showart.php?id=6300:lastrewievon24.02.05).*

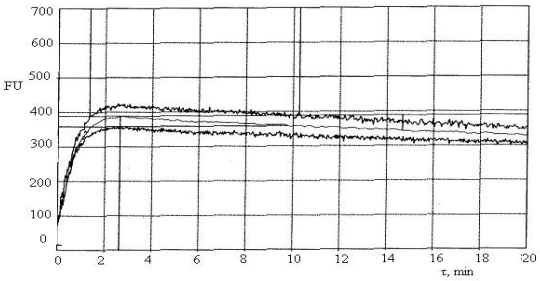

Fig. 2. Farinogram of the control dough sample.

was 98 FU units. It means that the analyzed dough sample had good quality (Fig. 2). Value of dough stability was 18.9 minutes, dough making quality – 46 FU, degree of dough softening – 389 FU with water absorption of 56.9%, and dough development time – 2.7 minutes.

The dough quality number with addition of wheat grain germinated 24 hours increased to 200 FU (Table 2) compared with the control dough sample. It was predicted that bread with this grain addition would be of good quality. Dough stability was not relevant compared with control dough sample. Dough consistency with water absorption value about 43.3% was 392 FU, dough development time – 2.7 minutes (Fig. 3a). The dough quality number with wheat grain addition germinated for 36 hours (Fig. 3b) decreased substantially to 22 FU, dough development time – to 1.5 minutes (Table 2). As indicated in the literature, quality of gluten changes by partial albumin proteolysis. *Disulfide* bond decrease and *–SH-* group increase is observed. Hidden *disulfide* bonds (*albumins* and *globulins*) mainly have cleaved. *Disulfide* bonds of grains germinated about one day splited only by 19%, but hidden *disulphide bonds* remained without a change, which demonstrates insignificant gluten quality changes. *Disulfide* bonds of grain germinated for more than 24 hours decreased by 64%, hidden *disulfide* bonds – by 58%, which shows significant gluten disaggregation (Казаков, 1989). Dough consistency with this grain additive was 532 FU, and water absorption – 41.7%. It was predicted that bread made from this dough would be with sticky mildness, lowered elasticity, and sweetish taste.

The following experimental results were obtained by adding germinated rye grain to wheat dough. Dough quality number with a 24-hour germinated rye grain additive decreased by 76.53% compared with control dough sample. The value of dough stability was low, similar to dough with wheat grain additive germinated 36 hours (Table 2). Though the value of dough development time was satisfactory – 121 FU, dough development time was by 52% less than that of the control dough sample and the dough sample with a 24-hour germinated wheat grain additive (Fig. 4a). Differences between rheological properties of experimental dough samples and control sample did not influence bread quality significantly.

Dough quality of the sample with grain additive germinated 36-hour decreased (Table 2). It indicates that bread with this grain additive would be of good quality. Dough stability was very low; dough development time was only 1.2 minutes (Fig. 4b). It could be explained with the high enzyme activity of starch in germinated rye grain; as a result the content of water-soluble compounds and amount of dextrins and reducing sugars increased. These transformations considerably retrograde the cooking properties of rye grain.

The dough quality number with hull-less barley additive germinated for 24 hours was by 73.5% lower compared with the control dough sample (Table 2) (it was rel-

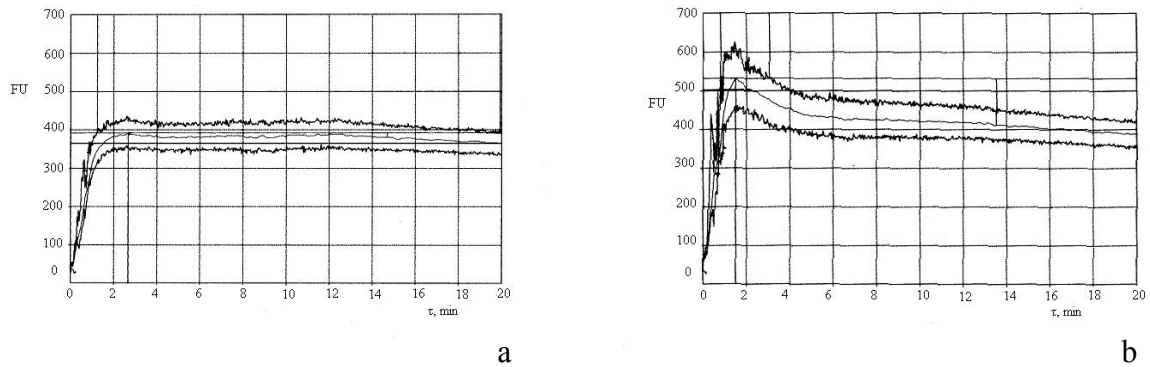

Fig. 3. Farinograms of dough samples with addition of wheat grain germinated 24 (a) and 36 (b) hours.

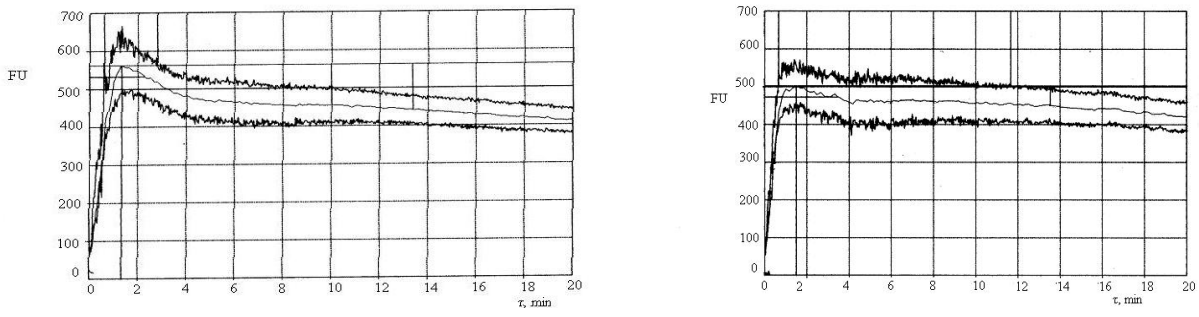

Fig. 4. Farinograms of dough samples with addition of rye grain germinated 24 (a) and 36 (b) hours.

evant change). Dough stability was not similar to dough stability value for the control dough sample, and it was 3.3 minutes. The quality of bread with this grain additive would be satisfactory (Fig. 5a). Dough development time value of wheat dough with germinated hull-less barley grain additive is similar to dough development time for the sample with a 24h germinated rye grain additive. Dough quality number with addition of hull-less barley grain germinated 36 hours decreased by 75.5% compared with the control dough sample, dough development time and degree of dough softening was not satisfactory (Fig. 5b). Therefore it is foreseen that the bread quality with this grain additive will be unsatisfactory.

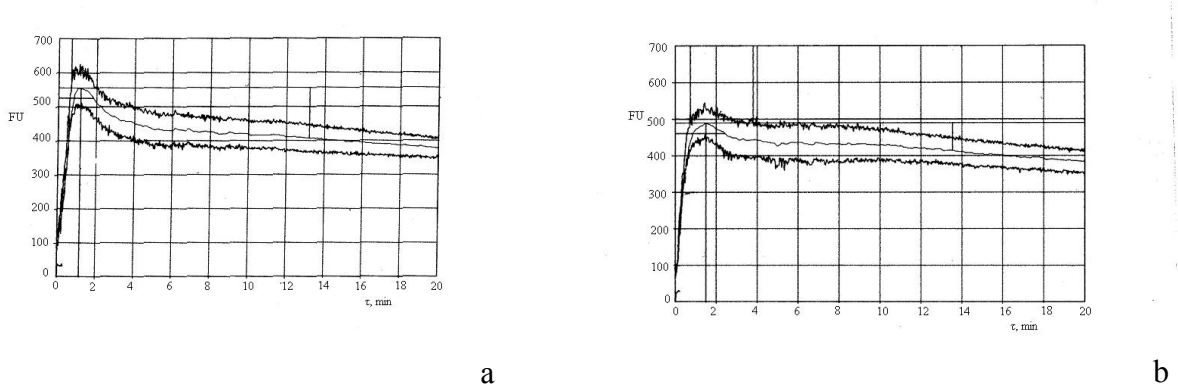

Fig. 5. Farinograms of dough samples with addition of hull-less barley grain germinated 24 (a) and 36 (b) hours.

Table 2

Data obtained by farinograph

Parameters	Dough samples						
	Control sample	With germinated wheat grain addition		With germinated rye grain addition		With germinated barley grain addition	
		24h	36h	24h	36h	24h	36h
Consistency, FU	389.0	392	532	562	556	503	490
Water absorption, %	56.9	43.3	41.7	42.2	42.0	39.3	40.4
Development time, min	2.7	2.7	1.5	1.4	1.2	1.5	1.5
Stability, min	18.9	18.7	2.3	2.2	1.3	3.3	3.1
Degree of softening, FU	46.0	11	120	121	149	66	76
Quality number	98.0	200	22	23	18	26	24

Conclusions

1. The optimum stability of gluten could be provided by wheat grain germinated for not more than 24 hours.

2. Germinated 24-hours wheat grain additive can improve the quality of dough.

3. The additive of 24-hours germinated rye and barley grain increase dough softening value, decreases dough development time.

4. Rheological properties of dough with an optimum germinated grain addition satisfy the dough quality standard requirements.

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