Research Journal of Recent Sciences ____ *Res. J. Recent Sci.*
Vol. **1(1),** 51-59, Jan. **(2012)**

OSMO-Convective Drying of Onion Slices

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Available online at: www.isca.in
(Received 28th September 2011)

Abstract

The present study is carried out to standardize the pretreatment of onion slices and study drying characteristics during convective drying. The effect of process parameters during osmotic dehydration such as osmosis, concentration and temperature of syrup on mass reduction, water loss and salt gain increased with increase of syrup concentration and temperature. The water loss and solid gain during osmosis at 5, 12.5 and 20 ˚Brix was varied in the range of 15.88 to 25.65 and 6.63 to 10.15 per cent at 35, 45 and 55˚ C temperatures respectively. The drying temperature and pretreatment as osmotic dehydration had a significant effect on the rehydration ratio and colour. The drying times of un-osmoses and osmoses onion slices by convective drying at 40 and 60 per cent drying temperature were 12, 10 and 8 and 6 hrs respectively. Quality of dried product in respect to colour and rehydration was superior. The osmo-convective dehydrated samples were found more acceptable than convective dried ones. The onion dried at 20˚C brix solution concentration, 55˚C osmosis temperature and 70°C drying temperature was more acceptable on the basis of colour and rehydration.

Keywords: Osmo-convective drying, colour value, Onion dehydration

Introduction

Onion (*Allium cepa L.*) is a famous spice commodity grown all over the world and consumed in the various forms. A global review of area and production of onion shows that it is grown in 126 countries over an area of 2.3 million hectares producing 40.0 million tones of dry onion. Sixty-two percent of the world's production is from Asiatic countries. India is the world's second largest producer of onion, is likely to have 527, 719 hectare in 2007-08, (Anonymous, 1997).

Onion is a major ingredient in Indian food and a politically sensitive commodity is typically cultivated thrice a year- in monsoon, winter and summer. Onion adds taste and flavor to a food and hence it is invariable used in several cuisines and culinary preparations in India. Owing to high nutritive qualities onion serves as an appetizer, food digester and health promoter. It posses good medicinal values and is recommended on medical ground also. Processing of onion into various products such as ketchup, chutney, sauce, puree, salsa, dry soup mixture etc. The pungent taste of onion is due to volatile oil, ally propyl disulphide present in it. India is one of the leading countries in the world producing white onion of high quality and exporting in considerable quantities, thereby earning foreign exchange enormously.

The simplest and most economic method for dehydration of foods is air-drying; although certain problems such as the considerable shrinkage caused by cell collapse following the loss of water, the poor re-hydration characteristics of dried products and unfavorable changes in colour, texture, flavor and nutritive value may occur. Onions are dried from initial moisture content of about 82 percent or less sufficient for storage and processing (Sagar, 2001). Also they are highly stable against deteriotive microbial and enzymatic reactions. The drying of onion by tray dryer is the conventional method. A faster dehydration that yields a higher quality production is always required. A number of drying technique has been developed over year and year such as conduction, convection, and radiation. The simplest and economic method for dehydration of foods is hot air-drying in conventional tray, cabinet or vaccum dryers but these dehydrated products have fewer acceptances since the products quality is considerably reduced. The problems associated with products obtained by air-drying are woody texture, slow or substantial amount of water loss. It also brings about undesirable changes in color, texture, flavor and loss in nutritive value.

Materials and Methods

The experiments were divided into two parts, viz. osmotic dehydration of onion slices in salt solution and convective drying of osmotically dehydrated product. The preliminary experiments were planned for fixing the levels of input variables such as concentration and temperature of salt solution, ratio of salt solution and onion and optimization of process parameters for osmotic dehydration followed by convective drying.

Experimental Procedure for Osmotic Dehydration: Selection of raw materials: The fresh onion Phule- Safed variety of white onion was used for this investigation. The onion was purchased from the local market.

Preparation of sample and solution: The selected variety of white onions were peeled and washed with water and unwanted material like dust, dirt, and surface adhering were removed. The onion bulbs were cut with a sharp stainless steel knife into circular slices of approximate 4 mm $\pm$ 1mm thickness. The thickness was measured with vernier calliper having least count of 0.001 mm.

Measurement of initial moisture content: The moisture content of fresh as well as osmotically dehydrated onion samples was determined by using air oven method and calculated by using following equation.

Percent moisture content (db) =

$$\frac{W1-W2}{W2} \quad ....\text{(Ranganna,2000)}$$

Measurement of total soluble solids: The total soluble solids of prepared solution was found out by using hand refractometer of various ranges, which give the reading directly in Brix. (Ranganna, 2000)

Osmosis of Onion Slices: In osmotic dehydration the prepared samples (onion slices) were weighed approximately 40 gm for every experiment and immersed in salt solution (5, 12.5 and 20° Brix) contained in a 1000 ml glass beaker. The beakers were placed inside the constant temperature water bath. The solution in the beakers was manually stirred at regular intervals to maintain uniform temperature. One beaker was removed from water bath at designed time (after every 10 min intervals) , samples were taken out and placed on absorbent paper for 5 minute or were immediately rinsed in flowing water and placed on tissue paper to remove the surface moisture to eliminate excess solution from the surface before weighing. Finally the samples were weighted and their moisture contents were determined.

Osmotic Dehydration Characteristics: Water loss: Water loss is the quantity of water lost by food during osmotic processing. The water loss (WL) is defined as the net weight loss of the fruit on initial weight basis and will be estimated as,

$$WL = \frac{W_i . X_i - W_\theta . X_\theta}{W_i} \quad ....\text{(Rahman,1996)}$$

Solid gain: The solids from the osmotic solution get added to the samples during osmotic dehydration. The loss of water from the sample takes place in osmotic dehydration consequently it increases the solid content. The solid gain is the net uptake of solids by the slices on initial weight basis and computed using following expression:

$$SG = \frac{W_\theta (1- X_\theta) - W_i (1- X_i) \times 100}{W_i} \quad ....\text{(Rahman,1996)}$$

Mass Reduction: The overall exchange in the solid and liquid of the sample do affect the final weight of the sample.

$$MR = \frac{W_i - W_\theta}{W_i} \quad ....\text{(Rahman, 1996)}$$

Level of Input Parameters in Convective Drying of Osmotically Dehydrated Onion: In convective drying of osmotic dehydrated onion slices, the details on experimental parameters varied according to the predetermined levels of input variables under study in osmotic dehydration and further followed by convective drying is shown in table 1.

Table- 1
Levels of Input Parameters in Convective Drying of Osmotically Dehydrated Onion

Pretreatment conditions of osmotic dehydration					Convective drying	
Duration of osmosis (h)	**Thickness of sample (mm)**	**Sample to solution ratio**	**Concentration of solution (^{0}Brix)**	**Temperature of solution(^{0}C)**	**Convective drying temperature (^{0}C)**	**Air velocity (m/s)**
1	**5**	**1:2.5**	**5**	35	**70**	
				45		
				55	**80**	
			12.5	35	**70**	
				45		
				55	**80**	
			20	35	**70**	
				45		
				55	**80**	

Drying Characteristics: Moisture content during drying: Moisture content (wb) during osmotic and convective drying was calculated as:

$$\text{Moisture content (wb)} = \frac{W_\theta - DM \times 100}{W_\theta} \quad \text{(Brooker } et\ al.\text{1974)}$$

Dry matter: It is the matter left after complete removal of moisture from the product.The dry matter percentage and weight of dry matter in sample were calculated as follows:

DM (%) = 100.0 - IMC (%wb) ……. (Brooker *et al.* 1974)

$$\text{Weight of DM} = \frac{\text{Initial mass of sample} \times DM\ (\%)}{100}$$

Quality Evaluation: The quality of a osmo-convective dried onion samples had been evaluated on the basis of several parameters such as salts gain, colour determination and rehydration characteristics.

Colour measurement: The Lovibond tintometer model F is a versatile and easy to use visual colorimeter for measuring of colour of liquids, solids, powders and pastes in terms of Lovibond Red, Yellow, Blue and neutral units. In this method placing the sample in position, focus the viewing tube until sharp image of the aperture is obtained. Slide the tabs controlling the coloured filters to the right. The proportions of Red, Yellow and Blue must be adjusted and colour is matched. After the matching of colour the value of each adjusted rack is noted.

Rehydration ratio: Rehydration of dried onion was done by placing 10g of the material in a beaker and flooding it with 1000 g of distilled water at 20°C. Rehydration was continued for 5 h. Rehydrated material was strained, blotted with filter paper and weighed. Rehydration ratio (RR) =

(C / D) ……… (Lewicki *et al.*1998)

Where, C = drained weight of rehydrated sample (g),
D = test of dehydrated sample (g)

Results and Discussion

Initial Moisture Content: The initial moisture content of white onion slices was determined by oven drying. The average initial moisture content of onion was found as 81 per cent (wb).

Effect of osmotic treatment on mass reduction: The mass reduction after osmotic dehydration was found to be in the range of 9.25 to 15.5 per cent, corresponding to experiments at low level (5 ºBrix, 35 ºC after 1 h) and high level (20 ºBrix, 55 ºC after1h). The mass reduction increased from 0 to 9.25, 0 to 10.25 and 0 to 11 per cent when duration of osmotic dehydration increased from 0 to 1 h for 5 ºBrix at 35 ºC,45 ºC and 55ºC temperatures, respectively. Similarly for 12.5 and 20 ºBrix, the mass reduction was found to vary from 0 to 9.75, 10.5 and 11.25 per cent and 13,14.25, 15.5 at 35ºC, 45ºC and 55ºC temperatures, respectively.

Effect of osmotic treatment on water loss: The Water loss after osmotic dehydration was found to be in the range of 15.88 to 25.65 per cent, corresponding to experiments at low level (5 ºBrix, 35 ºC after 1 h) and high level (20 ºBrix, 55 ºC after1h). The water loss increased from 0 to 15.88, 0 to 17.90 and 0 to 18.7 percent when duration of osmotic dehydration increased from 0 to 1 h for 5 ºBrix at 35ºC, 45ºC and 55ºC temperatures, respectively. Similarly for 12.5 and 20 ºBrix, the Water loss was found to vary from 0 to 16.47, 17.95 and 19.09 per cent and 21.84, 23.76, 25.65 at 35ºC, 45ºC and 55ºC temperatures, respectively. It can be observed when solution temperature increased from 35 to 55ºC for 20 ºBrix, water loss increased from 21.84 to 25.65 per cent after one hour of osmotic dehydration causing approximately 3.81 per cent point increment. Similarly for 12.5 ºBrix, the water loss increased from 16.47 to 19.09 per cent when solution temperature increased from 35 to 55ºC resulting into 2.62 percent point increment. Similar for 5 ^{0} Brix the water loss increased from 15.88 to 18.7 per cent when solution temperature increased from 35 to 55ºC resulting into 2.52 per cent point increment.

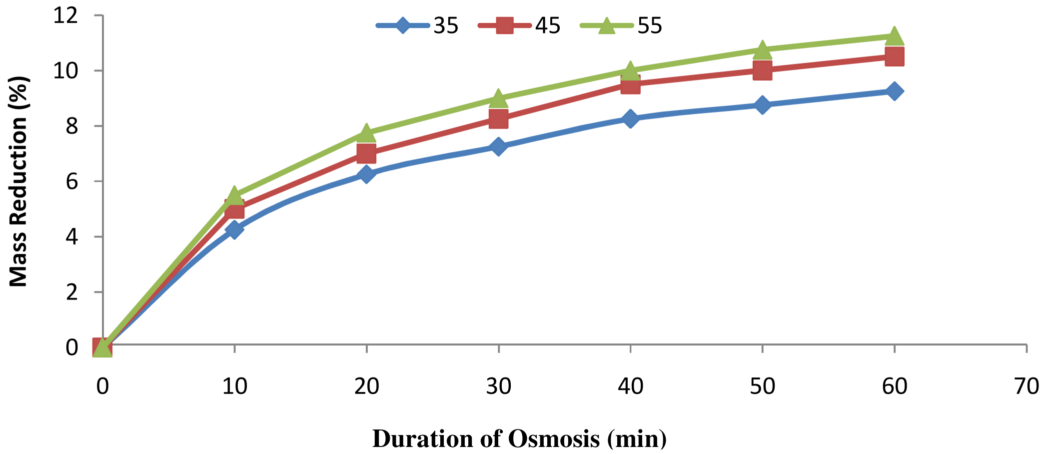
Effect of osmosis on Salt gain in osmosis: The salt gain increased from 0 to 6.63, 0 to 7.40, and 0 to 7.7 per cent when duration of osmotic dehydration increased from 0 to 1h for 5º Brix at 35ºC , 45ºC and 55 ºC temperatures, respectively. Similarly for 12.5 and 20 ºBrix, the salt gain was found to vary from 0 to 6.79, 0 to 7.40 and 0 to 7.84 and 0 to 8.84, 0 to 9.51 and 0 to 10.15 per cent at 35 ºC, 45 ºC and 55 ºC solution temperatures, respectively. It can be observed, when solution temperature increased from 35 to 55ºC for 20 ºBrix, salt gain increased from 8.84 to 10.15 per cent after one hour of osmotic dehydration causing approximately 1.31 per cent point increment. Similarly for 12.5 ºBrix, the salt gain increased from 6.7 to 7.84 per cent when solution temp increased from 35 to 55ºC resulting into 1.14 per cent point increase. Similarly for 5 ºBrix, the salt gain increased from 6.63 to 7.7 per cent when solution temp increased from 35 to 55ºC resulting into 1.07 per cent point increase.

It was revealed that salt gain increased with duration of osmosis and did not approach the equilibrium after 1 hour of osmotic dehydration. The salt gain also increased with the concentration of the solution (Fig.3). This is because of the increased concentration difference between onion and solution with increase in solution concentration. The salt gain also increased with increase in salt temperature. It may be due to collapse of the cell membrane at higher temperatures. Similar results have also been reported by Ertekin and Cakaloz, (1996) and Nsonzi and Ramaswamy, (1998) for peas and blueberries respectively.

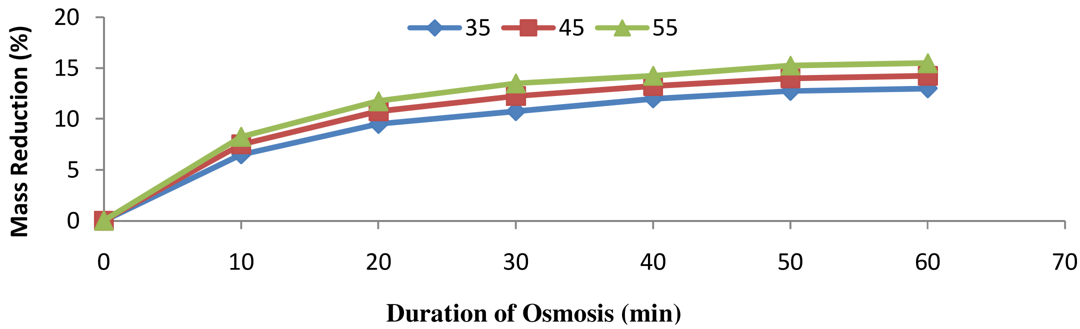
In this part results of osmotically dehydrated as well as unosmosed onion slices under convective drying have been presented. The osmotically dehydrated onion samples were taken out of the salt solution and blotted on tissue paper to remove the adhered water. These osmotically dehydrated onion slices were then dried in convective dryer at drying temperature 70˚C and 80˚C.

The drying curve of onion slices by convective drying and osmo-convective drying process at 70˚C and 80˚C are shown in Fig. 4 and Fig. 5.The drying time in convective drying of fresh onion slices was found to be higher than that observed in osmo-convective drying of onion slices. The drying times of unosmosed and osmosed onions slices by convective drying at 70˚C and 80˚C were 12 and 10 hrs respectively and 8 and 6 hrs respectively. Drying time can be reduced and final product improved using osmo-convective drying technique. Quality of dried product in respect to colour (White value range 0.5- 0.9) and rehydration ratio (4.21-3.19) was superior.

5⁰ Brix



12.5⁰ Brix



20⁰ Brix

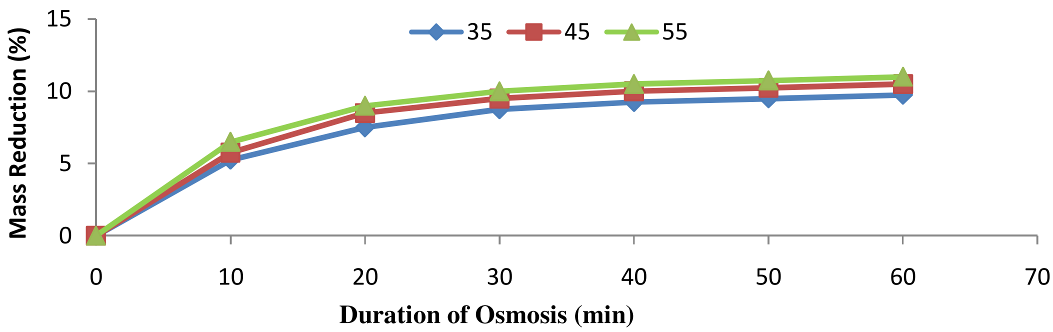


Figure-1
Variation in mass reduction with salt solution concentration and temperature.

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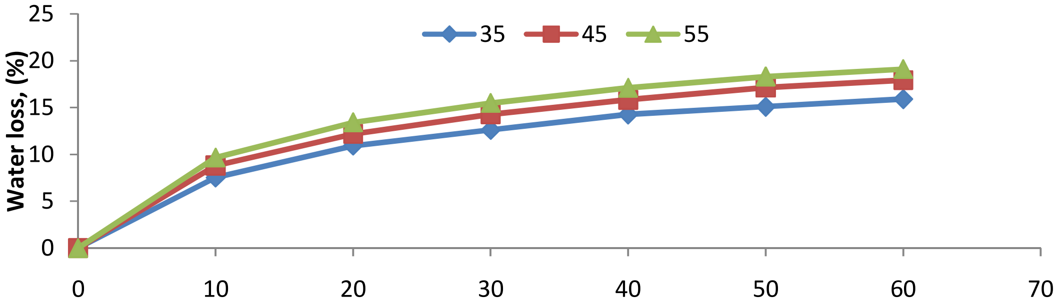
5 ^{0} Brix



Duration of Osmosis (min)

12.5^0 Brix

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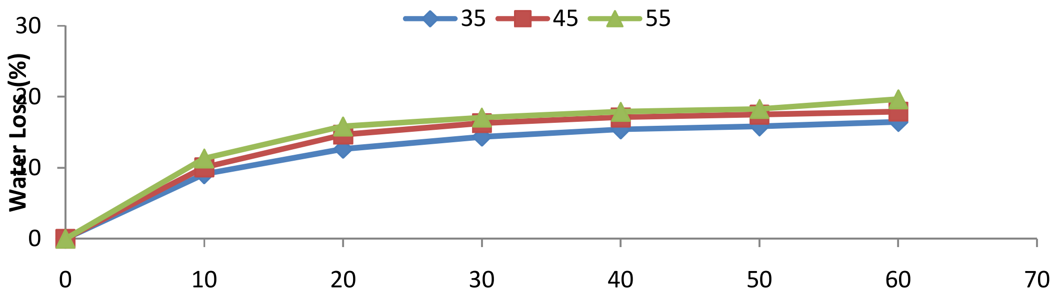
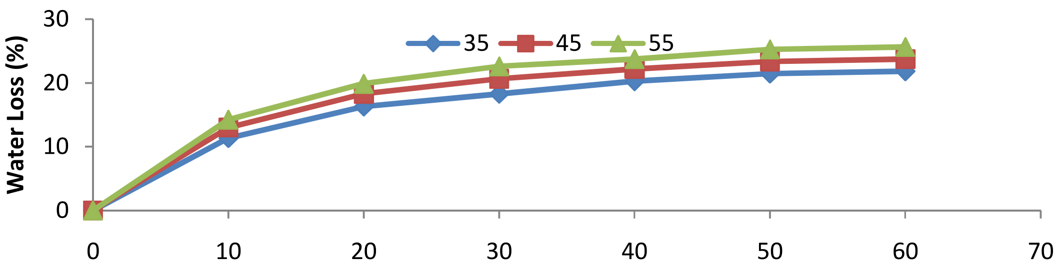


Duration of Osmosis (min)

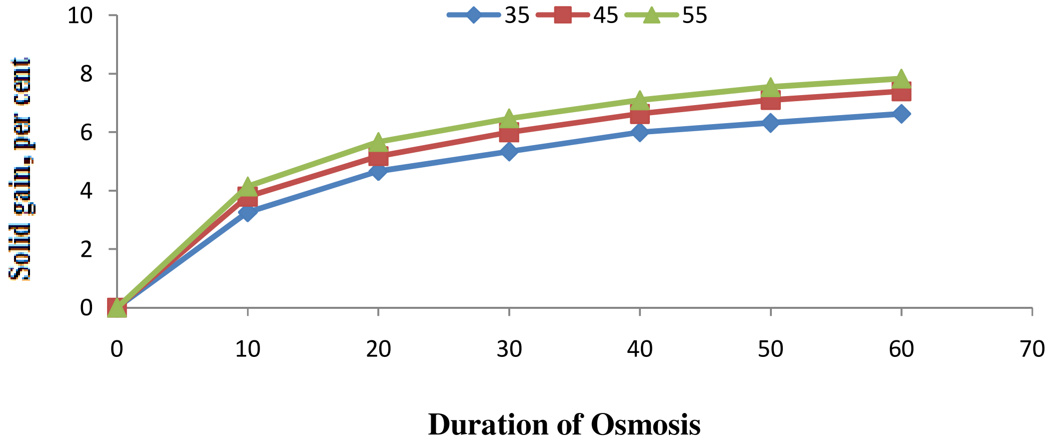
20^0 Brix



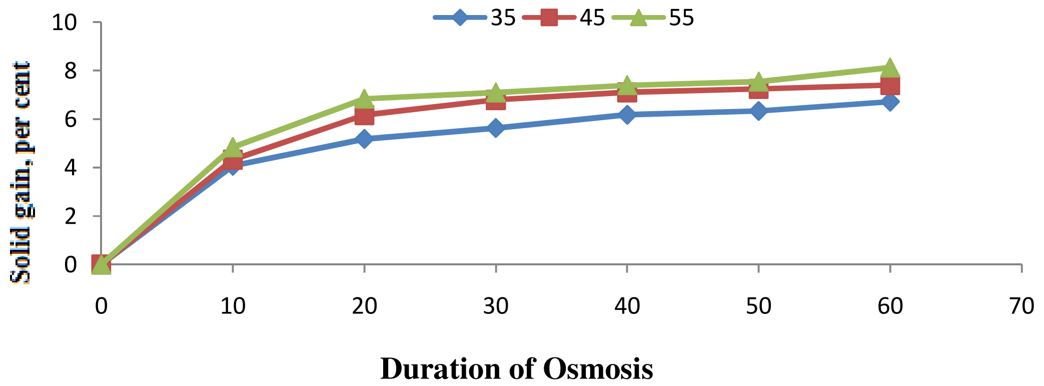
Duration of Osmosis (min)

Figure-2
Variation in water loss with salt solution concentration and temperature

5 ^{0} Brix



12.5^0 Brix



20^0 Brix

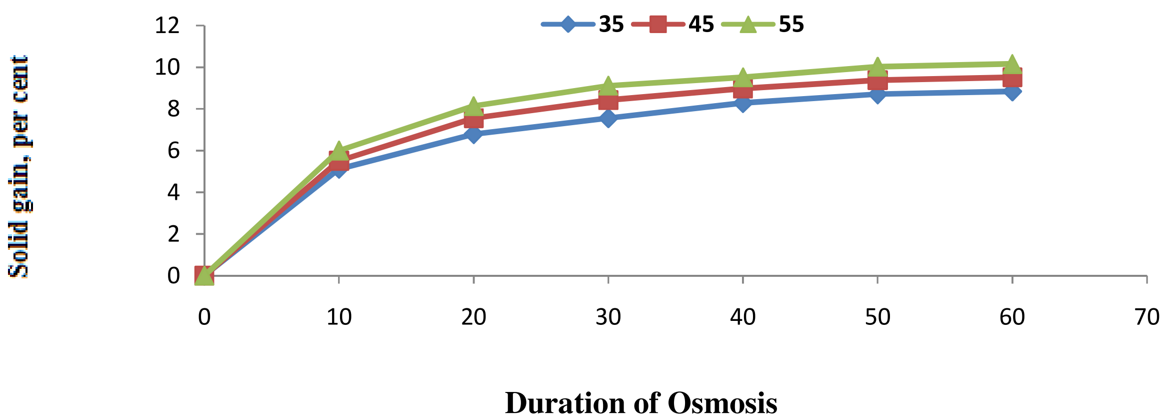


Figure-3
Variation in solid gain with salt solution concentration and temperature

Quality Evaluation of Dehydrated Onion Slices: The unosmosed and osmosed dehydrated onion samples were further evaluated for their quality aspects, such as colour and rehydration ratio.

Colour: Colour is often used as an indication of quality and freshness for food products. Colour values measured using a Lovibond Tintometer Colorimeter Model F.

Table-2
Drying time of onion slices under different conditions.

Sr. No	Drying temperature (˚C)	Time (min)	
		Convective dried samples	Osmo-convective dried samples
1	70	720	480
2	80	600	360

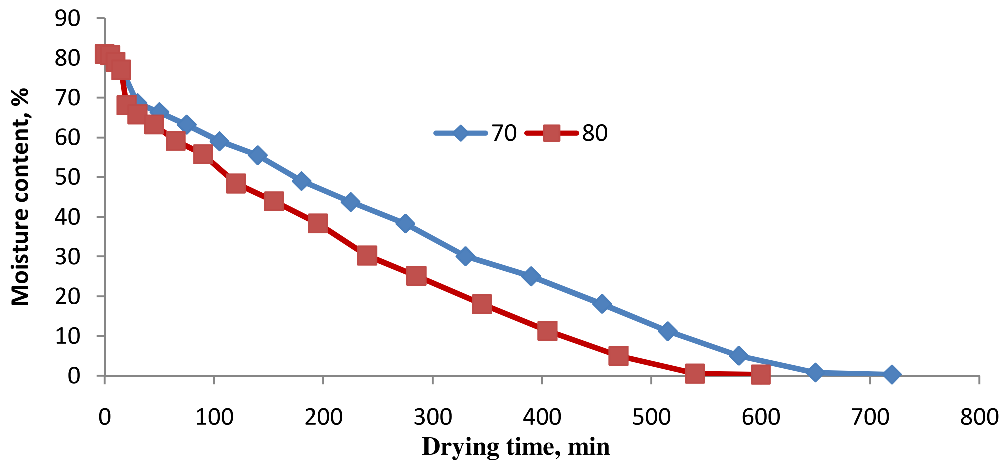


Figure-4
Variation in moisture content of fresh dried onion slices at different drying temperat

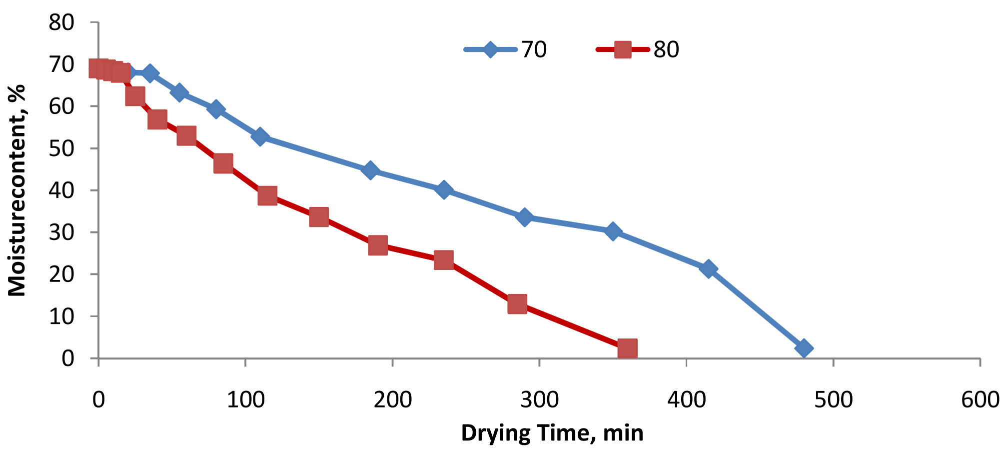


Figure-5
Variation in moisture content of osmo-convective dried onion slices at different drying temperature

It was observed that white value for convective dried and osmo-convective dried onion samples increased with decreasing temperature 80˚ to 70˚C. However, white value range was higher for osmosed (2.66) than un-osmosed (0.33) convective dried onion samples. The higher white value observed at 70˚C temperature for both unosmoed (0.33) and osmosed (2.66) dried onion samples, meaning that sample became lighter in colour at 70˚C temperature.

It was observed that yellow value for osmo-convective dried and convective dried onion samples increased with increasing temperature 70˚ to 80˚C. However, the yellow value was higher for unosmosed (22.3) than osmosed (7) osmo-convective dried onion samples at the same temperature. The yellow value was observed at 80°C temperature for both unosmosed (22.3) and osmosed (7) dried onion sample, meaning that sample became light yellow colour.

Table-3
White and Yellow Values of Convective and Osmo-Convective dried onion sample

Drying method	Drying temperature (˚C)	White	Yellow
Convective Drying	70	0.33	18
	80	0.16	22.3
Osmo-convective Drying	70	2.66	5.3
	80	1.33	7

Rehydration characteristics: The rehydration ratio (RR) was determined as explained in section 3.9.2. The value of the rehydration ratio of convective dried samples ranged from 3.74 to 4.21 at a drying temperature varied from 70˚C and 80˚C. The rehydration ratio of osmo-convective dried samples ranged from 2.42 to 3.19 depending on the experimental condition and was much lower than that of convective dried onion samples. The lowering of rehydration ratio due to osmosis has also been reported by Mazza, (1983). The low rehydration ratio of osmo-convective dried product could be due to higher amount of salt gain in the osmosed slices which in turn would not permit absorption of water on account of the preoccupation of pore spaces. (Table 3)

Table-4
Rehydration characteristics of convective and osmo-convective dried onion slices

Sr No.	Drying Techniques	Drying temperature (˚C)	Rehydration Ratio (RR)
1	Convective Drying	70	3.74
2		80	4.21
1	Osmo-convective Drying	70	2.42
2		80	3.19

Conclusions

Based on the results of the investigation, the following conclusions were drawn: Solution concentration, temperature of solution and duration of osmosis have definite effect on the kinetics of osmotic dehydration of onion samples. Water loss from the onion samples was very rapid for the first half hour of osmosis and reduced subsequently with duration of osmosis. In osmotic dehydration, an increase of salt concentration and temperature of osmosis increased water loss and solid gain. Osmosis as a pretreatment prior to convective drying was able to decrease drying time; it reduced drying time by approximately 40 percent. The values of rehydration ratio of convective dried sample ranged from 3.74 to 4.21 which were higher than the osmo-convective dried onion sample ranged from 2.42 to 3.19. Convective temperature and pretreatment as osmotic dehydration had a significant effect on the colour and rehydration ratio of dried samples. The dehydrated samples with osmotic pre-treatment were more appreciable incomparable to samples without osmotic treatment on the basis colour and rehydration ratio. The onion dehydration was more appreciable at 20 ^{0}Brix solution concentration, 55^{0}C osmosis at 70˚C convective drying temperature on the basis of colour and rehydration ratio.

Notifications: W_1 = Mass of original sample, W_2 = Mass of the sample after drying, g, W_θ = mass of slices after time θ, g**,** W_i = initial mass of slices, g **,** WR = weight reduction**,** W_θ = mass of slices after time θ, g **,** W_i = initial mass of slices, g**,** X_θ = water content as a fraction of mass of slices at time θ., X_i =water content as a fraction of initial mass of slices,

References

1. Baroni A.F. and M. B. Hubinger, Drying of onion: Effects of pretreatment on moisture transport. Drying technology **16**, 9,10, **(1998)**

2. Jain S.K., R.C. Verma, L. K. Murdia and P. K. Dashara, Mass transfer and drying characteristics of osmotically dehydrated papaya cubes followed by Air-drying, National convention held at hyderabad in 2004-2005, **(2004)**

3. Jannot Y., T. Andre, J. Rodolphe, and J. Nganhou, Modelling of banana convective dring by the drying characteristic curve (DCC) method. Drying technology **22(8),** 1949-1968, **(2004)**

4. Krokida, MK., Karathanos VT. and Maroulis ZB, Effect of osmotic dehydration on colour and sorption characteristics of apple and banana. *Drying Technology*, **18(4&5),** 937:50, **(2000)**

5. Pavasovic, V.,Stefanovic, M., and Stefanovic, R. Osmotic dehydration of fruit. : Drying 86. Ed. Mujumdar, A.S. Hemishpere Publ.CO., New York, Vol.**2**, 76, 1986.

6. Rahman M. S. and Jack Lamb, Osmotic dehydration, Drying technology, **19(6):** 1163-1176, **(1990)**

7. Ranganna S., Handbook of analysis and quality control for fruits and vegetable produce, Tata mcgraw hill publishing co-operation limited; New Delhi, **(2000)**.

8. Brooker D. B., F. W. Bakker and C. W. Hall, Drying and storage of grains and oil seeds, The AVI publishing company, Inc. west port, Connecticut: 56-71, **(1974)**.