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Influence of size of shred on quality of osmo-convectively dehydrated carrot shreds

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Abstract

Carrot (*Daucus carota* L.) is a major root vegetable grown all over the world for its delicious taste and significant nutritional value. Being rich in beta-carotene, carrots offer many health benefits. Carrots are seasonal and are perishable in nature due to high water content. Drying is one of most prominent preservation techniques to reduce the higher moisture from the fresh fruit and vegetable. Osmotic dehydration followed by convective drying helps in keeping the better quality of final dehydrated fruit and vegetable based product. Overall acceptability and mass transfer parameter during osmotic dehydration depends upon the size of sample. Hence Osmo-convectively dehydrated carrot shreds were prepared by varying the size of carrot shreds. The mass transfer parameters, colour, and texture (Hardness) were determined to study the influence of size of shreds on quality of osmo-dehydrated carrot shreds. Mass transfer parameters such as weight reduction, water loss and sugar gain increased with decrease in size of shreds. There was reduction in a* value with increase in size of shreds while decreasing trend was observed in L* and b* value of osmo-dehydrated carrot shreds. Hardness is not much affected by the varying shreds sizes of osmo-dehydrated carrot shreds. Osmo-convectively dehydrated carrot shreds with medium size obtained good overall sensory acceptance.

Keywords: Size of carrot shreds, osmosis, convective dehydration, mass transfer parameter

Introduction

Carrot (*Daucus carota* L.) is one of the top most nutrient rich and cost-accessible vegetables. Carrots are renowned for its numerous health benefits apart from its vibrant colour and distinct flavour. Carrot is a high-value crop loaded with nutritional benefits and an excellent source of vitamin A. It is a rich source of β-carotene and contains other vitamins, like thiamine, riboflavin, vitamin B-complex and minerals (Kaur, *et al*. 2009) [1]. A 100 g serving of fresh raw carrots is a rich source of essential nutrients, including with 42 kcal of energy, 1.1g protein, 1100 IU vitamin A, 8 mg ascorbic acid, 0.06 mg thiamine, calcium 37 mg, phosphorus 36 mg and 0.7 mg iron (Thamburaj and Singh, 2005) [2].

In India, carrots are most consumed vegetable in fresh form and processed into a variety of products such as sweet desert, juices and dehydrated products. However, being seasonal vegetable, carrots are abundantly available in particular season. Its nutritive quality decreases during storage and there is loss in its freshness, appearance, firmness and taste. Drying and dehydration is one of the popular alternative techniques of preservation to develop low moisture self-stable value added products having good keeping quality. Osmotic dehydration is a processing technique for preserving fruits and vegetables in which a removal of water is involved from low to high concentrations of solute through a semi permeable membrane (Tiwari, 2005) [3]. Pre-treatment improves nutritional, sensorial and functional properties of the dehydrated food without changing its integrity. It also improves the texture as well as stability of the pigment during dehydration and the storage of dehydrated product (Raoult-Wack, 1994; Rastogi, *et al*. 2002) [4, 5].

Blanching is to inactivate the enzyme present in food commodity and also retain freshness colour, texture stability, and nutritional quality, evacuate air between the cells, and eliminate microorganisms to some amount (Zilong Tian) [6]. It is beneficial prior to osmotic and convective dehydration. Effect of different pre-treatments such as blanching, freezing and thawing on quality of osmo-dehydrated shreds were studied (Vaidya, *et al*. 2023) [7]. The factors such as concentration and temperature of osmotic solution, solution to sample ratio of osmotic solution along with immersion time of osmosis process are important for the quality of osmo-dehydrated products (Singh and Gupta, 2007) [8]. The size of the sample also plays major role in mass transfer parameter which in turns affects the overall acceptability of the product. Hence, the present works was conducted to assess the influence of size of carrot shreds on overall acceptability of osmo-convectively dried carrot shreds.

Materials and Methods

The research was carried out at the department of Agricultural Process Engineering, College of Agricultural Engineering and Technology, VNMKV, Parbhani. Fresh and healthy orange coloured carrots were purchased from the local market for experiment. Carrots without any physical damage were peeled to remove undesirable hair and skin. After washing thoroughly, carrots were shredded after removing un-edible top and bottom portion into different sizes as per treatments using different hand grater. The sizes of carrot shreds were measured in terms of length, width and thickness using Vernier calliper (Least count 0.01 mm) and were categorized as S_1, S_2 and S_3.

Sample preparation

Carrots shreds of known weight were steam blanched for 2 minutes (More and Khodke 2022) [9] before osmotic dehydration. Osmotic solution of 50 °Brix concentration was prepared and blanched carrot shreds were dipped in a sugar solution having a shred to solution ratio of 1:4. The temperature of the syrup was maintained at 50 °C during the osmotic dehydration process four hours duration (Vaidya, *et al*. 2023; Singh *et al*., 2007).) [7, 10]. After four hours, the carrot shreds were taken out from the sugar solution and weight was recorded after wiping out excess syrup with the help of tissue paper. Osmotically dehydrated shreds were dried at 60 °C in a tray dryer with up to 5±1% (w b.) moisture content.

Quality assessment of osmo-convectively dehydrated carrot shreds

Moisture content

The moisture content of fresh carrot was determined using method of AOAC (2005) [11]. Approximately 5 g of sample of fresh and osmosed carrot shreds were taken and moisture content was determined using following formula.

$$Moisture\ C(\%\ w.b) = \frac{\text{Dried weight of sample(g)}}{\text{Weight of initial sample(g)}} \times 100$$

Mass transport parameters of osmo-dehydrated carrot shreds

The mass transport parameters *viz*, weight reduction (WR), water loss (WL) and solid gain (SG) was determined to assess the effect of size on overall quality of osmo-convectively dehydrated carrot shreds by using following expressions (El-Aouar *et al*., 2006; Vaidya, *et al*. 2023) [12, 7].

$$WR(\%) = \frac{Wi - Wf}{Wi} \times 100$$

$$WL\ (\%) = \frac{(WiXi - WfXf)}{Wi} \times 100$$

$$SG\ (\%) = \frac{Wf\left(1-\frac{Xf}{100}\right) - Wi\left(1-\frac{Xi}{100}\right)}{Wi} \times 100$$

Where Wi and Wf are the initial and final (time t) samples weights, respectively (g); Xi and Xf are the initial and final (time t) sample moisture content, respectively.

Texture, colour and sensory evaluation of osmo-convectively dehydrated carrot shreds

The texture was determined in terms of hardness of the osmo-dehydrated carrot shreds after convective drying. The hardness (N) of the carrot shreds was taken as the force in compression that corresponded to the breakage of samples (Bachir *et al*., 2011) [13] using a Texture Analyzer (Model: TA-XT plus, Stable Micro System, UK). The color of osmo-convectively dried carrot shreds was measured in terms of L*, a*, and b* values using a Hunter lab Colour Analyzer. Higher positive L* and a* value denotes intensity of lightness and redness respectively while b* value indicated yellowness of product.

Sensory quality parameters of osmo- osmo-convectively carrot shreds prepared by varying the size of carrots shreds were evaluated using a 9-point hedonic scale by standard method (ISI) (1971a-1971b). The various quality aspects *viz*; color, appearance, texture, taste, favor, and overall acceptability were considered for sensory evaluation. The average scores of all the 10 semi-trained panelists were computed for assessment.

Results and discussion

The mass transfer parameter and in turns overall sensory acceptance is greatly affects by th**e s**ize of carrot shreds. Hence the effect of shred size on qualities of osmotically dehydrated carrot shreds was assessed in terms of mass transfer parameters, hardness, colour and sensory characteristics.

Size of carrot shreds

Carrots were shredded into different sizes as per treatments by graters of different opening size. The sizes of shreds were measured in terms of length, width and thickness and data is presented in Table 1. The length of shreds was found as 15.75, 23.15 and 29.37 mm for S_1, S_2 and S_3 treatments respectively whereas the width of shreds was varied from 2.29, to 4.27 mm among the treatments. The Thickness of shreds was found to be 1.37, 2.13 and 3.05 mm for S_1, S_2 and S_3 sample of carrot shreds respectively.

Table 1: Size in terms of length, width and thickness of carrot shreds

Treatments	Length (mm)	Width (mm)	Thickness(mm)
S1 (Small)	15.75±2	2.29±0.5	1.37±0.5
S2 (Medium)	23.15±2	3.45±0.5	2.13±0.5
S3 (Large)	29.37±2	4. 27±0.5	3.05±0.5

Mass transport parameters

The impact of different sized carrot shreds on mass transfer during osmoic-dehydration of carrot shreds was assessed in terms of solid gain and water loss and weight reduction. The relevant mass transport data was compiled and depicted in Fig 1. The water loss, solid gain and weight reduction of carrot shreds were higher for S_1 treatment (Small size shreds) as compared to those with S_2 (Medium size) and S_3 treatment (Large size). Lowest sugar gain and water loss was recorded by S_3 treatment (Large size) followed by S_2 treatment (Large size).

It is clear from the data that weight reduction, water loss and sugar gain decreased with increase in size of shreds. Similar effect of increased in water loss and solid gain with reduction in thickness of slices during osmotic dehydration of carrot was reported by More and Khodke (2019) [9]. Rastogi and Raghavarao (1997) [14] also reported similar results for osmo-dehydration of carrot. The increase of water loss and solids gain with decrease in size may be due to increased surface area in contact with the osmotic solution (Oladele Kolawole *et al.* 2007) [15]. If the solid is bigger in size, it will dehydrate more slowly because the greater length of the diffusion path. Smaller pieces on the other hand dehydrate more rapidly (Rastogi, *et. al.*, 2002) [16].

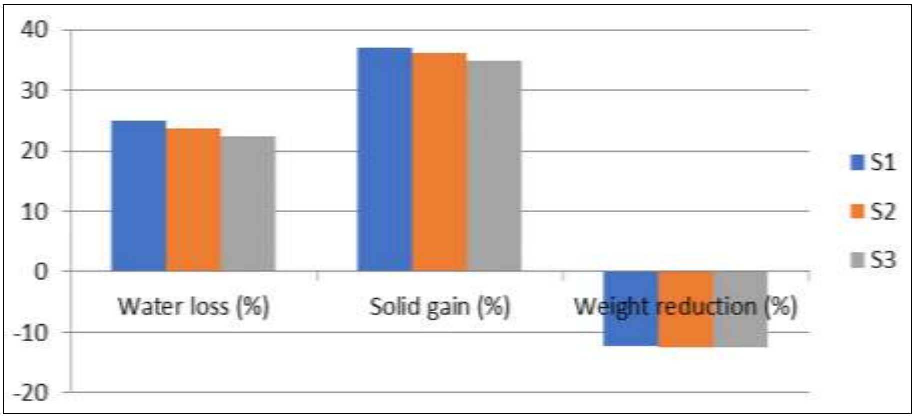

Fig 1: Effect of size of carrot shreds on mass transfer of osmo- dehydrated carrot shreds

Texture and Colour

The data regarding the hardness osmo-convectively dehydrated carrot shreds revealed that hardness positively affected by the size of the carrot shreds and presented in Fig. 2. Hardness value ranged from 6.305 N to 6.818 N. Maximum hardness was observed for S_3 treatment while minimum was recorded for S_1 treatment. This is in accordance with the findings on hardness of osmo-dehydrated carrot slices as affected by different thickness observed by More and Khodke (2019)) [9]. This increased hardness with increase in size of sample might be due to longer heat treatment and due to extended exposure of ginger slices to heat (Nath *et al*., 2013) [17].

Data pertaining to L*, a*, b* values of colour as influenced by size of the shreds is presented in Fig. 2. It is indicated from the data that higher L* and lower a* and b* values was noted for smaller size ie S_1 treatment which may be associated with higher solid gain than S_2 and S_3 size of carrot shreds. It is also cleared that L* value of carrot shreds decreased with increase in size of shreds whereas and a* and b* values were increased for increased size of carrot shreds. Similar trend in L*, a*, b* values of colour was also observed by More and Khodke (2019) [9] for osmo-convectively dried carrot slice. Maria *et al*., (2013) [18] narrated that it might be due to faster drying rates for lower thickness as thinner samples reaches higher internal temperatures easily which causes further degradation of carotenoids.

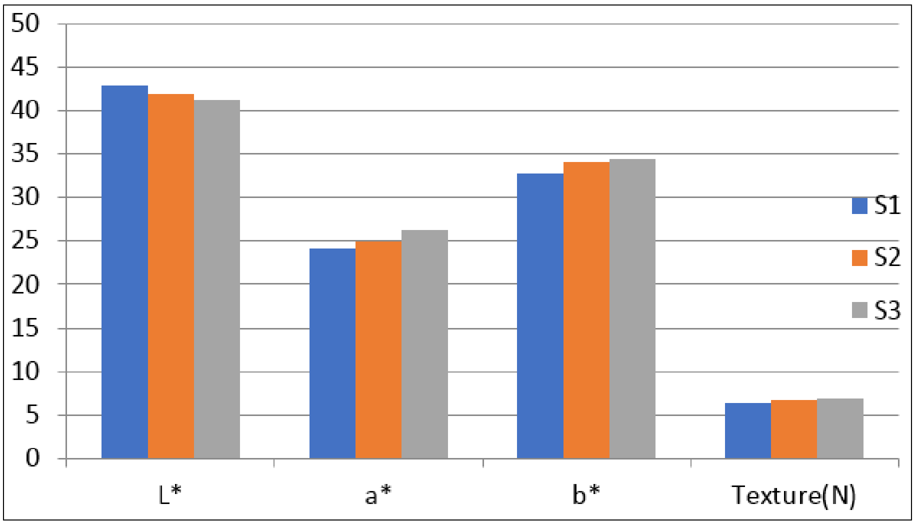

Fig 2: Effect of size of carrot shreds on colour and texture of osmo- dehydrated carrot shreds

Sensory evaluation

Osmo-convectively dried carrot shreds of different treatment were assessed for different sensory parameters *viz;* colour, appearance, flavour, texture and taste. Data pertaining to sensory quality parameters is presented in Fig. 3. It is clear that all samples were found acceptable in respect of sensory score obtained for individual characteristic i.e. colour, appearance, flavour, texture and taste. The treatments S_3 ie large size sample obtained lowest score for all sensory parameters while highest score was obtained for S_2 treatment. There is very little difference in the scores of all sensory parameters of S_1 and S_2 sample.

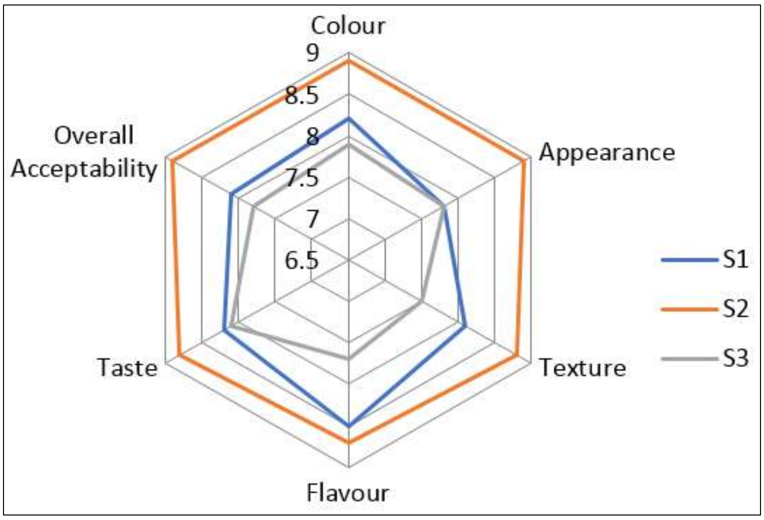

Fig 3: Effect of size of carrot shreds on sensory parameters of osmo- dehydrated carrot shreds

Conclusion

Mass transfer parameters ie water loss and sugar gain decreased with increase in the size of osmo-convectively dried shreds. L* value of carrot shreds decreased with increase in size of shreds. Hardness and a* and b* values were increased with size of carrot shreds. However, treatment S_2 having medium size of carrot shreds scored high overall acceptability for osmo-convectively dried carrot shreds.

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