FORMATION OF THE DOMESTIC MARKET OF GLUTEN-FREE PRODUCTS IN THE CONTEXT OF SUSTAINABLE DEVELOPMENT

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This article discusses the use of promising domestic raw materials in the technology of innovative agglutinin products that create a new generation of food products. Given the current conditions in Ukraine, there is a lack of a wide and diverse range of food products for people suffering from genetic diseases. One of these diseases is celiac disease (gluten enteropathy), a multifactorial, progressive disease caused by damage to the villi of the small intestine by certain food components (wheat, rye, barley) containing the protein gluten.

One of the ways to reproduce the state policy in the field of healthy nutrition of Ukrainian population is to create highly efficient technologies in agricultural industry, search for new domestic raw materials and develop an innovative generation of food products rich in essential micronutrients. Sales of such products will expand the range of domestic bread products and help replace expensive imported gluten-free products.

In addition, the introduction of innovative technologies using domestic raw materials in domestic enterprises and hospitality facilities remains an equally pressing issue. Taking into account the opinion of experts and the results of international experience, it is obvious that the introduction of advanced technologies in Ukrainian production will create a new generation of safe food products for gluten-dependent consumers and solve an important problem of our time.

Keywords: celiac disease, gluten-free raw materials, bakery products, oat flour, hospitality facilities

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Introduction

The term «gluten» is used by food industry professionals to refer to wheat proteins (glutenin and gliadin) that form gluten (Gorach et al., 2024). However, in medical practice and official international terminology, gluten is defined as a protein fraction of wheat (gliadin), rye (secalin), barley (gordenin) or their hybrids, and some people may be intolerant to this protein fraction (Montemurro et al., 2021, Buyalska et al., 2020, Farage et al., 2017, Arnone et al., 2012, Dulka et al., 2020).

The most problematic of the products traditionally made from the above-mentioned grain ingredients is the production of aggluten-free bread products. After all, the main role in shaping the quality, volume and porosity of the product is played by wheat protein - gluten, which forms the spongy base of the product. In the world practice, scientists combine the use of native, modified starches, gluten-free flour and hydrocolloids to imitate the gluten backbone. To improve the structure of the product, emulsifiers, starter cultures, protein isolates, prebiotics and amylolytic enzymes are

used to increase the nutritional value of dairy and egg products (Sapone et al., 2012, Kelly et al., 2008, Knežević et al., 2024).

Currently, the list of manufacturers engaged in the production of gluten-free products in Ukraine is not stable, as it shows an upward trend. Some products on the domestic market are labeled *«Gluten Free»* – the «*crossed spike*» quality and safety mark introduced in 2017. This mark certifies that the manufacturer complies with all European standards for gluten-free products, which are tested according to a clear algorithm and subject to production control. The Ukrainian gluten-free industry began to develop only in 2018, so before that period, key products on the market were of foreign origin (Dragomir et al., 2022, Demirkesen et al., 2022). The agreement on the use of the *«Crossed Spike»* trademark by domestic producers was signed a year later in 2019, the first license agreement for the right to use the global labeling on their own products. This event became an important example of safety standards in food production in Ukraine (Koshova et al., 2020, Horach et al., 2023, Bogue et al., 2008).

Given the statistics of the food consumption market analysis, bread and bread products are an essential element of the diet of Ukrainians, including gluten-sensitive consumers. For many years, bread has been one of the main sources of nutrients for the body. Another obvious marker of the third millennium is the inclusion of gluten-free products in the diet of one third of the world's population (Tarabella et al., 2019, Juhász et al.,2020, Šmídová et al., 2022). After all, millions of people began to refuse to consume gluten-containing products not only after confirming their celiac disease diagnosis, but also for general health maintenance and prevention of related diseases (obesity, diabetes, phenylketonuria, etc.) (Capriles et al.,2021, El Khoury et al., 2018).

Gluten-free bread is made from cereal flour, which, due to its chemical composition, does not contain gluten-forming proteins. None of the types of gluten-free flour raw materials can be considered equivalent to wheat flour in terms of functional and technological properties (Rai, et al., 2018, Riznyk et al., 2021, Cappelli et al.,2020). Gluten-free cereals have a high technological potential, and flour based on them is characterized by good nutritional and food value, as it is usually produced using a double milling method. In addition, the flour may contain natural pigments, as the recipe for bread products may provide for the use of other raw materials with their own original color (Arendt et al., 2011, Khairuddin et al.,2021).

Existing bread technologies involve the use of starch of various origins, including rice, corn, etc. After all, it is impossible to guarantee ready-made bread with satisfactory quality indicators, since the lack of structure-forming proteins in agglutinating raw materials leads to the formation of dough with unsatisfactory structural and mechanical characteristics. In view of this, improving the quality of aggluten bread products by using the latest raw materials remains an urgent task for domestic scientists and professionals in the restaurant industry. This, in turn, will ensure the formation and development of the Ukrainian market of gluten-free products.

Materials and methods

The object of the study was the technology of aggluten-free bread products. The subject of the study is domestic gluten-free products - oat flour of the «Ms. Tally» trademark. The composition and nutritional value of popular gluten-free raw materials (buckwheat, oat, corn, rice and amaranth flour) were analyzed during the development and introduction of new generation products.

During the research, statistical data, research results of leading scientists in the bakery industry and relevant methods of current regulatory documents were used. Thus, the mass fraction of moisture

was determined by the accelerated method of drying in an electric drying oven. The titratable acidity was determined by titration of a water-flour suspension (mash) according. The protein content in the raw materials was determined by the Kjeldahl method, which is an arbitration method for determining protein, includes several main stages: sample preparation, mineralization, distillation, and titration. The ash content of the fiber was determined by the classical method using a muffle furnace. The essence of the determination is the combustion of a sample of crushed raw materials, followed by the quantitative determination of the uncombusted residue. The fat content was determined by the refractometric method reference. The study of the total amount of dietary fiber (soluble and insoluble) was carried out by the enzymatic method reference (Lebedenko et al., 2014). The water absorption capacity (WAC) of the fiber was estimated by the water absorption coefficient, which was determined as the ratio of the weight of the raw material after moistening to its initial value according to a well-known method. The water-holding capacity (WHC) and fat-holding capacity (FHC) of oat flour were determined by the Schoch method by centrifugation with the addition of water or fat to study moisture retention or fat retention, respectively, by keeping in a water bath followed by centrifugation for 15 min at a frequency of 6000 rpm (Drobot et al., 2006).

Results and discussion

Having monitored the domestic market, the products manufactured in accordance with current standards and having quality certificates of the trademark (TM) «Ms Tally» (Cascade LLC) were selected for the study. This is the first manufacturer in Ukraine to officially receive the right to use «The Crossed Grain Trademark». The company has implemented the AOECS standard for the sale of gluten-free products. According to the standard, a license can be obtained for one year, during which time independent monitoring by the Ukrainian Association of Pediatric Pharmacists is periodically conducted.

For almost 20 years, Ukrainians have been consuming gluten-free products (flour, ready-made mixes, cereals and pasta) of the highest quality under the Ms Tally brand. The Ukrainian Celiac Disease Association recommends these products to people who follow an aggluten-free diet and those who prefer a healthy diet. Also, alternative types of flour TM «Ms Tally» are used in the production of baby food (Official website of the Ukrainian Celiac Disease Association (2023).

When choosing an alternative safe flour raw material, it is important to take into account the main characteristics, namely its chemical composition, dispersibility, water absorption, moisture retention, fat-solubility and gas-forming ability. When different types of aggluten flour are combined in one formulation, complex systems are formed, the properties of which are interrelated with the technological properties of the raw materials. Therefore, there was a need to study and analyze the technological characteristics and composition of the most popular domestic gluten-free products, namely buckwheat, oat, rice, corn, and amaranth flour (Table 1).

Each of the considered flour raw materials has distinctive characteristics and a unique composition, the use of which in the technology of gluten-free products will ensure high biological value of finished products, as evidenced by the results of domestic and foreign scientists. However, in our opinion, oat flour deserves special attention, as it is confidently ranked as a promising gluten-free raw material and is recommended for consumption by anyone who cares about their health, including people with gluten intolerance.

Oats occupy a special place among cereals due to their high protein content and amino acid composition. Oat protein is valuable, well balanced and contains all essential amino acids. If we

calculate the amino acid index, oat protein is superior to wheat flour protein in terms of the total amount of essential amino acids, especially lysine and threonine. Since the mid-1930s, oat flour has been used directly in food production and packaging as a natural antioxidant. Oat grain is rich in fats, so the glycerol composition of oat fat is as follows: monounsaturated and dinounsaturated glycerol – 42.5%, triunsaturated glycerol – 55.9%. As for fatty acids, oatmeal oil is nutritious and contains essential acids - linoleic and linolenic. Linoleic, oleic and palmitic acids make up 90-95 %, stearic and linolenic acids – 1-4 % (Riznyk et al., 2021).

Table 1. Comparative characteristics of quality indicators of gluten-free flours TM «Ms Tally»

Indicators	Buckwheat flour	Oat flour	Corn flour	Rice flour	Amaranth flour
Mass fraction of moisture, %.	8.9 ± 0.1	4.0 ± 0.1	12.5 ± 0.1	8.0 ± 0.1	10.9 ± 0.1
Titratable acidity, deg.	4.1 ± 0.1	4.2 ± 0.1	5.4 ± 0.1	1.2 ± 0.1	4.0 ± 0.1
Proteins, %.	12.6 ± 0.1	13.0 ± 0.1	9.0 ± 0.1	6.8 ± 0.1	8.9 ± 0.1
Fats, %.	3.3 ± 0.1	6.8 ± 0.1	4.9 ± 0.1	1.4 ± 0.1	1.7 ± 0.1
Carbohydrates, %.	69.8 ± 0.2	61.3 ± 0.2	71.8 ± 0.1	80.8 ± 0.1	61.0 ± 0.1
Fiber, %.	10.0 ± 0.1	6.5 ± 0.1	7.3 ± 0.1	0.4 ± 0.1	0.85 ± 0.1
Ash content, %	2.54 ± 0.1	1.97 ± 0.1	1.45 ± 0.1	0.6 ± 0.1	2.4 ± 0.1
Energy value, kcal/100 g	353 ± 5	369 ± 5	370 ± 5	366 ± 5	298 ± 5

A physiologically important dietary component of oats is β-glucan, a non-starchy water-soluble polysaccharide. It has been scientifically proven that β-glucan boosts immunity, normalizes blood lipids, lowers cholesterol, stimulates the growth of immune cells, and inhibits the development of cancer cells.

Flour is low in starch and gluten-free, and can be considered safe provided there is no contact with gluten-containing raw materials during cultivation, transportation, or storage. Oat flour and flakes make baked goods more crumbly, give them a delicate oat flavor and a pleasant light aroma. Since oats contain both insoluble and soluble fiber, oat flour improves the functioning of the gastrointestinal tract (insoluble fiber improves intestinal microflora, and soluble fiber normalizes gastric juice secretion).

In addition to its valuable amino acid composition and the presence of immunomodulators, oat flour has high functional and technological properties. In particular, moisture retention capacity (MRC), water absorption capacity (WAC) and fat binding capacity (FB), which determine the ability of the dough to retain the amount of water and fat specified in the recipe during the cooking process and significantly affect its rheological properties. Table 2 shows a comparative characterization of the above indicators for oat and wheat flour.

The research has shown that oat flour has 12.8 % and 47.5 % higher water absorption and moisture retention capacity than wheat flour. This is due to the higher degree of dispersion of oat raw materials, as well as the fact that the size of oat starch grains, which are almost half that of wheat,

have a larger specific surface area of contact with water and, accordingly, absorb more moisture (Rosell et al., 2014, Riznyk et al., 2023).

The determination of the fat-solubility of the tested samples shows a 19% advantage of oat flour over wheat flour. The formation of this indicator of flour raw materials is influenced by protein substances. Studies of the chemical composition of oat flour confirm the presence of hydrophobic groups that interact with lipids to form lipoproteins through non-covalent bonds, because this raw material is characterized by a higher content of protein substances, which, accordingly, have a different fractional composition from wheat flour.

Table 2. Characterization of functional and technological properties of oat and wheat flour

Indicators	Results of determination	
	Oat flour TM «Ms.Tally»	Wheat flour TM «Khutorok»
Moisture holding capacity (MHC), %	214 ± 5	145 ± 5
Water absorption capacity (WAC), %	2.2 ± 0.05	1.95 ± 0.05
Fat-binding capacity (FBC), mg/g	1.13 ± 0.05	0.95 ± 0.05

The analysis of the obtained results of the functional and technological properties of oat flour shows the expediency of increasing the calculated moisture content of the dough to ensure its required consistency and obtaining finished bread products of satisfactory quality.

Conclusions

The expediency and relevance of using oat flour in the production of bread products was confirmed. This gluten-free raw material has a rich chemical composition, excellent organoleptic and physicochemical characteristics and can be a raw material for the manufacture of special-purpose bakery products.

It was established that oat flour has 12.8% and 47.5% higher water absorption and ability to retain moisture than wheat flour. This is a prerequisite for increasing the moisture content of the oat flour dough. It was established that oat flour has a 19% higher fat-binding capacity compared to wheat flour. This is confirmed by the more valuable chemical composition of oatmeal. Therefore, oat flour is a valuable raw material for the production of gluten-free bakery products.

However, as of today, the bulk of gluten-free products in the domestic network still belong to foreign-made products, so for the implementation and stable development of the aggluten-free food market in Ukraine, it is important to conduct thorough scientific research, introduce innovative technologies, use own flour raw materials and fruitful cooperation between manufacturers.

Conflict of interest

The authors state no conflict of interest.

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