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THE EFFECTS OF COMMERCIAL BARLEY FLAKES ON DOUGH CHARACTERISTIC AND BREAD COMPOSITION

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ABSTRACT

White wheat flour was substituted with up to 25% of whole and fine barley flakes to determine the effects on physical properties of dough and bread quality. The chemical composition of the control bread and breads with up to 25% substitution of whole barley flakes were determined. Product acceptability was judged by sensory evaluation. In general, fine barley flakes concentration in the flour blends increased farinographic absorption to a greater degree than did whole barley flakes. However, whole barley flakes enhanced the dough development, dough stability and mixing tolerance index more than fine barley flakes. Replacing up to 25% of wheat flour with whole or fine barley flakes reduced the loaf volume. Breads containing 10% fine barley flakes or 15% whole barley flakes received the highest overall score. Bread, in which the whole barley flakes replaced up to 25% of the wheat flour, contained more ash, protein, dietary fiber and its fractions in comparison with the control bread.
Key words: barley flakes, dough, bread, sensory quality, dietary fiber

INTRODUCTION

The concept of functional foods with the emphasis on disease prevention has been predominantly implemented by the development of food enriched with well known physiological active nutrients [7, 12, 17, 18, 22, 29, 30]. Grain based foods are highly regarded by nutritionists. Cereals containing a wide range of macro and micro nutrients are used as a vehicle for nutrient fortification. Enrichment of foods by addition of high-fiber cereal grain components is one way to increase fiber intake [3, 4, 8, 21]. The dietary guidelines of most developed countries include a recommendation to encourage the increased consumption of bread and other cereal foods.

Most people in Poland prefer white bread made from white flour over whole wheat flour. To manufacture bread the white flours are used more often. This raw material is poorer in valuable nutritive components. Recently, barley and barley products deserve special attention among numerous natural ingredients used to enrich bread. Specialty grains, such as barley and barley products, offer many options for production of consumer goods with enhanced healthful benefits [5, 12, 15, 19].

Several studies have reported the use of barley products such as barley spent bran, barley flour, barley shorts fractions, β-glucan barley fractions etc. in various baking products. Most of these barley products are suitable to produce enriched flour that can be substituted for a portion of wheat flour in many cereal products including bread, muffins and pasta. [3, 8, 9, 13, 15, 22, 25].

The objective of this study was to assess the effects of whole and fine barley flakes on dough properties, bread characteristics, and to analyze the effects of adding whole barley flakes on chemical composition of the bread.

MATERIALS AND METHODS

Analytical data of the wheat flour and barley flakes used in this study are given in Table 1. The commercial wheat flour (WF), about 72% extraction, was used. The commercial whole barley flakes (WBF) were produced from a sample of typical barley as a rolled barley groats. The fine barley flakes (FBF, particle size < 200 μm) were obtained after milling of WBF using the laboratory mill type DM 90-60.

Table 1. Analytical data on raw material used [*]

Material	Protein[c)] [% db]	Ash [% db]	Fat [% db]	NDF[d)] [% db]	Dietary fiber fractions [% db]		
					Cellulose	Lignin	Hemicellulose[e)]
WF [a)]	10.8	0.64	1.5	1.26	0.27	0.16	
SD ±	0.09	0.01	0.1	0.17	0.08	0.05	0.83
WBF [b)]	9.8	1.24	2.0	7.74	0.72	0.32	
SD ±	0.07	0.01	0.1	0.22	0.07	0.03	6.70

[*] Data are means (±SD) of at least two determinations
[a)] Wheat flour; [b)] Whole barley flakes; [c)] Wheat protein: N x 5.7; barley protein: N x 6.25;
[d)] Neutral detergent fiber; [e)]calculated as [NDF - (Cellulose +Lignin)]

Barley flakes - wheat flour blends - were prepared at the 5, 10, 15, 20, and 25% of flakes substitution using WBF or FBF. The commercial WF was used as control.

Physical dough properties of the control and the ten blends were determined with the farinograph (50 g of flour at 14% moisture, 50-g bowl; C.W. Brabender Instruments, Inc.,) by the constant flour weight procedure of the AACC method 54-21 [1].

Loaves of bread were baked from the WF and the blends: WF-WBF and WF-FBF by a straight dough baking procedure with a 1-hr fermentation, and a proofing temperature of 30 ^{o}C. The baking formula based on flour weight, was as follows: WF or blends (500 g), compressed yeast (15 g), salt (7.5 g), and variable amounts of water added according to baking absorption determined with farinograph (consistency of 350 B.U. 14% mb). Dough was mixed in a specially designed mixer (Stephan UMTA 10). Then the dough was scaled, rounded, molded, and placed in the baking pans for fermentation. The loaves of bread were baked at 220^{o}C for 30 min. The volume of the cooled loaves was determined by a milletseed displacement using a loaf volumeter. Bread quality was evaluated by panelists who were asked to score the bread according to the following 10 point own scale: external appearance - 1 point; internal appearance - 9 points (color and grain of crumb - 5 points; flavor - 4 points).

The crust was removed from the sliced WBF bread and the crumb frozen immediately and then freeze-dried. The freeze-dried crumb samples were ground on a laboratory mill (Falling Number type 3100) to pass through a 0.8 mm screen and stored in containers. ICC – standard methods were used to determine moisture: No. 110/1, ash: No. 104/1, and protein: No. 105/2 [10]. Fat was determined according to the standard method for cereals and cereals products [2]. Neutral detergent fiber (NDF), acid detergent fiber (ADF), acid detergent lignin (ADL), and acid cellulose (ADC) were determined according to Van Soest method [26,27]. Thermostable α- amylase was used to digest starch [20]. The hemicellulose content was calculated as the difference between NDF and ADF. This quicker gravimetric method is an acceptable method for measurement of dietary fiber in fiber sources [11, 28].

All data are reported on a moisture-free basis and are means of at least duplicate determinations which were used for statistical analysis. Standard deviation (SD) of the mean is given for each value in Table 1 and Table 2. Analysis of variance was used to analyze the results. Specific mean differences were evaluated using the Tukey's test.

Table 2. Effects of barley flakes on farinographic characteristic of wheat dough

Sample	Barley flakes [%]	Dough development [min.]	Dough stability [min.]	Mixing tolerance index [B.U.]
WF [a)]	0	1.6	2.2	85
WBF [b)]	5	2.1	4.0	35
	10	3.0	5.4	30
	15	4.1	6.0	30
	20	5.2	6.2	30
	25	6.4	6.5	30
FBF [c)]	5	1.2	2.2	65
	10	1.3	2.4	65
	15	1.5	2.8	55
	20	1.7	4.0	45
	25	1.9	4.2	40

[a)] Wheat flour; [b)] Whole barley flakes; [c)] Fine barley flakes

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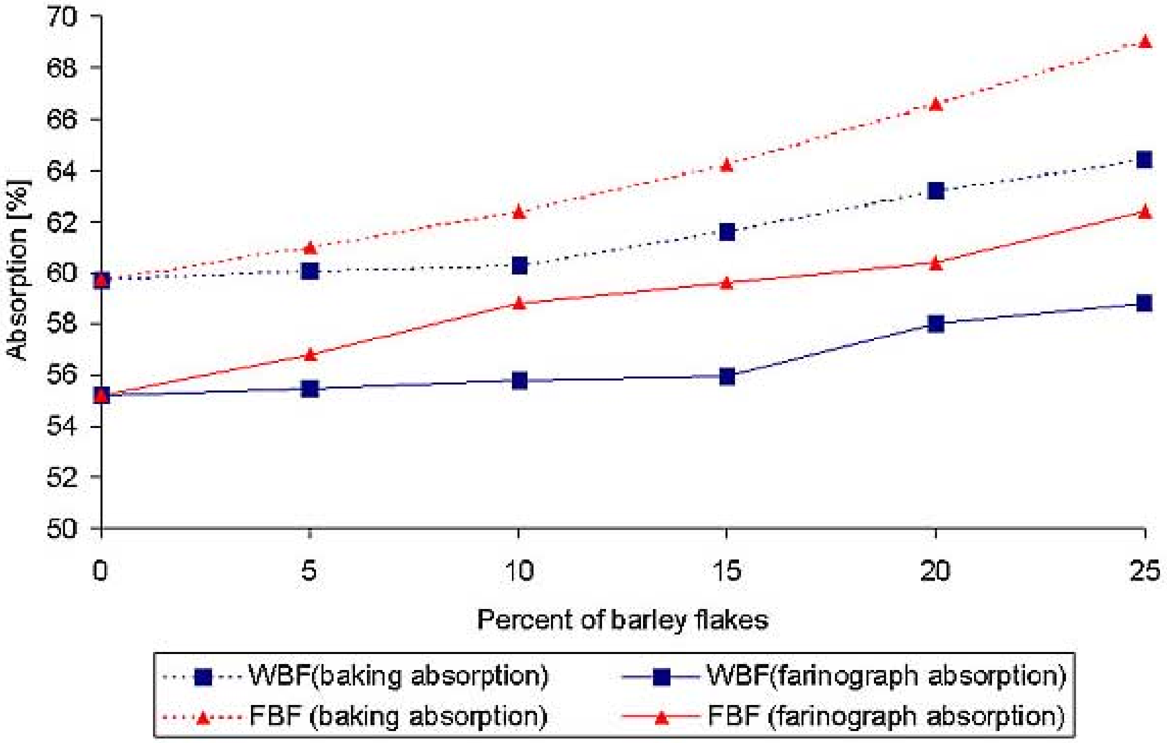
RESULTS AND DISCUSSION

Effects of barley flakes on the physical dough properties are shown in Figure 1 and Table 2. The water absorption (Fig. 1) increased with the increase of the barley flakes in the blends, but the fine barley flakes increased the water absorption more than whole barley flakes. The barely flakes also differed in effects on the following farinograpfic indices: development and stability of dough, and mixing tolerance index (MTI) as shown in Table 2. The increase of the barley flakes levels in flour blends improved dough development and dough stability times as well as MTI. These indices varied with flour replacement levels as well as with the material used. The incorporation of the whole barely flakes produced a dough that was more stable as shown by MTI values than the dough with fine barley flakes.

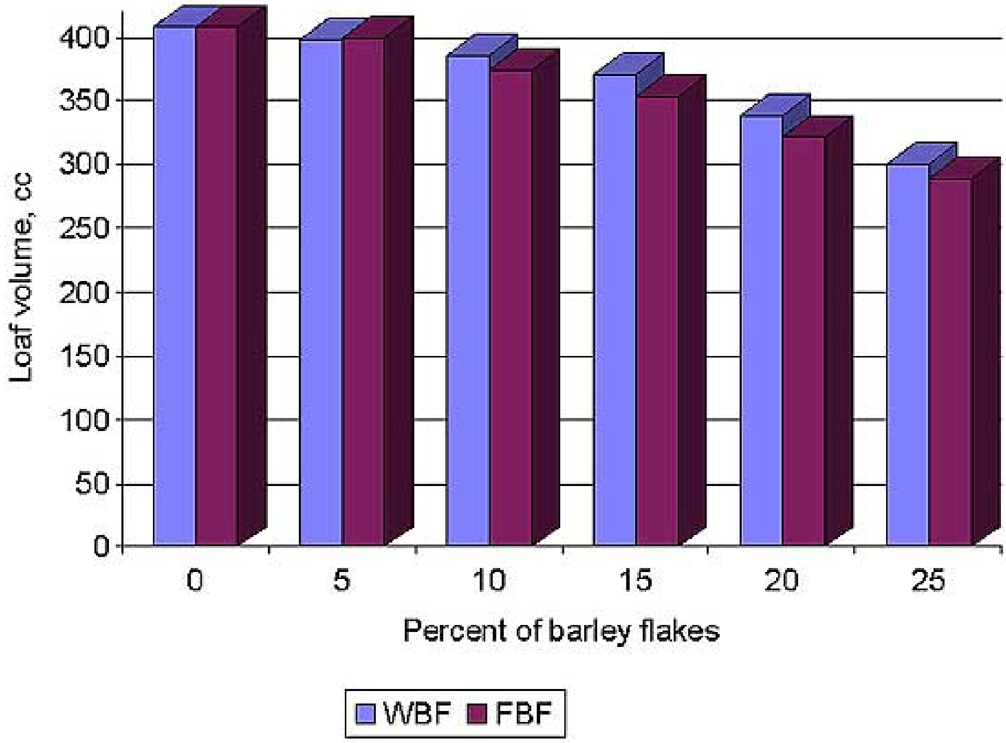
Figure 1. Water absorption [%] of dough from wheat flour with partial flour replacement by whole and fine barley flakes (WBF and FBF).



It was observed that chemical composition of barley or oat products [13,16,24], their percent in blend and a particle size of these products effect on the water absorption of the blend and properties of wheat-barely dough.

The effects of adding barley flakes on the loaf volume are shown in Figure 2. Replacing up to 25% of the WF with barley flakes (WBF and FBF) reduced loaf volume. When the flour was substituted with 5-25% levels of WBF or with 5-25% levels of FBF, loaf volumes decreased by 2.5-26.5% or 2.2-29.2%, respectively. Reductions in loaf volume were probably related primarily to the overall decrease in gluten content.

Figure 2. Effects of replacing wheat flour with whole and fine barley flakes (WBF and FBF) on loaf volume.

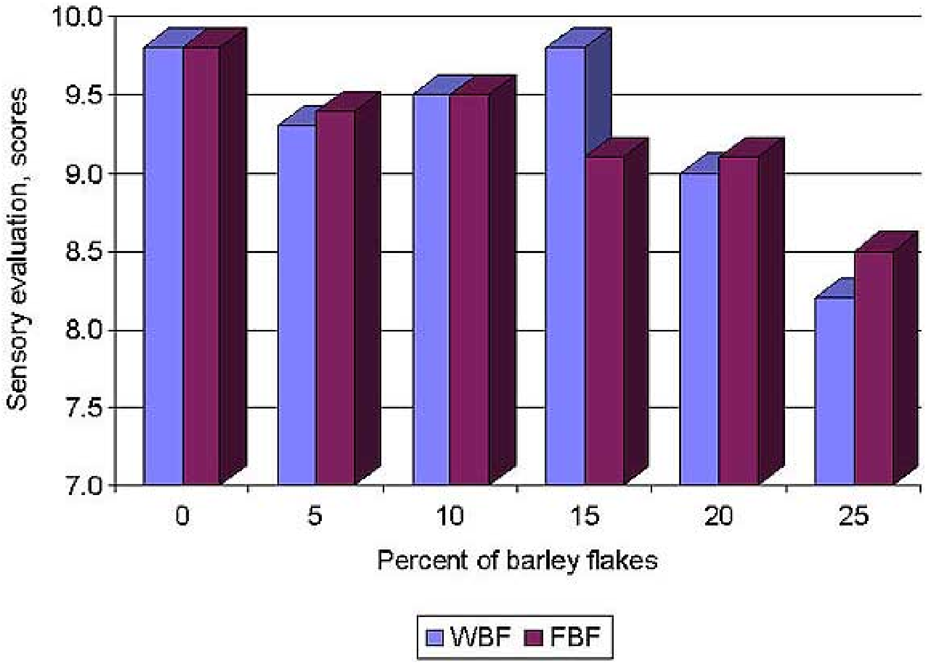


Pomeranz et al. [23] showed that fibrous materials impaired gas retention rather than gas production. Gluten dilution and gums present in the oat bran may have a strong influence on bread quality [15,16,23]. Dilution of wheat bread flour by substitution with barley or oat products can be improved by addition of vital gluten or dough conditioners. [5,14, 24].

Kawka and Wlad [14] showed that vital gluten (3%) or sodium stearoyl-2-lactylate (0.25%) used in blends containing 20-25% of barley flakes, whole and fine respectively, were effective in improving the loaf volume and bread quality.

Sensory evaluation of WF as control bread and barley breads is shown in Figure 3. The appearance of breads made with WBF and FBF at the 10% level of substitution was liked moderately. The quality of breads with 10-15% WBF, and 10% FBF were most liked. The 15% FBF bread received the lower scores as compared to 15% WBF bread and the control one. The panelists were asked to indicate their general preferences for WBF breads and FBF ones. Most of them chose breads made from WF with up to 15% of the flour replaced by WBF followed by bread with up to 10% of the flour replaced by FBF. They preferred the internal appearance of 15% WBF bread. They commented that the flavor of 15% WBF bread was more like in typical Polish mix bread. The crumb color of barley breads was a little darker than that of the control one. It was due to the slightly darker color of the barley flakes. The crust color of all barely breads was acceptable. Breads made with 15% WBF received the highest overall score.

Figure 3. Effects of replacing wheat flour with whole and fine barley flakes (WBF and FBF) on sensory evaluation of bread.



Since barley seems to be a potentially valuable crop, a series of studies were conducted to evaluate the properties of barely products and their role in the baking [3,5,6,22].

Bhatty [4] reported that no more than 10% barley flour could be incorporated into white pan bread without seriously affecting loaf volume and appearance.

Chaudhary and Weber [8] compared barley bran flour made from brewer's grain with other brans as dietary ingredients in white bread. Barley bran added at a level of 15% caused the smallest decrease in loaf volume, produced a loaf with substantially increased dietary fiber and reduced energy value, and gave the highest score of the different fiber-enriched breads.

The chemical components of the control and WBF breads are shown in Table 3. In all breads some differences in ash, protein, fat, and dietary fiber (NDF) contents were observed. WBF breads showed slight but significant increases in ash, protein and NDF contents over control bread. NDF increased significantly with the increase in WBF substitution. NDF level in breads with 5%, 10%, 15%, 20% and 25% WBF was higher than in the control bread by factors of 1,8, 1,9, 2,5, 3,3, and 4,5, respectively. The concentrations of cellulose, lignin and hemicellulose fractions were also higher in WBF breads as compared with the control bread. The hemicellulose fraction dominated in all WBF breads.

Table 3. Chemical composition of wheat and barley breads *

Sample	WBF[b)]	Ash	Protein	Fat	NDF[c)]	ADF[d)]	Dietary fiber fractions		
	[%]	[%db]	N x 5.8 [% db]	[%db]	[%db]	[%db]	Cellulose [%db]	Lignin [%db]	Hemicellulose[e)] [%db]
WF bread[a)]	0	1.14 [a]	11.9 [a]	1.5 [a]	1.15 [a]	0.62 [a]	0.53 [a]	0.09 [a]	0.53 [a]
WBF bread[b)]	5	1.12 [a]	11.8 [b]	1.3 [a]	2.12 [b]	0.70 [ab]	0.56 [a]	0.14 [ab]	1.42 [b]
	10	1.18 [b]	11.6 [c]	1.3 [a]	2.23 [b]	0.79 [b]	0.61 [a]	0.18 [ab]	1.44 [c]

	15	1.22 [c]	11.5 [d]	1.4 [a]	2.83 [c]	1.15 [c]	0.92 [b]	0.23 [abc]	1.68 [d]
	20	1.26 [d]	11.3 [e]	1.5 [a]	3.79 [d]	1.70 [d]	1.41 [c]	0.29 [bc]	2.09 [e]
	25	1.30 [e]	11.4 [f]	1.7 [a]	5.22 [e]	1.73 [d]	1.37 [c]	0.36 [c]	3.49 [f]

[*] Means in column followed by the same letter are not significantly different ($p< 0.05$)
[a)] Wheat flour; [b)] Whole barley flakes; [c)] Neutral detergent fiber [d)] Acid detergent fiber; [e)] Calculated as difference (NDF - ADF)

CONCLUSIONS

Barley flakes in flour blends increased the water absorption, improved the dough development, dough stability and mixing tolerance index. The incorporation of the whole or fine barley flakes into wheat bread formulation led to a decrease in loaf volume. Among barley flakes samples, the whole one decreased the volume slightly less than the fine sample. Bread containing up to 15% of barley flakes had acceptable sensory quality and a better chemical composition than white wheat bread. From the nutritional point of view, this bread is potentially healthful due to the increased fiber, and can be used as a prophylactic product.

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