Biological Forum – An International Journal 15(2): 609-613(2023)

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Influence of different Freezing and Thawing condition on Texture, Colour and Sensory Parameters of Osmo-convectively Dehydrated Carrot Slices

T.D. Kumavat[1*], P.G. More[2] and S.B. Jadhav[3]

[1]M.Tech. Student, Department of Agril. Process Engineering, CAET, VNMKV, Parbhani (Maharashtra), India.
[2]Assistant Professor, Department of Agril. Process Engineering, CAET, VNMKV, Parbhani (Maharashtra), India.
[3]Assistant Professor, Department of Agriculture Engineering, COA Ambajogai, VNMKV Parbhani (Maharashtra), India.

(Corresponding author: T.D. Kumavat)*

(Received: 03 January 2023; Revised: 09 February 2023; Accepted: 12 February 2023; Published: 17 February 2023)
(Published by Research Trend)

ABSTRACT: Carrot (*Daucus carota* L.) is very popular root crop, cultivated throughout the world. Being rich in bioactive compounds like carotenoids and other nutrients, carrot has an important place in human diet. Pre-treatment prior to processing helps to prevent the loss in nutritional, sensorial, textural and functional properties of dehydrated fruits and vegetable. Texture, colour and sensory parameter play an important role in consumer acceptance of dehydrated ready to eat products. In most of the earlier studies, carrot was osmo-dehydrated without freezing pretreatment and dried products were used after rehydration. During freeze thaw pretreatment, temperature and time of freezing and thawing plays an important role in final quality of osmo-dehydrated products. Considering the influence of freeze-thaw treatment on texture and colour of osmo-dehydrated product, the present investigation was carried out to assess the effect of freezing and thawing time on objectives and subjective evaluation of colour and texture osmo-convectively dehydrated carrot slices and also on overall acceptability of products. Blanched carrot slices were frozen -25 ^{o}C freezing temperature for 12 and 24 h duration. Thawing of frozen carrot slices was carried out at low and ambient temperature condition for 2 and 8 h duration. The effect of freezing and thawing duration on texture and colour of dried carrot slices were objectively evaluated in terms of hardness and L*, a*, b* value of colour. Also, subjective evaluation was carried out by using 9-point scale to assess the overall acceptability of osmo-convectively dehydrated carrot slices. It was found that hardness of osmo-convectively dehydrated carrot slices influenced by freezing and thawing time for both thawing condition. Subjective and objective evaluation of osmo-convectively dehydrated carrot slices showed higher the retention of colour in pre-frozen osmo-convectively dried carrot slices for 24 hours irrespective of thawing duration. Also non-significant difference was observed in hardness and colour values for 12 and 24 h freezing time. Osmo-convectively dehydrated carrot slices prepared by using 12 hours freezing time and 8 h thawing at low temperature condition obtained higher overall acceptance.

Keywords: Freezing, Osmotic dehydration, Colour, Hardness, Overall acceptability.

INTRODUCTION

Carrot (*Daucus carota* L.) is a very popular root crop cultivated all over the world for its fleshy, delicious, attractive edible roots (Selvakumar and Tiwari 2018). In India, carrot occupies an area of 110 thousand ha with 1910 thousand MT production (Ananymous, 2022). Carrot is rich in carotenoids, flavonoids, vitamins and minerals which possess numerous nutritive and health benefits. It has anti-carcinogens, anti-diabetic, anti-hypertensive cholesterol lowering and wound healing benefits (Silva, 2014). Due to its unique recognition as a source of natural antioxidants and immune enhancer characteristics, the consumption of carrot and its products is increasing day by day (Sharma *et al*., 2012). Fresh carrots are widely used in salads and curries in India and they can also be processed commercially into nutritionally dense products such as juice, concentrate, dried powder, tinned, candy, pickle, halwa, dehydrated non-fried carrot chips, deep-fried carrot chips and whole grain carrot chips (Sharma *et al.,* 2012; Krivokapic *et al*., 2020).

Food materials are exposed to high temperatures during the traditional drying process, which can have an unfavourable effect on the flavour, colour, and textural aspects of the finished product. Osmotic dehydration is useful for the partial removal of water from plant tissues by immersion in a hypertonic solution. For osmosis process, sugar and salt solution was used to reduce the moisture content of fruits and vegetable before actual drying process (Shete *et al*., 2018). Osmosis is less energy intensive than convective drying with better colour, texture and flavour retention along with minimum heat damage (Nazni and Karuna 2011).

Colour value L* of pre-frozen osmo-dehydrated apple slices was lower *than* untreated slices. Whereas lower a* and b* colour values were observed for unfrozen than pre-frozen slices. Thawing of frozen samples in polyethylene bags allowed the re-absorption of leached fluids, which increased the moisture content and reduced the loss due to pre-treatment. The increase in permeabilized cell membrane due to freezing pretreatment resulted in higher water loss and solids gain leading to porosity (Taiwo *et al.,* 2001). Freeze-thawed osmo-oven-dried African star apple recorded a rapid increase in water loss and solid gain during osmotic dehydration. When compared with the fresh African star apple, increase in L* value and decrease in a* and b* values were observed in the osmo-air-dried African star apple during storage. Higher colour intensity and chroma values were recorded for dried sample which was pre-osmosed in glucose solution than in sucrose solution (Falade *et al.*, 2007). Freezing at -50ºC temperature before osmotic dehydration increased the water loss and solid gain than un-frozen pomegranate seeds. Membrane deterioration was observed by scanning electron microscopy (SEM) during freezing which induced the losses of binding capacity among cell walls and cellular structure. The final osmotically dehydrated pomegranate seeds had an attractive colour, pleasant taste, texture and a good aroma (Bachir *et al*., 2011). The effect of high-pressure processing and freezing as pretreatment in vacuum fried carrot snacks were assessed. Freezing significantly decreased the hardness of vacuum fried carrot snacks (Albertos *et al*., 2016).

Pre-treatments before osmotic dehydration also assist in degassing as well as increasing the permeabilisation of the cell. The different pre-treatment such as blanching, freezing, high pressure, high intensity electric field and ultrasound have been reported enhanced mass transfer during osmotic dehydration (Ade-Omowaye *et al.,* 2003; Escobar *et al.*, 2007; Kowalska *et al.*, 2008). On the other hand, possibility of pigment losses was reported after freezing and thawing of strawberry (Oszmianski *et al.,* 2009; Holzwarth *et al.,* 2012). *Degradation of pigment in the carrot is directly responsible for the* colour of final product and affects its acceptability. As freeze-thaw treatment has greater influenced on texture of osmo-dehydrated product. It is necessary to assess the effect of freezing and thawing time on quality of final product. Therefore, the present study was carried out to evaluate impact of freezing and thawing time on colour and texture of osmo-convectively dehydrated carrot slices using objective and subjective methods.

MATERIAL AND METHODS

Sample preparation. Matured and uniform orange carrots were peeled and washed with water. The pre-blanched carrot slices of 3 mm thickness were frozen for -25 ºC temperature for 12 and 24 h duration in an air blast freezer. Then thawing was carried out at low and ambient temperature condition for 2 and 8 hours duration. After freezing and thawing, carrot slices were subjected to osmotic dehydration using sugar syrup of 50 ºBrix concentration. Temperature of the sugar solution was maintained as 50 ºC during 4 h duration of osmotic dehydration. Slice to sugar syrup ratio of 1:4 on W/V basis was maintained (Singh *et al.,* 2010). Osmosed carrot slices were further dried in mechanical tray dryer at 60 ºC temperature up to 6 ± 0.5 % moisture content (w.b).

Table 1: Experimental treatment details.

Treatment	Details
T_o	Control sample (without freeze-thaw)
T_1	Frozen for 12 h and low temperature thawing for 8 h
T_2	Frozen for 24 h and low temperature thawing for 8 h
T_3	Frozen for 12 h and ambient temperature thawing for 8 h
T_4	Frozen for 24 h and ambient temperature thawing for 8 h
T_5	Frozen for 12 h and low temperature thawing for 2 h
T_6	Frozen for 24 h and low temperature thawing for 2 h
T_7	Frozen for 12 h and ambient temperature thawing for 2 h
T_8	Frozen for 24 h and ambient temperature thawing for 2 h

Objective evaluation of Texture (Hardness) and Colour. The textural property in term of hardness of osmo-convectively dehydrated carrot slices were determined by measuring the force (Kg) needed to compress the osmo-convectively dehydrated carrot slices using Texture Analzer (Model: TA-XT plus, Stable Micro System, UK) equipped with 50 kg load cell. Ten randomly selected slices were used for the measurement of hardness and average of these values was taken for representing the texture of final osmo-dehydrated carrot slices. The colour was evaluated using a Hunter Lab Colour Analyzer-Labscan-2 (Hunter Associates Laboratory, Inc. Virginia, USA) in terms of L*, a*, and b* values.

Subjective evaluation of osmo-convectively dehydrated carrot slices. A sensory evaluation determines an overall acceptability of food products using the five senses of the human body. A panel of semi-trained participants was used to evaluate the sensory attributes of carrot slices prepared by varying the freezing and thawing time at different thawing condition. The numerous quality factors, such as colour, appearance, texture, taste, favour and overall acceptability were considered for evaluation using 9 point Hedonic scale.

Statistical Analysis. Hardness and colour value L, a, b in three replication and sensory parameters in ten replication were subjected to Analysis of Variance (ANOVA) in OPISTAT software.

RESULTS AND DISCUSSION

Hardness. Objective evaluation of the textural characteristics showed the significant influence of freezing and thawing time on hardness of osmo-convectively dehydrated carrot slices. Hardness of control sample (osmo-convectively dehydrated carrot slices without freeze-thaw treatment) was significantly highest than all other samples prepared using freeze-thaw pre-treatment. These findings are consistent with Albertos *et al.* (2016) for carrot snacks.

The carrot slices frozen for 24 hours and thawed for 8 h at ambient temperature condition had 4.21 Kg hardness. However, very slight difference was observed for osmo-convectively dehydrated carrot slices prepared with 12 and 24 h freezing time for 8 h low temperature thawing condition. Similar trend was observed for ambient thawing condition. Overall 2 h thawing period had higher hardness value than 8 h thawing period. Lower values of hardness of osmo-dehydrated carrot slices were reported for ambient temperature thawing than low temperature thawing condition. These lower values of hardness for higher thawing temperature might be due to greater loss of turgidity at higher thawing temperature which causes a decrease in hardness (Bachir *et al.,* 2011).

Table 2: ANOVA for the effect freezing and thawing time at different thawing condition on hardness and colour.

Effect	Hardness (Kg)	Colour value		
		L*	a*	b*
CD*	0.020	0.119	0.132	0.329
SE(m)	0.007	0.040	0.044	0.110
C.V.	0.236	0.156	0.232	0.574
S.S.	0.002	0.085	0.104	0.650
M.S.	0.000	0.005	0.006	0.036

*- 5% level of significance

Colour. Colour of omso-convectively dehydrated carrot slices were objectively evaluated in terms of L*, a* and b* values and the data was significantly affected by freezing and thawing pre-treatment before osmotic dehydration. Colour value L* (48.42) was highest for carrot slices prepared without freeze-thaw treatment. The control sample also recorded lower a* (25.42) and b* (22.92) values than all the pre-treated osmo-convectively dehydrated carrot slices. It meant that the pre-treatment positively enhanced the redness and yellowness of final dried slices. According to Taiwo *et al.* (2001) higher L* values of un-pretreated osmo-dehydrated apple slices might be due to enzymatic or non-enzymatic browning prior to the osmotic dehydration process.

There was slight increase in colour values L* and b* values for increased freezing time from 12 to 24 hours. Slight decreasing trend was also observed for colour value a*. These increase in L* and b* value and decrease in a* value was same for both low and ambient temperature thawing condition. Similar changes in L*, a* and b* values were reported in osmo-treated apple slices by Chauhan *et al.* (2011). These changes might be due to variation in solid gain during osmotic dehydration. The higher colour values L*, b* and lower a* value were reported, when thawing was carried out at ambient temperature for 2 and 8 h thawing time. Similar trend of increasing b* value as a result of increased thawing temperature for strawberry is enclosed accordance with Holzwarth *et al.* (2012).

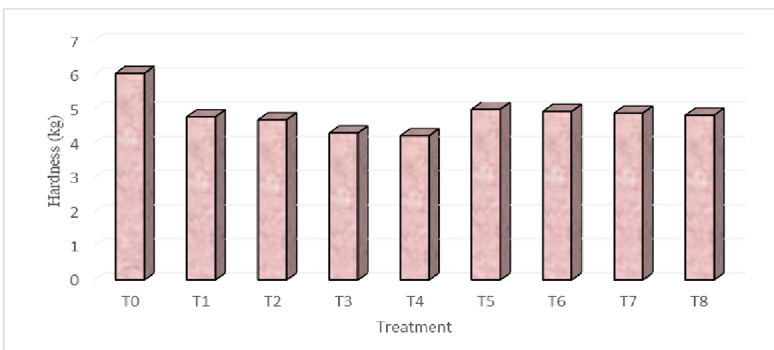

Fig. 1. Effect of freezing and thawing time on hardness of osmo-convectively dehydrated carrot slices.

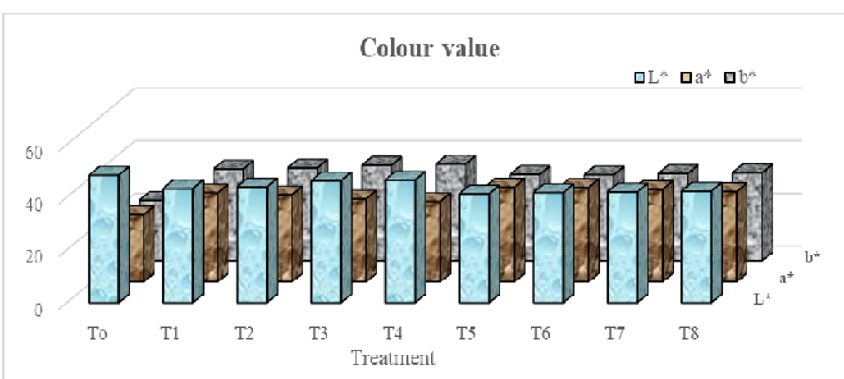

Fig. 2. Effect of freezing and thawing time on colour of osmo-convectively dehydrated carrot slices.

Sensory Evaluation. Colour and appearance, flavour, taste and texture were subjectively evaluated for the assessment of time duration effect of freezing and thawing pre-treatment on overall acceptance of final osmo-convectively dehydrated carrot slices. Control sampe obtained very low score for all sensory parameters as compared to pre-treated samples. Highest score in all sensory parameters were observed for the sample frozen for 24 hours and thawed for 8 h at low temperature thawing condition. Also sensory score were higher for low temperature thawing than ambient temperature thawing condition. However, non-significant difference was observed in the scores of all sensory parameters for 12 and 24 h freezing time. These higher texture, colour and appearance score for T_2 treatment are in closely related with the hardness and colour L*, a*, b* value during objective evaluation.

Table 3: Effect of freezing and thawing time on sensory parameter of osmo- convectively dehydrated carrot slices.

Effect	Colour and Appearance	Texture	Flavour	Taste	Overall acceptability
CD*	0.080*	0.042*	0.074*	0.053*	0.067*
SE(m)	0.028	0.015	0.026	0.019	0.024
C.V	1.149	0.616	1.070	0.764	4.062
S.S.	45.433	47.529	32.601	35.466	41.845
M.S.	5.679	5.941	4.075	4.433	5.231

*- 5% level of significance

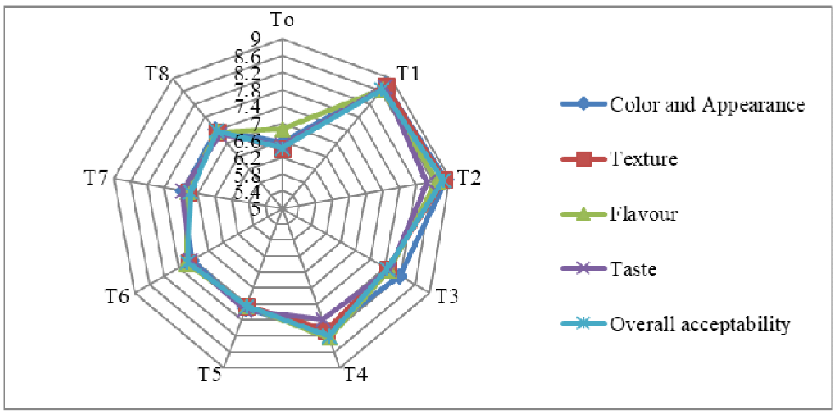

Fig. 3. Effect of freezing and thawing time on sensory parameter of osmo-convectively dehydrated carrot slices.

CONCLUSIONS

Hardness and colour of osmo-convectively dehydrated carrot slices was decreased with increased with increasing freezing and thawing time for both low and ambient thawing condition. According to subjective and objective evaluation, osmo-convectively dehydrated carrot slices prepared with 12 hours freezing and 8 h thawing time at low temperature condition obtained higher overall acceptance.

FUTURE SCOPE

There is a scope for the prediction of freeze-thaw pretreatment using different equation for osmotically dehydrated carrot sample.

Acknowledgement. The study was supported by Department of Agricultural Process Engineering, CAET, VNMKV, Parbhani and authors are thankful to institution for providing all the necessary facilities.
Conflict of Interest. None.

REFERENCES

Ade-Omowaye, B. I. O., Taiwo, K. A., Eshtiaghi, N. M., Angersbach, A. and D. Knorr. (2003). Comparative evaluation of the effects of pulsed electric field and freezing on cell membrane permeabilization and mass transfer during dehydration of red bell peppers. *Innovative Food Science and Emerging Technologies*, *4*,177–188.

Albertos, I., Martin-Diana, A. B., Sanz, M.A., Barat, V., Diez, A. M. and Jaime, D. Rico. (2016). Effect of high-pressure processing or freezing technologies as pretreatment in vacuum fried carrot sancks. *Innovative Food Science and Engineering Technologies*, *33*, 115-122.

Anaynmous (2022). Horticultural Crops Category Wise 2021-22 *(2 nd Adv. Est.)*

Anaynmous, (2022). Global Carrot and Turnips Market-Growth, Trends and Forecast (2020-2025), www.mordorintelligence.com.

Bachir, B., Besbes, S., Attia, H. and Blecker, C. (2011). Osmotic dehydration of pomegranate seeds (*Punica Granatum L*). Effect of freezing Pre-treatment. *Journal of Food Process Engineering*, *35*(3), 335-354.

Chauhan, O. P., Singh, A., Singh A., Raju P. S. and Bawa, A. S. (2011). Effects of osmotic agents on colour, textural, structural, thermal and sensory properties of apple slices. *International Journal of Food Properties*, *14*, 1037-1048.

Escobar, M., Lars, W., Federico, G. G. and Jenny, R. (2007). Effect of long- term storage and blanching pre-treatments on the osmotic dehydration kinetics of carrots (*Daucus carota* L. *cv. Nerac*). *Journal of Food Engineering*, *81*(2), 313-317.

Falade Kolawole, O. and Temilade, A. Adelakun (2007). Effect of pre-freezing and solutes on mass transfer during osmotic dehydration and color of oven-dried

African star apple during storage. *International Journal of Food Science & Technology, 42*(4), 394-402.

Holzwarth, M., Sabine, K., Reinhold, C. and Dietmar, R. K. (2012). Evaluation of the effect of different freezing and thawing method on color, polyphenol and ascorbic acid retention in strawberries (*Fragaria × ananassaduch*). *Food Research International, 48,* 242-248.

Kowalska, H., Andrzej, L. and Dominika, L. (2008).The effect of blanching and freezing on osmotic dehydration of pumpkin. *Journal of Food Engineering, 86*(1), 30-38.

Krivokapic, S, Tijana P & Svetlana P (2020). Chemical characterization, nutritional benefits and some processed products from carrot (*Daucus carota* L.) *Agriculture & Forestry*, *66*(2), 191-216.

Nazni, P. and Karuna T. D. (2011). Optimization of beetroot peel osmotic dehydration process using response surface methodology. *International Journal of Current Research, 3*(8), 27-32.

Oszmianski, J., Wojdylo, A. and Kolniak, J. (2009). Effect of L-ascorbic acid, sugar, Pectin and freeze–thaw treatment on polyphenol content of frozen strawberries. *Food Science and Technology*, *42*, 581–586.

Selvakumar, R. and Tiwari, R. B. (2018). Osmotic dehydration of temperate carrot (*Daucus carota* L.*) Indian farmer 5*(10), 1253-1259.

Sharma, K., Karki, S., Thakur, N. and Attri, S. (2012). Chemical composition, functional properties and processing of carrot- *a review J. Food Sci Technol., 49*(1), 22–32.

Shete, Y. V., Chavan, S.M., Champawat, P. S. and Jain S. K. (2018). Reviews on osmotic dehydration of fruits and vegetables. *Journal of Pharmacognosy and Phytochemistry*, *7*(2), 1964-1969.

Silva Dias, J. C. (2014) Nutritional and Health Benefits of carrots and Their Seed Extract. *Food and Nutrition Sci*., *5,* 2147-2156.

Singh, B., Parmjit, P., Nanda, V. and Kennedy, J. F. (2010). Optimization of osmotic dehydration process of carrot cubes in mixture of sucrose and sodium chloride solutions. *Food Chemistry, 123*,590-600.

Taiwo, K. A., Alexander A., Beatrice I. O., Ade-Omowaye and Dietrich K. (2001). Effects of Pretreatments on the Diffusion Kinetics and Some Quality Parameters of Osmotically Dehydrated Apple Slices. *J. Agric. Food Chem*., *49*(6), 2804–2811.

How to cite this article: T.D. Kumavat, P.G. More and S.B. Jadhav (2023). Influence of Different Freezing and Thawing condition on Texture, Colour and Sensory Parameters of osmo-convectively Dehydrated Carrot Slices. *Biological Forum – An International Journal, 15*(2): 609-613.