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REGULAR ARTICLE

THE COMPARISON OF QUALITY AND CHEMICAL COMPOSITION OF BREADS BAKED WITH RESIDUAL AND COMMERCIAL OAT FLOURS AND WHEAT FLOUR

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ABSTRACT

The aim of the present work was to compare the quality and nutritional value of breads with 50% addition of oat flours of different origin (commercial and residual – a by-product obtained during production of β-glucan preparation) to standard wheat bread. Commercial wheat and oat flours and residual oat flour, as well as wheat and 50/50% wheat/oat breads were used as material in this research. Quality of breads was evaluated by their volume, baking yield and total baking loss. Bread crumb texture profile was analyzed by texture analyzer TA.XT Plus. Organoleptic assesment was performed by 15 skilled pearson‘s panel. Moreover both in flours and breads protein, lipids, mineral compounds, dietary fiber (soluble and insoluble fraction) and β-glucans content were analyzed by AOAC methods.

Keywords: oat flours, bread, quality, nutritional value

INTRODUCTION

Oat grain when compared to wheat or rye grains is characterized by unusual chemical composition **(Butt *et. al*, 2008; Angioloni and Collar, 2012)**, because it contains a beneficial combination of nutritional compunds, and for that reason this cereal should be used in human nutrition.

Lipid content in oat grain is 2- 3 times higher than in other cereals (**Butt *et. al*, 2008; Angioloni and Collar, 2012**). Moreover it is characterized by high protein content, which is a good source of egzogenic aminoacids (**Hahn *et al.*, 1990; Butt *et al*., 2008; Gambuś *et al.*, 2011**). In comparison to other bread cereals, oat grain contains smaller amout of carbohydrates, but is more abundant in dietary fiber (especially β-glucans and pentosans). It is also source of vitamins, especially vitamin E, thiamine and pantothenic acid (**Hahn *et al.*, 1990; Butt *et al*., 2008; Gambuś *et al.*, 2011; Angioloni and Collar, 2012).**

Unique chemical composition of oat grain contributes to growing worlwide interest in this cereal in aspect of human nutrition (**Klava *et al*., 2007**). Special attention is paid to specific fraction of soluble fiber beacause, as it was proved, β-glucans affect on health promoting properties of oat grain and its products (**Mälkki, 2001; Jenkins *et al*., 2002; Liatis *et al*., 2009; Juvonen *et al*., 2009**).

Nowdays on the market there are an increasing number of preparations a growing number of oat based preparations. One such product is BETAVEN - β-glucans concentrate, containing approximately 30% of these compounds. This preparation is manufactured by Microstructure Ltd. in Warsaw, only by physical methods, without the use of any chemicals (**http://www.betaven...**). During production of this preparation is created a large amount of oatmeal, known as the residual oat flour (ORF), of high nutritional value. This flour, as demonstrated in this study can be successfully used in the baking industry (**Gibiński *et al*., 2010; Gambuś *et al*., 2011**).

The aim of this study was to compare the quality and nutritional value of bread with a 50% share of oat flour from different sources (commercial and residual) to standard wheat bread.

MATERIAL AND METHODS

Materials

Material consisted of commercial wheat flour (WF), residual oat flour (ORF) obtained as a byproduct from the production of Betaven preparation (Microstructure Ltd.) and commercial oat flour (OCF) purchased in Mill Paweł Bogutyn mill in Radzyń Podlaski. Material were also breads made from these flours according to a formula as described in table 1: wheat and bread wheat-oat (50:50%) breads.

Table 1 Composition/recipe of the investigated bread

Raw material	**WFB (wheat bread)**	**W-ORFB (wheat-oat bread – residual flour)**	**W-OCFB (wheat-oat bread – commercial flour**
Wheat flour type 650 [g] (PZZ Krakow, Poland)	1000	500	500
Residual oat flour [g] (Microstructure Ltd., Warsaw, Poland)	-	500	-
Commercial oat flour [g] (Paweł Bogutyn mill, Radzyń Podlaski, Poland)	-	-	500
Yeasts SAF-instant [g] (Lesaffre Group, Strasbourg Cedet, France)	30	30	30
Salt [g] (Janikosoda S.A., Janikowo, Poland)	20	20	20
Water [cm^3]	610	660	660

Bread dough was prepared in the spiral mixer Diosna SP 12 (Dierks & Söhne, Osnabrück, Germany). The dough was prefermented for 15 minutes, and then, after rounding, weighing 250 g, was moved to proofer for 30 minutes (40˚C, 85% relative humidity). Breads were baked in tins at 230˚C for 30 min in CONDO MIWE CO 2 608 oven (MIWE, Arnstein, Germany).

Quality evaluation

Quality of bread was evaluated by checking mass of the loaves, their volume by VolScan Profiler (Stable Micro Systems), 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 by texture analyzer TA.XT Plus (Stable Micro Systems), measuring hardness, chewiness, cohesiveness, springiness and resilience of crumb.

Chemical analyzes of bread

Chemical composition of flour and bread was checked by the following methods of **AOAC (2006):** water content – 925.10, total protein content – 950.36, raw fat – 935.38, ash – 930.05, dietary fiber (soluble and insoluble fractions) – 991.43, content of β-D-glucan- 995.16.

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 10 (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 oat flour on quality and organoleptic assessment of the breads

Oat flour is characterized by low baking performance, due to small amount of gluteins, which after hydratation are responsible for creation and maintaining of wheat bread proper structure. Moreoveroat flour contains considerable greater amounts of dietary fibre, which also has detrimental effect of bread quality (**Flander *et al.*, 2007; Gambuś *et al.*, 2011**) .

In this study it was observed no effect of oat flour, both commercial and ressidual, on cold bread weight as well as on total baking loss (table 2.), but it was found a significant increase in yield, which was associated with a higher water binding during dough preparation. Earlier studies (**Zhang *et al.*, 1998; Gibiński *et al.*, 2010; Gambuś *et al.*, 2011**) have shown

that oat flour and wheat-oat flour blends were characterized by higher water absorption, which allows on the introduction of more water to the dough during mixing.

Table 2 The results of organoleptic assesment of the investigated breads

Kind of bread	Weight of cold bread [g]	Total baking loss [%]	Yield of bread [%]	Bread volume [cm^3]	Specific volume [cm^3/g]	Sensory evaluation	
						Sum of scores	Quality grade
WFB	208.5 ±1.8 a*	16.61 ±0.74 a	134.3 ±1.2 a	762.1 ±26.2 b	3.64 ±0.13 b	39	I
WF-ORFB	211.2 ±2.9 a	15.52 ±1.14 a	140.2 ±1.9 b	395.7 ±12.0 a	1.84 ±0.07 a	37	I
WF-ORFB	209.1 ±2.6 a	16.35 ±1.05 a	138.9 ±1.7 b	391.6 ±26.5 a	1.82 ±0.13 a	37	I

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

Wheat-oat breads, irrespective of the type of flour, were characterized by significantly lower volume compared to wheat bread, yet they received high consumer acceptance and were classified as first quality grade (Table 2). A smaller number of points in an organoleptic assessment of wheat-oat breads was caused mainly due to lower appearance score, because loaves were less grown and were characterized by worse parameters of crust (Fig. 1).

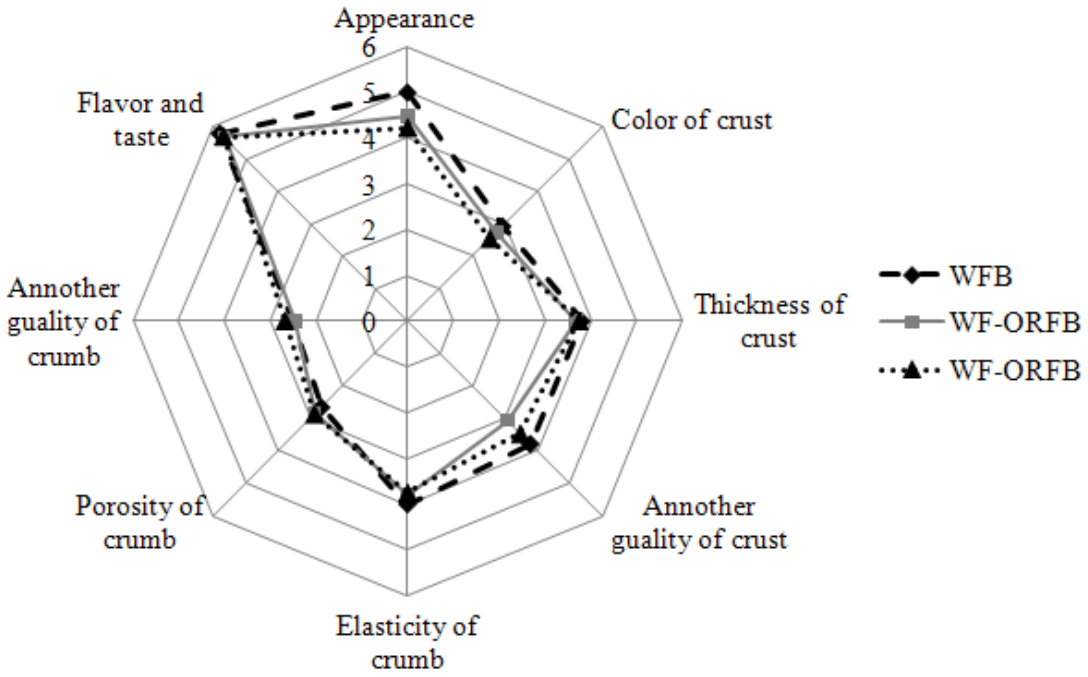

Figure 1 Organoleptic assessment of the investigated breads

A smaller volume of wheat-oat breads also caused the worse parameters of bread crumb texture, when compared to wheat bread crumb (Table 3). Regardless of the oat flour, wheat-oat bread crumb was characterized by higher hardness and chewiness, while such parameters like springiness, cohesiveness and resilience were lower. Moreover wheat-oat bread crumb was also characterized by high moisture. These features of wheat-oat bread crumb suggest their potentially lower glycemic index, when compared to more grown wheat bread (**Fardet et al., 2006**).

Table 3 Texture profile analysis of the crumb investigated breads

Kind of bread crumb	Moisture [%]	Hardness	Springiness	Cohesiveness	Chewiness	Resilience
WFB	40.71 ±0.44 b*	467.0 ±17.6 a	0.96 ±0.01 b	0.79 ±0.03 b	354.8 ±16.2 a	0.49 ±0.03 b
W-ORFB	41.53 ±0.51 b	1500.6 ±187.2 b	0.89 ±0.03 a	0.52 ±0.05 a	696.4 ±107.2 b	0.25 ±0.04 a
W-OCFB	39.54 ±0.58 a	1492.2 ±340.9 b	0.89 ±0.04 a	0.55 ±0.04 a	723.4 ±163.1 b	0.27 ±0.04 a

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

The influence of oat flour on nutritional value of bread

As shown in previous studies (**Gibiński *et al.*, 2010; Gambuś *et al.*, 2011**) addition of even small amount of oat flour to bread allows to modify the chemical composition of the final product. Test proved, that such addition increased the content of lipids, mineral compounds, fiber and β-glucans, when compared to standard wheat bread, regardless of oat flour type of (Table 4). However there was a slightly lower protein content in wheat-oat breads, the lowest in breads with addition of residual oat flour. But it should be keep in mind, that all the flours came from different sources, with potentially different chemical composition. However, it should be noted, that the biological value of oat flour protein greatly exceeds the value of wheat one.

Table 4 Chemical composition of breads

Chemical composition		WFB	W-ORFB	W-OCFB
Protein		13.49 ±0.10 c*	13.01 ±0.01 a	13.36 ±0.02 b
Fat		1.80 ±0.01 a	5.62 ±0.01 b	5.52 ±0.04 b
Ash		2.73 ±0.01 a	3.00 ±0.03 b	2.92 ±0.07 b
Dietary fibre	**insoluble**	3.18 ±0.02 a	3.56 ±0.02 b	3.67 ±0,05 c
	soluble	1.84 ±0.06 a	2.26 ±0.03 b	1.91 ±0.06 a
	total	5.02 ±0.09 a	5.82 ±0.02 c	5.58 ±0.10 b
β-glukans		0.15 ±0.02 a	0.80 ±0.02 b	0.85 ±0.01 c

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

Breads with residual oat flour addition slightly differ in chemical composition from those with commercial oat flour. Residual flour breads were characterized by significantly lower level of protein, insoluble dietary fiber and β-glucans (table 4). Such composition is the result of the application of flour obtained from different grain, in different ways, although it is clear from Table 5, the residual flour, which is a by-product during the production of β-glucans concentrate is not much different from the commercial oat flour.

Table 5 Chemical composition of flour

Chemical composition		WF	W-ORF	W-OCF
Protein		12.79 ±0.07 b*	12.05 ±0.12 a	12.31 ±0.15 b
Fat		1.39 ±0.01 a	8.49 ±0.17 b	8.45 ±0.06 b
Ash		0.57 ±0.05 a	1.42 ±0.06 b	1.40 ±0.03 b
Dietary fibre	**insoluble**	1.35 ±0.02 a	3.05 ±0.00 b	3.23 ±0.05 c
	soluble	1.46 ±0.02 a	2.52 ±0.04 b	2.54 ±0.05 b
	total	2.81 ±0.04 a	5.57 ±0.04 b	5.77 ±0,11 b
β-glukans		0.13 ±0.02 a	1.58 ±0.02 b	1.62 ±0.00 c

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

CONCLUSION

Wheat – oat breads (50/50%), indepedently of type used oat flour type were characterized by significantly lower volume when compared to wheat breads, nevertheless providing the higher yield, and also comparable organoleptic assesssment, because all investigated type of breads were graded as first class. In wheat – oat breads higher level of lipids, mineral compounds, dietary fiber and β-glucans was found than in standard wheat breads. Residual oat flour, byproduct of BETAVEN dietary fiber preparation production (Microstructure Ltd, Warsaw) can be successfully used for bread baking. Final product is characterized by comparable quality and dietary parameters like breads with addition of commercial oat flour.

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