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ASSESSMENT OF THE QUALITY OF CREAM-WHITE CANDY WITH THE ADDITION OF FRUIT AND BERRY PASTE DURING STORAGE

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Summary

One of the trends in modern nutrition is targeting people who care about their health. Confectionery made from sugar is in stable demand among people of different age groups, and research into their enrichment with vital nutrients is promising. One of the ways to implement such a task is the use of fruit and berry processing products, in particular in the form of pastes, during the production of candies. The purpose of the research was to evaluate the quality of cream-whipped candies with the addition of apple, quince and blackcurrant paste (40:50:10) during storage.

It was established that the process of hydrolysis of the lipid component of candies with paste occurs at a higher rate compared to the control. This is due to their higher acidity and moisture. However, the fats of candies with the addition of fruit and berry paste are less prone to the formation of peroxides, which is explained by the presence in their composition of a significant number of polyphenolic compounds with pronounced antioxidant properties (anthocyanins and catechins), which are absent in the control sample. In particular, on the 60th day of storage, the value of the peroxide value for the sample with the additive was 27.9 % less than that of the control product.

It has been established that candies with paste lose moisture more slowly due to the higher content of non-starch polysaccharides. Thus, on the 60th day, the moisture content of the control decreased by 11.33 %, and the product with paste decreased by 8.72 %. Smaller moisture losses ensure greater stability of their rheological characteristics during storage. It was noted that the strength and density of such candies increase more slowly than in the sample without the additive.

The results of the research indicate the compliance of cream-whipped candies with fruit and berry paste to the normative storage terms in terms of oxidative stability of the lipid complex, physico-chemical and sensory indicators.

Keywords: cream-whipped candies, fruit and berry paste, quality, hydrolysis of fats, oxidation of fats, storage.

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1. Introduction

One of the trends in modern nutrition is targeting people who care about their health. The motivational factors influencing the food preferences of this group of consumers are, in particular, the naturalness of the raw ingredients and the presence of substances useful for health [1]. The COVID-19 pandemic had a significant impact on the increase in demand for functional and safe food products [2]. According to studies [3, 4], about 40 % of consumers have changed their eating behavior as a result of the pandemic, in particular, in the direction of increasing the

consumption of healthy food. This makes it necessary to adapt the most commonly used food products to the changed requirements of the consumer.

Confectionery products, including sugar confectionery, are in stable demand among people of different age groups. This makes the choice of such products promising for modification in the direction of naturalness and functionality. One of the ways to implement this task can be the use of fruit and berry processing products during the production of sugar confectionery. The peculiarity of the chemical composition of such raw materials is the presence of various compounds, which, on the one hand, have high physiological significance for humans, and on the other hand, exhibit a number of technological properties. For example, pectin substances are physiological radioprotectors and biosorbents for binding heavy metals [5], and in food systems can perform the functions of a structure former. Polyphenolic compounds have a positive effect on metabolic processes in the human body and are capable of exerting an antioxidant, immunomodulating, and antimicrobial effect on it, and their addition to food products helps extend shelf life or provides the necessary color [6]. Organic acids improve digestion processes and suppress the development of pathogenic microflora in the intestines, and when added to food products have a preservative effect [7]. In addition, fruit and berry raw materials contain other biologically active compounds (vitamins, minerals, etc.) in easily digestible forms for the human body. It also has original sensory properties that go well with the organoleptic properties of sugar confectionery. This proves the perspective of using fruit and berry raw materials in the technology of sugar confectionery products both as an enrichment and as a technological component that will improve the nutrient composition of the products and remove artificial food additives from their formulation.

Given the seasonality, fruit and berry raw materials in sugar confectionery technologies are used mainly in the form of processed commercial forms suitable for long-term storage with preservation of properties (juices, pastes, powders, etc.).

It is recommended to use concentrated cherry, pomegranate and grape juices in the marshmallow technology instead of corn syrup. This not only gives products color and original taste characteristics without adding artificial flavoring and coloring additives, but also allows to reduce the sugar content of products and give them antioxidant properties [8]. A similar effect is also achieved by adding barberry extract [9], red beet juice [10], strawberry, persimmon or carrot juice [11] to marshmallows.

During the production of jelly candies, it is suggested to add grape juice as a natural dye [12]. Such products are characterized by a high content of anthocyanins, which give them a rich purple color. It is also recommended to use orange and raspberry juices as a source of color, taste and bioactive compounds in jelly candies [13].

However, the introduction of juices does not give the opportunity to use the nutraceutical and technological potential of fruit and berry raw materials to the maximum. Mostly they perform the function of a natural dye. It is more appropriate to introduce fruits and berries in the form of pastes, purees or powders, in which the derivatives of raw materials are more concentrated.

It is recommended to use finely dispersed powders from grape skins, which are a secondary product of the wine and juice industry, during the production of soft chewing candies. The addition of the additive gives the candies antioxidant properties, grape taste and aroma, and red color [14].

The paper [15] proposed the technology of jelly candies with the addition of pastes from quince, apples or grapes (in the amount of 10 %) and cryopowders from rose hips, sea buckthorn and grapes (in the amount of 1.5 %). The introduction of additives made it possible not only to remove synthetic dyes and flavors from the recipe, but also to reduce the recipe amount of gelling agent by 20 % and the amount of sugar by 5 %. It is also possible to obtain jelly candies with a natural composition and improved biological value if passion fruit puree is used in their production [16].

Replacing apple puree in the recipe of fruit-jelly candies with a mixture of orange and viburnum puree (25:75) allows to improve the nutritional composition of the products and give them antioxidant properties [17].

When using feijoa puree and kiwi puree in the amount of 20 % and 15 %, respectively, in the technology of cream-whipped candies, it is recommended to reduce the dosage of sugar and gelling agents. Such candies have a higher content of dietary fibers, minerals, polyphenols and organic acids than in the traditional sample [18].

To obtain chewing candies with an improved nutritional profile, it is suggested to add mashed dates and tamarind to their composition. The high sweetness of these fruits makes it possible to reduce the percentage of sugar in products [19].

The work [20] proposed the technology of soft candies based on banana-ginger puree (in a ratio of 94:6), which are characterized by a high content of antioxidants.

The analysis of the given data shows the perspective of using fruit and berry raw materials in the technology of candy products to solve a number of issues: enrichment with useful nutrients, removal of synthetic flavoring additives and dyes from the composition, regulation of the dosage of technological additives (structure stabilizers, antioxidants, preservatives, moisture-retaining agents, etc.).

In view of the above, the technology of cream-whipped candies with the addition of fruit and berry paste based on apples, quince, and blackcurrants has been substantiated in previous studies. It is recommended to add paste to cream-whipped candy masses in the amount of 15 % of the total mass of recipe raw materials and at the same time reduce the dosage of agar by 40 %. Such products acquire an original lilac color, a pleasant yogurt taste and the aroma of red currants. The nutritional composition of the product is significantly improved – the content of non-starch polysaccharides increases by 2 times, the product is enriched with vitamin C and polyphenolic compounds, which are absent in the control sample [21]. However, the change in the recipe composition of products affects the quality indicators of products not only immediately after their manufacture. Given the presence of various functional substances (pectins, polyphenols, organic acids, etc.) in the used fruit and berry paste, additional research is needed to assess the stability of the quality indicators of the developed products during storage.

Taking this into account, the aim of the work was to evaluate the quality of cream-whipped candies with the addition of fruit and berry paste during storage. This will make it possible to establish compliance of the developed candies with regulatory storage terms.

Achieving the set aim was carried out by solving the following objectives:

– analysis of the oxidative stability of the lipid complex of whipped cream candies with and without fruit and berry paste;

– assessment of physico-chemical parameters (strength, density, moisture) in whipped cream candies with and without fruit and berry paste;

– assessment of the sensory properties of cream-whipped candies with and without fruit and berry paste.

2. Materials and methods of research

The traditional technology of cream-whipped candies was chosen as a control sample for research. The recipe of such candies includes white sugar, starch molasses, agar, citric acid, dry egg albumen, flavoring, whole milk condensed with sugar, fat, water and chocolate mass for glazing. For the production of a test sample of cream-whipped candies, the flavoring and citric acid were removed from the recipe, the dosage of agar was reduced by 40 %, and fruit and berry paste was added in the amount of 15 % of the mass of raw materials. Fruit and berry paste was made from apples, quince and black currant (40:50:10) according to the technology described in [22]. Candy production was carried out according to the technological scheme given in [21]. Candies (control and experimental sample) were stored at a temperature of 20±2 °C for 60 days (normative storage period). The samples were packed in a waterproof polymer film. Preparation of samples for research involved removal of chocolate glaze. Oxidative stability of the lipid complex of candies was evaluated every 10 days, physicochemical properties were evaluated at 30 and 60 days of storage, organoleptic properties were determined at 60 days of storage.

The oxidative stability of the lipid complex of candies was assessed by the indicators of acid AV (Acid Value) and peroxide values PV (Peroxide value), which were determined according to standard methods [23].

The relative change in acid (dAV) and peroxide (dPV) values of the lipid component of the studied samples during storage (relative to the first day) was determined in accordance with the recommendations described in [24].

The density was determined by the ratio of the mass of the sample to its volume (in kg/m3). The strength was measured on a Valent device by the load that causes the structure of the sample to break (in grams). Moisture (in %) was determined through the indicator of the content of dry substances, which was measured by the refractometric method. The total acidity was determined by the titrometric method (in degrees).

Statistical processing of the results was performed for a series of parallel measurements (n=4–5, p<0.05) using standard Microsoft Office software packages.

Determination of sensory indicators of candies was carried out with the involvement of a group of experts based on indicators of color, smell and taste.

3. Research results and their discussion

At the first stage, the parameters of the cream-whipped candies under study were determined, which may play a role in product changes during storage (**Table 1**).

Table 1

Characteristics of the tested samples of cream-whipped candies on the day of manufacture

Sample	Total acidity, degrees	Moisture, %	The content of organic acids in terms of malic acid, % [21]	The content of non-starch polysaccharides, % [21]	Recipe content of the fat component, %
Control	5.8±0.2	20.3±0.7	0.15	0.43	24.36
With fruit and berry paste	6.9±0.2	21.8±0.7	0.40	0.86	20.74

It has been established that cream-whipped candies with fruit and berry paste have higher acidity, due to the presence of a significant amount of organic acids in the composition – 2.7 times more than in the control. They are also characterized by a slightly higher moisture, which is explained by the introduction of a significant amount of moisture-retaining substances. Thus, the content of non-starch polysaccharides in candies with paste is 2 times higher than in the sample without additives.

The content of prescription fat in the control and experimental samples of whipped cream candies is 24.36 % and 20.74 %, respectively. Also, the recipe of such products contains up to 12 % condensed milk with a fat content of 8 %. With this in mind, at the first stage of research, the changes occurring during the storage process in the lipid complex of the analyzed samples of candies were evaluated. Oxidative stability of the lipid complex was determined by indicators of acid (AV, mg KOH/g) and peroxide (PV, mmol ½O/kg) values (**Fig. 1**).

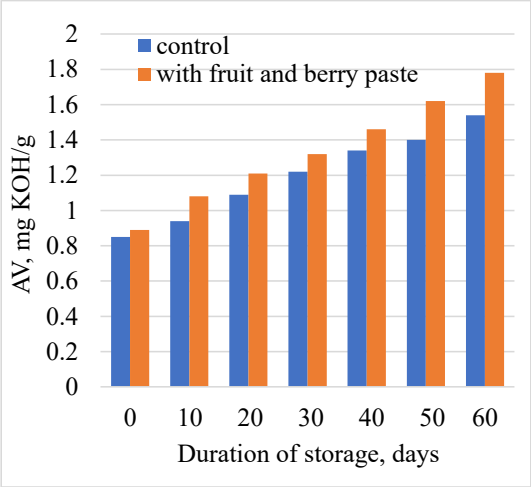
The indicator of the acid value of fat reflects the presence of free fatty acids in it, which are the primary products of oxidation. Free fatty acids are formed as a result of fat hydrolysis. Acids are the catalysts of this process – the more of them, the more intense the hydrolytic processes. Considering the fact that candies with the addition of fruit and berry paste have higher acidity and moisture (**Table 1**), the process of hydrolysis of their lipid component occurs at a faster rate compared to the control sample. In particular, the relative change in the acid value index (dAV) of the lipid component of candies with fruit and berry paste on the 60th day of storage was equal to 1.00 versus 0.81 in the control (**Table 2**).

At the end of storage, the acid value of this sample was 1.78 mg KOH/g, which exceeds the control by 15.6 % (**Fig. 1, *a***). According to regulatory requirements, the value of the acid value for edible fats should be ≤2 mg KOH/g. That is, at the end of storage, the tested candy samples meet the regulatory requirements in terms of the acid value of their lipid component.

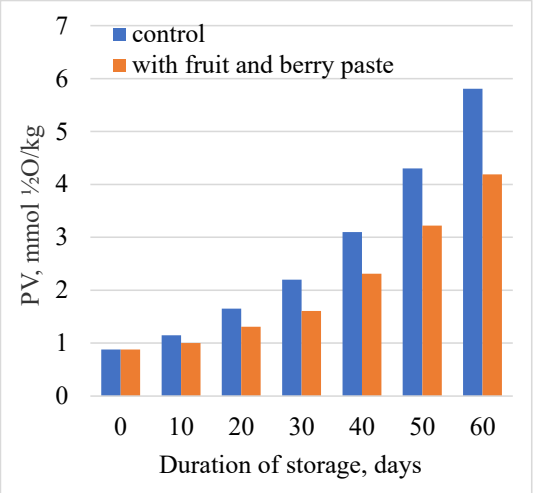
The primary products of fat oxidation also include peroxide compounds, the amount of which is characterized by the peroxide value. The results of the conducted research (**Fig. 1, *b***, **Table 2**) show that the fats of candies with the addition of fruit and berry paste are less prone to the formation of peroxides. In particular, on the 30th day of storage, the value of the peroxide value for the sample with

the additive was equal to 1.61 mmol ½O/kg, which is 26.8 % less compared to the control. The relative change in the peroxide value at this time was 0.83 and 1.50, respectively, that is, the oxidation of the sample without the additive was 1.8 times more intense. At the end of storage, the difference in the values of peroxide values of the studied samples became more pronounced. So, on the 60th day of storage for the control sample PV=5.81 mmol ½ O/kg, and for candies with paste *PV*=4.19 mmol ½ O/kg. That is, the difference in the values of peroxide values was already 27.9 %. Greater resistance to oxidation of cream-whipped candies with the addition of fruit and berry paste is explained by the presence in their composition of a significant number of polyphenolic compounds, which are absent in the control sample. According to [21], the polyphenols of candies with additives are represented mainly by anthocyanins and catechins, which are powerful antioxidants [25]. However, during storage, antioxidants are used to neutralize peroxide radicals. Therefore, after 60 days, the difference in the relative changes of peroxide values decreased slightly and amounted to 1.5 times – for the control d*PV*=5.60, and for the sample with the additive *dPV*=3.46.

According to regulatory requirements, the value of peroxide value for edible fats should be ≤10 mmol ½ O/kg. That is, at the end of storage, the tested candy samples meet the requirements for this indicator.



a



b

Fig. 1. Changes in the lipid composition of the studied samples of whipped cream candies during storage: *a* – acid value (AV); *b* – peroxide value (PV) (p<0.05, n=4, σ=4.2...4.4 %)

Table 2

Relative change in acid and peroxide values of the lipid component of the tested candy samples during storage (relative to the first day)

Sample	Duration of storage, days					
	10	20	30	40	50	60
Relative change in acid value (δAV)						
Control	0.11	0.28	0.44	0.58	0.65	0.81
With fruit and berry paste	0.21	0.36	0.48	0.64	0.82	1.00
Relative change in peroxide value (δPV)						
Control	0.31	0.88	1.50	2.52	3.89	5.60
With fruit and berry paste	0.14	0.49	0.83	1.63	2.66	3.76

Important indicators, the changes of which largely determine the quality of cream-whipped candies during the storage process, are moisture, strength and density (**Fig. 2**).

In the process of storing cream-whipped candies due to the syneresis of hydrocolloids, the amount of free moisture increases. Over time, the processes of internal diffusion of water from the center to the outer layer of the case accelerate. This moisture concentrates between the body of the candy and the glaze, which can cause it to crumble. It was established that candies with fruit and berry paste had a lower tendency to moisture loss (**Fig. 2, *a*, Table 3**).

Table 3

Changes in the physical and chemical parameters of the tested candy samples during storage (relative to the first day)

Sample	Indicator changes, %					
	Moisture		Strength		Density	
	For 30 days	For 60 days	For 30 days	For 60 days	For 30 days	For 60 days
Control	–6.90	–11.33	+4.09	+11.55	+2.50	+9.35
With fruit and berry paste	–5.50	–8.72	+3.51	+10.35	+2.20	+8.11

In particular, the moisture loss of the control sample on the 30th day of storage compared to the first day was 6.9 %, and the sample with the additive – 5.5 %. On the 60th day, the moisture content of the control decreased by 11.33 %, and the product with paste decreased by 8.72 %. The tendency towards better moisture retention during storage can be explained by the presence in candies with paste of other types of non-starch polysaccharides, in addition to pectin, which have water-retaining properties. These substances absorb the water that was released from the gelatinizers during syneresis, thus preventing its migration to the hull surface.

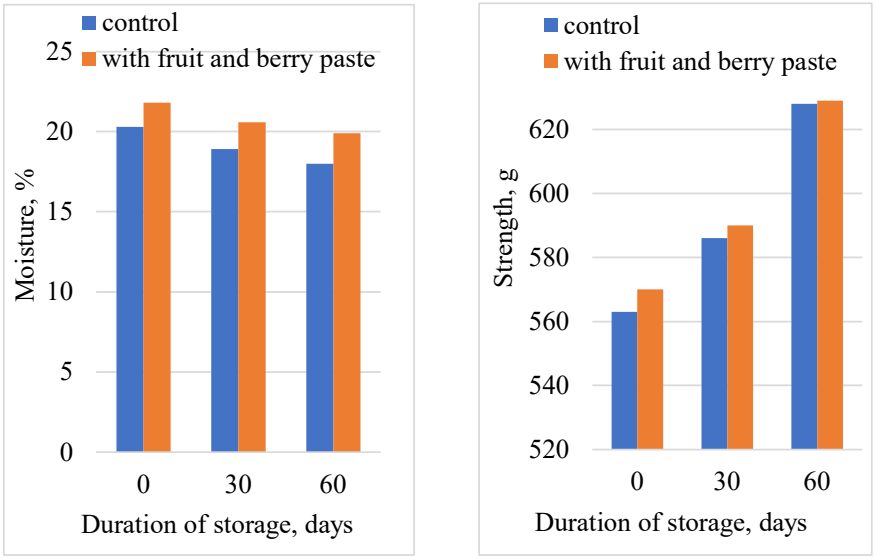
Smaller losses of moisture in cream-whipped candies with fruit and berry pastes during storage ensure greater stability of their structural and mechanical characteristics. Thus, both studied samples are characterized by an increase in strength and density (**Fig. 2, *b*, *c***). However, after 60 days, the strength of the control increases by 11.55 %, and the strength of the sample with the additive increases by 10.35 % (**Table 3**). That is, in terms of strength, they are practically equal, despite the fact that the initial strength of candies with paste was higher. The increase in the density of products with an additive is also slower. The increase in the value of this indicator at the end of storage for the control is 9.35 %, and for the developed product – 8.11 % (**Table 3**).

That is, in terms of structural and mechanical properties, at the end of the shelf life, candies with fruit and vegetable paste are not inferior to the control product.

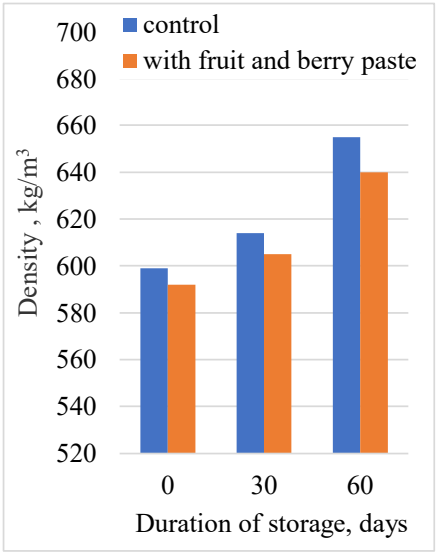
Also, at the end of storage, all tested samples had satisfactory sensory characteristics. The color of the products with the additive did not change, the taste and smell were also favorable.

Thus, at the end of storage, all studied samples meet the regulatory requirements in terms of the state of the lipid complex, physico-chemical and sensory characteristics. The results of the research indicate the compliance of cream-whipped candies with fruit and berry paste to the normative storage terms in terms of oxidative stability of the lipid complex, physico-chemical and sensory indicators. However, the above materials do not analyze changes in

microbiological safety indicators, which is important in view of the higher moisture of candies with pastes. This is a weakness of the presented studies. For the further development of the obtained results, the authors plan to continue research on the assessment of changes in the microbiological indicators of cream-whipped candies with fruit and berry paste during storage.



a *b*



c

Fig. 2. Changes in the physico-chemical quality indicators of the studied samples of cream-whipped candies during storage: *a* – moisture; *b* – strength; *c* – density (p<0.05, n=5, σ=4.0...4.2 %)

4. Conclusions

The quality of cream-whipped candies with the addition of apple, quince and blackcurrant fruit and berry paste during storage has been evaluated.

It has been established that the process of hydrolysis of the lipid component of candies with paste occurs at a higher rate compared to the control sample. This is due to their higher acidity and moisture. However, the fats of candies with the addition of fruit and berry paste are less prone to the formation of peroxides, which is explained by the presence in their composi-

tion of a significant number of polyphenolic compounds with pronounced antioxidant properties (anthocyanins and catechins), which are absent in the control sample.

It has been noted that candies with fruit and berry paste lose moisture more slowly due to the higher content of non-starch polysaccharides. Smaller moisture losses ensure greater stability of their structural and mechanical characteristics during storage. It has been noted that the strength and density of such candies increase more slowly than in the sample without the additive.

It has been established that at the end of storage, all the studied samples had satisfactory sensory characteristics.

Conflict of interest

The authors declare that there is no conflict of interest in relation to this paper, as well as the published research results, including the financial aspects of con-ducting the research, obtaining and using its results, as well as any non-financial personal relationships.

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The study was performed without financial support.

Data availability

Data will be made available on reasonable request.

Use of artificial intelligence

The authors confirm that they did not use artificial intelligence technologies when creating the current work.

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