

Changes in biologically active substances of stone fruits under the influence of low temperatures

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Abstract. Sufficient consumption of natural biologically active substances (BAS) – vitamins, dietary fiber, mineral compounds – reduces the risk of developing diseases associated with negative external factors. A large number of BAS are contained in the cherry plum fruits. Cherry plum is characterized by storage short term, during which quality changes are possible. Studies have been conducted on the low temperatures effect the change of BAS in cherry plum fruits. Studied objects were five cherry plum varieties grown in the Russian southern regions – Dinnaya, Zhemchuzhina, Obilnaya, Puteshestvennitsa, Neberdzhayskaya ranyaya. It was found that during storage, the physical and chemical parameters change slightly, the dry substances content decreases (within 1.3-3.2 %), sugars (5.5-7.0 %), the total acids content increases (2.8 3.3 %). The BAS content slight decrease during storage does not significantly affect the nutritional value of cherry plum fruits. The ascorbic acid reduction is 9.8-17.3 %, the anthocyanins content decreases on average from 16.9 to 19.7 %, the beta-carotene content decreases by 8.7-14.8 %, the reduction level of pectin substances is 15.75-22.2 %. Thus, the freezing method application allows to preserve valuable BAS in cherry plum fruits and use them in the future as a basis for the production of functional food products.

1 Introduction

In the modern world, a human is exposed to a large number of negative factors, which include: a polluted environment, a high content of synthetic chemicals in food, the consumption of high-caloric products, an increase in the number of chronic diseases associated with stress and metabolic disorder. To reduce this impact, scientists have developed and are introducing into production functional food products containing substances necessary for the body, supporting correct metabolism, increasing resistance to stress and diseases [1-4].

Such substances include various biologically active substances that are part of plants – vitamins, minerals, soluble and insoluble dietary fibers, phenolic compounds. Various methods of conservation using high temperatures are applied in order to preserve these substances. However, the most effective method is the freezing of fruit and berry and

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vegetable raw materials. This method allows to preserve the content of biologically active substances in plant raw materials as much as possible [5-9].

Stone fruits – plums, cherry plums, cherries, apricots and others, contain a large complex of biologically active compounds, which include ascorbic acid, pectin substances, carotenoids, phenolic compounds, etc. These substances are essential components for maintaining normal metabolism of the human body. Significant losses of biologically active substances occur during technological processing due to exposition to high temperatures, so their content is low in the composition of preserved foods [10-13].

Freezing fresh fruits is one of the ways to preserve biologically active substances as much as possible. The analysis of scientific research conducted by scientists from different countries in this direction shows the lack of information on changes in biologically active substances of certain types of plant raw materials during freezing and subsequent storage, which hinders the use of such raw materials in the production of functional food products [14-17].

Therefore, the issues of studying changes in biologically active substances of fruit raw materials for the purpose of their possible use as natural biocorrectors in the production of food products are important and relevant [18, 19].

2 Materials and methods

The objects of the study were the fruits of different varieties of cherry plums of early maturation, grown in the southern regions of Russia, in the Krasnodar region. The study was carried out for varieties of cherry plum Dinnaya, Zhemchuzhina, Obilnaya, Puteshestvennitsa, Neberdzhayskaya ranyaya.

Samples of varieties were taken for the study in the amount of five packaging units, weighing 15 kg for each variety. Average samples with a mass of 3 kg were then taken from the selected samples and then three separate samples with a mass of 1 kg were formed, which were packed in plastic bags. A label was affixed to each sample, indicating the grade, net weight, freezing temperature and the date of the beginning of storage.

The freezing process was carried out by the method of shock freezing at a temperature of minus 30 °C. Changes in biologically active substances – ascorbic acid, beta-carotene, pectin substances, vitamin E, phenolic substances – were studied before laying for storage and after each removal from storage.

Storage was carried out in ordinary cold rooms at a temperature of minus 20 °C, the storage duration was three months. The samples were examined every month.

The study of the chemical composition was carried out by generally accepted methods. The dry matter content was determined using a refractometer HANNA, the content of titratable acids – by titration with 0.1 N sodium hydroxide converted to malic acid, the content of ascorbic acid – by titration with using potassium iodate, beta-carotene – using a UNICO spectrophotometer, the sugar content – by Bertrand method, vitamin E – by thin-layer chromatography.

3 Results and discussion

To study the effect of low temperature on the biologically active substances of stone fruits, their content in cherry plum fruits of different varieties was determined before and after storage. The results of the obtained data are presented in Table 1.

Table 1. Physico-chemical parameters of cherry plum fruits before storage

Plum cherry variety	Dry matter %	Sugars, %	Organic acids, %	Ascorbic acid, mg %	Anthocyanins, mg %	β-carotene, μg %	Pectic substances, %	
							SP*	PP*
Obilnaya	13.2	7.9	2.59	9.22	339	167	0.53	0.43
Puteshestvennitsa	12.1	6.9	2.31	7.22	477	154	0.43	0.39
Dinnaya	11.7	10.0	1.09	5.29	378	133	0.44	0.26
Neberdzhayskaya ranyaya	11.4	6.7	2.0	8.60	323	184	0.31	0.38
Zhemchuzhina	13.2	8.4	1.99	6.11	784	176	0.48	0.42

* SP – Soluble pectin; PP – protopectin

The obtained data about the change in the physico-chemical parameters of frozen cherry plum fruits after storage showed the following:

- There was a change in the content of dry matter. Depending on the variety, the decrease in this indicator was different. Thus, for Dinnaya, Zhemchuzhina and Puteshestvennitsa cherry plum varieties, the decrease in the content of dry matter was 1.3-2.1 %, for the Obilnaya and Neberdzhayskaya ranyaya varieties – within limits of 2.9-3.2 %.
- The sugar content during storage also decreased in all varieties of cherry plum and was within limits of 5.5-7.5 %.
- During storage, an increase in the total acidity index in the range within 2.8-3.3% was found for all varieties of cherry plum.

Ascorbic acid is an indispensable vitamin. It improves the body's resistance to infectious diseases, increases efficiency, and is a natural antioxidant. Fig. 1 shows the changes that characterize the decrease in the content of ascorbic acid during storage. Its losses depended on the variety of cherry plum and ranged from 9.8 to 15%. The smallest decrease in ascorbic acid was noted in the fruits of the cherry plum variety Neberdzhayskaya ranyaya – 9.8%, the biggest losses – 15% in the varieties Obilnaya and Puteshestvennitsa.

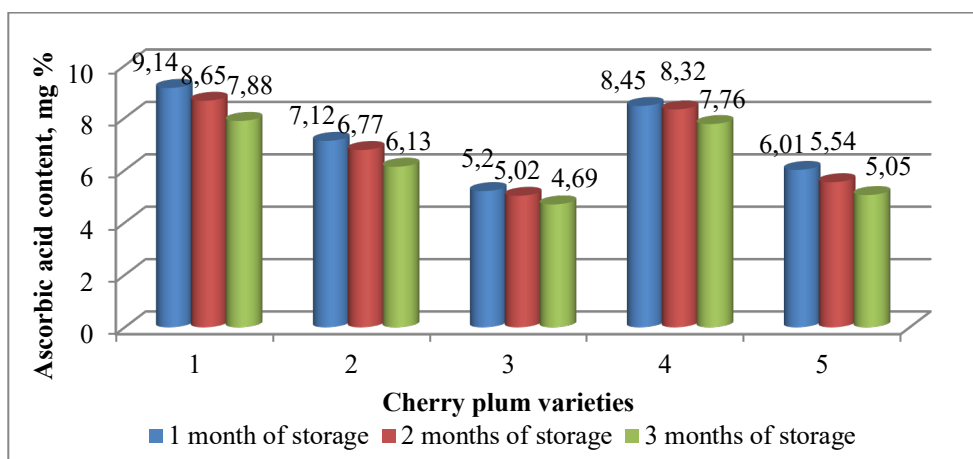


Fig. 1. Changes in the content of ascorbic acid in cherry plum fruits during storage: 1 – Obilnaya variety, 2 – Puteshestvennitsa variety, 3 – Dinnaya variety, 4 – Neberdzhayskaya ranyaya variety, 5 – Zhemchuzhina variety

Anthocyanins are natural coloring substances that give the coloration of cherry plum fruits from bright red to purple. Anthocyanins act as anti-inflammatory agents, regulate the processes of the gastrointestinal tract, improve the functioning of the intestines. During the study of the changes in the number of anthocyanins in cherry plum fruits (Fig. 2), it was found that during storage in the frozen state, the content of anthocyanins undergoes significant changes. Their losses by the end of storage range from 16.9 % (for the Zhemchuzhina cherry plum variety) to 19.7 % (for the Obilnaya cherry plum variety).

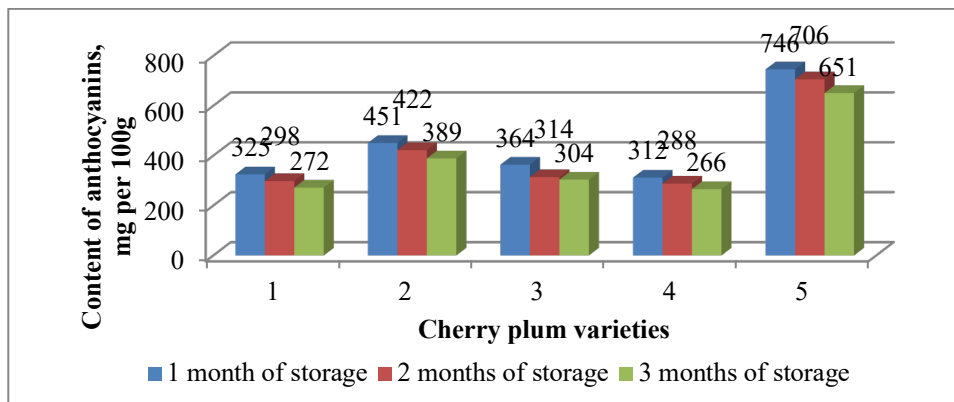


Fig. 2. Changes in the content of anthocyanins in cherry plum fruits during storage: 1 – Obilnaya variety, 2 – Puteshestvennitsa variety, 3 – Dinnaya variety, 4 – Neberdzhayskaya ranyaya variety, 5 – Zhemchuzhina variety

Beta-carotene belongs to the group of carotenoids, which are natural antioxidants. They protect cells from damage, inhibit the process of senescence of the body. Beta-carotene was the most resistant to the effects of low temperature (Fig. 3). Its losses during storage were in the range from 5.6 to 10.2 % for the Obilnaya, Dinnaya, Puteshestvennitsa and Neberdzhayskaya ranyaya varieties. Only in the Zhemchuzhina variety, the losses were significantly higher – 14.8 %.

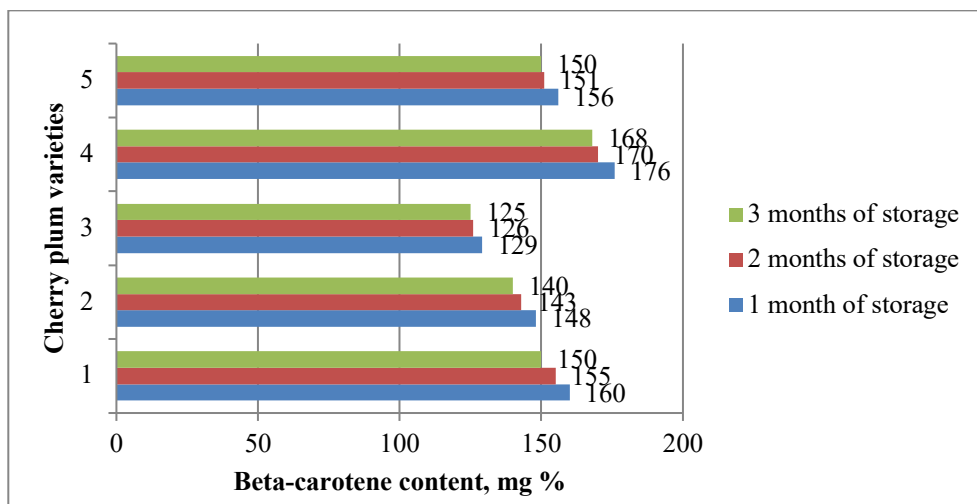


Fig. 3. Changes in the beta-carotene content in cherry plum fruits during storage: 1 – Obilnaya variety, 2 – Puteshestvennitsa variety, 3 – Dinnaya variety, 4 – Neberdzhayskaya ranyaya variety, 5 – Zhemchuzhina variety

Pectic substances belong to the group of dietary fibers. The human body needs natural detoxifiers, radioprotectors, and antioxidants. Fig. 4 shows the changes in pectic substances in cherry plum fruits. The obtained data characterize significant losses during storage, which range from 15.75% to 22.2%. At the same time, the smallest losses were observed in the Dinnaya and Puteshestvennitsa varieties, the largest – in the Zhemchuzhina variety.

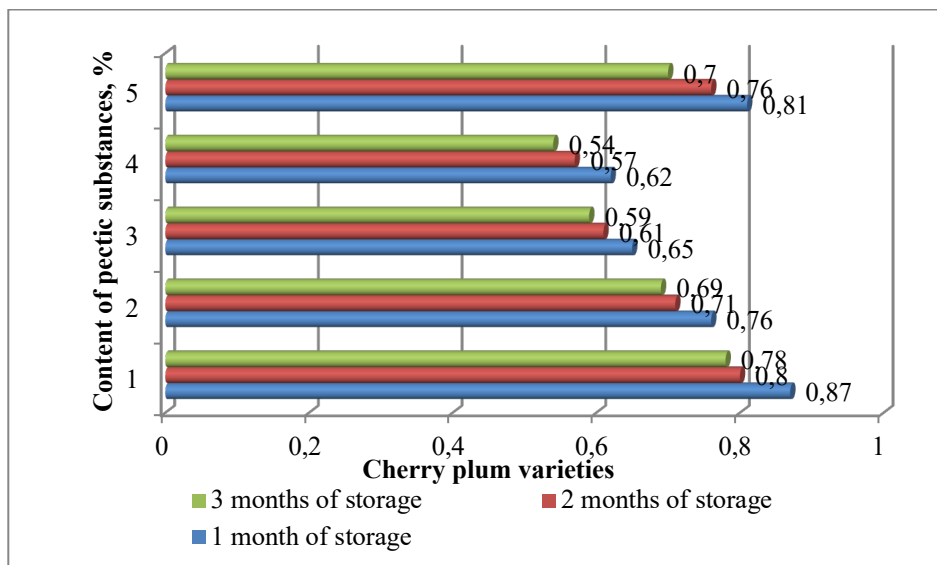


Fig. 4. Changes in the content of pectic substances in cherry plum fruits during storage: 1 – Obilnaya variety, 2 – Puteshestvennitsa variety, 3 – Dinnaya variety, 4 – Neberdzhayskaya ranyaya variety, 5 – Zhemchuzhina variety

4 Conclusion

There is a change in its physico-chemical parameters and biologically active substances during storage of fruit raw materials in a frozen state for 3 months. There is a decrease in the content of dry matter (1.3-3.2%), sugars (5.5-7.0%). The content of total acids increases (in the range from 2.8 to 3.3%).

A slight decrease in the content of biologically active substances during storage does not significantly affect the nutritional value of cherry plum fruits. The reduction of ascorbic acid is 9.8-17.3%, the content of anthocyanins decreases on average from 16.9 to 19.7%, the content of beta-carotene decreases by 8.7-14.8%, the reduction level of pectic substances is 15.75-22.2%.

The obtained data confirm the preservation of most of the biologically active substances in cherry plum fruits during storage at low temperatures and allow the use of the studied raw materials after defrosting in fresh form and for obtaining functional food products.

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