Current Horticulture 11(2): 76–78, May–August 2023 DOI: 10.48165/chr.2023.11.2.10

Enhancing shelf-life of carrot (*Daucus carota*) by different treatments during post-harvest processing

Raja. P, Abitha, M and Ganapathy, S

Department of Food Process Engineering., AEC&RI,
Tamil Nadu Agricultural University, Coimbatore, Tamil Tadu, India

Received: 12 November 2021; **Accepted:** 11 Januray 2023

The study was carried out on the effect of physical, chemical and biological treatments on carrot (*Daucus carota L.*) for enhancing shelf-life during post-harvest processing at Department . of Food Process Engineering., Agricultural Engieering college & Research Institute, Tamil Nadu Agricultural University, Coimbatore. The most significant changes in post-harvest quality were weight loss, bitterness, bacterial deterioration, rooting and sprouting. Losses in carrots are due to *Sclerotinia* rot, *Botrytis* rot, Bacterial soft rot (*Erwinia sp.*) and sour rot (*Geotrichum sp.*). Among different methods, combination of chlorination and ozonization during washing followed by application of *Lactobacillus plantarum 020* at the rate of 10 ml / litre of wash water was more effective.

About 20 - 30% of the total carrot is lost due to postharvest spoilage and water loss (Shibairo *et al*. 2002). The losses in vegetables are much higher due to inadequate post-harvest handling, transportation and storage facility (Sarkar *et al.*, 2020). The major constraint in its processing is postharvest losses caused due to microbial spoilage. Processed carrots have less than 48 hours of shelf-life. Therefor study was undertaken to find out post-harvest microbial management techniques.

The probiotic culture, *Lactobacillus plantarum* 020, (source: NDRI, Karnal, India) was cultured in De Man, Rogosa and Sharpe (MRS) broth for 24 h at 37^{o}C. The culture was harvested, centrifuged and prepared for further study. Harvested cells were mixed in sterile distilled water to get 10^{9} CFU per ml and used for different treatments. The starter culture prepared as above was used to treat carrots at the rate of 10 ml culture per 1000 ml of wash water during post-harvest processing. Ten ml of prepared starter culture of *Lactobacillus plantarum* 020 was introduced into 1000 ml wash water to get 1% inoculum. Prepared wash water was kept at room temperature for one hour and used to treat carrots.

The treatments were: T_{0}, Control; T_{1}, Chlorination (200 ppm) + Ozonization (30 min); T_{2}, Chlorination (200 ppm) + *Lactobacillus plantarum* 020; T_{3}, Ozonization (30 min) + *Lactobacillus plantarum* 020 and T_{4}, chlorination (200 ppm) + ozonization (30 min) + *Lactobacillus plantarum* 020.

The population density of bacteria, fungi, actinomycetes and viability of probiotic culture was enumerated by serial dilution plate technique (Parkinson *et al*., 1971). A known quantity of whole carrot sample was transferred to peptone water to get 10^{-1} dilution. After thoroughly mixing it, one ml of this dilution was transferred to 9 ml peptone water to get 10^{-2} dilution. Likewise, sample was diluted serially with 9 ml peptone water till appropriate dilution was obtained.

Carotene content in carrot was estimated following the procedure as described by Lee (1986). The carotene content was measured on days 0, 2, 4 and 6. Measured quantity of sample was homogenized in a pestle and mortar using acetone and extracted repeatedly using acetone until the residue is colourless. This mixture is then added to a separating funnel containing petroleum ether. Five per cent sodium sulfate solution was then added to the solution. The petroleum ether extract was removed from the funnel and added to anhydrous sodium sulfate. Carotene content was estimated using spectrophotometry method, in which yellowish colour formed is measured against spectrophotometer at the wavelength of 453 nm. Total quantity of carotene content in 100 g of carrot sample is calculated using the formula:

***Corresponding author :** hdasangi@gmail.com

$$\text{Total carotene} = \frac{\text{Absorbance of sample} \times \text{Total volume} \times 100}{0.2592 \times \text{weight of the sample} \times 1000}$$

Weight loss in carrots during storage was found using an analytical balance with a precision of 1×10^{-4}g. The loss of colour during storage was estimated with a spectrophotometer (HunterLab's MiniScan EZ) which provides a 31.8 mm port size that has a 25 mm viewed area. The relative intensities of light at different wavelength along visible spectrum (400-700 nm) are then analyzed to produce numeric results, indicating the colour of the sample. The results were expressed as Hunter colour values of L*, a* and b*, where L* value denotes lightness (+) and darkness (-), a* value is used to indicate the redness (+) and greenness (-) and the b* value is used to denote the yellowness (+) and blueness (-) of sample.

The changes in hardness of carrots during storage were measured using a texture analyser (Brookfield, CT3 Texture Analyzer, India). The following specifications were loaded. The Brookfield texture analyser had load cell of 50 kg capacity, the probe was chosen TA44, an aluminium cylinder with 4 mm diameter, compression was the selected test type. The target value was fixed to 5 mm distance and no hold time was fixed. The trigger load was fixed to 10 g with a test speed 1 mm/s. These parameters once set, will automatically run the data for the remaining samples. The hardness of a carrot is measured by maximum force required to compress the sample.

The statistical analysis was carried out using AGRES software. Differences were considered to be significant at $p<0.05$. The data were subjected to analysis of variance (ANOVA) with a mean comparison performed using two factorial completely randomized design.

The carotene content was significantly affected by the storage period, storage temperature and treatments used ($p<0.05$). During storage, there was a sharp decline in the total carotene content in carrots. However, carotene content was maintained in samples treated with probiotic culture. The carotene content ranged from 5.9625 ± 0.76 to 13.35 ±0.37 during storage. The carotene content having the presence of probiotics was found higher during storage compared to samples without probiotics. The carotene content of samples treated with T_0, T_1, T_2, T_3 and T_4 on 0th day were 13.3, 11.68, 10.12, 10.70 and 12.14 mg/100g on 0th day respectively. On storage there was a minimal degradation in total carotene content in samples. Since, untreated sample had a maximum spoilage on 6th day, carotene content of T_0 samples were not recorded. The carotene content of samples treated with T_1, T_2, T_3 and T_4 on the 6th day were 7.99, 7.02, 6.86, 7.65 mg/100g. Among treatments used, T_1 and T_4 had minimal degradation in carotene content compared with other treated samples. Abitha *et al*. (2019) studied the impact of probiotics in preserving the microbiological property and nutritional quality in carrot and found similar results.

The study showed the ability of probiotic cultures in reduced carotene content degradation during storage under room temperature among other treated samples. The degradation in carotene content of untreated sample was observed mainly due to spoilage. On the 6th day of storage, there was a maximum spoilage in untreated samples degrading the total carotene content, whereas a minimum degradation in carotene was observed in treated samples.

Several *Bacillus* sp. known as endophytes can prevent deleterious effects of pathogenic microorganisms (Popy Bora *et al*., 2019). The probiotic strains of *L. casei, L. acidophilus, L. plantarum,* and *L. delbrueckiiare* are resistant to low pH, did not influence the lycopene content and its chemical properties (Ferdousi *et al*., 2013).

There was a steady increase in per cent weight loss in all samples during the storage period. The percent weight loss among samples ranged between 7.9 ± 0.85 to 35.996 ± 0.65. The highest weight loss was observed in untreated samples. At the end of storage, probiotics treated samples retained the weight in samples, as probiotics cells in surface reduced microbial load causing spoilage. Among treated samples, carrots coated with *Lactobacillus plantarum* 020 maintained weight during storage at room temperature. The per cent weight loss in samples treated with T_0, T_1, T_2, T_3, T_4 were 36.99, 27.79, 23.24, 25.16 and 22% respectively. Among treated samples, T_4 and T_2 had a reduced weight loss percentage among other treated samples with 23.24 and 22 % weight loss percent.

The microorganism also maintained a good cell vitality during storage preserving its moisture. Probiotic used as an edible coating to improve the quality factor of minimally processed carrots showed a reduced effect in colour and showed a greater

retention in moisture content of carrots (Shigematsu *et al*., 2018). The use of probiotics as an edible coating demonstrated a slowdown in moisture loss from food products (Soukoulis *et al*., 2014).

The L* value of carrots ranged from 51.26 to 54.57 during storage. The L* value indicates lightness of sample. The a* value ranged 24.09 to 32.86 during storage indicating the redness of the sample. The b* value ranged from 27.77 to 34.38 during storage indicating the yellowness of the sample. Carrots showed more changes in colour after treatments. Luminosity was significantly different in all samples compared to the control. There was an increase in lightness in all treated carrots. Similarly a decrease in intensity of redness and yellowness of the treated carrots was observed when compared to the control. On the 6th day of storage, T_4 treated samples had a minimum change in lightness L* compared to the 0th day of T_4 treated carrots. T_1 treated carrots had higher intensity in reddness (a*value) and yellowness (b*value) than other treated samples by the 6th day of storage.

Similar results were reported by (Bermúdez-Aguirre and Barbosa-Cánovas, 2013). Different treatment methods used along with the processing conditions largely affects the colour value of carrots. This change in colour may be due to various chemical and enzymatic changes that occur during various treatments.

The hardness varied according to microbial load and moisture content present on the 6^{th} day of storage. The untreated sample had an increased microbial load, softening tissues as most of the roots were spoiled. Hence, T_0 samples were excluded in hardness determination. Among the samples, T_4 samples were observed to maintain the firmness than other treated samples by the 6th day of storage. Similar results were reported on hardness test for different varieties of carrots. The hardness of carrots largely depends on the variety and stage of maturity at which carrots are harvested.

Carrots treated with chlorine, ozone and *Lactobacillus plantarum* 020 had minimum degradation in firmness than other combination treated samples. Chlorine, ozone and *Lactobacillus plantarum* 020 treated carrots required 47.697 N, deformation at hardness were on 2.08 mm distance, adhesiveness of 1.6 mJ and 5 fractures in carrots on the 6th day of storage. Carrots processed with the above treatment had a shelf-life of six days under normal room temperature, whereas shelf-life of untreated carrots was two days under normal room temperature. The finding of the study could be adopted well in real field conditions to improve carrot shelf-life.

REFERENCES

Abitha, M., S Ganapathy and P Raja. 2019. "Impact of probiotics in preserving the microbiological property and nutritional quality in carrots". *Journal of Pharmacognosy and Phytochemistry* **8**(3): 4395-400.

Bermúdez-Aguirre, Daniela, and Gustavo V %J Food Control Barbosa-Cánovas. 2013. "Disinfection of selected vegetables under nonthermal treatments: Chlorine, acid citric, ultraviolet light and ozone." **29** (1):82-90.

Ferdousi, Rohollah, Millad Rouhi, Reza Mohammadi, Amir Mohamad Mortazavian, Kianosh Khosravi-Darani, and Aziz Homayouni Rad. 2013. "Evaluation of probiotic survivability in yogurt exposed to cold chain interruption." *Iranian journal of pharmaceutical research: IJPR* **12**(Suppl):139.

Lee CY. 1986. "Changes in carotenoid content of carrots during growth and post-harvest storage." *Food chemistry* **20**(4):285-93.

Parkinson, Dennis, Timothy RG GRAY, and Stanley Thomas WILLIAMS. 1971. "Methods for studying the ecology of soil micro-organisms." *Methods for studying the ecology of soil micro-organisms.*

Popy Bora, Kakumoni Saikia, Hrishikesh Hazarkia and Gavas Ragesh. 2019. "Exploring potential of bacterial endophytes in disease management of horticultural crops". *Current Horticulture* **7**(2): 32–37.

Shibairo, S. I., Upadhyaya, M. K., & Toivonen, P. M. 2002. Changes in water potential, osmotic potential, and tissue electrolyte leakage during mass loss in carrots stored under different conditions. *Scientia Horticulturae* **95**(1–2): 13-21.

Shigematsu, Elke, Claudia Dorta, FC!bio J Rodrigues, Marina F Cedran, Juliana A Giannoni, Marie Oshiiwa, and Maria A Mauro. 2018. "Edible coating with probiotic as a quality factor for minimally processed carrots." *Journal of Food Science and Technology* **55**(9):3712-20.

Soukoulis, Christos, Lina Yonekura, Heng-Hui Gan, Solmaz Behboudi-Jobbehdar, Christopher Parmenter, and Ian Fisk. 2014. "Probiotic edible films as a new strategy for developing functional bakery products: The case of pan bread." *Food Hydrocolloids* **39**:231-242.

Sarkar Susheel Kumar, Panwar Sanjeev, Paul Kumar Ranjit, Tomar Sonia, Kumar Nitin and Morya O P. 2020. "Assessment of pre- and post-harvest losses of vegetables in Kanpur district of Uttar Pradesh". *Current Horticulture* **8**(2): 29–3.