Trends in Life Sciences
An International Peer-reviewed Journal
www.sciencejournal.in

USE OF GERMINAL PRODUCT FROM PEA GRAIN IN BAKING BREAD

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ABSTRACT
Germinal product obtained from pea grain is a highly valuable raw material. Effect of addition of germinal product from pea grain to premium wheat flour on the protein content and gluten quality and quantity is studied. Optimal dosage of germinal product in bread from premium wheat flour is stated. It is shown, that addition of germinal product from pea grain improves organoleptic, physical and chemical quality parameters, food and biological value of bread.

KEYWORDS: flour; protein; gluten; dough; amino acid; biological value.

INTRODUCTION

Premium wheat flour is made from fine-grained particles of the central part of endosperm of wheat caryopsis. It does not practically contain any bran. Its ash content makes no more than 0,55 %; gluten content is not less than 28,0 %; cellulose content is 0,10 %. Besides, premium wheat flour has higher starch content and insignificant amount of protein and vitamins (Tutelyan et al., 2002). Essential amino acids (lysine and methionine) content is the lowest among other grades of wheat flour (Auerman, 2005).

Because of this the basic drawbacks of bakery products from premium wheat flour are low biological value and high caloric content which indicate the necessity of correction of chemical composition of such products (Koryachkina, 2013). There is a search of raw materials now which can enrich wheat flour with essential micronutrients. Thus, for example, for enrichment of bread with amino acid lysine it is offered to use 5-20 % of vigna flour (Hallén et al., 2004). The use of unconventional grain crops (common wheat with yellow-coloured grain, emmer wheat, barley with hulless grain) improves component structure of bread for account of increase of vitamins B content, food fibers and antioxidants (Hofmanová et al., 2014). The technology of addition of pea flour to yeasted dough allowed increasing albumens content for 13-15 % without reducing its quality and not extending the terms of doughing (Gatko, 2003). The use of 5-10 % of rice groats preliminary boiled to semireadiness in baking bread from premium wheat flour allowed increasing monosaccharides and disaccharides by 22 %, cellulose by 20,4 %, magnesium by 18,5 %, phosphorus by 6,4 %, sodium by 1,0 %, vitamin PP by 2,0 % in finished product (Zakharova et al., 2008). 5 % of crushed pea seed coats are a source of dietary cellulose in white bread (Kasprzak et al., 2010).

Such by-products of grain processing as the germs are valuable suppliers of biologically active substances representing the most important part of grain from physiological point of view. Germs surpass almost all known vegetable products in protein content. Germ protein has higher biological value. Thus, for example, germ protein of wheat has higher lysine content than dry whole milk, Dutch cheese, beef and other products of animal origin which are sources of lysine in man's nutrition. (Babenko, 2001) The lipids quantity extracted from germs fluctuates from 8,0 to 27,6 % (Vasilinets, 2001). Carbohydrate complex of germs is represented basically by sugars, with the prevalence of sucrose and raffinose (Babenko, 2001). Study of chemical composition of rice germs showed that there are 32,2 % of starch, 3,7 % of cellulose, 18,16 % of fiber, 18,9 % of lipids in them (Krasin, 2008). Corn germs extracted as a by-product while processing corn grain contain lipids (34,8 %), protein (19,3 %), starch (2,7 %), cellulose (5 %), pentosans (3,7 %), water-soluble carbohydrates (8,2%), ashes (7,7 %), and, besides, vitamins E, B_1, B_4, B_6, B_9, PP, H and β-carotin (Shazzo, 2011). Germinal products from pea grain has higher protein content (46,88-51,00 %). Lipids content is on average 5,94%; fat-soluble vitamins A and E content is 1,95 and 7,85 mg/100 г respectively; carotinoids – 6,08 mg/100г (Shelepina, 2013). Proteins are valuable sources of essential amino acids threonine, leucine, tyrosine, phenylalanine and lysine. In lipid complex unsaturated fat acids prevail. In this connection the use of germs can contribute to increase of biological value and assortment of bakery products, the basic component of which is premium wheat flour.

MATERIALS AND METHODS

Germinal product (GP) was obtained from pea grains of variety Temp (smooth seeds) which were selected by State Scientific Centre of Selection of The All-Russia Research Institute of Legumes and Groat Crops (GNU VNIIZBK) (Oryol, Russia). Grain was soaked in distilled water at temperature + 2-4ºC for 24 hours. Then seed coats were removed with scalpel and the swollen pedicle with a bud and a rootlet was separated from cotyledon. The germs were dried at + 18-20ºC and milled with a laboratory mill LZM-1M into fine flour and bolted through sieve № 43.

Protein content in wheat flour and wheat flour with 0,5-3,0% GP was defined according to GOST 10846-91 (State Standard Specification); crude gluten content according to GOST 27839-88; colour and elasticity of crude gluten was defined organoleptically, extensibility was defined with a ruler having millimetre points. The dough for bread was straight. Kneading was carried out in dough-makers. Calculated quantity of water at temperature no more than 45°C, bakery compressed yeast, table salt, 20 % of sifted premium wheat flour of the total mass of wheat flour and sifted GP were put in a vat. The received suspension was intensively mixed 5 minutes. Then the rest part of premium wheat flour was added. The dough was intensively mixed to make it homogeneous. The dough temperature after kneading should be (31±1) °C. The dough was put into the chamber for 170 minutes for fermentation. In the course of fermentation the dough was pressed down twice in 60 minutes and in 120 minutes from the beginning of the process of fermentation. Mature dough was weighed and divided into equal in weight pieces. Each piece of dough was pressed down some times to remove carbonic acid. The pieces were shaped oblong form or ball form and placed into the baking cases greased with vegetable oil or on a baking sheet. Cases or sheet with dough pieces were put into thermostat for 45 … 50 minutes to proof it. After that dough intermediates were put into the oven with moistening of the baking chamber at temperature 220 … 230°C. The baking process of pan bread was 28 minutes; hearth bread – 26 minutes. After baking the top crust of bread was moistened with water and the bread was cooled. There were trial laboratory bakings to estimate influence of GP on the quality of premium wheat flour bread. During researches four samples of bread with GP content of 0,5; 1,0; 1,5 and 2,0 % accordingly instead of a part of premium wheat flour has been received.

Organoleptic estimation of baked bread was made according to the following indicators: appearance, crumb, taste, crunch, lump-forming capacity at chewing, crumbleness. Porosity of bread was defined according to the ratio of void content of crumb to the total volume of bread crumb expressed in per cent (GOST 5669-96); acidity – in accordance with GOST 5670-96; volume – in accordance with GOST 27669-88; stability of shape according to the relation of height to diameter of hearth bread (Puchkova, 2004). Protein in bread was defined according to GOST 10846-91; lipids in accordance with GOST 5668-68; ashes in accordance with GOST P 51411-99; crude cellulose in accordance with GOST P 52839-2007; starch in accordance with GOST 10845-98; sugar was defined with permanganate method (Ermakov et al., 1987); mineral elements (calcium, sodium, magnesium) were defined with atomic-absorbtive method; phosphorus in accordance with GOST 26657-97; vitamin B_1 in accordance with GOST 29138-91. Defining of amino-acid protein composition was made with amino-acid analyzer Aracus (Lisitsyn et al., 2002). Tryptophan content was defined with spectrophotometer Varian by Graham chemical method. Biological value of bread protein was calculated according to amino-acid scores with use of FAO/ WHO scale. Statistical data processing was done using statistical package Microsoft Excel 2010, defining standard error of the mean and average square deviation at significance level of 95 %.

RESULTS AND DISCUSSION

The study of influence of GP addition to wheat flour on its quality was carried out to define the expediency of use of GP from pea grain as an enriching additive in manufacture of bakery products and to choose an optimal dosage. It was established, that adding GP to wheat flour increased protein content in it. Thus, if wheat flour without the additive had 12,86 % of protein, at addition of 0,5-3,0 % GP it increased, accordingly, by 0,39-8,70 %. Besides, adding GP from pea grain to wheat flour increased crude gluten content. At dosage of GP from 0,5 to 2,0 % crude gluten content increased by 0,80-2,84 %. The greatest yield of crude gluten was noted in the sample of flour with 2,0 % dosage of GP. Further increase of additive share in wheat flour gradually decreased crude gluten content. It was ascertained that addition of GP from pea grain to wheat flour did not essentially influence the colour gluten (Table 1). Extensibility of gluten at various additive dosages was good. Adding 2,0 % of GP wheat gluten demonstrated the best elasticity. Gluten extensibility was up to the control sample. At addition of 1,0 and 1,5 % of germinal product extensibility decreased by 0,3 and 0,5 sm, accordingly, in comparison with wheat flour. Further increase of additive quantity (2,0-3,0 %) slightly increased gluten extensibility in wheat flour. Extensibility decrease of gluten and increase of its elasticity at GP addition indicate its

strengthening. Probably, it is connected with enzyme lipoxygenase in GP which improves oxidation of unsaturated fat acids in the presence of atmospheric oxygen with formation hydroperoxide compounds which inhibit proteolytic enzymes of flour and strengthen intramolecular protein structure.

Considering the findings, 0,5-2,0 % GP was added to dough composition instead of a part of premium wheat flour in bread manufacturing. Tasting estimation of baked bread showed, that bread with GP, unlike the control sample, had smooth crust surface of golden shade when 1,0-2,0 % of GP was added. In the presence of 1,5-2,0 % of the additive the colour of bread crumb became purely white. When 1,0-2,0 % of GP were added there was an insignificant, pleasant leguminous taste. The bread crumb at all investigated additive dosages was elastic and finely porous, as in the control sample. Crunch and lump-forming capacity during chewing were absent. With 0,5 % of GP the bread crumb was slightly crumbly. With GP dosage from 1,0 to 2,0 % crumbleness was absent.

Addition of 1,0-2,0 % of GP to the dough composition increased acidity of bread by 0,3-0,6 degrees in comparison with the control sample (Table 2). The best porosity of both pan, and hearth bread was noticed at addition of 1,0 % of GP. It was by 1,1 and 1,6 %, accordingly, more than the control sample that indicates increase of aerogen ability of dough when such quantity of GP is added. Porosity of pan bread was up to the control at the dosage of germinal product of 1,5 %. At dosage of 0,5 % of GP porosity of pan bread decreased by 2,8 %, and porosity of hearth bread was by 1,2 % more than the control sample. Porosity decreased to 68,1 (pan bread) and 68,4 % (hearth bread) in bread with 2,0 % of GP, that mismatches the requirements of GOST 27842-88 concerning bread from premium wheat flour. The greatest specific volume of bread was noted at adding of 1,0 % of GP, the least – at adding of 2,0 % of GP. GP decreased stability of bread shape. However, hearth bread with 1,0 % of GP instead of wheat flour had the best shape stability (0,86).

Thus, the research showed, that bread with of 1,0 % of GP from pea grain instead of premium wheat flour has the best quality indicators. This sample of bread has regular shape, smooth convex surface of crust, without damage, light-golden colour, white crumb, with good elasticity and fine, thin-walled and even porosity, pleasant aroma, taste typical of bread, with insignificant leguminous pleasant taste, not unleavened. The sample of bread with 1,0 % of GP exceeds the control sample on porosity, stability of shape and specific volume. Protein content in bread with 1,0 % of GP increased by 1,0 % in comparison with the control sample, lipids – by 4,9 %, monosaccharides and disaccharides – by 14,0 %, cellulose – by 30,0 %, ashes – by 2,4 % (Table 3). The developed product had increased content of sodium, calcium, phosphorus and magnesium. Vitamin B_1 content in bread with GP is by 5,0 % more than in bread with traditional components.

The content of such essential amino acids as threonine increased by 87,6 %, isoleucine – by 51,6 %, lysine – by 30,7 % (Table 4) in bread with replacement of wheat flour by 1,0 % of GP. Methionine content essentially decreased (by 58,4%) and the content of valine, leucine and tryptophan decreased slightly. Bread with the additive exceeded the control sample in the quantity of aspartic, histidine, arginine and proline, and in the sum of essential amino acids and in the total content of amino acids.

Calculation of biological value of protein of bread with GP showed, that amino-acid scores of threonine, lysine and isoleucine exceed the scores of these amino acids in the protein of the control sample by 68,0; 20,0 and 30,8 % accordingly (Table 5). The scores of valine, leucine and triptophan are a little lower in the protein of bread with the additive. Amino acid methionine limits biological value of protein of both bread made of traditional components, and bread with GP.

Addition of 0,5-3,0 % of GP from pea grain to wheat flour composition increases protein content by 0,39-8,70 % in it. Dosage 0,5-2,0 % of GP increases crude gluten by 0,80-2,84 %. Bread with addition of 1,0 % GP to dough composition instead of wheat flour has the best consumer properties, exceeding the control sample in porosity, specific volume and stability of shape. Use of GP in bread manufacture increases protein content by 1,0 %, lipids – by 4,9 %, monosaccharides and disaccharides – by 14,0 %, cellulose – by 30,0 %, ashes – by 2,4 %, vitamin B_1 – by 5,0 %, essential amino acids: threonine – by 87,6 %, isoleucine – by 51,6 %, lysine – by 30,7 % in final product.

Table 1. Raw gluten quality of flour

Flour samples	Indicators of raw gluten quality		
	colour	elasticity	extensibility, sm
Wheat flour (Control)	light	good	14,5±0,10
Wheat flour with GP, % instead of flour			
0,5	light	good	14,5±0,15
1,0	light	good	14,2±0,25
1,5	light	good	14,0±0,18
2,0	light	very good	14,5±0,23
2,5	light	good	14,8±0,15
3,0	light	good	15,0±0,24

Table 2. Physicochemical quality parameters of bread with GP

Indicators	Wheat flour bread (Control)	Wheat flour bread with addition of GP, %			
		0,5	1,0	1,5	2,0
Acidity, degree.	1,8±0,0	1,8±0,1	2,1±0,0	2,2±0,1	2,4±0,1
Porosity, %:					
pan bread	73,1±0,2	70,3±0,1	74,2±0,2	73,0±0,2	68,1±0,1
hearth bread	73,2±0,1	74,4±0,2	74,8±0,2	71,1±0,1	68,4±0,1
Specific volume, sm^3/kg:					
pan bread	3,1±0,1	2,9±0,1	3,2±0,1	3,0±0,2	2,9±0,1
hearth bread	3,2±0,1	3,2±0,2	3,4±0,1	3,3±0,2	3,0±0,1
Stability of shape (H/D)	0,93±0,01	0,76±0,02	0,86±0,02	0,78±0,01	0,74±0,02

Table 3. Chemical composition of bread with GP

Indicators	Wheat flour bread (Control)	Wheat flour bread with addition of 1,0 % of GP
Content, g/100 g DM: Protein	13,95±0,00	14,09±0,00
Lipids	0,82±0,01	0,86±0,00
Monosaccharides and disaccharides	0,64±0,01	0,73±0,02
Starch	48,20±0,2	47,60±0,2
Cellulose	0,10±0,01	0,13±0,01
Ashes	1,67±0,02	1,71±0,01
Content, mg/100 g DM: Sodium	310,0±0,1	370,0±0,2
Calcium	60,0±0,1	70,0±0,1
Phosphorus	240,0±0,2	250,0±0,3
Magnesium	15,0±0,1	16,5±0,1
Vitamin B_1	0,100±0,01	0,103±0,02

Table 4. Protein amino acid composition of bread with GP

Indicators	Wheat flour bread (Control)	Wheat flour bread with addition of 1,0 % of GP	+, – % of Control
Amino Acid Content, mg/100 g of product: Aspartic	620,244	832,877	+ 34,3
Threonine	442,472	830,287	+ 87,6
Glutamic + Serine	5374,889	4951,757	– 7,9
Glycine	680,230	538,355	– 20,9
Alanine	422,500	361,314	– 14,5
Valine+Cystine	421,383	384,849	– 8,7
Methionine	160,147	66,577	– 58,4
Isoleucine	341,435	517,749	+ 51,6
Leucine	1142,328	1093,481	– 4,3
Tyrosine	468,108	431,466	– 7,8
Phenylalanine	658,526	622,145	– 5,5
Histidine	488,577	507,490	+ 3,9
Lysine	517,312	676,031	+ 30,7
Arginine	516,805	550,403	+ 6,5
Proline	1598,473	1624,488	+ 1,6
Tryptophan	98,0	96,2	– 1,8
Total of essential amino acids	3781,603	4287,319	+ 13,4
Total of amino acids	13951,429	14085,469	+ 1,0

Table 5. Biological value of bread protein with GP

Product	Chemical score of amino acid, %							
	threonine	valine	methionine	isoleucine	leucine	phenylalanine + tyrosine	lysine	tryptophan
Wheat flour bread (Control)	79,25	60,40	52,27	61,25	117,00	134,67	67,27	70,00
Wheat flour bread with addition of 1,0 % of GP	147,25	54,60	21,36	92,00	110,86	124,67	87,27	68,00

ACKNOWLEDGEMENTS

The results are obtained in the framework of the state order of the Ministry of Education and Science of the Russian Federation.

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