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ANALYSIS OF THE IMPACT OF COMPONENT COMPOSITION ON THE TECHNOLOGICAL PROPERTIES OF FLOUR-BASED CONFECTIONERY PRODUCTS

Abstract. The article presents the results of a study on the effect of adding powders made from pear and black currant on the quality of semi-finished products and finished goods, using sugar cookies as an example. The physicochemical and technological properties of pear and black currant powders, as well as their impact on dough structure, texture, and organoleptic characteristics of the finished product, were considered. Changes in the technological properties of semi-finished and finished flour confectionery products are presented depending on changes in the component composition. It was found that the optimal concentration of pear powder is 6%, while 4.5% of blackcurrant powder improves dough plasticity and increases water absorption, enriches the product with vitamins, organic acids, and antioxidants, and enhances the functional properties of the finished product.

Keywords: pear powder, currant powder, sugar cookies, functional ingredients, natural additives.

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Introduction. The use of fruit and berry raw materials in the technology of flour confectionery provides significant advantages, enriching products with valuable nutrients and improving their organoleptic properties. The addition of berry powders, such as currants, helps to increase the content of dietary fiber, vitamins and minerals in products, which makes them more beneficial to the health of consumers [1].

The development of new directions in the production of functional nutrition products based on non-traditional types of plant raw materials is becoming increasingly relevant [2,3].

The use of fruit and berry additives also improves the taste characteristics and appearance of confectionery products. For example, the introduction of blackcurrant berry powder into the pastry dough gives the product an attractive color and flavor without compromising its physico-chemical properties [4].

In addition, the use of fruit and berry raw materials helps to increase the shelf life of products due to the natural antioxidants contained in berries. This reduces the need for artificial preservatives and improves the environmental cleanliness of products [3].

Thus, the integration of fruit and berry raw materials into the formulations of flour confectionery products not only increases their nutritional and biological value, but also improves consumer properties, which helps to expand the range and increase the competitiveness of products on the market [5].

The chemical composition of fruit and berry raw materials is very important and rich for the human body. They are enriched with vitamins, macro- and microelements that positively affect the functioning of the central nervous and cardiovascular systems, promote the growth and development of bone and muscle tissue, regulate acid-base balance, maintain homeostasis and help in the prevention of diseases. In addition, fruits and berries contain a lot of dietary fiber, flavonoids, antioxidants, and other biologically active substances [6].

Black currant berries contain a whole complex of biologically active and nutritional substances (vitamins, phenolic compounds, organic acids, dietary fiber, micronutrients) that have a stimulating effect on many functions of the human body. The composition of sugars characterizing the nutritional value of berries is quantitatively dominated by fructose with a low content of glucose and sucrose [7]. Black currant and its processed products are used as auxiliary means to improve the quality and increase the storage capacity of the target products [8].

Black currant has a huge number of important components. 100 g of berries contain vitamin C – 200 mg, iron – 1.3 mg, potassium – 372 mg, caloric content – 45 kcal. It has a beneficial effect on the work of the heart and brain, strengthens blood vessels, eliminates intestinal problems; reduces inflammatory processes and promotes the regeneration of damaged cells; regulates glucose levels; calms the nervous system; reduces the harmful effects of radioactive elements; normalizes metabolic processes; prevents the growth of cancer cells [9].

The main sugars in black currant berries are fructose 48-60% of the total sugar content, glucose 38-47%, and sucrose [10]. Organic acids contained in black currant are represented by citric acid (75-97% of the total acid content), malic acid, quinic acid, and ascorbic acid [11]. The main organic acid found in blackcurrant pomace was citric acid, although malic acid was also identified [12]. Black currant berries contain significant amounts of dietary fiber, including 2.68% insoluble and 1.62% soluble [10].

The total content of phenolic compounds in berries varies from 598 to 2798 mg/100 g, the content of anthocyanins ranges from 160-411 mg/100 g, including delphinidin-3-O-glucoside, delphinidin-3-O-rutinoside, cyanidin-3-O-glucoside and cyanidin-3-O-rutinoside they are characteristic of black currants. 92-97% of the total amount of anthocyanins in black currants are cyanidin and delphinidin glycosides (3-O-glucoside and 3-O-rutinoside) [13].

The total antioxidant capacity of black currant, measured by the photometric FRAP (Ferric Reducing/Antioxidant Power) method using a photometric reagent – tripyridyltriazine, 1,10-phenanthroline, 2,2'-dipyridyl in terms of Fe^{3+} recovery intensity, is 51.6 ± 1.2 mmol Fe^{2+}/g, and is one of the highest compared to other berries [14]. Black currant fruits contain 116-342 mg/100 g of ascorbic acid and 160-411 mg/100 g of anthocyanins, which are the most common representatives of polyphenolic compounds in this fruit [15].

Studies show that the addition of blackcurrant powder in an amount of 10-15% by weight of flour improves the organoleptic and physico-chemical

parameters of sponge dough. The foaming ability of the mixture, the specific volume and porosity of the baked semi-finished product increase compared to the control, and the products acquire a finely porous, lush structure. The introduction of pear powder into the formulation of sugar biscuits in the amount of 2.5-3% by weight of sugar and fat solids does not change the organoleptic parameters, but increases the physiological value of the product.

The introduction of pear powder into the formulation of sugar biscuits is a promising direction for enriching confectionery products with biologically active substances and improving their organoleptic characteristics. Pears are rich in vitamins, minerals, and dietary fiber, which makes them attractive for use in the food industry [16].

Pear powder is obtained by drying and grinding pear fruits. It contains a significant amount of carbohydrates, mainly in the form of fructose and glucose, dietary fiber, vitamins (C, K, group B) and minerals (potassium, copper). Dietary fiber helps improve digestion, and vitamins and minerals increase the overall nutritional value of the product.

The addition of pear powder to sugar cookie dough affects its rheological properties. The dietary fibers present in the powder can bind water, changing the consistency of the dough and requiring adjustments to the formulation to achieve optimal plasticity. In addition, natural sugars from pear powder can promote caramelization, improving the color and flavor of the finished product [17].

The addition of pear powder affects the physico-chemical parameters of cookies, such as moisture, acidity and the content of reducing sugars. Dietary fiber can increase the moisture binding capacity of the product, which slows down its hardening and prolongs its shelf life. Natural sugars from pear powder can increase the overall sweetness of the product, which should be taken into account when dosing sugar in the formulation [18].

The use of pear powder in the production of sugar biscuits makes it possible to enrich the product with valuable nutrients, improve its organoleptic properties and extend its shelf life. However, when developing the formulation, it is necessary to take into account the effect of the powder on the rheological properties of the dough and the physico-chemical parameters of the finished product in order to ensure high quality and consumer attractiveness of the product.

The use of blackcurrant and pear powders in the production of sugar biscuits is a promising direction for enriching confectionery products with biologically active substances and improving their quality characteristics. Black currant is rich in vitamins C, P and group B, and also contains a significant amount of anthocyanins and pectin substances with antioxidant properties. Pears, in turn, are a source of dietary fiber, organic acids, and trace elements such as potassium and magnesium. The introduction of powders from these fruits into the cookie formulation helps to increase its nutritional value and functional properties.

The use of fruit and berry powders affects the technological properties of the dough and the finished product. The addition of blackcurrant powder improves the structural and mechanical properties of the dough, increasing its viscosity and plasticity, which facilitates the molding of products. Pear powder, due to its high content of pectin substances, can affect the hydration properties of the dough, helping to retain moisture and prevent staling of the finished product. In addition, the natural antioxidants present in fruit and berry powders can slow down the oxidation of fats, increasing the shelf life of products.

Materials and methods. Organoleptic and physico-chemical research methods were used to carry out the work. The following research materials were selected:

- GOST 26574-85. Wheat flour baking;
- currant and pear powder;
- control samples of sugar cookies;
- experimental samples of sugar cookies.

Quality indicators were determined by the methods described in the following regulatory documents: GOST 5897-90 Methods for determining organoleptic quality indicators; GOST 5898-87 Methods for determining acidity and alkalinity; GOST 5900-73 Methods for determining moisture and dry substances; GOST 10114-80 Method for determining wetness.

Methods for determining organoleptic parameters according to GOST 5897-90 include visual assessment of the appearance and color of the product, tactile analysis of consistency, as well as tasting to determine taste and odor. The assessment is carried out under standardized conditions using standards or scales for quantitative and qualitative characteristics. Trained experts participate in the process, and the results are recorded in protocols for further analysis and comparison with established quality standards.

According to GOST 5898-87, the method for determining alkalinity is based on titration of a sample of a food product solution with a standard acid solution (HCl) in the presence of an indicator such as phenolphthalein. The sample of the substance is dissolved in distilled water and titrated until the color of the indicator changes, which indicates that a neutral reaction has been achieved. The amount of acid consumed is fixed, and based on it, the alkalinity is calculated in established units.

GOST 5900-73 describes the determination of humidity using a «SESH-3M» drying cabinet by weighing a pre-prepared sample before and after drying. A sample of the product with a mass set by the standard is evenly distributed on a pallet and placed in a drying cabinet, where it is kept at a set temperature (105°C) for a certain time to a constant mass. After cooling in the desiccator, re-weighing is carried out, and humidity is calculated from the difference in weight before and after drying, expressed as a percentage of the initial mass of the sample.

The process of obtaining powder from pears includes the following steps: receiving raw materials, washing fruits, removing seeds, slicing 0.3-0.5 mm thick, drying in a drying unit, grinding in a laboratory mill, sieving through a sieve and obtaining the finished product – powder from pears.

The process of obtaining powder from fruits is different from the process of obtaining powder from berries. These differences are related to the physical characteristics, shape and structure of fruits and berries.

To obtain powder from pears and black currants, an electric Neptune dryer was used, designed for drying vegetables and fruits. The pears were sliced 0.3-0.5 mm thick and dried at a temperature of 55-70°C for 15 hours. To dry the black currant and then obtain the powder, a temperature regime of 40-50°C with a duration of 10-15 hours was used, controlling the degree of drying of the berries.

Dried fruits and berries were crushed using an LZM-1M laboratory mill. The resulting powder from the pear was sieved through a laboratory sieve made of silk material. At the same time, blackcurrant powder, due to the peculiarities of the physical structure of the berries, did not require additional sieving.

Research results and discussion. The chemical composition of blackcurrant and pear powders has a significant effect on the quality of sugar cookies. Currant

powder is rich in organic acids, vitamins (especially vitamin C), pectin and anthocyanins, which give baked goods a rich taste, light acidity and a natural dark shade. Due to the high content of antioxidants, such additives can prolong the freshness of the product, preventing the oxidation of fats. In addition, currant pectin improves the texture of cookies, making them softer and more airy.

Pear powder, in turn, is characterized by a high content of natural sugars, fiber and tannins. Its use gives the liver a sweet taste and a subtle fruity aroma. Natural sugars from pears contribute to caramelization, improving the color of the cookie crust, and fiber increases its nutritional value. However, an excess of pear powder can make the dough more dense, which should be taken into account when developing the recipe.

Table 1

Macronutrient composition of pear powder

Name of the macronutrient	Mass fraction, g/100 g
Carbohydrates	48.20
Dietary fiber, including:	35.94
Pectin substances	8,61
pectin	0.91
pro pectin	7.70
hemicellulose	11.20
cellulose	16.13
Proteins	4.48
Lipids	0.12
Mineral substances	4,20
Organic acids	1.05

Based on the data in Table 1, it can be concluded that pear powder is a product with a high carbohydrate content (48.20 g/100 g), which makes it a valuable source of energy. The substantial amount of dietary fiber (35.94 g/100 g), including pectins (0.91 g), propectins (7.70 g), hemicellulose (11.20 g) and cellulose (16.13 g), emphasizes its importance for maintaining the normal functioning of the digestive system.

In addition, pear powder is characterized by a moderate protein content (4.48 g/100 g), low lipid content (0.12 g/100 g), as well as the presence of minerals (4.20 g/100 g) and organic acids (1.05 g/100 g). These indicators indicate its high nutritional value and wide application possibilities in the food industry, especially for the creation of functional and fortified products.

Table 2

Chemical composition of 100 g of black currant

Chemical Substance	Quantity
1	2
Water, g	82.0-85.0
Proteins, g	1.0-1.4
Fats, g	0.2-0.4
Carbohydrates, g	6.6-15.4
Mono- and disaccharides, g	6.7-13.7
Fiber, g	3.0
Starch, g	0.6-2.7

Table 2 (continued)

1	2

Pectin, g	0.38-1.5
Organic acids, g	2.2-3.9
Ash, g	0.9
Vitamin β-carotene, mg	0.08-0.11
Vitamin E, mg	0.72
Vitamin B_1, mg	0.03
Vitamin B_2, mg	0.04
Vitamin B_6, mg	0.13
Vitamin B_9, mcg	5.0
Vitamin PP, mg	0.3

Based on the data in Table 2, it can be concluded that the main energy component is carbohydrates (6.6-15.4 g/100 g), among which mono- and disaccharides account for a significant proportion (6.7-13.7 g/100 g). The content of dietary fiber, including fiber (3.0 g), pectin (0.6-2.7 g) and starch (0.38-1.5 g), is also noted, which emphasizes the benefits of the product for maintaining the normal functioning of the digestive system.

In addition to carbohydrates, black currant contains a small amount of proteins (1.0-1.4 g) and fats (0.2-0.4 g), as well as organic acids (0.38-1.5 g), which help to improve the taste and provide antioxidant properties. The berry also contains minerals (ash – 2.2-3.9 g) and vitamins, including beta-carotene, vitamin E, as well as B and PP vitamins. This composition makes black currant a valuable product for dietary and therapeutic nutrition.

Table 3

The effect of pear powder on gluten quality

Option	Gluten content, %	Indicator for the IDC device-1
The control sample	32	87,9
1,5 %	31	83,6
3%	29.7	80,1
4,5%	29.5	79,3
6%	29	78,9
7,5%	28,7	78,5

Based on the data in Table 3, conclusions can be drawn about the effect of adding pear powder on the gluten content and the test quality index according to the IDK-1 device. With an increase in the proportion of pear powder in the samples, a decrease in gluten content is observed: from 32% in the control sample to 28.7% with the addition of 7.5% powder. This indicates that pear powder can be used to adjust the texture of the dough, making it less elastic and softer.

Based on the data analysis, it was found that adding 6% pear powder to the sugar cookie recipe is the optimal solution. The gluten content decreased from 32% (control sample) to 29% with the addition of 6% pear powder, which improved the plasticity and softness of the dough. This is due to the high sugar content in pear powder, which interact with flour proteins and form glycoproteins that strengthen the structure of the dough.

Table 4

Physico-chemical parameters of sugar biscuits with the addition of 6% pear powder and 1.5; 3; 4.5; 6; 7.5% currant powder

Indicators according to GOST	The control sample	6%+1.5	6%+3	6%+4.5	6%+6	6%+7.5
Humidity, %	6	6.3	6.9	7.2	7.8	8.5
Wetness, %	152.1	153.8	159.5	164.7	171.6	182.3
Alkalinity, deg	1.70	1.70	1.72	1.72	1.74	1.76

The addition of pear and currant powders increases the moisture and wetness of the biscuits, improving their softness and structural stability. With an increase in the concentration of blackcurrant powder, humidity (up to 8.5%) and water absorption (up to 182.3%) increase. The alkalinity varies slightly, which indicates the stability of the acid-base balance of the product.

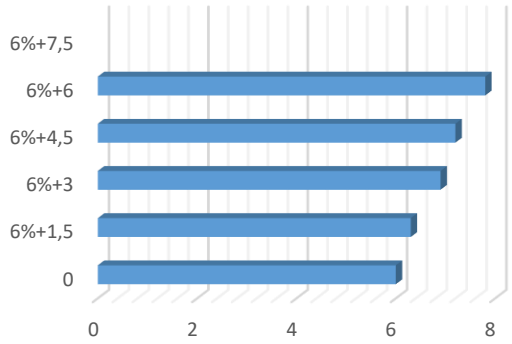

Fig. 1 – Mass fraction of moisture in finished products, %

Based on the data (Fig. 1), it can be noted that the addition of blackcurrant powder in combination with 6% pear powder has a significant effect on the moisture index. In the control sample, the humidity index is 6%. When 1.5% blackcurrant powder is added, the humidity increases to 6.3%, and when 3% is added, it increases to 6.9%.

A further increase in the content of blackcurrant powder leads to a more pronounced increase in humidity: at 4.5% it is 7.2%, and with a maximum addition of 7.5% it reaches 8.5%. This indicates the ability of powders to bind and retain moisture, which may be due to their chemical composition, in particular, the high content of pectins and other hydrophilic substances.

Thus, the use of a combination of pear and currant powders makes it possible to increase the moisture content of the product, which is important for improving its texture and increasing shelf life. These results emphasize the prospects of using these powders in functional food formulations.

Based on the graph (Fig. 2), it can be concluded that the addition of blackcurrant powder in combination with 6% pear powder increases the wetting index. In the control sample, the wetness index is 152.1%. With the addition of 1.5% blackcurrant powder, the wetness increases to 153.8%, and with an increase in the proportion of blackcurrant powder to 7.5%, it reaches 182.3%. This indicates the synergistic effect of the interaction of the two powders, which increases the ability of the dough to absorb water.

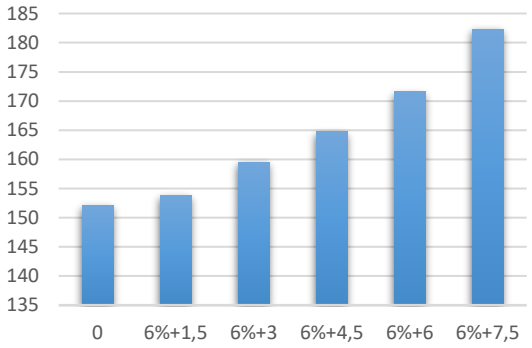

Fig. 2 – Wetness of finished products, %

The dynamics of wetness growth is explained by the high content of hydrophilic components, such as dietary fiber and pectin, in blackcurrant powder. This property allows the use of this powder combination in product formulations where increased moisture capacity is required, for example, in bakery or confectionery products, providing improved structural and textural characteristics of finished products.

Based on the conducted research, it was found that the combination of 6% pear powder and 4.5% blackcurrant powder is the most optimal option for developing a sugar cookie recipe. This combination of ingredients ensures balanced moisture (7.2%) and wetness (164.7%), which positively affects the structure of the dough, its plasticity and formability. Due to these properties, the organoleptic characteristics of the finished product are improved, including softness and delicacy of texture.

In addition, the introduction of powders in this proportion enriches the product with functional components such as dietary fiber and pectins, which are contained in the composition of pear and currant powders. This makes it possible to increase the nutritional value of cookies while preserving their traditional taste qualities. Thus, this formulation can be recommended for use in the production of sugar cookies with improved quality characteristics and functional properties.

Conclusion. The study showed that the use of powders from pears and currants has a positive effect on the quality of both semi-finished products and finished products. The addition of fruit powders improves the textural characteristics of the dough, makes it more plastic and soft, and also provides high water absorption capacity. These changes improve the process of forming dough blanks, facilitating their processing and creating favorable conditions for baking.

Pear and black currant, acting as functional ingredients, enrich the chemical composition of the finished product. The high content of sugars, dietary fibers, vitamins and organic acids allows you to increase the nutritional value of sugar cookies by adding useful substances that have a beneficial effect on the human body. The inclusion of these ingredients also enhances the taste characteristics of the products, adding fruity notes and natural sweetness.

Thus, pear and blackcurrant powders not only improve production processes, but also contribute to the creation of functional products. The use of these ingredients opens up prospects for the development of confectionery products with improved organoleptic and nutritional properties that meet modern consumer requirements for healthy and high-quality nutrition.

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КОНДИТЕРЛІК ӨНІМДЕРДІҢ ТЕХНОЛОГИЯЛЫҚ ҚАСИЕТТЕРІНЕ КОМПОНЕНТТІК ҚҰРАМНЫҢ ӘСЕРІН ТАЛДАУ

Аңдатпа. Мақалада алмұрт пен қара қарақат ұнтақтарын қантты печенье мысалында жартылай фабрикаттар мен дайын өнімдердің сапасына әсерін зерттеу нәтижелері көрсетілген. Алмұрт және қара қарақат ұнтақтарының физико-химиялық және технологиялық қасиеттері, олардың қамырдың құрылымына, текстурасына және дайын өнімнің органолептикалық сипаттамаларына әсері қарастырылды. Жартылай фабрикаттар мен дайын ұннан жасалған кондитерлік өнімдердің технологиялық қасиеттерінің өзгерістері құрамының өзгеруіне байланысты ұсынылған. Зерттеу барысында алмұрт ұнтағының оңтайлы концентрациясы 6%, ал қарақат ұнтағының 4,5% екені анықталды. Бұл қамырдың пластикалылығын жақсартып, су сіңіргіштігін арттырып, өнімді дәрумендермен, органикалық қышқылдармен және антиоксиданттармен байытатыны және дайын өнімнің функционалдық қасиеттерін жақсартатыны анықталды.

Тірек сөздер: алмұрт ұнтағы, қара қарақат ұнтағы, қантты печенье, функционалды ингредиенттер, табиғи қоспалар.

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АНАЛИЗ ВЛИЯНИЯ КОМПОНЕНТНОГО СОСТАВА НА ТЕХНОЛОГИЧЕСКИЕ СВОЙСТВА МУЧНЫХ КОНДИТЕРСКИХ ИЗДЕЛИЙ

Аннотация. В статье представлены результаты исследования влияния добавления порошков из груши и черной смородины на качество полуфабрикатов и готовых изделий, на примере сахарного печенья. Рассмотрены физико-химические и технологические свойства грушевого и черносмородинового порошков, их влияние на структуру теста, текстуру и органолептические характеристики готового продукта. Представлены изменения технологических свойств полуфабрикатов и готовых мучных кондитерских изделий в зависимости от изменения компонентного состава. Установлено, что оптимальная концентрация грушевого порошка составляет 6% и 4,5% черносмородинового порошка обеспечивает улучшение пластичности теста, повышение водопоглощения, обогащая продукт витаминами, органическими кислотами и антиоксидантами, усиливает функциональные свойства готового изделия.

Ключевые слова: грушевый порошок, смородиновый порошок, сахарное печенье, функциональные ингредиенты, натуральные добавки.