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BREAD PRODUCTS HIGH IN BIOLOGICALLY COMPLETE PROTEIN

Sharan A.V.
c.t.s., as.prof.
Makhynko V.M.
d.t.s., as.prof.
ORCID: 0000-0003-2039-5137
Sharan L.O.
c.t.s., as.prof.
National University of Food Technologies, Ukraine, Kyiv, Volodymyrska str. 68, 01601

Abstract. *Bread products are traditional daily foods. However, their chemical composition is rather imbalanced. First of all, it's because of deficiency of protein which is one of the most important components of nutrition. The problem is particularly acute for people with increased need in protein consumption (people of hard physical labor, athletes, tourists, etc.). The study proposes to use vegetable protein isolates to increase nutritional and biological value of various groups of bread products. Recipes of high-protein breads and bread sticks (balls), and an innovative product – crumb briquette – were developed based on technological research. Information on nutritional, biological and energy value of the developed products are given. The study shows that protein content in the final products increased by 1.5…2.5 times, and their biological value also rose due to greater quantity of lysine. It will allow to label such bread products as high-protein products. These products are also suitable for use in tourist nutrition and may be included in dry rations of servicemen.*

Key words: *bread, vegetable protein, nutritional value, biological value.*

Introduction.

Nutrition largely determines people's state of health and ability to work. Protein is one of the most important nutrients. Consumption of sufficient quantity of protein (subject to its high biological value) is one of the most important signs of a balanced diet. So, many countries developed protein consumption standards for people of various age, sex, and level of physical activity based on recommendations proposed by FAO/WHO. Developers of traditional foods mainly focus on young people of middle age and low level of physical loads. But for consumers with higher levels of physical activity, as well as strength athletes, tourists and servicemen, protein consumption norms are 1.5-2.5 times greater than average values [1]. That is why these consumer groups need customized high-protein products, in particular, and bakery products, as traditional everyday foods.

Main text.

Based on analysis of protein enrichers of bread products available on the market, it was proposed to use high-protein vegetable raw materials (HVRMs) in baking technology, namely, vegetable protein isolates which have high (approximately 90%) protein content and no anti-nutritional substances. They include dry wheat gluten and the following protein isolates: soy (SPI), rice (RPI) and pea (PPI).

Based on the technological research of how addition of selected types of raw materials influence the process and the quality of dough and bread making, it was proposed to use the following ratios between these recipe components and dry wheat gluten (DWG): SPI:DWG = 10:17, PPI:DWG = 10:11, RPI:DWG = 9:12 % instead

of flour portion. It was established that the two-stage method of preparing dough with addition of HVRMs at the dough kneading stage is efficient. The main indicators of nutritional and biological value of the developed types of bread compared to wheat control (without HVRMs) and protein control (with only 21% of DWG in the recipe) are given in table 1. The calculation was made according to the generally accepted methods [2].

Table 1

Nutritional and biological value of products (per 100 g)

Product	Content, g			Energy value/caloric value, kJ/kcal	Protein utilization, %	Quantity of digested protein, g
	proteins	fats	carbohydrates			
Control (wheat bread)	7.8	0.7	54.6	1018/243	44.5	3.5
Protein control	18.8	2.9	41.3	1077/257	34.0	6.4
SPI:DWG = 10:17	20.0	3.5	33.4	960/229	51.5	10.3
PPI:DWG = 10:11	16.8	3.0	38.9	1006/240	62.3	10.5
RPI:DWG = 9:12	17.8	2.63	38.1	997/238	38.0	6.8

Authoring

It was established that the total quantity of protein increased by 2…2.5 times and lysine content – by 21…60%, which caused increase of the quantity of digested protein in all the developed bread samples by 0.4…4.0 g, and growth of biological value of the proposed products by 8…14%. According to the international labeling requirements [3], all the developed types of bread may be called high-protein products, and consuming daily norm of them (about 200 g) can satisfy needs of consumers' bodies with high level of physical activity for vegetable proteins by 47…61%.

The use of DWG as a recipe component ensures better structural and mechanical properties of dough and better quality of finished products; however, it but has negative effect on their biological value. After all, DWG has less content of the limiting amino acid lysine than even wheat flour does. So, it is proposed to use HVRMs in the bread production technology where negative effect of their addition would not be so noticeable. Bread sticks and bread balls are best to meet these requirements. Their production technology provides for shorter fermentation process and adding more yeast and fat. The presence of flavors (caraway-seeds, vanillin, citrus essence) in these products' recipes will help to mask unusual taste and aroma due to the addition of legume isolates, and a lesser mass fraction of moisture (up to 10%) will ensure high concentration of protein in the finished product.

PPI and SPI are selected as protein enrichers because of their high biological value and affordable price. The following optimal HVRMs dosage was established based on the range of studies: PPI – 5%, SPI – 12% instead of flour portion. The products made under the proposed recipes have necessary consumer values, by 66.5% greater protein content (Table 2), and balanced protein-carbohydrate component (1:3.5).

Table 2

Comparison of chemical composition, biological and energy values of control sample and the developed products

Component	*Bread sticks "Aromatic" (control)*	*Bread sticks with PPI*	*Bread balls with SPI*
Proteins, g/100 g	10.8	13.9	18.0
Fats, g/100 g	4.4	4.3	3.9
Carbohydrates, g/100 g	76.9	71.5	62.9
Essential amino acids, mg:			
valine	526	653	877
histidine	227	293	508
isoleucine	547	661	885
leucine	826	1047	1388
lysine	305	536	849
methionine + cystine	340	395	468
threonine	340	447	682
tryptophan	124	145	221
phenylalanine + tyrosine	462	739	1096
Energy value/caloric value, kJ/kcal	1635/390.3	1594/380.4	1504/358.9

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Almost three-fold growth of lysine content caused increase of its amino acid rate to 98.3% (bringing thereby the product closer to the reference protein by lysine content), and 1.5-fold increase of amino acid utilization. The consumption of the proposed bread sticks and bread balls doubles (from 25 to 50%, abs.) satisfaction of body's physiological needs for vegetable protein which indicates high efficiency and prospects of using the developed low-moisture-content bread products with HVRMs as elements of nutrition in hiking and as a part of dry rations of servicemen.

The studies show that one of the factors that limit the quantity of the added HVRMs is the technology. So, requirements for "ideal" high-protein product were formulated. According to these criteria, a product that meets all the requirements was selected – it's crumb briquettes made by pressing dried bread crumbs with additional raw materials. The absence of fermentation stage allows to pick up the ratio of recipe components based on the researcher's target. And the absence of baking stage will ensure maximum preservation of the added protein substances and will not affect their biological value. The following dosages were found optimal for the crumb briquette recipe: SPI – 12%, the quantity of maltodextrin – 11.6% to crumbs mass [4]. Calculation of nutritional value of the developed briquettes showed increase (Table 3) of both the total quantity of protein in the finished products (by more than twice) and the content of the amino acid lysine, limiting for wheat flour products (by 3.5 times).

The developed crumb briquettes have by 35% (abs.) greater biological value, even compared to the high-protein breads developed by us, and also have necessary

organoleptic, physical and chemical properties that meet the main requirements for "pocket" nutrition of tourists and servicemen: low weight and volume, necessary strength, sufficient shelf life, high concentration of easily digestible carbohydrates and biologically complete protein due to the low mass fraction of moisture.

Table 3

Nutritional and biological value of the developed crumb briquettes

Element of chemical composition	Cream biscuits (control)	High-protein crumb briquettes	Deviation, %
Proteins, g/100 g	8,5	17,6	+107,2
Fats, g/100 g	10,83	1,2	-88,9
Carbohydrates, g/100 g	69,6	67,9	-2,4
Energy value/caloric value, kJ/kcal	1717/409,9	1478/352,8	-13,9
Amino acids, mg/100 g of product:			
valine	393	852	+116,8
isoleucine	359	860	+139,4
leucine	668	1355	+102,9
lysine	226	792	+250,3
methionine + cystine	302	516	+70,8
threonine	269	650	+141,8
tryptophan	85	214	+151,9
phenylalanine + tyrosine	628	1414	+125,2

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Summary and conclusions.

Considering the requirements for chemical composition of bread products and the increased protein needs of bodies of consumers with high levels of physical activity (people of hard physical labor, tourists, strength athletes, etc.), it was proposed to use vegetable protein isolates in baking technology. It was shown that adding up to 10% of these raw materials together with 11…17% of dry wheat gluten (as a technological additive) allows to increase protein content in bakery products by 2…2.5 times with simultaneous increase of its biological value by 8…14%. Adding vegetable protein isolates (5…12%) to decreased moisture content products (bread sticks and bread balls) increases the quantity of protein by 65% and improves the protein-carbohydrate balance of the chemical composition. The developed high-protein crumb briquettes contain more than twice as much protein as traditional crumb products, and their biological value is close to the reference protein. It indicates that the purpose of the work – creating bread products of higher nutritional

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