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# Studies on Osmotic Dehydration of Carrot Slices

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***Abstract* - Fresh carrots (Ducus carota L.) are rich in β-carotene, a precursor of vitamin A. It is moderately perishable in nature; therefore it is necessary to develop suitable techniques for preservation. The research was carried out at APE department of K. K. Wagh College of Agricultural Engineering and Technology. In the present report, efforts were made to analyze the effect of different concentrations of osmotic agents i.e. salt solutions (5%, 8%, 11% concentration) and sugar solutions (550Brix, 600Brix, 650Brix concentration) on drying and various physical parameters of carrot slices. Comparative study of the effect osmotic agents was also studied. 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 0Brix concentration while ash content was found least in sugar solution of 55 0Brix concentration. The sugar solution of concentration 600Brix is best for osmotic dehydration of carrot slices.***

***Index Terms: Ducus carota L., osmotic dehydration, physical parameters***

## I. INTRODUCTION

Fruit and vegetables contribute crucial source of nutrients in the daily human diet. World fruit production is estimated to be 434.7 million metric tons and vegetables 90.0million metric tons. India is second largest fruits and vegetable producer and its annual production is 44 million metric tons from an area 3,949,000 ha during 2000 to 2002 (Srivastava and Kumar, 2002). In India, postharvest losses of fruits and vegetables are estimated more than 25%.

Many processing techniques can be employed to preserve fruits and vegetables by drying and dehydration is one of the most important operations that are widely practiced because of considerable saving in packaging, storage etc.

Osmotic dehydration has received greater attention in recent years as an effective method for preservation of fruits and vegetables. Being simple process, it facilitates processing of fruits and vegetables with retention of initial fruit characteristics like colour, aroma, texture and nutritional composition. It is less energy intensive than air or vacuum drying because it can be conducted at lower or ambient temperature. It involves dehydration of fruits in two stages: (1) Removal of water using as an osmotic agent and (2) Subsequent dehydration in the dryer where moisture content is further reduced the product shelf stable.

Carrot is one of the important root vegetable crops. Carrot (Ducus carota L.) is rich in β-carotene, a precursor of vitamin A. Carrot containing about 5 - 8 mg β-carotene per 100g. It is highly nutritious as it contains an appreciable amount of vitamins B1, B2, and B12. It also has high fiber content which contributes to a healthy diet. Dehydration vegetables can be used in many processed or ready to eat food in place of fresh foods and have several advantages such as convenience in transportation, storage, preparation, and use.

Most fruits and vegetables have a definite harvesting and a limited shelf life. Most harvested fruits quickly deteriorate due to microbial and biochemical activity. Different preservation methods are used to extend the shelf life by a few weeks, one year or more. The method includes canning, bottling, freezing, drying, fermentation, pasteurization, chemical additives, packaging, and irradiation.

The technique of food dehydration is probably the oldest method of food preservation. The main purpose of drying is to allow longer periods of storage, minimize packaging requirement and reduce shipping weight.

*Objectives:*

In light of the above points following objectives were decided for the research study:-

i. To study the effect of osmotic dehydration of carrot slices in salt & sugar solution.
ii. To determine the effect of concentration of osmotic solution on carrot slices at room temperature.
iii. To determine the physical parameters of dehydrated carrot.

## II. MATERIALS AND METHOD

***A Materials**: > Raw materials:*

Carrot:-The carrot (Daucus carota) is a root vegetable, usually orange in color. The carrot is a biennial plant. 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 Soil science, of K. K. Wagh College of Agricultural Engineering and Technology Nashik -03 & the department of Food Chemistry and Nutrition, in K. K. Wagh College of Food Technology, Nashik-03.

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.

*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.

*Tray dryer:*

The tray drier was used to dry the carrot slices after the osmotic treatment in salt and sugar solution.

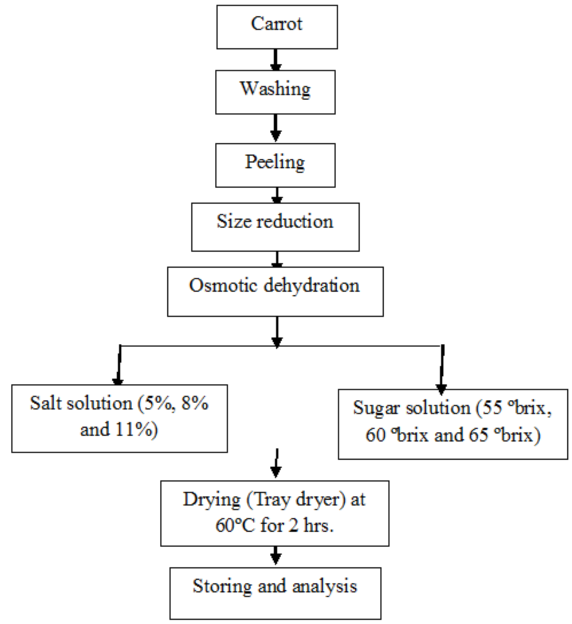
*Knife:*

The knife was used to cut the carrot in slices with proper size.

*Peeler:*

The peeler was used to peel the carrot skin.

***B Methods*** > *Flow Chart*




Flow chart: Osmotic dehydration of carrot slices

## III. PROCEDURE FOR THE EXPERIMENT

Sample preparation:

Carrots were washed, cleaned from dirt, peeled using knife and sliced to required size of 3 mm thickness and 3 cm diameter. The size reduced carrot was then weighed to 30 gm to standardize the amount required for various treatments of the study.

Plate No. 3.11 peeled carrot Plate No. 3.12 Carrot slices

### A. *Osmotic Treatment:*

The size reduced carrots were then dehydrated osmotically in solutions containing 5%, 8%, 11% of sodium chloride and 55º Brix, 60º Brix, 65º Brix of sucrose for 4 hours separately in water bath at 44ºC temperature. The samples were then drained to remove the excess water present in the surface of osmotically dehydrated slices.

Table 1. Osmotic treatments in salt and sugar solution

| Sr. No. | Osmotic Treatment | |
|---|---|---|
| | Salt Solution Concentration | Sugar Solution Concentration |
| 1 | 5% | 55 ºBrix |
| 2 | 8% | 60 ºBrix |
| 3 | 11% | 65 ºBrix |


Plate No. 3.13 Sugar solution


Plate No. 3.14 salt solution

Plate No. 3.15 Slices dipped in sugar solution

Plate No. 3.16 Slices dipped in salt solution

Plate No. 3.17 Treated in sugar solution

Plate No. 3.18 Treated in salt solution

Various tests were done with a measured quantity of osmotically dehydrated samples to access the following parameters:

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 Test:

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:

$$\text{Total ash content (\%)} = \frac{\text{Final weight (gm)}}{\text{Initial weight (gm)}} \times 100$$

(Ranganna S, 2005)

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

## IV. RESULTS AND DISCUSSION

The present study was conducted in the Department of Agricultural Process Engineering, K. K. Wagh College of Agricultural Engineering & Technology, Nashik for osmotic dehydration of carrot slices. 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 tray dryer.

The weights of samples during drying were recorded & then physical analysis was carried out. The results of the study are presented in this chapter.

Physical analysis:-

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. The fig 4.1 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 50.43% for 8% salt solution and 19.25% for 60º Brix of sugar solution. So, moisture content reduction is obtained more for carrot slices soaked in sugar solution than salt solution.

Similarly, the fig 4.2 shows the graph of moisture content vs concentration of sugar solution.

Table No. 3. Moisture Content

| Sr. No. | Salt solution | | Sugar solution | |
|---|---|---|---|---|
| | **Concentration** | **M. C. (%)** | **Concentration** | **M. C. (%)** |
| 1. | 5% | 57.26 | 55º Brix | 21.00 |
| 2. | 8% | 50.43 | 60º Brix | 19.25 |
| 3. | 11% | 53.00 | 65º Brix | 22.11 |

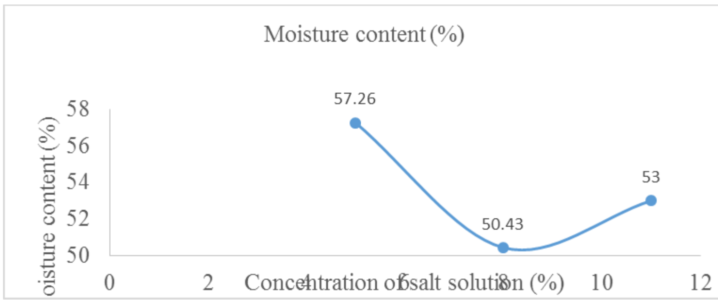



Fig. No. 4.1 Moisture content vs concentration of salt solution

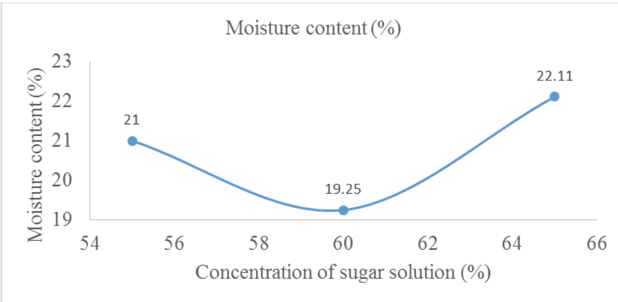



Fig. No. 4.2 Moisture content vs concentration of sugar solution

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 were studied and optimum values were found. It was 49.57% for 8% of the salt solution and 80.25% 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.

The fig 4.3 shows the graph of dry matter content vs concentration of salt solution.

Similarly fig 4.4 shows the graph of dry matter content vs concentration of sugar solution.

Table No. 4 Dry matter content:

| Sr. No. | Salt solution | | Sugar solution | |
|---|---|---|---|---|
| | Concentration | Dry matter content (%) | Concentration | Dry matter content (%) |
| 1. | 5% | 42.74 | 55ºBrix | 79 |
| 2. | 8% | 49.57 | 60ºBrix | 80.25 |
| 3. | 11% | 47 | 65ºBrix | 77.89 |

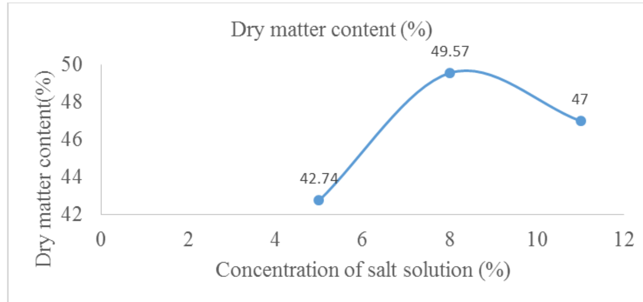



Fig. No. 4.3 Dry matter content vs concentration of salt solution

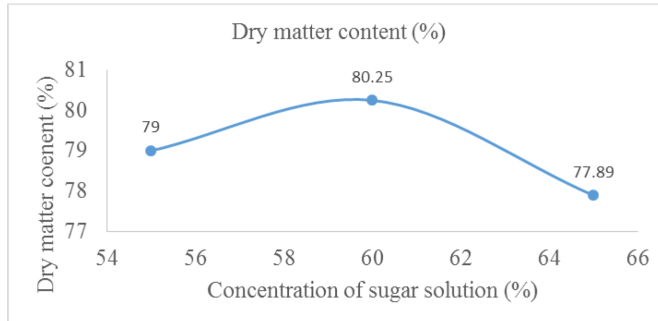



Fig. No. 4.4 Dry matter content vs concentration of salt solution

Dehydration ratio:

Dehydration ratios were found out to know the loss in weight of carrot slices after drying. As concentration increased the dehydration ratio also increased and optimum values were found for 8% of the salt solution and 60ºBrix sugar solution. Fig 4.5 shows the graph of dehydration ratio vs concentration of salt solution.

Similarly, fig 4.6 shows the graph of dehydration ratio vs concentration of sugar solution.

Table No. 4.3 Dehydration ratio:

| Sr. | Salt solution | | Sugar solution | |
|---|---|---|---|---|
| | Concentration | Dehydration ratio | Concentration | Dehydration ratio |
| 1. | 5% | 4.7 | 55ºBrix | 4.67 |
| 2. | 8% | 4.92 | 60ºBrix | 4.92 |
| 3. | 11% | 4.62 | 65ºBrix | 4.48 |

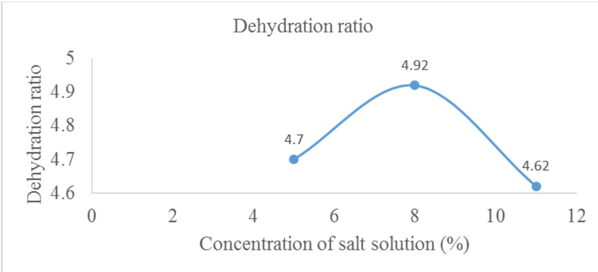



Fig. No. 4.5 Dehydration ratio vs concentration of salt solution

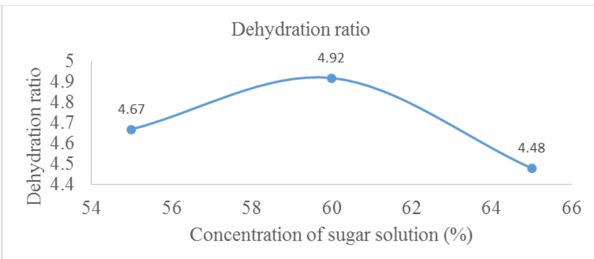



Fig No. 4.6 Dehydration ratio vs concentration of sugar solution

Ash content:

Fig 4.7 shows the graph of ash content vs concentration of salt solution. The ash content 9.45, 10.51 & 10.9 was present in 5%, 8% & 11% of salt solution respectively.

Similarly, fig 4.8 shows the graph of ash content vs concentration of salt solution. The ash content 4.65, 5.30 & 5.93 was present in 55ºBrix, 60ºBrix & 65ºBrix solution respectively.

Table No.4 Ash content

| Sr. No. | Salt solution | | Sugar solution | |
|---|---|---|---|---|
| | **Concentration** | **Ash content (%)** | **Concentration** | **Ash content (%)** |
| 1. | 5% | 9.45 | 55ºBrix | 4.65 |
| 2. | 8% | 10.51 | 60ºBrix | 5.30 |
| 3. | 11% | 10.9 | 65ºBrix | 5.93 |

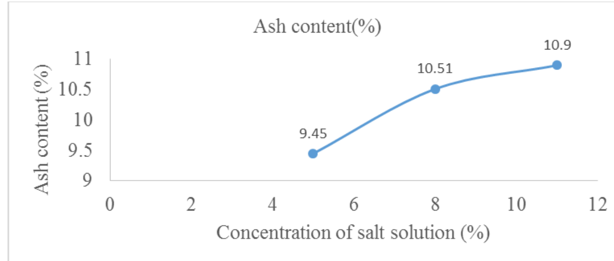



Fig No. 4.7 Ash content vs concentration of salt solution

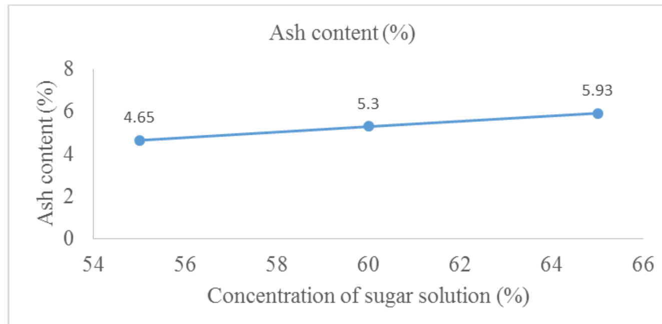



Fig No. 4.8 Ash content vs concentration of sugar solution

## V. CONCLUSION

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 600 Brix i.e. 19.25%.
- The dry matter content was found highest in carrot slices which were treated with sugar solution of 600 Brix i.e. 80.75%.
- Dehydration ratio was found better in carrot slices which were treated with a salt solution of 8% and with sugar solution of 600Brix i.e. 4.92.
- Ash content was found least in carrot slices which are treated with sugar solution of 550 Brix i.e. 4.65%.
- The sugar solution of 600Brix was best for dehydration of carrot slices.

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