Preparation of fruit products and analysis of their chemical and organoleptic assessment

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Abstract. Processing of fruits and grapes and the creation of high-quality food items are completely consistent with the requirements of not destroying the produced crop. Making candied fruits from fresh fruits is a processed product that can increase the shelf life of the fruits by many years. The processing of fruits and grapes to produce high-value food products can be done without destroying the cultivated crop. Candied fruits, for example, are a processed product made from fresh fruits that can significantly prolong their shelf life for many years. Research was conducted in 2021-2022 at the Scientific Research Institute of Horticulture, Viticulture and Winemaking named after Academician M. Mirzaev "Department of Storage and Processing of Fruit and Grapes". The results depicted that the dry matter content of candied fruits was generally higher than 70-75%, which was consistent across most sources. An analysis of processed products made from grain fruits showed that candied fruits made from apricots had a dry matter content of 94.5-97.2%, while peaches had a dry matter content of 93.8-95.1%, and plums had a dry matter content of 85.7-88.6%. It is worth noting that apricots and peaches contained particularly high levels of dry matter.

1 Introduction

Fruit and grape processing and the production of high-value food products are fully compatible with the conditions of non-destruction of the cultivated crop. A processed product from fresh fruits is the preparation of candied fruits, which can extend their shelf life for several years [1-7, 9]. The aim is to provide the population with fruit products throughout the year, as well as to meet the demand for raw materials in the confectionery industry. Unlike other artificially colored and flavored sweets, candied fruits retain the vitamins and minerals present in the fruit without losing their value [1]. Candied fruits or candied fruits are fruits treated with sugar, in which the long-term storage of fruits is ensured depending on the concentration of sugar. Usually, when citric acid is added to the sugar syrup, it is possible to prevent sugarcane from being damaged by various fungi. Also, adding aromatic spices is one of the factors that increase their quality and marketability [1-3].

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In foreign literature, the study of dry matter of sugarcane products is an important scientific result, and it is said that dry matter can be increased due to cooking in sucrose and glucose-fructose pastes, and it was observed that orange peels lose the most dry matter when prepared in glucose-fructose paste [4]. Candied Japanese apricots are usually obtained through a long-term osmotic dehydration process. In the study, the effect of high hydrostatic pressure and initial heat treatment on the change of some biologically active compounds and antioxidant properties was studied [5]. It has been shown in this experiment that Japanese apricot candied fruits treated with high hydrostatic pressure are characterized by high organoleptic taste characteristics, high dry matter content and high antioxidant properties. Therefore, it has been proven that it is possible to obtain high-quality sugarcane products due to various technological changes, as well as coordination of preparation processes before processing.

The quality of products obtained during fruit processing is very important. Because depending on the quality, the possibility of long-term storage and transportation of the product is evaluated. Among quality indicators, dry matter content of processed fruit products stands out among many factors. Candied fruit products made by processing fruit products attract attention due to their naturalness and benefits for the human body. At the same time, a certain index of dry matter is important for long-term storage of candied fruits [6, 7].

The effects of sucrose and calcium chloride (CaCl) content in orange and cherry fruit concentrate on the physico-chemical properties of apple juice and storage period were studied. In this case, the ratio of orange concentrate and syrup in the ratio of 1:3 is optimal, and the calcium chloride content is 0.96% and the storage period is 82 days. It was also found that the ratio of cherry concentrate and calcium chloride is 2:2, and the shelf life is 90 days in the preparation of apple preserves [8]. In a study conducted in Serbia, dried fruits - plums, apricots, figs, grapes, aronia and bilberries, and candied fruits - cranberries, cherries and plums were studied as a test. According to the results of studies, the amount of phenolic substances in dried fruits and candied fruits was placed in the following sequence: dried chokeberry - dried bilberry - dried plum - cherry and apricot skin - dried grape - cranberry skin, fig skin and blackberry skin. The antioxidant properties of these products varied as did the content of phenolic substances. It was observed that the antioxidant properties of the product were strongly positively correlated ($R=0.9931$, $P<0.001$) with the general indicators of the important indicator phenolic substances [9].

In Latvia, different varieties of cherries were processed. In this, the fruits were dried and the candied fruit product was prepared. 5 varieties of cherry were selected for making candied fruit: “Bulatnikovskaya”, “Orlitsa”, “Shokoladnitsa”, “Tamaris” and “Zentenes”. The organoleptic method was used to evaluate candied fruits. As a result, candied fruits made from the Shokoladnitsa cherry variety received a high score, although it had a sour taste compared to other varieties, the Orlitsa variety showed higher results in terms of polyphenol content, and the Bulatnikovskaya variety in terms of soluble dry matter [10]. Gooseberry, plum, and mountain ash candied fruit were used in the study [11, 12] on determining the effect of temperature and time on the content of sorbic acid and sugar content in candied fruit preservation. The samples were stored in a refrigerator at 8°C and at room temperature (20°C) for 11 months. According to the obtained data, the content of sorbic acid was directly affected by temperature and storage period. The sorbic acid content of the candied fruits stored in the refrigerator was higher than the candied fruits stored in the room. At the same time, it was noted that after eleven months of storage, the total acidity of candied fruit decreased, while the sugar content slightly increased.The chemical composition, preservation and other properties of candied fruit made from fruits are widely covered in the scientific works indicated above [4-7, 9]. At the same time, the issues of preparation of candies from a wide range of fruits and their study have not been covered in research. We hope that our scientific work will play an important role in solving these urgent issues .

2 Materials and methods

Research was conducted in 2021-2022 at the Scientific Research Institute of Horticulture, Viticulture and Winemaking named after Academician M. Mirzaev "Department of Storage and Processing of Fruit and Grapes".

Candied fruits were made from apricots, peaches, plums, plums, lemons, strawberries and golden currants. Two varieties of each type of fruit were selected, their fruit quality was evaluated, and then candied fruit was prepared. Their preparation was organized in the following order [1-7]:

sorting fruits into varieties and varieties, removing damaged and diseased ones, cleaning them from seeds and separating them into classes according to size and color;

the separated fruits are washed, and according to the structure of the skin and flesh of the fruit, they are sliced and pierced (to spread the sugar mixture on the fruit);

The general scheme of making candied fruit products from fruits is as follows (Fig. 1):

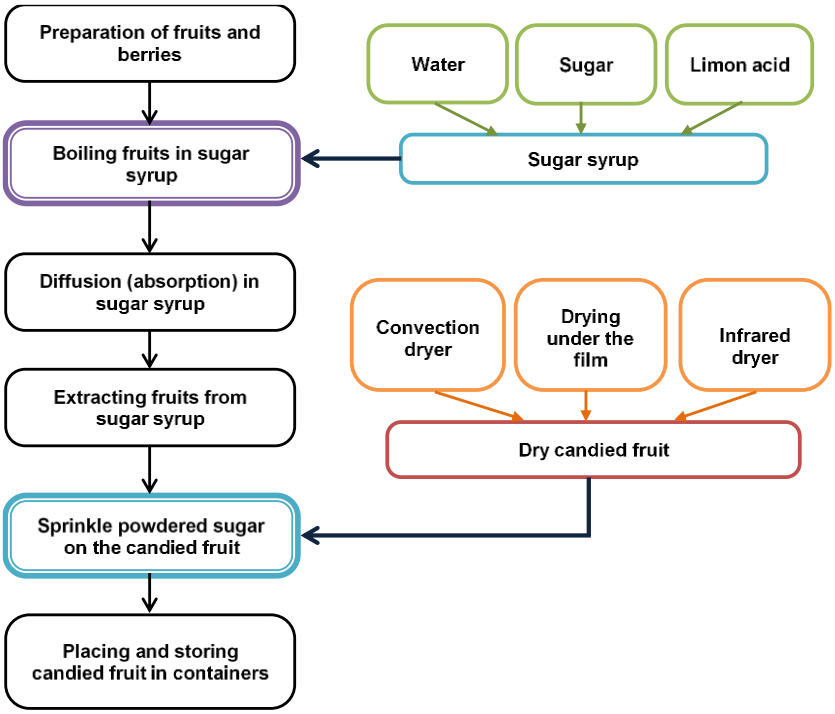

Fig. 1. General overview of making candied fruits.

Each indicator of the candied fruit is rated on a 5-point scale, and an overall assessment is made based on the results. In addition to the organoleptic evaluation, the chemical composition of the candied fruit is studied, particularly its dry matter content. This analysis is carried out using the ACZET MV 200 dry matter measuring equipment [7-11].

During the candied fruit-making process, three parts of sugar are mixed with two parts of water and heated. Citric acid is added to the resulting mixture, which is then used to cook the fruit [4-6]. Once the fruit has been cooked, it is filtered and sorted before being placed in a drying machine. The drying process is carefully monitored to ensure that the fruit is dried optimally. When the drying process is complete, the candied fruit is sprinkled with sugar and stored in jars made of plastic or glass [9-11].

3 Results and discussion

Analysis of the organoleptic evaluation of fruit products. Organoleptic evaluation of candied fruit prepared according to the general technological procedure was carried out. According to it, the appearance of candied fruits, their color, smell, consistency and taste were evaluated. Scientific staff of the institute, horticulture specialists, technologists of food production took part in the assessment. Each indicator was evaluated on a 5-point scale, and a general organoleptic conclusion was given to candied fruits (Table 1).

Table 1. Indicators of organoleptic evaluation of candied fruit made from different types of fruit.

Indicators / Fruit types	Organoleptic assessment of fruits on a 5-point scale				
	Appearance	**Color**	**Smell**	**Consistency**	**Taste**
Apricot	4.5	4.7	3.2	4.1	4.5
Peach	4.3	4.3	3.3	3.7	4.1
Plum	3.9	4.1	3.2	3.9	4.0
Jiyda	4.1	4.2	3.5	4.2	4.0
Lemon	4.0	3.9	4.1	3.4	3.5
Strawberry	3.5	3.6	3.7	3.8	3.9
Golden currant	3.6	4.0	3.0	3.1	3.2

As a result of the research, it was found that the organoleptic evaluation of fruit and berry jams differs from each other and depends on the characteristics of the variety. According to the above table, in the organoleptic evaluation of fruits, apricot fruits took the highest place in terms of appearance (4.5 points), while the lowest was found in strawberries (3.5 points), which means that fruit structure and firmness are of great importance for processing. Also, the aromas of cycads are absent or very low, which can also be seen in the evaluation: from 3.0 points (golden currant) to 4.1 points (lemon). However, the difference in the color of candied fruits was large within the crop types. For example, the color of candied fruits made from strawberry fruits was evaluated with 3.6 points , while candied fruits made from apricot fruits was evaluated at 4.7 points. A similar pattern was seen in the consistency of candied fruits and the difference in their taste.

If we pay attention to the tasting evaluation of fruit products, the overall average score for each type of fruit was calculated and interpreted as follows. For example, the average price of candied fruit made from apricot fruit is 4.20 points, respectively, peach candied fruit - 3.94 points, plum candied fruit - 3.82 points; plumber – 4.0 points; lemon - 3.78 points; strawberry - 3.70 points and golden currant - 3.38 points. When we analyze the overall score, we see that candied fruits made from apricots and plums passed the tasting with a high score. Also, if we pay attention to the dispersion of the scores obtained in the tasting, a small dispersion was observed in strawberry fruits - 0.025, which means that the scores obtained for various characteristics are almost not different from the overall average score. On the other hand, the index of dispersion of apricots made from apricots is 0.360, that is, the evaluations of organoleptic indicators differ sharply from the overall average evaluation.

Dry matter is generally higher than 70-75% in candied fruits, not so drastically different, in most sources. In this case, the concentration of sugar content is important, as well as the criteria for drying candied fruits. In the study, strawberry candied fruits showed the highest performance among the studied berries with a dry matter content of 96.4-96.8%. The analysis of processed products of grain fruits shows that candied fruits of apricot made 94.5-97.2%, peach 93.8-95.1%, plum 85.7-88.6%. It should be noted here that apricots and peaches contain a very high amount of dry matter. It is probably due to this feature that candied apricot and peach fruits were highly rated in the organoleptic evaluation (Table 2).

Table 2. The amount of dry matter contained in candied fruits.

Types of candied fruits	Dry matter content, %
Made from the fruits of the Cobra variety of strawberries	96.05
Made from white currants	95.86
It is prepared during the technical ripening period of the Meyer lemon fruits	94.31
It is prepared from the fruits of the Subhoni variety of apricots	93.74
Made from blackcurrant fruits	92.21
It is prepared from the fruits of strawberry varieties imported from Italy	91.64
Behi is made from the fruits of the Samarkand large-fruited variety	89.77
Made from the fruits of the White Luchchak variety of peaches	89.70
Prepared with the peel of the fruits of the Meyer variety of lemon	89.40
Made from Nectarine peach fruits	88.72
Made from the fruits of the Champion variety of peaches	88.30
Fruits of the Ispolinsky variety of plums are prepared with seeds removed	86.22
Prepared by removing the peel of Meyer lemon fruits	86.10
Made from the fruits of the Muyassar variety of peaches	85.84
The fruits of the Kirgizsky prevoskhodny variety of plums are prepared with the seeds removed	84.42
The fruits of the Kyrgyz Prevoskhodny plum variety were prepared without removing the seeds	83.72
Made from the fruits of the Ta-yan-tsao variety of Jujube	80.97
Fruits of the Ispolinsky variety of plums are prepared without removing the seeds	80.0

When we evaluate candied fruits obtained from subtropical plants in chilongji and lemon processing, we can see that they are differentiated based on the variety and preparation technology. For example, candied fruits of Jujube had a dry matter content of 82.8-88.1%, while candied fruits of lemon differed in dry matter content from 79.5-94.2%. Here, the high difference is based on the fact that the fruits of lemons are picked at different ripening times, as well as processed with peel and without peel.

As it was determined in the research, it is shown that the dry matter content of all studied candied fruit species was in the range of 80.0-96.05%. According to GOST standard requirements for production of candied fruit, dry matter should not be less than 75%. In our study, if we divide the amount of dry matter of sugarcane products into equal parts, that is, the number of products with 80.0-85.0% dry matter - 4, 85.1-90.0% - 8, 90.1-95.0% - We separated 4 samples and 2 samples with dry matter above 95.1%. At the same time, the amount of dry matter of sugarcane made from berries showed the highest values, while the dry matter content of sugarcane made mainly from grain fruits was minimal.

During the determination of dry matter, the solution medium (pH) of sugar products made

from fruits was determined in the study. According to him, it was proved that the environment of candied fruits is an alkaline environment with pH=8.35-8.84. A cross-comparative analysis of the amount of dry matter of candied fruits and the solution medium indicates that there is a weak correlation relationship (R^2 = +0.035).

Study of the amount of sugar content and the proportion of sucrose, fructose and glucose in sugarcane. In the study, the sugar content and its fractions of candied fruit products made from different fruits were studied. If we pay attention to the amount of total sugar in the dry matter of candied fruits, the highest sugar content was observed in candied fruit made from apricots (Yubileyniy Navoi variety). At the same time, the minimum amount of sugar was determined in golden currant (Altinoy variety) sugar. The reason why the difference is not that big is because all the fresh fruits are cooked in sugar syrup during processing.

When we analyze the sugar content of total sugar, we see that it is divided into three main sugars: sucrose, fructose and glucose (Table 3). If we conditionally divide candied fruit products made from fruits into 3 groups according to the amount of total sugar, the first group (70-75%) - 2 samples, the second group (76-80%) - 10 samples and the third group (81-86%) – 6 samples are included. In turn, the total sugar content of the main sugarcane is in the range of 76-80%.

Meyer (technically ripe, unpeeled, green) variety of lemon showed the lowest value of sucrose content, while apricot Yaltirog variety candied fruit showed the highest value with 66.8% sucrose. The exact opposite was observed for fructose. In this case, the content of fructose in the candied fruit of the Yaltirok variety of apricot was 11.4%, while the fructose content of the candied fruit of the Meyer lemon variety was 29.5%. The sugar content of Meyer variety of lemon (fully ripe, with peel, yellow color) reached 14.4%, while the sugar content of U-sin-hun variety of chilongjiida contained 5.7% glucose.If we analyze the content of sucrose in fruit juices, the amount of sucrose is 37.3-66.8% of the total sugar content, and the difference between the lowest and highest values reaches 29.5%. Similarly, when comparing fructose content, the minimum fructose figure was 11.4%, the maximum figure was 29.5%, and the ratio in between was 18.1%. The changes in the amount of glucose are not so great - the minimum amount of glucose is 5.7%, the maximum is 14.4%, and the ratio between them reaches 8.7%.

Table 3. Total sugar content and sucrose, fructose, and glucose content of dry matter in sugarcane

#	Fruit type	Varietal name	Total sugar content, %	from that		
				sucrose	fructose	glucose
1	Apricot	Jubilee Navoi	85.6	57.9	16.2	11.5
2	Apricot	Shiny	84.0	66.8	11.4	5.8
3	Strawberry	Cobra	82.5	58.8	12.6	11.1
4	Lemon (technically ripe, with peel, green)	Meyer	82.0	41.6	28.5	11.9
5	Strawberry	Muto	81.7	57.2	14.4	10.1
6	Peach	Nectarine jelly	81.0	54.5	17.6	8.9
7	Peach	Well done	80.4	51.0	19.7	9.7
8	Golden currant	Rukhshona	79.0	54.6	14.1	10.3
9	Peach	Champion	78.4	48.4	18.7	11.3
10	Lemon (fully ripe, with peel, yellow)	Meyer	78.4	44.9	19.1	14.4

#	Fruit type	Varietal name	Total sugar content, %	from that		
				sucrose	fructose	glucose
11	Lemon (technically ripe, without peel, green)	Meyer	77.1	37.3	29.5	10.3
12	Plums (seedless)	Chernosliv Samarkandsky	77.0	45.2	22.9	8.9
13	Plums (with pits)	Chernosliv Samarkandsky	76.9	44.0	24.8	8.1
14	In Chilongji	U-sin-hun	76.3	49.2	21.4	5.7
15	In Chilongji	Li-zhao	76.2	45.9	23.4	6.9
16	Plums (seedless)	Black plum	76.0	42.9	23.7	9.4
17	Plums (with pits)	Black plum	75.8	42.0	24.6	9.2
18	Golden currant	Golden	71.3	45.4	13.8	12.1

The analysis shows that the variance of sucrose content is 57.66, the variance of fructose content is 29.28, and the variance of glucose content is 4.97. It can be seen that the content of sucrose in candies made from different fruits is the variable amount in the widest range, the amount of fructose is less variable and the least variation is related to the amount of glucose.

The study proved that the change in the amount of sugar in the dry matter of candied fruits depends on the types of fruits, varieties and methods of candied fruit preparation. At the same time, the period of fruit picking is of decisive importance. It is possible to increase the amount of sugar in dry matter in sugar by removing the seeds directly before cooking sugarcane.

When we analyze the ratio of sucrose to total sugar, we can see that they are positively correlated. But it can be said that the ratio of the amount of fructose to the total amount of sugar is inversely correlated. Glucose also had a positive correlation, as did sucrose, but the relationship was relatively weak.

Sucrose content was found to be higher than fructose and glucose in all sugars, but only glucose content was the lowest compared to others.

Taking into account the above, the amount of sugar in candies is different and is correctly correlated with the amount of sucrose, the same can be observed with the amount of glucose, but the opposite can be seen with the amount of fructose. In all the sugarcane in the study, with higher accumulation of sucrose, their shelf life also increases.

4 Conclusions

The process of creating candied fruits from various types and varieties of fruits requires the establishment of specific technological standards for each fruit. Research indicates that candied fruits made from apricots and plums possess favorable organoleptic qualities. However, candied fruits made from berries have a lower organoleptic value. The study also reveals that the dry matter content of dried fruit products meets the standard requirements. Additionally, the dry matter of sugarcane products and their dissolution medium index have a weak correlation. The total sugar content of candies comprises sucrose, fructose, and glucose. When comparing sucrose, fructose, and glucose in terms of total sugar content, it was found that sucrose-total sugar and glucose-total sugar ratios are accurately correlated with the dry matter content.

In summary, the production of candied fruits requires specific technological standards for processing each type of fruit. Apricots and plums are good candidates for making candied fruits, while berries have a lower organoleptic value. The dry matter content of dried fruit products meets standard requirements, and there is weak correlation between the dry matter of sugarcane products and their dissolution medium index. The total sugar content of candies is comprised of sucrose, fructose, and glucose, with sucrose-total sugar and glucose-total sugar ratios having accurate correlation with the dry matter content. These findings can be used to develop guidelines for producing high-quality candied fruit products.

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