RESEARCH REGARDING STORING AND KEEPING DIFFERENT VARIETIES OF CARROTS AND PARSLEY

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RESEARCH ARTICLE

Abstract

Carrots and parsley are root crops suitable for short and long-term storage by traditional and modern methods. During the storage period, as a result of the ambient storage factors that influence the metabolic activity of the roots, a number of physiological changes take place in the roots, through a series of impairments: weight loss, spoilage losses and qualitative depreciations.

Keywords: carrot, parsley, conditioning, storage, losses.
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INTRODUCTION

The carrot and parsley are part of the root vegetable species, widely cultivated both nationally and globally. This important share of production is due to the food importance of these species and the relatively moderate climatic requirements (minimum germination temperature 4-5^{0}C, optimum 20^{0}C; optimum temperature for the growth and accumulation of reserve substances 18-20^{0}C).

The high food value of carrot roots is due to the large amounts of provitamin A, group B and C vitamins with antioxidant role, mineral substances, as well as pectocellulosic fibers with high hydration capacity, allowing toxic residues resulting from metabolism (cholesterol, free radicals) to be eliminated. Thus, the carrot could be considered a medicine, with it's therapeutic properties being used for medicinal purposes in order to normalize the functions of the human body, being of important use in anemia, growth disorders in children, and maintaing the digestive and hepatic functions to a proper level. Additionally, carrots also have a diuretic effect and have been proved beneficial in nervous system disorders, rheumatism, and eye diseases. Fresh carrot juice has an energizing, anti-infective, antiulcerous and anticancer effect, being recommended in daily food consumption especially in children, pregnant women, diabetics and in more restrictive diets. Moreover, the tea made from seeds is used in cosmetics.

Regarding it's economic importance, carrot allows producers to make early crops whose yields can be capitalized in spring, starting in May, at high prices, as well as of autumn crops designed to preserve and capitalize the roots during winter.

In comparison, parsley is grown especially for the thickened root, serving to prepare foods and preserves. The leaves, rich in ethereal oils, are used to flavor and garnish various dishes. The roots contain carbohydrates, lipids, proteins, mineral salts (calcium, iron, magnesium), vitamins (A, B1, B2, C) and volatile substances which provide its specific flavor.

Like carrots, parsley is also used as a medicinal plant, as a digestive tonic and remedy for kidney, liver, pectoral angina and heart diseases, as well as in the treatment of malaria and anemia. Leaf tea is recommended for patients with stomach ulcers, and the root tea has a diuretic effect. Fresh leaves are used to soothe stings caused by insect bites.

Due to the food, dietary, medicinal value and the fact that consumption is possible throughout the year, the two species constitute a valuable food source.

The conditions and requirements in the lots intended for preservation must be met by the use of varieties suitable for preservation and ensuring appropriate production technologies.

The most suitable for storage are the late varieties, reaching full maturity at the end of autumn, when the air temperature has values closer to those in which the storage takes place. They also have a longer dormancy period.

It is recommended to plant crops on light soils, moderately fertilized with doses of nitrogen (N) 50-100; phosphorus (P): 120-150; potassium (K): 120-160 kg s.a./ha. Doses of 150 kg s.a. of N caused an 8% increase in losses from deposits (Beceanu D., 2000). Carrot and, in general, all the root plants have a high consumption of nitrogen during the phase of the formation of the rosette of leaves and the appearance of the flowering stems, of potassium in the second half of the vegetation period, and of phosphorus less, but constantly throughout the vegetation (Dumitrescu M., et al., 1998). Fertilization with potassium determines the achievement of high root yields and has a favorable effect on the content of sugars, therefore on the taste of carrot roots, as well as on the storage capacity (Beceanu 1994).

Irrigation must be stopped at least 2 weeks before harvest. Phytosanitary treatments should be applied on time. Harvesting carrots and parsley begins in June for the early crop and at the end of September for the late crop.

Taking over the production for storage is done as carefully as possible. If harvesting is done too early, the roots will not accumulate a maximum of dry matter, the epidermis ending up too thin, being exposed to dehydration. Delay in harvesting leads to lignification or spongy structure. The state of time influences the degree of cleanliness and the degree of humidity of the roots.

Careful handling and transport, in the shortest possible time, prevent damage or injury to the product, bringing some lots to the warehouse in good condition. The conditioning ensures that only first quality roots are preserved.

Conditioning of carrot roots starts in the field by cutting the leaves about 2 cm above the collar, pre-sorting and packaging. Roots with a turgid appearance, firm, whole, clean, healthy, without bumps, not lignified and without external moisture are considered appropriate.

Parsley roots are considered more perishable than carrots due to their specific structure and texture: large number of lenticels, large parenchyma cells, with thinner cell walls, large intercellular spaces, which favor dehydration. Wounds caused by handling and transport heal with difficulty or do not heal at all, remaining open. Parsley is harvested in two phases: first the leaves are cut, which are used separately, then the roots are harvested. Parsley roots corresponding to first quality must have a regular shape, free from cracks, crushes, traces of attack or spots, with max. 1% cohesive soil, with an equatorial diameter of 20-50 mm.

In order to store and preserve the two species of roots, traditional methods can be used: in the furrow, in bulk, in trenches by stratification, in simple or improvised warehouses with natural ventilation, or refrigerated storage.

Storage in simple warehouses with natural ventilation is carried out in brick wall constructions, provided with windows and doors, which allow the necessary ventilation. The root crops are stored in these spaces in P-type crates stacked in 6-7 rows. The stacking is carried out crosswise, and for good air circulation spaces of at least 0.8 m are provided on the ceiling, 20 cm on the walls and 0.5-0.6 m between the stacks. The storage temperature is 0-1^{0}C, maintained through repeated ventilation during cold nights. When the outside temperature drops below -5^{0}C, doors and windows are lined with mats or other insulating materials. Losses until March are approximately 17.5% (Beceanu D., 2000).

Cold storage of root vegetables requires large batches of high quality roots (200-300 kg/cell), which can be delivered after at least 6 months of storage.

During storage, the metabolic activity of the roots continues through the phenomena of respiration and transpiration. The reduction of metabolic activity is achieved by regulating the environmental factors in the warehouse, namely the temperature, the relative humidity of the air and the circulation of air currents.

The recommended temperature at which carrot and parsley roots are stored is 0.5-3^{0}C and relative air humidity 90-95%. The recommendations in the specialized literature, however, mention a lower temperature level of 0-1^{0}C or even 0-0.5^{0}C, which will be maintained within the limits of 0-2^{0}C and the relative air humidity of 90-95% or even 95-98%. Air circulation speed at the beginning of storage is 2 m/s, and during storage 0.5-1 m/s (Ardelean, 2013, Beceanu D., & Balint G., 1999, Beceanu, 1998, Beceanu, 2002, Beceanu, 2003. Burzo, 1984, Burzo, 1986, Ceaușescu, 1987, Gherghi, 1981, Gherghi, 1983, Gherghi, 1987, Gherghi, 1989, Gherghi, 1994, Marca, 1987, Marca, 2004, Potec, 1983, Potec, 1985, Milică, 1988, Radu, 1967, Rusu, 1996).

MATERIAL AND METHODS

The Berlicum carrot variety and the Sugared parsley variety were studied, both varieties being late. The research was carried out during autumn-winter of 2020-2021.

The carrot and parsley crop was established by direct seeding in the field after a lettuce and radish crop. The land was prepared in advance by mobilizing at 20 cm, shredding and opening the sowing furrows. Sowing was performed in May for parsley and in June for carrot. The crop maintenance works carried out were: weeding, irrigation after sowing, then at 2-3 day intervals, partial fertilization with N, P, K, thinning of plants 4-5 cm apart in a row, combating diseases and pests with fungicides and insecticides to keep crops clean.

Harvesting was performed manually in October, in dry weather, to avoid the roots' strong adhesion to the soil and to allow immediate storage. Harvesting was done when the roots were mature, corresponding to the complete formation of the periderm, but without the beginning of lemnification and when the characteristic size of the variety has been reached. Immediately after harvesting, the root conditioning operation was carried out: cutting the leaves 1-2 cm above the parcel, calibration, sorting by removing plant residues, soil and other impurities, sorting of first quality roots intended for storage in warehouses.

Before the harvesting campaign, the packaging (type P crates) and the storage spaces (shed) were prepared by repairing the spaces and crates, disinfecting them with milk of lime 2% and spraying with copper sulfate solution 2%. These treatments are necessary to avoid infections with Sclerotinia sclerotiorum (white rot), Erwinia carotovora (wet rot), Rhizoctonia carotae (purple rot) and other specific root diseases. It is very important that roots from crops infested with diseases and pests are not introduced into the warehouses. The tractor trailers or means of transport used must also be disinfected.

Carrot and parsley roots were stored under the same conditions, in a shed, simple construction, equipped with windows and an access door. The roots were packed in type P crates, being filled 5 cm below the upper edge of the crate. The crates were palletized on two levels and enough space was left to be able to check the condition of the roots and ensure air circulation. In the first part of the storage (October-November), the temperature and relative humidity of the air was regulated by repeated ventilations, and when the temperature dropped below 0^0C the ventilations were reduced, then at temperatures below -5^0C the windows and the door were lined with isolating materials. Through repeated airing, the formation of condensation on the roots was avoided.

Throughout storage, the health status of the roots was evaluated at three-day intervals and the quality deteriorations that occur.

RESULTS AND DISCUSSIONS

After the conditioning operation, root samples were taken from the two species and chemical and organoleptic determinations were made. In this sense, the content in soluble dry matter and the content in vitamin C were quantitatively determined. Regarding the organoleptic properties, the following characteristics were analyzed: shape specific to the variety, color and condition of the epidermis, color, consistency and juiciness of the pulp, degree of maturity, taste and aroma of the roots.

The content in dry solluble matter and Vit.C are presented in table 1.

Table 1

Solluble dry matter and Vit. C content in carrot and parsley.

Type	(%)	Vit. C (mg %)
Carrot	10.9	6.9
Parsley	13	23.8

The soluble dry matter content is very good, which allows the roots to be stored for a longer period.

The vitamin C content is significant, especially in parsley, which is why it is recommended to consume it throughout the year, especially in the winter in the form of raw vegetable salads, ensuring an intake of vitamins and mineral salts for consumers.

During storage, carrot and parsley roots continue metabolic processes. The most obvious are breathing and sweating.

During the respiration process, the roots release carbon dioxide into the environment and absorb oxygen from the outside environment. The amount of carbon dioxide released by the roots is an indicator of the intensity of the respiration process during storage. Carrot and parsley roots are part of the

group of horticultural products with medium respiratory intensity (10-20 mg CO2).

At the same time, during respiration, the roots lose part of the contained water, which, together with the free water in the tissues, can be released from the horticultural products through the transpiration process. The loss of water from horticultural products is inversely correlated with the relative humidity of the air, so if it has a value between 98-100% it is considered that the removal of water from the products is zero. Taking into account the two metabolic processes that take place in the roots, maximum attention must be paid to the environmental factors, namely the temperature and the relative humidity of the air in the storage spaces. In controlled-atmosphere spaces, storage is carried out under optimal conditions, as environmental factors are easily regulated. The situation is different in spaces with natural ventilation, where the regulation of the temperature and relative humidity of the air is achieved only by ventilation and depends very much on the external atmospheric conditions.

Thus, in the climatic conditions of the autumn (October-November) of 2020, characterized by relatively high temperatures and low relative air humidity, being a dry autumn, the regulation of the two environmental factors was achieved through ventilation, especially during the night, when the temperatures were lower. Through these ventilations, the aim was to keep the temperatures as low as possible, maintain a relative air humidity as high as possible, and also avoid the formation of condensation on the roots.

In the first part of the storage (October-November), the temperature and relative humidity of the air was regulated by repeated ventilations, and when the temperature dropped below 0^0C the ventilations became rare. In the following period, when the temperature dropped below -50C, the windows and the door were lined with synthetic insulating materials.

The storage period was 4 months (October – February). Throughout the storage period, the health of the roots was checked. In the crates where outbreaks of infection appeared, the compromised specimens were extracted and the type of deterioration was determined (Table 2). In the middle of February, it was decided to stop the storage due to the fact that the quantitative and qualitative depreciations were increasing, and root aging phenomena appeared.

The highest losses were in both species the qualitative ones, materialized by phenomena of dehydration, aging, the appearance of spots, which required the storage to stop. Dehydration phenomena are due to the excessive loss of water from the roots, which could not be recovered, due to the temperature (0^0C) and the relative humidity of the air being too low (below 85%). All these inappropriate storage values determined physiological changes in the roots through the appearance of spots, which constituted a favorable environment for the emergence of new foci of infection with microorganisms. Among the diseases identified in the warehouse are: Alternaria, produced by the fungus Alternaria porrii f. sp. dauci, rhizoctonia caused by Rhizoctonia carotae and black rot caused by Thielaviopsis basicola.

The obtained results reveal higher total losses in parsley roots. These higher losses compared to carrot roots are due to the fact that parsley roots belong to a more perishable category due to their specific texture and structure. The large number of lenticels, large parenchyma cells with thinner cell walls, large intercellular spaces favor dehydration, although the rhizoderm is thicker than in carrot.

Due to the recording of these significant losses in carrot and parsley roots, it was decided to stop storage. After being removed from storage, the roots were sorted by removing old, diseased specimens, after which the operation of washing them with water was carried out, they were washed and packed in clean, disinfected crates in order to be sold on the market.

Table 2

Soluble dry matter and vitamin C content in carrot and parsley

Type	Duration of storage	Weight loss (%)	Damage losses (%)	Quantitative losses (%)	Total losses (%)
Carrot	4 months	5.9	5.3	7.1	18.3
Parsley	4 months	6.2	5.9	7.4	19.5

CONCLUSIONS

The following conclusions can be drawn from the study regarding the behavior of carrot and parsley roots during storage in unused spaces:

1. The soluble dry matter content at the time of harvesting is good, allowing the roots to be stored for longer periods and, at the same time, provides an adequate intake of carbohydrates necessary for the human body.

2. The vitamin C content is significant, especially in parsley, which recommends consuming them throughout the year, especially in the winter in the form of raw vegetable salads, ensuring an intake of vitamins and mineral salts for consumers.

3. Carrot and parsley roots continue their metabolic activity during storage, having a medium respiratory intensity.

4. During the processes of breathing and transpiration, the roots lose part of the water, an undesirable phenomenon, because it can favor their dehydration.

5. These metabolic phenomena can be reduced by adjusting the environmental factors (temperature, relative air humidity, air current circulation) to the required values.

6. In the unused warehouses, the control of these environmental factors was achieved by repeated ventilations at the beginning of the storage period, then as the external temperature decreased, the number of ventilations was reduced, and when the external temperature decreased below the value of -5^{0}C, it was necessary to cover the windows and the door with synthetic insulating materials, which allowed maintaining a temperature between 0-20C in the storage space.

7. During the 4 months of storage, there were weight losses, due to spoilage and quality, which had a higher value for the parsley.

8. Following the significant losses recorded in February, it was decided to stop storing and selling the roots on the market.

9. Storage in unused spaces (warehouses) in the current economic conditions is a very cheap way of storage, which is recommended especially in areas with a favorable climate, where very low temperatures are not recorded during the autumn-winter period.

10. It is recommended to continue research on the use of cheap ways of storing both root horticultural products and other horticultural species.

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