STUDY ON QUALITY INDICES OF FRESH AND PRESERVED FRUITS BY FREEZING

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Abstract

Fruits are foods of plant origin, nutritionally valued for their rich content of carbohydrates, mineral salts, vitamins and organic acids.

Fresh or processed fruits cover about 15% of human energy needs. Fresh fruits are both foodstuffs, but also raw materials because they are used to obtain culinary preparations, and they are industrialized products intended for food.

Freezing is the process of cooling food products to temperatures below the solidification point of the water contained in the product, achieving cooling with the formation of ice crystals. The solidification point is between -0.5 °C... - 4 °C, depending on the nature of the product. Freezing is a method of fruit preservation in order to preserve the organoleptic and physico-chemical qualities for a longer period of time.

Freezing increases the shelf life of food products by 5-50 times compared to refrigeration. The increase in the duration of preservation occurs due to the slowing down or even the complete inhibition of the development of microorganisms, the reduction or stopping of metabolic processes, as well as due to the decrease in the intensity of biochemical processes.

The fresh and frozen fruit quality index study was conducted for fresh and frozen strawberries, blueberries and redcurrants over a 12-month period.

Key Words: freezing, organoleptic characteristics, acidity, vitamin C

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INTRODUCTION

Freezing is the technological process by which most of the water in the cell juice of a product turns into ice crystals. Freezing involves treating products with temperatures between -30 and -40°C, temperatures at which water turns into ice in a relatively short time. The freezing temperature is specific to each product, depending on the cell juice concentration, specific heat, thermal conductivity, the size of the products (whole or divided), the temperature difference between the product and the cooling agent, the speed with which the heating agent circulates through the installation (Lazăr Vasile, 2006).

Freezing is one of the most used methods for preserving food products, which ensures obtaining good quality products, under the conditions of applying an appropriate technology. Microorganisms tolerate temperature reduction below 0°C quite well, bacterial and mold spores can survive for a long time, even at the temperature of liquid air (-190°C), reactivating when favorable conditions are created. Yeasts can adapt to low temperatures, causing some products stored at -9°C to ferment. Enzymes reduce their reaction speed as lower temperatures are used, but they retain a reduced activity, which can cause the appearance of color, taste, aroma defects, and, upon thawing, they can show more intense activity than before freezing (Brad Segal & Constanța Balint, 1982).

Freezing is a preservation method that has the potential to provide a high degree of safety, nutritional value, sensory quality and convenience. A primary advantage of freezing compared to other preservation methods is the provision of better-quality food products at times and places remote from harvesting points. Nutritional quality is a growing concern for consumers and the challenge of the frozen food industry is to maximize the retention of nutrients without compromising the microbiological safety of food (Violeta Nour, 2014)

The essence of the freezing phenomenon consists in the transformation of the water in the cellular vacuoles into ice crystals by the product giving up heat to the refrigerant. The freezing process is conventionally divided into: refrigeration (until the start of freezing of the juice in the product), freezing of the juice (formation of ice crystals) and lowering the temperature of the product below the freezing point of the juice, up to the temperature at which the product is to be stored later (Potec Ion et al., 1983).

The freezing process must be managed in such a way that the product passes as quickly as possible from the phase of maximum water crystallization, which is between -1 and -5^{o}C, during which 60-75% of the total water content solidifies. The technological process must then be continued by subcooling the product to a final temperature of -18...-25^{o}C, at which 90-95% of the contained water solidifies (Banu Constantin, 2007).

Freezing food products should be done as soon as possible after harvesting. The quality of the frozen vegetable products will depend on the quality of the various raw materials (the physiological state of the vegetable production at the time of harvesting, the speed and quality of the technological processing process). Varieties with a firm texture without mechanical and microbiological damage, brightly colored and shiny are preferred (Banu Constantin, 1992).

Strawberries intended for freezing must belong to varieties that are small or medium in size, highly pigmented, have a bright red color and glossy appearance, have fine-grained flesh, no cavity (air chamber) in the center or are small in size, they have few and light-colored seeds, they have a specific acidic taste (Petru Niculita, Nicolae Purice, 1986).

Blueberries are fruits from spontaneous or cultured flora, intensely colored and aromatic that freeze with good results, in a fluidized layer with a thickness of 25-40 mm for a duration of 4-7 minutes. They can be frozen loose, in bulk and with sugar and do not require antioxidant treatments. Currants freeze with or without rachis, the dark-colored and thin-skinned varieties. They are frozen separately, in blocks and within a maximum of 7 minutes, or with sugar in cans (Gherghi Andrei).

Horticultural products undergo a series of physical and biochemical changes as a result of freezing. Under the action of low temperatures, the water in the aforementioned products turns into ice crystals, first the free water and then the water in the cell juice, the formation of ice crystals being influenced by the temperature level and the freezing speed. When freezing occurs rapidly, water freezes and forms crystals both in the intercellular and intracellular space. The formed crystals are small, numerous and evenly distributed throughout the mass of the frozen product, and the cell walls are no longer broken, as happens during slow freezing (-12^{o}C...-15^{o}C), when the size of the ice crystals exceeds the volume of the intercellular spaces and break cell membranes (Beceanu Dumitru, Adrian Chira, 2003).

Another modification of horticultural products consists in the dehydration of the tissues, due to the evaporation of water from the superficial layers due to the difference in water vapor pressure at the level of the surface in contact with the air. The faster the freezing rate, the lower the rate of water evaporation. Following dehydration, weight loss occurs, which in bulk frozen batches reaches up to 1.5%. The loss of water through evaporation favors the penetration of oxygen and thus the oxidation of phenolic compounds by polyphenol oxidase takes place, resulting in the browning of the product (Beceanu Dumitru, Adrian Chira, Pașca Ioan, 2008).

MATERIAL AND METHOD

For the study on the quality indices of fresh and frozen preserved fruits, 3 varieties of fruits were analyzed: strawberries, blueberries and red currants. They were purchased from a supermarket and were frozen for a period of 12 months, packed in plastic casseroles, an operation that took place in the laboratory of the Faculty of Environmental Protection - Food Preservation Methods.

The conclusions regarding the quality indices for the analyzed samples were: organoleptic characteristics and physico-chemical analyses, performed on fresh fruit and frozen fruit after a storage period of 12 months.

The organoleptic characteristics analyzed were: consistency, color, taste, smell and shape, using grades from 1 to 10 as indicators.

Each organoleptic characteristic is given a grade(n) from 1 to 10, which is multiplied by a proportionality factor (Fp), which shows the importance of the respective property for the analyzed product. The sum of the proportionality factors must be 10.

For fresh and frozen fruits, the following values were taken for proportionality factors:

taste – 3, consistency – 3, smell – 2, color -1, shape -1.

The chemical analyzes performed were: soluble dry matter; the pH; acidity and amount of vitamin C.

The determination of the soluble dry matter content (°R) of the fruits was carried out with the help of the digital refractometer.

The determination of the acidity expressed in g malic acid/100ml was carried out by titrating the working samples with sodium hydroxide, and of the pH by direct determination with the pH-meter.

The determination of vitamin C in fruits was carried out by titrating the samples with an iodine solution, in the presence of starch as an indicator.

The physical-chemical analysis methods allow the assessment of the quality level of the products, and the follow-up over time of the evolution of the physical-chemical parameters, allows for an accurate assessment of the storage period for frozen fruits.

RESULTS AND DISCUSSIONS

In the study on the quality indices of fresh and freeze-preserved fruits, we looked at: the organoleptic characteristics of the fruits before and after freezing and the chemical physico-chemical components: soluble dry matter, pH, acidity and vitamin C content of the fresh fruits and after freezing and keeping for a period of 12 months.

1.Determination of organoleptic characteristics

The organoleptic characteristics represent a main element of the fruit selection regarding the freezing behavior.

The organoleptic evaluation of the 3 frozen fruit assortments: strawberries, blueberries and red currants, was done before and after 12 months of freezing preservation.

Based on the organoleptic analyses: color, taste, smell, consistency and shape, a general organoleptic score was calculated, obtaining quality ratings for the 3 varieties.

The grades obtained for the 3 varieties of fresh and frozen fruit analyzed over a period of 12 months are recorded in table 1.

Table 1

Organoleptic notes

No. crt.	Assortment of fruits	Organoleptic note	
		Before freezing	After freezing
1.	Strawberries	9,5	8,0
2.	Blueberries	9,0	8,5
3.	Red currants	10	9,0

Regarding the organoleptic characteristics, the fresh fruits received organoleptic notes between 9.0 for blueberries, 9.5 for strawberries and 10 for red currants. By freezing the fruits, it is observed that the grades obtained by the three varieties of fruit after thawing are different: they are higher for the frozen berries - blueberries and red currants, which received grades 8.5 and 9, respectively; and strawberries, which are perishable fruits, received a score of 8.

The consistency of thawed strawberries is lower, this is due to the very thin cell walls, which through freezing and thawing lose their firmness and are softer, which in fact also determines their perishability. Defrosted blueberries and redcurrants have good texture and firmness because they are small berries that have a lower water content in their composition, but also have thicker cell walls which results in better freezing behavior.

2.Determination of dry soluble substance.

For fruits, soluble dry matter is an important indicator of fresh and frozen products. It varies depending on the species and the method of preservation. The values of soluble dry matter, for the analyzed fresh and frozen fruits, are recorded in table 2.

Table 2

Soluble dry matter content of fruits

No. crt.	Assortment of fruits	Soluble dry matter		Value difference °R
		Before freezing °R	After freezing °R	
1.	Strawberries	10,5	7,5	-3,0
2.	Blueberries	10,9	10,7	-0,2
3.	Red currants	14,1	12,4	-1,7

From the analyzed data, it can be seen that red currants, both fresh and frozen, had the highest content of soluble dry matter, and strawberries had the lowest. Fresh redcurrants initially had 14.1 °R, and after 12 months of freezing have 12.4 °R, followed by blueberries, which initially had 10.9 °R , and after 12 months of freezing have 10.7 °R. Fresh strawberries had 10.5 °R, and after 12 months of freezing they show 7.5 °R, respectively a decrease of 3 °R. This decrease occurs due to mechanical damage to the fruit structure during freezing, when the expansion of ice crystals damages their cell walls, due to their delicate structure.

3. Determination of pH and acidity

Regarding the pH, the cellular juice undergoes important changes during the freezing process, determined by the concentration of the vacuolar juice as a result of the loss of water through freezing, thus it becomes acidified, the hardly soluble salts found in small quantities in the cellular juice precipitate more easily, which changes the composition and the pH.

The pH and acidity values for the fresh and frozen fruits studied are presented in table 3.

Table 3

Fruit pH and acidity

No. crt.	Assortment of fruits	PH		The acidity g malic acid /100 ml	
		Before freezing	After freezing	Before freezing	After freezing
1.	Strawberries	4,58	4,46	0,75	0,60
2.	Blueberries	4,27	4,13	0,85	0,75
3.	Red currants	3,92	3,80	1,05	0,90

From the data presented, it is found that the pH of fresh fruits is between 3.92 for red currants, 4.27 for blueberries and 4.58 for strawberries.

The frozen fruits analyzed have a pH between 3.80-4.46. The lowest pH is recorded for red currants 3.80, followed by blueberries with 4.13, and the highest value is presented by strawberries at 4.46. Frozen fruit as a whole has a lower pH than fresh fruit.

The acidity has values between 0.75-1.05 g malic acid/100 ml for fresh fruit, and for frozen fruit between 0.60-0.90 g malic acid/100 ml. Strawberries have the lowest acidity of 0.75 g malic acid/100 ml in fresh fruit and 0.60 g malic acid/100 ml in frozen fruit, followed by blueberries with 0.85 g malic acid/100 ml in fresh fruit and 0.75 g malic acid/100 ml in frozen fruit. Red currants have the highest acidity, 1.05 g malic acid/100 ml for fresh fruit and 0.90 g malic acid/100 ml for frozen fruit.

4. Determination of vitamin C content

Vitamin C is a powerful antioxidant that protects the immune system, an essential nutrient that the human body needs, but which the body cannot produce and needs to be obtained through additional intake from fresh or frozen fruits and vegetables in the off-season.

The values of vitamin C content for the assortment of analyzed fruits are recorded in table 4.

Table 4

Vitamin C content

No. crt.	Assortment of fruits	Vitamin C content		Losses
		Before freezing mg/100ml	After freezing mg/100ml	
1.	Strawberries	26,5	15,7	-10,8
2.	Blueberries	20,2	15,4	-4,8
3.	Red currants	21,5	16,2	-5,3

From the data presented, it can be seen that the vitamin C content varies depending on the species, being between 21.5-26.5 mg/100ml for fresh fruits and 15.4-16.2 mg/100ml for frozen fruits. Thus, strawberries have a lower vitamin C content after freezing due to more intense metabolic activity, namely 15.7 mg/100ml, frozen blueberries have a vitamin C content of 15.4 mg/100ml and red currants have the highest content of vitamin C, respectively 16.2 mg/100ml.

Losses of vitamin C recorded in frozen fruits are higher in the case of strawberries, which are perishable fruits, compared to blueberries and red currants, which have berries, and their skin better preserves the integrity of the fruit and its chemical components during freezing.

The vitamin C content of frozen fruit is lower than that of fresh fruit, but compared to other fruit preservation methods: heat treatments, drying, it is higher.

CONCLUSIONS

Fruits are an important source of vitamins, minerals and antioxidants. Vitamins are substances that the body needs in small quantities but cannot be without, as they intervene in the development of vital processes. Minerals represent 6% of body weight and perform extremely diverse and important functions for the body. They are low in fat and calories and protect the body against heart disease and cancer.

Preservation of fruit by freezing is a way of preserving fruit for a longer period of time. The increase in shelf life obtained by freezing and frozen storage is based on the effects of low temperatures of strongly slowing down or completely inhibiting the development of microorganisms and reducing the speed of chemical and biochemical reactions.

In the study on the quality indices of the fruit assortment: strawberries, blueberries and red currants, fresh and frozen, we followed the organoleptic and physico-chemical characteristics.

Regarding the organoleptic characteristics, the fresh fruits received organoleptic scores between 9.0 for blueberries, 9.5 for strawberries and 10 for red currants.

By freezing the fruits, they notice that the grades obtained by the three varieties of fruit after thawing are different: they are higher for the frozen berries - blueberries and red currants, which received grades 8.5 and 9, respectively; and strawberries, which are perishable fruits, received a score of 8.

Regarding the physico-chemical components, their values differ depending on the type of fruit.

During freezing storage, the dry matter content decreases, due to mechanical damage to the fruit structure during freezing, when the expansion of ice crystals damages their cell walls, and cell juice losses occur.

In terms of pH, frozen fruit as a whole has a lower pH than fresh fruit. The acidity of frozen fruit is lower than that of fresh fruit.

The vitamin C content of frozen fruit is lower than that of fresh fruit, but compared to other fruit preservation methods: heat treatments, drying, it is higher.

Through the analysis of fresh and frozen fruits and the interpretation of the results, it is found that they retain their quality indices in a proportion of about 70-80%, after about 12 months of storage, compared to fresh fruits, and can be successfully consumed in the off-season and more chosen during the winter when the body needs vitamins.

Due to the quality indices obtained by frozen fruits, freezing preservation is an effective method of preserving fruits for consumption throughout the year or for their use in various culinary preparations.

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