This paper considers the influence of different quantities and shapes of fresh sliced pumpkin on the culinary quality of a cupcake. A change in the culinary quality of the cupcake depending on the amount of sliced pumpkin has been established. It was found that the cupcake's surface color and crumb depended on the amount of fresh sliced pumpkin. The shape of the slice did not change these cupcake parameters. The color of the surface of the cupcake with the addition of 5–25 % of the sliced pumpkin was at the level of control – light yellow. When adding 30–40 % – yellow; 45–50 % – dark yellow. The cupcake's crumb color with the addition of 5–10 % of sliced pumpkin and without it was light yellow. Adding 15–35 % of sliced pumpkin provided for a yellow color of the crumb. With the addition of 40–50 % of sliced pumpkin, the color was orange. The use of fresh sliced pumpkin in the amount of 25 % reliably reduces the smell and taste of the consumer evaluation of the cupcake. At the same time, the level of smell and taste was good (7 points). It should be noted that when adding 20 % fresh sliced pumpkin, the smell and taste of pumpkin in the cupcake was weak – 7 points.

Social studies have been conducted and the main criteria for cupcake buyers have been established. It was found that cupcakes are in high demand and have the prospect of being enriched with pumpkin. Among the respondents, the new product had a high probability of buying. Its price is less important in this case. It was proven that its chemical composition and culinary quality are of greatest importance when choosing a cupcake.

In the technology of cupcake production, it is necessary to add 20–25 % of fresh sliced pumpkin of various shapes relative to the mass of the dough. The use of this amount of sliced pumpkin makes it possible to bake a cupcake with a light-yellow surface and yellow crumb. The consumable level of the cupcake is good while the smell and taste of the pumpkin in it is weak.

The recommendations provided here could be used by small-scale grain processing enterprises when baking flour confectionery products

Keywords: sliced pumpkin, pumpkin's slice shape, culinary quality of cupcake, smell and taste of cupcake

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DEVISING THE RECIPE FOR A CAKE WITH FRESH SLICED PUMPKIN ACCORDING TO CULINARY QUALITY INDICATORS

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1. Introduction

One of the urgent tasks facing the food industry is the production of products with high biological value [1]. As evidenced by world practice [2], the enrichment of bakery products makes it possible to improve health at minimal costs. Bakery and confectionery products are considered the most popular in the world in terms of taste and energy value in food [3]. The leading

role among confectionery products belongs to flour confectionery. About 30 % of the range and production volume of all flour confectionery products account for cupcakes [4]. The production of cupcakes is based on wheat flour [5].

Wheat is an important grain crop and accounts for a significant share in total grain consumption worldwide [6]. Wheat grain is characterized by significant fluctuations in the properties of raw materials. All this reduces the quality of bakery products, often leads to the use of improvers and preservatives of synthetic origin. The production of confectionery products from flour of the highest grade leads to the loss of important biologically active substances. Thus, the content of B vitamins and mineral elements in flour of the highest grade decreases by 2–6 times [7].

People strive for a healthy lifestyle, rational nutrition [8]. Food industry companies are trying to take this into consideration in their products. Natural ingredients containing vitamins, macro- and microelements with therapeutic, prophylactic, and functional properties are introduced into the formulation. The use of fruit and berry products in the confectionery industry is relevant [9].

Pumpkin is rich in vitamins and mineral elements while having a low energy content [10, 11]. Pumpkin pulp has a high content of beta-carotene. According to scientists [12], the content of beta-carotene in fresh pumpkin can range from 2.66 to 6.67 m/100 g depending on its type and variety.

The use of products rich in beta-carotene reduces the risk of developing certain types of cancer, provide protection against asthma and heart disease [13]. In pumpkin pulp, the content of dietary fiber can be up to 1.1 g/100 g [14]. Dietary fiber is very important for health, in particular for the prevention of cardiometabolic diseases, maintaining normal function of the gastrointestinal tract and microbiota [15]. At the same time, the pumpkin is easily absorbed, so it can be used to enrich confectionery [16].

Scientific research into this area is important for confectionery production. The results of such studies are necessary for practice because the development of a cupcake recipe would make it possible to effectively use fresh pumpkin in the form of slices. Thus, improving the quality of traditional flour confectionery products by using natural raw materials with a high content of biologically active substances is a relevant task. Therefore, pumpkin is a valuable raw material for the development of functional food products.

2. Literature review and problem statement

It was established in [17] that the addition of fresh pumpkin puree to the recipe of bread from flour of the highest grade affected the smell and taste. Thus, adding 80 % of fresh pumpkin puree relative to the mass of flour contributed to the formation of a pleasant pumpkin, nutmeg, and nutty smell and taste. The crust was yellow, the top was light brown. The sensory assessment, in that case, corresponded to the expectations of the target category of bread consumers. However, the cited studies were conducted with bread, so it is not possible to use recommendations for a cupcake.

Study [18] proved that to produce high-quality wheat bread, it is necessary to add 10 % of pumpkin powder and no more than 20 % of pumpkin pomace. With this content of pumpkin processing products, the culinary quality of bread was high – 5 points. In [19], it is proved that pumpkin powder has a positive effect on the stretchability of gluten, increases the fermentation activity of baker's yeast. Ultimately, this contributes to improving the culinary characteristics of bread. However, the cited study used pumpkin processing products. Fresh sliced pumpkin differs in properties from powder and pomace.

A sensory assessment of various cookie samples showed that the highest quality was obtained from 10 % of pumpkin flour and 90 % of wheat flour. It should be noted that the culinary quality of cookies without powder was lower. Cookies enriched with pumpkin powder had a yellow color and better taste [20]. Scientists [21] have proved that the higher quality of the product was due to the addition of pumpkin flour. In [22], it is proved that the replacement of 5–10 % of wheat flour with pumpkin flour had a positive effect on culinary quality. Increasing the replacement of flour to 15 % and above adversely affected the taste of the product.

It is established in [23] that it is necessary to add 2.76 % of the flour from pumpkin seeds to the recipe of sugar cookies. With this formulation, the culinary quality of cookies is high. In addition, the content of dietary fiber and mineral elements increased significantly in cookies. However, the cited studies relate to cookies. The technological process of making cookies is different from that for a cupcake.

Scientists [24] have found that the use of pumpkin flour affects the color, smell, and taste of the cupcake. It was established that the addition of 15 % of pumpkin flour did not reduce the culinary quality of cookies. That amount of pumpkin flour is acceptable for cookie consumers. However, the properties of pumpkin flour differ from fresh sliced pumpkin.

In [25], it is proved that cookies with 10–15 % of pumpkin flour had the highest culinary quality. The color was golden yellow without the smell of pumpkin. The strength of the biscuits was at the level of control. However, the addition of 20 % of pumpkin flour contributed to the formation of the bitter taste of cookies. However, those research results cannot be used for a cupcake with fresh pumpkin because it contains more water compared to pumpkin flour.

In [26], it is proved that the use of pumpkin flour contributed to the improvement of organoleptic indicators of the quality of sugar cookies. Thus, without the use of pumpkin flour, the color of the cookies was at the level of 8.5 points, the smell was 8.0, the appearance was 8.0, the consistency was 8.0, the taste was 8.0 points. The use of 10 % of pumpkin flour worsened the color of cookies to 8.0 points. The smell was at the level of 9.0 points, the appearance was 8.5, the consistency was 8.5, the taste was 8.5 points. However, the research considers only cookies and pumpkin flour. Similar results of the culinary quality of cookies were obtained in another study [27].

It is established [28] that when using pumpkin flour as an ingredient in a recipe in the amount of 5 g/100 g per muffin, one can achieve an attractive color, high fiber content, as well as reduce the sugar content without deterioration of culinary quality. However, the results of the cited research relate to the use of pumpkin flour in cupcake technology.

Study [29] found that pumpkin puree can be used in bread technology after heat treatment. The possibility of introducing 5 to 25 % of puree in bread technology has been proven. However, the cited study was aimed at studying the nutritional and biological value of bread. The formation of the quality of the finished product, depending on the amount of pumpkin puree, has not been studied. In addition, the results can be applied to bread technology. Cupcake technology is significantly different from bread technology.

Scientists [30] found that the addition of chia in the recipe of bread reduces its specific volume and culinary quality. Obvi-

ously, this is due to the content of dietary fiber, the content of which in chia seeds is high. In addition, it is proved in [31] that the addition of low-fat flour from pumpkin seeds increases the staleness of bread from spelt. The consistency of bread crumb at the same time contains less moisture, which affects the sensory indicators of its quality.

Thus, previous studies reviewed in this chapter emphasize the possibility of enriching flour products with pumpkin processing products. Finished products enriched with pumpkin are characterized by a higher biological value compared to traditional analogs. The culinary quality of flour products (including confectionery) varies significantly depending on the quantity and type of added pumpkin processing products. A large body of research [21–28] forms an idea of the use of pumpkin flour or seeds to enrich flour products but require additional studies into the technology of enriching cupcakes with fresh pumpkin slices. Therefore, it is advisable to devise technology for enriching cupcakes with fresh sliced pumpkin, based on the principles of obtaining a finished product with high culinary quality indicators.

3. The aim and objectives of the study

The aim of this study is to devise a recipe for the cupcake enriched with fresh sliced pumpkin. This will make it possible to expand the range of flour confectionery products through the production of products with increased biological value.

To accomplish the aim, the following tasks have been set:

– to explore a promising market for ready-to-eat products enriched with moisture-containing raw materials to justify the criteria for optimizing the technology of production of cupcakes enriched with sliced pumpkin;

– to establish the culinary quality of cupcakes enriched with sliced pumpkin;

– to determine the indicators of the generalized function of desirability when enriching a cupcake with fresh sliced pumpkin.

4. The study materials and methods

4. 1. The study object and hypothesis

The object of our study is the technology of cupcake production. According to the proposed hypothesis of the study, the addition of fresh sliced pumpkin to the cupcakes could expand the range of finished products. Increasing the proportion of sliced pumpkins would reduce the amount of simple carbohydrates inherent in traditional cupcake production recipes. Therefore, it is expected to achieve an increase in the biological value and a decrease in the caloric content of the resulting products, which follows from the well-known information on the chemical composition of pumpkin.

4. 2. Raw materials to produce a cupcake enriched with sliced pumpkin

Pumpkin was added to the cupcake in the form of slices. Depending on the shape and size of the resulting pieces, four variants of sliced pumpkin were obtained. We used nutmeg pumpkin (*Cucurbitamoschata (Duch.) Duch. exPoir.*), the Dolya variety (Ukraine).

Characteristics of the volume of pieces of sliced pumpkin:

– No. 1 – from 22.4 mm^3 to 27.9 mm^3;

– No. 2 – from 7.1 mm^3 to 11.1 mm^3;

– No. 3 – from 140.4 mm^3 to 169.7 mm^3;

– No. 4 – from 5.0 mm^3 to 7.4 mm^3.

Pieces of pumpkin had a rectangular shape.

4. 3. The program, methodology, equipment for studying the properties of the cupcake enriched with sliced pumpkin

The research was conducted in the laboratory of the Department of Food Technologies at the Uman National University of Horticulture (Uman, Ukraine).

The dough for the cupcake was prepared according to the following recipe: flour – 70 g, powdered sugar – 50 g, margarine (fat content, 72 %) – 50 g, eggs – 50 g, salt – 0.2 g, baking powder (baking soda+sodium phosphate) – 2.5 g, vanilla sugar – 0.3 g. First, we prepared the dough. Salt and vanilla sugar were added to margarine at room temperature. Then it was whisked for 5–7 minutes in a dough mixer (RoyaltyLine RL-PKM1900.7, Germany) with 60–65 revolutions per 1 minute. After that, icing sugar was added and whipped for 5–7 minutes more. Then we added eggs and whisked for 10 minutes. After that, wheat flour of the highest grade was added and mixed in a mixer for 3–5 minutes. Fresh sliced pumpkin was added to the prepared dough. The amount of sliced pumpkin ranged from 5 to 50 % with an interval of 5 %. The baking temperature was 180–185 °C.

Traditional methods of culinary evaluation of flour confectionery products are not adapted to the integrated establishment of the quality of products enriched with moisture-containing raw materials. Therefore, during the assessment of the culinary quality of finished products, a modified scale was developed, taking into consideration the peculiarities of changing the shape, color, consistency, taste, and smell of pumpkin-enriched products (Table 1).

Table 1

Scale of evaluation of a cupcake made from triticale flour and wheat enriched with unconventional raw materials of increased biological value [32]

Score	9	7	5	3	1
1	2	3	4	5	6
Cupcake surface color	Determine the actual one. It can vary from light yellow to dark brown. The color of the lower crust may differ from the color of the upper and side crusts				
Surface	The surface is not burned. The surface of cupcakes made on chemical baking powder may reveal cracks and breaks that do not change the product type. Specify convex, even, or concave				
	Determine for cupcakes without baking powder				
	without cracks or the presence of cracks does not spoil the appearance	with single cracks, the width of which is not more than 1.0 cm	with cracks, the width of which is 1.0–2.0 cm, occupying up to 25 % of the surface	with cracks, the width of which is 1.0–2.0 cm, occupying up to 25–50 % of the surface	with cracks, the width of which is more than 2.0 cm, occupying ≥51 % of the surface

Continuation of Table 1

1	2	3	4	5	6
The consistency of crumb	Determine the actual consistency. It can be crumbly, with pores, without pores, plastic, soft, hard, stiff, juicy, dry, greasy, not greasy, sticky, gum-like, elastic, inelastic, little elastic, dense, compacting strongly, weakly, does not compact				
Determine the actual crumb color					
Porosity	small, thin-walled, or thick-walled, uniform	pore-free or other part of the crumb occupies up to 25 % of the cross-section	pore-free or other part of the pulp occupies 26–50 % of the cross-section	pore-free or other part of the crumb occupies 51–75 % of the cross-section	pore-free or other part of the pulp occupies 76–100 % of the cross-section
Product consumption rating options					
$Smell_1$	excellent	good	medium	satisfactory	unsatisfactory
$Taste_1$	excellent	good	medium	satisfactory	unsatisfactory
Smell and taste of raw materials of increased biological value					
$Smell_2$	absent	weak	pronounced	strong	very strong
$Taste_2$	absent	weak	pronounced	strong	very strong

The peculiarity of the proposed method of culinary evaluation is the use of both expert evaluation and evaluation of the product from the point of view of the consumer.

4. 4. Statistical treatment of experimental data

Our study was conducted in four repetitions that were randomized over time. The results were treated using the Microsoft Excel 2010 (Microsoft Corporation, USA) and Statistica 12 (StatSoftStatisticaUltimateAcademic, Ukraine) software in accordance with methodological recommendations from [33, 34].

4. 5. Social surveys

The initiator of the survey is scientists from the Department of Food Technologies at Uman NUS, Ukraine. The focus groups represent potential consumers of different age categories. The place of our study is the city of Uman, Ukraine. The number of respondents involved is 526. The study time was Quarter 4, 2021.

5. Results of studying the culinary quality of the cupcake depending on the shape and share of the added pumpkin

5. 1. Results of studying the promising market of cupcakes enriched with sliced pumpkin

In a market environment, food competitiveness is a key requirement for production. The introduction of new technologies into production is associated with economic risks. During the modernization or reorganization of production, the volume of fixed assets increases, which is reflected in the technical and economic indicators of production. Forecasting the payback period of costs associated with the modernization or reorganization of production is impossible without analyzing the potential market for such products.

Increasing the competitiveness of food, in particular flour confectionery is possible as a result of the expansion of the relevant range. It is advisable to take into consideration modern market trends in relation to products of increased biological value, reduced caloric content, and high culinary qualities.

Based on the results of a social survey of potential consumers of cupcakes enriched with sliced pumpkin, a tendency to adhere to a healthy lifestyle was established, which involves systematic monitoring of health. Among respondents, no more than 33.3 % do not control their health, or sometimes undergo medical examinations. 11.1 % of respondents indicated that they systematically monitor their health and are guided by the recommendations of doctors (including nutritionists for the formation of a daily diet). For most respondents (55.6 %), control of their health is executed at a high level, which is due to the systematic medical examinations (once a year, or two years).

Consumer interest in the chemical composition of the finished product was high among most respondents (Fig. 1).

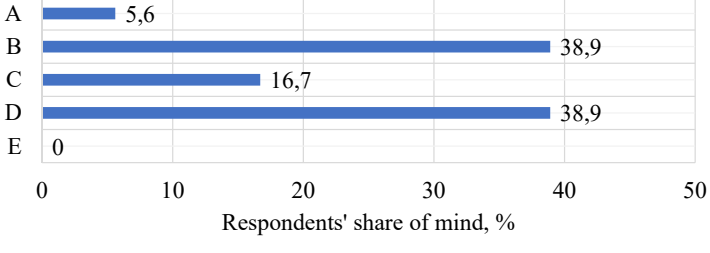

Fig. 1. How often are you interested in the chemical composition of food (energy value, protein content, fats, carbohydrates): A — it does not matter to me; B — sometimes I pay attention; C — I often pay attention; D — I pay attention every time I buy products; E — I form a diet of foods according to their biological value

There were no respondents who selected products in accordance with their biological value during the formation of the diet. Such results may be related to the focus of testing for flour confectionery, which formed a group of persons interested in such products. 5.6 % of respondents were categorically not interested in the chemical composition of food. High interest in the chemical composition of products before their purchase was expressed by most respondents (55.6 %).

The minimum number of respondents (5.6 %) claimed that culinary (organoleptic) indicators of food are not important to them when choosing food (Fig. 2).

Most respondents recognized that the culinary properties of the finished product are important and are a prerequisite for deciding to purchase the appropriate product. At the same time, the purchasing power of the surveyed potential consumers was quite high (Fig. 3).

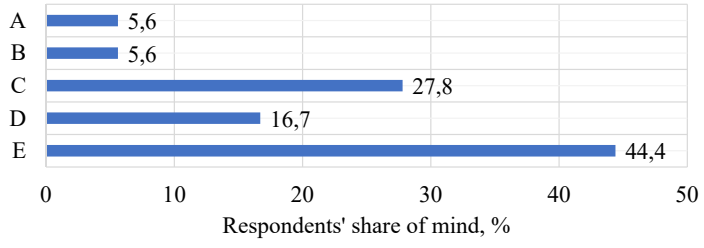

Fig. 2. How important are organoleptic properties for you (taste, smell, color, etc.) when choosing a food product: A — I do not think when choosing food; B — sometimes I take them into consideration; C — I often take them into consideration; D — I take them into consideration very often; E — constantly considering

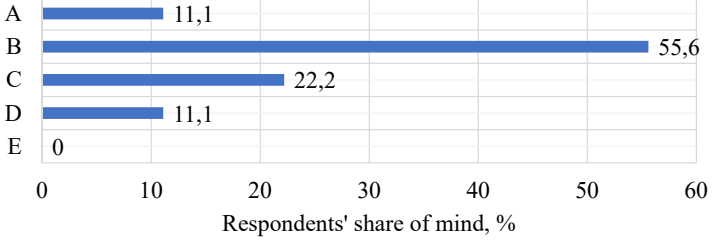

Fig. 3. Of what priority is the price when choosing a food product: A — the price is not of interest; B — the price impact is not significant; C — I prefer products of lower cost; D — I often prefer products of lower cost; E — I buy products of the lowest cost only

For a significant share of respondents (11.1 %), the price of food did not play a significant role in the decision to purchase it. Most respondents (55.6 %) claimed that the price factor is not a significant factor in the decision to purchase a food product. However, for a third of respondents, the price of food influenced the decision to purchase it.

Among the potential consumers surveyed, there were no conservatives, and therefore they were, at different probabilities, ready to purchase a new food product (Fig. 4).

A significant proportion of respondents (22.4 %) were ready to purchase a new product while 55.6 % of the respondents claimed a high probability of purchasing such a product.

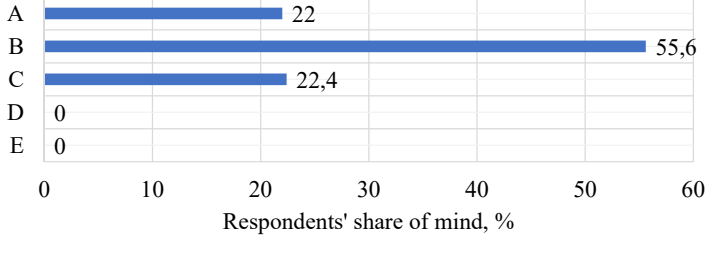

Fig. 4. When you see a new product on the shelf, you: A — I will immediately purchase it; B — I compare it with analogs and buy; C — I will wait for feedback from friends about this product and buy it; D — most likely, I will not buy it; E — I buy only time-tested products

When asked: "Choose one or more of the specified foods that you like to consume with coffee (tea)", 55.6 % of the respondents positively noted flour confectionery, including cupcakes. Most respondents (66.7 %) like to consume bakery products with tea or coffee, including buns, cakes, pies, etc. 65.4 % of the respondents like to consume chocolate and candies with tea or coffee. Halva and sandwiches are not enjoying significant popularity among consumers. Halva is likely to be consumed with tea by 22.2 % of the respondents, and sandwiches – 16.7 % of the respondents.

For most respondents, despite the popularity of flour confectionery, in particular cupcakes, the latter are not a daily food product (Fig. 5). However, most respondents accepted the systematic consumption of such products.

A significant proportion of the respondents (44.4 %) claimed to have a desire to taste confectionery enriched with non-traditional raw materials (chia, quinoa, pumpkin, carrots, fruits, etc.). During the analysis of the issue of readiness for consumption of products enriched with non-traditional raw materials, no negative answers were recorded.

Most respondents (77.8 %) claimed to be aware of the benefits of pumpkin. 16.7 5 respondents hesitated with knowledge of the importance of pumpkin consumption in the daily diet, and only 5.6 5 potential consumers surveyed claimed that they did not have information about the benefits of pumpkin consumption.

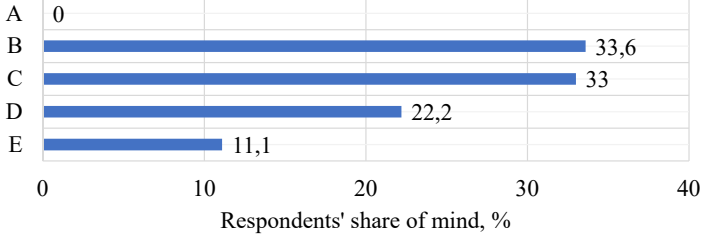

Fig. 5. Frequency of cupcake consumption by potential consumers: A — daily; B once a week; C — once a month; D — every few months; E — difficult to answer

A significant proportion of the respondents (33.2 %) positively thought about pumpkin processing products and like to consume them. It is highly likely that 27.8 % of the respondents have a positive attitude towards the consumption of pumpkin-enriched products. The share of respondents (5.6 %) who had a negative attitude towards pumpkin processing products was identified as well. Other respondents argued for a neutral attitude toward pumpkin processing products.

A significant number of the respondents indicated the expediency of enriching biscuits (72.2 % of the respondents) and cupcakes (61.1 % of the respondents) with pumpkin (Fig. 6).

A significant proportion of the respondents (50 %) expressed a desire to taste a cupcake or biscuit enriched with pumpkin.

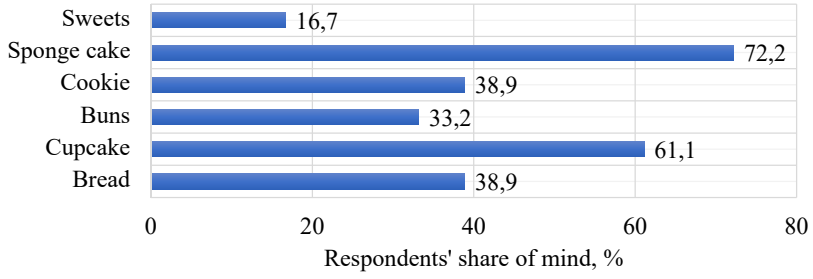

Fig. 6. Food products that, in the opinion of potential consumers, are advisable to be enriched with pumpkin

5. 2. The culinary quality of the cupcake enriched with sliced pumpkin depending on its shape and share in the finished product

Along with technological indicators, the culinary quality of the finished product is crucial for the modern consumer, as evidenced by the results of the social study among potential consumers [35].

Despite certain signs of subjectivity, establishing the culinary quality of a finished product requires a high level of competence of experts [36]. During studying the culinary quality of the finished product, three experts were involved. The total level of competence of the board was 88 points (82 %), which corresponds to a high level in solving the relevant task.

The statements of experts in determining the indicators of culinary quality, in particular smell and taste, were agreed upon (Coeff. Of Concordance=0.11579; Aver. rank r=0.10904; Coeff. Of Concordance>Aver. rank r) and coincide (p=0.000<0.05).

In terms of the studied quality indicators, the type of sliced pumpkin did not exert a reliable impact. The key influence on the formation of the studied indicators of culinary quality of the finished product was exerted by the share of pumpkin added to cupcakes.

The main purpose of adding unconventional raw materials, in particular sliced pumpkin, is to increase the biological value of cupcakes, reduce their caloric content, saturate them with biologically active substances. At the same time, the introduction of additional raw materials changes the culinary properties of the finished product, and, in some cases, leads to their significant deterioration. In addition, there is a possibility of a negative attitude of consumers to the taste characteristics of non-traditional raw materials, and, therefore, determining the level of saturation of additional raw materials with a foreign smell and taste of the finished product was an appropriate task.

There was no reliable impact on the indicators of culinary quality of cupcakes enriched with sliced pumpkin, depending on the geometrical parameters of its pieces.

The color of the cupcake surface and its crumb varied significantly depending on the amount of sliced pumpkin added and remained unchanged depending on the type of sliced pumpkin (Tables 1, 2).

The change in the color of the cupcake surface occurred with the addition of 30 % of sliced pumpkin or more. Significant color changes from light yellow to dark yellow were recorded when adding more than 45 % of sliced pumpkin.

The cupcake's crumb color changed coloration identically depending on the amount of sliced pumpkin added before changing the color of the cupcake surface. However, qualitative changes were recorded with less added sliced pumpkin. The change in color from light yellow to yellow occurred with the addition of sliced pumpkin in the amount from 15 to 35 %. An increase in the proportion of sliced pumpkin from 40 % to 50 % led to a significant change in the color of the cupcake's crumb color to orange.

Table 1

The color of the cupcake surface depending on the type and amount of sliced pumpkin

Amount of added sliced pumpkin	Sliced pumpkin			
	No. 1	No. 2	No. 3	No. 4
Control	light yellow	light yellow	light yellow	light yellow
5	light yellow	light yellow	light yellow	light yellow
10	light yellow	light yellow	light yellow	light yellow
15	light yellow	light yellow	light yellow	light yellow
20	light yellow	light yellow	light yellow	light yellow
25	light yellow	light yellow	light yellow	light yellow
30	yellow	yellow	yellow	yellow
35	yellow	yellow	yellow	yellow
40	yellow	yellow	yellow	yellow
45	dark yellow	dark yellow	dark yellow	dark yellow
50	dark yellow	dark yellow	dark yellow	dark yellow

Table 2

The cupcake's crumb color depending on the type and amount of sliced pumpkin

Amount of added sliced pumpkin	Sliced pumpkin			
	No. 1	No. 2	No. 3	No. 4
Control	light yellow	light yellow	light yellow	light yellow
5	light yellow	light yellow	light yellow	light yellow
10	light yellow	light yellow	light yellow	light yellow
15	yellow	yellow	yellow	yellow
20	yellow	yellow	yellow	yellow
25	yellow	yellow	yellow	yellow
30	yellow	yellow	yellow	yellow
35	yellow	yellow	yellow	yellow
40	orange	orange	orange	orange
45	orange	orange	orange	orange
50	orange	orange	orange	orange

It is proved that the increase in the proportion of sliced pumpkin caused noticeable changes in the taste and smell of cupcakes (Fig. 7).

Non-significant changes in the smell of the finished product occurred with the addition of a minimum amount of sliced pumpkin (5–10 %). Further increase in the amount of added unconventional raw materials led to a significant decrease in the estimates of the smell and taste of the finished product.

Despite the presence of a pronounced smell and taste of the added raw materials, the overall level of culinary quality of the finished product from the consumer's point of view was high when adding up to 30 % of sliced pumpkin (Fig. 8).

The increase in the amount of sliced pumpkin to 45–50 % significantly reduced the smell and taste of the finished product from the consumer's point of view due to the excessive foreign taste of the added product.

5. 3. Determining the indicator of the generalized function of desirability when enriching a cupcake with sliced pumpkin

The high rates of culinary quality of cupcakes were recorded with a minimum amount of added sliced pumpkin (Fig. 9). The increase in the amount of added sliced pumpkin led to a decrease in the indicator of the generalized function of desirability, as a projection of the functions of taste and smell.

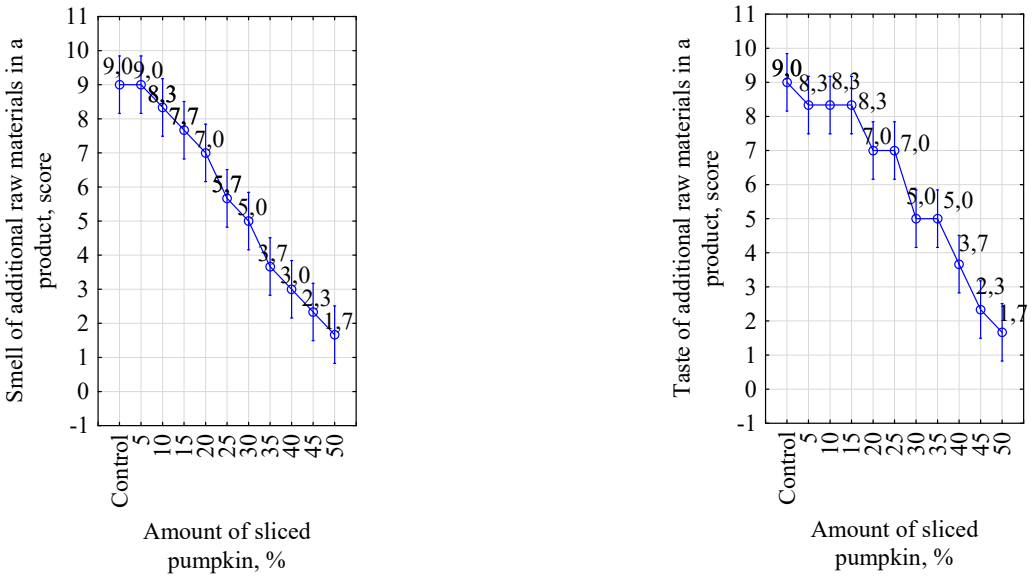

Fig. 7. Culinary indication of pumpkin in the finished product depending on its share: *a* — the smell of an additional product; *b* — the taste of an additional product

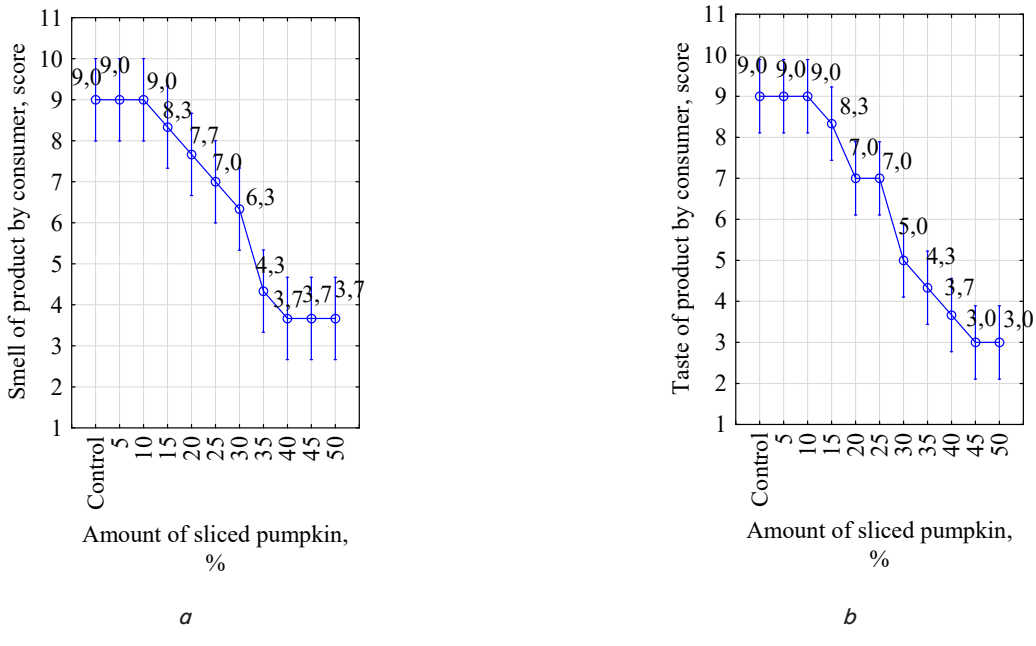

Fig. 8. Culinary indication of pumpkin in the finished product depending on its share from the point of view of the consumer: *a* — the smell of an additional product; *b* — the taste of an additional product

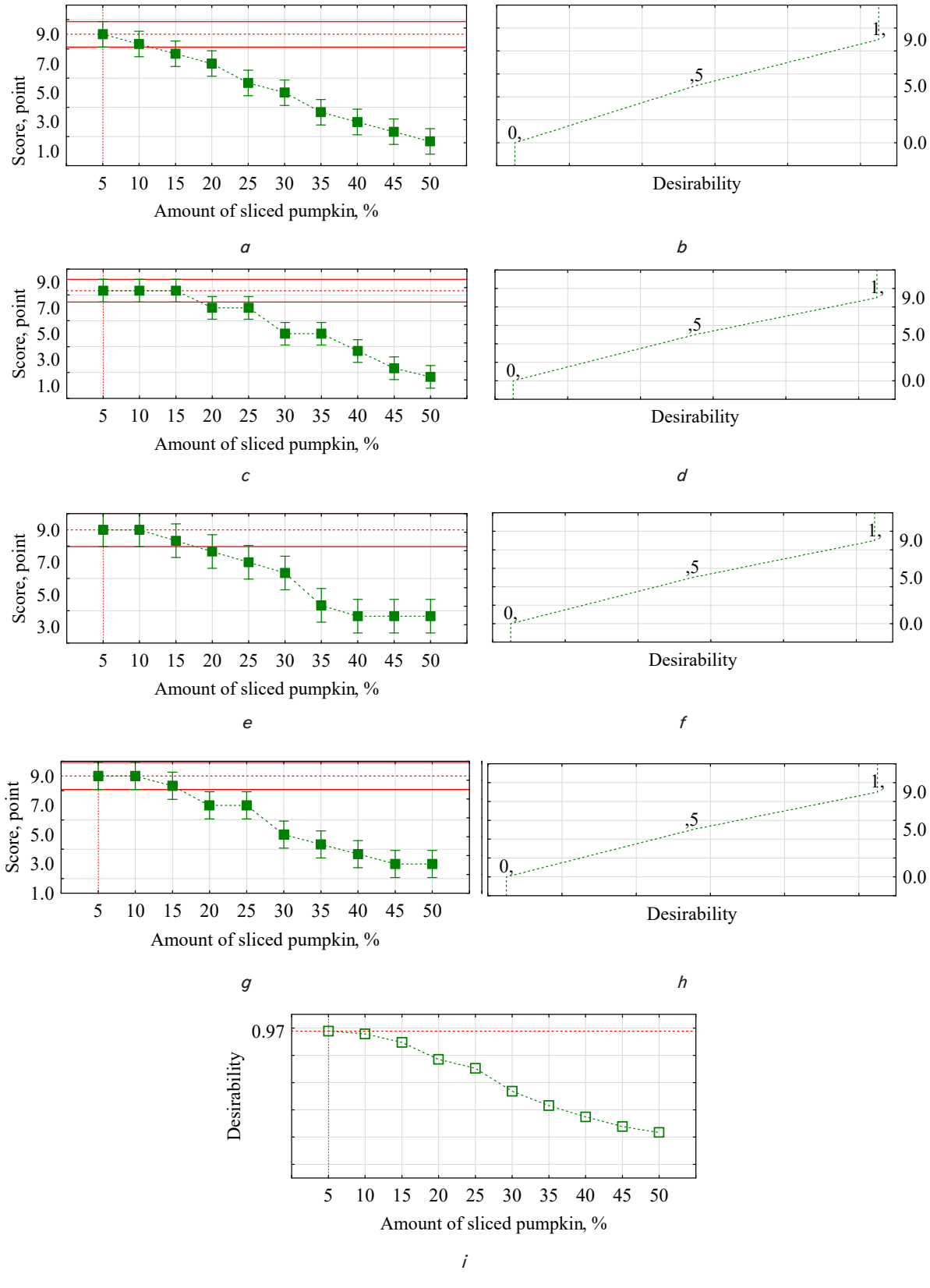

Fig. 9. Determining the indicator of the generalized function of desirability as a projection of the functions of taste and smell: *a* — the smell of additional raw materials in the product, point; *b* — formation of requirements for the level of desirability of the smell of additional raw materials in the product; *c* — taste of additional raw materials in the product; *d* — formation of requirements for the level of desirability of the taste of additional raw materials in the product; *e* — the smell of the product from the point of view of the consumer; *f* — formation of requirements for the level of desirability of the smell of the product from the point of view of the consumer; *g* — the taste of the product from the point of view of the consumer; *h* – formation of requirements for the level of desirability of the taste of the product from the point of view of the consumer; *i* — generalized function of desirability

The optimum zone for the generalized desirability function was at a point that corresponded to 5 % of the added sliced pumpkin. However, a significant decrease in the indicator of the generalized function of desirability was recorded with the addition of 20 % of sliced pumpkin or more.

6. Discussing the results of the study into expanding the range of cupcakes enriched with pumpkin

The level of interest of the modern consumer in the biological value of consumption products, in particular their chemical composition (Fig. 1), is due to the evolution of popular trends in healthy eating. Products of increased biological value are distinguished by specialized indications on the package. In addition, the issue of a healthy lifestyle is systematically raised. Therefore, the modern consumer, who is in the information space, is familiar with the properties of food nutrients and takes into consideration these characteristics when deciding on the purchase of food products. However, the basic needs of consumers, despite their interest in the chemical composition of consumed products, are significantly related to their organoleptic properties (Fig. 2). This is due to the lack of motivation of consumers to form a dietary and balanced diet. These trends are confirmed by world practice [37], which indicates the high popularity of products with a high content of simple carbohydrates with high indicators of culinary quality. Those trends are also confirmed by the results of the social survey given in the current work (Fig. 5). However, the systematic use of simple carbohydrates has a negative impact on the human body, contributes to the formation and development of chronic diseases, and requires a solution consistent with the current tasks set ahead of the food industry [38]. A positive phenomenon is a sufficient number of innovators (Fig. 4) who are highly likely to be able to consume new types of food. In part, a significant proportion of innovators or early innovators among potential consumers is due to a wide range of foodstuffs and sufficient purchasing power, as confirmed by social research (Fig. 3).

Adding fresh pumpkin potentially reduces the caloric content of the finished product. However, due to the terpenes and aromatic compounds present in the pumpkin, the smell and taste of the finished product deteriorate (Fig. 7, 8). Such conclusions were drawn from the point of view of both experts and potential consumers. The probable cause of the deterioration of the indicators of culinary evaluation is a short period of heat treatment during which there is no inactivation of aromatic compounds that occur in sliced pumpkin.

However, it can be assumed that other biologically active substances contained in the fresh sliced pumpkin retain their properties in the finished product. However, this assumption requires further study. The change in the color of the finished product is due to a significant number of carotenoids in sliced pumpkin. The dough during the preparation of cupcakes changed color from light to rich yellow, which was reflected in the subsequent color of the surface of the cupcake and its crumb (Tables 1, 2). At the same time, the change in coloration did not depend on the shape of the sliced pumpkin. This feature of the color of the dough is due to a significant number of carotenoids in the pumpkin.

Based on the results of statistical treatment, an optimum zone has been identified, which makes it possible to obtain a high indicator of the generalized function of desirability. It is proved that important indicators of culinary quality remain at a high level in samples enriched with sliced pumpkin up to 20 %. Therefore, during the modernization of the classical technology of cupcake production, enterprises are recommended to add up to 20 % of fresh sliced pumpkin. At the same time, there are no requirements for the shape of pumpkin slices. It is important to adjust the shredder so that the volume of the resulting pumpkin slices is from 5 to 170 cm^3.

The peculiarity of the proposed method of enriching cupcakes is the use of fresh sliced pumpkin. Studies [13, 39] are based on the use of pumpkin flour, which in general is a common practice of enriching flour products, including confectionery. The drying process is complex and time-consuming, requiring the use of specialized equipment (dryers), involving a significant amount of energy, which significantly increases the cost of the finished product. The energy intensity of the drying process depends on the moisture content in the product that is subjected to such treatment. When using pumpkin flour, confectionery manufacturers are forced to either significantly modernize production with the installation of a pumpkin drying line or look for a suitable product on the market. The use of the proposed method will allow enterprises of different productivity without significant changes in the technological process to test new types of products and investigate the response of the consumer market. Our results make it possible to form accurate forecasts of the culinary quality of the finished product at the stage of forming a formulation, which is of practical importance and minimizes the financial risks associated with the adaptation period of the technology implementation. Increasing market share of pumpkin-enriched products is projected to stimulate its producers and specialized processing plants in the future.

The results of our research, in addition to practical importance, are of scientific significance since they close the existing niche of uncertainties associated with the use of fresh sliced pumpkin. The established causal relationships make it possible to expand the understanding of changes in the culinary properties of cupcakes depending on the amount and shape of added moisture-containing products (sliced pumpkin).

It is advisable to indicate the limitations inherent in the research given in this work. The results can be reproduced when using nutmeg pumpkin (*Cucurbitamoschata (Duch.) Duch. exPoir.*) or other species that has similar properties. This is due to the content of carotenoids in the specified type of product and other aromatic substances, the mechanism of influence of which on the culinary quality of cupcakes is traced in the results of this work. The use of raw materials fresh, which has significant differences from nutmeg pumpkin, requires additional study. Restrictions in the practical application of production recommendations relate to the productivity of the latter. The process of baking cupcakes, described in our paper, as well as the recommendations highlighted, are appropriate for the introduction at small-scale enterprises. The introduction of technological solutions at high-productivity enterprises requires additional production tests.

Owing to the social research, it is determined that the criteria for optimizing cupcake technology are its chemical composition and culinary quality of the product. In the technology of cupcake production, it is necessary to add 20–25 % of fresh sliced pumpkin of various shapes relative to the mass of the dough. The use of this amount of sliced pumpkin

makes it possible to bake a cupcake with a light-yellow surface and yellow crumb. The consumable level of the cupcake is good while the smell and taste of the pumpkin in it is weak.

The limitation of this study is the use of only one variety of pumpkin. The application of recommendations for another type of pumpkin may not ensure that the result is obtained in accordance with the current paper. In addition, the results of our studies cannot be used for pumpkin flour and pumpkin paste because they have properties that differ from fresh sliced pumpkin.

The results of the social survey form the opinions of consumers inherent in the region of conducting such a survey. In addition, it is projected to dynamically change the preferences of potential consumers of new types of products. Therefore, it is expedient to launch systematic market monitoring to form an enterprise development strategy that will have the opportunity to adapt to market conditions.

The current study can be advanced by expanding information about the physicochemical and technical-economic indicators of products enriched with pumpkin. It requires a comprehensive comparison of the production of flour confectionery products enriched with various pumpkin processing products (fresh pumpkin, pumpkin flour, pumpkin paste, etc.). The promising direction of extending the range of flour confectionery products using moisture-containing raw materials requires an in-depth study into the rheological properties of the dough. The establishment of causal relationships between the addition of fresh pumpkin and the structural-mechanical properties of the dough, its humidity, and viscosity will make it possible to form scientifically based recommendations for industrial production. It is required to additionally establish the biological value of the products obtained. Conducting such studies could lead to the possibility of operators of the bakery and confectionery market to form more accurate forecasts for the modernization of production facilities.

7. Conclusions

1. Social studies have been conducted and the main criteria for cupcake buyers have been established. It was found that cupcakes are in high demand and have the prospect of being enriched with pumpkin. Among the respondents, the new product has a high probability of buying. Its price is less important. It is proved that its chemical composition and culinary quality are of greatest importance when choosing a cupcake.

2. The culinary quality (smell, taste, the surface and crumb color) of the cupcake with the addition of fresh sliced pumpkin of different shapes and quantities has been determined. It is established that the color of the surface and the cupcake crumb depended on the amount of fresh sliced pumpkin. The shape of the sliced pumpkin did not change these cupcake parameters. The color of the surface of the cupcake when adding 5–25 % of the sliced pumpkin was at the level of control – light yellow. When adding 30–40 % – yellow, 45–50 % – dark yellow. The color of the cupcake crumb with 5–10 % of sliced pumpkin and without sliced pumpkin was light yellow. The addition of 15–35 % of the sliced pumpkin provided a yellow crumb color. At 40–50 % of the sliced pumpkin, the color was orange. The use of fresh sliced pumpkin in the amount of 25 % reliably reduces the smell and taste of the consumer evaluation of the cupcake. At the same time, the level of smell and taste was good (7 points). It should be noted that when adding 20 % of fresh sliced pumpkin, the smell and taste of pumpkin in the cupcake was weak – 7 points.

3. In the technology of cupcake production, it is necessary to add 20–25 % of fresh sliced pumpkin of various shapes relative to the mass of the dough. The use of this amount of sliced pumpkin makes it possible to bake a cupcake with a light-yellow surface and yellow crumb. The consumer level of the cupcake is good, and the smell and taste of the pumpkin in it is weak.

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