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Article

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DETERMINATION OF QUALITY INDICATORS OF MARMALADE WITH ADDITION OF MULTI-COMPONENT FRUIT AND BERRY PASTE DURING STORAGE

The object of research is the technology of jelly-fruit marmalade with the addition of multicomponent fruit and berry paste from apples, quince and black currant. Marmalade products are in demand due to their attractive appearance, excellent taste, aroma and good absorption by the body. This delicacy is characterized by the absence of fat, high sugar content and the presence of functionally physiological ingredients. Due to the growing interest of consumers in products of increased nutritional value, the technology of jelly-fruit marmalade with the addition of multicomponent fruit and berry paste from apples, quince and black currant has been improved. New confectionery products must first of all be safe for human health, therefore, organoleptic, physicochemical and microbiological indicators of the quality of marmalade were determined during storage.

In terms of organoleptic quality indicators, both control and experimental marmalade samples have high quality indicators during the shelf life. The storage duration affects the consistency of the marmalade, which becomes protracted after 3 months of storage and contributes to a decrease in the color saturation of all samples. The loss of the mass fraction of moisture in the control sample of marmalade up to 6.1 % and the sample with fruit and berry paste – up to 5.0 %, an increase in acid accumulation by 4.0–20.6 % for the control and by 4.0–20 % for the sample marmalade with pasta. It is noted that the content of reducing substances increases in the control sample by 18.0–50.0 %, which is 11.8–15.0 %, and in the sample with the addition of paste – by 10.8–36.9 %, which is 12.3–15.2 %. The data obtained is admissible and meets the established quality requirements in accordance with the requirements of regulatory documents.

Microbiological quality indicators have been determined and it has been established that new samples of marmalade with multicomponent paste, both freshly prepared and after a guaranteed shelf life, comply with the standards of all current requirements for the quality of food products. The safety of jellied fruit marmalade on agar with the addition of multicomponent fruit and berry paste from apples, quince and black currant has been proven during the guaranteed shelf life of 3 months.

Keywords: *technology of marmalade, multicomponent paste, quality characteristics, storage of marmalade, microbiological characteristics, nutritional value.*

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1. Introduction

A wide range of products and a variety of raw materials that make up confectionery products determine excellent terms and conditions for storing the finished delicacy. Reduced moisture content and increased dry matter content of confectionery products cause their increased safety at a favorable temperature. However, along with these positive factors, the substances present in the chemical composition of the product and their physical properties can have a negative effect on the finished product during storage. Therefore, it is essential to find criteria that limit the shelf life of confectionery products and conduct a study of their features to ensure very acceptable terms [1, 2].

Confectionery with a dry consistency during storage is more susceptible to physical changes such as staleness or moisture. However, sometimes their mold or fermentation can occur, the reason for this is the processes of moisture transfer, and the driving force is the activity of the water. The rate of transition of water from one phase to another depends on the physical properties of the system, as well as the difference between the equilibrium and working concentration. The relationship between the factors is established by means of the equations of diffuse kinetics. To predict moisture loss

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during storage of these products, it is proposed to use the molecular diffusion coefficient, which makes it possible to substantiate the type of jelly-forming agent, the thickness of the package and the storage temperature of products with a given shelf life [3, 4].

The work [5] notes the relevance of scientific research of marmalade products based on functional ingredients from non-traditional types of fruit and berry raw materials, designed to strengthen and maintain the health of the population. However, vegetable raw materials can both increase the nutritional value of products and affect the shelf life of products due to their contamination. Therefore, it is indisputably important that scientists conduct research on the effects of a variety of plant materials:

– cryogenic additives from fruits and vegetables [6, 7];
– linseed oil [8];
– juice from sea buckthorn berries [9];
– kelp [10], etc. for the shelf life of marmalade.

In [11], the technology of jelly-fruit marmalade on agar was improved with the addition of a developed fruit-berry paste. This development will allow to expand the range of marmalade products of inflated nutritional value.

To assess the quality and compliance with the shelf life of the developed samples of marmalade, it is necessary to conduct a study of the indicators regulated by the regulatory documentation for this type of product.

The object of research is the technology of jelly-fruit marmalade with the addition of multicomponent fruit and berry paste from apples, quince and black currant. *The aim of research* is to determine the organoleptic, physicochemical and microbiological indicators of marmalade during storage.

2. Methods of research

«Black currant» marmalade was chosen as a control [12]. The experimental sample was a fruit jelly with a multicomponent fruit paste in the amount of 30 % with the exception of the recipe composition of the blackcurrant supply and a decrease in the amount of agar by 30 %, the technology of which was substantiated by preliminary studies [11].

To determine the quality of marmalade during storage, organoleptic, physicochemical and microbiological indicators have been determined.

The study of the obtained organoleptic properties of the prototypes was carried out by an expert commission consisting of 5 members of the Kharkiv State University of Food Technology and Trade (Kharkiv, Ukraine) on a 5-point scale.

The listed characteristics of the properties of marmalade were determined by the following methods. The mass fraction of moisture in the marmalade was determined by the refractometric method, acidity – by the titrometric method, the content of reducing substances – by the ferricyanide method. Determination of microbiological indicators of marmalade was carried out by standard methods in freshly prepared samples and after a guaranteed shelf life of 3 months. For this, the total number of mesophilic aerobic and facultative anaerobic microorganisms (QMAFAnM), molds and yeasts, pathogenic microorganisms and the presence of bacteria of the *E. coli* group were determined.

The storage of the marmalade packed in an opaque plastic bag was carried out in accordance with all the requirements of regulatory documents (DSTU 4333-2004). Namely, in a clean and ventilated room, not infected with pests, at a temperature not exceeding 18 °C and a relative humidity of not more than 75–80 %, without access to direct sunlight.

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

3. Research results and discussion

According to the results of preliminary studies [11], it was found that the addition of a multicomponent fruit and berry paste improves the organoleptic characteristics of the marmalade quality. Adding 30 % of the paste gives the products a pleasant taste and smell of black currant, purple, and allows to reduce the prescription amount of jelly-forming agent by 30 %.

However, for a full assessment of the developed technology of marmalade, it is necessary to check the conformity of the quality of new samples during the guaranteed shelf life. For jelly-fruit marmalade, this period is 3 months. Therefore, the next step was to determine the change in organoleptic (Table 1) and physicochemical indicators of freshly made marmalade, after 1 month of storage, 2 months and 3 months (Fig. 1–3).

As it is possible to see from the Table 1, the appearance, surface, taste and smell of both the control and the prototypes of marmalade hardly change during the shelf life. However, the storage duration affects the consistency of the marmalade; after 3 months of storage, it becomes somewhat protracted in all samples. The color of the products becomes less saturated. So, the control sample of marmalade after 2 months of storage changes from dark purple to purple, and after 3 – it becomes light purple. At the same time, the color of marmalade with multi-component paste changes after 3 months of storage from saturated to light purple. Since the guaranteed shelf life of DSTU is 3 months, all quality indicators meet the established requirements.

Table 1

Organoleptic indicators of marmalade quality during storage

<table>
<tr><th rowspan="2">Sample</th><th colspan="5">Indicator</th></tr>
<tr><th>Appearance</th><th>Consistency</th><th>Surface</th><th>Taste and smell</th><th>Color</th></tr>
<tr><td colspan="6">Control</td></tr>
<tr><td>1 day</td><td rowspan="3">Correct shape, with a clear outline, no deformation</td><td rowspan="2">Jelly-shaped, not hard</td><td rowspan="3">Evenly strewn with white crystalline sugar, elastic</td><td rowspan="3">The properties of this product are free of foreign taste and smell</td><td rowspan="2">Dark purple</td></tr>
<tr><td>1 month</td></tr>
<tr><td>2 months</td><td>Purple</td></tr>
<tr><td>3 months</td><td></td><td>Jelly-shaped, a little hard</td><td></td><td></td><td>Light purple</td></tr>
<tr><td colspan="6">Fruit jelly with the addition of pasta</td></tr>
<tr><td>1 day</td><td rowspan="3">Correct shape, with a clear outline, no deformation</td><td rowspan="2">Jelly-shaped, not hard</td><td rowspan="3">Evenly strewn with white crystalline sugar, elastic</td><td rowspan="3">Inherent in this product, sweet and sour, with a pleasant aftertaste and smell of black currant</td><td rowspan="2">Deep purple</td></tr>
<tr><td>1 month</td></tr>
<tr><td>2 months</td><td rowspan="2">Purple</td></tr>
<tr><td>3 months</td><td></td><td>shaped, a little hard</td><td></td><td></td><td></td></tr>
</table>

The mass fraction of moisture of all samples of marmalade during the guaranteed shelf life (Fig. 1) decreases, which is a natural process of drying products. In the control sample, the mass fraction of moisture decreases to 6.1 %, in the sample with fruit and berry paste – to 5.0 %, but these changes are not significant.

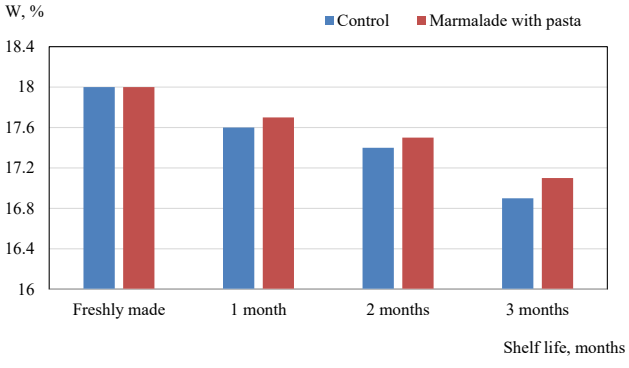

Fig. 1. Change in the mass fraction of moisture in the samples of marmalade during the guaranteed shelf life

The data obtained on changes in acidity in the samples (Fig. 2) indicate an increase in acidity during storage of marmalade, which is explained by the process of acid accumulation. Thus, the acidity increases by 4.0–20.6 % for the control sample, and by 4.0–20 % for the marmalade sample with a paste that is permissible according to the requirements of DSTU 4333:2018 (7.5–22.5 degrees).

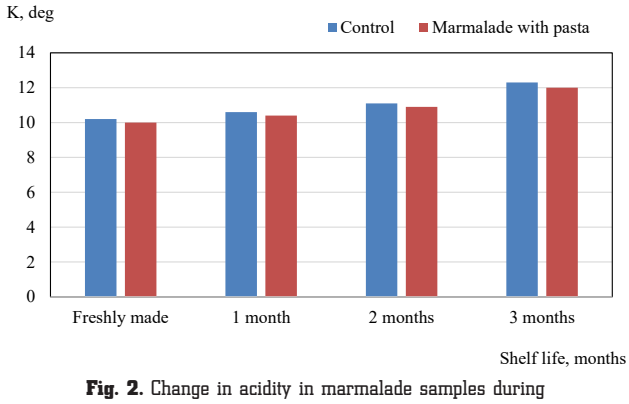

Fig. 2. Change in acidity in marmalade samples during the guaranteed shelf life

An excessive increase in the content of reducing substances in marmalade can lead to waterlogging of products, while a decrease can lead to sugaring or drying of products, which is unacceptable in the production of marmalade products. Therefore, it was deemed appropriate to determine the changes in the reducing substances during storage (Fig. 3). It was found that the content of reducing substances increases in the control sample by 18.0–50.0 %, which is 11.8–15.0 %, and in the sample with the addition of paste – by 10.8–36.9 %, which is 12.3–15.2 %. The obtained data are admissible, since according to the requirements of DSTU 4333:2018, the content of reducing substances should be no more than 28 %.

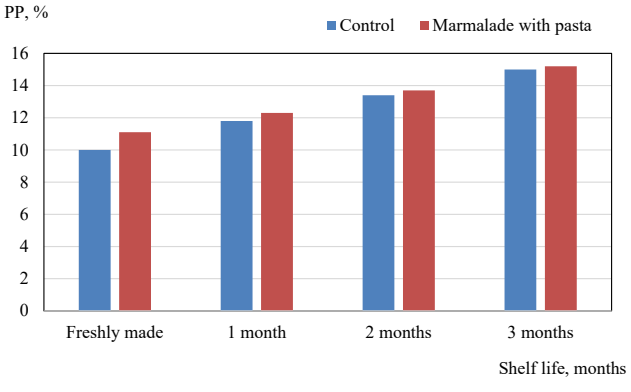

Fig. 3. Change in the content of reducing substances in marmalade samples during the guaranteed shelf life

Based on the above data of physical and chemical indicators, it can be argued that the developed marmalade products with the addition of multicomponent fruit and berry paste meet all the requirements of regulatory documents during the guaranteed shelf life.

The use of plant raw materials in the manufacture of marmalade products can affect the microbiological indicators, therefore, it would be advisable to determine them in new products (Table 2).

According to the results of determining microbiological quality indicators, new samples of freshly made marmalade and after a guaranteed shelf life meet the standards with all applicable requirements for the quality of food products. Thus, the developed samples of marmalade are safe from the point of view of microbial contamination and can be recommended for consumption.

The limitation of this study is the difficulty of establishing the quality indicators of fruit and berry raw materials during its processing by a low-temperature method in comparison with the traditional one. The development of this research is the development of dietary confectionery products, namely pastille-marmalade, with a low sugar content.

Table 2

Microbiological indicators of the quality of marmalade with multicomponent past

Marmalade sample		QMAFAnM, CFU in 1 g, no more	Coliforms, in 0.1 g	Pathogenic microorganisms, including bacteria of the genus Salmonella, in 25 g	Molds, CFU in 1 g, no more
DSTU standard		$1 \cdot 10^3$	Not allowed	In 0.1 g	50
Control	Freshly made	2.7·10	Not found	Not found	<10
	In 3 months	3.7·10			<10
With multi-component paste	Freshly made	2.9·10	Not found	Not found	<10
	In 3 months	4.2·10			<10

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4. Conclusions

The quality indicators of jelly-fruit marmalade on agar with the addition of multicomponent fruit and berry paste from apples, quince and black currant were determined during the guaranteed shelf life of 3 months. The appearance, surface, taste and smell of both control and prototypes of marmalade hardly change during the shelf life. The consistency of marmalade after 3 months of storage becomes somewhat lingering in all samples, and the color of the products becomes less saturated. The content of reducing substances increases in the control sample by 18.0–50.0 %, and in the sample with the addition of paste – by 10.8–36.9 %. It was found that the new product meets the requirements of regulatory documents in all respects. Consequently, the improved technology of marmalade is safe, recommended for consumption and competitive due to the reduction in the cost of products due to the reduction of the prescription amount of the jelly-forming agent by 30 %.

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