

Substantiation of biotechnological approaches to creation of food systems "mixture for baking pancakes" of increased biological value

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Abstract. Numerous scientific studies have established the incompleteness of wheat flour proteins. In this regard, numerous attempts have been made to increase the biological value of proteins by creating appropriate flour composite mixtures using, as a rule, secondary raw materials obtained in the production of cereals and cereals products. Analysis of literary sources, as well as practice and author's research show that to increase the biological value of wheat and other types of flour, a soy flour component can be used by obtaining flour compositions on their basis. As a working hypothesis, it was assumed that an increase in the nutritional and biological value of mixtures for baking flour products in the form of semi-finished food concentrates is possible and expedient by using shell-cotyledon and germ-cotyledon flour obtained from secondary soybean raw materials obtained using units of the KPSM-850 type. Along with the increase in the biological value of such mixtures, their composition contains vitamin E in the range of 4-5 mg/100 g, as well as other essential micronutrients. The introduction of such additional components as meat and liver powder into the composition of semi-finished food concentrates of flour products made it possible to obtain products of this range with high nutritional and biological value.

1 Introduction

Due to the incompleteness of wheat flour proteins, scientists and practitioners continue to search for rational ways to increase the biological value of products based on it.

Studies [1] found that wheat flour proteins of the 1st grade are deficient in lysine - 38% and threonine - 68% of the FAO/WHO standard and excess in methionine and cystine - 114%.

One of the ways to solve this problem is the fortification of wheat flour, flour from legumes, the addition of egg white, milk proteins, etc. [12].

So, soy flour contains lysine - 116-149%, but at the same time its protein is deficient in methionine and cystine - 71%.

At the same time, the relevance and prospects of the use of soybean raw materials in the food industry are noted by many scientists, including Petibskaya V.S., Zaitseva E.S.,

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Babich A.A., Begeulov M.Sh. [3 - 6].

There are also known numerous studies aimed at increasing the food and biological activity of wheat flour, mixtures based on it, as well as bakery products [7 - 14].

Thus, studies aimed at increasing the nutritional and biological value of composite mixtures based on wheat flour are an urgent problem that needs to be addressed.

The purpose of the research is to substantiate biotechnological approaches to increase nutritional and biological value in the form of mixtures for baking pancakes.

Research objectives:

1) substantiate biotechnological approaches to the use of soy and meat components of the required physical form, acceptable for their use in food concentrates such as “Baking Mixture”;

2) give a comparative characteristic of the obtained food systems in the form of “Baking Mixture” in terms of biological value.

The results of studies to substantiate the possibility and feasibility of using the soy component in baking mixtures are shown in tables 1 - 3 [15].

2 Materials and Methods

The composition of chemical elements determines the nutritional value of grain crops, as well as products of its processing. Grains of beans, in particular soybeans and grains of cereals, although they belong to different genera, but have a significant amount of protein, which, in turn, directly affects the calorie content of food products obtained from them for both humans and animals.

Their number reaches up to sixty percent, which cannot be said about tuberous crops, which, in turn, contain quite a few valuable nutrients.

Table 1. Content of essential amino acids (A, g/100 g) and amino acid score (S,%) of flour proteins and flour binary compositions.

Flour and flour components	Name of amino acids (NAA)								
	Valine	Isoleucine	Leucine	Lysine	Methionine + cysteine	Threonine	Phenylalanine + tyrosine	Tryptophan	ΣNAA
FAO/WHO standard									
A/S	5.0/100	4.0/100	7.0/100	5.5/100	3.5/100	4.0/100	6.0/100	1.0/100	36/100
Soy									
A/S	5.9/118	5.1/127	7.4/106	5.7/104	2.9/83	3.9/98	7.5/125	1.2/120	39.6/110
Oatmeal									
A/S	4.7/95	3.9/97	7.0/100	4.2/76	3.7/106	3.5/87	9.1/152	1.7/170	37.8/105
Soy-oatmeal									
A/S	5.2/104	4.3/110	7.2/103	4.8/87	3.4/97	3.7/90	8.5/141	1.5/150	38.6/107

As a result of a large number of studies, it has been noticed that, in fact, their actual value is quite close to probable. Amino acids are found in all plant tissues and undoubtedly play a significant role in the metabolism. Almost all of them work as activators of enzymes and vitamins. The composition of amino acids affects the quality of human food and animal feed. A defect in amino acids, especially in irreplaceable ones, causes serious illness in humans and animals. Amino acids are considered the end product of protein breakdown in

the digestive tract. They work as the structural material for the formation of proteins in the human and animal body. Studies have shown that the inaccessibility or defect of essential amino acids in food leads to a violation of the metabolism (negative nitrogen balance), a stop of protein regeneration in the body, loss of appetite, pathological changes in the nervous system, organs of internal secretion, blood composition, enzyme systems, etc. A person's daily need for essential amino acids (according to F.M. Prutskov et al.) (in g): lysine - 3–5.2, valine - 3.8–4, leucine - 4–9, isoleucine - 3–4, methionine - 2–4, threonine - 2–3.5, tryptophan - 1–1.1, phenylalanine - 2–4.4. Eight amino acids - valine, isoleucine, leucine, lysine, methionine, threonine, tryptophan, and phenylalanine are indispensable and if at least one of their proteins is not available, protein synthesis is not feasible. Of these, more important amino acids are lysine, methionine and tryptophan. For example, they limit the introduction of other amino acids for the synthesis of a protein molecule.

Table 2. Content of essential amino acids (A, g / 100 g) and amino acid score (S,%) of flour proteins and flour binary compositions.

Flour and flour components	Name of amino acids (NAA)								
	Valine	Isoleucine	Leucine	Lysine	Methionine + cysteine	Threonine	Phenylalanine + tyrosine	Tryptophan	ΣNAA
Rice									
A/S	6.0/120	3.3/82	6.2/88	2.6/47	4.24/121	2.4/60	6.6/110	1.0/100	29.2/81.1
Soybean-rice									
A/S	5.96/112	4.02/100	6.68/96	3.84/55	3.7/104.5	3.0/75	7.0/116	1.0/106	35.54/98.7
Corn									
A/S	4.2/83	3.1/78	12.8/183	2.5/45	2.9/83	2.5/61	8.4/140	0.7/67	37.1/102.7
Soybean-corn									
A/S	4.9/97	3.9/98	10.7/152	3.8/68	3.4/96	3.0/76	8.0/134	0.9/88	38.6/105

Analysis of the data presented in tables 1 - 3 shows that composite mixtures have a higher biological value.

Despite the not so high content of methionine+cysteine in soy flour, lysine and threonine in oat and soybean flour, lysine and threonine in soy rice flour, lysine, threonine and tryptophan in soybean corn flour, lysine and threonine in soybean wheat and rye flour, one should not underestimate their nutritional value.

At the same time, beef of the 1st category also has an excess content of lysine, as well as the methionine+cysteine complex. Amino acid score: 151% for lysine and 108% for methionine+cysteine, respectively [2].

Thus, the creation of food products based on these components in the form of dry mixtures will allow realizing the effect of mutual enrichment of plant proteins that are

complementary to each other in the content of limiting amino acids.

At the next stage of research, biotechnological approaches were implemented to obtain innovative products - shell-cotyledon and germ-cotyledon soy flour from secondary soybean raw materials, prepared using the KPSM-850 equipment set [15, 16].

Table 3. Content of essential amino acids (A, g / 100 g) and amino acid score (S,%) of flour proteins and flour binary compositions.

Flour and flour components	Name of amino acids (NAA)								
	Valine	Isoleucine	Leucine	Lysine	Methionine + cysteine	Threonine	Phenylalanine + tyrosine	Tryptophan	ΣNAA
Buckwheat flour									
A/S	5.2/107	4.3/107	7.0/100	5.1/93	6.0/171	4.0/100	9.0/150	1.2/120	41.8/116.1
Soy buckwheat flour									
A/S	5.5/111	4.4/111	7.1/102	5.3/97	4.7/136	3.9/99	8.4/140	1.2/120	42.3/117.6
Wheat flour									
A/S	5.5/110	5.3/132	8.1/116	2.6/48	4.0/114	3.18/80	8.8/146	1.2/120	38.7/107.6
Soybean wheat flour									
A/S	5.6/113	5.22/130	7.8/112	3.8/70	3.56/102	3.47/86	8.30/136	1.2/120	39.2/109.1
Rye flour									
A/S	4.5/91.4	3.6/90	6.2/88.5	3.7/67.2	3.8/108.5	3.2/80	7.2/120	1.2/120	33.5/92.9
Soybean rye flour									
A/S	5.1/102	4.2/105	6.7/95.4	4.8/88.2	3.4/98.2	3.5/93	7.3/122	1.2/120	36.2/100.7

The expediency of using soy casing in the form of a biological additive in flour systems was proved by the author of works [17, 18].

At the same time, the beef component in the form of meat and liver powder was obtained by preliminary blanching of raw materials, preparation of minced meat in grinder and its subsequent drying in the ESPIS-4-Universal unit with additional disintegration of the dried minced meat by blending.

On the basis of the obtained components, basic wheat-soy-meat compositions were formed by mixing in accordance with two options:

- with shell-cotyledon soy flour - 25% protein content;
- with germ-cotyledon soy flour - 48.25% protein content.

3 Results

The recipe of the formed mixtures for baking pancakes is presented in table 4, and their comparative characteristics in terms of biological value are presented in table 5.

Using "Home-style pancake mixture" in food preparation will significantly reduce the amount of traditional raw materials, but at the same time enrich the food with valuable food substances. This is becoming more relevant due to the increase in the acreage of soybeans in our country from year to year. In this regard, there is no shortage of soybean raw materials despite its large shipments outside Russia. The proposed additive is even more preferable due to the use of waste fractions of raw materials.

Table 4. The recipe for the mixture for baking pancakes.

Content by option	Pancake mixture ingredients											
	Wheat baking flour	Soybean shell-cotyledon flour	Soybean germ-cotyledon flour	Egg powder	Powdered milk	Meat powder (beef)	Liver powder	Ginger	Turmeric	Salt	Baking soda	Citric acid
Mixture for baking pancakes No. 1	38.78	25.0	-	1.15	3.0	30	-	0.01	0.01	1.5	0.3	0.2
Mixture for baking pancakes No. 2	32.38	-	30.43	1.6	3.6	-	30	0.01	0.01	1.5	0.3	0.2

Table 5. Comparative characteristics of proteins of mixtures for baking pancakes by the content of essential amino acids (A, g / 100 g) and amino acid score (S,%).

	Name of amino acids (NAA)								
	Valine	Isoleucine	Leucine	Lysine	Methionine + cysteine	Threonine	Phenylalanine + tyrosine	Tryptophan	ΣNAA
By FAO / WHO scale									
A/S	5.0/100	4.0/100	7.0/100	5.5/100	3.5/100	4.0/100	6.0/100	1.0/100	36.0/100
By recipe No. 1									
A	13.9	6.3	8.2	5.9	3.92	3.89	9.0	1.1	52.6
S	213.6	157.5	117.1	107.3	112	97.2	156.6	110	146.1
By recipe No. 2									
A	12.6	7.8	9.9	8.9	4.62	4.83	9.8	1.25	59.7
S	210	195	141.1	161.8	132	120.7	163.3	125	165.8

4 Discussion

Analysis of the data given in table 5 shows that the proposed products differ significantly from traditional raw materials in terms of the content of essential amino acids, and “Home-style pancake mixture” (TU-91-95-002-0094332-2004) can be used to prepare products with high biological values.

Particularly noteworthy is the fact that the amount of essential amino acids and the amino acid score content in both recipes increased significantly. This is especially pronounced for an essential amino acid like valine.

In addition, the use of shell-cotyledon and germ-cotyledon compositions in mixtures for baking pancakes according to the developed recipe makes it possible to enrich finished products with vitamin E and other micronutrients contained in soybean fat.

On the basis of the research carried out and the data obtained, technical documentation was developed in the form of an industry standard of the Far Eastern State Agrarian University for innovative products. The method for obtaining these products is protected by a patent for an invention, and therefore has significant novelty [19].

It is also proposed to use modified soybean flour in functional food systems.

It was obtained on the basis of a soy-ginger suspension, the production of which was carried out by preliminary soaking of soy seeds and fresh ginger particles at a ratio of 1:1 in a mineralized aqua environment.

A soy-citrus suspension was prepared in a similar way using crushed citrus peel.

The result of the research was the study of the processes of soy protein extraction and its precipitation in suspensions - soy-ginger and soy-citrus protein-carbohydrate dispersed system.

As a result of numerous studies, the following was revealed that more indicative in terms of obtaining and isolating protein components and other physiologically active substances from soybean seeds is their extraction process from pre-germinated soybean seeds to a specific seedling length. An additional positive effect on the process is caused by the use of mineralized water and the germination process itself, leading to a significant increase in the content of vitamin C in the product.

The introduction of a berry-acid ensemble as a coagulant, which is a natural precipitant, also allows further use of whey for the production of fortified drinks and obtaining a colored protein-carbohydrate coagulum, which has important concentrations of physiologically functional food ingredients in the form of vitamins and flavonoids.

In this regard, when studying the process of protein coagulation, it was found that many of the arising protein particles depend on the intense acidity of the aqueous fraction, the concentration of dry substances in the solution of the berry-acid ensemble, and also the temperature of the dispersed medium - a soy protein-vitamin suspension.

Three factors were identified as the main ones in the process of mathematical processing for obtaining flour: the mass fraction of the additive (ginger and citrus peel) – $M_F, \%$ (X_1); diameter of granules - d_G, mm (X_2); drying temperature - $t, ^\circ\text{C}$ (X_3).

The organoleptic assessment is also a criterion for optimization.

As a result of exploratory experiments, the main levels of variation of the indicated factors were determined.

Table 6 shows the process factors and levels of their variation.

Table 6. Factors and levels of variation for the flour production process.

Variation factors			Variation levels
$X_1 / M_F, \%$	$X_2 / d_G, \text{mm}$	$X_3 / t, ^\circ\text{C}$	
50.0	2.0	80.0	Main (m)
25.0	1.0	20.0	Variation interval (E)

Repeatedly conducted tastings helped to find out that the obtained characteristics of modified soybean flour have optimal external data and pleasant color. Good taste and aroma properties were confirmed by tasting.

As a result of detailed research, the best recipe was achieved, as well as characteristics and modes of the process for obtaining modified soy-ginger and soy-citrus flour, and a manufacturing technology was proposed.

The proposed additive in the form of soy-protein-carbohydrate flour must fully meet the claims of both consumers and manufacturers and be developed according to technical documentation, which is approved in a certain manner with the strictest observance of

generally accepted sanitary norms and rules provided in this regard for all companies in the food industry.

Table 7 shows data on the chemical composition and energy value of modified soybean flour.

Table 7. Biochemical composition and energy value of the additive in the form of modified soybean flour.

Product	Mass fraction of basic substances, %						Vitamins, mg/100 g			Energy value, kcal/100g
	water	proteins	fats	carbohydrates	fiber	mineral substances	C	E	Bioflavonoids in terms of rutin	
Protein-vitamin-carbohydrate flour	9	20	9	41	9.5	8	100.00	5.8	24.3	371.2

The presented additive in the form of soy-protein-carbohydrate flour must meet the requirements of consumers in terms of physical and chemical parameters. The indicators are as follows:

- moisture content of the modified flour is no more than 10%, which guarantees long-term storage of the product;
- protein content is significant, specifically, not less than 19%;
- fat content - no more than 5%;
- additive contains a significant amount of carbohydrates - 56.4%;
- minerals in it - no more than 4.2%.

The energy value of the additive is calculated, which is 371 kcal/100 g. The passage through sieve No. 43 is determined, which was at least 70%.

5 Conclusion

The possibility and expediency of increasing the biological value of food systems based on wheat flour in the form of a mixture for baking pancakes by using shell-cotyledon and germ-cotyledon flour from secondary soybean raw materials, as well as beef meat and liver powder concentrates, has been proved.

It was found that the proposed food concentrate of flour products "Mixture for baking pancakes" has an increased biological value in comparison with traditional counterparts and contains vitamin E in an amount of 4-5 mg/100 g.

These scientifically grounded biotechnological approaches in the form of formalized industry standards of the Far Eastern State Agrarian University can be recommended to manufacturers of semi-finished food concentrates of flour products "Mixture for baking pancakes "Armeyskiye".

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