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Analysis of Extruded Grain Crops using Protein Fillings by Neural Network

Zhumalieva G. E.[1], Chomanov U. Ch.[2]*, Tultabaeva T. Ch.[3], Tultabaev M. Ch.[4], Kenenbay G.S.[5], Kasymbek R[6].

[1] LLP "Kazakh Research Institute of Processing and Food Industry", 050060, Kazakhstan
zhumalieva@gmail.com

[2] LLP "Kazakh Research Institute of Processing and Food Industry", 050060, Kazakhstan
chomanovu@gmail.com

[3] LLP "Kazakh Research Institute of Processing and Food Industry", 050060, Kazakhstan
tultubaeva@gmail.com

[4] LLP "Kazakh Research Institute of Processing and Food Industry", 050060, Kazakhstan
tultubaevmch@gmail.com

[5] LLP "Kazakh Research Institute of Processing and Food Industry", 050060, Kazakhstan
kenebaygs@gmail.com

[6] LLP "Kazakh Research Institute of Processing and Food Industry", 050060, Kazakhstan
kasymbekr@gmail.com

ABSTRACT

Great prospects for innovative technologies are laid in the production of fast-food products that are easily digestible, with functional properties, more perfect in comparison with products produced using traditional confectionery technology.

Currently, the Kazakh retail market of ready-made food products and high-readiness food products produced on the basis of grain raw materials is mainly represented by foreign manufacturers. In connection with the above, it is noted that for Kazakhstan, the organization of new production of these food products is simply unique for capturing the market of high-readiness products in Kazakhstan. In this regard, our work has developed a protein filling for starting extruded grain products.

The physicochemical, organoleptic and microbiological parameters of the protein filling were studied. It was noted that the moisture content in the test samples decreases by 6.6; 8.3; 10.3; 14.2 and 17.9 % compared to the control sample. It was found that the humidity and water activity in the protein filling decreases, which helps to prevent the development of microorganisms and store products for long-term storage. It was revealed that intestinal coli and pathogenic microorganisms were not detected in the protein filling. It was found that the optimal mode for protein filling is at a drying temperature of 1500C for 20 seconds. It was noted that no E. coli or pathogenic microorganisms were found in the protein filling.

Key words : Protein filling, triticale, extruded products, microbiological indicators, organoleptic indicators, physical and chemical indicators

1. INTRODUCTION

At all times, the problem of full and healthy food has been one of the most important issues facing human society. The deterioration of the environmental situation in the world in recent decades and the associated high level of contamination of food with radio nuclides, toxic chemical compounds, heavy metals, biological agents, and microorganisms contributes to the growth of negative trends in the health of the population. Therefore, along with the traditional approach to the role of food in human health, a new direction has been developed in recent years - functional nutrition. Nutrition must meet not only physiological needs, but also perform preventive tasks. Today, there is no doubt about the validity of enriching food with vitamins and trace elements that correct the existing imbalance that is typical in the diet of most modern people [1].

Based on the analysis of economic and technological features of the production of various types of cottage cheese products, it is believed that at this stage of development, technologies are very promising, in which raw materials are effectively used for the production of cottage cheese of high nutritional and biological value.

Interest in cottage cheese as a dietary product has increased significantly in recent years, which has led to an expansion of the range and an increase in its production. Previously, consumers gave their preference to cottage cheese products with a high fat content. And today, semi-fat and low-fat cottage cheese products are in great demand, the use of which is very useful for health, since they contain a large number of essential amino acids with high biological value. In our country, recently, cottage cheese is positioned as a dietary product, low-fat cottage cheese is the basis of many diets. Cottage cheese and cottage cheese desserts perfectly fit into the idea of a healthy lifestyle and proper nutrition. Even if the product is not enriched with prebiotics, vitamins and bifidocultures, the buyer is convinced that cottage cheese or cottage cheese dessert brings not only pleasure from pleasant taste sensations, but also a certain benefit to the body. This way the consumer is convinced that they are

improving their quality of life and taking care of their health [3].

For normal functioning of the body, along with proteins, minerals are also necessary, the most important of which are calcium and phosphorus compounds. They are the basis of bone and teeth. Calcium is also necessary for the normal functioning of the heart muscle and Central nervous system, and phosphorus is needed in brain and bone tissue. According to the number of calcium and phosphorus salts, as well as their physiologically favorable ratio to each other, cottage cheese is the most popular among other food products: it contains about 0.4% of them. It should be added that a large amount of calcium makes cottage cheese an indispensable product for bone fractures, diseases of the hematopoietic apparatus, rickets, etc. cottage Cheese also contributes to the excretion of urine, so it is recommended for hypertension, heart diseases, kidney diseases, etc. [3].

To obtain a high-quality product, a preliminary selection of raw materials should be carried out. It is relevant to study the possibility of using cottage cheese in the national protein filling for extruded products.

With the help of extrusion, it is possible to carry out complex processing of raw materials, which consists in the joint action of temperature, pressure and shear forces created by the working body of the extruder. At the same time, the processing time of raw materials is very short, which allows to preserve thermolabile substances in the product, and the possibility of processing a wide range of raw materials has caused considerable interest among food manufacturers. In addition, the extruder can replace a whole set of machines and mechanisms necessary for the production of products, which provides a large economic effect of production. Its use makes it possible to make the process continuous, easily controlled, and universal in terms of processed raw materials and finished products [4] .

Increasing interest in extrusion technology has given rise to a large number of design solutions that can stabilize the process parameters, expand the range of changes in performance characteristics, and increase the range of products produced on a single machine [5].

The market for extruded products has been formed relatively recently, while abroad, such products have long been part of the daily diet for many. The greatest development in this area has occurred in the last 10 years. During this period, the consumption of extrudates increased several times. The number of brands represented on our market, both domestic and foreign, has increased significantly. Filling the Kazakhstan market of extrusion products has created serious competition among manufacturers, which was an incentive for the emergence of new technologies, products and trends in this area. It should be noted that in the last 1.5-2 years the market for extruded products has moved from extensive to intensive development, i.e. the growth of the market is not ensured by increase in production of one specific product, and the development of new types of products and consumers switching to these new products [1-3].

A separate segment in the extrusion products market is co-extruded products. These are products that consist of a grain shell, inside of which there is a filling (fat, protein, fruit or flavored). Coextrudates are the most "young" in the domestic market, their development in Russia began approximately only in the 1990of the 20th century. This is due to the specifics of their production technology and more complex design of the equipment. Currently, the increasing interest of major manufacturers in co-extruded products is due to the ability to attract consumers by expanding the range of functional novelties. This is evidenced by an annual increase in production by 15-17%. Today, among ready-made breakfasts, pillows and tubes with filling take second place and are second only to corn flakes. Therefore, coextrudates can take their place among confectionery products, which will increase the total number of consumers and increase the profit of the manufacturer [6].

From the above data, it follows that food extrusion is a fairly progressive way to obtain high-quality food products. Its main advantages include the flexibility of technological schemes, high performance with small equipment dimensions, process continuity and relatively low production costs. However, in Kazakhstan, this technology has not yet been widely developed and requires a number of complex measures for the successful development of the consumer food market. This is primarily due to the fact that in the processing industries, extrusion is an insufficiently studied process. The reason for this is the insufficient technological base for the development and creation of universal experimental facilities and the lack of theoretical knowledge about the laws of the process, which prevents the selection of optimal technological parameters for extrusion processing of various plant raw materials.

The purpose of this work was to develop a national protein additive in the production of extruded products and to study the organoleptic, physical, chemical and microbiological properties of this product and the shelf life of the protein filling for the production of extruded products.

2. MATERIALS AND METHODS

Triticale of the "Taza" variety, cottage cheese (low-fat), jam, and vanillin were used as objects of research.

When performing the work, we used standard, generally accepted organoleptic, physical and chemical methods of research.

To assess the quality of raw materials, standard methods for determining organoleptic, physical and chemical quality indicators were used.

Quality indicators of grain crops were determined in accordance with the methods set out in the following normative documents:

- determination of color, taste and crunch according to GOST 27558-87 [2];
- determination of the mass moisture content of grain crops according to GOST 9404-88 [3];
- determination of grain ash content on the Infrascan device;
- determination of the quantity and quality of raw gluten on the Infrascan device;
- determination of protein content on the Infrascan device;

- determination of the acidity of grain crops according to GOST 27493-87 [4];
- microbiological indicators of cottage cheese according to GOST R 52738-2007
- organoleptic indicators of cottage cheese according to GOST R52096-2003
- physical and chemical indicators according to GOST R52096-2003.

One of the most common useful dairy and protein products that are in high demand among the population is cottage cheese, which in terms of nutritional value is almost equal to such animal products as meat, fish and egg. When choosing cottage cheese as an enriched product, we were guided by the following factors: it is a protein that is the most valuable part of milk and in concentrated form contained in cottage cheese and has an important share in the market of dairy products [7-8].

When choosing a national protein filling, we took into account the need for maximum enrichment of the product with animal proteins and minerals in order to achieve their therapeutic and prophylactic dose. Products of processing of plant raw materials were introduced into various products in the form of food additives.

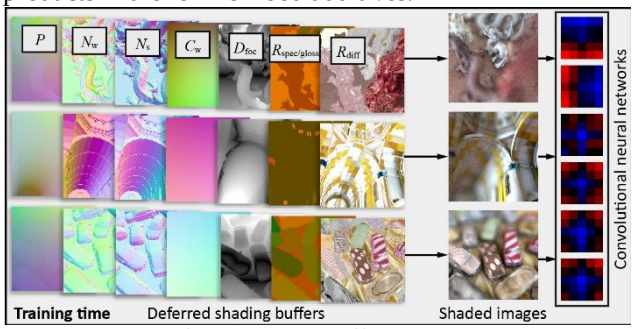

Figure 1: Deferred shading buffers in neural network

The main raw materials for the fillings were cottage cheese, crushed sprouted triticale, jam and vanillin. Triticale was sprouted and ground under laboratory conditions. The moisture content of cottage cheese is 64.2-65.0%.

To increase the range of finished products enriched with cottage cheese, it is necessary to modify the technology of obtaining the product with the use of triticale sprouted, rich in vitamins and micro-macroelements. This will allow you to use it to meet the physiological needs of the human body in nutrients and energy and perform therapeutic and preventive functions[6].

According to physical, chemical and organoleptic parameters, in accordance with GOST 31453-2013 "cottage Cheese", the product must meet the requirements presented in table 1.

The method for developing a protein filling includes the process of drying in high-temperature fat of cottage cheese and its aging, cooling, and adding crushed sprouted triticale with flavoring additives to the curd mass. Drying in high-temperature fat of cottage cheese was carried out in laboratory conditions at a temperature range from 120 to 170°C to remove moisture. To do this, the oil was heated at various temperatures from 120 ...170°C. Then the fat-free cottage cheese was lowered into the oil and kept for 20 seconds. After that, the curd was pressed and cooled to room temperature. Organoleptic and physico-chemical parameters of cottage cheese were determined when dried in high-temperature fat (table 1,2).

Table 1: Physico-chemical and organoleptic parameters of cottage cheese

Name of the indicator	The norm for fat-free products with a mass fraction of fat,%, not less than 1.8
Consistency and appearance	soft, spotting or crumbly with or without palpable particles of milk protein. For a low - fat product, there is a slight release of serum
Taste and smell	clean, fermented milk, without foreign tastes and odors
Color	white or cream-colored, uniform throughout the mass
Mass fraction of protein, %, not less than	1,8
Mass fraction of moisture, %	80,0
Acidity, 0T, no more	240

Table 2: Physico-chemical and organoleptic parameters of cottage cheese

Indicators	Control (without drying)	Drying temperature, °C				
		120	130	140	150	170
Acidity, ^{0}T	176	180	182	186	192	200
Humidity, %	79,0	67,6	65,5	58,0	50,8	49,0
Water activity	0,9889	,9820	0,9801	0,9787	0,9743	0,9736
Organoleptic indicator						
Consistency and appearance	soft, crumbly with the presence of milk protein particles			viscous, molten mass		
Taste and smell	clean, fermented milk, without foreign tastes and odors	clean, slightly pronounced taste and smell oil				
Color	white	white with a cream tint, uniform throughout the mass		not uniform, brownish		

Table 2 shows that the physical and chemical parameters of cottage cheese when dried in high-temperature fat differ in moisture content from the control sample. In cottage cheese, after drying at a temperature of 120-130°C, the humidity decreases by 11.4 and 13.5 %, and after drying at a temperature of 140, 150 and 170°C, the humidity content decreases by 21.0; 28.2 and 30 % compared to the control sample. And so during the drying of cottage cheese in high-temperature fat, the moisture content is reduced from 11.4 to 30%, depending on the temperature. Apparently, the decrease in moisture in fat-free cottage cheese is due to the fact that the bound water in the microcapillaries of the protein molecules is reduced, resulting in the amount of the liquid phase is reduced, hence the mass is obtained crumbly.

According to organoleptic characteristics, after drying at a temperature of 170°C, the consistency of the curd becomes viscous and molten mass, when mixed, it clumps and has a brownish color compared to other samples, and at a temperature of 120 to 150°C, the mass does not differ in consistency and appearance from the control sample. After drying, the color has a cream tint compared to the control sample, all samples have a slightly pronounced taste and smell of oil [11,12].

Figure 2 shows cottage cheese after drying at different temperatures.

The use of crushed sprouted triticale in protein filling for long-term storage, which contains b vitamins, vitamins C, A, E and a complex of various macro-and microelements: magnesium, zinc, potassium, iron and contributes to the nutritional value of the finished product. When sprouting triticale, all enzymes, vitamins and micro-macronutrients are in an active state, which allows you to enrich the composition of protein fillings with useful substances for the human body.

Figure 2: Cottage cheese after drying in high-temperature fat (120 -170°C)

Thus, it was found experimentally that the optimal temperature during the drying of cottage cheese is 150 °C. Experimentally determined the recommended amount of sprouted triticale for adding to the protein filling. A larger amount of adding sprouted triticale to the mixture has a negative effect on the taste of the product. When developing fillings, we took into account the combination of components, organoleptic characteristics (taste, smell, appearance) and the safety of nutrients. When preparing protein fillings using sprouted crushed triticale, the ratio of components was adopted. Table 3 shows the composition of the prepared protein filling.

Table 3: Composition of protein filling

Raw	Quantities of raw materials per 100, g
Cottage cheese (fat-free)	60
Sprouted crushed triticale	20
Jam	20
Vanillin	0,5

When preparing the protein filling, the sprouted triticale grains were dried and crushed, the humidity of the crushed triticale was 6.0 – 7.0 % and the acidity was 5.4 ^{0}H. the optimal ratio of cottage cheese, triticale and jam was determined Experimentally when preparing the protein filling for long-term storage. Adding strawberry jam to the filling improved the organoleptic characteristics, the taste is pleasantly sweet, the color is light pink. Vanillin was used to enhance the aroma and taste indicators in the form of a pleasant aftertaste with strawberry notes. With the addition of chopped triticale into cheese after drying, the mass is crumbly, and when you add jam increased the content of mono - and dikhanov in the product (water soluble substances), which form the hydration shell, binding moisture from the capillaries of protein molecules, causing the amount of liquid phase in the product increases and, consequently, the mass is homogeneous pasty mass [10].

According to the organoleptic evaluation of the protein filling with filler, it was found that when adding a flavor filler, the organoleptic parameters of the protein filling improve, and the flavor composition is formed in combination with sprouted crushed triticale [5]. When choosing the optimal amount of flavor filler, it results in a protein filling with a long-term storage with a slightly sweet taste, optimal structural and mechanical properties are achieved, and a fairly pleasant crunch and sweetness is obtained. Cottage cheese products obtained from different manufacturers and under different conditions are very different from each other in terms of viscosity, humidity, friability and taste. When preparing protein fillings based on cottage cheese with high-temperature drying in fat, different curd mass is also obtained, differing in humidity, friability and taste [9].

Figure 3 shows protein fillings obtained from cottage cheese dried at different temperatures (120-1700C) in fat.

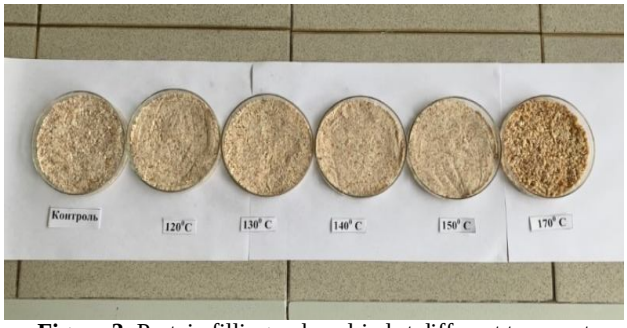

Figure 3: Protein fillings when dried at different temperatures (120-1700 C)

Table 4 and figure 3 show the organoleptic and physico-chemical parameters of protein filling with cottage cheese dried at different temperatures (120-1700C) in fat.

Table 4: Organoleptic parameters of protein filling

Indicators	Control (without drying)	Drying temperature, °C				
		120	130	140	150	170
organoleptic indicator						
Consistency and appearance	soft, homogeneous, pasty mass with particles of added triticale					soft, crumbly, with lumps and particles of added triticale
Taste and smell	characteristic, sweet, with a pronounced taste of the additive being added, a pleasant crunch is felt when chewing					
Color	light pinkish, uniform throughout the mass with inclusions					light brown, uneven throughout the mass with inclusions

According to table 4, according to the results of research, it was found that in appearance all the samples were a homogeneous, pasty mass with inclusions and had a soft consistency. The color of the products is light pinkish and had a pronounced taste and smell of the added additive. when chewing, a pleasant crunch was felt.

According to research data, it was found that the optimal sample for further research was taken protein filling when dried at a temperature of 1500C in fat for 20 seconds.

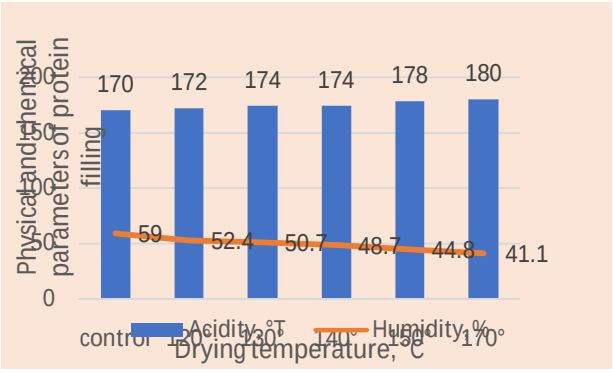

Figure 4: Physical and chemical parameters (humidity, acidity) of protein filling when drying at different temperatures

Microbiological parameters of the optimal sample (drying temperature 1500C) in high-temperature fat were studied. Analysis of the presented data shows that the moisture content in the test samples decreases by 6.6; 8.3; 10.3; 14.2 and 17.9 % compared to the control sample. Reducing humidity and water activity helps prevent the development of microorganisms and store products for long-term storage. According to this indicator, the acidity in the test samples increases by 10 0T compared to the control sample.

Table 5: Microbiological parameters of protein filling

Microbiological indicators	Characteristic
Bgcp (coliform) in 0.01 g of product	not detected
Pathogenic microorganisms, including Salmonella in 25 g	not detected
S. Aureus staphylococci in 0.1 g of product	not detected

Table 5 shows the microbiological parameters of the protein filling. The presented data show that no E. coli or pathogenic microorganisms were detected in the prepared protein filling.

3. CONCLUSION

Analyzing the results of the organoleptic evaluation of the national protein filling with filler, we can conclude that when adding a flavor filler, the organoleptic characteristics of the curd filling improve, and a flavor composition is formed in combination with sprouted crushed triticale. When choosing the optimal amount of flavor filler, they result in a national protein filling with a slightly sweet taste, optimal structural and mechanical properties are achieved, and a sufficiently thick consistency and sweetness is obtained. It was found that the protein filling of E. coli and pathogens were not detected.

Thus, the results of studies of organoleptic, physical and chemical parameters allow us to recommend the introduction of sprouted triticale with flavoring fillers in cottage cheese fillings.

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