RESEARCH ON THE INFLUENCE OF STORAGE CONDITIONS ON THE QUALITY INDICES OF SOME VARIETIES OF PEPPERS GROWN IN PROTECTED AREAS

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RESEARCH ARTICLE

Abstract
The quality of peppers intended for fresh consumption varies according to the genetic characteristics of the species and varieties, the cultivation technology applied, the prevailing soil and climatic conditions during the given year, and the storage environment. Ensuring optimal storage conditions extends and staggers the periods of consumption and delivery to the consumer. Maintaining ideal environmental factors during storage affects the primary quality indicators for peppers.

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INTRODUCTION

Peppers belong to the group of solanaceous-fruiting vegetables, with a wide variety of types and hybrids, cultivated both in open fields and in protected areas, ensuring the necessary quantities for fresh consumption throughout the year. However, peppers are also valuable as raw materials that can be processed and preserved by various methods, enabling the production of diverse end products appreciated for their chemical composition and flavor. Processing methods produce a wide range of pastes, vinegar-preserved products, thermosterilized, frozen, or dehydrated items.

Peppers, bell peppers, and scallions are valued in the human diet primarily for their high vitamin content (especially vitamin C), mineral salts, and relatively low energy value. Their pleasant flavor comes from natural essential oils, while the spicy taste of chili peppers results from their high capsaicin content, an alkaloid responsible for their hot flavor. The slightly acidic taste is due to a stable acidity content (0.3% citric acid) (Beceanu D., 2003).

Peppers are harvested by hand, except for those intended for industrial paprika production, which are harvested mechanically. The optimal harvest time is determined by the specific stage of maturity—the sub-phase of eating maturity F_1 - F_2 or physiological maturity F_4 - F_5—and the intended purpose and transportation, as peppers have the natural ability to continue ripening after being picked. It is usually recommended to harvest peppers at the F_4 eating maturity sub-phase, when the fruit has the size, color, and luster characteristic of the variety. For gingers and long peppers, eating maturity coincides with physiological maturity.

According to STAS 1422-85 standards, the stem length of first-quality peppers must be 1 cm from the calyx, while for second quality, only an unbroken calyx is required. Peppers without stems have an extended shelf life but lack an ideal market appearance and are prone to storage diseases.

Presorting is done during harvesting, selecting only healthy, undamaged, and clean specimens free from frost, sun damage, mechanical damage, or early softening of tissues. Fruit with damaged calyx, either underripe or overripe, or with unhealed injuries is not allowed. For industrial purposes, peppers must have a uniform shape typical of the variety, white seeds, and a sweet flavor. Only hot pepper varieties should contain spicy flesh.

Handling and transportation of peppers must occur swiftly due to their high perishability, thin skin, and high-water content (91-93%), which leads to turgidity loss (Burton 1982; Beceanu D., 1998, 2003). Peppers are sorted, graded, sized, packed, and may be waxed and pre-packaged as needed.

Sizing for large and long peppers is based on the maximum diameter of the stem area, which must be at least 60 mm for first quality and 40 mm for second quality. The equatorial diameter of bell peppers should be at least 70 mm for quality I and 50 mm for quality II. Waxing with edible coatings extends the shelf life of bell peppers intended for export by 3-5 days and for longer varieties by 6-10 days, decreasing respiration rates and increasing carotenoid pigment levels (Dobreanu, M., et al., 1980).

Peppers can be packed in P-type crates or plastic crates, with special cardboard boxes used for export. Pre-packaging is done in netted or synthetic sacks.

Transport of peppers should occur as soon as possible, avoiding storage or extended holding of ripening batches. Quality stability is better maintained by pre-cooling for 6 hours at 8 °C, as slow cooling is unfavorable. Peppers harvested at sub-phase F_0-F_1 (green maturity, suitable for cooking) show more than 30% storage losses and physiological disorders. Bell peppers in sub-phase F_3-F_4 (full maturity, ready for consumption) can ripen in 4-6 days with an average of 10% losses at 15-20°C and 85-90% relative humidity (Ciurel, Mihaela, 1980).

Short-term storage is only used to stagger deliveries and extend fall consumption. The surface microflora is abundant, with fungal growth promoted by increasing temperatures; however, temperatures of 7-8°C prevent sporulation and limit fungal spread (Tașcă, Gh., 1982).

Peppers are stored at 8-10°C when at eating maturity (F_1-F_2) and 1-2°C when at physiological maturity (F_4-F_5), under high relative humidity (93-96%) maintained under polyethylene covers. In the first case, storage life for thin-fleshed (under 3 mm) bell pepper varieties is 14-20 days. For physiologically mature bell peppers, storage may last 40-45 days (Iordănesu C., 1978; Gherghi A., 1994, 2000). Greenhouse-grown bell peppers can be kept for 4-5 days at 14-16°C or for up to 20 days at 8-10°C with 90% relative humidity (Iordănescu, Olga, 1982). In Western Europe, bell peppers remain fresh at 7-10°C and 90-95% relative humidity for 1-4 weeks. Packing in perforated film helps maintain quality (Ardelean A. G., 2009; Ciofu, R., et al., 2004; Potec, L., Roșu, T.A. Tudor,1983; Purcărea C., 2008; I. F. Radu, 1985).

MATERIAL AND METHODS

The analyses were conducted in September 2024 on red and green bell pepper varieties, as well as the Kapia pepper variety, grown in greenhouses. The main indicators analyzed for the freshly harvested samples and after a 10-day temporary storage period included soluble dry matter content, titratable acidity, and vitamin C content.

Sampling occurred on the same day as the harvest. The temporary storage of the pepper samples was conducted at 10°C for 10 days in refrigerated warehouses. Both organoleptic and chemical analyses were performed on the selected varieties.

The soluble dry matter was determined using a refractometric method, directly in the field with a Zeiss portable refractometer for fresh produce. Titratable acidity was determined as follows: fresh products were ground, filtered, and titrated with a sodium hydroxide solution of known concentration, using phenolphthalein as a color indicator.

Vitamin C content was determined using the iodometric method. To do this, 15 g of the sample was weighed from the average collected sample on an analytical balance and mixed with 2 g of quartz sand and 10 ml of metaphosphoric acid to form a homogeneous paste. This mixture was then transferred to a 50 ml graduated flask and diluted to the mark with metaphosphoric acid. The mixture was filtered, and 10 ml of the filtrate was used for analysis. Two titrations were performed for accuracy.

For the titration of the standard ascorbic acid solution, 10 ml of ascorbic acid, 20 ml of distilled water, two drops of 1 M hydrochloric acid solution, and 15 drops of 1% starch solution were placed in a conical flask and titrated with an iodine solution until the color turned blue-violet (V).

For the sample titration, the same procedure was followed, except that the standard ascorbic acid solution was replaced by 10 ml of the sample filtrate. The titration was carried out with iodine solution until the color changed to violet-blue (V_1).

Vitamin C content was calculated using the formula:

Vit. C (mg/100 g of product) = $10 \times V_1 \times 5 / V \times m \times 100$

RESULTS AND DISCUSSIONS

Chemical analyses carried out on green and red bell peppers and Kapia peppers, fresh and after temporary storage, revealed the average values shown in Tables 1 and 2.

Table 1

Chemical indicators determined in freshly harvested samples of peppers

Variety / average of the samples	Sample weight (g)	Soluble dry matter (%)	Titratable acidity (ml NaOH 0,1 n)	Vit. C (mg/100)
Green bell pepper	200	5.8	2.90	169.3
Red bell pepper	200	6.8	2.82	176
Kapia peppers	200	6.9	2.71	158.7

Table 2

Chemical indicators determined in pepper samples after temporary storage

Variety / average of samples	Sample weight(g)	Soluble dry matter (%)	Titratable acidity (ml NaOH 0,1 n)	Vit. C (mg/100)
Green bell pepper	200	3.89	2.00	156
Red bell pepper	200	4.95	1.93	161.2
Kapia peppers	200	5.01	1.90	146

A comparative study of the data obtained from fresh peppers and those stored for 10 days shows a slight decrease in the values of the analyzed chemical indicators.

The soluble dry matter content decreased in all varieties studied after the temporary storage period. This decrease depends on the species, variety, and environmental factors (temperature, relative humidity, oxygen, and carbon dioxide levels) in the storage environment.

Regarding titratable acidity (ml NaOH 0.1n), there was minimal change, with the peppers becoming slightly more acidic due to some water loss from the fruit, thereby concentrating the cell juice. This reduction in turgidity was due to the lack of humidity control in the storage area.

Most plant species tend to exhibit a decrease in ascorbic acid content over time. The ascorbic acid content in temporarily stored peppers decreased by approximately 8% over the 10-day storage period at 10°C. These losses are relatively minor compared to those in other vegetables. Studies have shown that the stability of ascorbic acid in plant tissues is influenced by the presence of ascorbate oxidase, a metalloenzyme with copper cations as a cofactor. Peppers maintain a more stable ascorbic acid content due to their lower levels of ascorbate oxidase.

From an organoleptic perspective, the peppers retained their flavor, although there was a slight reduction in aroma and turgidity.

CONCLUSIONS

From the studies carried out on the main quality indicators of freshly harvested and temporarily stored peppers, the following conclusions can be drawn:

The highest soluble solids content is found in fresh red and Kapia peppers, with slightly lower levels in green peppers.

Titratable acidity is highest in fresh green and red bell peppers.

Ascorbic acid content is highest in fresh red bell peppers, followed by green bell peppers.

Changes in these chemical quality indicators were observed in samples stored temporarily under conditions where only temperature was controlled.

Soluble dry matter content exhibited small losses in all varieties during temporary storage.

Titratable acidity (ml NaOH 0.1n) changed the least, with peppers becoming slightly more acidic due to minor water loss, as visually noted by a decrease in turgidity.

Recorded ascorbic acid losses for all pepper varieties were low, likely due to the lower ascorbate oxidase content in the fruit.

From an organoleptic perspective, the peppers retained their flavor, though there was a slight reduction in aroma and turgidity, attributed to the lack of relative humidity control in the storage facility.

These changes in the chemical composition of temporarily stored peppers are due in part to the species-specific characteristics and, on the other hand, to the environmental conditions in storage, where only temperature was controlled.

Based on the analysis of these quality indicators in fresh and temporarily stored peppers, we conclude that temperature is essential for temporary storage of all three varieties studied, ensuring that fruit quality remains largely unaffected.

Ensuring optimal storage conditions enables extended and staggered periods of consumption and delivery to consumers.

Further research is recommended on the impact of storage conditions on quality indices in pepper fruits.

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