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Ajeet Rundla
Research Scholar, Vaugh Institute of Agricultural Engineering & Technology, Sam Higginbottom University of Agriculture, Technology & Sciences, Prayagraj, Uttar Pradesh, India

Atul Anand Mishra
Vaugh Institute of Agricultural Engineering & Technology, Sam Higginbottom University of Agriculture, Technology & Sciences, Prayagraj, Uttar Pradesh, India

Corresponding Author:
Ajeet Rundla
Research Scholar, Vaugh Institute of Agricultural Engineering & Technology, Sam Higginbottom University of Agriculture, Technology & Sciences, Prayagraj, Uttar Pradesh, India

Studies on physical properties of osmotically dehydrated carrot (*Daucus carota* L.) slices in salt solution

Ajeet Rundla and Atul Anand Mishra

Abstract
The present study was conducted in the Department of Food Process Engineering, Vaugh Institute of Agricultural Engineering and Technology, Allahabad for osmotic dehydration of carrot slices with microwave drying. In this work, studied the effect of different concentrations of salt solutions (5%, 8%, 11% concentration) on microwave drying and various physical parameters of carrot slices. Overall analysis of the physical parameters of the dehydrated carrot slices indicated that optimum values of moisture content of osmotic dehydrated carrot slices in salt solutions was 51.12%, 48.88% dry matter content, 4.84 dehydration ratio for 8% salt solution. The ash content 9.35, 10.41 & 10.1 was present in 5%, 8% and 11% of salt solution.

Keywords: Osmotic dehydration, salt, carrot

Introduction
Carrot (*Daucus carota* L.) is a very popular winter vegetable and one of the important root crops cultivated throughout the world for its fleshly delicious, attractive edible roots. It's grown in spring, summer and autumn seasons, in temperate countries and during winter in tropical and subtropical regions.

Fresh carrots cannot be stored for more than 3–4 days under ordinary conditions, but shelf life can be extended to 7–8 months if stored in crates covered with perforated plastic film at 0 ºC and 93–96% relative humidity (Chadda, 2002) [2]. Out of these methods, freeze-drying produces the highest quality food products, but it is the expensive method of preservation. So a simple and inexpensive similar process, which has low capital investment cost and make them available for the regions away from production zones.

There are several techniques for processing of fruits and vegetables. Among them, dehydration of perishables like fruits and vegetables are best suited under Indian conditions (Sagar and Suresh Kumar, 2010) [7]. Osmotic dehydration has been widely used for fruits and vegetables preservation due to its potential to keep sensory and nutritional properties similar to the fresh fruits and enrich products with some compounds, like the functional foods (Prothon *et al.*, 2001) [5].

Osmotic dehydration is the process by which there is partial removal of water from the cellular materials when these are placed in a concentrated solution of soluble solute. Osmotic dehydration is effective at ambient temperature and saves the color, texture and flavor of food from heat, is used as a pretreatment to improve the nutritional, sensorial and functional properties of food (Nanjundaswamy *et al.*, 1978) [4].

Research Methodology
The present study was conducted in the Department of Food Process Engineering, Vaugh Institute of Agricultural Engineering and Technology, Allahabad for osmotic dehydration of carrot slices with microwave drying. Following material and method were used in this study:

Materials
Carrot: The carrot (*Daucus carota* L.) is a root vegetable, usually orange in color. The carrot root vegetable of good quality and well matured procured from local market of carrot. Fully matured, reddish colored, spotless carrots were used for osmotic dehydration.

Salt: Common salt (NaCl) was purchased from local market.

Equipment and instruments used: The weighing balances, hot air oven and muffle furnace were used from the department of Food Process Engineering, of Vaugh Institute of Agricultural Engineering and Technology Allahabad. The weighing balances were used for weighing carrot slices and salt at different proportion. The hot air oven was used to determine the moisture content of osmotically dehydrated carrot of different concentrations of salt solutions. The muffle furnace was used to measure the ash content of osmotically dehydrated carrot slices of different concentrations of salt and sugar solution. Microwave was used to dry the carrot slices after the osmotic treatment in salt and sugar solution. Microwave manufactured by ken star specification (Model= OM-20 EGO, Output power=800W, Frequency =2450 MHz) used for the study.

Experimental procedure

Carrot slices preparation: Carrot with uniform colour, size shape, were selected, weighed and washed. Peeled carrots were thoroughly washed with tap water, weighed and cut into 3-4 mm thick slices after removing top and bottom portion. Prepared slices were again weighed to record the yield recovery of fresh slices to be used for osmotic dehydration. After words, slices were subjected to low- temperature-long-time (LTLT) blanching for 5 min at 60°C. Blanched carrots were air cooled and used for osmotic dehydration.

Salt solution preparation: Salt solution of three different concentration *viz*. 5%, 8% and 11% was prepared. For 200 gm of prepared carrot slices 400 ml solution is required. For making 400 ml of 5% salt solution 20 gm salt and 380 ml water was used. For making 8% of salt solution 32 gm salt and 368 ml water was used. For making of 11% salt solution 44 gm salt and 356 ml water was used.

Osmosis: Prepared carrot slices of 200 gm each were dipped in 5%, 8% and 11% salt solution in the slices to solution ratio of 1:2 (W/V) and allowed to continue osmosis for 4 hours at 44 ºC. During the process of osmosis, water flows out of the carrot slices to the salt and fraction of solute moves into the carrot slices. At the end of the treatment for a particular osmotic duration, the carrot slices were taken out of the osmotic solution and these osmosed carrot slices were weighed to know the extent of water removal from the slices by osmosis.

Microwave drying: A sample of 200 g of carrot was placed in a tray in microwave. The oven was modified with an aspiration system for draining inside air. During the drying period the microwave applied maximum power level for 60 s and power off for 15 s (Baysal *et al.*, 2003) [1].

Observation record

Moisture content: The initial moisture content of the raw material was determined by using the hot air oven. 10 g of the sample was taken in a preweighed moisture box and dried. The temperature of the hot air oven was maintained at70°C. The sample dried till bone dry weight was obtained. The dish with the sample was cooled in desiccators and weighed. This was repeated till the difference in weight between two successive weights become approximately similar. From the weight loss during drying, the amount of moisture was calculated using the following formula and the moisture can be represented in percentage.

$$\text{Moisture Content (\%)} = \frac{\text{Initial wt. (gm)} - \text{Final wt. (gm)}}{\text{Initial wt. (gm)}}$$

3.3.2 Ash content: Ash content represents the inorganic residue remaining after destruction of organic matter. It may not necessary be exactly equivalent to mineral matter as some losses may occur due to volatilization. About 5gsample was accurately weighed into a pre-weighed, clean crucible. The crucible heated to the point of charring of the sample on a hot plate. The crucible with the carbon residue obtained as a result of ignition, was placed in muffle furnace at temperature of 650º C until the carbon residue disappears. Allowed to cool and then weighed. From the difference in weight obtained the ash content was calculated using the formula:
(Ranganna S, 2005) [6].

$$\text{Total ash content (\%)} = \frac{\text{Final weight (gm)}}{\text{Initial weight (gm)}} \text{x100}$$

Dehydration ratio: Dehydration is the removal of water content in sample up to bone dry matter. The dehydration ratio was calculated by:

$$\text{Dehydration ratio} = \frac{\text{Wt. of material}}{\text{Wt. of dehydrated material}}$$

Dry matter content: The dry matter content was calculated by:

Dry matter content (%) = 100 – moisture content

Results and Discussions

Moisture content

Moisture content was determined for finding the amount of moisture present after the osmotic dehydration of carrot slices in different concentrations of salt. Table 1 shows the obtained moisture content value in salt solution. The figure 1 shows the graph of moisture content vs concentration of salt solution. The moisture content of osmotic dehydrated carrot slices in salt solutions was studied and optimum values were found. It was 51.12% for 8% salt solution.

Table 1: Moisture content of osmotic dehydrated carrot slices in different concentration of salt solutions

S. No.	Concentration	M.C. (%)
1	5%	58.33
2	8%	51.12
3	11%	54.14

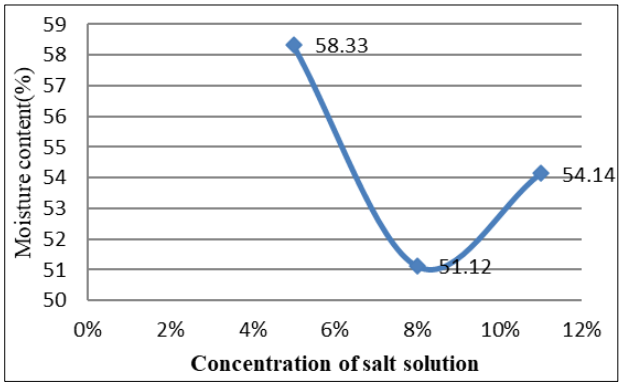

Fig 1: Moisture content (%)

Dry matter content

Dry matter content of osmotic dehydrated carrot slices were found out to know the mass of solute penetrated from the osmotic solution during the process. Dry matter content of osmotic dehydrated carrot slices in salt solution was studied and optimum values were found. Table 2 shows the obtained dry matter content value in salt solution. It was 48.88% for 8% of the salt solution. The figure 2 shows the graph of dry matter content vs concentration of salt solution.

Table 2: Dry matter content of osmotic dehydrated carrot slices in different concentration of salt solutions

S. No.	Concentration	Dry matter content (%)
1	5%	41.67
2	8%	48.88
3	11%	45.86

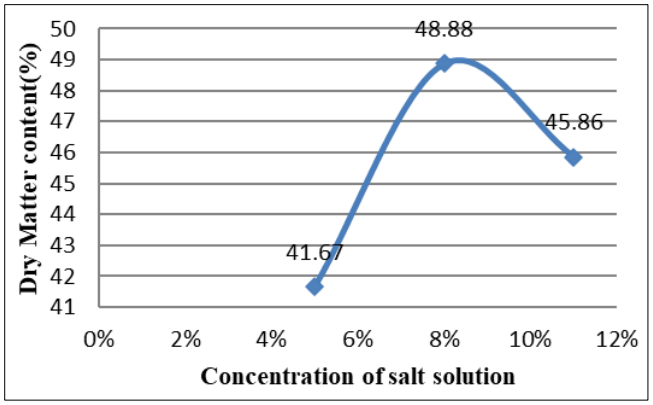

Fig 2: Dry Matter content (%)

Dehydration Ratio

Dehydration ratios were found out to know the loss in weight of carrot slices after drying. Table 3 shows the obtained dehydration ratio value in salt solution. As concentration increased the dehydration ratio also increased and optimum values were found for 8% of the salt solution. Figure 3 shows the graph of dehydration ratio vs concentration of salt solution.

Table 3: Dehydration Ratio of osmotic dehydrated carrot slices in different concentration of salt solutions

S. No.	Concentration	Dehydration Ratio
1	5%	4.5
2	8%	4.84
3	11%	4.52

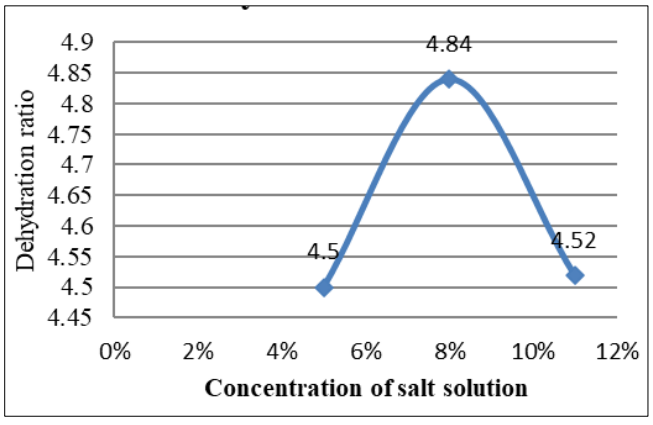

Fig 3: Dehydration Ratio

Ash content

Table 4 shows the obtained ash content value in salt solution. Figure 4 shows the graph of ash content vs concentration of salt solution. The ash content 9.35, 10.41 & 10.1 was present in 5%, 8% and 11% of salt solution respectively.

Table 4: Ash content of osmotic dehydrated carrot slices in different concentration of salt solutions

S. No.	Concentration	Ash content
1	5%	9.35
2	8%	10.41
3	11%	10.1

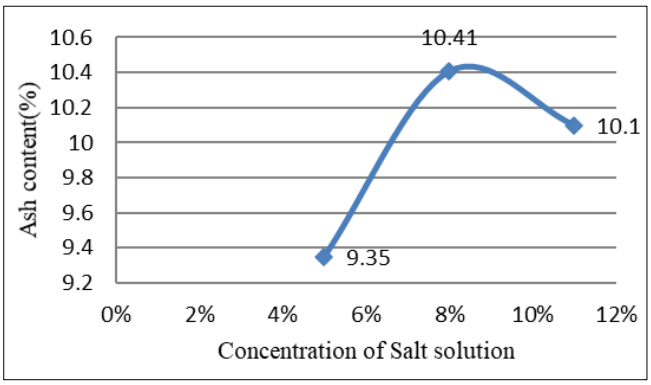

Fig 3: Ash content (%)

Conclusion

It may be concluded that 8% salt solution is better for osmotic dehydration of carrot slices. Overall physical parameter was found good in the concentration of 8% salt solution.

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