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USING OF WHITE FOOD LUPIN PRODUCTS IN TECHNOLOGY OF FUNCTIONAL BAKERY PRODUCTS

Annotation. *The expediency and the possibility of using protein plant raw material in technology of functional bakery products have been proven. The results of studying white food lupine products influence on nutritional and biological value of bakery products have been presented.*

Key words: *white food lupine, nutritional value, biological value, bakery products, functional food products.*

I. Introduction. Nutrition is of great importance in human life and belongs to the most important factors that determine national health, its potential and prospects. Analysis of nutritional status of nowadays has shown that human diet is rich in such macronutrients as fats and simple carbohydrates, by contrast to deficient / lacking micronutrients (e. g. food fibre, vitamins with antioxidant activity, mineral and biologically active substances, etc.). Society faces a controversial issue: on the one hand they have to eat less, on the other hand – more. Modern man who eats mostly spontaneously, actually overeats and is undernourished at the same time. Such "hidden hunger" syndrome causes the diseases of civilization.

Scientists have invented a number of possible ways to solve this problem. First, it is the use of food supplements (usually in the form of tablets, capsules, solutions), which are the components of natural products (vitamins, minerals, biologically active substances of plant, animal and microbial origin, extracts and individual components of food and approved medicinal plants), which allow to enrich the diet without increasing its calorie content.

Another effective direction to a healthier diet of modern man is creating of food with pre-regulated / adjustable, bespoke composition, that is 'enriched', or 'functional' food products. Such foods are known as fortified foods, or functional

foods. Functional group includes a wide range of food products, but their main overall purpose is to improve the individual functions of the body and the cardiovascular system, increasing resistance to the effects of adverse environmental factors, and normalization of microflora in the gastrointestinal tract. These functional products should be characterized by the following qualities: the necessary nutritional value, a nice taste and positive physiological effect on the human body. Healthy food products are not drugs and can not cure diseases, but as a part of daily diet, they are able to participate in the regulation of protective biological mechanisms of the body, helping to prevent and protect against disease, slow the aging process, increase endurance and improve emotional state in the modern tense environmental situation.

II. Statement of the problem. Bread and bakery products are the main food, which the average daily intake is about 300 g. It should be noted that in a great / wide variety of food stuffs bakery products are characterized by complete absence or minimal content of flavourings, colourings, preservatives and others, compared to other products. Safety for human and naturalness are the main factors that determine the choice of bakery products as the basis for creating functional products with pre-planned chemical composition and physiological properties.

Along with these advantages bakery products are imbalanced by major nutrients: high carbohydrate content and a small amount of protein with defective amino acid composition. The main limiting amino acids of wheat flour are lysine and threonine. In this connection a search and developing of possible ways to improve the biological, nutritional and consumer value of bakery products is important and timely.

Choosing of plant raw material to solve the problem of increasing of the bread biological value is justified in view of the global trend to increase the share of vegetable production to provide human with protein [3]. This trend is triggered due to the understanding of inefficient use of plant protein in feed production. Indeed, the coefficient of efficiency of vegetable protein use in livestock (transformation ratio in meat) is very low – 4 ... 6% (beef) to 12 ... 15% (pork), by contrast to average loss of 90% [4]. Thus, the raw materials choice of vegetable origin to enhance the biological

value of food coincides with the desire of mankind to use much larger resources of vegetable protein than animal directly in food, and to generate biologically valuable processed foods.

Legumes seeds such as peas, beans, soybeans, lupines, lentils, broad beans, chickpeas, mung beans, peanuts and so on have large protein content. Legumes grow profitably even in those areas where their yield is below average, because of soil and climate conditions. Taking into account this fact as well as great interest in soy and promising high-protein plant food such as white lupine which recently has been attracting more and more attention among engineers, developers and entrepreneurs Ukraine has enlarged the acreage of this crop.

III. Results. The researches to increase the biological and nutritional value of bakery products using the products of legume seeds, including soy and white lupin, have been conducted. Experimental data on the chemical composition of the flour of soybean cultivar “Uspix-2” and lupin cultivar “Dieta” and for comparison high grade white flour are presented in Table 1.

Table 1 – Chemical composition of wheat flour and legume flours

Nutrients	Wheat flour (high grade)	Soy	White lupin
Protein, % d.m.	11,9	34,4	36,6
Fat, % d.m.	1,3	23,3	11,9
Carbohydrates, % d.m., including	79,7	12,9	3,7
– starch			
– fibre	0,1	6,1	12,7
– pectin	0	0	11,0
– pentosans	0	7,3	13,0
Ash, % CP, including	0,5	5,7	4,2
Macroelements (mg/100 g):	3	6	20,1
Na	122	1607	1194
K			
Ca	18	348	147
Mg	16	226	174
P	86	603	465
Microelements (µg/100 g):	2410	15000	9850
Fe			
Co	–	31,2	11,5
Zn	1270	2010	3650

Vitamins	(mg/100	g):	0,17	0,94	0,87
B ₁					
B ₂			0,04	0,22	0,36
PP			1,20	2,20	2,20

d.m. – dry matter

Data analysis showed that legume seeds do not only contain almost three times as much complete protein than high grade wheat flour does, but can also successfully complete the composition of wheat protein by the limited amino acids [2].

Lupin seeds with a low starch content (3,7 % on a dry matter) contain a significant amount of the dietary fiber such as cellulose, pectin substances and pentosans. The research results of the pectin substance fractions out of the lupin products (whole grain lupine flour and lupin malt flour) are presented in the article [1]. The chelating ability of the bakery products with these lupin products towards heavy metal ions has been proven. It has been found that bread with lupine products could excrete 2,3-2,7 times as much lead from the body (for comparison, soy flour bread excretes only 1,5 times as much) than bread without supplements.

The high content of vitamins, macro- and microelements of lupin seeds which is ten times higher than their content of wheat flour can successfully complement and enrich the chemical composition of bakery products.

Experimental studies have given the opportunity to reasonably choosing of the optimal quantity of lupin products for bakery product fortification and to determine the optimal technological parameters and modes of production. The proposed methods allow obtaining products with the appropriate physical and chemical and organoleptic properties.

The protein content and comparative evaluation of amino acid composition in bakery products with lupin products have been determined with the aim of studying possibility of their using in development of functional bakery products.

Bread has been made by substitution of 10 % white flour with whole grain lupine flour and lupine malt flour. The determination of protein amino acid

composition of protein of the finished products have been conducted on an the automatic amino acid analyzer T-339 (“Mikrotechna”, Czech Republic).

The research results (Table 2) have shown that baked goods with lupin products have the protein content by 24.0...31.4 % higher compared with bread made out of first grade wheat flour. The analysis of essential amino acid profile has confirmed that bakery products with investigated products compared with control have higher scores of essential amino acids such as lysine (by 11,7..13,5 %) and threonine (by 29,2...30,6 %).

Table 2 – Amino acid content in bread

Amino acid	Amino acid content					
	Without supplements (control)		With 10 % of lupin seed flour		With 10 % of lupin malt flour	
	mg/100 g	mg/1 g of protein	mg /100 g	mg/1 g of protein	mg /100 g	mg/1 g of protein
Valine	383	41,1	422	36,5	420	34,3
Isoleucine	301	32,3	377	32,7	393	32,1
Leucine	702	75,4	760	65,8	798	65,2
Lysine	223	24,0	351	30,4	384	31,38
Methionine	71	7,6	65	5,6	64	5,2
Threonine	342	36,7	559	48,4	599	49,0
Phenylalanine	388	41,7	449	38,9	483	39,5
<i>Aminon acid score, %:</i>						
Lysine	43,6		55,3		57,1	
Threonine	91,8		121,0		122,4	
Methionine + Cysteine	68,1		55,7		57,8	
Valine	82,3		73,1		68,6	
Isoleucine	80,8		81,6		80,3	
Leucine	107,7		94,0		93,2	
Phenylalanine+ Tyrosine	125,3		120,5		120,7	
Limited amino acid, score, %	Lysine – 43,6		Lysine – 55,3		Lysine – 57,1	

The first limited amino acid for all samples is lysine but its score in bread with lupin products is by 11.7...13.5 % higher compared with control sample. Thus, lupin

product incorporation into wheat flour in the amount of 10 % of its weight improves the biological value of bakery products.

The nutritional value of bread has been evaluated by calculation of the chemical composition of products (the control sample and bread with addition of 10 % lupin products) and providing with daily needs of the main nutrients by consumption of 277 g of these products (18-29 year-old-women , first group — very low intensity work). Calculation results are presented in Table 3.

The content of major nutrients, vitamins, and mineral elements has been calculated with reference to data on the chemical composition of baking raw materials [5]. Also data on the chemical composition of lupine products that has been determined experimentally has been used.

Table 3 – Nutritional value and providing of daily nutritional requirements by consumption of 277 g of bread

Nutrients	Chemical composition of bread (g per 100 g of bread)			Providing of daily nutritional requirements by consumption of 277 g of bread, %		
	Without supplements	With 10 % of lupin seed flour	With 10 % of lupin malt flour	Without supplements	With 10 % of lupin seed flour	With 10 % of lupin malt flour
Protein, g	9,3	11,5	12,2	46,8	57,9	61,4
Fat, g	0,9	1,2	1,3	4,5	5,9	6,4
Carbohydrates, g	45,1	43,1	42,9	39,0	37,3	37,1
Fibre, g	0,1	0,7	0,6	1,2	7,6	6,8
Minerals, mg:						
Calcium	18,7	25,6	38,7	4,7	6,4	9,7
Magnesium	28,2	35,4	72,9	22,3	28,0	57,7
Phosphorus	78,0	97,5	105,1	18,0	22,5	24,3
Iron	1,4	1,8	2,9	22,8	29,3	47,2
Vitamins, mg:						
α-tocopherol	0,09	0,05	0,17	2,5	1,4	4,7
Energy, kcal	204,8	204,4	204,7	28,4	28,3	28,3

It has been established that replacing 10% of wheat flour with lupin products can increase bread protein content by 23,6...31,2% and fat content by 33,3% and 44,4%. In

addition, by carbohydrate content decreasing cellulose content has increased significantly in the investigated samples: 6 times as much in the sample with lupin flour, 5 times as much in the sample with lupin malt for comparison with bread without additions. Vitamin and mineral content has also increased. Thus, calcium content has been increased by 37...107.0 %, magnesium – by 25.5...158.5 %, phosphorus – by 25.0...34,7%, iron – by 28.6...107.1 %. The content of α -tocopherol in bread with lupin malt has exceeded this index for the control sample by 88.9 %.

Taking into account the obtained results we have concluded that bakery products with lupin have the same energy value as the control sample but are characterized by higher nutritional and biological value.

That is why they can be classified as functional foods. Bakery product freshness is one of the main quality indicators in evaluation of consumer properties. Bread quality is usually reduced during its storage that is with its complex physical, chemical, colloidal and biochemical processes such as changes in carbohydrates and proteins (staling) and moisture loss (drying).

The lupin product influence on the redistribution of moisture forms in baked bread and during its shelf life has been investigated by the method of differential thermal analysis (DTA). Results analysis (Table 4) has shown that the bound water content is higher in the studied samples than in the control sample.

Table 4 – Kinetic parameters of derivatogram of bread crumb

Sample	Shelf life, hours	Free water content, %	Bound water content, %
Control (without additive)	3	69,8	30,2
	24	71,9	28,1
With 10 % addition to flour weight			
Lupin flour	3	67,2	32,8
	24	68,8	31,2
Lupin malt flour	3	65,6	34,4
	24	67,2	32,8

Redistribution of moisture forms can be explained by the fact that bread with lupine products contains more proteins that contribute to the strengthening of the crumb structure, increase hydration ties, that in turn retards moisture loss during

storage of bread. In addition, non-starch polysaccharides, including soluble and insoluble pentosans, are also added with lupin products that can strongly bind water and dam starch retrogradation and, thus, prolong the product shelf life.

Results analysis shows that the bound water content in fresh bread with lupin products is higher by 8.6...13.9 % and after 24 h of storage by 11.0...16.7 % than in the control sample. During storage the bound water loss in the control sample has been 6.9 % while in the bread with lupine products 4.7...4.9 % respectively.

Thus, the studies give the possibility to state that using lupin products contribute to shelf life extension of wheat bread and have positive influence on consumer properties of goods.

IV. Conclusions. Functional food consumption is one of the conditions for providing and maintaining good health and wellness. The research has proven that using white lupine products and other legumes is relevant to use in the technology of functional bakery products as a source of complete protein, fibres, vitamins, and minerals.

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