Effect of Process Variable in Osmo-Convective Dehydration of Pomegranate Arils

Swati Vasudev Mulik
Department of Agricultural Engineering
Maharashtra Institute of Technology
Aurangabad, Maharashtra-431004.(India)

Prof .M.G. Bhosale
Department of Agricultural Engineering
Maharashtra Institute of Technology
Aurangabad, Maharashtra-431004. (India)

Abstract-The present study is carried out to standardize the pretreatment of pomegranate arils and study drying characteristics during convective drying. The effect of process parameters during osmotic dehydration such as duration of osmosis, concentration and temperature of syrup on mass reduction, water loss and sugar gain were studied. It was found that the mass reduction, water loss and sugar gain increased with increase of syrup concentration and temperature. The water loss, mass reduction and sugar gain during osmosis at 30,40 and 50ºBrix was varied in the range of 23.50 to 44.05 per cent, and 21.25 to 35.63and 2.25to 12.96 per cent at 40, 50 and 60ºC temperatures respectively. The drying level and pretreatment as osmotic dehydration had a significant effect on the sensory evaluation and rehydration ratio. The drying times of unosmosed and osmosed pomegranate arils by convective drying at 50, 60 and 700C drying level were 11.66, 8.33 and 6.66 hrs respectively and 7.5, 6.66 and 5 hrs respectively. Quality of dried product in respect to rehydration was superior. The osmo-convective dehydrated samples were found more acceptable than convective dried ones. The pomegranate dried at 400Brix solution concentrations, 400C osmosis temperatures and 600C osmo-convective dryer level was more acceptable on the basis of rehydration ratio.

Keywords- Pomegranate, osmotic dehydration, water loss, mass reduction, sugar gain, convective drying

I.INTRODUCTION

Pomegranate (*Punica granatum*) is grown in tropical and subtropical regions of the world. The total area under cultivation of pomegranate in India is 107.00 thousand ha and production is around 743.00 thousand tons. Pomegranate fruit is one of the most popular, nutritionally rich fruit with unique flavour, taste, and heath promoting characteristics. Pomegranate is a seasonal fruit with very short shelf life therefore it is required to make a self stable value added products from guava using simple drying technology. India is the largest producer of pomegranate with 30 to 40 thousand hectares area and is one of the best loved fruit of country. In India, Maharashtra will lead the table with highest area, production and productivity of pomegranate followed by Karnataka and others states.

Dehydration is an important process to preserve raw food materials and products in the food industry. Nowadays, fresh fruits and vegetables have been increasing in popularity for consumption compared to canned fruits. Researchers have looked for new ways to improve the quality of preserved food products; one of these methods is osmotic dehydration. It has been widely used as a pre-treatment step in food drying process since it can reduce the overall energy requirement for further drying process. Osmotic dehydration removes water from the fruit up to a certain level, and the final water content is too high for adequate food preservation. Therefore, these foods are not stable and usually complementary drying process is required.

Osmotic dehydration is one of the less energy intensive techniques than air or vacuum drying process because it can be conducted at low or ambient temperature. It is the process of water removal by immersing water containing cellular sugars in concentrated aqueous solution. However, it is difficult to obtain a perfect semi-permeable membrane in food systems due to their complex internal structure and there is always some sugar diffusion process. The water and acid diffuse at faster rates initially and get reduced at later stage, while solute from concentrated solution diffuses in opposite direction. The solute penetration in food material is less at first, but increases with respect to time. The solute (sugar) penetration in the fruit directly affects the quality *i.e.* both flavour and taste of the end product (Lazarides and Mavroudis 1995).

Some of the advantages of osmotic process are minimized heat damage, least discolouration of fruits by enzymatic browning, increased retention of volatile, flavours and aroma, improved textural quality and lower energy consumption than the air drying. Although, osmotic process will not give a product of sufficiently low moisture content to be considered a shelf stable product and therefore, osmosed product needs to be further dried, through air, vacuum or freeze drying (Lenart and Lewicki 1988).

II.MATERIALS AND METHODS

The experiments were divided into two parts, *viz.* osmotic dehydration of pomegranate in sugar syrup and Convective drying of osmotically dehydrated products. The preliminary experiments were planned for fixing levels of input variables such as concentration and temperature of sugar solution, ratio of sugar solution and fruits. The experiments were also conducted to assess the quality of the unosmosis and osmo-convective dehydrated product.

Procedure for experiment

1. Raw materials –pomegranate, sugar and distilled water are purchase from local market.

2.Sample and solution preparation-take matured pomegranate .the selected fruit washed under tap water remove to all impurities before arils separation prepared sugar syrup by various concentration it dissolving required amount of distilled water.

3. Measurement of moisture content -the moisture content as well as osmotically dehydrated pomegranate arils was determine by hot air oven method and calculated by the following formula.

$$\%\text{ of moisture content} = \frac{\text{Initial Wt} - \text{final Wt}}{\text{Initial wt}}$$ ………Ranganna, 2000

4. Osmotic dehydration of pomegranate arils-Take 25 g pomegranate samples and immersed in sugar solution at 30, 40 and 50^0brix contained in 250 ml beaker the beakers were placed inside the constant temperature water bath. One beaker was removed from the water bath at designated time and placed on tissue paper to remove the surface moisture. The samples were weighed and their moisture contents were determined.

5. Osmotic dehydration characteristics –there are three drying characteristics will be calculated such as water loss mass reduction and sugar gain.

Water loss (WL)-Water loss is the quantity of water lost by food during osmotic processing. Calculated by the following formula.

$$WL\% = \frac{W1X1 - W2X2}{W1}$$ …. Rehman1996

Mass Reduction -The mass reduction (MR) can be defined as the net weight loss of the fruit on initial weight basis.formula for mass reduction are as follows.

$$MR = \frac{W1 - W2}{W1}$$ …… Rehman 1996

Sugar gain -The sugar gain is the net uptake of sugars by the pomegranate arils on initial weight basis. It is computed using following expression:

SG =WL-MR

6. The level of input parameter in convective drying of osmotically dehydrated pomegranate sample-The independent variable under the study in osmotic dehydration and further followed by convective drying as shown in table 1.

Table.1 level of input parameter in convective drying of osmotically dehydrated pomegranate sample.

Pretreatment conditions of osmotic dehydration					Convective drying temperature (^{0}C)
Sr. No.	Sugar Concentration (^{o}Brix)	Syrup Temperature (^{o}C)	Duration of Osmosis (h)	Syrup to Sample Ratio	
1	30	40,50,and 60	2.30	5:1	50,60and 70
2	40	40,50,and 60	2.30	5:1	50,60and 70
3	50	40,50,and 60	2.30	5:1	50,60and 70

7. Drying characteristics

Moisture content during drying –moisture content of osmotic and convective drying are as follows.

$$\%\ of\ moisture\ content(w.b) = \frac{Initial\ Wt - final\ Wt}{Initial\ wt} \times 100$$

Drying Rate(R) = The moisture content data recorded during experiments were analysed to determine the moisture lost from the sample of pomegranate arils in a particular time interval. The drying rate of sample was calculated by following mass balance equation (Brooker *et al.*, 1974).

$$R = \frac{WML(g)}{Time\ interval(h)}$$

Where,

WML = Initial weight of sample – Final Weight of sample

8. Quality Evaluation -The quality of the unosmosis and osmo-convective dehydrated pomegranate sample is depending upon the rehydration characteristics.

Rehydration ratio-in rehydration ratio dried pomegranate samples was done by placing 10 g sample in beaker and flooding with 1000 g of distilled water at 5 hrs.the sample was strained and filter with paper and weight. The formula for rehydration ratio is (Lewicki *et.al.*1998).

RR=C/D

Where,

C = Weight of re-hydrated sample (g)

D = Test weight of dehydrated sample (g)

III.RESULT AND DISCUSSION

Initial moisture content – The initial moisture content of osmotically dehydrated pomegranate sample was found to be 82.82 % (w.b) by the hot air oven method.

Effect of water loss in osmosis- The water loss after osmotic dehydration was found to be in the range of 23.50 to 44.05 %. The water loss increased from 0 to 30.29, 37.64 and 38.97 per cent when duration of osmotic dehydration increased from 0 to 2.30 h for 30^{o}Brix at 40, 50 and 60^{o}C temperatures respectively. For 40^{o}Brix, the water loss was found to vary from 0 to 32.37, 40.42, and 41.02% and similarly at 50^{o}Brix was found to vary from 0 to 34.05, 40.82 and 44.05 % at 40, 50 and 60^{o}C respectively.

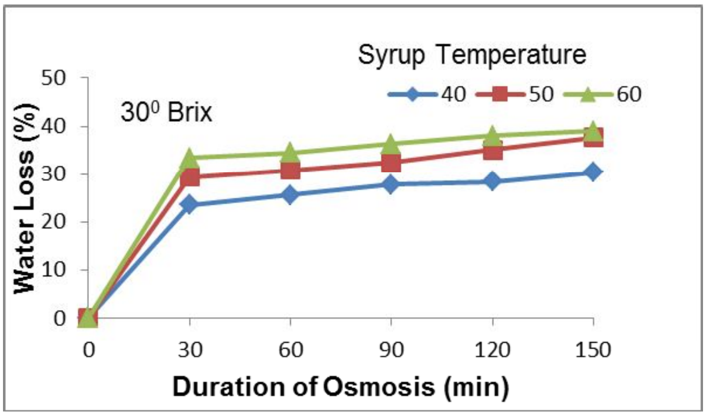
A low temperature and concentration condition (40^{o}C-30^{o}Brix) resulted in a low water loss (30.29 % after 2.30 h of osmosis) and a high temp and concentration condition (60^{o}C-50^{o}Brix) resulted in a higher water loss (44.05 % after 2.30 h of osmosis). This indicates that water loss can be increased by either increasing the syrup temperature or concentration of solution (Fig.1).

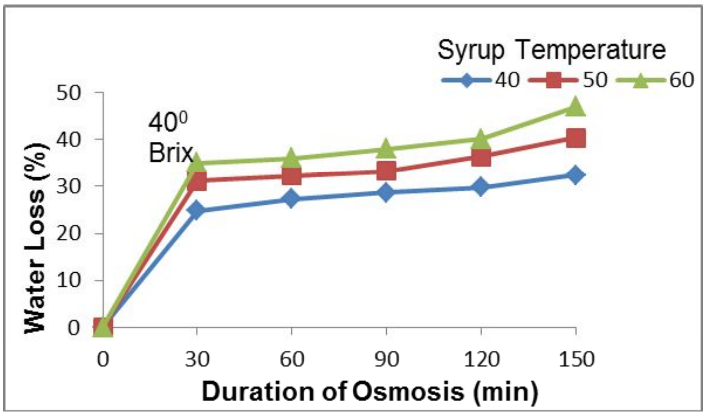
Effect of mass reduction in osmosis- The mass reduction after osmotic dehydration was found to be in the range of 21.25 to 35.63 %. The mass reduction increased from 0 to 26.22, 31.01 and 32.25 per cent when duration of osmotic dehydration increased from 0 to 2.30 h at 40, 50 and 60°C temperatures respectively for 30°Brix while for 40° and 50°Brix it was found to vary from 0 to 27.75, 32.11 and 34.12 % and from 0 to 29.25, 34.10 and 35.63 per cent at 40, 50 and 60°C respectively. (Patil, 2011)

A low temperature and concentration condition (40°C-30°Brix) resulted in a low mass reduction (21.25 % after 2.30 h of osmosis) and a high temp and concentration condition (60°C-50°Brix) resulted in a higher mass reduction (35.63 % after 2.30 h of osmosis) (Fig.2). This indicates that mass reduction can be increased by either increasing the syrup temperature or concentration of solution. Finally resulted the mass reduction increased with increase in temperatures as shown in fig.2.

Effect of sugar gain in osmosis- The mass reduction after osmotic dehydration was found to be in the range of 2.25 to 12.96 %. The sugar gain was increased from 0 to 4.07, 6.63 and 6.72 % when duration of osmotic dehydration increased from 0 to 2.30 h for 30°Brix concentration at 40, 50 and 60°C syrup temperatures respectively. For 40°Brix concentration, the sugar gain was found to vary from 0 to 4.62, 8.31 and 12.90 and for 50°Brix it varied from 0 to 7.50, 8.38 and 12.96 % for 40, 50 and 60°C syrup temperature respectively.

A low temperature and concentration condition (40°C-30°Brix) gives a low sugar gain (4.07 % after 2.30 h of osmosis) and a high temp and concentration condition (60°C-50°Brix) gives a higher sugar gain (12.96 per cent after 2.30 h of osmosis). The low temperature-high concentration condition 40°C-40°Brix and 40°C-50°Brix gives a slightly lower sugar gain of 4.62 and 7.50 after 2.30 h of osmosis than high temperature-high concentration condition 60°C-40°Brix and 60°C-50°Brix as 12.90 and 12.96 % sugar gain (after 2.30 h of osmosis) indicates a pronounced effect of temperature on sugar gain shown in fig.3 (Ertekin and Cakaloz (1996) and Nsonzi and Ramaswamy (1998).





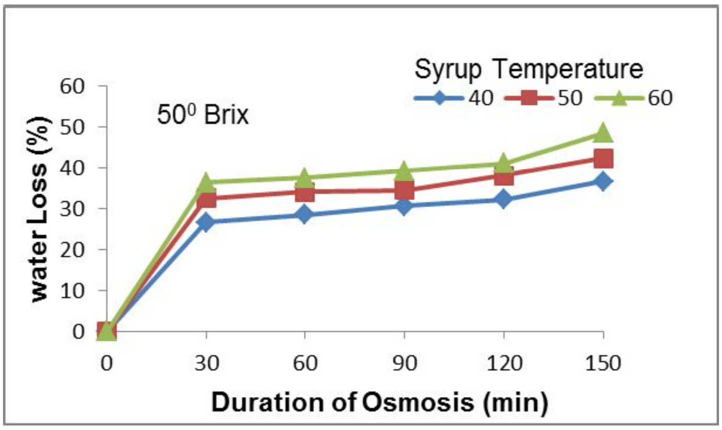
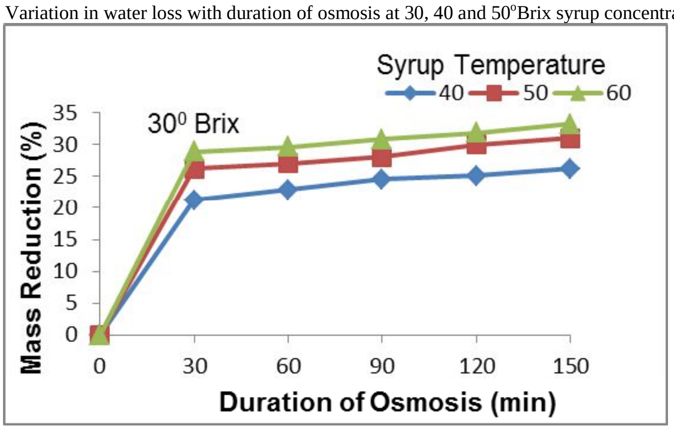
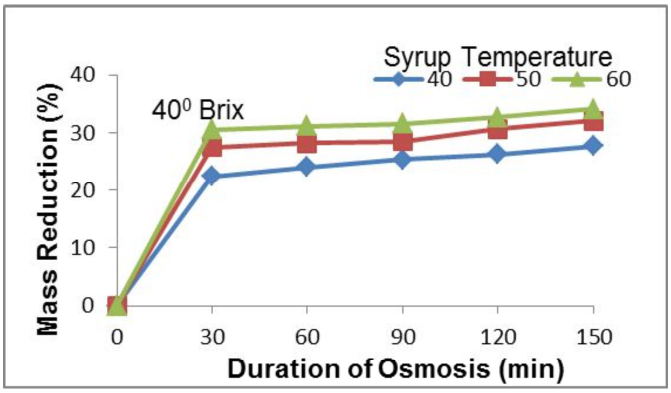


Fig.1 Variation in water loss with duration of osmosis at 30, 40 and 50^{o}Brix syrup concentration





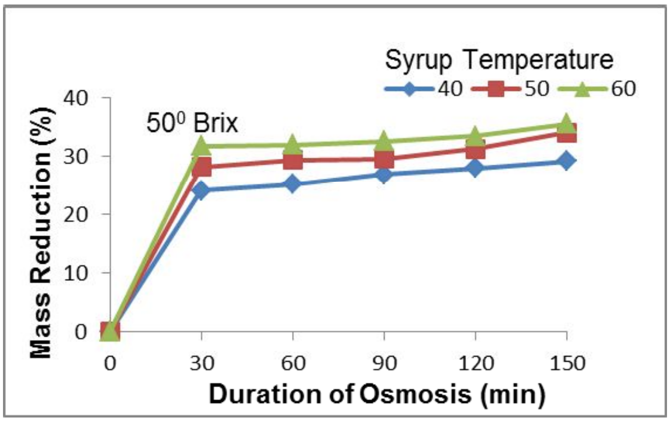
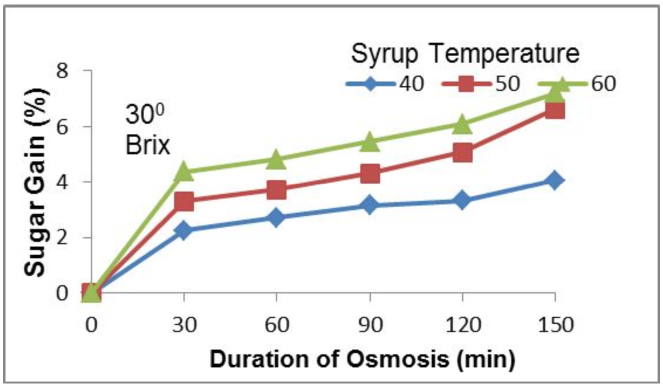
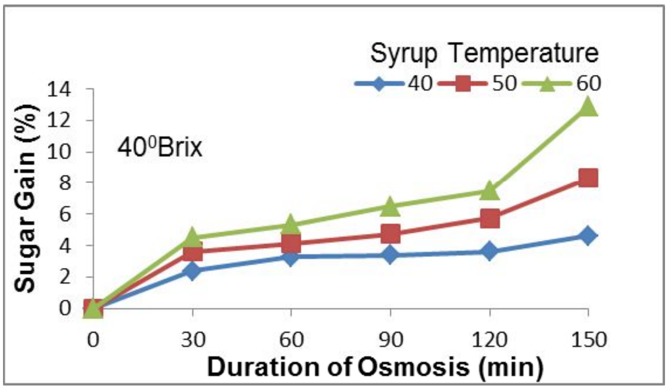


Fig.2 Variation in mass reduction with duration of osmosis at 30, 40 and 50oBrix syrup concentration





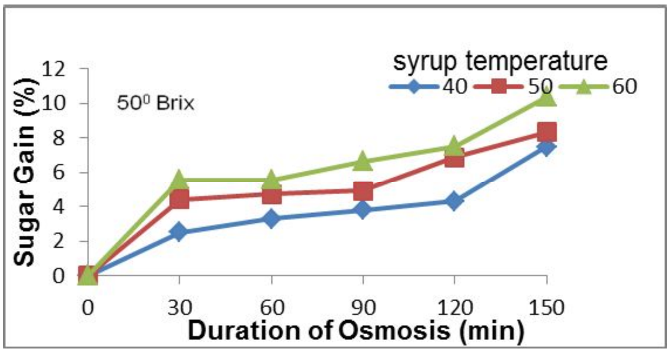


Fig.3 Variation in sugar gain with duration of osmosis at 30, 40 and 50oBrix syrup concentration

Convective drying–In this part result osmotically dehydrated as well as unosmosed pomegranate arils convective drying has been presented. The osmotically dehydrated pomegranate arils dried in convective drying at 50, 60 and 70^0C.

The drying curve of the pomegranate sample of convective and osmo-convective drying process at 50, 60 and 70^0C as shown in fig.4 and 5. The drying time of convective drying pomegranate arils was found to be higher than that of osmo-convective drying of pomegranate arils. The drying times of unosmosed and osmosed pomegranate arils by convective drying at 50, 60 and 70^0C drying level were 11.66, 8.33 and 6.66 hrs respectively and 7.5,6.66 and 5 hrs respectively. Drying time can be reduced and final product improved using osmo-convective drying technique as shown in table.2 Quality of dried product in respect to rehydration ratio (range from 3.65 to 4.52) is 60^0C at osmo-convective dehydration was superior.

Table.2. Drying time of pomegranate arils under different conditions.

Sr. No	Convective drying levels (^{0}C)	Time (min)	
		Convective dried samples	Osmo- Convective dried samples
1	50	700	450
2	60	500	400
3	70	400	300

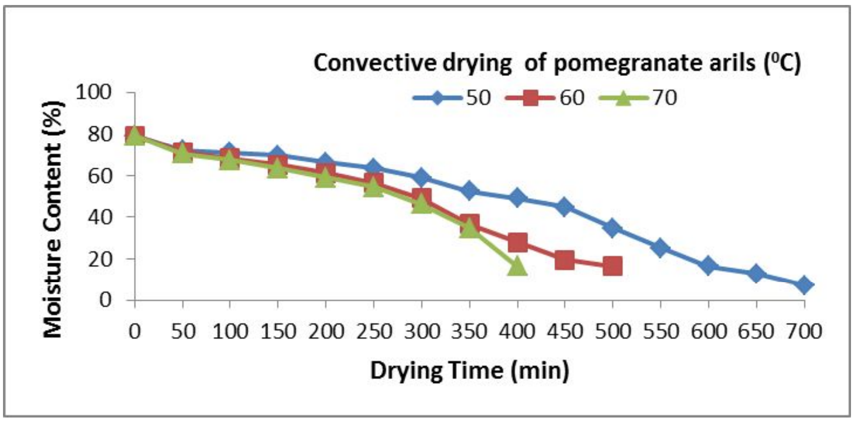


Fig.4 Variation in moisture content of fresh pomegranate arils at different convective dryer levels.

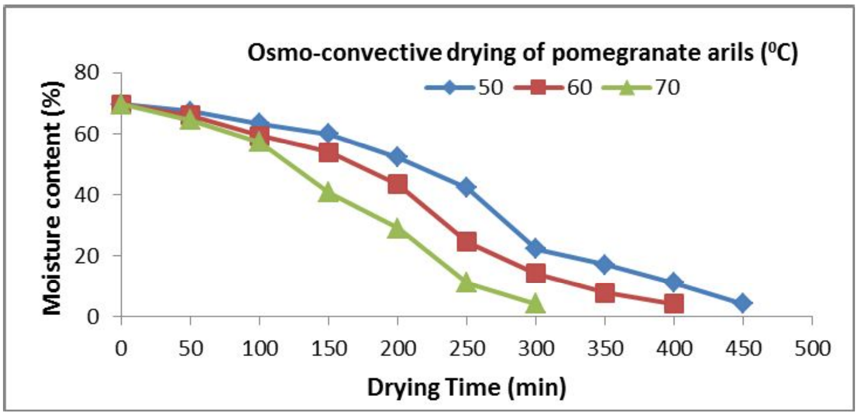


Fig.5 Variation in moisture content of fresh pomegranate arils at different osmo-convective dryer levels.

Quality evaluation of the dehydrated pomegranate arils- The unosmosed and osmosed dehydrated pomegranate arils were further evaluated for their quality aspects of re-hydration ratio.

Rehydration ratio-The value of the rehydration ratio of convective dried samples ranged from 3.65 to 4.52 at a drying levels varied from 50,60 and 70^{0}C. The rehydration ratio of osmo-convective dried samples ranged from 2.55 to 3.98 depending on the experimental condition and was much lower than that of convective dried pomegranate 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 sugar gain in the osmosed arils which in turn would not permit absorption of water on account of the preoccupation of pore spaces (Table 3).

Table.3. Rehydrational characteristics of convective and osmo-convective dried pomegranate arils.

Sr.no	Drying Techniques	Drying Level (^{0}C)	Rehydration ratio(RR)
1	Convective Drying	50	3.65
2		60	4.12
3		70	4.52
4	Osmo-convective Drying	50	2.55
5		60	2.82
6		70	3.38

IV.CONCLUSIONS

It was concluded that the Solution concentration, temperature of solution and duration of osmosis have definite effect on the osmotic dehydration of pomegranate arils. Water loss from the pomegranate arils was very rapid for the first 30 min of osmosis and reduced subsequently with duration of osmosis. In osmotic dehydration, an increase of sugar concentration and temperature of osmosis increased water loss,mass reduction and solid gain. Osmosis as a pretreatment prior to convective drying was able to decrease drying time; it reduced drying time by approximately 45 percent. The values of rehydration ratio of convective dried sample ranged from 3.65 to 4.52which are higher than the osmo-convective dried sample range from 2.55 to 3.98. Convective temperature and pretreatment as osmotic dehydration had a significant effect on the rehydration ratio of dried samples. The dehydrated samples with osmotic pre-treatment were more appreciable incomparable to samples without osmotic treatment on the basis rehydration ratio. The pomegranate dehydration was more appreciable at 40 0Brix solution concentration, 40^0C osmosis at 60°C convective drying temperature on the basis of rehydration ratio.

Notifications:-W_1=Mass of seeds after time1,W_2 =Initial mass of seeds g. X_1 = Water content as a fraction of mass of seeds at time, 1.X_2 =Water content as a fraction of initial mass of seeds, fraction.

REFERENCES

[1] Anita p. and Tiwari R.B. 2014 Effect of Different Osmotic Pretreatments on Weight Loss, Yield and Moisture Loss in Osmotically Dehydrated Guava. *Journal of AgriSearch 1(1):49-54.*

[2] Patil M.M, Kalse S.B. and Jain S.K 2012 OSMO-Convective Drying of Onion Slices. *Research Journal of Recent Sciences, 51-59.*

[3] Chaudhari, AP; Kumbhar, BK and Narain M. 2000. Effect of some process parameters on osmotic dehydration of papaya. *Journal of Institution of Engineers (Agricultural Engineering division)*, 81:59-63.

[4] Lewicki, PP and Lenart, A. 1995. Osmotic dehydration of fruits and vegetables. *Handbook of Industrial Drying* Edited by Majumdar, AS Marcel Dekker, Inc: 691-713.

[5] Pokharkar, S.M. 1994. Studies on osmotic concentration and air drying of pineapple slices. *Unpublished Ph D Thesis*, Indian Institute of Technology, Kharagpur. *Journal of Food Process Engineering,* 14:163-71.

[6] Lenart, A and Flink, JM. 1984a. Osmotic concentration of potato. I Criteria for the end point of the osmotic process.*Journal of Food Technology,* 19:45-63.

[7] AOAC 1984. *Official Methods of Analysis.* 14th Ed. Edited by Sidney Williums. Published by the Association of Official Analytical Chemists, Inc. Arlington, Virginia, 22209, USA.

[8] Brooker, D.B; Bakker, F.W and Hall, C.W; 1974. Drying and storage of grains and oilseeds. *The AVI Publishing Company, Inc.* Westport, Connecticut: 56-71.

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

[10] Nsonzi, F and Ramaswamy, H.S. 1998. Osmotic dehydration kinetics of blueberries. *Drying Technology*, 16(3-5):725-41.

[11] Lenart, A and Flink, JM. 1984a. Osmotic concentration of potato.I Criteria for the end point of the osmotic process. *Journal of Food Technology*, 19:45-63