The Andhra Agric. J 63 (3): 701-705, 2016

Osmotic Dehydration of Beetroot Slices in Salt Solution

N Vinoda, B V V Balaram Bhagath, K Lavanya,V Bhargavi and N Yadagirish Babu
College of Agricultural Engineering, Bapatla 522 10, Andhra Pradesh

ABSTRACT

Study was conducted for selecting suitable osmotic treatment of beet root slices in a salt solution of different concentrations followed by suitable drying methods such as tray drying, solar cabinet drying and sun drying. Beetroot slices were dipped in osmotic solution, in a solution to sample ratio of 15:1 & 10:1 at 15% and 10% concentrations respectively for dehydration period of 90 min at a temperature of 60^{o}C in a hot air bath. The water loss & weight reduction of osmotically treated beet root slices were increased with increase in concentration and solute gain was decreased with increase in concentration. The quality of osmotic dehydrated beet root slices was best at 15% salt concentration dried in tray dryer.

Key words: osmotic dehydration, weight loss, solute gain, weight reduction.

Beta vulgaris, commonly known as beetroot or beet which is the common American English term for the vegetable is a flowering plant species in the family Chenopodiaceae. Beta vulgaris roots containing significant amounts of vitamin C, while the leaves excellent source of vitamin A. It is among the sweetest of vegetables, containing more sugar even than carrots or sweet corn (Pratibha singh et.al 2008). The content of sugar in beetroot is not more than 10%.

Fresh beetroot is highly perishable which needs preservation methods to increase its shelf-life. One of the preservation methods ensuring microbial safety of biological products is drying but certain problems such as the considerable shrinkage caused by cell collapse following the loss of water, the poor re-hydration characteristics of dried product and unfavourable changes in colour, texture, flavor and nutritive value may occur. Osmotic dehydration is one of the most useful pre-treatments for drying of fruits and vegetables

Osmotic dehydration is the process of partial removal of water from the cellular materials when placed in the concentrated solution of soluble solute. Osmotic dehydration, which is effective even at ambient temperature and saves the color, flavor and texture of food from heat and is used as a pre-treatment to improve the nutritional, sensorial and functional properties of food (Sagar 2009). Sugar, glucose, fructose, corn syrup and sodium chloride are the common osmotic agents. The main process variables, such as concentration and composition of osmotic solution, temperature, immersion time, agitation, nature of food and its geometry and solution to sample ratio are influence on the mass transfer mechanism.

For achieving high yield of final product, the kinetics of solid gain is more important than that of water loss. Kinetics of water loss in osmotic dehydration has been extensively studied for many fruits, including blueberries (dermesonlouoglou et al., 2005; Sodhi and Komal 2006). The quality traits and nutritional value of osmo dried fruits and vegetables can be modified depending on the parameters of the dehydration process and osmotic agent used (Mandala et al., 2005; Chiralt and Talens, 2005). Hence the present study was carried out to analyse the effect of solute concentration on water loss, solute gain, weight reduction of beetroot slices and also a suitable drying methods for improving the quality of beetroot slices.

MATERIAL AND METHODS

Raw material:

Fresh beetroots of local variety were procured from local market, Bapatla with an initial moisture content of 89% (w.b.) were procured from local market. Healthy and defects free beetroots were sorted and selected for conducting experiment.

Osmotic agent:

Salt was used as osmotic agent and was procured from local market to prepare osmotic solution of 10% and 15% concentrations on the basis of (%w/v).

Preparation of osmotic agent:

Osmotic solution was prepared by dissolving calculated amount of salt in distilled water so as to obtain required concentration at 60°C temperature in hot water bath.

Preparation of sample for osmotic dehydration:

Procured beetroots were thoroughly washed with water to remove dust and dirt particles adhering to the surface. After washing, beetroots were peeled by scraping with a sharp steel peeler by manually and washed again to remove the scrapped material on beetroots. The peeled beetroots were cut into 3 mm thickness and 2-3 cm diameter slices manually by using sharp stainless steel knife.

Experimental procedure for osmotic dehydration:

Beetroot slices were dipped in osmotic solution at 10% and 15% concentrations in a period of 90 min at a temperature of 60°C in the hot water bath. The constant temperature 60°C was maintained during the process. After 90 min time, samples were taken out from the solution and wiped with tissue paper to remove traces of osmotic solution adhering to beetroot slices and then dried in different methods such as tray drying, solar cabinet drying and sun drying.

Tray drying

Osmotically treated beetroot samples were weighed by electrical balance. The beetroot samples were spread in the form of thin layer (3mm thickness) on aluminum trays. These aluminum trays were put in air cross flow cabinet dryer at a temperature of 60°C and time 8 h. The air velocity in the cabinet dryer is 0.3 m/s to 2.3 m/s.

Solar cabinet drying:

Solar cabinet dryer consists of an enclosure with transparent cover and perforated trays. The osmotically treated beetroot slices were spread in the form of thin layer (3 mm thickness) on perforated trays inside the dryer. Solar radiation entering the enclosure is absorbed in the product itself and the surrounding internal surfaces of the enclosure. As a result, moisture is removed from the product and the air inside is heated. Drying in solar cabinet dryer was continued until the beetroot slices were dried to approximately below 10% of moisture content.

Sun drying

About 500 g of osmotically treated beetroot slices were taken and are spread uniformly with a bed thickness of 3mm on a rectangular black color polythene sheet. Then the samples were placed in open sun for drying from 8.00 am to 5.00 pm during April, 2011. During drying, the slices were frequently stirred manually. Reduction in weight due to moisture loss was recorded at every one-hour interval during drying. The drying was continued until there is no significant variation in the moisture loss.

Determination of moisture content (w.b.):

The moisture content was determined and expressed in wet basis by using the following equation.

Moisture content (% w.b.) =

$$\frac{initial\ weight - final\ weight}{initial\ weight} \times 100$$

Water loss (%):

Water loss was determined by the following equation (Hawkes and Flink., 1978).

Water loss/100g fresh beetroots

$$= \frac{(w_0 - w_t) + (s_t - s_0)}{w_0} \times 100$$

w_0 - Initial weight of beetroots, g

w_1 - Weight of beetroots after osmosis, g

s_0 - Initial weight of solids in beetroots, g

s_1 -Weight of solids after osmosis, g

Solute gain (%):

Solute gain was determined by the following equation (Hawkes and Flink., 1978).

Table 1. Water loss, Solute gain and Weight reduction at different concentrations.

Salt Concentration (%w/v)	Time (min.)	Temperature (°C)	Water loss(%)	Solute gain(%)	Weight reduction (%)
10	90	60	17.56	4.14	13.42
15	90	60	25.06	3.81	21.25

Fig.1. Variation of moisture content against drying time in different drying methods at 10% salt concentration.

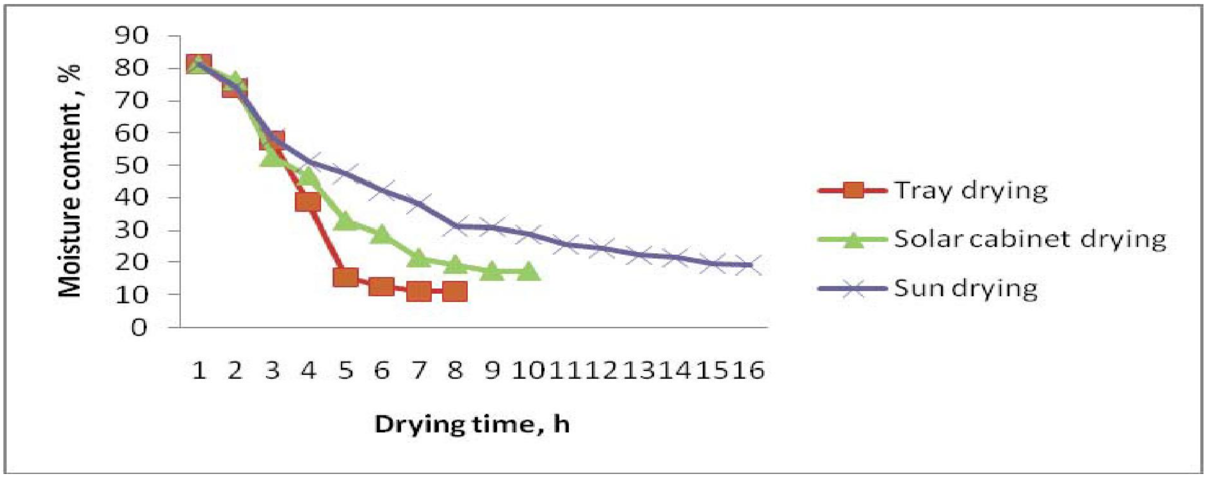


Fig.2 Variation of moisture content against drying time in different drying methods at 15% salt concentration.

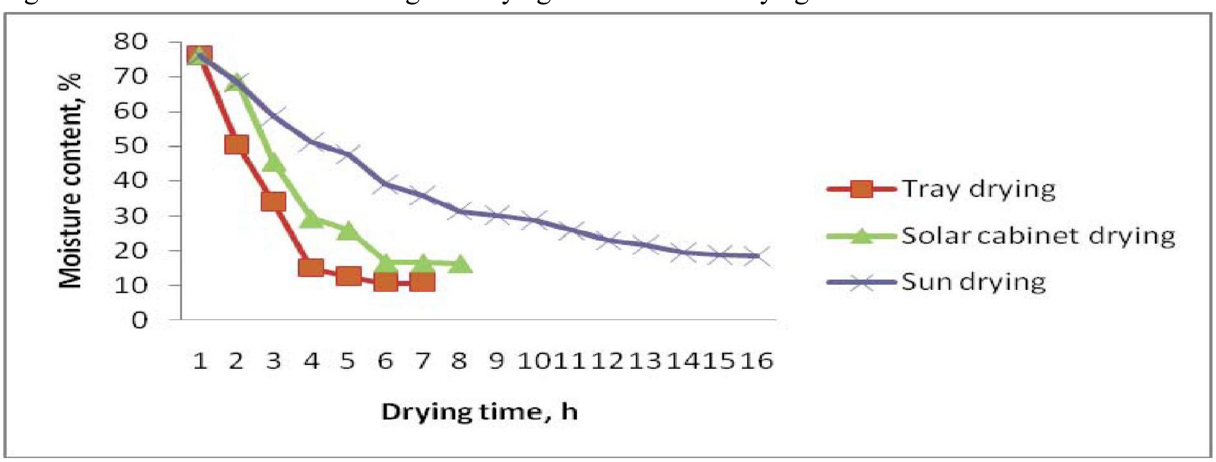
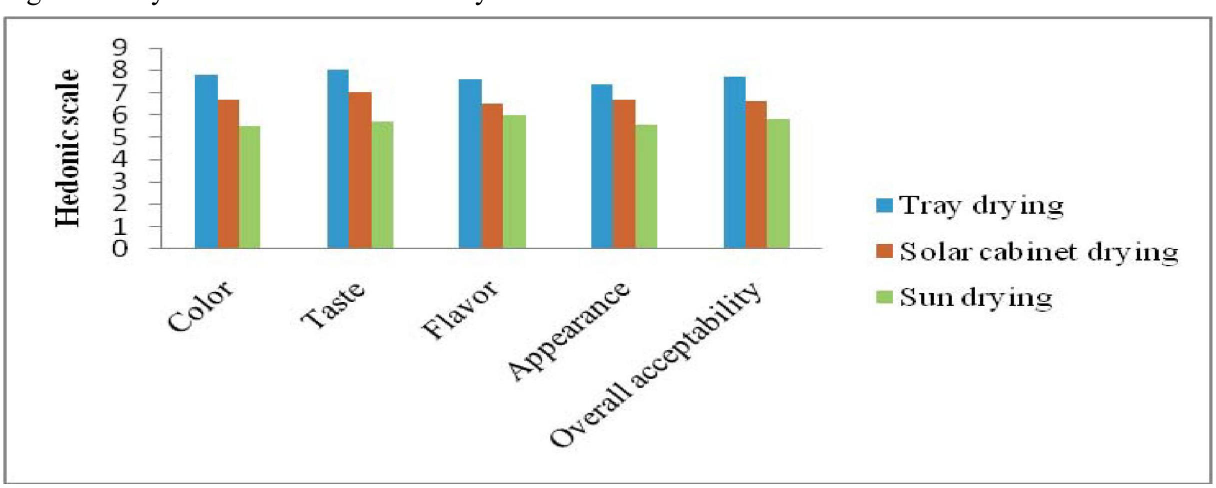


Fig.3 Sensory evaluation of osmotic dehydrated beetroot slices at 10% salt concentration.



Solute gain/100g fresh beetroots =

$$\frac{s_t - s_0}{w_0} \times 100$$

Weight reduction (%):

Weight reduction was determine by the following formula (Hawkes and Flink., 1978)
Weight reduction = Water loss,% – Solute gain, %

Sensory evaluation of osmotic dehydrated beetroots:

The osmotic dehydrated beetroot slices were tested for acceptability by sensory evaluation. The sensory quality was evaluated by a panel of 10 members, trained to score the quality attributes of beetroots slices. Samples were scored for overall visual quality using a hedonic scale. The Hedonic scale used for the testing of various quality parameters like color, taste, flavor, appearance and overall acceptability is taken as below *(Joshi, 2006)*.

RESULTS AND DISCUSSION

Effect of osmotic concentration on water loss, solute gain and weight reduction:

Water loss:

The water loss was increased from 17.56 to 25.06% with increase in concentration from 10 to 15 % (%w/v) at 60ºC, at 90 min process duration as shown in Table 1, due to decrease in moisture contents and weights of beetroot slices after the osmosis.

Solute gain:

The solute gain was decreased with increase in osmotic solution concentration might be due to lower viscosity of more concentrated salt solution. The solute gain was decreased from 4.14 to 3.81 % with increase in concentration from 10 to 15% (%w/v) at 60ºC, at 90 min process duration as shown in Table 1.

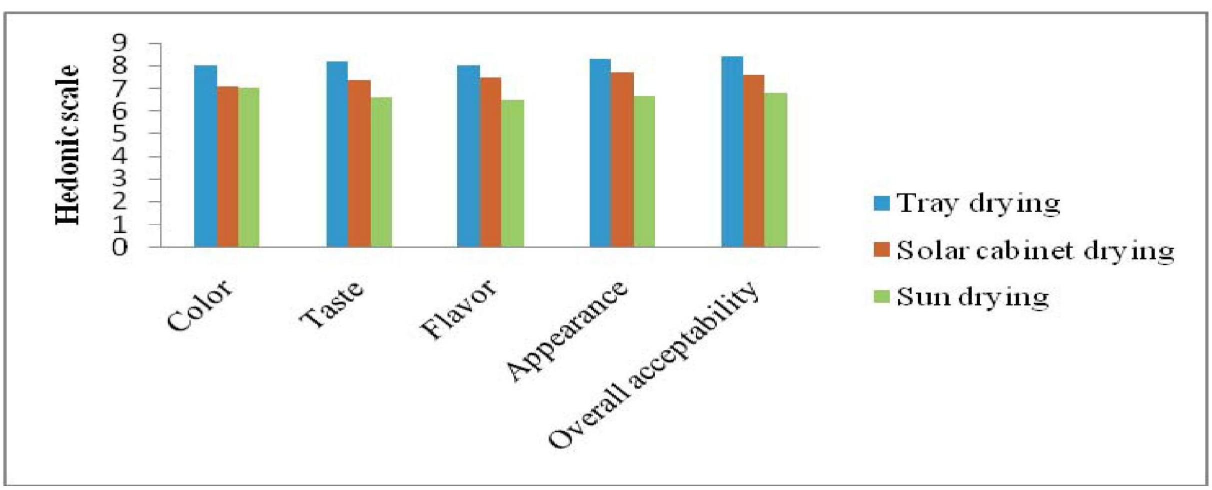
Weight reduction:

The weight reduction was increased with increase in osmotic solution concentration might be due to the water activity of the osmotic solution which decreases with the increase in solute concentration in the osmotic solution. The weight reduction was increased from 13.42 to 21.25 % with increase in concentration from 10 to 15% (%w/v) at 60ºC, at 90 min process duration as shown in Table 1.

Effect of drying methods on moisture content of beetroot slices at 10% concentration:

It was observed that the moisture content of osmotic dehydrated beetroot slices samples decreases with increase in drying time in all drying methods. The moisture content of osmotically dehydrated beetroot slices samples was decreased from 81.35 to 11 %, 81.35 to 17.37% and 81.35 to 19.04% in tray drying, solar cabinet drying and sun drying in total drying period of 8, 10, 16 h respectively as shown in Fig.1. This shows that the reduction in moisture content was more in tray drying in a drying period of 8 h.

Fig.4 Sensory evaluation of osmotic dehydrated beetroot slices at 15% salt concentration.



Effect of drying methods on moisture content of beetroot slices at 15% concentration:

It was observed that the moisture content of osmotic dehydrated beetroot slices samples decreases with increase in drying time in all drying methods. The moisture content of osmotically dehydrated beetroot slices samples was decreased from 76.03 to 10.65%, 76.03 to 16.25% and 76.03 to 18.25% in tray drying, solar cabinet drying and sun drying in total drying period of 6, 8, 16 h respectively as shown in Fig.2. This shows that the reduction in moisture content was more in tray drying in a drying period of 6 h.

Sensory evaluation of osmotic dehydrated beetroot slices at 10% concentration:

A sensory evaluation method adopted for the analysis of acceptability of the osmotic dehydrated beetroot slices with the help of a hedonic scale and the results suggested that the overall acceptability is better when beetroot slices were dried in tray dryer. The color (7.8), taste (8), flavour (7.6), appearance (7.4) and overall acceptability (7.7) was observed a high rating in tray drying followed by solar cabinet drying and sun drying as shown in Fig.3. This shows that the quality of osmotic dehydrated beetroot slices was better in tray drying compared to solar cabinet drying and sun drying

Sensory evaluation of osmotic dehydrated beetroot slices at 15% salt Concentration:

The color (8.0), taste (8.2), flavour (8.0), appearance (8.3) and overall acceptability (8.4) is observed a high rating in tray drying followed by solar cabinet drying and as shown in Fig.4. This shows that the quality of osmotic dehydrated beetroot slices was better in tray drying compared to solar cabinet drying and sun drying.

CONCLUSIONS

The optimum concentration for osmotic dehydration of beetroot slices were 15% (% w/v) among 10% and 15% concentrations. The water loss was increased from 17.56 to 25.06 % with increase in concentration from 10 to 15 % (%w/v) at 60ºC, at 90 min process duration. The solute gain was decreased from 4.14 to 3.81 % with increase in concentration from 10 to 15% (%w/v) at 60ºC, at 90 min process duration. The colour, taste, flavour, appearance and overall acceptability is observed a high rating in tray drying followed by solar cabinet drying and sun drying. Finally, it can be concluded that the quality of osmotic dehydrated beetroot slices was best at 15% salt concentration dried in tray dryer.

LITERATURE CITED

Chiralt A and Talens P 2005 Physical and chemical changes induced by osmotic dehydration in plant tissues. *Journal of Food Engineering,* 67: 167-177.

Dermesonlouoglou E K, Giannakourou M C, Bakalis S and Taoukis P S 2005 Mass transport properties of watermelon tissue in osmotic solutions and effect of osmotic dehydration on frozen watermelon quality. *Acta Horticulture*, 674: 481-487.

Hawkes and Flink 1978 Osmotic concentration of fruit slices prior to freeze drying. *Journal of Food Processing and Preservation*,265-284.

Joshi V K 2006 Applications of sensory evaluation. Sensory science principles and applications in food evaluation. Agrotech publishing academy, Udaipur. 342-345.

Mandala I G, Anagnostaras E F and Oikonomou C K 2005 Influence of osmoticdehydration conditions on apple air-drying kinetics and their quality characteristics.*Journal of Food Engineering,* 69: 307-316.

Prathibha singh and Kalpana Kulshresha 2008 Nutritional quality of food supplements based on carrot powder and grits. *Journal of food science technology*, 45(1): 99-101.

Sagar V R 2009 Changes in quality of ready-to-eat dehydrated carrot shreds during storage. *Journal of food science technology*, 45(2): 177-178.

Sodhi N S and Komal N S 2006 Osmotic dehydration kinetics of carrots. *Journal of Food Science and Technology,* 43(4): 374-376.

Received on 29.06.2015 and revised on 24.02.2016)