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# DEVELOPMENT OF COARSE CORN FLOUR TECHNOLOGY FOR BAKING FUNCTIONAL BREAD

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The object of the study is coarse corn flour for baking bread in the Republic of Kazakhstan. The problem to be solved is following. When using bakery products made from premium wheat flour and other varieties that contain gluten, it is possible to say that there is no health and functional direction, only the value of its nutritional value and maintaining its satiety. A promising area is the development of special types of bakery and cereal products made from coarse corn flour containing nutritious and biologically active substances: dietary fibers, fats, carbohydrates, vitamins, enzymes, micro- and macronutrients and functional proteins.

As a result of the study, "Kazakhstanska" corn varieties with coarse grinding were studied and a comparative analysis with a control sample of wheat flour of water absorption capacity, in which coarse corn and the control sample showed the same result of 55.6%, with a combined change slightly.

It was found that in corn flour, of all the protein fractions, the water-soluble one accounts for only 11.63% of the total amount of protein. The protein part is made up of prolamins (20.17%) and glutelins (29.20%), which are soluble in alcohol and in an alkaline solution. Corn flour contains more insoluble protein than wheat flour – 2,367 and 1,044, respectively.

Corn bread made from coarse flour without admixture of wheat flour, prepared by the baking method, meets the requirements of consumers in taste and aroma, and due to this, the formulation technology has been developed. Considering this, the developed recipe technology is tailored specifically to the "Kazakhstanska" variety, which will allow the production of bread products from coarse corn flour for functional and dietary nutrition

**Keywords:** corn flour, coarse flour, water absorption capacity, proteins, acidity, dough

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## 1. Introduction

More than 550 different primary and by-products are produced from corn worldwide. More than 50% of the total gross corn grain harvest is used in the food industry, for seed production, and other products. Corn grain is used to produce flour, grits, oil, popcorn, corn sticks, and corn flakes. Corn is also used to produce preservatives, starch, syrup, alcohol, beer, as well as binders, nutrient media for microorganism cultures, certain medications, extracts, pastes, and other products.

The bakery industry belongs directly to the leading food industries of the agroindustrial complex and performs the task of developing essential products. According to official statistics the Republic of Kazakhstan, bread production has been increasing in recent years, and the product range is expanding

accordingly. In this regard, the use of bread and bakery products in technology is becoming increasingly relevant [1].

The article [2] examines the combined flour of various possibilities for improving the baking quality of gluten-free bakery products, leveling the crumb structure and increasing the final volume of bread. During the study, bread was baked from a mixture of rice and corn flour with the addition of flaxseed flour.

Characteristically, this work is important in the disclosure of technology, but here it must be taken into account that corn flour and coarse flour differ in physiochemical composition. Accordingly, more interests in the study are emerging in the future.

Bread products made from wheat flour are consumed worldwide, some individuals are intolerant to prolamins of

wheat and the related cereals oats, rye, and barley. This intolerance, celiac disease, seriously impairs intestinal absorption and can lead to severe malnutrition [3].

Thus, the relevance of the scientific topic related to the study of coarse corn flour as a functional ingredient is due to the need:

- increasing the biological and technological value of food products;
- development of methodological approaches to assessing the stability and effectiveness of biologically active components in products. Therefore, study aimed at developing and substantiating the parameters of the use of coarse corn flour is relevant.

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## 2. Literature review and problem statement

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In paper [4] the results are presented and study, five different wheat varieties (Glosa, Joker, Apache, Alcantara, and Anapurna) were experimentally analyzed. As a result of the conducted study, the Joker variety was recognized as the most economically profitable and resilient variety. Despite the higher cost of seeds and comparatively lower baking performance, it compensated for this by significantly increasing yields. Key quality indicators monitored throughout the experimental cycle include weight in hectoliters (MH), protein and gluten content. The average weight values in hectoliters per storage volume obtained for five exceptionally promising wheat varieties correspond to the ranges indicated in the official data. Catalog of varieties. It is noteworthy that the Glosa variety showed the highest protein content – 14.2%, while the Joker variety showed the lowest protein content – 11.6%. The average gluten content ranged from 20% to 32%. But it should be noted that the object of the study was carried out from local raw materials, which may differ in indicators.

And in the work [5], a technology with a different method for processing corn is investigated. Corn itself does not accumulate nitrates and is therefore considered an environmentally friendly product. Industrial corn processing includes four types of production: milling, feed, starch and alcoholic fermentation. Industrial processing of corn grain is mainly carried out in two ways. The first way is that the corn is not divided into its component parts. This method is used to produce cereals, flour, corn flakes, a wide range of breakfast cereals, canned corn, as well as fried products of various shapes from corn dough: crackers, sticks, stars, pads, alphabets, chips, waffles, crisps, etc. The second method is to separate it into its components in order to extract as much starch as possible and obtain shoots, pulp and soluble substances in a relatively pure form. But there are other approaches to processing corn, which may differ in the amount of minerals and proteins.

The paper [6] presents, the effects of addition of wheat (10, 20 and 30%) and corn bran (10 and 20%) on rheological and bread making properties of flour were examined. To improve dough and bread properties, glucose oxidase (GO) and hexose oxidase (HO) (15–30 and 45 mg/kg) were used separately in each bran-wheat flour formula with L-ascorbic acid at 75 mg/kg, glucose at 0.5% and vital gluten at 9.2%. Water absorption and development time increased as the amount of wheat and corn bran increased, while dough stability, maximum resistance to extension, extensibility, energy and loaf volume decreased. Corn bran was found to be more detrimental to dough rheology and bread characteristics than wheat bran.

Corn bran and wheat bran could be used at bread making up to levels of 10 and 20%, respectively. Addition of 30 mg/kg of HO in combination with constant additives was most effective in improving dough and bread characteristics and GO with its 15 mg/kg usage level followed it. Further increasing of enzyme levels led to over oxidizing of doughs and breads. Corn bran up to 10% and wheat bran up to 20% levels can be used in bread making. To improve dough and bread quality, besides L-ascorbic acid (75 mg/kg) and vital gluten (as a percentage of added bran weight), GO (15 mg/kg) or HO (30 mg/kg) could be incorporated into wheat flour-bran mixtures. However, the amount of enzyme should be carefully chosen because when they are used above the mentioned levels, they cause overoxidation of doughs and small loaf volumes are obtained. As a conclusion; by using the corn bran, which is a by-product of the starch industry, not only could it be possible to offer healthy alternative breads which contain high amounts of dietary fiber to consumers, but it could also be possible to obtain economical value by evaluating such a by-product in the bread industry.

The study [7] studied the effect of different amounts of corn flour and additives on the quality parameters of corn bread, a traditional recipe in which it was found that the additive, which is one of the main sources of variation, has a strong, very significant ( $p < 0.01$ ) effect on weight, volume, specific volume, crumb color and the crust of bread, as well as the moisture content of the crumb for 0, 1 and 2 days. In addition, it was also found that the same source of variation has a strong, very significant ( $p < 0.01$ ) effect on appearance, porosity, texture, volume, crust color, crumb color, chewiness, taste, aroma, general acceptability, as well as on hardness, adhesion, elasticity, chewiness. and stickiness. it is measured after 0, 1 and 2 days. parameters. In addition, the analysis of variance showed that the relationship between the addition and the amount of corn flour was significant,  $p < 0.01$ , for most features. therefore, can say that the calibration.

Coarse flour is used for making porridge, while fine flour is used for puddings, dumplings, pancakes, dumplings, and other pastries. Adding corn flour to baked goods (cakes, rosettes, eclairs, and cookies) makes them more flavorful and crumbly. Corn flour is also used in brewing as an additive to wheat flour; it has a higher extractive content than barley flour.

Corn starch is widely used in confectionery and bakery industries, and for the production of crystalline medicinal glucose, molasses, and other products. Corn germ is used to produce industrial and edible oils and tocopherol. Corn waste is used in feed production and the chemical industry [8]. Along with corn grain, other parts of the plant are also used.

Gluten present in foods as a result of cross-contact or mislabeling can cause serious health problems in people with wheat allergies and celiac disease. Enzyme immunoassays such as enzyme immunoassay (ELISA) and lateral flow assay (LFD) are widely used to detect traces of gluten in foods. However, the effectiveness of immunoassays may be influenced by factors unrelated to the assay itself, such as the nutritional matrix and processing conditions.

The paper [9] presents corn bread with added gluten (0–500 ppm) and wheat flour (20–1000 ppm) It was prepared at various addition levels and baking conditions (204.4°C for 20, 27 and 34 minutes) to study the accuracy of gluten content determination using seven immunological analysis kits (three sets of LFD and four sets of test systems). ELIZA). Baking conditions had no negative effect on the stability and immunoreactivity of gluten proteins, measured by Western

blotting using three different antibodies. However, the degree of gluten extraction varied depending on the ELISA kit used and the gluten source used to make corn bread, which affected the accuracy of gluten quantification (BioKits – 9–77%; Morinaga – 91–137%; R-Biopharm – 61–108%; and Romer Labs – 113–190%). The degree of gluten extraction decreased with increasing baking time for most of the ELISA kits analyzed. Both the sample and analytical variance increased with increasing gluten content. The predicted analytical coefficient of variation associated with all ELISA kits was below 12% for all gluten levels, indicating good analytical accuracy.

Corn contains such valuable components as protein, vitamin C, B vitamins, vitamin PP, potassium and phosphorus. Such protein fractions as albumins, globulins, prolamins and glutelins have been found in corn grain. The amount of individual proteins varies significantly depending on the growing conditions of the variety and the properties of the plants. The greatest variation is observed in the content of alcohol- and alkali-soluble proteins. The amount of albumins does not exceed 14%, globulins – 22.6%, while the content of prolamins reaches up to 60%, glutelins – 38% of the total amount of grain protein. Researchers have proven that due to its high nutritional and biological value, corn is well absorbed by the human body. Regular consumption of corn products activates metabolic processes in the body, which leads to overall health, improved well-being, and increased vitality [10].

In this paper [11], the optimization of the extrusion process for the production of extruded corn flour (ECM) was studied, which can be used in the production of corn bread in a direct way. The following parameters of the extrusion process were considered: the temperature in the cylinder  $T_c$  (111–159°C), the moisture content  $M_c$  (12.10–24.77%) and the screw rotation speed  $S_s$  (160–460 rpm), as well as their effect on the moisture content in crushed extrudates (ME), the expansion index (EI), bulk density (BD), water solubility index (WSI), water absorption index (WAI), and cold paste viscosity (CPV) of extrudates were studied. The effect of the addition of ECM on the viscosity of the wheat and corn flour mixture was monitored. The optimal combination of extrusion conditions was  $M_c = 21.21\%$ ;  $T_c = 145^\circ\text{C}$ ;  $S_s = 263.5$  rpm. The properties of ECM under optimal extrusion conditions were:  $M_c = 10.97\%$ ;  $EI = 4.22$ ;  $WAI = 7.84$  g/g of body weight;  $WSI = 14.88\%$ ;  $BD = 36.35$  g/100 ml and  $CPV = 1220$  BU. In an amount of 30% of the amount of wheat flour, ECM can be used to produce corn bread in a direct way.

The paper [12] presents the indicators of rheological properties. According to the results obtained, it has been experimentally established that the nature of the change in the specific intensity of kneading dough, which contributed to the production of bread of the best quality at a rotational speed of the kneading unit of 150 rpm, is optimal. The intensity of the dough kneading reduces the kneading time from 290 s at  $n_m = 60$  rpm to 90 s at  $n_m = 240$  rpm. The optimal kneading time was 124 seconds. The results obtained make it possible to determine the water absorption capacity of flour in the production of bakery products, taking into account its baking properties and dough formulation, and, accordingly, the optimal moisture content of the dough. But here it is necessary to take into account the baking modes of bread, which will require further study.

All this suggests that it is advisable to conduct a study this shows that makes it possible to study and provide indicators such as physico-chemical properties, and give recommen-

dations on the developed formulation and technologies for further expansion of the range of bakery products. products made from corn flour.

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### 3. The aim and objectives of the study

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The aim of the study is to development of coarse corn flour for the production of bakery products as a functional ingredient.

To achieve this aim, the following objectives were accomplished:

- to study of qualitative indicators (physico-chemical properties, vitamin parameters, minerals, water absorption capacity) of coarse corn flour of the Kazakhstanska variety;
- to determine the content of the protein fraction when grinding corn;
- to select a recipe and development of a technological scheme for making corn bread using coarse corn flour.

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### 4. Materials and methods

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#### 4.1. The object and hypothesis of the study

The object of the study is coarse corn flour for baking bread in the Republic of Kazakhstan. This will increase the range of bread products in a functional direction and at the same time increase the raw materials for baking bread, which are practically not used in the country of the Republic of Kazakhstan.

Experimental studies were conducted in the laboratories of the M. Auezov South Kazakhstan University. The quality of Kazakhstanska corn, coarse flour, particle dispersion, physico-chemical parameters, nutritional and energy value and chemical composition were determined. A technology for making bread from coarse corn flour based on coarse corn flour has been developed, and the quality indicators of coarse corn flour have also been studied. The importance of the problem under discussion is associated with a decrease in the use of foods containing dietary fiber in quantities necessary to meet the functional needs of the body, and as a result, an increase in a number of diseases of the gastrointestinal tract, cardiovascular, etc. The actual daily intake of various products does not exceed 20 g/day per inhabitant of our country, while hygienists recommend 50–60 g / day, as indicated in the article [13].

It is consistent that corn flour, especially coarse flour, which is the traditional technology of the first stage of grinding, is coarse in our country, the dispersion ranges from 800–1000 microns, which is undoubtedly rich in micro and macro elements, and will improve the bread assortment precisely due to its consumption.

The following experiments were performed:

- study of qualitative indicators (physico-chemical properties, vitamin parameters, minerals, water absorption capacity) of coarse corn flour of the Kazakhstanska variety;
- determination of the protein fraction content during corn milling;
- recommendations of the recipe and the development of technological modes of bread preparation using corn combined poly-stress starter culture for the production of corn bread.

#### 4.2. Preparation of curd samples

Corn grain; coarse corn flour; combined poly-strain starter culture; pressed yeast; salt; drinking water; dough; corn bread.

Experimental studies were carried out using the following modern methods, which make it possible to obtain characteristics of raw materials and finished products based on a set of indicators:

- quantitative determination of protein content and protein fraction was carried out in Nutritest testing laboratories. The determination method is based on a preliminary determination of the protein concentration in the product (Kjeldahl method);

- the mass fraction of moisture was determined in accordance with ISO 3087:2011 by drying the sample at a temperature of 103–105°C until a constant mass was obtained;

- the mass fraction of fat was determined by the Soxhlet method in accordance. The method includes repeated extraction of fat with a solvent from a dried sample, removal of the solvent and drying of the fat until a constant mass is obtained.

## 5. The results of the study on coarse corn flour for baking bread.

### 5.1. Analysis of the qualitative index of coarse corn flour

Qualitative indicators the composition of experimental samples of coarse corn flour is presented in Table 1.

Table 1

Qualitative indicators the composition of experimental samples of coarse corn flour

Indicators	Actually received
Physico-chemical	
Moisture, %	12.5
Acidity, H	2.0
Ash content, g/100 g	0.9
Nutritional value	
Proteins, g/100 g	9.28
Fats, g/100g	4–6.5
Carbohydrates, g/100g	74.37
Energy value, calories /100g	394
Vitamin composition	
Vitamin B1, mg/100 g	0.36
Vitamin B2, mg/100g	0.13
Vitamin PP, mg/100 g	1.90
β-carotene, mg/100 g	0.21
Mineral substances, mg/100g	
Fe	7.86
Si	64.06
Ca	55.81
Mg	25.54
P	196.50
Na	8.64
K	292

Corn can rightfully be called a miniature chemical plant. A quarter of the elements of the periodic table are selectively accumulated and processed in it. Corn grains contain phosphorus, magnesium and potassium, iron and other macro- and microelements. Corn is able to inhibit the processes of fermentation and putrefaction in the intestine, which gives grounds for its inclusion in diets with enterocolitis. A very valuable substance is obtained from corn – glutamic acid,

which is widely used in the treatment of nervous and mental diseases. It plays an important role in metabolism, especially of the brain and heart. In addition, glutamic acid is an integral part of folic acid, an important hematopoietic vitamin.

When kneading the dough, it is possible to notice that the preparation of corn dough requires more water than wheat dough. To study this fact, the water absorption capacity of fine and coarse corn and wheat flour was determined. For the experiments, wheat and corn flour of fine and coarse grinding were used, obtained in an experimental laboratory mill. Wheat flour of the 1st grade served as a control. The moisture absorption capacity of corn and wheat flour is shown in Table 2.

Table 2

Moisture absorption capacity of corn and wheat flour

Indicators	Wheat flour 1/s (control)	Fine wheat flour	Coarse wheat flour	Fine corn flour	Coarse corn flour
Moisture-absorbing ability, %	55.6	55.6	45.5	62.5	55.6

It has been experimentally established that corn flour is able to bind more water than wheat flour. Table 2 shows that the moisture absorption capacity of fine corn flour is almost 7% higher than that of fine wheat flour, and the moisture absorption capacity of coarse corn flour is 10% higher than that of wheat flour. The moisture absorption capacity of fine wheat flour obtained under laboratory conditions is equal to the moisture absorption capacity of Grade 1 wheat flour used as a control sample.

Then, adhering to the Moisture-absorbing ability indicator, a series of pastries were performed, varying the moisture content of the dough (from 45 to 60%). So, when the dough was 45% moist, the bread had a very dense and moist crumb. The dough with a moisture content of 50% also did not provide satisfactory quality, the bread crumb had a dense structure with traces of impurity. At 55% humidity, the dough was easier to process, and the crumb became drier. Increasing the moisture content of the dough to 60% is unacceptable, as it turned out to be too thin, but the finished bread was the same as at 55% humidity. The experimental results showed that when the dough is 55–55.5% moist, the bread acquires the desired crumb structure and the shape of a loaf. The tasting showed that the taste and aromatic characteristics of the bread are not satisfactory: weakly expressed aroma, the crumb is dense, poorly loosened, porosity is poorly developed. In corn bread with a titrated acidity of 3.5–3.6 degrees, no signs of potato disease were found for 5 days.

To improve the taste, aroma and porous structure of corn bread, the possibility of making dough using coarse corn flour was explored.

Corn poly-strain starter culture was added to the dough in a dose of 10 to 70% of the flour weight. The starter culture was characterized by the following indicators: appearance – without delamination, fermentable, color – orange-yellow, aroma – characteristic of the starter culture, with a pronounced sour-milk taste, odorless mold, humidity - 65.5%, titrated acidity – 12.2 degrees, lifting force – 29 minutes, tonic session duration – 24 minutes. The control was a version of corn bread prepared without the addition of poly-strain starter culture with a dose of pressed yeast of 3%, in experimental versions the amount of pressed yeast was reduced from 3% to 0.5%.

To determine the reduced amount of pressed yeast, a series of baking was carried out. As a result of baking, it was concluded that the most acceptable amount is 0.5% pressed yeast by weight of flour. The finished products were analyzed according to generally accepted methods.

It was found that when adding from 10 to 40% of the starter culture, the finished products practically did not differ from the control version, that is, the bread crumb was dense, the porosity was not sufficiently developed. The variant with the addition of 50% poly-strain starter culture, compared with the control and previous variants, bread with the addition of coarse corn flour had a more developed porosity, pronounced taste and aroma characteristic of this type of product. The variants with the addition of 60 and 70% poly-strain starter culture to the dough are similar in appearance to the variant in which 50% starter culture was added, but acid was felt. A preliminary conclusion was made that the initial dose of 50% was the best option.

To investigate this issue, baking was carried out with the addition of dry gluten in the amount of 10 to 20% by weight of corn flour to the control version of corn bread prepared without the use of poly-strain starter culture. The finished products were stored in provocative conditions, in a thermostat at a temperature of 35–37°C, for 7 days. The results showed that bread containing 10% dry gluten began to show signs of potato disease after 96 hours, bread with 15% gluten became ill after 84 hours, and the variant with 20% gluten showed signs of disease after 60 hours of storage. The specific taste and smell of bread affected by potato disease is attributed to products of deep proteolysis of crumb protein substances [14]. Based on the above, it is possible to preliminarily assume and agree with the work [15] that the absence of gluten in corn flour provides resistance to *B. Subtilis*. The results presented in [16] show that the properties investigated depend not only on wheat or corn flour but also on the starter culture.

**5. 2. Determination of the protein fraction content in coarse corn flour**

Corn flour has a high protein content compared to traditional types of flour. The protein content in coarse corn flour and finished corn bread was determined by fractions. The results of these studies are presented in Table 3.

Table 3

Protein fraction content in grams per 100 g of product

Proteins	Per g/100 g of product			
	Grade 1 wheat flour	Corn flour	Corn poly-strain starter culture	Corn bread
Albumins	0.624	1.080	0.383	0.324
Globulins	1.512	0.648	0.394	0.227
Prolamines	4.272	1.872	0.941	0.907
Gluten	3.384	2.718	1.980	1.18
Insoluble proteins	1.044	2.367	0.724	0.812

The albumin content in corn flour is 1,080 g/100g of the product, globulins – 0.648 g/100 g, prolamins – 1,872 g/100g, glutelins – 2.718 g/100 g and insoluble protein – 2.367 g/100 g. In the corn starter culture: albumins – 0.383, globulins – 0.394 g/100 g, prolamins – 0.941 g/100 g, glutelins – 1.980 g/100 g and insoluble protein – 0.724 g/100 g. In cornbread: albumins – 0.324, globulins – 0.227 g /100 g, prolamins – 0.907 g/100 g, glutelins – 1.18 g /100 g and insoluble protein – 0.812 g/100 g.

It was found that in corn flour, of all the protein fractions, the water-soluble one accounts for only 11.63% of the total amount

of protein. The protein part is made up of prolamins (20.17%) and glutelins (29.20%), which are soluble in alcohol and in an alkaline solution. Corn flour contains more insoluble protein than wheat flour – 2,367 and 1,044, respectively. In terms of the content of the remaining protein fractions, corn flour is also superior to wheat flour. Grade 1 wheat flour contains albumins of 0.624 g/100 g, globulins of 1.512 g/100 g, prolamins of 4.272 g/100 g, and glutelins of 3.384 g/100 g.

**5. 3. Development of technological modes of dough preparation using coarse corn flour**

The recommended recipe and cooking mode for cornbread are shown in Table 4.

Table 4

Recommended recipe for corn bread made from coarse corn flour

Raw material	kg/100 kg of flour
Coarse corn flour	50
Corn poly-strain starter culture	50
Pressed yeast	0.5
Salt	1.5
Moisture dough piece, %	55–55.5
Duration of fermentation, min	90
Fermentation temperature, °C	30–35
Final acidity of the dough, deg	6.0–6.2
Baking chamber temperature, °C	210–220
Baking time, min	30–35

When studying the physico-chemical characteristics of coarse corn flour with the addition of poly-strain starter culture, a formulation of combined flour in 50–50 proportions with the addition of poly-strain corn starter culture is recommended to improve the quality of the appearance and swelling of bread.

The process of making dough is one of the most important stages of bread preparation. To obtain high-quality products, it is necessary to create optimal conditions for the maturation of the dough and the accumulation of aromatic and flavoring substances in it. Further, for comparative data and to obtain the best result, studies were conducted on the production of bread from coarse corn flour with the addition of different percentages of poly-strain corn starter culture.

The dough was prepared according to the technological scheme shown in Fig. 1.

The technological scheme in Fig. 1 is the preparation of coarse corn flour and is often sieved (or mixed with finer ones) to improve the structure. Using warm water at a temperature of 40–45°C) for baking flour, sequentially, preparing poly-strain starter culture and dissolving pressed yeast. The dough is left for 30–60 minutes to cool down to 30–40°C and the ripening process takes place to increase the strength of the starter culture.

After making the dough, the dough is kneaded. The difference between corn flour and coarse flour is that the water absorption capacity varies one and a half times higher than wheat flour. Due to the water absorption, the dough becomes more elastic. Knead the dough for 10–15 minutes, until smooth. The dough is left to ferment at a temperature of 35–37°C for 90 minutes. With this technology, carbon dioxide accumulates to ensure a high rise in the dough. After the whole process, they switch to dividing the dough into portions of the desired weight by 600 grams. The formed blanks are placed in greased molds for final proofing for 40–60 minutes and then baked to 220°C. Cornbread dries quickly, so it is better to store it in an airtight container.

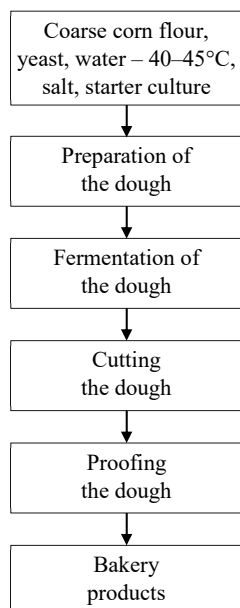


Fig. 1. Technological scheme of making corn bread using coarse corn flour

## 6. Discussion of the development of coarse corn flour technology for baking bread

The choice of corn varieties was based on the “Kazakhstanska” variety, which is now popular in the southern region of the Republic of Kazakhstan, and there was no need to study other varieties of corn. The results in Table 1 allowed to conclude that the physico-chemical composition of the “Kazakhstanska” variety is very low in acidity and high in calories, and this is due to the mineral content, which is dominated by macronutrients such as potassium 292 mg, which stimulates the nervous system and controls blood pressure, followed by phosphorus -196 mg, which ensures the integrity of bones and teeth, as well as silicon calcium exceeding 50 grams, are uniquely rich in vitamins PP, as a regulator of cholesterol levels and the normal functioning of the nervous and cardiovascular systems. Thus, the development of technologies can be considered as one of the most important ranges of bread products of functional attractiveness. The most important factor is the water absorption capacity, it was noticeable in Table 2, which showed the same indicator with wheat flour and slightly different with combined wheat and corn flour, which was more than 50%. The results for protein fractions in Table 3 with low Gluten content showed more attractive indicators, showing 1.9% when ground, and 1.18% when baked, which will have a beneficial effect on human health. The results and conclusions obtained are applicable to the recommendation of the recipe and to the development of a new technology for baking bread from coarse corn (Fig. 1). This can only apply to the results obtained in the southern region of the Republic of Kazakhstan, which differs from other regions of the Republic of Kazakhstan in climatic conditions. The developed recommended recipe for coarse corn bread showed that 50% of coarse flour consists of pure corn flour, and 50% consists of coarse corn flour. Similar analyses were performed using grain flour in [17] and showed a predominantly high protein and fat content. The developed recommended recipe for coarse corn bread has shown that 50% of coarse flour consists of pure corn flour.

The limitation of the study is that only the physicochemical composition and protein fractions of corn flour were studied. In addition, the moisture absorption capacity was evaluated from wheat flour. The disadvantage should also be considered the lack of sensory assessment of taste and aroma. Prospects of the study include expanding the range of factors, conducting in vivo assimilation tests, and studying the effects of combination with other crops.

## 7. Conclusions

1. When identifying indicators, namely physico-chemical properties, minerals really predominate, such as silicon, calcium, phosphorus, and potassium, which will affect the functionality of their purpose. Nevertheless, it is important that the indicators of vitamin groups are very characteristic. This is due to the fact that the surface layers of corn contain useful substances.

2. It has been established that coarse corn flour contains the least amount of protein, but is rich in vitamins and minerals, which will have a positive effect on human health. It has been revealed that the chemical composition of corn flour can serve as a nutrient medium for the vital activity of its own lactic acid bacteria and yeast. To obtain a combined poly-strain corn starter culture, directed cultivation modes have been developed on a nutrient medium consisting of flour and water. According to the content of protein fractions in corn flour, it can be said that gluten is less than in other proteins.

3. Bread based on coarse corn flour was successfully developed on the basis of traditional baking in the Republic of Kazakhstan. The recipe used coarse corn flour, poly-strain corn starter culture, pressed yeast, salt. The experimental method of baking bread from coarse corn flour used for its functionality with its indicators has shown importance in the study.

## Conflict of interest

The authors declare that they have no conflict of interest in relation to this study, whether financial, personal, authorship or otherwise, that could affect the study and its results presented in this paper.

## Financing

The study was performed without financial support.

## Data availability

Data will be made available on reasonable request

## Use of artificial intelligence

The authors confirm that artificial intelligence technologies were used in the preparation of this manuscript exclusively for translating words and sentences into English.

The authors declare the use of generative AI tools under full human supervision for the following task: translation of text fragments into English.

No AI tools were used for generating scientific content, data analysis, interpretation, or conclusions.

The authors bear full responsibility for the final version of the manuscript.

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### Authors' contributions

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**Alimzhan Imanbayev:** Conceptualization, **Methodology**, Resources, **Software**; **Zeinep Nurseitova:** Project administration, Conceptualization, **Methodology**; **Khoji-akbar Abdurahimov:** Project administration, Supervision, Resources; **Gulnoza Djakhangirova:** Conceptualization, **Methodology**; **Malikov Azim:** Resources, **Software**.

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