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REGULAR ARTICLE

QUALITY AND NUTRITIONAL VALUE OF WHEAT BREAD WITH A PREPARATION OF OAT PROTEINS

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ABSTRACT

The aim of this study was to investigate possibilities and advisability of the use of oats insoluble protein preparation for the production of wheat bread, in order to increase the amount of protein and biological value of protein in this kind of bakery. Research material consisted of the preparation of insoluble oats protein, wheat flour and wheat bread made with the share of oat protein: 5%, 7.5% and 10%, by weight of wheat flour. AOAC methods (2006) were used to determine protein, β-D-glucan and dietary fiber in raw materials and final products. Amino acid composition was measured with the help of amino acid analyzer AAA 400 and used to calculate chemical score (CS) and the integrated index of essential amino acids (EAAI), according to FAO/WHO/UNU, 2007. Quality of breads was evaluated by their volume, baking yield and total baking loss, and organoleptic assessment. Bread crumb texture profile was analyzed by texture analyzer TA.XT Plus.

Keywords: wheat bread, oat protein, nutritional value, chemical score

INTRODUCTION

Oats protein contains considerable quantities of essential amino acids in comparison to wheat (**Hahn *et al.*, 1990; Butt *et al.*, 2008; Gambuś *et al.*, 2011**), so its use in the

production of wheat bread should result in improving biological value of the final product. The preparation offered by FUTURUM company, according to producer's declaration, contains mainly insoluble oats protein (**WO 2011/078711 A1)**, and therefore could be significantly different from water soluble globulin, which represents about 80% of total oats protein **(Pedo *et al.,* 1999; Salehifar and Shahed, 2007)**.

The application of nutritional supplements in the production of wheat bread is often accompanied by decreasing quality, caused by gluten weakening **(Gibiński *et al.,* 2010)**. Other studies demonstrate that the introduction of oats based raw materials into bread dough is possible only to a certain extent, limited by organoleptic quality of the final product **(Oomah, 1983; Flander *et al.,* 2007; Salehifar and Shahed, 2007; Kawka, 2009; Gambuś *et al.,* 2011)**.

The aim of the study was to investigate possibilities and advisability of the use of oats insoluble protein preparation for the production of wheat bread, in order to increase the amount of protein and biological value of protein in this kind of bakery.

MATERIAL AND METHODS

Material

Research material was the preparation of insoluble oats protein, manufactured by FUTURUM Ltd., according to patent WO 2011/078711 A1. The research material included also wheat flour type 650 (PZZ Krakow, Poland) and wheat bread manufactured with varying levels of oat protein preparation. The share of 5%, 7.5% and 10% of this preparation per weight of wheat flour, was used in preparing of the dough

Bread baking

The dough consisting of wheat flour type 650, oats protein preparation, salt, yeast and water was prepared in an electric mixer type ML 300 (ZBPP, Bydgoszcz, Polska) for 12 minutes. The consistency of the dough was adjusted to 350 FU, checked by Brabender farinograph. Addition of oats protein preparation resulted in an increase of water absorption of the applied flour mix.

First fermentation was conducted for 20 minutes, and after dividing dough into pieces of 70 g, the second fermentation followed for 25 minutes at 40°C and relative humidity 85%

in proving cabinet. Loaves were baked in aluminum pans at 230ºC, in an electric modular oven Miwe Condo, type C – 52 (MIWE, Arnstein, Germany), for 20 minutes. After baking the loaves were cooled for 1 hour and used for further analyzes.

Bread quality evaluation

Quality of bread was evaluated by checking mass of the loaves, its volume by rapeseed displacement, and calculating yield and total baking loss **(Jakubczyk and Haber, 1981)**. Organoleptic assessment was performed according to **PN-A-74108:1996**, by a 15-person panel with checked sensory sensitivity. Texture profile analysis was performed with the help of texture analyzer TA.XT Plus, measuring hardness, chewiness, cohesiveness, springiness and resilience of crumb.

Chemical analyzes of bread

Chemical composition of bread, as well as oats protein preparation was checked by the following methods of **AOAC (2006):** water content – 925.10, total protein content – 950.36, dietary fiber (soluble and insoluble fractions) – 991.43, content of β-D-glucan- 995.16.

The content of amino acids was determined with amino acid analyzer AAA 400 (**Smith, 2003; Ingos, 2007**). Basing on the results chemical score (CS) and the integrated index of essential amino acids (EAAI), were calculated according to **WHO/FAO /UNU, 2007**.

Statistical analysis

All measurements were done in at least two replicates, and the results were subject to one factor analysis of variance (ANOVA), applying software package Statistica 9.0 (USA). The significance of differences was evaluated by Duncan's test, at $\alpha \leq 0.05$. The results are represented as mean value ± standard deviation (SD).

RESULTS AND DISCUSSION

The influence of oats protein preparation on quality and organoleptic score of wheat bread

The applied preparation in amounts exceeding 5% had negative impact on the quality of test bread. Loaves with 7.5% and 10% of the preparation were characterized by significantly lower volume, and were qualified as fourth quality class by a sensory panel (Table 1). The increasing share of the preparation in test breads, resulted in a decreased volume (tab.1, fig. 1 and 2), which is in accordance with earlier reports on the influence of oats raw materials on bread volume (**Flander *et al.*, 2007; Gambuś *et al.*, 2011**). Bread containing 5% oats protein preparation was highly appreciated by consumers (I quality class) and had volume comparable to standard wheat bread. The increase in water addition, corresponding to growing share of protein preparation resulted in rising of bread yield (tab.1).

Bread with 5 and 7.5% oat protein preparation was characterized by a worse texture profile resulting from the greater crumb hardness and chewiness (tab.2), although these changes were statistically insignificant. Bread with the largest share of the preparation (10%) was characterized by significantly higher hardness and chewiness compared to the standard bread.

Table 1 Quality assessment of the analyzed bread

Kind of bread	Weight of cold bread [g]	Bread volume [cm^3]	Bread volume from 100g flour [cm^3]	Yield of bread [%]	Total baking loss [%]	Sensory evaluation	
						Sum of scores	Quality grade
Standard bread	59.31 ±0.34 a*	271.25 ±2.50 c	577.94 ±5.33 b	126.37 ±0.73 a	15.27 ±0.49 ab	39	I
Standard bread +5% oat protein	58.67 ±0.52 ab	267.50 ±6.45 bc	583.81 ±14.09 b	128.05 ±1.14 b	16.19 ±0.74 b	38	I
Standard bread +7.5% oat protein	59.41 ±0.17 ab	257.50 ±6.45 b	563.66 ±14.13 b	130.05 ±0.36 c	15.13 ±0.24 ab	16	IV
Standard bread +10% oat protein	59.47 ±0.71 b	243.75 ±11.09 a	535.45 ±24.35 a	130.63 ±1.57 c	15.05 ±1.02 a	14	IV

*Values in column marked by the different letters are significantly different at $\alpha \leq 0.05$; ±SD

Fig 1 Overall appearance of loaves

Fig 2 Cross-section of loaves

Table 2 Moisture content and texture profile analysis of bread crumb

Kind of bread	Hardness [N]	Springiness	Cohesiveness	Chewiness [N]	Resilience	Moisture of crumb [%]
Standard bread	7.87 ±2.06 a*	0.96 ±0.01 a	0.76 ±0.03 a	5.73 ±1.22 a	0.43 ±0.04 a	41.65 ±0.53 a
Standard bread +5% oat protein	11.43 ±2.23 ab	0.96 ±0.01 a	0.78 ±0.00 a	8.60 ±1.71 ab	0.47 ±0.02 a	41.93 ±0.37 a
Standard bread +7.5% oat protein	12.44 ±1.73 ab	0.96 ±0.01 a	0.77 ±0.02 a	9.16 ±0.91 ab	0.46 ±0.03 a	42.43 ±0.01 a
Standard bread +10% oat protein	14.97 ±0.04 b	0.96 ±0.02 a	0.80 ±0.06 a	11.49 ±1.13 b	0.48 ±0.04 a	42.97 ±0.59 a

*Values in column marked by the different letters are significantly different at $\alpha \leq 0.05$; ±SD

Comparison of the nutritional value of the preparation of oat insoluble protein and wheat flour and baked breads.

Oats protein preparation was characterized by significantly higher protein content in comparison to wheat flour. It also contained higher level of soluble dietary fiber which was mainly caused by the presence of β-glucans (tab. 3).

Native oats protein is water soluble in 80%, while the insoluble fractions (prolamins and glutelins) represent only 20% (**Pedo et al., 1999; Salehifar and Shahed, 2007).** This is different in comparison to other cereals, and contributes to high biological value of oats protein (**Pedo et al., 1999**). The analyzed preparation contained significantly more essential and conditionally essential amino acids than wheat flour (tab.4) and revealed much better chemical score (CS-73,76) in comparison to wheat protein (42,79). In both cases lysine was the limiting amino acid.

Table 3 Contents of protein, β-glucans and dietary fiber in raw materials and resulting bread

Kind of products	Protein (Nx6.25)	β-glukans	Dietary fibre		
			soluble	Insoluble	total
	g/100g d.m.				
Oats protein preparation	18.33 ±0.01 B*	1.79 ±0.02 b	2.06 ±0.06 b	1.40 ±0.1 a 2	3.46 ±0.0 a 6
Wheat flour type 650	12.10 ±0.20 a	0.20 ±0.03 a	1.22 ±0.13 a	1.79 ±0.0 b 2	3.01 ±0.1 a 6
Standard bread	12.86 ±0.05 a	0.25 ±0.02 a	0.45 ±0.04 a	3.48 ±0.0 a 7	3.93 ±0.0 a 3
Standard bread +5% oat protein	13.19 ±0.22 b	0.31 ±0.02 b	1.11 ±0.04 b	3.35 ±0.0 a 2	4.46 ±0.0 b 2
Standard bread +7.5% oat protein	13.58 ±0.01 c	0.38 ±0.02 c	1.22 ±0.07 bc	3.43 ±0.1 a 1	4.65 ±0.1 bc 8
Standard bread +10% oat protein	14.15 ±0.02 d	0.41 ±0.01 c	1.29 ±0.04 c	3.46 ±0.0 a 2	4.75 ±0.0 c 6

*Values in column marked by the different letters are significantly different at $\alpha \leq 0.05$; ±SD

Table 4 Contents of essential, conditionally essential amino acids and chemical score (CS) and the integrated index of essential amino acids (EAAI) in raw materials and resulting bread

	Oats protein preparation	Wheat flour type 650	Standard bread	Standard bread +5% oat protein	Standard bread +7.5% oat protein	Standard bread +10% oat protein
Thr	0.597b* ±0.033	0.297a ±0.019	0.371a ±0.002	0.380ab ±0.014	0.392bc ±0.006	0.397c ±0.008
Val	1.005b ±0.047	0.470a ±0.025	0.550a ±0.024	0.559ab ±0.006	0.582b ±0.004	0.587b ±0.011
Ile	0.798b ±0.031	0.405a ±0.026	0.492a ±0.004	0.506ab ±0.011	0.514b ±0.006	0.518b ±0.012
Leu	1.456b ±0.060	0.799a ±0.034	0.907a ±0.009	0.933ab ±0.021	0.951b ±0.014	0.958b ±0.024
Tyr	0.667b ±0.040	0.390a ±0.004	0.370a ±0.032	0.411b ±0.003	0.424b ±0.010	0.433b ±0.011
Phe	1.044b ±0.043	0.589a ±0.019	0.637a ±0.005	0.658ab ±0.025	0.670b ±0.002	0.672b ±0.014
His	0.448b ±0.012	0.268a ±0.003	0.325a ±0.014	0.341a ±0.002	0.352a ±0.026	0.354a ±0.023
Lys	0.563b ±0.024	0.228a ±0.019	0.354a ±0.004	0.348ab ±0.014	0.361b ±0.002	0.363b ±0.006
CS**	73.76b ±3.10	42.79a ±3.54	63.76a ±0.68	61.36a ±2.49	63.27a ±0.29	63.02a ±1.12
EAA	95.74b ±0.58	89.81a ±1.01	93.77a ±0.14	93.26a ±0.54	93.67a ±0.06	93.62a ±0.24

*Values in column marked by the different letters are significantly different at $\alpha \leq 0.05$; ±SD

** The limiting amino acid was lysine

Each applied level of addition significantly influenced protein content of bread. The resulting loaves also contained higher level of soluble dietary fiber which was mainly caused by the introduction of β-glucans (tab. 3).

Higher contents of protein in the preparation, compared with wheat flour contributed to a greater number of amino acids in breads with its addition - a statistically significant increase of almost all amino acids was observed in breads with 7.5 and 10% of the preparation

(tab.4). However, there were no differences in the biological value of protein between bread with oat protein preparation and standard. The chemical score of protein was for all loaves about 63%, while the integrated essential amino acid ratio of about 93%.

CONCLUSION

The addition of insoluble oats protein concentrated in an amount of 5% did not affect quality of the analyzed bread, while the samples with its higher level were characterized by significantly lower volume, poorer texture and low consumer acceptance. Breads baked with oat protein preparation, compared with a standard wheat bread, contained significantly more protein and soluble fiber fractions, including β-glucans. Although oat protein preparation was characterized by higher biological value of protein compared to wheat flour, its addition did not improve biological value of protein in the resulting bread.

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