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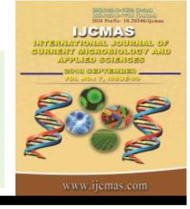

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Studies on Physical and Organoleptic Properties of Osmotically Dehydrated Carrot (*Daucus carota* L.) Slices

Ajeet Rundla*, Atul Anand Mishra and R.N. Shukla

Vaugh Institute of Agricultural Engineering & Technology, Allahabad-211007, India

**Corresponding author*

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A B S T R A C T

In this work, studied the effect of different concentrations of osmotic agents i.e. salt solutions (5%, 8%, 11% concentration) and sugar solutions (55^{o}Brix, 60^{o}Brix, 65^{o}Brix concentration) on microwave drying and various physical parameters of carrot slices. Overall analysis of the physical parameters of the dehydrated carrot slices indicated that the sugar solution is superior to that of salt solution. In initial analysis, if fresh carrot slices, the colour was reddish and moisture content was observed very high. The time required for osmotic drying was 4 hrs for each concentration of all solutions. After the dehydration of carrot slices, the reddish color was maintained in sugar solution of all concentrations. Moisture content, dry matter content, dehydration ratio results was found better in sugar solution of 60^{o}Brix concentration while ash content was found least in sugar solution of 55^{o}Brix concentration.

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^{o}C and 93–96% relative humidity (Chadda, 2002). 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.

Though there is sufficient production of carrot in India, yet its availability is scanty for greater part of the year. Due to seasonal difference in different place in price of carrots, preparation of carrot products is difficult to main season when it is available in plenty.

Carrot being a perishable and seasonal crop, it is not possible to readily make it available throughout the year. So, osmotic dehydration of carrot during the main growing season is one of the important alternatives for preservation. It can also be used for making value added products throughout the year specially vitamin A rich functional products for children's (Sra *et al.*, 2011).

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). 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).

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).

Hence, in recognition of the above needs and in order to explore the possibility of preparation of osmotically dehydrated carrot slices the present investigation was undertake with the following objectives.

To study the effect of osmotic dehydration of carrot slices in salt & sugar solution at 45^0C at different concentration of solution.

To determine the effects of osmotic dehydration on physical parameter of carrot slices.

To study the effect of various osmotic treatments on sensory quality of osmoticaly dehydrated carrot slices.

Materials and Methods

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.

Sugar and salt

Common sugar (Sucrose) and salt (NaCl) were 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, salt and sugar at different proportion. The hot air oven was used to determine the moisture content of osmotically dehydrated carrot of different concentrations of salt and sugar solutions.

Electronic balance

Electronic balance manufactured by National scale specification (Capacity=600 g, least count=100 mg) were used for the study.

Muffle furnace

The muffle furnace was used to measure the ash content of osmotically dehydrated carrot slices of different concentrations of salt and sugar solution.

Microwave

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.

Hot air oven

Hot air oven was used to determine moisture content in carrot slices. Hot air oven manufactured by Swastika Bio Remedies Pvt. Ltd specification (Thermostat=50-300^{o}C, 3 switch heating knob) used for the study.

Water bath

Water bath manufactured by E.G.O. specification (Thermostat=30-110^{o}C, voltage 220V) were used for the study.

Methods

The process flow sheet of osmotic dehydration of carrot slices is presented in figure 1.

Experimental procedure

Procedure for the experiment

Sample preparation

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.

Sugar syrup preparation

Sugar syrup of three different concentrations viz. 55°Brix, 60°Brix and 65°Brix was prepared. For 200 gm of prepared carrot slices 400 gm of syrup is required. For making 400 gm of 55°Brix concentration sugar syrup 220 gm of sugar and 180 gm of water was used, for 60°Bri sugar syrup 240 gm of sugar and 160 gm of water was used, for 65°Brix concentration sugar syrup 260 gm of sugar and 140gm of water was used. In this investigation slice to sugar syrup ratio was maintained 1:2 (W/V).

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 55, 60 and 65°Brix sugar syrup and 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^{0}C. During the process of osmosis, water flows out of the carrot slices to the syrup and 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).

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 pre-weighed 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.

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

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:

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

(Ranganna S, 2005)

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 Discussion

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. The primary processing was done and samples were prepared.

The samples were osmotically dehydrated in different concentrations of salt and sugar solution. The samples were then dried using microwave drying.

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 and sugar. Table 1 shows the obtained moisture content value in salt and sugar solution. The figure 2 shows the graph of moisture content vs concentration of salt solution. The moisture content of osmotic dehydrated carrot slices in both salt and sugar solutions were studied and optimum values were found. It was 51.12% for 8% salt solution and 20.12% for 60ºBrix of sugar solution. Similar observations were reported by Mondhe *et al.,* (2017). So, moisture content reduction is obtained more for carrot slices soaked in sugar solution than salt solution.

Similarly, the figure 3 shows the graph of moisture content vs concentration of sugar solution.

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 both salt and sugar solution was studied and optimum values were found. Table 2 shows the obtained dry matter content value in salt and sugar solution. It was 48.88% for 8% of the salt solution and 79.88% for 60ºBrix of sugar solution. Dry matter content is obtained more for carrot slices soaked in sugar solution than a salt solution which implies that solute penetration from sugar solution is more than salt solution. Similar observations were reported by Mondhe *et al.*, (2017).

The figure 4 shows the graph of dry matter content vs concentration of salt solution. Similarly figure 5 shows the graph of dry matter content vs concentration of sugar solution.

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 and sugar solution.

As concentration increased the dehydration ratio also increased and optimum values were found for 8% of the salt solution and 60ºBrix sugar solution. Similar observations were reported by Mondhe *et al.,* (2017). Figure 6 shows the graph of dehydration ratio vs concentration of salt solution. Similarly, figure 7 shows the graph of dehydration ratio vs concentration of sugar solution.

Ash content

Table 4 shows the obtained ash content value in salt and sugar solution. Figure 8 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. Similar observations were reported by Mondhe *et al.,* (2017).

Similarly, figure 9 shows the graph of ash content vs concentration of salt solution. The ash content 4.57, 5.22 and 5.82 was present in 55ºBrix, 60ºBrix and 65ºBrix solution respectively.

Effect of different osmotic dehydration on sensory quality of osmotically dehydrated carrot slices

Effect on Colour

Data given in Table 5 and 6 indicates that sensory score for colour was significantly superior in osmotically dehydrated carrot slices as compared to fresh carrot,

Fig.1 Osmotic dehydration of carrot slices

Selection of uniform size, thickness, colour carrots

↓

Washing

↓

Peeling

↓

Preparation of carrot slices

↓

Blanching (60°C for 5 min.)

↓

Osmotic dehydration (45°C for 4 hrs.)

↓

Sugar syrup (55°Brix, 60°Brix, 65°Brix) | Salt solution (5%, 8% and 11%)

↓

Microwave drying

↓

Packaging and storage

Fig.2 Moisture content vs concentration of salt solution

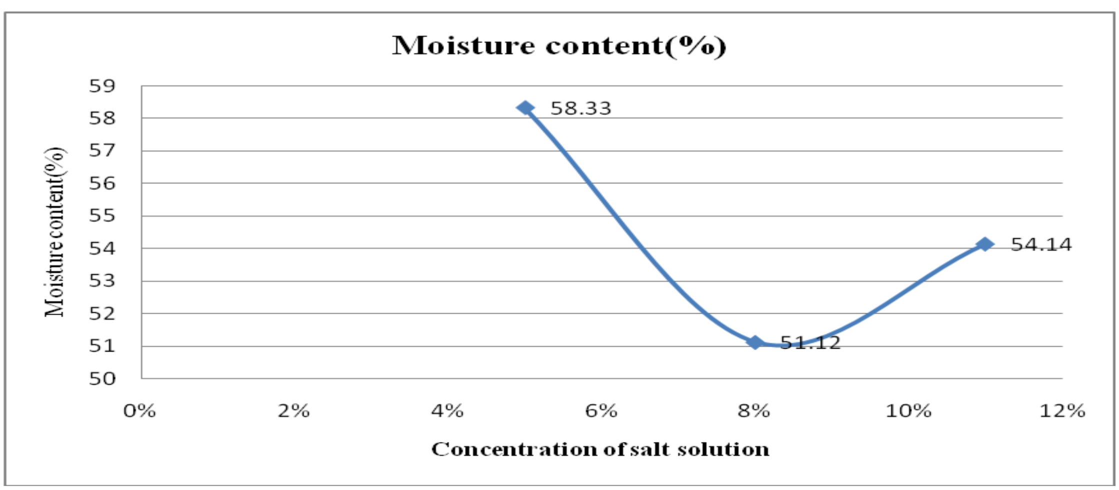

Fig.3 Moisture content vs concentration of sugar solution

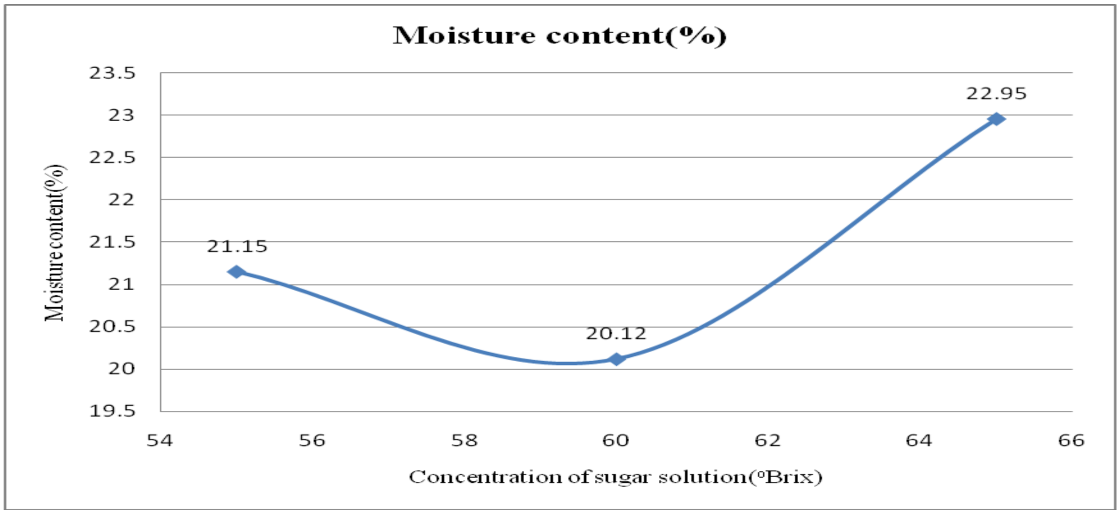

Fig.4 Dry matter content vs concentration of salt solution

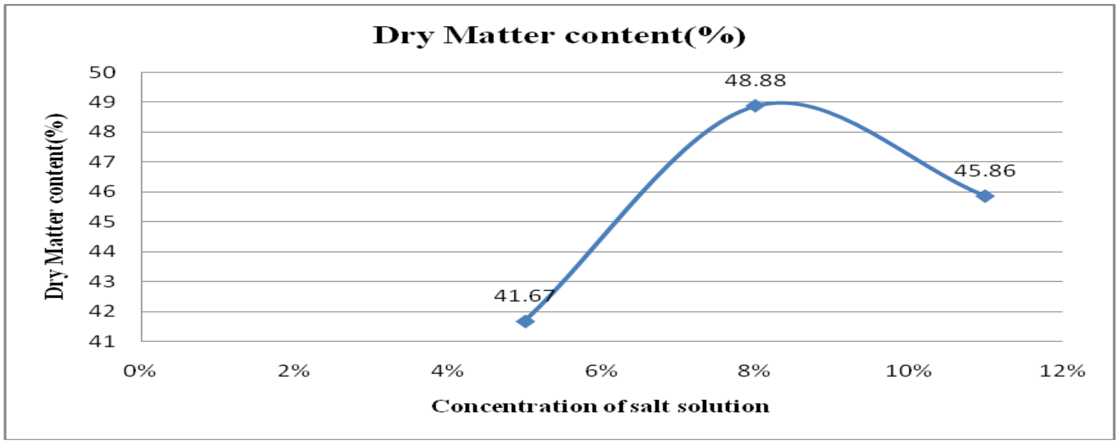

Fig.5 Dry matter content vs concentration of sugar solution

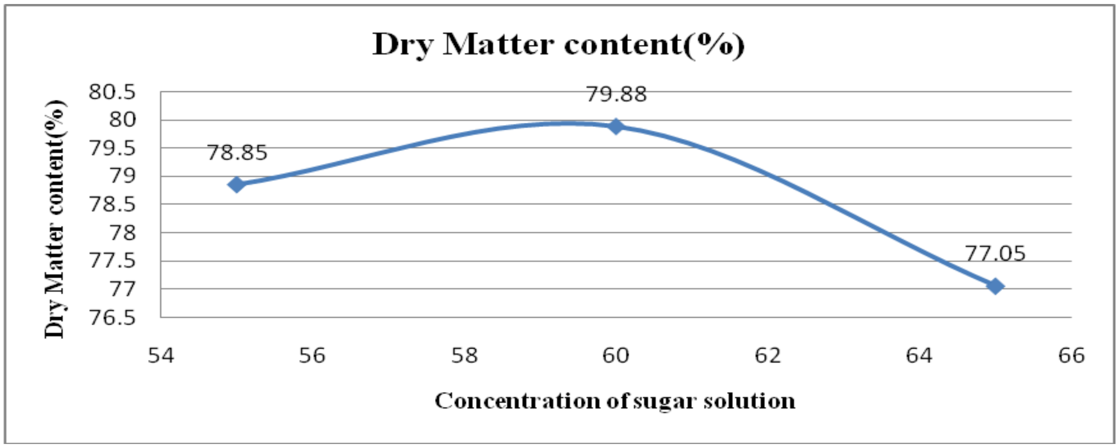

Fig.6 Dehydration ratio vs concentration of salt solution

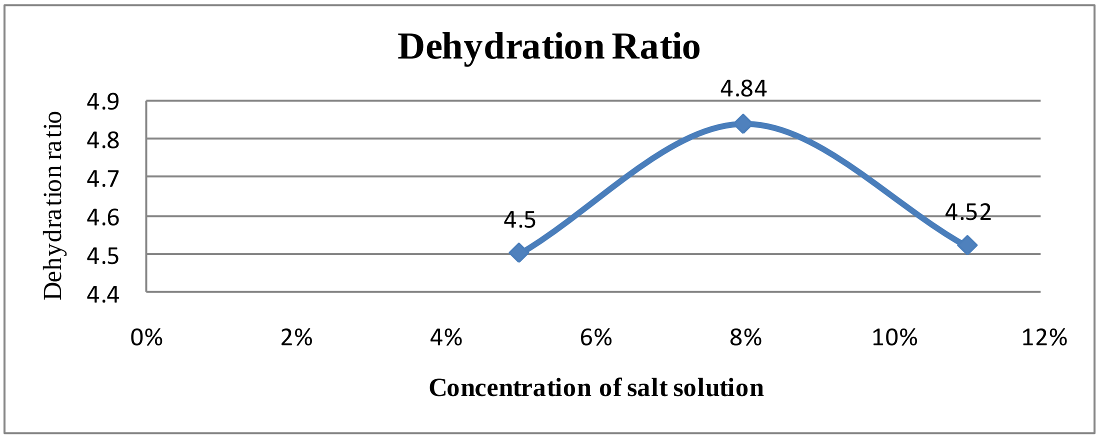

Fig.7 Dehydration ratio vs concentration of sugar solution

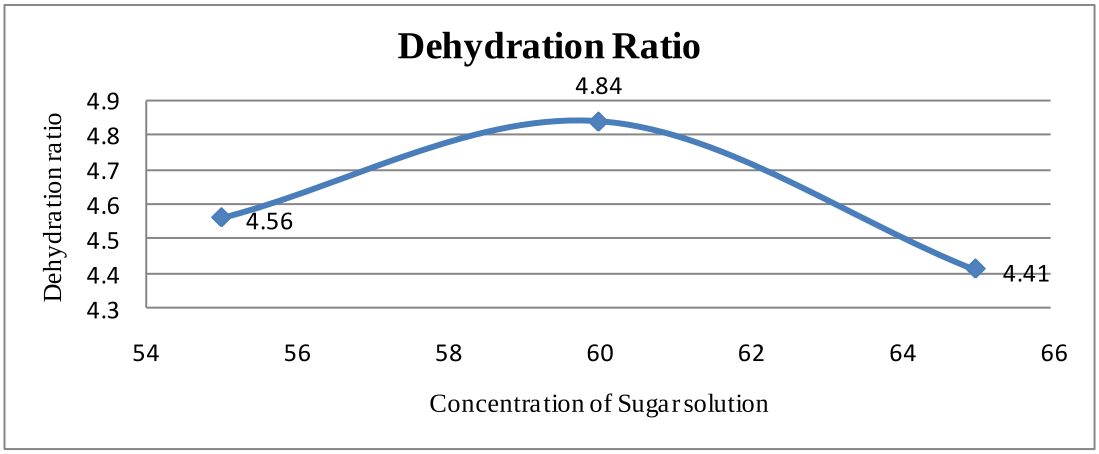

Fig.8 Ash content vs concentration of salt solution

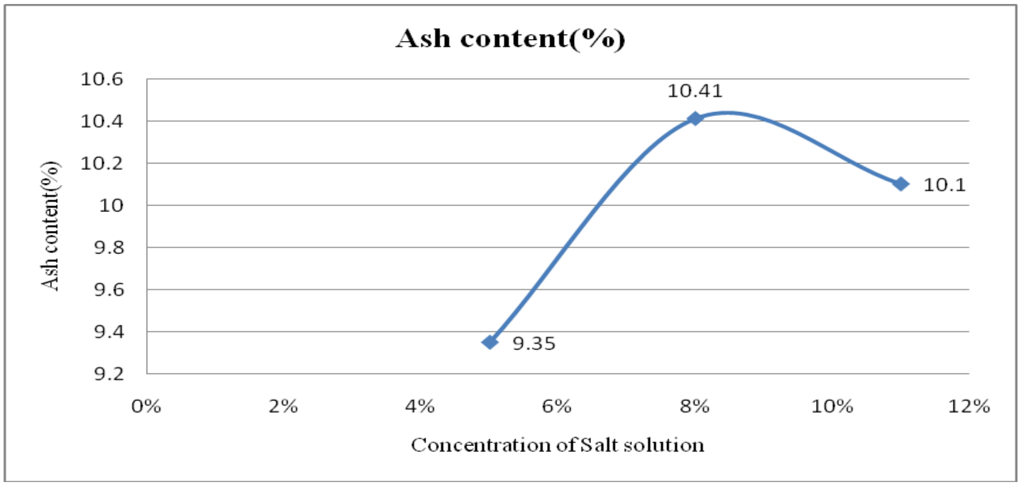

Fig.9 Ash content vs concentration of sugar solution

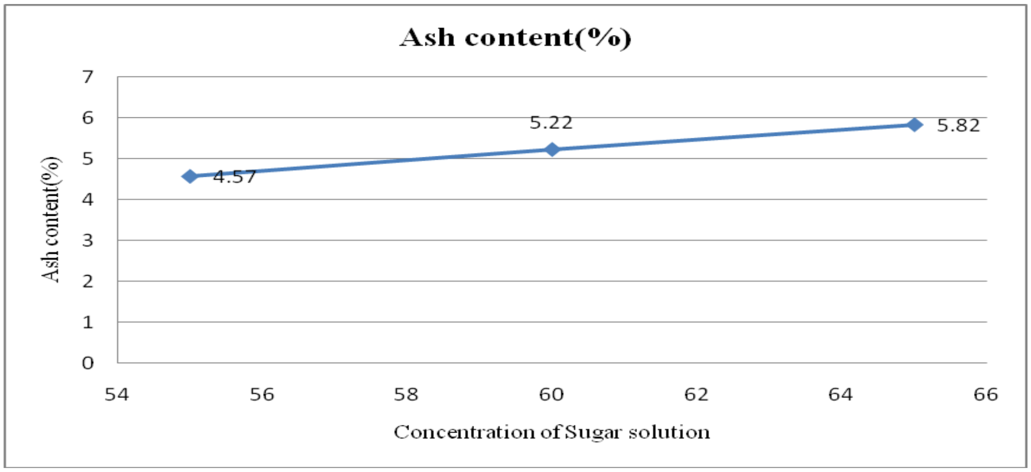

Table.1 Moisture content

Sr. No.	Salt solution		Sugar solution	
	Concentration	M.C. (%)	Concentration	M.C. (%)
1	5%	58.33	55° Brix	21.15
2	8%	51.12	60° Brix	20.12
3	11%	54.14	65° Brix	22.95

Table.2 Dry matter content

Sr. No.	Salt solution		Sugar solution	
	Concentration	Dry matter Content (%)	Concentration	Dry matter Content (%)
1	5%	41.67	55° Brix	78.85
2	8%	48.88	60° Brix	79.88
3	11%	45.86	65° Brix	77.05

Table.3 Dehydration ratio

Sr. No.	Salt solution		Sugar solution	
	Concentration	**Dehydration Ratio**	**Concentration**	**Dehydration Ratio**
1	5%	4.5	55° Brix	4.56
2	8%	4.84	60° Brix	4.84
3	11%	4.52	65° Brix	4.41

Table.4 Ash content

Sr. No.	Salt solution		Sugar solution	
	Concentration	Ash Content (%)	Concentration	Ash Content (%)
1	5%	9.35	55° Brix	4.57
2	8%	10.41	60° Brix	5.22
3	11%	10.1	65° Brix	5.82

Table.5 Sensory score for colour treated with sugar solution

Sample code	Sugar Concentration (^{0}Brix)	Colour(30)
T_1	55 ^{0}Brix	24.45
T_2	60 ^{0}Brix	25.87
T_3	65 ^{0}Brix	22.28

Table.6 Sensory score for colour treated with salt solution

Sample code	Salt Concentration (%)	Colour(30)
T_4	5%	19.80
T_5	8%	17.32
T_6	11%	15.42

Table.7 Sensory score for texture treated with sugar solution

Sample code	Sugar Concentration (^{0}Brix)	Texture(30)
T_1	55 ^{0}Brix	20.23
T_2	60 ^{0}Brix	22.85
T_3	65 ^{0}Brix	19.15

Table.8 Sensory score for texture treated with salt solution:

Sample code	Salt Concentration (%)	Texture(30)
T_4	5%	20.32
T_5	8%	21.50
T_6	11%	12.38

Table.9 Sensory score for flavor treated with sugar solution

Sample code	Sugar Concentration (^{0}Brix)	Flavor (40)
T_1	55 ^{0}Brix	28.10
T_2	60 ^{0}Brix	30.45
T_3	65 ^{0}Brix	25.12

Table.10 Sensory score for flavor treated with salt solution

Sample code	Salt Concentration (%)	Flavor(40)
T_4	5%	28.40
T_5	8%	24.35
T_6	11%	18.60

No significant variations was observed among osmotically dehydrated carrot slices except in case of T2 (60°Brix syrup) which has significantly higher 25.87 score for colour was closely followed by T1 (24.45) and T3 (22.28), while minimum score (15.42) was obtained in T6 (11% salt solution).

Effect on texture

The different treatments significantly affected the texture of dehydrated carrot slices (Table 7 and 8). The overall texture score for osmotically dehydrated carrot slices was significantly superior to the untreated control sample. The maximum score (22.85) for texture was recorded in treatment T2 (60°Brix syrup). The minimum score (12.38) was observed in case of control slices (T9).

Effect on flavor

Data pertaining to sensory score for flavour is given in Table 9 and 10 indicates that the score for flavor in osmotically dehydrated carrot slices was significantly superior as compared to untreated control samples.

Samples obtained by osmotic pre-treatments were found to have statistically non-significant variations with respect to score for flavor among most of the treatments.

Carrot slices made by using 60°Brix (T2) rated significantly (30.45) followed (28.40) by treatment T4 (5% salt solution). The minimum score 18.60 was recorded in control (T6 11% salt solution).

Based on the result reported in chapter 4, following conclusions were drawn:

After the dehydration of carrot slices, the reddish color was maintained in sugar solution of all concentrations.

The moisture content was found lower in carrot slices which were treated with sugar solution of 60°Brix i.e. 20.12%.

The dry matter content was found highest in carrot slices which were treated with sugar solution of 60°Brix i.e. 79.88%.

Dehydration ratio was found better in carrot slices which were treated with a salt solution of 8% and with sugar solution of 60°Brix i.e. 4.84.

Ash content was found least in carrot slices which are treated with sugar solution of 55°Brix i.e. 4.57%.

The sugar solution of 60°Brix was best for dehydration of carrot slices.

References

Baysal, T., Icier, F., Ersus, S., Yldz, H. (2004). Effects of microwave and infrared drying on the quality of carrot and garlic. European Food Research and Technology. 218 (1): 68-73.

Chadda, K.L. 2002. Handbook of Horticulture. ICAR, New Delhi, India.

Mondhe, D.S., S. E. Shinde, S. S. Deshmukh (2017). Studies on Osmotic

Dehydration of Carrot Slices, 1(4): 35-41.

Nanjundaswamy, A.M., Radha Krishaiah Setty, G., Balachandran, C., Saroja, S., Murthy Reddy, K.B.S., 1978, Studies on development of new categories of dehydrated products from indigenous fruits. *Indian Food Packer*, 32(1): 91-98.

Prothon, F., Ahrne, L. M., Funebo, T., Kidman, S., Langton, M., Sjoholm, I., 2001, Effects of combined osmotic and microwave dehydration of apple on texture, microstructure and rehydration characteristics. *Lebensmittel-Wissenschaft und Technologie*, 34: 95–101.

Ranganna S. (1995). Hand Book of Analysis and Quality Control for Fruit and Vegetable Products. 2nd ed., Tata McGraw-Hill Pub. Co, Ltd. New Delhi, India.

Sagar, V., Suresh Kumar, P., 2010, Recent advances in drying and dehydration of fruits and vegetables. *J. Food Sci. Technol.*, 47: 15-26.

Sra, S.K., Sandhu, K.S., Ahluwalia, P., 2011, Effect of processing parameters on physico-chemical and culinary quality of dried carrot slices. *J. Food Sci. Technol.*, 48(2): 159–166.

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