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**ODESSA NATIONAL ACADEMY OF
FOOD TECHNOLOGIES**

International Competition of
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**BLACK SEA
SCIENCE 2020
PROCEEDINGS**



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Ministry of Education and Science of Ukraine
Odessa National Academy of Food Technologies

International Competition of Student Scientific Works

BLACK SEA SCIENCE 2020

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1. FOOD SCIENCE AND TECHNOLOGIES

PASTA OF NON-TRADITIONAL POLY-CEREAL RAW MATERIALS**Author:** Kyrmyzy Marat**Supervisor:** Aigul Timurbekova*Kazakh National Agrarian University (Kazakhstan)*

Abstract. *The object of research is loose grain raw materials, flour from whole grains of various cereals and poly-cereal mixture based on it, which is a valuable source of nutrients and minerals for the production of pasta.*

The purpose of the research is to study the possibility of making pasta of high nutritional and biological value on the basis of non-traditional poly-cereal raw materials.

Method and methodology of the work. *The basis for the development of the recipe for making poly-cereal pasta from composite flour mixtures of whole grains of cereals and cereals is based on the methodology for designing their composition, which allows you to regulate the content of nutrients in the product that meet the requirements of rational and adequate nutrition, providing a preventive focus.*

Application area. *Pasta production, in particular the production of pasta of high nutritional value based on a combined recipe.*

Economic efficiency and significance of the work. *The results obtained help to expand the range of new food products, improve the structure of nutrition, strengthen health, increase the immune protection of the human body, which is due to a positive socio-economic effect.*

Keywords: *pasta; grain of grain crops; grain of leguminous crops; grain of cereals; poly-cereal raw materials; non-traditional raw materials.*

I. INTRODUCTION

For the production of traditional pasta, hard wheat varieties are used, which are "poor" in chemical composition with the most important nutrients. In this regard, it is possible to increase the nutritional value of pasta by adding natural ingredients, such as corn, millet, buckwheat, barley or oats, as well as other grains/legumes that differ significantly in chemical composition from traditional raw materials. Therefore, the production of pasta based on non-traditional poly-cereal raw materials is one of the promising areas for creating functional products.

The basis for the development of the recipe for making poly-cereal pasta from homogeneous composite flour mixtures of whole grains of cereals and cereals is based on the methodology for designing its composition, which allows you to regulate the content of nutrients in the product that meet the requirements of rational and adequate nutrition, providing a preventive focus.

Thus, pasta made from non-traditional raw materials, compared with other types of flour products, will have a number of advantages: high digestibility of basic nutrients, high consumer properties (each category of people can meet their taste needs), long shelf life, low cost and availability for all segments of the population. However, in our country, such products are not produced, and manufacturers have to use baking flour from soft wheat, whose protein is deficient in the most important essential amino acids.

The purpose of the research is to study the possibility of making pasta of high nutritional and biological value on the basis of non-traditional poly-cereal raw materials.

II. ANALYTICAL REVIEW OF THE LITERATURE

2.1 Ways of improving the technology of pasta production

There are scientific papers devoted to the balanced introduction of plant raw materials (vegetable or berry crops) in order to enrich pasta with dietary fibers, minerals, organic acids, vitamins and antioxidants. They also use lactic acid leaven or whey for enrichment with biologically active substances; egg shells are used for mineral enrichment; yeast is used to increase the protein content; tomato-based products are enriched to increase the mineral content; a method for enriching pasta to solve problems of iodine deficiency has been developed, using seaweed [1-6].

In addition to increasing the nutritional value of pasta, scientific work is aimed at improving the technological modes of pressing and cooking. Since the introduced components significantly change the structural and mechanical properties of the dough and change the cooking properties of pasta. In this regard, the development of new recipes requires the development of a full cycle of technology from the preparation of raw materials and flour mixture recipes to the production of finished products with an assessment of consumer properties that have undergone heat treatment [3].

Simultaneously with the expansion of the range based on non-traditional raw materials, the production of pasta with the inclusion of coarse flour is becoming more and more interesting. Currently, the production of pasta with the inclusion of bran in the recipe has been established. This direction can be improved without restrictions, because Kazakhstan has a rich grain potential. We need to use the full potential of the grain industry. This area needs to be studied and improved on an ongoing basis.

Thus, further development of pasta production will be aimed at expanding the range of products for the use of new types of raw materials, such as non-traditional poly-cereal raw materials, as well as improving the technological processes of pressing, forming dough, drying and cooking pasta.

2.2 Recommendations for developing a promising range of pasta

The modern pasta industry is developing along the following path: reducing the production cycle and energy costs; reducing the cooking time of pasta and expanding the raw material base of pasta production by using non-traditional raw materials [3, 5].

In the result of the analysis of patent researches it should be noted that at the modern level of development of the pasta industry, the range is regularly updated with new products, characterized by a rich chemical composition and also the ratio of amylase and amylopectin, the gelatinization temperature and granule size. At the same time, a promising direction in the development of pasta production is the use of coarse flour varieties of various cereals and legumes. Different combinations of them will give new varieties of pasta therapeutic and preventive properties, and the consumption of new pasta will give a functional status in the prevention of a number of chronic diseases.

III. OBJECT, SUBJECT AND RESEARCH METHODS

3.1 Object of research

The objects of research are: bulk grain raw materials, flour from whole grains of various cereals and poly-cereal mixture based on it, which is a valuable source of nutrients and minerals for the production of pasta.

3.2 Subject and methods of experimental research

The subject and methodology of the research work included information-analytical and laboratory parts of the study with the use of experiment planning, analytical processing of the results of technological experiments using modern laboratory equipment and computer programs.

Analytical studies were carried out on the basis of Kazakh National Agrarian University, namely in the conditions of research laboratories of the educational research and production Center for processing technology and Agro technological HUB.

3.2.1 Method of developing a poly-cereal mixture recipe

Poly-cereal mixtures for the production of a promising range of pasta based on non-traditional raw materials were made in accordance with the results of automated calculation using software [7], which is intended for compounding composite mixtures based on flour from whole grains of cereals and leguminous crop.

3.2.2 Nutritional value of the flour mixture, rheological properties, duration of kneading and speed of pressing the pasta dough

The chemical composition (mass fraction of protein, starch and fiber content, ash content) was determined using an infrared analyzer.

Study of rheological properties of the dough. The main technological properties that determine the effectiveness of the technological process of pressing pasta dough are elastic-plastic properties: viscosity, elasticity and extensibility of the dough. In this regard, we studied the rheological properties of pasta dough made in accordance with the developed recipe based on poly-cereal raw materials. It is obvious that the prepared mixture will differ not by low values of indicators of the studied properties. In this regard, to give the dough the best elastic-plastic properties, dry wheat gluten was introduced into the recipe, for binding all the components introduced into the mixture recipe.

Determination of the rheological properties of flour using Chopin's Alveograph [8]. The essence of the method consists in kneading dough of constant humidity and a solution of sodium chloride, after which the dough is installed in a special compartment of the Alveograph, where the dough extensibility is determined during the inflating of the dough balls, and automatic plotting with curves showing the rheology of the flour.

Determination of water absorption and rheology of flour using a Farinograph [9]. The study was conducted on a Farinograph from Brabender, Germany. The principle of operation is to mix the dough in a dough mixer, with the addition of the necessary amount of water in order to obtain the desired consistency. The results of the study were recorded in the observation log.

The Farinograph device was used to study water absorption, dough formation time, dough stability, dough dilution rate, and the quality level of the Farinograph.

The production of pasta. Preparation of pasta was carried out on a laboratory screw pasta press.

The dough humidity was 38 %. To prepare the dough (recipe № 1, № 2, № 3), water with a temperature of 35° C was used.

3.2.3 Methods for evaluating the quality of pasta

The quality assessment of consumer properties of pasta was determined in accordance with STST 51865-2002, according to which the assessment is descriptive. It also provides a point-based assessment of the quality of pasta, which in turn

facilitates the comparative assessment of products, more objectively reflects their consumer advantages and changes in quality during their long-term storage.

The evaluation of the developed batch of pasta was made according to the following indicators: appearance, color, smell, taste, consistency, and state of cooking water. Each indicator is characterized by five or six descriptive categories with the assignment of the specified points. The total maximum score is 100 points.

According to the method of evaluating organoleptic indicators of the quality of pasta can be divided into four groups: excellent, good, satisfactory, unsatisfactory.

The "Excellent" category is considered to be pasta products that retain their shape after cooking, are freely separated from each other, and have a smooth surface. The taste and smell are well-defined, characteristic of this product. The color is typical, well-defined, the consistency is elastic, without a powdery core. Cooking water with a small content of suspended particles. The score must be at least 96 points.

For pasta products of the "Good" category, light sticking, more turbid water after cooking, a slight darkening or enlightenment is allowed. The taste and smell are well-defined, typical. The estimated score is 95-84.

Products of the "Satisfactory" category are characterized by a less pronounced taste and smell, noticeable sticking after cooking, a darkish or excessively light color, turbid water, and a softened consistency. The estimated score is 83-75.

Products with a score below 75 are considered "Unsatisfactory" pasta. During cooking, their integrity is violated, they stick together, acquire a faded color, "empty" or very weakly pronounced taste and smell.

IV. RESULT OF WORK

4.1 The recipe of the poly-cereal mixture was developed and the organoleptic properties of the dough for making pasta from non-traditional raw materials were studied

A computer program was used to calculate the nutritional value of poly-cereal flour [7]. As a result of the calculation, three recipes for pasta made from non-traditional raw materials were selected. The calculated values of the selected recipes are shown in table 1.

Table 1 – Pasta recipes from non-traditional raw materials

Name	Recipe 1, %	Recipe 2, %	Recipe 3, %
Wheat	0	0	0
Barley	0	0	16
Corn	33.33333333333333	50	25
Oats	33.33333333333333	16.66666666666667	15
Buckwheat	0	16.66666666666667	27.3
Millet	16.66666666666667	0	0
Peas	0	0	16.7
Soy	16.66666666666667	16.66666666666667	
Protein	18.028	17.824	18.5
Starch	60.256	63.076	56.7
Fiber	8.076	6.684	13.23
Fat	8.61	8.348	7.76
Ash content	3.664	2.946	5.34

4.2 The rheological properties of pasta dough based on non-traditional raw materials are studied

In the course of experimental studies, the elasticity of the dough was studied, which is characterized by the maximum resistance of the dough plate when it inflates into a bubble (P, mm). We studied the dough extensibility, characterized by the maximum volume of the resulting dough bubble (L, mm). Along with indicators of flour strength, it is also necessary to take into account the data of alveogram that characterize the ratio of P/L (elasticity and extensibility) of the dough. We determined the specific work spent on the deformation of the dough (W, a.u.) when the experimental dough sample was inflated into a bubble. We determined the coefficient of elasticity (Ie, %), which is characterized by the dough's resistance to stretching when deformed along two axes.

Experimental data showed that the plates of pasta dough from non-traditional raw materials had the worst rheological properties, which were not just recognized by Chopin's ALVEO-consist graph, which is due to the high content of water-soluble protein fraction, which is not able to bind water. The structure of the dough was crumbly, disintegrating even with small values of deformation. Only the control sample of the dough plate based on first-grade flour had a high characteristic of rheological properties, which is explained by the fact that the protein fraction of cereals is represented mainly by gliadin and gluten, which are insoluble in water, a characteristic feature of which is weak solubility in water and therefore in the dough they are able to bind water, swell. The results of experimental studies to determine the rheological properties of the control sample of the dough are shown in table 2.

Table 2 – Rheological properties of first-grade flour dough (control sample)

Name of the indicator	The control (I grade wheat flour)
Dough elasticity, P, mm·H ₂ O	137
The extensibility of the dough, L, mm	84
Specific work, W, a.u.	455
Elasticity-to-extensibility ratio, P/L	1.63
The coefficient of elasticity, Ie, %	68.9

Further, experimental studies were conducted to improve the rheological properties of pasta dough from non-traditional raw materials. To optimize the rheological properties of the pasta dough and improve the quality of the finished product, dry wheat gluten (hereinafter referred to as DWG) was added to the poly-cereal flour mixture in an amount of 15, 25, 35 %, respectively, according to three selected recipes. The results were compared with a control sample of first-grade flour dough. The results of the research are presented in tables 3-5.

Table 3 – Rheological properties of pasta dough from poly-cereal flour mixture, Recipe No. 1

Name of the indicator	Introduction of the DWG, %		
	15	25	35
Dough elasticity, P, mm·H ₂ O	181	253	188
The extensibility of the dough, L, mm	81.4	38.5	103.6
Specific work, W, a.u.	132	193	330
Elasticity-to-extensibility ratio, P/L	13.66	17.01	7.09
The coefficient of elasticity, Ie, %	12.4	9.3	29.5
Flour humidity, %	8.47	8.3	8.2

Table 4 – Rheological properties of pasta dough from poly-cereal flour mixture, Recipe No. 2

Name of the indicator	Introduction of the DWG, %		
	15	25	35
Dough elasticity, P, mm·H ₂ O	121	238	168
The extensibility of the dough, L, mm	40.0	41.01	40.1
Specific work, W, e. a.	79	162	162
Elasticity-to-extensibility ratio, P/L	16.59	22.33	19.81
The coefficient of elasticity, Ie, %	92.9	9.1	36.2
Flour humidity, %	10.38	8.09	8.12

Table 5 – Rheological properties of pasta dough from poly-cereal flour mixture, Recipe No. 3

Name of the indicator	Introduction of the DWG, %		
	15	25	35
Dough elasticity, P, mm·H ₂ O	96	162	103
The extensibility of the dough, L, mm	92.4	42.2	29.5
Specific work, W, a.u.	129	164	124
Elasticity-to-extensibility ratio, P/L	8.91	8.07	6.01
The coefficient of elasticity, Ie, %	61.6	11.2	40.0
Flour humidity, %	8.05	8.2	7.7

4.3 The chemical composition of the mixtures composed from non-traditional poly-cereal raw materials

The chemical composition of the prepared mixtures with different percentages of DWG (15, 25, 35 %) was studied by near-infrared spectroscopy. The results of the analysis and the results of calculating the nutritional value are presented in table 6.

The analysis of the presented data shows that an increase in the percentage of DWG from 15 % to 35 % in the pasta dough recipe leads to an increase in the calorie content of the flour mixture. At the same time, dry wheat gluten, due to its chemical composition, significantly reduces the calorific value of the original poly-cereal mixture.

Table 6 – Values of the chemical composition of the prepared pasta dough recipe with the DWG entered

Recipe No. 1 +15 % DWG		Recipe No. 1 + 25 % DWG		Recipe No. 1 + 35 % DWG	
Protein, %	16.68	Protein, %	18.31	Protein, %	26.25
Fat, %	3.96	Fat, %	3.96	Fat, %	4.88
Fiber, %	1.35	Fiber, %	1.37	Fiber, %	1.5
Ash content, %	0.51	Ash content, %	0.6	Ash content, %	0.89
Calories, kcal	107.4	Calories, kcal	114.01	Calories, kcal	154.54
Recipe No. 2 + 15 % DWG		Recipe No. 2 + 25 % DWG		Recipe No. 2 + 35 % DWG	
Protein, %	17.12	Protein, %	18.91	Protein, %	22.7
Fat, %	3.10	Fat, %	3.25	Fat, %	3.65
Fiber, %	1.29	Fiber, %	1.4	Fiber, %	1.45
Ash content, %	0.42	Ash content, %	0.48	Ash content, %	0.59
Calories, kcal	101.2	Calories, kcal	110.1	Calories, kcal	129.08
Recipe No. 3 + 15 % DWG		Recipe No. 3 + 25 % DWG		Recipe No. 3 + 35 % DWG	
Protein, %	13.08	Protein, %	15.99	Protein, %	20.29
Fat, %	2.35	Fat, %	2.73	Fat, %	3.13
Fiber, %	1.19	Fiber, %	1.25	Fiber, %	1.34
Ash content, %	0.35	Ash content, %	0.42	Ash content, %	0.55
Calories, kcal	77.93	Calories, kcal	93.21	Calories, kcal	114.35

4.4 The assessment of the organoleptic quality indicators

We studied the effect of the drying agent temperature on the organoleptic quality indicators of pasta products with the addition of 25 % DWG. Organoleptic indicators of pasta quality are presented in table 7.

Table 7 – Results of organoleptic indicators of quality of pasta dried by convective method at different temperatures (40 °C, 50 °C and 60 °C)

Name of the indicator	Temperature of the pasta drying agent		
	40 °C	50 °C	60 °C
Pasta – Recipe No. 1 + 15 % DWG			
Color	Light brown, not transparent	Light brown, not transparent	Light brown, not transparent
The surface	Rough	Rough	Rough
The fracture	Mealy	Mealy	Mealy
Form	in the form of pasta – "horns"	in the form of pasta – "horns"	in the form of pasta – "horns"
Taste, smell	Typical of this type of products, without any shades, sweet flavor, free from foreign smell peculiar to pastry	Typical of this type of products, without any shades, sweet flavor, free from foreign smell peculiar to pastry	Typical of this type of products, without any shades, sweet flavor, free from foreign smell peculiar to pastry
Pasta – Recipe No. 2+ 25 % DWG			
Color	Light brownish, not transparent	Light brownish, not transparent	Light brownish, not transparent
The surface	Rough	Rough	Rough
The fracture	Mealy	Mealy	Mealy

Continuation of Table 7

Name of the indicator	Temperature of the pasta drying agent		
	40 °C	50 °C	60 °C
Form	in the form of pasta – "horns"	in the form of pasta – "horns"	in the form of pasta – "horns"
Taste, smell	Typical of this type of products, without any shades, sweet flavor, free from foreign smell peculiar to pastry	Typical of this type of products, without any shades, sweet flavor, free from foreign smell peculiar to pastry	Typical of this type of products, without any shades, sweet flavor, free from foreign smell peculiar to pastry
Pasta – Recipe No. 3 + 25 % DWG			
Color	Brown, not transparent	Brown, not transparent	Brown, not transparent
The surface	Rough	Rough	Rough
The fracture	Mealy	Mealy	Mealy
Form	In the form of pasta – "horns"	in the form of pasta – "horns"	in the form of pasta – "horns"
Taste, smell	Typical of this type of products, without any shades, sweet flavor, free from foreign smell peculiar to pastry	Typical of this type of products, without any shades, sweet flavor, free from foreign smell peculiar to pastry	Typical of this type of products, without any shades, sweet flavor, free from foreign smell peculiar to pastry

The results presented in table 7 indicate that the drying temperature does not affect the organoleptic characteristics of pasta. At the same time, the recipe composition of pasta affects the color and condition of the surface of dry products. For example, pasta products with a high content of corn in the recipe color the structure in a light yellow shade, and the presence of buckwheat gives a light brown color. The pasta products had a slight rough surface, which can be explained by the quality of the pasta press matrix.

Figure 1 shows the organoleptic characteristics of samples of poly-cereal pasta (1st row) for three recipes before cooking, pasta after cooking (2nd row) and their cooking water (3rd row). The volume of pasta samples after cooking increased by at least 2 times compared to the volume of pasta samples before cooking. The cooking water has become slightly turbid, with a small amount of suspended particles.



Figure 1 – Pasta from non-traditional poly-cereal raw materials of high nutritional value

The general results of organoleptic evaluation of pasta are presented in table 8.

Table 8 – Results of the General assessment of organoleptic quality indicators of pasta from non-traditional raw materials

No.	Name of the indicator	Brief description	Score	Recipe		
				No. 1	No. 2	No. 3
I	Appearance	The surface is smooth, the shape is correct, the products do not stick together	25			
		The shape is correct, the surface is rough, the edges are slightly loosened, the products do not stick together	23	23	23	23
		The shape is correct, the surface is smooth, the products slightly stick together or a small part of them loses their shape	22			
I	Appearance	The shape is correct, the products noticeably stick together or partially lose their shape, or partially have cracks	15			
		Products stick together to form lumps, or a significant number of them lose their shape, or have cracks	5			
		Most of the products lose their shape, stick together or turn into fragments after cooking	2			
II	The color	Plain, typical for this variety.	15			
		Solid color, slightly darker or lighter	12	12	12	12
		Significantly darker or lighter	10			
		Not plain	5			
		Grey, brown	2			
III	The smell	Typical, very well expressed.	10			10
		Good, but not sufficiently expressed	8	8		
		Weakly expressed	6		6	
		Unspoken, "empty"	4			
		Foreigner	0			
IV	The taste	Typical, very well expressed.	25			
		Typical, well-defined	23	23		23
		Typical, weakly expressed	20		20	
		"Empty"	10			
		Foreigner	0			
V	Consistency	Elastic, without flour core	15	15		15
		Slightly softened	12		12	
		Soft	8			
		Soft, slightly spreading	5			
		Highly sprawling	0			
VI	Cooking water	Slightly muddy	10			10
		Slightly turbid, with a small amount of suspended particles.	9			
VI	Cooking water	Slightly turbid, with a small amount of suspended particles and small fragments	8	8		
		Muddy	7		7	
		Muddy, with a small number of fragments	5			
		Very muddy, with a large number of large and small fragments.	2			
Total score			100	89	80	93

The results of the evaluation of organoleptic indicators of the quality of pasta indicate the high quality of the developed food products.

Thus, the obtained results of the rating evaluation of organoleptic indicators showed that the developed pasta products meet the following categories:

- pasta recipe No. 1-89 points, category "Good". Characteristic: light sticking, more turbid water after cooking, slight darkening or enlightenment is allowed. The taste and smell are well-defined, typical;
- pasta recipe No. 2-80 points, category "Satisfactory". Characteristic: less pronounced taste and smell, noticeable sticking after cooking, dark or excessively light color, cloudy water, softened consistency;
- pasta recipe No. 3-93 points, category "Good". Characteristic: light sticking, more turbid water after cooking, slight darkening or enlightenment is allowed. The taste and smell are well-defined, typical.

V. CONCLUSIONS

1. The analysis of the current state of domestic production showed that the Republic of Kazakhstan has established the production of pasta in a wide range, but their production volumes do not fully meet the domestic demand, there is a high share of imports of pasta.

2. The pasta market is characterized by steady development, there is a tendency to strengthen the positions of domestic producers in the conditions of increasing competition from manufacturers of countries of the near and far abroad.

3. In the production of traditional pasta, hard wheat varieties are used, which are "poor" in chemical composition with the most important nutrients.

4. It is possible to increase the nutritional value of pasta by adding natural ingredients such as corn, millet, buckwheat, barley or oats, as well as other grains/legumes that differ significantly in chemical composition from traditional raw materials. Therefore, the production of pasta based on non-traditional poly-cereal raw materials is one of the promising areas for creating functional products.

5. We have developed 3 (three) recipes for a poly-cereal mixture with the addition of dry wheat gluten for the preparation of pasta dough.

6. The rheological properties of the dough for making pasta from non-traditional raw materials with the use of modern laboratory equipment were studied.

7. The results of the evaluation of organoleptic indicators of the quality of pasta indicate the high quality of the developed food products.

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