# RESEARCH REGARDING THE INFLUENCE OF CONSERVATION BY USING DEEP – FROZEN METHODOLOGY OVER THE QUALITY OF SOME HORTICULTURE PRODUCTS

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**Abstract**

Vegetables improve human life by means of the many nutrients they contain. The nutritional quality of frozen products is intensified by the quality of the raw material, which uses correct manufacturing practices in the preservation process, while horticultural products are stored at the appropriate temperature. Competing with new minimum food processing technologies, industrial freezing is the most satisfactory method for maintaining quality for long storage periods. The main purpose of this study is to determine the influence of a preservation process based on the use of the cold, of cryoanabiosis, respectively on fresh vegetables frozen using a domestic and industrial method. We monitored the possible qualitative changes after the storage of the frozen biological material and the difference between the application of a home preservation technology, respectively the application of an industrial preservation technology on the products under analysis. The main objectives of the study are to examine the quality of frozen vegetables by determining the sensory and physical-chemical characteristics of cold-preserved products. The study material to be analysed is represented by three species of vegetables, as follows: carrot (*Daucus carota*), root parsley (*Petroselium crispum*), respectively broccoli (*Brassica oleracea*). The sensory evaluation of the products studied showed that frozen products using the industrial system had superior characteristics compared to those frozen at home. It is found that after the freezing of horticultural products using a domestic and industrial method there were no significant differences in the results of physical and chemical tests, as these kept their nutritional value high. Regarding the pH results, the biggest differences were identified in the case of broccoli. Thus, as the frozen broccoli in the industrial system registered a value of 5.7, and the frozen broccoli in the domestic system a value of 6.58. Acidification of the product may occur due to the freezing of water in the cells, followed by an increasingly concentrated accumulation of cell fluid containing diluents and colloidal substances. The water content increased in the case of products frozen by using a domestic system, presenting higher values as compared to the humidity of industrial frozen products, but also compared to the reference values as follows: carrots and parsley registered a humidity of 90% and 86%, respectively. The higher value in the case of the humidity parameter is caused by a higher amount of released cell juice, due to a slow freezing which led to the formation of ice crystals or to the occurrence of the plasmolysis phenomenon. The soluble dry matter shows several differences. Products frozen at home have higher values compared to industrially frozen products. The most significant difference appears in the case of root parsley frozen at home with a value of 11%. Therefore, freezing showed the following advantages: the lowering of the temperature of the product below 0°C ensured the keeping of the plant product longer, and most of the biochemical reactions were stopped during freezing and also the blocking of the multiplication of microorganisms took place.

**Key words:** freezing, horticultural products, vitamin C

Carrot (*Daucus carota*) is an edible root especially popular among vegetables due to its versatility in culinary use and its healthy composition enriched with phytonutrients, fibre and minerals (Lascu D., 2008).

Carrots are sensitive to heat, temperatures higher than 30°C cause lower quality and poor production, those higher than 24°C lead to thick and short roots, rich in carotene, and those lower than 13°C result in thin and long roots, faintly coloured (Ciofu R., 2004). Carrots are stored by silage in the furrow, in bulk, in ditches by sand stratification or stored in warehouses with natural ventilation. The optimum temperature is of 0.5… 30°C, at the relative humidity of 90 - 95%.

Although carrots have the ability to resist long periods in a fresh condition, they are very suitable for freezing, and therefore they are processed in industrial quantities. Economic considerations determine the preservation of this

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vegetable in different sizes, taking into account the influence of the freezing process on total costs. Therefore, small carrots (babycarrot) are frozen as a whole, and large ones take various shapes (cubes, slices).

The flow of technological operations begins with the *calibration*, *washing*, *removal* of the package and cleaning of the *shell*. The most efficient method of removing any mineral residue is steam cleaning, on the other hand it leads to the realization of a finished product of very good quality. This stage takes place at a pressure of 7 kg/cm3, 35 seconds (Mihalca G., 1980).

In case of carrots, strong cooling results in better quality. Moreover, without being previously scalded frozen carrots show better results than carrots that have been scalded and then frozen, because the blanching operation can cause the product to lose its consistency and vitamin content (Murariu O.C. *et al*, 2014; 2015). Through the power of separation of the oscillating mass, the removal of the undersized fractions of the carrot takes place. This operation takes place before freezing.

The most efficient method for maintaining the best possible quality of the carrot is represented by the scraped freezing, which uses fluidized layer installations (Murariu F. *et al*, 2019). This may be due to the rapid freezing time, so that both large and irregular ice crystals do not form on the surface of the product and inside it. The freezing time for the whole carrot is 25 minutes, and for the sliced carrot a maximum of 5-6 minutes.

Parsley under the scientific name of *Petroselinum hortense* is part of the *Umbeliferae* family and is widely cultivated as a medicinal plant, a spice and a vegetable.

The root must have the following characteristics in order to be considered suitable for freezing: white, dense, juicy pulp. Parsley from the autumn harvest is preferred.

To obtain a consistent colour and increase the storage period, parsley is scalded for one minute for slices and cubes and 5 minutes for the whole root. In the presence of air there are oxidation reactions that result in the degradation of parsley, especially of unripened parsley, and to avoid this situation it should be kept in cold water with 0.5% salt.

Broccoli is becoming increasingly popular as a fresh vegetable and is a significant source of nutritious antioxidants, such as vitamins and carotenoids. Broccoli is distinguished by the amount of vitamin C it contains, folic acid, beta-carotene and dietary fibre (Tian D., 2016).

Special importance will be given to the preservation of broccoli because it has a high degree of perishability. When kept fresh at a temperature of 10℃, it does not undergo major changes, while at a temperature of 15 - 20℃, broccoli can be affected from a qualitative point of view. Broccoli can be stored for a maximum of 2 - 3 weeks, even in warehouses with a controlled atmosphere the temperature of which is less than 5℃. Research into food preservation technologies usually focuses on one of two aspects: selecting process conditions to minimize product quality loss or developing engineering design methodologies to ensure that the required process can be performed at low cost (Petcu C. *et al*, 2014).

In the latter aspect, heat transfer is usually a major concern. The heat must be removed from the product by cooling or freezing and subsequently the product must be kept at a constant temperature in storage. There are also important effects of moisture transfer, especially evaporation from the product surface. Therefore, the main purpose of the research is to determine the influence of a preservation process based on the use of that cold, cryoanabiosis, on fresh vegetables frozen by a domestic and industrial method.

## MATERIAL AND METHODS

The variation of the qualitative parameters following the technological process of preservation by freezing and the difference between the freezing using an industrial system and a domestic system on the vegetables studied was analysed.

The products of household origin were packed in plastic bags with closing system having dimensions of 20 x 13 cm and a capacity of 1 litre. They were subjected to a heat freezing treatment at a temperature of -18 ℃ for 7 days. The samples frozen using an industrial system were purchased from the Iași commercial network, being packed in polyethylene bags.

In order to determine the quality of the products studied, the following determinations were performed: sensory evaluation and physical-chemical evaluation of horticultural products by determining the physical-chemical parameters: vitamin C (mg/100 g product); humidity (%); pH, soluble dry matter (%).

To perform all the analyses listed above, a suitable instrument is required, as follows: pH meter, Zeiss refractometer, thermostat oven, various reagents that will highlight the desired component (oxalic acid, phenolphthalein, sodium hydroxide), refrigerator (Danivelici C. *et al,* 2006).

The sensory analysis of the vegetables in question was performed by the students of the University of Agricultural Sciences and Veterinary Medicine, Iași, being considered non-specialized tasters and involved the individual filling in of a questionnaire. The evaluation of the defrosted vegetables consisted in the award of grades from 1 to 10, grade 1 representing the most non-compliant condition of the product in question, and grade 10 places the defrosted product in the best quality standard.

The sensory analysis was completed by the centralization of the grades obtained, calculating the arithmetic mean of each property found in the questionnaire and classifying the evaluated horticultural products in a quality category.

Determination of vitamin C is based on the property of ascorbic acid to produce an oxidative-reducing reaction in the presence of 2 - 6 *dichlorphenolindophenol* (Murariu *et al,* 2014; 2017; 2018).

Grind 10 g of vegetable product in a mortar, transfer everything to a 100 ml Berzelius beaker, add 50 ml of distilled water and let it boil in a water bath at 70 ℃ for 20 minutes. After boiling and cooling the sample to 20 ℃, the contents shall be poured into a 100 ml volumetric flask, is brought to the mark and filtered using filter paper into an Erlenmayer flask. From the filtrate take 10 ml over which add 2-3 drops of phenolphthalein and titrate the sample with NaOH, until the colour turns pale pink. When establishing the pH value of the vegetables, a portable pH meter was used, the electrode of which is detachable, with a measurement accuracy of 0.2. Before performing the readings, the pH-adjustment operation will be carried out, using the solutions of electrode calibration buffer and cleaning with distilled water. The pH values of the vegetables will be read from the LCD screen of the pH meter.

The determination of the soluble dry matter is carried out using a Zeiss hand-held refractometer. The preparation of the refractometer consists in wiping the prism and the movable plate using an alcohol-soaked gauze, calibrating the device by putting 2-3 drops of distilled water (20℃) on the movable plate and the closing thereof. Take the refractometer to the eye and adjust the eyepiece, checking that the total reflection limit is 0. If it is not at 0 then it is considered that the device is not calibrated and a correction will be made to the adjusting screw with a screwdriver.

The actual analysis consists in preparing the sample, weighing 50 grams of frozen vegetable product and defrosting it in an Erlenmeyer flask, covering it with a watch glass. The contents are homogenized, a few drops are taken with the help of a stick and placed on the prism of the refractometer.

The determination of the total humidity is based on the weight loss of the biological material analysed using the oven drying method, at a temperature of 70℃, 10 hours. Before being placed in the oven, the samples of each biological material studied are weighed and placed in previously weighted numbered glass or metal ampoules. Drying is considered complete when the difference between two weighings does not exceed 0.005 g. To cool the samples, they are placed in a desiccator, then a new weighing will take place.

## RESULT AND DISCUTIONS

Following the sensory analysis, the suitability of the broccoli and carrot product for preservation with the help of low temperatures was highlighted. The frozen broccoli and carrot product in the industrial system were evaluated with maximum score presenting a colour characteristic to the defrosted product, an odour and a taste specific to the vegetable variety.

At the same time, the industrial freezing results in the preservation of the external properties due to a well-developed system of control of the environment, of the freezing speed and of the air circulation inside the freezing installation.

At the opposite side, the parsley root product stands out for its inferior value due to the following quality parameters: texture, degree of oxidation, degree of hydration, taste and smell.

The amount of vitamin C varies in horticultural products depending on their variety, species and time of harvest. Therefore, vitamin C is found in an amount of 5 mg/100 g fresh carrot product, 150 mg/100 g fresh product represented by parsley root, and in broccoli this content varies between 110 - 113 mg /100 g fresh product (*Lascu D., 2008*).

Defrosted products (in the household) recorded a significant loss of vitamin C. In the case of broccoli, it decreased by approximately 28%, registering an amount of 31.68 mg/100 g of product. Significant losses were recorded in the parsley root, reaching 26.4 mg/100 g of product. For carrots, the freezing process resulted in a decrease of up to 50% of vitamin C. In case of products frozen by using an industrial system, the values are slightly higher, as follows: 37.84 mg/100 g broccoli product, 27.28 mg/100 g parsley root product and 3.52 mg/100 g carrot product.

It can be seen that vegetables frozen by using an industrial technological system obtained better values than vegetables frozen using a domestic system. The most relevant difference is in the case of industrial frozen broccoli, which recorded 6 units more vitamin C. For parsley root and carrot, the differences are of one unit. In the case of carrots, the amount of vitamin C decreases between 0.1 - 0.2% per day, according to specialized reports. The main causes of damage to ascorbic acid are: long storage time, poor storage, all associated with high storage temperatures.

In case of freezing using a domestic system, the losses of vitamin C are higher compared to products frozen by using an industrial system, because the temperature that provides good stability of ascorbic acid is reached over a longer period of time. According to detailed studies, the degradation appears easier and faster at -18 °C, instead with an adequate conservation at -25 °C it remains unchanged.

The way the product is packaged reduces the ascorbic acid content. Although the products were packed in polyethylene bags with a closure system, the penetration of oxygen was not completely stopped.

The most significant pH difference is in case of broccoli, the one frozen at home has a value of 5.7, and the broccoli frozen at industrial level has a pH of 6.58. Both values fall within the reference values. Differences of two units are found in the case of both root parsley and carrot. Homemade root parsley (P2) has a pH of 5.8 while C2 has a value of 6.07. Homemade frozen carrot P3 has a value of 5.58 and C3 5.72.

Among the most well-known reasons for the change in pH we list:

- in the constitution of the cellular liquid there are substances of dilution and in suspension, which determine the increase of its concentration at the moment of the decrease of the temperature and the initiation of the freezing process, and thus the acidification of the cell takes place;

-phosphates are very insoluble in cell juice and precipitate more slowly, which causes a change in pH by more than one unit.

The relation of the values obtained to those in the research literature highlights the fact that the carrot frozen both in a domestic and in an industrial system has a superior value [90% - 88.42%], along with the parsley root with a water content that has inferior value that falls within the range of variation [82.8% - 82%] (Lascu D., 2008).

The increase in the humidity of the products may be due to temperature fluctuations, thus ice crystals being formed in the tissues, destroying the cells. At the same time, improper storage of the raw material, a slow freezing speed and the degree of maturation can justify a higher humidity.

In the case of products frozen at home, the values of soluble dry matter are represented by the following values: 6.3% for broccoli, 11% for root parsley and 9.8% for carrots. The results of the analysis for industrially preserved products are lower as follows: for broccoli there was a percentage of 5.9%, parsley root 9.6% and carrot 8%. This difference can be explained by the higher degree of maturation of products frozen using the industrial system.

The decrease of the soluble dry matter is caused by the increase of the temperature, which determines the increase of the respiration rate, as the carrot and parsley root have an average respiration rate (5 - 10 $cm^3$/kgh); and to support it, complex carbohydrates are converted to glucose. In this case, the increase in the temperature of the products is given by their preparation for the carrying out of the analysis and removal from the cold room.

## CONCLUSIONS

Following the sensory examination, products frozen by using the industrial system showed better characteristics than those frozen using a domestic system.

The organoleptic analysis of the vegetables resulted in the following things: a decrease in their characteristics after freezing; among vegetables, broccoli and carrots best retain their properties as compared to parsley root.

Both freezing systems have reduced ascorbic acid content by up to 50%.

It is found that after the freezing of horticultural products using a domestic and industrial there were no significant differences in terms of the results of physical and chemical analysis, which kept their nutritional value high.

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