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Article

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DETERMINATION OF THE COMPREHENSIVE INDICATOR OF PASTILLE WITH THE USE OF MULTI-COMPONENT FRUIT-BERRY PASTE

The object of research in this work is the technology of pastille with the addition of multicomponent fruit and berry paste. Pastille are becoming more and more popular in the world for all segments of the population. Usually, the main ingredients for their manufacture are fruit raw materials, a structurant and egg white, therefore, the products contain practically no fat and have a low calorie content.

It is proposed to replace 75 % of traditional applesauce in the recipe with a multicomponent fruit and berry paste made from apples, cranberries, hawthorn. It was found that such a composition makes it possible to obtain products with an increased content of pectin substances, ascorbic acid, polyphenols, including anthocyanins, catechins and flavonols.

The work is aimed at studying the application of the principles of qualimetry to determine a complex indicator of the quality of pastille For this, the organoleptic and physicochemical indicators of the quality of the developed pastille were taken from previous studies and the chemical composition was determined and the content of biologically active substances was calculated relative to the average daily human need. The content of pectin substances in new products increases 1.7 times and satisfies the average daily human need by 18.2 %. The content of ascorbic acid is 4.2 times higher, which is 20.5 % of the average daily human need, and polyphenols 3.2 times higher – 579.0 %. The data obtained make it possible to consider the developed product functional.

The next step was to determine the complex indicator of products by the qualimetric method. For a more complete disclosure of product properties, a structure of pastille quality indicators has been developed – a «tree of properties». Thus, the comprehensive assessment of the quality of the control sample corresponds to the indicator «good» (0.66), while the integrated assessment of pastille with multicomponent paste corresponds to the indicator «very good» (0.98).

On the basis of organoleptic, physicochemical indicators and chemical composition of products, it was established that the indicator of a comprehensive assessment of the quality of a pastille with a multicomponent paste, taking into account all group indicators, is 48 % higher compared to the control.

Keywords: *pastille technology, complex indicator, multicomponent paste, quality indicators, nutritional value.*

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1. Introduction

One of the trends in the manufacture of confectionery products is to increase their nutritional value. A number of nutritionists advise using pastille and pastille, because compared to other products, such as chocolate or cakes, they practically do not contain fat and have significantly lower calorie content. In addition, the raw materials included in their composition (egg white, pectin) are not only technologically necessary components for the formation of the structure of products, but are also useful functional ingredients for the body. The use of relatively low temperature conditions for processing the whipped mass allows to preserve all the useful substances and properties of the raw material. As a result, all this makes the group of pastels a convenient object for enrichment with functional ingredients.

The works [1, 2] show the possibility of introducing a sweetener of natural origin (stevia) and iodine-containing raw materials (elamin) in the production of pastille. The proposed technology somewhat expands the range of products, but does not contribute to solving the problem of complex enrichment. Studies on the use of the iodine-containing dietary supplement «Iodcasein» in the pastille technology have shown that it does not change the quality indicators of the pastille mass, but this technology is offered by a greater proportion for people with iodine deficiency in the body [3].

A study was carried out to add *C. ternatea* leaves to improve the physicochemical properties and sensory sensitivity of pastille [4]. Used exotic for us additives of the fruit Ciku (*Manilkara zapota*), also known as sapodilla [5]. However, mass production using these technologies is limited due to the specificity of this raw material.

Scientists have proposed replacing applesauce in sugar beet puree in the technology of whipped products [6] and the manufacture of pastille on fructose with Jerusalem artichoke powder [7]. However, an unresolved issue is the effect of herbal supplements on the obtained structural and mechanical properties and consumer properties in general. This confirms the feasibility of research in this direction. Confectionery products become functional as a result of partial or complete replacement of ingredients that are beneficial to human health. But sometimes the addition of additives for product enrichment can significantly reduce the organoleptic characteristics of products, which is unacceptable [8]. The use of a comprehensive assessment will make it possible to establish the quality of products in terms of all quality indicators, to make an informed choice of the best products and to quantitatively assess the prospects of technological development.

The technology for the production of functional pastille is proposed with the introduction of the developed multicomponent fruit and berry paste based on apples, cranberries, hawthorn [9]. This technology expands the range of vegetable semi-finished products with a high content of functionally physiological ingredients and pastille with increased nutritional value.

To assess the quality of the developed technology and predict its competitiveness in the confectionery market, let's consider it expedient to determine the complex indicator of pastille using a multicomponent fruit and berry paste.

The object of research in this work is the technology of pastille with the addition of multicomponent fruit and berry paste. *The aim of research* is to apply the principles of qualimetry to determine a complex indicator of the quality of pastille.

2. Methods of research

Vanilla pastille with the addition of applesauce was chosen as a control [10]. The prototype was a candy with fruit and berry multicomponent paste in the amount of 75 % from the replacement of applesauce, the technology of which was substantiated by previous studies [9].

To calculate the complex indicator of the quality of pastille, its chemical composition was determined (the content of pectin substances, ascorbic acid, polyphenols, including anthocyanins, catechins and flavonols).

Quality indicators were determined using the following methods. The content of pectin substances was determined by the calcium-pectate method, low-molecular phenolic compounds – by the colorimetric method according to GOST 4373:2005. The content of catechins and flavonols was determined by the chromatographic method.

The quantitative determination of antioxidants was carried out by the spectrophotometric method. The spectra of the pastille samples were recorded on an SF-46 spectrophotometer (Russia) in the ultraviolet and visible regions. The thickness of the absorbing layer was 1 cm.

The quantitative content of the sum of oxidizable polyphenolic compounds was determined by the method of permanganatometry according to the method of the State Pharmacopoeia of Ukraine.

The magnitude of the error for all studies was $\sigma = 3–5$ %, the number of replicates of experiments was $n = 5$, the probability was $P \geq 0.95$.

3. Research results and their discussion

Previous studies [9] have established that the addition of multi-component fruit and berry paste improves the organoleptic characteristics of the quality of the pastille. Replacing 75 % applesauce with a paste gives the products a pleasant taste and smell of cranberry, uniformly red in color. The consistency and structure of the products becomes somewhat protracted, which is allowed by the regulatory documentation for glue pastille.

Taking into account the aim of increasing the content of physiologically functional ingredients, the chemical composition of the pastille was determined with the addition of a multicomponent fruit and berry paste and a control sample (Table 1).

Table 1 shows that the addition of multicomponent fruit and berry paste to the recipe composition of the pastille increases the content of all biologically active substances in comparison with the control sample. Thus, the content of pectin substances increases 1.7 times (18.2 g/100 g), which satisfies the average daily human need by 18.2 %. The content of ascorbic acid is 4.2 times higher, which is 20.5 % of the average daily human need, and polyphenols 3.2 times higher – 579.0 %. Thus, based on the data obtained on the chemical composition of products, the developed product can be considered functional.

The next step was to determine the complex indicator of products by the qualimetric method. For a more complete disclosure of product properties, a structure of pastille quality indicators has been developed – a «tree of properties» (Table 2).

Table 1

Chemical composition of 100 g pastille with the addition of multi-component fruit and berry paste

Substance	Average daily requirement	Pastille with applesauce (control)		Pastille with multicomponent paste	
		Content of substances in 100 g	% of the average daily requirement	Content of substances in 100 g	% of the average daily requirement
Pectin substances, g	10.0	1.07±0.05	10.7	1.82±0.09	18.2
Ascorbic acid, mg	70.0	4.89±0.24	7.0	14.33±0.71	20.5
Polyphenols, mg	50.0	91.0±4.55	182.0	289.5±14.5	579.0
– anthocyanins, mg	200.0	–	–	86.4±4.32	43.2
– catechins, mg	100.0	42.0±2.1	42.0	55.1±2.76	55.1
– flavonols, mg	20.0	4.27±0.21	21.4	40.8±2.04	204.0

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Table 2

«Properties tree» of pastille

Pastille quality (P_o=1.00)	Organoleptic properties (P_A=0.30)	Structure	P_{A1}	0.15
		Taste and smell	P_{A2}	0.30
		Color	P_{A3}	0.25
		Consistency	P_{A4}	0.20
		Surface	P_{A5}	0.10
	Physical and chemical properties (P_B=0.25)	Mass fraction of dry substances	P_{B1}	0.25
		Mass fraction of reducing substances	P_{B2}	0.35
		Density	P_{B3}	0.15
		Total acidity	P_{B4}	0.25
	Biological and nutritional value (P_C=0.45)	Pectin substances	P_{C1}	0.25
		Ascorbic acid	P_{C2}	0.25
		Polyphenols	P_{C3}	0.15
		Anthocyanins	P_{C4}	0.15
		Catechins	P_{C5}	0.10
		Flavonols	P_{C6}	0.10

For its construction, certain groups of properties were selected. Group A includes organoleptic properties: structure, color, smell, taste, texture and surface. Group B included physical and chemical properties: mass fraction of dry substances, mass fraction of reducing substances, density and total acidity. Group C included indicators of the content of pectin substances, ascorbic acid, polyphenols, including anthocyanins, catechins and flavonols. Despite the fact that the properties that are included in the trees are not the same in importance, the expert group determined the weight coefficients of single and group quality indicators.

For pastille, the most significant is the improvement of organoleptic characteristics and an increase in their chemical composition. Physicochemical indicators are important, but the main thing is their compliance with quality requirements. Therefore, the following group weight indicators were selected: 0.30 – for organoleptic, 0.25 – for physical and chemical properties, and 0.45 – for biological and nutritional value.

The calculation of the complex indicator of the quality of pastille began with the determination of the group complex indicators at the first level. Calculations of organoleptic properties (P_A) were carried out within the expert group on a 50-point system. The absolute values of sensory characteristics were converted to relative dimensionless values using the Harrington desirability function plot. For groups B and C, the maximum allowable value was taken according to the regulatory documentation or the best value from the point of view of maximizing the content, or as in the control sample (Table 3).

The results of the conversion of absolute quality indicators into relative dimensionless values are given in Table 4.

Table 3

Baselines for properties of groups B and C

Group of properties	Indicator	Units	Baseline value
B	Pb_1 [3]	%	85.0
	Pb_2 [2]	%	9.9
	Pb_3 [1]	kg/m^3	700.0
	Pb_4 [2]	deg	6.4
C	Pc_1 [2]	g/100 g	1.82
	Pc_2 [2]	mg/100 g	14.3
	Pc_3 [2]	mg/100 g	289.5
	Pc_4 [2]	mg/100 g	86.4
	Pc_5 [2]	mg/100 g	55.1
	Pc_6 [2]	mg/100 g	40.8

Notes: [1] – maximum permissible value according to regulatory documents; [2] – taken from the point of view of maximizing content; [3] – as in the control sample

Table 4

Determination of the relative quality indicators of pastille samples

Units	$K_{i\text{-th}}$ quality indicators			Relative quality indicators		
	Code	Control	Pastille with multi-component paste	Code	Control	Pastille with multi-component paste
Score	P_{A1}	48	48	KA_1	0.96	0.96
Score	P_{A2}	45	50	KA_2	0.90	1.00
Score	P_{A3}	45	50	KA_3	0.90	1.00
Score	P_{A4}	47	48	KA_4	0.94	0.96
Score	P_{A5}	49	49	KA_5	0.98	0.98
%	P_{B1}	85.0	81.0	KB_1	1.00	0.95
%	P_{B2}	8.0	9.9	KB_2	0.89	1.0
kg/m^3	P_{B3}	605.0	580.0	KB_3	0.86	0.82
deg	P_{B4}	5.10	6.40	KB_4	0.79	1.00
g/100 g	P_{C1}	1.07	1.82	KC_1	0.58	1.00
mg/100 g	P_{C2}	4.89	14.33	KC_2	0.33	1.00
mg/100 g	P_{C3}	91.0	289.5	KC_3	0.31	1.00
mg/100 g	P_{C4}	0.0	86.4	KC_4	0.00	1.00
mg/100 g	P_{C5}	42.0	55.1	KC_5	0.76	1.00
mg/100 g	P_{C6}	4.27	40.8	KC_6	0.10	1.00

Assessment of group properties was carried out taking into account the relative values of quality indicators in the group and their weighting factors (Table 2). On the basis of the calculation, a model of the quality of pastille was built by group properties (Fig. 1) and its comprehensive quality assessment was calculated (Table 5).

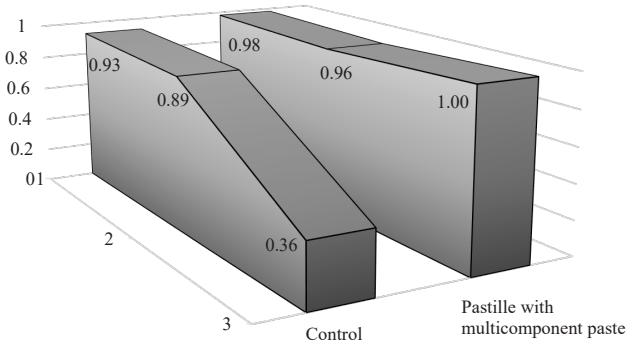

Fig. 1. Model of the quality of the studied pastille samples by group properties: 1 – organoleptic; 2 – physical and chemical; 3 – biological and nutritional value

It can be seen from the above data that the developed pastille with multicomponent fruit and berry paste has improved properties for each group.

Table 5

Comprehensive assessment of the quality of pastille

Sample	Quality assessment by properties			Complex indicator
	Organo-leptic	Physico-chemical	Biological and nutritional value	K_0
Pastille (control sample)	0.3·0.93	0.25·0.89	0.45·0.36	0.66
Pastille with multi-component paste	0.3·0.98	0.25·0.96	0.45·1.00	0.98

To understand the assessment scale, the indicators are distributed according to this scale: very good – 1.00–0.80; good – 0.80–0.60; satisfactory – 0.60–0.40; bad – 0.40–0.20.

Thus, from Table 5 it can be seen that the complex assessment of the quality of the control sample corresponds to the indicator «good» (0.66), while the complex assessment of the pastille with multicomponent paste corresponds to the indicator «very good» (0.98).

4. Conclusions

Based on the determination of the chemical composition of the products, it was found that due to the addition of a multicomponent fruit and berry paste from apples, cranberries and hawthorn to the recipe composition of the pastille, the content of all biologically active substances increases in comparison with the control sample. The content of pectin substances increases 1.7 times (18.2 g/100 g), ascorbic acid – 4.2 times (14.33 mg/100 g), polyphenols – 3.2 times (289.5 mg/100 g). It was found that a comprehensive assessment of the quality of a pastille with a multicomponent paste, taking into account group indicators (organoleptic, physicochemical, biological and nutritional value), exceeds the corresponding sample made using the classical technology by 48 %. Thus, the improved pastille technology is competitive.

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