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REGULAR ARTICLE

AMINOACIDS COMPOSITION OF PROTEINS IN WHEAT AND OAT FLOURS USED IN BREADS PRODUCTION

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ABSTRACT

Oat grain contains a protein with high biological value, the highest among all bread-making cereals. An addition of oat flour in breadmaking should lead to improvement of protein's biological value in this product. Therefore, the aim of this study was to compare the amino acids composition and biological value of the commercial wheat flour and oat flours of different sources (commercial and residual). Residual oat flour was obtained as a byproduct from the production of Betaven - dietary-fibre preparation). Also proteins of wheat and wheat–oat breads (50/50%) baked with these flours.

Material consisted of flours (wheat and commercial and residual oat), as well as breads (wheat and wheat-oat (50:50%)) baked by a single phase method. Raw materials were analyzed on the amino acid composition by amino acid analyzer AAA 400. On this basis the chemical score (CS) and essential amino acid index (EAAI), according to the FAO /WHO/UNU (2007) were evaluated.

Keywords: (protein, amino acids, oats, bread)

INTRODUCTION

Bread plays an important role in the human diet, because it is main of source of energy, protein, carbohydrates, fiber, minerals and vitamins in diet (**Różyło and Laskowski, 2009; Dewettinck *et al.*, 2008**). Nutritional value of bread mainly depends of type of flour used in bread-making and application of other technological additives.

Wheat flour, used in the production of bread, is usually characterized by a high carbohydrates and proteins, but this protein has a very low nutritional value, because it contains lower proportion of essential amino acids (**Dewettinck *et al.*, 2008; Ndife *et al.*, 2011**). Oat is abundant in these compounds, and oat's protein contains higher proportion of essential amino acids than wheat protein (**Hahn *et al.*, 1990; Butt *et al.*, 2008; Gambuś *et al.*, 2011**). Oat grains is ususally better source of lysin, threonin, as well as phenyloalanin and tyrosine than other cereals (**Gibiński *et al.*, 2005**). The highest share of oat protein, ie 70 – 80% of total protein, are globulins and albumins, the remaing part (about 20%) are prolamins and glutenins (**Pedo *et al.*, 1999; Salehifar and Shahed, 2007)**. High content of globulin distinguished oat from other cereals proteins, and contributes to its distinctively high biological value.

The aim of the study was to compare the amino acid composition and protein biological value of wheat flour and oat flours from different sources (commercial and residual flour). Residual oat flour is obtained as a byproduct from the production of β-glukans preparation - Betaven, as well as proteins of wheat and wheat-oat (50/50%) breads baked from the flour.

MATERIAL AND METHODS

Materials

Material consisted of commercial wheat flour (WF), residual oat flour (ORF) obtained as a byproduct from the production of β-glucans concentrate, containing approximately 30% of these compounds called Betaven, produced by Microstructure Ltd. in Warsaw, and commercial oat flour (OCF) purchased in Mill Paweł Bogutyn 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.

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).

Table 1 Composition/recipe of the investigated bread

Raw materials	**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

Aminoacids composition

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 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 content of nonessential and conditional essential amino acids in the investigated products

Wheat flour, compared to oat flour, whatever type, was characterized by a significantly higher content of proline, and the amount of glutamic acid and glutamine (Tab. 2), which led to their higher content in wheat bread than in wheat-oat bread (Tab. 3). These amino acids are the most typical for the prolamin and glutelin of cereal grains.

Table 2 The content of nonessential and conditional essential amino acids in the investigated flours

	WF	ORF	OCF
Asp+Asn	0.483 ±0.001 a*	0.955 ±0.017 b	1.000 ±0.018 c
Ser	0.613 ±0.010 c	0.565 ±0.013 a	0.583 ±0.008 b
Glu+Gln[1]	5.227 ±0.072 b	2.879 ±0.098 a	2.975 ±0.044 a
Pro[1]	1.558 ±0.051 b	0.619 ±0.015 a	0.638 ±0.019 a
Gly[1]	0.469 ±0.012 a	0.607 ±0.017 b	0.620 ±0.012 b
Ala	0.386 ±0.010 a	0.558 ±0.017 b	0.575 ±0.011 b
Arg[1]	0.473 ±0.010 a	0.859 ±0.028 b	0.889 ±0.022 b

[1] conditional essential amino acids

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

Table 3 The content of nonessential and conditional essential amino acids in the investigated breads

	WFB	W-ORFB	W-OCFB
Asp+Asn	0.570 ±0.013 a*	0.814 ±0.008 b	0.831 ±0.002 c
Ser	0.631 ±0.021 a	0.636 ±0.006 a	0.645 ±0.003 a
Glu+Gln[1]	4.987 ±0.141 b	4.089 ±0.020 a	4.139 ±0.002 a
Pro[1]	1.513 ±0.026 b	1.100 ±0.004 a	1.121 ±0.012 a
Gly[1]	0.498 ±0.016 a	0.595 ±0.005 b	0.606 ±0.001 b
Ala	0.439 ±0.017 a	0.552 ±0.004 b	0.562 ±0.001 b
Arg[1]	0.524 ±0.019 a	0.736 ±0.003 b	0.747 ±0.004 b

[1] conditional essential amino acids
*Values in rows marked by the different letters are significantly different at $\alpha \leq 0.05$; ±SD

Other amino acids were present in wheat flour in smaller amounts than in oat flours. A similar dependence was observed when comparison breads amino acids composition was done.

The content of essential and conditional essential amino acids in the tested products

Wheat flour, compared to oat flour, contained a smaller amount of essential amino acids, but oat flours contained almost twice more lysine than wheat flour (Tab. 4). Similar relations were observed in the case of bread with addition of both types of oat flours (Tab. 5).

Comparing the chemical composition of commercial and residual oat flours, it was observed that flour resulting from the production of β-glucan preparation (depleted of dietary fiber) contained a significantly less amount of threonine and sum of aspartic acid and asparagine. Breads with addition of residual flour also contained less of these amino acids, than breads with commercial oat flour.

Table 4 The content of essential and conditional essential amino acids relatively in the investigated flours

	WF	ORF	OCF
Thr	0.317 ±0.002 a*	0.383 ±0.006 b	0.403 ±0.007 c
Val	0.558 ±0.016 a	0.641 ±0.017 b	0.663 ±0.009 b
Ile	0.509 ±0.011 a	0.499 ±0.017 a	0.515 ±0.006 a
Leu	0.953 ±0.017 a	0.947 ±0.034 a	0.979 ±0.013 a
Tyr[1]	0.418 ±0.014 a	0.490 ±0.018 b	0.508 ±0.007 b
Phe	0.689 ±0.010 b	0.659 ±0.023 a	0.677 ±0.008 ab
His	0.352 ±0.005 a	0.342 ±0.011 a	0.353 ±0.005 a
Lys	0.261 ±0.003 a	0.473 ±0.017 b	0.486 ±0.009 b
Cys[1]	0.291 ±0.009 a	0.338 ±0.009 b	0.332 ±0.013 b
Met	0.217 ±0.007 a	0.220 ±0.006 a	0.215 ±0.008 a

[1] conditional essential amino acids

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

Table 5 The content of essential and conditional essential amino acids in the test breads

	WFB	W-ORFB	W-OCFB
Thr	0.366 ±0.014 a*	0.406 ±0.004 b	0.413 ±0.003 b
Val	0.588 ±0.019 a	0.664 ±0.003 b	0.677 ±0.005 b
Ile	0.532 ±0.015 a	0.561 ±0.002 b	0.572 ±0.006 b
Leu	0.978 ±0.030 a	1.029 ±0.005 b	1.056 ±0.016 b
Tyr[1]	0.439 ±0.008 a	0.481 ±0.004 b	0.505 ±0.003 c
Phe	0.687 ±0.023 a	0.719 ±0.005 b	0.719 ±0.015 b
His	0.373 ±0.009 a	0.403 ±0.005 b	0.401 ±0.005 b
Lys	0.336 ±0.010 a	0.479 ±0.014 b	0.475 ±0.004 b
Cys[1]	0.287 ±0.008 a	0.309 ±0.008 b	0.310 ±0.017 b

Met	0.198 ±0.003 a	0.207 ±0.006 a	0.205 ±0.012 a

[1] conditional essential amino acids

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

The criterion of the biological value of protein assessing is not only the content of amino acids in the product, but also the indicator of limiting essential amino acid as Chemical Score, and Essential Amino Acid Index (EAAI). These indicators also take into account the body's requirements for individual amino acids (**WHO/FAO/UNU, 2007; Jabłoński, 2000**). Limiting amino acid in the all studied flours was lysine (Tab. 6), which is typical for cereal products, while the second limiting amino acid in all tested products was threonine.

50% substitution of wheat flour by oat flour in bread significantly improved the biological value of wheat-oat bread protein. Both amino acids composition as well as the value of Chemical Score (CS) and Essential Amino Acid Index (EAAI) were improved, that was confirmed the research of other author researches (**Gibiński *et al.*, 2010; Gambuś *et al.*, 2011**). It was observed no differences in protein biological value between protein from bread with addition of commercal and residual oat flours.

Table 6 Chemical Score (CS) and Essential Amino Acid Index (EAAI) the investigated products

	CS [%]		EAAI [%]
	lizyna	treonina	
WF	32.33 ±0.48 a*	67.72 ±0.48 a	82.71 ±0.11 a
ORF	67.76 ±2.50 b	93.64 ±1.47 b	94.47 ±0.54 b
OCF	67.48 ±1.21 b	95.45 ±1.57 c	94.65 ±0.25 b
WFB	42.89 ±1.29 a	77.64 ±4.87 a	87.44 ±0.73 a
W-ORFB	59.96 ±1.69 b	86.73 ±0.80 b	92.15 ±0.39 b
W-OCFB	58.52 ±0.53 b	86.84 ±0.65 b	91.89 ±0.05 b

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

CONCLUSION

Oat flour was characterized by far more better amino acid composition compared to wheat flour, which was proved not only by greater share of essential amino acids, but also the higher value of chemical score and essential amino acid index. The use of oat flour for bread

wheat production at 50% level, significantly increased the content of essential amino acids and biological value of bread with addition of oat flour. It was observed no difference between addition of residual oat flour, by-product of BETAVEN - dietary fibre preparation, and commercial oat flour.

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