

Grain Bread with Buckwheat Bran Flour for a Healthy Diet

Nadezhda N. Alekhina, Elena I. Ponomareva, Svetlana I. Lukina and Alexandr A. Smirnykh
Federal State Budget Educational Institution of Higher Education
“Voronezh State University of Engineering Technologies” (FSBEI HE “VSUET”),
Voronezh Region, Voronezh, Russia

Abstract: The possibility of using buckwheat bran flour in the recipes of bakery products is investigated. This flour has balanced chemical composition and high nutritional value which makes it a promising ingredient for use in the production of new types of healthful and dietary foods (particularly bread) based on cereal crops. Bread as a staple food is a convenient product for enrichment with macro- and micronutrients. The purpose of our study was to improve the quality parameters of bread made from bio-activated wheat grain through the use of buckwheat bran flour in the recipe. It was found that the addition of this flour allowed increasing the bread antioxidant activity by 12.5%, dietary fiber content by 21.0% and minerals by 15.0-39.5%. As a result, the total product cost reduced by 44.5% and the developed bread may be considered a new product for a healthy diet.

Key words: Bio-activated wheat grain, buckwheat bran flour, bread, nutritional value, antioxidant activity, bran flour

INTRODUCTION

Expanding the range of higher nutritional value foods is one of the most challenging healthy diet improvement tasks. The changing rhythm of contemporary society, readily available bakery products depleted in physiologically necessary ingredients, traditional use of refined ingredients and other relatively negative factors determine the requirement to develop new high nutrition bakery products (Lukina *et al.*, 2013; Delcour *et al.*, 2013; Elke *et al.*, 2013).

The program Strategy of Development of Food and Processing Industries of the Russian Federation for the Period till 2020 covers expansion of cereal-based product manufacturing and commercial use of food processing by-products to increase the output of finished goods and their quality parameters.

Grain bread may be one of the sources of biologically active substances and dietary fiber which are necessary components of a balanced diet. A variety of technologies and a range of bakery products containing bio-activated grain additives and various natural ingredients in their recipes have been developed at the Voronezh State University of Engineering Technologies (Russia,

Voronezh), the Department of Bakery, Confectionery, Pasta and Grain Processing Technologies (Alekhina *et al.*, 2015).

A promising way to increase nutritional and biological value of bakery products is the improvement of recipes by addition of natural enrichers including the products of particular physiological significance such as buckwheat bran flour (Breadmaking, 2016).

The use of buckwheat bran flour as an enricher in food production including bakery products will increase their protein, dietary fiber and minerals content, make it possible to provide complex enrichment of products, expand their range, save the main raw materials and also use the milling industry by-product in commercial production (Ponomareva *et al.*, 2015).

The purpose of the research was to improve the quality of bread made from bio-activated wheat through the addition of buckwheat bran flour.

MATERIALS AND METHODS

In the research we used wheat (GOST (Russian National Standard) R 52554-2006), pressed yeast for

Table 1: Dough recipe on “Khmelevaya Zlakovaya” dry leavening for grain bread

Raw materials	Raw material consumption to make bread dough	
	1 (control sample)	2
3-rd grade wheat (food grain) (kg)	90.00/138.60*	85.00/130.9*
Pressed bakery yeast (kg)	2.00	2.00
Food salt (kg)	1.50	1.50
Buckwheat bran flour (kg)	-	5.0
Dry leaven “Khmelevaya lakovaya” (kg)	10.0	10.0
Water (kg)	18.3	23.2

*Weight of bio-activated wheat grain with a moisture content of 44%

baking (GOST R 54731-2011), white salt (GOST R 51574-2000), water (SanPiN (Russian Sanitary Rules and Regulations) 2.1.4.1074-01), dry leavening “Khmelevaya Zlakovaya” (TU (Russian Technical Specifications) 9195-327-02068108-2015), buckwheat bran flour (TU 9293-293-02068108-2014) and bakery products made from bio-activated wheat grain and “Khmelevaya Zlakovaya” dry leavening “Biokhmelevoy” bread (TU 9110-328-02068108-2015) (control sample) and “Grey” bread (TU 9110-329-02068108-2015).

Preparation of wheat grain for baking included the following steps first debris and impurities were removed, then it was washed, left to swell in water and germinate for 10-12 h and milled. Bread was made from bio-activated wheat grain with addition of 10.0% of “Khmelevaya Zlakovaya” dry leavening. Buckwheat bran flour was added to the dough recipe of “Grey” bread (Table 1). Bread-making process in general was standard for making bread (Technology of breadmaking, 1999; Dobraszczyk *et al.*, 2003; Dobraszczyk *et al.*, 2003).

The 24 h after baking, the bread was analyzed for antioxidant activity, 24 and 72 h after baking for microbiology.

The total antioxidant activity of the bakery products made was tested in TsvetYauza-01-AA chromatograph (Certificate of Conformity for Measuring Equipment Type No.45174 of 29.12.2011, Russia).

Microflora of bread was analyzed for the number of mesophilic aerobic and facultative anaerobic microorganisms (NMAFAM) according to GOST 10444.15-94 and for the presence of molds and yeasts according to GOST 10444.12-88 (Goldman *et al.*, 2008). During a 7 days period of storage in summer and winter conditions, the products were visually checked for mold and development of the “potato disease” (*Bac. mesentericus* and *Bac. subtilis*) was monitored on a daily basis in accordance with the guidelines for prevention of “potato disease” in bread. Nutritional, energy and biological values of products made from bio-activated

wheat grain were identified by calculation. The extent of covering the nutrient daily requirement was calculated in accordance with SanPiN 2.3.2. 1078-01 and the unified sanitary and epidemiological and hygienic requirements for goods subject to sanitary-and-epidemiologic supervision. Vitamin calculation was performed taking into account the storage coefficients.

RESULTS AND DISCUSSION

The study of antioxidant activity of the bread from bio-activated wheat showed that antioxidant content in “Biokhmelevoy” bread was 12.5% less than in “Grey” bread (Fig. 1).

Increased antioxidant activity of bread from bio-activated wheat flour is achieved by the addition of buckwheat bran flour to the bread recipe because the buckwheat bran flour has high content of bioflavonoids (quercetin, rutin) powerful antioxidants that protect cells of human body from the damaging effects of free radicals, support their normal functions and also slow the aging processes (Ponomareva *et al.*, 2008). Antioxidant activity of buckwheat bran flour is almost 15 times higher than that of the bio-activated wheat grain (Len Marquart *et al.*, 2008).

Results of chemical composition analysis showed that the products are rich in proteins, fiber, minerals and vitamins. However, the chemical composition of “Grey” bread made with buckwheat bran flour was more optimum vs. “Biokhmelevoy” bread.

“Grey” bread sample has higher content of the following nutrients than the control sample protein by 2.7%, fiber by 21.0%, calcium 39.5%, Mg 31.0%, iron 15.0% (Table 2). Consumption of 100 g of “Grey” bread will provide 20.9% of a person daily requirement of dietary fiber which is 3.5% higher vs. the control sample. Studies have also shown that the two bread samples have slightly different content of vitamins (Table 2).

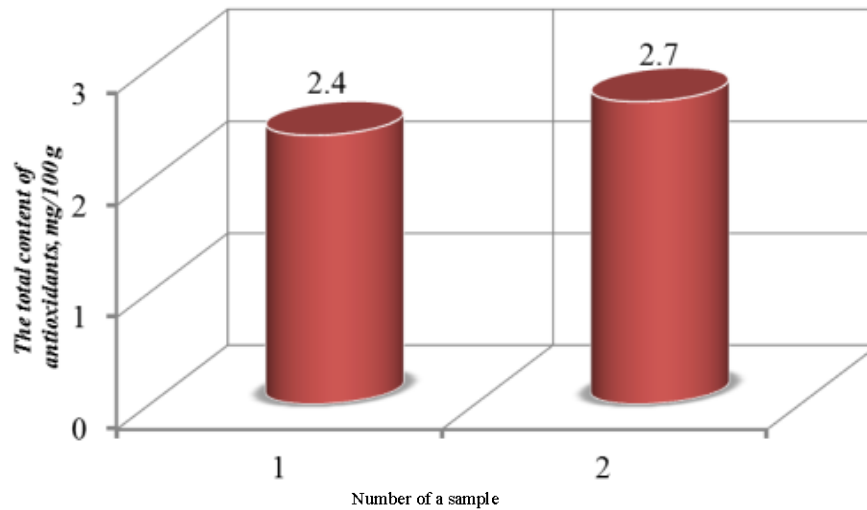


Fig. 1: Total content of antioxidants in the products based on total solids: 1: "Biokhmelevoy" bread (control sample); 2: "Grey" bread"

Table 2: Chemical composition of bakery products, energy value and meeting nutrient daily requirements

Content per 100 g					
Ingredients	"Biokhmelevoy" bread	Meeting daily requirement (%)	"Grey" bread	Daily requirement Meeting daily requirement (%)	(SanPiN 2.3.2. 1078-01) (g) (mg)
Protein (g)	7.40	9.8	7.6	10.2	75
Fat (g)	1.30	1.5	1.4	1.6	83
Carbohydrates (g)	32.60	8.9	30.9	8.5	365
Dietary fiber (g)	5.20	17.4	6.3	20.9	30
Minerals (mg)					
Calcium	39.90	4.0	55.7	5.6	1000
Magnesium	88.10	22.0	115.4	28.9	400
Phosphorus	236.70	23.7	242.9	24.3	1000
Iron	3.30	23.7	3.8	27.3	14
Vitamins (mg)					
Thiamin	0.35	23.0	0.33	22.1	1.5
Riboflavin	0.19	10.7	0.19	10.4	1.8
Energy value (kJ)	717.30	6.9	698.10	6.7	10460

Table 3: Composition of essential amino acids and biological value of bio-activated wheat grain products

Ingredient content per 100 g of bread							
Amino acids	"Biokhmelevoy"			"Grey"			Adequate daily intake (mg)*
	Amino-acid (mg/g protein)	Amino-acid score (%)	Meeting daily requirement (%)	Amino-acid (mg/g protein)	Amino-acid score (%)	Meeting daily requirement (%)	
Valine	40.4	80.8	1.6	40.1	80.2	1.6	2500
Isoleucine	27.1	67.8	1.4	26.8	66.9	1.3	2000
Leucine	61.2	87.4	1.3	60.0	85.7	1.3	4600
Lysine	32.9	59.8	0.8	33.8	61.5	0.8	4100
Methionine+cystine	27.5	78.6	1.5	26.8	76.7	1.5	1800
Threonine	35.2	88.0	1.5	35.5	88.7	1.5	2400
Tryptophan	15.8	158.0	1.9	14.9	149.8	1.9	800
Phenylalanine+tyrosine	80.9	134.8	1.8	78.4	130.6	1.8	4400
Biological value (%)	65.4				68.8		

*Unified epidemiological and sanitary requirements for products subject to epidemiological and sanitary surveillance (supervision)" EurAsEC Customs Union (Supplement 5)

Table 4: Total bacterial count of bio-activated wheat grain bread

Bread	Microbiology, CFU/g, bread in storage					
	24 h after baking			72 h afterbaking		
	NMAFAM	Mold	Yeast	NMAFAM	Mold	Yeast
"Biokhmelevoy" (control sample)	$0.75 \cdot 10^2$	<10	<10	$1.3 \cdot 10^2$	<10	<10
"Grey"	$<0.1 \cdot 10^2$	<10	<10	$0.72 \cdot 10^2$	<10	<10

The control sample energy value slightly exceeded that of the "Grey" bread sample and amounted to (717.3 kJ). Biological value of "Grey" bread was a bit higher than that of "Biokhmelevoy" bread (68.8 and 65.4%, respectively (Table 3). This is accomplished by including buckwheat bran flour in the "Grey" bread recipe, which contains proteins with more balanced composition of amino acids than bio-activated wheat grain.

It was found that 24 h after baking, "Grey" bread had lower overall bacterial count (below 0.1×10^2 CFU/g) vs. "Biokhmelevoy" bread (0.75×10^2 CFU/g). During storage, the number of Mesophilic Aerobic and Facultative Anaerobic Microorganisms (NMAFAM) in the bread samples was increasing and 72 h after baking reached 0.72×10^2 CFU/g in "Grey" bread and 1.3×10^2 CFU/g in "Biokhmelevoy" bread (Table 4) but the amount of molds and yeasts did not exceed 10 CFU/g.

A relatively high microbiological purity of "Grey" bread is related to partial replacement of bio-activated wheat grain in the bread recipe with buckwheat bran flour which has lower microbial contamination (overall bacterial count).

It is also worth noting that the highest rate of bread mold growth in the summer occurred in "Biokhmelevoy" bread, presence of bread mold in it was found on the 4th day (90 h after baking) while in "Grey" bread mold was found on the 5th day (112 h after baking). During storage, no "potato disease" was found in any bread samples.

Thus, a positive effect of using buckwheat bran flour on the quality parameters of bread made from bio-activated wheat grain was identified its antioxidant activity increased by 12.5% and total bacterial count reduced by 44.5%.

CONCLUSION

The results of our studies have shown that introduction of buckwheat bran flour in the recipe of

bread made from bio-activated wheat grain allows increasing its nutritional value (dietary fiber, calcium, magnesium and iron content). The 100 g of "Grey" bread provide 10.2% of our daily requirement of protein, 20.9% of dietary fiber, 5.6-28.9% of minerals and 0.8-1.9% of essential amino acids.

Thus, the use of buckwheat bran flour in the technology of making sprouted wheat grain bread with high nutritional value and microbiological purity can be recommended.

REFERENCES

- Alekhhina, N.N., E.I. Ponomareva and I.A. Bakayeva, 2015. Bread with Higher Nutritional Value on the Basis of the Bio-Activated Wheat Grain Leavening: Monograph. Voronezh State University of Engineering Technology, Voronezh, Russia, Pages: 224.
- Breadmaking, 2016. Improving Quality. 2nd Edn., Woodhead Publishing, Sawston, Cambridge, Pages: 832.
- Delcour, J.A. and K. Poutanen, 2013. Fibre-Rich and Wholegrain Foods: Improving Quality. 1st Edn., Elsevier Science, Amsterdam, Netherlands, Pages: 496.
- Elke, K.A. and E. Zannini, 2013. Cereal Grains for the Food and Beverage Industries. 1st Edn., Woodhead Publishing, Sawston, Cambridge, Pages: 512.
- Goldman, E. and L.H. Green, 2009. Practical Handbook of Microbiology. 2nd Edn., CRC Press, New York, USA., ISBN-13: 9781420009330, Pages: 864.
- Lukina, S.I., A.A. Zhuravlev and M.K. Sadygova, 2013. Nonconventional types of flour in technology of cupcakes. J. Khlebo Prod., 10: 44-45.

- Marquart, L., D.R.Jr, Jacobs, G.H. McIntosh, K. Poutanen and M. Reicks, 2008. Whole Grains and Health. Blackwell Publishing, Hoboken, New Jersey, ISBN-13:978-0-8138-0777-5, Pages: 334.
- Ponomareva, E.I., S.I. Lukina and N.N. Alekhina, 2015. Buckwheat bran is a promising raw material for the production of food. J. Khlebo Prod., 6: 42-43.