

# Prospects for the use of soyan cake in the production of rye and wheat bread

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**Abstract.** In this paper, an analysis was made of the use and consumption of soybean meal. Studied organoleptic, physico-chemical, functional and technological indicators of soybean cake. The safety of the use of cake in the production of bakery products has been established. Due to its economic value, reduced price, and high content of nutrients such as protein, fiber, carbohydrates and antioxidants, the use of soybean meal in the production of rye-wheat bread has been explored by partially replacing wheat flour.

## 1 Introduction

Oilseeds are rich in phytochemicals (phenolic compounds, carotenoids, polyphenols, flavonoids, lignans, phytosterols, tocopherols and tocotrienols), proteins, fats, ash, fiber, carbohydrates, vitamins (A, K, E, C, B1, B2, B3, B6) and minerals (P, Cu, Ca, K, Mg, Mn, Fe, Zn, Se). Vitamins are important for the functioning of the skin, nerves and digestive system, maintaining cells and playing an antioxidant role, minerals are involved in metabolic and enzymatic processes, and phytochemicals have antioxidant activity, reduce tumors, inflammation in the body and improve immunity. As a result, oilseeds play an important role in human nutrition [1, 2].

Soybean is an ancient culture, whose homeland is China, where it began to be grown more than 5 thousand years ago BC, from where it spread to the countries of South and Southeast Asia. Soybean was brought to Europe in the 18th century, it has been cultivated in the USA since the 19th century and has become the leading crop of this country [3, 4]. In recent years, 80-90% of the world's gross soybean production is used for feed purposes, 8-10% for food and 2-5% for technical needs (for oil production). Cakes and meal left after oil extraction are an unsurpassed feed additive that compensates for the lack of protein in feed mixtures for many species of animals, birds and fish. However, a number of specialists from leading producing countries believe that it is more expedient to use soybeans not for feed, but for food purposes. The economic importance of soybeans as a food crop is explained by the unique chemical composition of its seeds. Depending on varietal characteristics and growing conditions, they can contain 27-50% protein, 15-28% oil, 14.0-33.2% carbohydrates, a small amount of fiber and 3.6-6.4% ash. The content of mineral salts ranges from 3.2 to 4.2%, calcium - from 320

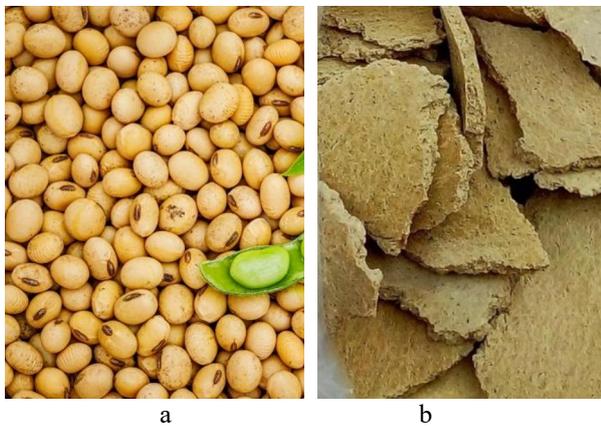
to 350 mg, iron - from 9.2 to 14.9 mg and phosphorus - from 580 to 630 mg per 100 g of dry matter. Iron, which is part of soy, is much better absorbed by the body, unlike other products. Soybean seeds are rich in vitamins: they contain large amounts of vitamins P, C, PP, E, and in some quantities - A, B1, B2, B3, B6, K [5, 6]. The main components of soybeans for which it is grown are protein and oil. Soy contains more protein than beef. The advantages of soy protein over animals are mainly that it, being complete (contains a complete set of amino acids necessary for the human body, including eight essential ones - isoleucine, leucine, lysine, methionine, phenylalanine, tryptophan, threonine and valine), is cheaper than an animal, consists mainly of (88-90%) water-soluble proteins, which are much better absorbed, with no risk of uric acid formation, which causes gout [7-10].

The yield of meal per unit of raw material in soybeans is 75-80% and is the highest among oilseeds. The protein in soybean meal is much cheaper than the protein in sunflower, alfalfa, peas and other legumes. Dietary protein is made from wholemeal powders, granules and textured proteins that are used as additives to natural meats or seafood. Soy protein and flour are widely used in the manufacture of infant and dietary nutritional formulas. Soy isolates and concentrates containing 70-90% protein have found application in the production of flour products, milk substitutes, whipped cream, cheese spreads, ice cream, etc. The introduction of 2-5% isolate into the recipe of a meat product (sausage) improves the commercial quality of products and increases its yield by binding fat, water and juice. Soy isolates with high foaming ability are used in the production of confectionery products [11, 12]. Mature soybean grains are used to prepare a variety of products - cereals, various sauces, canned food, soybean sprouts, from which salads,

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soups, main dishes are prepared. The use of soybean cake in the production of bread protects the bread from premature drying, increases the protein content in it by 7-12% and improves the nutritional and taste qualities of the product [13,14].

Soybean meal is obtained by mechanical extraction of soybeans (Fig. 1).



**Fig. 1.** Soy (a) and soybean cake (b).

Soybean meal world leaders: China - 68.5 million tons, USA - 41.1 million tons, Argentina - 34.7 million tons Export leaders: Argentina - 32.4 million tons, Brazil - 15.2 million tons, USA - 10.5 million tons. Main importers: EU - 20.2 million tons, Vietnam - 5.2 million tons, Indonesia - 4.6 million tons.

Over the past few years, Kazakhstan continues to dynamically develop the oil and fat sector and increase the production of oilseeds. Moreover, the country seeks not only to increase the export of raw materials, but also to expand the markets for the sale of finished oil and fat products. Such aspirations have made Kazakhstan one of the key suppliers of vegetable oils and meal/cake in the Central Asian market.

Soybean meal is imported on a large scale. Thus, the volume of its imports in 2020 increased by almost 30% compared to 2019. The main suppliers of such feeds to Kazakhstan are Russia and Argentina. They import over 70% and 20% of their total soybean meal, respectively.

The main consumer of oilseed meal/cake is the poultry industry of the Republic of Kazakhstan (up to 66% of the total production). About 90% of domestic consumption is sunflower and soybean meal/cake due to high production.

The production of sunflower and soybean meal/cake in the Republic of Kazakhstan increased by an average of 46.7%, exports of products increased by 217.8%, with a slight decrease in the 2018-2019 season. The consumption of sunflower and soybean seed cakes slightly increased by 36.9%.

The use of soybean cake makes it possible to increase the content of lysine in the proteins of the cake flour, to bring the ratio of fatty acids  $\omega$ -6: $\omega$ -3 to values from 3:1 to 5:1, and also to increase the oxidative stability of the oil in the flour from the cake, and therefore, the its suitability, thermal stability of flour in the production of functional foods [15].

## 2 Material and method

The method for obtaining flour from oilseed cake includes preliminary crushing of oilseed cake, additional grinding of pre-crushed cake, sifting grinding on sieves. At the same time, as a cake, soybean cake with a mass fraction of oil of 5.0-9.0% on an absolutely dry substance, which, after additional grinding, are mixed at the following ratios, wt.%: 77-95, the resulting mixture is crushed, the resulting grinding is sieved on sieves with a hole size of 250, 450, 710 microns, and the exit from the sieves of 450 microns and 710 microns is subjected to additional grinding [16].

## 3 Results and discussion

Studies have been carried out on organoleptic and physico-chemical indicators of the quality of the obtained soybean cake according to GOST 8057-95 Food soybean cake (Table 1).

**Table 1.** Organoleptic and physico-chemical indicators of the quality of soybean cake.

The name of indicators	Norms
Appearance	Without foreign inclusions and impurities visible visually.
Color	yellow powder
Smell	Peculiar to the corresponding type of oilseed raw material without foreign smell (mustiness, mold, burning, etc.)
Taste	Peculiar to the corresponding type of oilseed raw materials, without rancidity and other foreign flavors
Metal-magnetic impurity, mg per 1 kg of cake, no more than	None
Consistency	Loose, homogeneous
Other foreign impurities	None
Pest infestation or presence of traces of infestation	None

In order to use soybean meal in the production of bread and bakery products, the meal has been tested for safety. In terms of safety, soybean cake meets the standards. The content of proteins in soybean cake is 32.6%. The moisture content is an important factor in maintaining the stability of the cake over a long period of time [17]. A level below 12% is considered safe for storage as it prevents the rapid growth of mold [18]. The fat content was 18.8%.

From the data presented in the table, it follows that, according to organoleptic and physical indicators, the quality of soybean cake meets the established requirements for cake and is safe for their further use in food production.

The high calorie content is explained by the high fat content (18.8%) in the cake, as they are obtained after a single cold pressing, which have better nutritional properties than the meal obtained after degreasing with organic solvents.

Increasing the value of domestic oilseed by-products can enable the reuse of materials in the supply chain as they add value to food, reduce costs, promote economic growth and reduce the risks associated with their disposal in the environment.

For scientific justification and determination of rational ways of using oilseed cake as an additive, their functional and technological properties were studied: water-binding, water-retaining capacity, bulk density (table 2), which allow predicting the behavior of the system in certain recipes and modes.

**Table 2.** Moisture-binding and water-retaining abilities of soybean cake.

Researched indicators	Results
BCC	2.5628
BYC	4.2863
Bulk density	0.648

The table shows that soybean cake is a promising raw material for use in bakery products.

The water-retaining capacity of the WSS cakes was determined by heating the samples in a water bath. To do this, weighed 2 g cakes and added to them 20 ml of distilled water and thoroughly mixed until a homogeneous mass. Then they were placed in a water bath at a temperature of 80°C for 30 minutes. At the end of the time, the tubes were centrifuged at 1500 rpm for 20 minutes. The maximum amount of added water at which no separation of the aqueous phase was observed during centrifugation, g/g, was taken as the WSL value.

The supernatant was removed and the samples were weighed. The WSL was calculated as the difference between the hydrated and dry residue.

Water holding capacity (WHC) provides information on the degradation of molecular components by measuring the amount of solid components released from proteins and other molecules. The SVR for the soybean meal meal was 4.29. The bulk density was determined by the volumetric method. To do this, 5 g of cake was placed in a 100 ml cylinder and gently tapped 20 times. Values were calculated as sample weight divided by flour volume (g/ml).

In order to use soybean cake for rye-wheat bread, samples of control and experimental bread samples were prepared with the addition of soybean cake. The formulation is shown below in Table 3.

**Table 3.** Recipe for rye-wheat bread (control and test).

№	Name of raw materials	Control sample, gr	Sample with the addition of soybean meal, gr
<b>dough</b>			
2	Rye malt, gr	250	250
3	Water, gr	675	675
4	Sugar sand, gr	125	125
<b>sponge</b>			
1	Flour of the 1st grade, gr	240	216
2	Soybean meal	-	24
3	Rye flour, gr	55	55
4	Water, gr	180	180

5	Opara, gr	80	80
6	Yeast, gr	5	5
7	Sugar, gr	10	10
8	Salt, gr	10	10
9	Vegetable oil, gr	10	10

Bulk density of soybean cake - 0.648. The indicator decreased with humidity and increased with a decrease in lipid content. Bulk density is an important property in packaging and processing processes in the food industry. It is a measure of the severity of flour and depends on the intermolecular forces of attraction, particle size, and the number of positions in the compound [19]. Other values found in the literature ranged from 0.592 g/mL to 0.741 g/mL [20].

The above research results confirm the environmental and food safety, high nutritional properties of oilseed cake, which can serve as a valuable ingredient for enriching bread and bakery products.

The rich chemical composition of the studied soybean seed cake shows the feasibility of their widespread use as a protein-mineral additive in order to improve and increase the biological and nutritional value of bakery products.

Soybean flour has a pronounced water-retaining ability, therefore, in order to study the effect of vegetable oil cakes on the technological properties of the emulsion for foodstuffs, the influence of soybean cake on standard samples of rye-wheat bread according to GOST 2077-84 was studied. The research presents the results of organoleptic, physico-chemical parameters of rye-wheat bread.

Samples of bread with the addition of soybean meal were examined according to ST RK 984-2008 "Bread from wheat flour. General technical conditions" and TR CU 021/2011 "On food safety", approved by the decision of the Commission of the Customs Union of 09.12.2011 No. 880. Test conditions: humidity - 40.8%, temperature - 24.30C. Organoleptic characteristics correspond to norms.

The weight of the dough piece is 550 gr.  
 Finished product weight - 500 gr.

In the studied samples, 10% of wheat flour was replaced with soybean flour.

Laboratory studies to determine the organoleptic and physico-chemical characteristics were carried out in accordance with GOST 2077-84 "Rye, rye-wheat and wheat-rye bread. General technical conditions" and TR CU 021/2011 "On food safety", approved by the decision of the Commission of the Customs Union of 09.12.2011 No. 880.

Test conditions: humidity - 40.8%, temperature - 24.30C. The results of the analyzes are shown in table 4.

**Table 4.** Physical and chemical characteristics of rye-wheat flour with the addition of soybean cake.

№	The name of indicators	Characteristics and norms	Rye-wheat bread (control sample)	Rye-wheat bread with soy flour
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1	Pest infestation of grain stocks GOST 26312.3	not allowed	None
2	Porosity, % GOST 5669	-	69.69
3	Crumb moisture, % GOST 21094	51.0	44.36
4	Crumb acidity, degree, not more than GOST 5670	12.0	3.33
5	Ash content (in terms of dry matter),% no more than GOST 26312.3	0.75	0.67
6	Gluten raw: Quantity, %, no more than GOST 27839	-	11.76

## 4 Conclusions

As can be seen from the tabular data, the results of the analysis meet the requirements: for compliance with GOST 2077-84 “Rye, rye-wheat and wheat-rye bread. General technical conditions” and TR CU 021/2011 “On food safety”, approved by the decision of the Commission of the Customs Union of 09.12.2011 No. 880 on quality and safety indicators.

Thus, it was found that the addition of secondary raw materials from the oil and fat industry, in particular soybean cake, when baking rye-wheat bread does not adversely affect the organoleptic and physico-chemical properties.

## Acknowledgments

This research has been/was/is funded by the Ministry of Trade and Integration of the Republic of Kazakhstan, Committee of Technical Regulation and Metrology, Kazakhstan Institute of Standardization and Metrology (Grant No. BR12967830 «Development of technical regulation tools in order to improve the efficiency, safety, resource-saving of food production and eco-friendly packaging»)

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