Ministry of Education and Science of Ukraine

ODESA NATIONAL UNIVERSITY OF TECHNOLOGY

International Competition of
Student Scientific Works

BLACK SEA SCIENCE 2023

PROCEEDINGS

ODESA, ONUT 2023

Ministry of Education and Science of Ukraine

Odesa National University of Technology

International Competition of Student Scientific Works

BLACK SEA SCIENCE 2023

Proceedings

Odesa, ONUT
2023

IMPROVEMENT OF THE TECHNOLOGY OF MEAT PASTRY SEMI-FINISHED PRODUCTS USING GLUTEN-FREE VEGETABLE RAW MATERIALS

Author: Serhii Chernyshov
Advisors: Anna Helikh,
Nataliia Bolhova
Sumy National Agrarian University (Ukraine)

Abstract. *Comprehensive studies have been carried out, which allow theoretically and experimentally justifying the introduction of gluten -freeing vegetable raw materials, hereinafter gluten-free vegetable raw materials, as a physiological and functional ingredient for the formation of consumer properties and increasing the biological value of meat dough semi-finished products. The choice of gluten-free vegetable raw materials as a physiological-functional ingredient of semi-finished meat dough was scientifically justified; the main functional-technological properties and physical-chemical parameters were investigated. The optimal ratio of gluten-free vegetable raw materials and auxiliary ingredients in the recipe of meat dough semi-finished products was established. The choice of components was theoretically justified and the formation of the optimal recipe composition of minced meat dough semi-finished products was carried out. The recipe and production technology of meat dough semi-finished products using gluten-free vegetable raw materials - "Gluten -free" dumplings have been developed. The organoleptic and physical-chemical indicators, nutritional and energy value, main safety indicators and expiration dates of semi-finished meat dough products were studied.*

Key words: meat dough semi-finished products, minced meat, gluten -free vegetable raw materials, dietary food, celiac disease, dumpling technology, model dough systems, protein, protein, rice flour, sorghum flour, flax flour.

I. INTRODUCTION

At the current stage of development of modern society, there is a need to apply new science-based solutions for the production of specialized food products. This is due to an increase in the number of people suffering from hereditary diseases of the gastrointestinal tract. According to statistics, the average prevalence of celiac disease among the population of Ukraine is 1:200, but in recent years, a positive trend towards its growth has been observed.

Thanks to progress in the field of diagnosis of chronic diseases, as well as medical and clinical experience regarding the possibility of a comfortable existence for celiac disease patients , it has been established that adherence to an adequate lifelong gluten -free diet is the only way to restore body dysfunctions and maintain quality of life.

As the review of literary sources shows, the most promising types of gluten -free raw materials widely used in the production technology of specialized food products are rice flour, sorghum flour, amaranth flour, flax flour and corn starch.

The use of gluten-free vegetable raw materials, which has different nutritional and biological value, functional-technological and rheological properties, the use of

innovative methods of component modification allows to significantly reduce the need to use a large number of auxiliary structure-forming components. And thereby ensure the stability of the quality of manufactured food products and obtain food products balanced in composition.

Gluten -free food products is strictly regulated by the provisions "On the safety of certain types of specialized food products, including dietetic-curative and dietary-prophylactic food". Despite this, as shown by analytical data and the results of inspection control studies, the composition of some types of such products does not meet the mandatory safety and quality requirements. Most of the gluten -free food products produced are characterized by insufficient content of complete protein, vitamins, reduced organoleptic characteristics, short shelf life, high cost and, in some cases; do not meet the specifications declared by the manufacturer.

Meat semi-finished products are a source of plant and animal protein, some essential nutrients necessary for normal human growth, development and life. In this regard, it can be assumed that the use of meat semi-finished products with the use of gluten-free vegetable crops will eliminate protein-energy and iron deficiency in the human body.

The lack of the required amount of scientific research in the field of production of specialized meat semi-finished products requires the expansion of theoretical knowledge and the evidence base, which determines the necessity and relevance of the development of technology for the production of meat semi-finished products of high nutritional and biological value for the nutrition of people suffering from gluten allergy (celiac disease) and healthy food in general.

The expediency of combining different types of gluten-free vegetable raw materials, which differ in functional-technological, structural-mechanical properties, chemical composition and biological value as components of semi-finished meat, which provide high biological value and optimal properties of the dough system, has been scientifically substantiated and experimentally confirmed.

The technology for the production of meat semi-finished products using gluten-free vegetable raw materials for consumers suffering from celiac disease has been developed, the nutritional and biological value, physical-chemical and organoleptic indicators of the product have been determined.

Taking into account the primary importance of a gluten -free diet in the prevention and treatment of celiac disease , the production of new types of specialized gluten -free food products , maximally balanced in terms of nutrient composition and sensorial adequate to the consumer properties of traditional analogues , is gaining special relevance.

II. LITERATURE ANALYSIS

Having analyzed a large volume of scientific research works in the field of clinical diagnosis and therapy of celiac disease. it was established that the only effective and most accessible possibility of improving the patient's condition and normalizing the gastrointestinal tract remains adherence to a lifelong diet based on the selection of an adequate gluten -free diet, taking into account the age, characteristics of the patient's condition in period of the disease [1,2].

Diet is based on the principle of consumption of carbohydrate components provided by the use of gluten -free cereals and flour, vegetables, fruits and berries. The presence of protein and fat products in the diet (low-fat varieties of meat, eggs, dairy products, vegetable and animal fats) is important for the diet. Assessment of the perspective of using plant raw materials, based on their composition and properties, is described and cited in many scientific works of domestic and foreign scientists [3-5].

Of particular interest are scientific works on the study of model dough systems with amaranth flour, which can serve as a basis for further research. In their research, the authors determined that monolithic amaranth particles, consisting of starch tightly bound to protein, give the dough elastic properties [5-7].

The proposed recipe for the production of gluten -free confectionery products based on rice flour. The authors scientifically substantiated that the compositional ratio of rice flour and starch 1:1 allows to reduce the need to use sodium bicarbonate (up to 40%), to optimize the indicators of humidity, wetting and to improve the organoleptic characteristics of gluten -free cookies, which gave an impetus to the expansion of the product range of this segment [8 -10].

Another vegetable crop of the oleaginous family, which is widely used in the recipes of specialized and functional food products, is flax and its processing products. The authors have scientifically substantiated the technology of obtaining flax flour with different lipid and protein content. The introduction of flax flour into the recipe helps to improve the elastic properties of gluten, values of effective viscosity, indicators of specific volume and porosity of bread [11, 12].

In recent years, scientific interest in researching the properties of sorghum and its processing products in various food systems has grown significantly. This is primarily based on the unique technological properties of this vegetable raw material. A number of works by domestic and foreign scientists have been devoted to the study of the chemical composition of sorghum of various varieties [13]. The chemical composition of sorghum flour is described in detail in numerous works of scientists [14].

The problem of improving the quality of gluten -free products remains an open question for experts in the food industry all over the world. Forming high-quality physical-chemical and organoleptic indicators of food products is a complex technological task. Therefore, improving the technology of meat dough semi-finished products using gluten -free vegetable raw materials is an urgent task today.

III. OBJECT, SUBJECT, AND METHODS OF RESEARCH

Formulation of the purpose of the work. Improvement of the technology of meat dough semi-finished products and establishing the optimal ratio of gluten-free vegetable raw materials and auxiliary ingredients in the recipe of meat dough semi-finished products, researching their organoleptic and physical-chemical indicators, establishing nutritional, biological value, main safety indicators of meat dough semi-finished products, determining expiration dates.

The object of the research is meat semi-finished products using gluten-free vegetable raw materials.

The subject of the research is meat semi-finished products using gluten-free vegetable raw materials.

Research methods: modern methods of chemical, physical-chemical, organoleptic, microbiological research, as well as methods of mathematical processing of the obtained data.

IV. RESULTS

Because the chemical composition of gluten-free vegetable raw materials can affect the functional-technological and rheological properties of dispersed systems, at the next stage, a study of their chemical composition was conducted, the results of which are presented in Table 1.

Table 1. Chemical composition of gluten-free vegetable raw materials

α=0.05

Name	Moisture, %	Protein, %	Carbohydrates, %	Fat,%	Ash, %
Rice flour	10.6	7.9	78.6	2.5	0.4
Sorghum flour	8.3	24.3	57.2	6.8	3,4
Flax flour	6.0	33.8	36.5	18.9	4.8
Amaranth flour	6.9	8.6	75.3	6.4	2.8
Cornstarch	11.3	1.0	87.3	0.1	0.3

As can be seen from the above data, flax and sorghum flour differ in their high protein content, which determines high structure-forming properties, at the same time, the high fat content limits the use of this type of gluten-free vegetable raw materials in large quantities in the recipes of semi-finished products that require long storage periods. Rice, amaranth flour and corn starch, due to the presence of a large amount of starch polysaccharides and the ability to pasteurize at low temperatures, will provide model dough systems with the necessary rheological characteristics, reduce caloric content and enrich the product with highly digestible carbohydrates.

The dynamics of biochemical changes and transformations of the main components of gluten-free vegetable raw materials during dough kneading are correlated with the functional and technological properties of the raw materials, such as: fat-absorbing capacity (FAC), water- absorbing capacity (WAC), water- holding capacity (WHC) and fat -holding capacity (FHC), which allow justify the choice of technological parameters of the dough. Flour and starch with a temperature of 23±2°C were used for experimental research.

The results of the study of the functional and technological properties of gluten-free vegetable raw materials are presented in Table 2.

Table 2. Functional and technological properties of gluten-free vegetable raw materials

α=0.05

Name	WHC,%	FAC, %	FHC, %	WAC, %
Wheat flour	89.3	109.0	91.4	109.0
Rice flour	93.5	107.6	82.2	146.0
Amaranth flour	89.9	108.7	91.3	182.0
Sorghum flour	95.1	122.0	95.4	188.0
Flax flour	124.3	115.0	110.3	289.0
Cornstarch	77.3	102.0	80.1	103.6

Experimental data show that flax flour has the maximum indicators of WHC, FHC, and the highest level of FAC (122%) is noted in sorghum flour. These results are due, first of all, to the ratio of the main groups of biopolymers and the fractional composition of proteins of the raw material. The high content in flax and amaranth flour of water-soluble proteins (albumins -up to 44% and 57%, respectively) and non-starch polysaccharides, characterized by high hydrophilicity, determines the maximum values of WHC and swelling. The presence in rice flour of starch polysaccharides (up to 55%), the alcohol- soluble fraction of protein (glutenins) up to 70% of the total fractional composition, as well as in wheat flour up to 50% of amino acids with pronounced hydrophobic properties, determines the low values of WHC and FHC.

The obtained results emphasize the necessity of using rice, amaranth and sorghum flour in the formulation of gluten -free flour mixture. This fact is confirmed by the analysis of studies obtained during the study of structural and mechanical properties and chemical composition of raw materials. The prospect of compositional supplementation with flax flour is due to the possibility of increasing the functional and technological properties of the gluten -free flour mixture, due to the high indicators of WAC, FAC, WHC, FHC, the presence of a large amount of fats and pentosanes, which have a cryoprotective effect and increase the plasticity of the dough.

In the production of gluten -free dumpling dough, flour and starch were used that meet the basic requirements for the gluten content in gluten-free vegetable raw materials (<10 mg/kg).

Taking into account the results of the research, the compositions of gluten -free dumpling dough were produced in a batch of experimental and control samples of frozen dough semi-finished products according to the table. 3 recipes.

Table 3. Recipes of control and experimental samples of dumplings

Raw materials, spices and materials	Rate of expenditure	
	Control sample	"Gluten-free" dumplings
Main raw material, kg/100 kg of unsalted raw material		
Ribbed beef	34.7	34.7
Meat of broiler chickens	14.0	14.0
Raw fat	5.0	5.0
Wheat flour	35.0	-
Gluten-free flour mixture*	-	33.4
Chicken eggs are edible	3.2	4.0
Fresh onion	7.3	7.3
Olive oil	-	0.8
Vegetable sunflower oil	0.8	-
Auxiliary raw materials and materials, g/100 kg of raw materials		
Ground black pepper/allspice	100	100
Coriander	100	100
Garlic is fresh	100	100
Food kitchen salt	1700	1700
Wheat flour for dusting	1000	-
Rice flour for dusting	-	1500

* Gluten-free flour mixture (kg): rice flour -23.2; sorghum flour -5.2; flax flour -1.2; corn starch -3.8.

During the production of the dough, drinking water was used for control samples of dumplings. The duration of dough kneading was carried out until the dough had a plastic, uniform consistency, and for control samples of dumplings, it was about 15 minutes. After kneading the dough, it was supposed to be kept for 40 minutes at a temperature not higher than 20-25°C. Manufactured control and experimental samples of dumplings were examined according to the main quality indicators. In the course of research on the chemical composition, the content of food substances and the energy value of dumplings were determined (Table 4).

Table 4. Chemical composition of control and experimental samples of dumplings

α=0.05

The name of the dumpling sample	The mass fraction,%					Energy value/ Caloric value, kJ / kcal
	moisture	protein	fat	carbohydrates	ashes	
Control	53.5	11.6	11.3	22.5	1.1	973/226
"Gluten-free" dumplings	54.6	12.1	11.7	20.3	1.3	962//230

On the basis of the obtained research results, it was established that "Gluten - free" dumplings are characterized by an increased content of moisture, protein and fat. The ratio of these nutrients (1:1:4.5) in experimental samples of semi-finished products is close to the optimal assimilation of the product by the human body (1:1:4).

The output of the control sample of dumplings is 121%, "Gluten - free" dumplings- 124%. The mass fraction of moisture of gluten -free dumpling dough, determined by calculation, was equal to 42%, wheat - 40%. The temperature of gluten -free dumpling dough was 27±1°C, the control sample of dumpling dough was -26±1°C.

In the course of the experimental tests, it was established that the control and experimental samples of dumplings correspond to the main quality indicators characteristic of this type of semi-finished products. On the basis of the conducted tasting studies, it was established that "Gluten - free" dumplings are characterized by a plastic, soft and homogeneous dough consistency, while the control samples of dumplings have a more elastic and dense dough shell. Minced frozen dough semi-finished products were characterized by a uniform juicy consistency, without visible inclusions of connective tissue. To achieve the best organoleptic characteristics of the finished product, it is recommended to cook "Gluten - free" dumplings for 6-7 minutes.

According to the regulation "On the safety of meat and meat products", frozen semi-finished products in the dough must meet the safety indicators - in terms of the content of toxic elements, antibiotics, pesticides and radionuclides. Hygienic requirements and indicators of "Gluten - free" dumplings are presented in Table 5.

Table 5. Hygienic requirements and safety indicators of "Gluten - free" dumplings

Name of substance (element)		The permissible level of its content, mg/kg (for radionuclides - Bq /kg), no more	Test results
Toxic elements:	Lead	0.5	Not found
	Arsenic	0.1	Not found
	Cadmium	0.05	Not found
	Mercury	0.03	Not found
Radionuclides:	Cesium-137	200	Not found

According to the obtained results of the studied safety indicators, it can be concluded that no toxic elements and radionuclides, which cause food poisoning and

toxicosis in the human body, were found in «Gluten - free" dumplings.

“Gluten – free” dumplings have established expiration dates not more than two months from the moment of manufacture at a storage temperature not higher than -18°C.

V. CONCLUSIONS

Based on a set of experimental studies, it can be stated that an effective way to improve the quality of gluten -free dumpling dough is to combine gluten -free types of flour and starch with different functional and rheological properties, nutritional and biological value. It was established that the recipe composition of the gluten -free flour mixture should include 69.46 %- of rice flour, 15.57 % -sorghum flour, 3.59 % - flax flour and 11.38 % -corn starch.

Based on the results of experimental studies, the ratio of main and auxiliary components was obtained, the recipe and technology for making "Gluten - free" dumplings was developed. Based on the obtained research results, it was established that "Gluten - free" dumplings are characterized by an increased content of moisture, protein and fat. The ratio of these nutrients (1:1:4.5) in experimental samples of semi-finished products is close to the optimal assimilation of the product by the human body (1:1:4).

According to the obtained results of the studied safety indicators, it can be concluded that there are no toxic elements and radionuclides that cause food poisoning and toxicosis in the human body in "Gluten -free" dumplings. "Gluten -free" dumplings have established expiration dates not more than two months from the moment of manufacture at a storage temperature not higher than -18°C.

"Gluten-free" dumplings are a high-quality and biologically valuable product for dietary nutrition and contribute to the expansion of the range of gluten -free products.

VI. REFERENCES

1. Gubska O.H. Celiac disease. On the problems of diagnosis and treatment of this disease in Ukraine / O.H. Gubska // Food and processing industry. - 2008. - No. 7. - P. 24-26.

2. Drobot V. I. Requirements for bakery products for patients with celiac disease / V. I. Drobot , A. M. Hryshchenko // Bakery and confectionery industry of Ukraine. - 2009. - No. 6 (55). – P. 33–34.

3. Tuire I., Marja-Leena L., Teea S., Katri H. et al. Persistent duodenal intraepithelial lymphocytosis despite a long-term strict gluten-free diet in celiac disease // Am. J. Gastroenterol. 2012. Vol. 107, N 10. P. 1563–1569.

4. Lanzini A., Lanzarotto F., Villanacci V., Mora A. et al. Complete recovery of intestinal mucosa occurs very rarely in adult coeliac patients despite adherence to gluten-free diet // Aliment. Pharmacol. Ther. 2009. Vol. 29, N 12. P. 1299–1308.

5. Coțovanu, I., Stoenescu, G. & Mironeasa, S. Amaranth influence on wheat flour dough rheology: Optimal particle size and amount of flour replacement. J. Microbiol. Biotechnol. Food Sci. 10, 336–373. https://doi.org/10.15414/jmbfs.2020.10.3.366-373 (2020).

6. Coțovanu, I. & Mironeasa, S. Impact of different amaranth particle size addition levels on wheat flour dough rheology and bread characteristics. Foods 10, 1539. https://doi.org/10.3390/foods10071539 (2021). 25. Coţovanu , I. & Mironeasa , S. Features of bread made from different amaranth flour fractions partially substituting wheat flour. Appl. Sci. 12, 897. https://doi.org/10.3390/app12020897 (2022).

7. Kotsiou, K.; Sacharidis, DD; Matsakidou, A.; Boliaderis, CG; Lazaridou, A. Physicochemical and functional aspects of composite wheat-roasted amaranth flours in relation to dough rheology, bread quality and staling phenomena. Food Hydrocoll. 2022, 124, 107322.

8. Boye, J.; Zare, F.; Platch, A. Pulse proteins: Processing, characterization, functional properties and applications in food and feed. Int. Food Res. J. 2010, 43, 414–431.

9. Kaur, R.; Prasad, K. Technological, processing and nutritional aspects of rice flour—A review. Trends Food Sci. Technol. 2021, 109, 448–463.

10. Parenti, O.; Guerrini, L.; Zanoni, B. Techniques and technologies for the breadmaking process with unrefined rice flours. Trends Food Sci. Technol. 2020, 99, 152–166.

11. Bajk, BH; Pinto, AM; Ahn -Jarvis, J.; Ryden, P.; Perez-Moral, N.; van der Schoot, A.; Stocchi, C.; Bland, C.; Berry, SE; Ellis, PR; et al. The impact of replacing line flour with cellular legume powder on starch bioaccessibility, glycemic response and bread roll quality: A double-blind randomized controlled trial in healthy participants. Food Hydrosol. 2021, 114, 106565.

12. Boukid, F.; Folloni, S.; Ranieri, R.; Vittadini, E. A compendium of line germ: Separation, stabilization and food applications. Trends Food Sci. Technol. 2018, 78, 120–133.

13. Codină, GG Recent Advances in Cereals, Legumes and Oilseeds Grain Products Rheology and Quality. Appl. Sci. 2022, 12, 1035.

14. Garrido-Galand, S.; Asensio-Grau, A.; Calvo -Lerma, J.; Heredia, A.; Andrés, A. The potential of fermentation on nutritional and technological improvement of cereal and legume flours: A review. Int. Food Res. J. 2021, 145, 110398.

TABLE OF CONTENTS