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DESIGNING THE INFLUENCE OF OPERATIONAL PARAMETERS OF SPELT FLOUR ON THE QUALITY OF PASTA

ПРОЄКТУВАННЯ ВПЛИВУ ЕКСПЛУАТАЦІЙНИХ ПАРАМЕТРІВ БОРОШНА ЗІ СПЕЛЬТИ НА ЯКІСТЬ МАКАРОННИХ ВИРОБІВ

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Abstract. *The article examines the range of pasta products. Its diversity depends on the quality of flour, technological equipment of pasta production, the presence of prescription additives, and the availability of packaging materials. Experts know that high-quality pasta can only be made from special flour produced from durum wheat. In recent years, the shortage of such flour has increased significantly, so flour whose properties do not meet the technological requirements is used for the production of pasta.*

The purpose of the article is to evaluate the use of spelt flour for the production of pasta. Spelt is characterized by a high content of complete protein, which includes essential amino acids. Spelt flour is significantly higher than wheat flour in terms of unsaturated fatty acids, fiber, iron, and B vitamins. The study showed the effect of different dosages of spelt flour on the properties of pasta dough, semi-finished and finished products. An increase in the amount of crude gluten was observed

in the samples of pasta dough with the addition of spelt flour due to the amount of protein added. It was determined that the quality of all gluten samples was characterized as good and elastic. An increase in the hydration capacity of gluten and a decrease in the critical moisture content during drying with the introduction of 18% spelt flour were found. A low-temperature convective drying regime is recommended for semi-finished pasta products with the proposed spelt flour due to the high content of active enzymes in it, which can cause darkening of products during drying. The finished products were characterized by a uniform, even color with a milky tint, without dark specks and traces of unmixed mixing. The cooking properties of the spelt flour samples were characterized as good, all samples retained their shape by 100 %, the dry matter loss during cooking was within the requirements of regulatory documents.

As a result of the studies, the expediency of using spelt flour for the production of pasta has been proved.

Key words: *pasta; flour; spelt; gluten; hydration capacity.*

Introduction.

The pasta sector of the Ukrainian food industry is an important and dynamically developing industry for the production of consumer food. The range of pasta products is expanding, new advanced technologies are being introduced, and equipment is being improved. New types of raw materials are used and fundamentally new products are developed to meet the needs of the population.

The concept of Ukraine's state policy in the field of healthy nutrition determines the relevance of producing products for mass consumption with a therapeutic and preventive focus.

Due to the shortage of pasta flour made from durum wheat (cereals, semi-cereals), most pasta products in Ukraine are made from bakery flour.

Functional foods include products that use only products of natural origin and environmentally friendly raw materials that do not contain genetically modified components. All of these requirements must be met when choosing enrichments for pasta [1-3].

The main disadvantage of soft wheat pasta is its low nutritional value and high calorie content. Soft wheat pasta contains 11-12% protein, 70-72% carbohydrates (mainly starch), 13% moisture, 0,5-0,7% fat, and a small amount of minerals and fiber. Therefore, in the production of pasta, it is advisable to use various enrichments to improve their biological and nutritional value [4-7].

To eliminate these shortcomings, it is necessary to investigate the possibility of using spelt flour for the production of pasta.

Research methodology.

Pasta products must meet the requirements of the standard and must be produced according to recipes and technological instructions approved in accordance with the established procedure, in compliance with the sanitary rules for pasta industry enterprises in force in Ukraine. The quality of pasta products is assessed by organoleptic and physicochemical parameters in accordance with DSTU 7043:2009. Pasta products. General technical conditions. The organoleptic characteristics of pasta are its color, surface, shape, taste, smell, and condition after cooking.

Spelt or spelt is a cereal crop for making flour, flakes or germination. This cereal is known for the fact that it has never been subjected to hybridization or genetic modification. Spelt is quickly absorbed by the body, regulates blood sugar levels and removes excess cholesterol. Thanks to slow carbohydrates, spelt gives a feeling of satiety and helps to lose weight. Thanks to its vitamin complex, spelt perfectly strengthens the immune system. This cereal also improves the functioning of the cardiovascular system and cleanses the body of toxins.

Unlike other crops, spelt contains all essential amino acids. The body needs these substances to build new cells and repair damaged tissue.

The «slow» carbohydrates that make up spelt (mucopolysaccharides) have the ability to saturate the body with long-term energy and strengthen the immune system. Therefore, spelt flour is also an excellent choice in terms of nutritional value. It is much easier to digest than many other milling products [8-10].

Spelt flour is characterized by low water absorption capacity and a high ratio of dough elasticity to extensibility. In terms of "strength", it is one of the weakest types of flour. In terms of technological (cooking, milling, baking) properties, spelt flour is close to durum wheat flour, and surpasses wheat flour in quality.

Since this ancient grain is very rich in protein, it also has a high gluten content. This provides spelt flour with excellent baking properties; products made from it acquire a dense structure and rich color.

Considering all of the above, it is promising to study the influence of the main indicators of spelt flour on its baking properties, to establish the optimal particle size

distribution of spelt flour.

Research results.

The aim of the study was to determine the structural and mechanical parameters of flour for the production of pasta The object of research was wheat bakery flour of the highest grade and spelt flour produced in Ukraine. Non-traditional flour was added to the dough at a dosage of 12, 15, and 18% by weight of wheat flour.

One of the main stages in the production of pasta is dough kneading. During the process of kneading pasta dough, moisture is evenly distributed throughout the dough (pastification), as well as the gradual swelling of starch grains and protein substances in the flour[11-13].

After kneading, the pasta dough is an evenly moistened, loose mass consisting of small lumps and crumbs. The spelt flour dough fills the intake turns of the pressing screw well, since the flour additive has a low water absorption capacity and forms a plastic, small lumpy dough. The effect of spelt flour on gluten properties was studied. The results are shown in Table 1.

Table 1: Effect of spelt flour on the properties of gluten washed from pasta dough

Gluten quality indicators	Values of indicators			
	Control	Dosage of spelt flour, %		
		12,0	15,0	18,0
Crude gluten content, %	24,1	26,4	28,5	32,8
Extensibility, cm	12	13	14	15
Elasticity	good			
Ndef, units of IDC / group	83,8/II	90,2/II	95,9/II	114,5/III
Gluten hydration capacity, %	74,2	80,9	91,1	97,9

The following effect of spelt flour on the gluten quality of wheat flour was determined. At a dosage of 18%, the quality of gluten deteriorated to group III (unsatisfactory weak). Gluten extensibility increased from 12 to 15 cm, while in all samples gluten was characterized as medium in terms of extensibility.

In terms of elasticity, gluten was characterized as good. It is known that from the point of view of nutritional value, the optimal gluten content in dough is 30-32%. The

amount of washed gluten increased in the dough samples with the addition of non-traditional flour by 2,3, 4,4, and 8,7 %.

The hydration capacity of gluten is the amount of water that is bound by high molecular weight proteins. The hydration capacity of gluten in dough samples with the addition of spelt flour increased by 6.7, 16.9, and 23.7%, respectively, which is explained by an increase in protein content with the addition of spelt flour. The curves of dependence of the amount and quality of gluten washed out of the dough and the hydration capacity of gluten on the dosage of non-traditional flour are shown in Figure 1.

Thus, the research results showed that spelt flour, when added to pasta dough at a dosage of 12-18% by weight of wheat flour, does not have a significant negative effect on the gluten of wheat flour: the dough after kneading had the required consistency, and the gluten content and hydration capacity contributed to better pastification and plasticity of the dough and improved.

To study the effect of spelt flour on the properties of semi-finished products after kneading the dough, the researchers opened the ball valve of the laboratory pasta press and, after compacting the dough in the screw chamber, formed it through a vermicelli matrix.

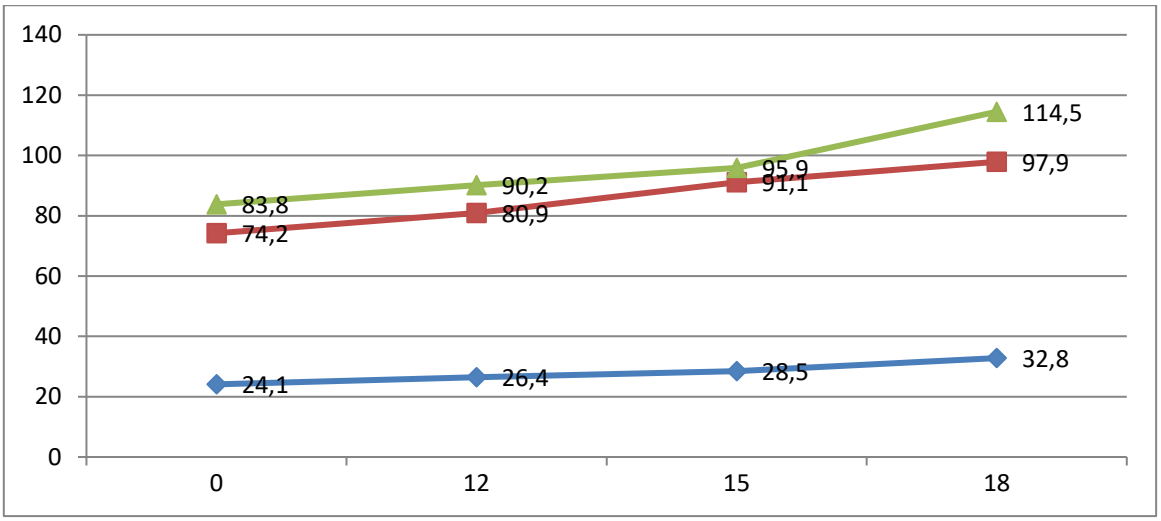

Figure 1 – Graphs of dependence: 1 – quantity; 2 – gluten hydration capacity on the dosage of flour and spelt,% ; 3 – quality

After molding, the billets were cut into individual products 30 mm long and placed in metal trays for further drying. The appearance, temperature at the exit from the matrix and relative elongation of the raw extruded semi-finished products were determined.

The data on the improvement of gluten hydration capacity when adding spelt flour were confirmed by the color of the semi-finished products - homogeneous, without spots, stripes and specks, indicating complete pastification of the additive flour particles and its good distribution in the pasta dough.

All semi-finished products retained their shape well during molding through the matrix and processing: they did not tear, stick together, crumble when cut, or stick to the knife and drying trays.

The relative elongation of raw pasta, determined immediately after it leaves the matrix, characterizes the plasticity of the resulting semi-finished products.

This indicator is measured in plastic materials (as a percentage of the original sample length) and is more important for materials with high plasticity. The addition of spelt flour has a positive effect on the plasticity of semi-finished products: it increased by 0.25, 1.0 and 3.7%, respectively. Raw pasta products were plastic, retained their shape, and did not crumble when cut and laid out on drying surfaces.

Different temperature regimes are used to dry pasta. The optimal mode for this production is the one that produces the best quality products with the least amount of time and energy. When selecting and developing drying modes, two features should be taken into account: during drying, their linear and volumetric dimensions are reduced by 6-8%, and the structural and mechanical properties of the product change.

The plasticity of semi-finished pasta is important when choosing drying modes that would allow molded pieces to be dried in the shortest possible time, preventing shrinkage, darkening, and cracking. The plasticity of molded semi-finished products consisting of wheat flour and water is imparted by the gliadin fraction of flour gluten - the higher its share in gluten, the more plastic the raw products will be [14-16].

Taking into account the chemical composition of the enrichments, a low-temperature drying mode was chosen for drying semi-finished products. After

processing, the pasta was placed on metal trays and dried at 45°C in a thermostat until the mass fraction of moisture in the products was no more than 13%. After drying, the products were cooled in the thermostat with the heating elements turned off to avoid cracking and deformation.

It was found that by increasing the hydration capacity of gluten in semi-finished products, the critical moisture content decreases when the material passes from a plastic state to an elastic one and it is necessary to soften the parameters of the drying air.

The increase in plasticity is associated, as noted above, with the addition of additional amounts of protein, fiber, and pectin substances with high moisture absorption capacity to the dough along with non-traditional vegetable flour. This increases the content of bound moisture in semi-finished products and, as a result, their plasticity. This makes it possible to dry products at higher temperatures and low relative humidity without fear of cracking and shrinkage, up to a moisture content of 14-16%.

The quality of the finished pasta products was evaluated by organoleptic, physicochemical parameters and cooking properties.

Products made from dough with spelt flour had a yellow, uniform color. All products had a mealy breakage, which is explained by the absence of a vacuum operation during the production of pasta in a laboratory press. However, this drawback is not significant, as it can be easily eliminated when working on a pasta press equipped with a vacuum station or a vacuum pump.

The moisture content of the products was in the range of 12,4-13,0%. The acidity of the products is primarily determined by the acidity of the initial flour, since the pasta dough is not fermented. The acidity of the finished products did not differ significantly from the acidity of wheat flour and spelt flour (1,8 and 2,0 degrees).

Increasing the dosage of spelt flour contributed to an increase in the strength of dry products compared to the control sample by 53,5-71,4%. This is due to an increase in the amount of protein substances introduced with the additive, as they bind starch grains in the pasta dough into a strong matrix [17-19].

The dependence of the mechanical strength of the products on the dosage of the flour additive is shown in Fig. 2.

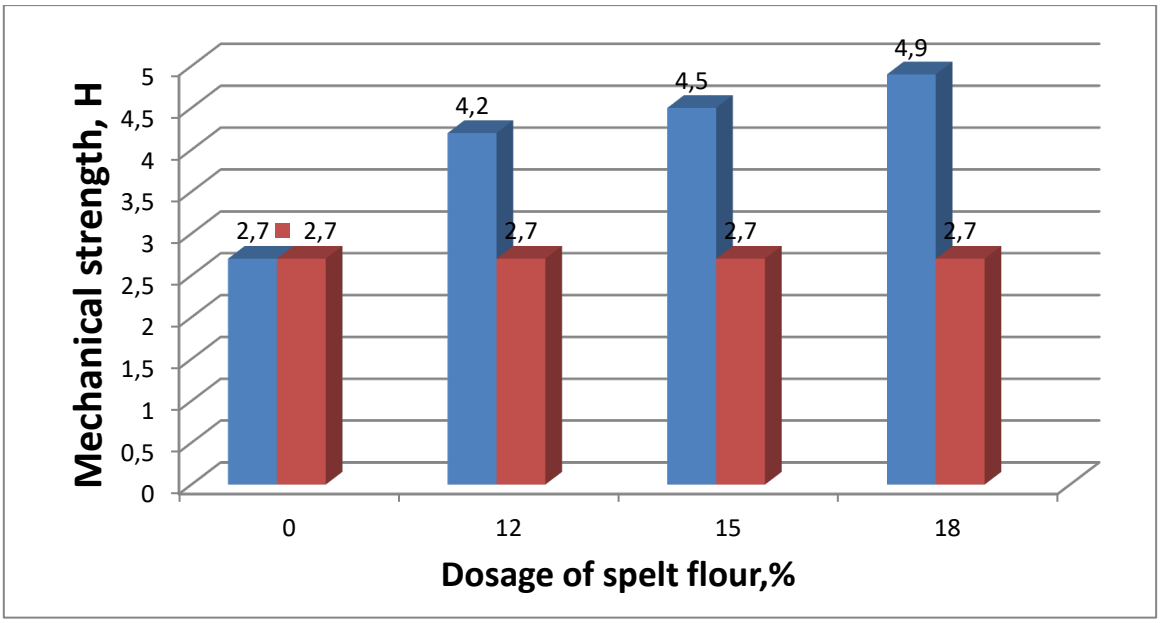

Figure 2 – Effect of spelt flour dosage on the mechanical strength of products

The cooking properties of pasta are characterized by the duration of cooking until tender, the amount of water absorbed, the loss of dry matter, the strength and shape retention of the cooked products, and the state after cooking (sticking) [20-22].

All samples did not stick together after cooking, and the shape retention was 100%.

One of the most important quality indicators characterizing the strength of the pasta structure is the loss of dry matter during cooking. For the analyzed products, the loss of dry matter during cooking was in the range of 2,16-5,6%, which meets the requirements of DSTU 7043:2009 «Pasta products. General technical conditions» (not more than 6.0%) for products of all groups, except for small format and thread-like products with a diameter of up to 1 mm. In the work, filamentous pasta products of the vermicelli type with a diameter of 1,3 mm were produced.

The introduction of additional protein from spelt flour helps to reduce the dry matter content in the cooking medium by 41.4, 50.1 and 61.42% compared to the control sample. The sample with 18% of spelt flour was characterized by the lowest values of the dry matter loss during cooking – 2,6%, respectively [23-30].

Conclusions.

The conducted studies have shown the possibility of obtaining good quality pasta with the introduction of such a recipe component as spelt flour.

Based on the results obtained during the analysis of the quality of pasta, the recommended dosage of non-traditional flour to obtain a product with improved nutritional value that meets the requirements of current regulatory documents is 18%.

The introduction of spelt flour into the pasta recipe will enrich the product with complete protein, vitamins and minerals and will not cause significant changes in the technological process.

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Анотація. *У статті досліджується асортимент макаронних виробів. Його різноманіття залежить від якості борошна, технологічного обладнання макаронних виробництв, присутності рецептурних добавок, наявності пакувальних матеріалів. Фахівцям відомо, що високоякісні макаронні вироби можна зробити лише зі спеціального борошна, яке виробляють з твердої пшениці. Протягом останніх років дефіцит такого борошна значно зріс, тому для виробництва макаронних виробів використовується борошно, властивості якого не відповідають технологічним вимогам.*

Метою статті є оцінка використання борошна зі спельти для виробництва макаронних виробів. Спельта характеризується високим вмістом повноцінного білку, до складу якого входять незамінні амінокислоти. Борошно зі спельти значно перевершує пшеничне за змістом ненасичених жирних кислот, клітковини, заліза, вітамінів групи В. Дослідження показало вплив різних дозувань борошна зі спельти на властивості макаронного тіста, напівфабрикатів і готових виробів. Відмічено збільшення кількості сирої клейковини, що відмивається із зразків макаронного тіста із внесенням борошна зі спельти за рахунок кількості білку, що додатково вносився. Визначено, що за якістю усі зразки клейковини характеризувалися як добрі та еластичні. Встановлено збільшення гідратаційної здатності клейковини і зниження значення критичної вологості під час сушіння при введенні 18% борошна зі спельти. Рекомендований низькотемпературний режим конвективного сушіння для макаронних напівфабрикатів з пропонованим борошном зі спельти із-за високого вмісту в ньому активних ферментів, які можуть викликати потемніння виробів при сушінні. Готові вироби відрізнялися однотонним рівним кольором з молочним відтінком, без темних вкраплень і слідів непромішування. Варильні властивості зразків борошна зі спельти характеризувалися як добрі, усі зразки зберігали свою форму на 100 %, показник втрат сухої речовини при варінні зберігався в межах вимог нормативної документації.

У результаті проведених досліджень доведена доцільність застосування борошна зі спельти для виробництва макаронних виробів.

Ключові слова: *макаронні вироби; борошно; спельта; клейковина; гідратаційна здатність.*

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