RESEARCH ON THE EFFECT OF PRESERVATION BY FREEZING ON THE QUALITY INDICATORS OF VEGETABLES

Alina Grigoriţa ARDELEAN#1

**University of Oradea, Faculty of Environmental Protection, 26 Gen. Magheru St., 410048 Oradea, Romania, e-mail:* alina_popa_alina@yahoo.com

RESEARCH ARTICLE

Abstract

Vegetables are products that can be frozen as is after first carrying out specific preparation operations. During the freezing and thawing operations, a series of changes occur in the physico-chemical and organoleptic characteristics, which are mainly due to changes in color, structure-texture, and the degradation of some components, especially vitamin C.

Keywords: vegetables, quality indicators, freezing
#Corresponding author: Alina Grigoriţa Ardelean

INTRODUCTION

Frozen vegetables represent a popular assortment, ensuring the necessary supply of vegetables in the off-season, and are used in the preparation of various culinary dishes.

Freezing is suitable for all species of vegetables and can be carried out by different methods depending on the specifics of the raw material.

The freezing point is a characteristic of the species, variety, and degree of maturation, being determined by the concentration of the cell sap. Thus, in the physiological maturity phase, the cell sap concentration is maximal, which determines a lower freezing point value.

The freezing point for tomatoes is -0.89°C, cucumbers -0.82°C, and for onions -1.10°C. (A. Ardelean, 2009, 2015).

During freezing and storage, a series of physico-chemical and organoleptic changes occur.

During preservation by freezing, weight losses are exclusively due to physico-chemical processes. Until the first layers of the product freeze, the losses are due to the evaporation of water from its surface, which causes the dehydration of the products. In the phases of freezing, cooling to the final temperature, and storage, weight losses occur through the sublimation of ice from the product's surface (I.F. Radu, 1985, I.F. Radu, Gherghi A., 1967, Gherghi A., 1995, 1998. Ioancea L. et al., 1998, Burzo I., et al., 1984, 1986).

Among the factors that affect the intensity of the weight loss process, the most important are: the nature of the product, the temperature and relative humidity of the air, the quality of the product's packaging, and the air velocity at the product's surface. Weight losses increase with temperature and air velocity but decrease with its humidity.

At the same time, the freezing method influences the percentage of water lost by the vegetables. Studies have shown that with the rapid freezing method, vegetables lose a smaller amount of water compared to the slow freezing process.

Another negative effect of freezing is the change in texture by losing the consistency of the vegetables, a phenomenon due to the loss of cellular liquid during thawing, as a result of damage to the cell membranes. Due to these changes, the structure-texture becomes looser, and weight losses due to water evaporation and cell sap leakage are observed at the bottom of the packaging (Potec, I. et al, 1983, 1985, Beceanu D, Chira A., 2003, Beceanu D., 1994, 1998, 2002, Gh. Mihalca, 1980,).

Among the important chemical changes that occur during the technological flow are: soluble dry matter content, total acidity, and vitamin C losses.

Organoleptic changes refer to diminished losses of aroma and taste due to the effect of the blanching operation, the degradation of some components, and the loss of cell sap.

Research on vitamin C content has revealed that freezing causes vitamin losses, as they are water-soluble, but the losses are much smaller compared to other processing methods

(Inoue K. et al., 1998, Neamţu G. et al., 1993, 1997, Cornelia Purcărea, 2005, 2008, Carmen Hura, 2006). These vitamin losses in fruits are also due to degradation during freezing.

MATERIAL AND METHODS

Research was conducted in the year 2025, at the Faculty of Environmental Protection Oradea.

In the studies, local vegetable varieties purchased from the local agri-food market were used.

The research was carried out on fresh vegetables as well as those frozen for three months.

The operations of the technological freezing flow are as follows: harvesting, temporary storage by refrigeration, quantitative and qualitative reception, conditioning operations (sorting, washing, cleaning, dividing), packaging, freezing, storage, delivery.

Harvesting was done at technological maturity for all species.

Temporary storage was carried out for 3 hours by refrigeration at a temperature of 7°C.

Sorting was done immediately after the washing operation, so that only specimens with a uniform degree of maturity and health were retained for preservation.

Cleaning consists of removing the epidermis from cucumbers, the parchment-like skins and the root disc from onions, followed by dividing the vegetables into slices (onions and tomatoes) and halves (cucumbers). No antioxidant treatments were performed, so that the quality changes in the frozen products would not be influenced. The cleaning, dividing, and peeling operations were carried out very quickly, avoiding the appearance of browning (oxidation).

The packaging of frozen vegetables was done in 250g containers.

Slow freezing was carried out in a domestic freezer.

Storage was done at a temperature of –18°C for three months.

Soluble dry matter was determined refractometrically with a portable refractometer for fresh and frozen products.

Total titratable acidity was determined as follows: for fresh products, they were crushed, filtered, and titrated with sodium hydroxide solution with a known factor, in the presence of phenolphthalein as a color indicator.

The vitamin C content was determined by the iodometric method.

RESULTS AND DISCUSSIONS

The frozen vegetable samples were thawed at ambient temperature.

Several samples were analyzed from each species, so the results refer to the average of the samples.

The main quality indicators of vegetables refer to soluble dry matter, total titratable acidity, and vitamin C. Also, textural changes and sensory properties of fresh and frozen vegetables were evaluated.

The quality indicators were determined for fresh vegetables (Table 1) and those frozen for three months (Table 2).

Table 1

Quality indicators of fresh vegetables

No.	Sample	Soluble dry matter % (sample average)	Total titratable acidity (ml NaOH, sample average)	Vit. C % (sample average)
1	Cucumber	2.0	1.00	11.2
2	Tomatoes	5.0	3.55	25.0
3	Red onion	9.1	2.17	4.9
4	Red bell pepper	7.1	2.89	178.0

Table 2

Quality indicators of vegetables frozen for 3 months

No.	Sample	Soluble dry matter % (sample average)	Total titratable acidity (ml NaOH, sample average)	Vit. C % (sample average)
1	Cucumber	2.20	1.20	10.7
2	Tomatoes	4.60	3.14	24.2
3	Red onion	8.80	2.10	4.0
4	Red bell pepper	6.90	2.10	177.0

Vegetables are products rich in vitamins, mineral salts, organic acids, and nutrients with plastic, energetic, and biocatalytic roles, contributing to completing the necessary nutrients in the diet.

The study of the chemical quality indicators of fresh vegetables highlighted the highest content of soluble dry matter in onion and red pepper (9.1% and 7.1%, respectively). Cucumber has the lowest content of soluble dry matter (2%), being the species with the highest water content.

Regarding the acid content, expressed by the number of ml of NaOH used for titration, it increased slightly in the frozen samples.

The highest vitamin C content was found in red bell pepper at 178%, and the lowest in red onion at 4.9%.

The physical quality indicators studied refer to the textural changes of the vegetables. It should be mentioned that species with a firm structure-texture, which are preferable for this preservation method, were preserved.

The sensory properties were highlighted by organoleptic analyses. Thus, for products preserved and stored for three months, the following changes are noted. The soluble dry matter content decreased very little in all species (0.2-0.37%). The total titratable acidity content increased, the preserved vegetables being slightly more acidic than the fresh ones. The decrease in vitamin C content is due to the chemical degradation suffered during freezing, storage, and thawing.

Regarding the textural changes that occurred in vegetables preserved by slow freezing, they refer to a reduction in firmness, as a result of losing a certain part of the water from their composition. The largest losses of cell sap were recorded in tomatoes and cucumber, being species with a higher water content. The lowest firmness was observed in the tomato slices.

From a sensory point of view, a decrease in organoleptic characteristics, namely taste and aroma, was noted in onion and tomatoes. The aroma and taste were best preserved in cucumbers and peppers. The pigmentation was preserved; the thawed vegetables show an intense coloration similar to the fresh products.

CONCLUSIONS

From the analysis of the results obtained regarding the quality changes in the vegetable samples preserved by freezing, the following conclusions can be drawn:

1. The soluble dry matter (s.d.m.) content shows a slight decrease for samples stored for a period of three months.
2. The total titratable acidity increased very slightly during the storage period.
3. The vitamin C content decreases, primarily due to cell sap losses and because chemical degradation occurs during freezing and thawing.
4. Regarding the organoleptic properties, some changes are observed: the structure-texture of the vegetables becomes looser, more pronounced in tomatoes and cucumber, a phenomenon that is more intense in the case of slow freezing, as a result of the cracking of cell membranes and the epidermis during the freezing and thawing operations, respectively. The taste and aroma lose their intensity compared to fresh vegetables. This aspect is due to water losses, which also carry away some of the dissolved substances responsible for these properties. The pigmentation does not show changes compared to fresh products.
5. The vitamin C content decreased slightly in all frozen *[Translator's note: original text says "fruits" here, likely a typo, context is vegetables]* vegetables due to the chemical degradation suffered during freezing,

storage, and thawing.

6. Due to the peculiarities of vegetables (thin epidermis, rich in cell sap, perishable), it is recommended to carry out harvesting operations at the optimal harvesting time, without exceeding the technological maturity phase. Overripe vegetables have a more fragile structure-texture (tomatoes), with imminent possibilities of alteration, as well as the presence of mature seeds in cucumber.

7. From the analysis of the results obtained regarding the main quality indicators of fresh and frozen vegetables, it was concluded that the preservation method by freezing has minimal effects on these indicators, compared to other processing and preservation methods, the products retaining their nutritional and organoleptic values close to the initial values of the fresh products.

8. Also, the use of rigid packaging such as containers and the reduction of handling operations are recommended for the same reasons.

9. Thawing of vegetables is done at ambient temperature so that cell sap losses are minimal.

10. It is recommended to continue research on vegetable freezing by other methods as well.

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