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**Gousia Gani**
Division of FST (SKUAST-K), Shalimar, Srinagar, Jammu and Kashmir, India

**Tashooq AH Bhat**
Division of FST (SKUAST-K), Shalimar, Srinagar, Jammu and Kashmir, India

**Beenish**
Division of FST (SKUAST-K), Shalimar, Srinagar, Jammu and Kashmir, India

**Correspondence**
**Tashooq Ah Bhat**
Division of FST (SKUAST-K), Shalimar, Srinagar, Jammu and Kashmir, India

# Effect of drying temperature on the microbial characteristics of osmo-dehydrated carrot slices

**Gousia Gani, Tashooq AH Bhat and Beenish**

**Abstract**
Osmotic dehydration of carrot slices was carried out in sugar solutions at different solution concentrations, temperatures and process duration of 120min. The osmotically pretreated carrot slices were further dehydrated in a cabinet dryer at 65 $^0$C for 4hr and microwave oven at an input power of 20W for 22min. and then analyzed for microbial characteristics. The drying temperature and pretreatment as osmotic dehydration had a significant effect on microbial quality. The microbial quality increased with increase of syrup concentration and temperature. The best quality was observed in osmo-tray dehydrated carrot slices treated with 50$^0$B syrup concentration and 40 $^0$C syrup temperature compared to osmo-microwave dehydrated carrot slices. The optimum conditions of various process parameters were 30-50$^0$B sugar concentration, 30 $^0$C and 40 $^0$C osmotic solution temperature and process duration of 120 min.

**Keywords:** Drying temperature, microbial characteristics, osmo-dehydrated carrot slices

## Introduction
Carrot (*Daucus carota* L.) is one of the important root vegetable crops and is highly nutritious as it contains appreciable amounts of vitamins $B_1$, $B_2$, $B_6$ and $B_{12}$ aside from being rich in beta-carotene. Carrot is a highly perishable commodity. It can be stored for 2-3 days at ordinary temperature and for 10-14 days at 0 $^0$C. So post-harvest wastage during its peak period is very high. These wastages are due to microbial infestation, improper post-harvest handling, lack of marketing, transportation and storage facilities etc. So attempt was made to preserve this valuable root crop to reduce post-harvest loses by dehydration using tray drier and microwave oven to study the shelf life.

Out of various methods of extending the shelf life of perishable crops, osmotic dehydration is one of the simple and inexpensive alternate processes, which offers a way to make available this low cost, highly perishable and valuable crop available for the regions away from production zones and also during off season. Conversion of fresh carrot into other products, such as dried form, adds market value, generates consumer convenience and extends the shelf life of the material. Drying, which is a common technique in food preservation, can be used to produce a new form of carrot. Shelf life extension of the dried product is due to moisture removal and deterioration are retarded or limited. Consumers generally expect the dried product to have properties close to those of the original material. Various drying techniques have been widely studied in order to obtain the best quality dried food products.

Osmotic drying has been combined with conventional drying method such as hot air-drying to reduce shelf-stable products. The product obtained by osmotic process is more stable than untreated fruit and vegetables during storage, due to low water activity by solute gain and water loss. At low water activity, reduced chemical reaction and the growth of toxin-producing micro-organisms in the food are low. The aim of the research was to study the microbial characteristics of osmo dehydrated carrot slices using tray drying and microwave drying.

## Materials and Methods
### Sample preparation
Good quality carrots were procured for this investigation from the local market Allahabad on daily basis prior to each set of experiment. Undamaged carrots without any defect on visual inspection were selected. The carrots were thoroughly washed and cut into 3mm slices. Sucrose was used as an osmotic agent and was purchased from the local market. Initial moisture content of carrot slices was 86.7%.

### Osmotic solutions

Osmosis solutions of different concentrations (30-50$^0$B) were prepared by dissolving the desired solutes on a w/w basis with distilled water. A magnetic stirrer was used to dissolve the contents. Sucrose was weighed on an electronic balance. Fresh osmotic solution was prepared for every run

### Experimental Procedure

The experiments were conducted in the laboratories of the Department of Food Process Engineering, SHIATS, Allahabad (India). Fresh, well-graded carrots were procured from the local market of Allahabad, and the experiments were conducted on the same day. After washing, peeling was accomplished manually by stainless steel hand peeler. The green parts of carrots were removed to retain the final quality of the product. A vegetable dicer was used to prepare carrot slices of 3mm. The carrot slices were washed with fresh water to remove the carrot fines adhered to the surface of the carrot slices. The leftover material of carrot slices was separated manually. No blanching was conducted prior to osmosis as it has been reported to be detrimental to osmotic dehydration processes as a result of the loss of semi-permeability of the cell membranes (Ponting 1973) and reduction of beta-carotene (Sharma *et al*. 2000; Reyes *et al*. 2002). Sugar solution was chosen for osmosis, as it is an excellent osmotic agent, retarding oxidative and non-enzymatic browning (Arya *et al*. 1979). For each experiment, known weights of carrot slices (51 g) were put in stainless steel containers containing calculated volumes of osmotic solutions of different concentrations (30-50$^0$B) preset at the specified temperature (30-40 $^0$C) in a hot water bath under shaking conditions. The sample to solution ratio in osmotic dehydration process was kept as 1:10. The carrot slices were removed from the osmotic solutions after 120min. and rinsed with water to remove the surplus solvent adhering to the surfaces. These osmotically dehydrated slices were then spread on the absorbent paper to remove the free water present on the surface. The slices were dehydrated to final moisture of 8-13% (wet basis) using a hot air drier preset at an air temperature of 65 $^0$C and 9-14% (w.b.) using microwave oven preset at an input power of 20W. The moisture content of fresh carrots was 86.7% (wet basis). The dried samples were cooled in a desiccator containing silica gel for 1 h, packed in low-density polyethylene bags and kept at ambient temperature (28–35C) for quality analysis. The analysis was completed within 2 days. The stored samples were analyzed for water loss, solid gain and at intervals of 15 days for microbial characteristics.

### Statistical analysis

The experiments were conducted by adopting completely randomized design of the data recoded. During the course of investigation, product of different formulations were analysed statistically by the 'Analysis of Variance' (ANOVA). The significant effect of treatment is judged with the help of 'F' (Variance Ratio). F values were compared with the table value of F at 5% level of significance. If calculated value exceeds the table value, the affect is considered to be significant. The significance is tested at 5% level.

### Results and Discussions

The prepared osmotic dehydrated carrot slices were evaluated for microbial characteristics. The changes in microbial quality of the dehydrated carrot slices stored at ambient temperature are presented in Fig. 1 and Fig. 2.

The data for the change in microbial quality was collected at each 15 days interval. The results indicated that the microbial quality of the osmotic dehydrated carrot slices decreased in all treatments. This decrease could be due to the temperature fluctuations and moisture ingress during the storage period of the products. As we know that moisture and food were the key factors for the growth of yeasts and molds.

Considering the importance of the microbiological aspect of cut osmodehydrated products, it is important to assess the impact that can be obtained from the OD treatment proposed in the present study on said aspect. For this reason, microbiological analysis was performed on osmodehydration with sucrose. The microbial counts of the osmotic dehydrated carrot slices of various sugar concentrations was nil initially and increased slightly during storage. No microorganism was traceable initially due to the higher dilution used for the enumeration. Osmotray dehydrated carrot slices prepared by 50$^0$B sugar solution and 40 $^0$C solution temperature showed minimum of microbial counts than that prepared by 30 $^0$C solution temperature. The condition was similar for osmo-microwave dehydrated carrot slices. Osmotic dehydrated carrot slices prepared by 30$^0$B sugar solution exhibited slightly higher microbial population than the rest of the slices. In general, the microbial population of the carrot slices prepared for the experiment was quite low even at the end of 45 days of storage, though there was a significant increase in moisture content over the period.

Gianotti *et al*. (2001) conducted several OD processes immersing kiwifruit pieces in sucrose solutions of different concentrations (40 to 65$^0$B) in order to study the microbiological quality of fruit after 2hr of osmotic process. The authors stated that high sucrose concentrations caused a hindrance of cell adhesion at fruit surface and slowed down microbial growth during storage.

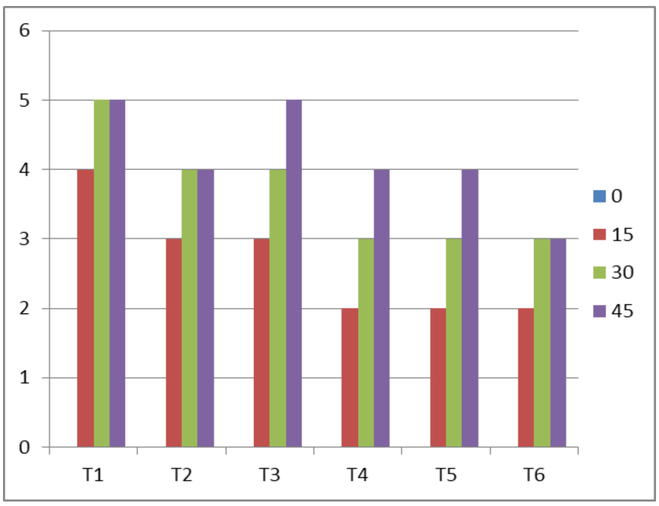


**Fig 1:** Effect of storage period on yeast and mold growth (cfu/g) of osmo-tray dehyd-rated carrot.

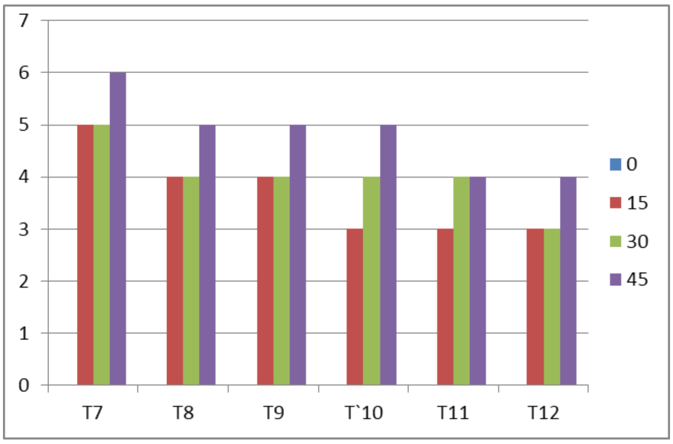


**Fig 2:** Effect of storage period on yeast and mold growth (cfu/g) of osmo-micro- wave dehydrated carrot slices.

## Conclusion

Osmotic pretreatment was used to improve the microbiological properties of carrot slices. Drying of the carrot slices using tray drying and microwave drying yielded samples with lower water activity. Microwave drying gave samples with higher moisture, darker, more red colour and softer texture, so the microbial growth was more in microwave dehydrated samples. Tray drying gave samples with less moisture, bright colour and good texture, so the microbial growth was less in tray dehydrated samples. Results obtained evident that the effect of application of the osmotic dehydration pretreatment using sugar solution prior to hot drying and microwave drying was able to improve the microbiological quality of carrot slices. The carrot dehydration was more appreciable at $50^0$B solution concentration and 40 $^0$C osmosis temperature followed by 65 $^0$C hot air drying temperature on the basis of microbiological quality compared to microwave drying.

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