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Effect of drying methods and pretreatments on dehydration and rehydration characteristics of osmo-dried papaya slices

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■ **ABSTRACT :** Papaya slices were treated with different pre-treatments namely control, T_1 = Control, T_2 = Potassium metabisulphate, T_3 = Sodium bisulphate and T_4 = Blanching at 95°C for 4 minute. The treated sample were osmosed in syrup solution of 55 °Brix and 65 °Brix for period of 180 minutes, than wiped and dried in tray dryer and hot air oven dryer at 60°C. It was revealed from the results that, drying of papaya slices in a hot air oven dryer takes only 600 minutes for drying from an initial weight of sample to final weight of sample. The rehydration ratio was recorded of 65 °Brix that 4.95, 2.61, 3.05 and 2.89 for T_1, T_2, T_3 and T_4 samples after 90 days. Drying of papaya slices in a Tray dryer takes only 660 minutes. The dehydration ratio was recorded of 65 °Brix that 8.40, 3.52, 4.13 and 3.10 for T_1, T_2, T_3 and T_4 samples.

■ **KEY WORDS :** Dehydration ratio, Rehydration ratio, Co-efficient, Osmo-dried papaya slice

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Osmotic dehydration (OD) is one of most important complementary treatment and food preservation technique in the processing of dehydrated foods, since it presents some benefits such as reducing the damage of heat to the flavour, colour, inhibiting the browning of enzymes and decrease the energy costs (Alakali *et al*., 2006 and Torres *et al*., 2006). Osmotic dehydration results in increased shelf-life, little bit loss of aroma in dried and semidried food stuffs, lessening the load of freezing and to freeze the food without causing unnecessary changes in texture (Petrotos and Lazarides, 2001). It has been reported that osmotic dehydration reduced upto 50 per cent weight of fresh vegetables and fruits (Rastogi and Raghavararo, 1997).

Osmotic dehydration of fresh produce can also be used as a pre-treatment to additional supplementary drying processing to improve sensory, functional and even nutritional properties.Water removal from fruit and vegetables by drying is one of the oldest forms of food preservation known to man and is the most important process to preserve food. Water, being one of the main food components, has a decisive direct influence on the quality and durability of foodstuffs through its effect on many physico-chemical and biological changes. The use of the osmotic dehydration process in the food industry has several advantages: quality improvement in terms of colour, flavour and texture, energy efficiency, packaging and distribution cost reduction, no chemical pretreatment, providing required product (El-Aour *et al*., 2006). In the process of osmotic dehydration, fruit is placed into a hypertonic solution where water is drawn out of the produce and into the solution due to the differences in their concentrations (Kumar *et al*., 2019). The loss in water content of a sample is depending on drying time. In general the time of treatment increase, the weight loss increased but the rate at which this occur decrease (Kumari *et al*., 2013). Drying is a complex process involving transient heat and mass transfer and various factors should be taken into account (Prakash *et al*., 2004). For an optimized dryer and process design and improved drying process parameters and hence quality (Amin *et al*., 2015).

Experimental plan:

Papaya slices were pre-treatment with treatments (T_1 = Control, T_2 = Potassium metabisulphate, T_3= Sodium bisulphate and T_4 = Blanching at 95°C for 4 min.) in osmotic solution at temperature of 50°C. Then the samples were dried under hot air oven drier at 60°C temperature. During the process, osmosis was carried out in sucrose solution at a varying concentration of 55°Brix and 65°Brix. At each experimental condition, osmotic dehydration was carried out for 180 minutes and data are observed at each 30 min intervals.

Experimental procedure:

The papaya was procured from the local market of Meerut (UP) in 2018. The papaya was then washed, and decides into 2.5 x 2.5 x 2.5 cm Size. The papaya slices were treated above decided treatments for 30 minutes and then the sample were removed from treated solution and placed at room temperature for 15 minutes and then weighted by electrical balance. After that the samples were osmosed with sugar solution (55°Brix and 65°Brix) for 180 minutes at 50°C temperature and then the osmo-dried papaya slices were dried in hot air oven drying at 60°C.

Dehydration ratio (DR):

Dehydration ratio was calculated by taking the weights of sample before drying and the weight of sample after drying.

Calculation:

$$\text{Dehydration ratio (D.R.)} = \frac{\text{Weight of sample before drying}}{\text{Weight of sample after drying}}$$

Rehydration ratio (RR):

Rehydration tests for dehydrated samples were carried out by immersing 5 g sample in 50 ml distilled water at 35°C in a 100 ml beaker kept in a hot water bath to maintain a water temperature of 35°C for 5 hr (Nsonzi and Ramaswamy, 1998). Dehydrated samples were evaluated for rehydration ratio, from the weight before and after the rehydration.

$$\text{Rehydration ratio (R.R.)} = \frac{C}{D}$$

where,

C = Drained weight of rehydrated sample (g)

D = Test weight of dehydrated samples (g).

$$\text{Co-efficient of reconstitution} = \frac{\text{Rehydration ratio (R.R.)}}{\text{Dehydration ratio (D.R.)}}$$

Per cent water in rehydrated material:

The per cent water in rehydrated material was determinedas per the methods of Ranganna (2003).

$$\text{Per cent water in rehydrated material} = \frac{\text{(Drained wt. of rehydrated material)} - \text{(Dry matter content in sample taken for rehydration)}}{\text{Drained wt. of rehydrated material}} \times 100$$

■ RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Effect on dehydration ratio of osmo-dried papaya slices through different drying methods:

It was found that the dehydration ratio data on tray dryer and H.A.O. dryer of osmo-dried papaya slices ranged 8.12 (T_1) and 7.53 (T_1) at same level of (55°) brix, 8.40 (T_1) and 7.81 (T_1) at 65 °Brix. The value of dehydration ratio were found that 3.81 (T_2), 4.45 (T_3) and 3.35 (T_4) at 55 °Brix for tray dryer. And the value of dehydration ratio were found that 3.52 (T_2), 4.13 (T_3) and 3.10 (T_4) at 65 °Brix for tray dryer. The dehydration ratio of H.A.O. dried papaya slices were obtained 3.53 (T_2), 4.35 (T_3) and 3.86 (T_4) at 55 °Brix. And the value of dehydration ratio were found that 3.90 (T_2), 4.84 (T_3) and 4.14 (T_4) at 65 °Brix for tray dryer. The complete data are show in Table 1.

Effect on rehydration ratio:

Rehydration is a complex phenomenon affected by numerous factors. Important factor that would affect the rehydration is the changing of cell structure during the drying process. It was found that there is difference between the rehydration characteristics of dried products with different pre-treatments even when the products were dried by the same drying method. In most cases, the changing of cell structure is related to drying product temperature. The rehydration ratio of tray dried papaya slices were immersed in syrup concentration of 55 °Brix and 65 °Brix for different storage on 0, 30, 60 and 90 days time periods. The Effect of rehydration ratio on osmo-convective dehydration papaya slices clearly shows in Table 2.

Osmotic pretreatment resulted in decrease in the diffusion co-efficient of water. This might be due to attributed to an increase in the proportion of ruptured and shrunken cells caused by osmotic treatment which in turn reduced the ability of dried onion tissues to absorb water. As temperature increased, the rehydration ratio increased slightly resulting in a proportional increase in the rehydration efficiency. This is because the faster drying caused less damage to the cells and as a consequence the water absorption efficiency was more. The pretreatment resulted in ruptured and shrunken cells in cellular structure, which, in turn, decreased the diffusion co-efficient of water absorption (Gouda *et al*., 2017).

Effect on rehydration ratio for tray dryer at 55 °Brix during storage:

It was observed that the rehydration ratio of T_1 sample 4.814, 4.819, 4.82 and 4.821 after 0, 30, 60 and 90 days of storage period respectively. The T_2 sample was observed that the rehydration ratio 3.06, 3.08, 3.1 and 3.12 after same storage period, respectively. The $T_3$was observed that the rehydration ratio 2.42, 2.46, 2.47 and 2.47 on same storage period. And the T_4 samples was observed that the rehydration ratio 3.44, 3.45, 3.45 and 3.45 after 0, 30, 60 and 90 days of storage period, respectively. The complete data are show in Table 2.

Table 1: Effect on dehydration ratio of different drying methods

Treatments	Tray dryer		H.A.O. dryer	
	55°Brix	65°Brix	55°Brix	65°Brix
T_1	8.12	8.40	7.53	7.81
T_2	3.81	3.52	3.53	3.90
T_3	4.45	4.13	4.35	4.84
T_4	3.35	3.10	3.86	4.14

Table 2 : Effect on rehydration ratio of different drying methods at 55 °Brix

Treatments	Rehydration ratio (R.R.)							
	T.D.	H.A.O.	T.D.	H.A.O.	T.D.	H.A.O.	T.D.	H.A.O.
	0day	0day	30days	30 days	60 days	60 days	90 days	90 days
T_1	4.814	5.04	4.819	5.06	4.82	5.07	4.821	5.08
T_2	3.06	2.24	3.08	2.27	3.1	2.29	3.11	2.3
T_3	2.42	3.02	2.46	3.05	2.47	3.07	2.47	3.07
T_4	3.04	2.48	3.45	2.54	3.45	2.55	3.45	2.56

Description: T.D.= Tray dryer, H.A.O.= Hot air oven, °B = Degree brix

Table 3 : Effect on rehydration ratio of different drying methods at 65 °Brix

Treatments	Rehydration ratio (R.R.)							
	T.D.	H.A.O.	T.D.	H.A.O.	T.D.	H.A.O.	T.D.	H.A.O.
	0day	0day	30days	30 days	60 days	60 days	90 days	90 days
T_1	4.92	4.88	4.93	4.9	4.96	4.91	4.96	4.95
T_2	2.62	2.56	2.64	2.57	2.67	2.59	2.69	2.61
T_3	2.94	3	2.95	3.02	2.96	3.04	2.98	3.05
T_4	1.8	2.8	2	2.83	2.05	2.85	2.1	2.89

Description: T.D.= Tray dryer, H.A.O.= Hot air oven, °B = Digree brix

Effect on rehydration ratio for H.A.O. dryer at 55 °Brix during storage :

It was observed that the rehydration ratio of T_1 sample 5.04, 5.06, 5.07 and 5.08 after 0, 30, 60 and 90 days of storage period, respectively. The T_2 sample was observed that the rehydration ratio 2.04, 2.27, 2.29 and 2.30 after same storage period, respectively. The T_3 was observed that the rehydration ratio 3.02, 3.05, 3.07 and 3.07 on same storage period. And the T_4 samples was observed that the rehydration ratio 2.48, 2.54, 2.55 and 2.56 after 0, 30, 60 and 90 days of storage period, respectively. The complete data are show in Table 2.

Effect on rehydration ratio for tray dryerat 65° Brix during storage:

It was observed that the rehydration ratio of T_1 sample 4.92, 4.93, 4.96 and 4.96 after 0, 30, 60 and 90 days of storage period, respectively. The T_2 sample was observed that the rehydration ratio 2.62, 2.64, 2.67 and 2.69 after same storage period, respectively. The $T_3$was observed that the rehydration ratio 2.94, 2.95, 2.96 and 2.98 on same storage period. And the T_4 samples was observed that the rehydration ratio 1.8, 2.0, 2.05 and 2.1 after 0, 30, 60 and 90 days of storage period, respectively. The complete data are show in Table 3.

Effect on rehydration ratio for H.A.O. dryer at 65 °Brix during storage:

It was observed that the rehydration ratio of T_1 sample 4.88, 4.9, 4.91 and 4.95 after 0, 30, 60 and 90 days of storage period, respectively. The T_2 sample was observed that the rehydration ratio 2.56, 2.57, 2.59 and

Table 4 : Effect of tray drying method on rehydration characteristics of osmo-dried papaya slices at 55 °Brix

	Treatments	Rehydration	Dehydration	Co-efficient of reconstitution	M.C. (wb%) of rehydrated
Tray dryer	T_1	4.814	8.12	0.593	79.38%
	T_2	3.06	3.81	0.803	67.32%
	T_3	2.42	4.45	0.544	58.68%
	T_4	3.04	3.35	0.907	70.93%

Table 5 : Effect of tray drying method on rehydration characteristics of osmo-dried papaya slices at 65 °Brix

	Treatments	Rehydration	Dehydration	Co-efficient of reconstitution	M.C. (wb%) of rehydrated
Tray dryer	T_1	4.92	8.40	0.586	79.67%
	T_2	2.62	3.52	0.744	61.83%
	T_3	2.94	4.13	0.712	65.99%
	T_4	1.8	3.10	0.581	44.44%

Table 6 : Effect of hot air oven drying method on rehydration characteristics of osmo-dried papaya slices at 55 °Brix

	Treatments	Rehydration	Dehydration	Co-efficient of reconstitution	M.C. (wb%) of rehydrated
Tray dryer	T_1	5.04	7.53	0.669	80.16%
	T_2	2.24	3.53	0.635	55.36%
	T_3	3.02	4.35	0.694	66.89%
	T_4	2.48	3.86	0.642	59.68%

Table 7 : Effect of hot air oven drying method on rehydration characteristics of osmo-dried papaya slices at 65 °Brix

	Treatments	Rehydration	Dehydration	Co-efficient of reconstitution	M.C. (wb%) of rehydrated
Tray dryer	T_1	4.88	7.81	0.6248	79.51%
	T_2	2.56	3.90	0.656	60.94%
	T_3	3	4.84	0.620	66.67%
	T_4	2.8	4.14	0.676	64.29%

2.61 after same storage period, respectively. The T_3 was observed that the rehydration ratio 3.0, 3.02, 3.04 and 3.05 on same storage period. And the T_4 samples was observed that the rehydration ratio 2.80, 2.83, 2.85 and 2.89 after 0, 30, 60 and 90 days of storage period, respectively. The complete data are show in Table 3.

Effect of drying methods on rehydration characteristics of osmo-dried papaya slices:

In this study the rehydration characteristics, dried products were boiled for final reconstitution (the stage at which the absorption of water is maximum). It was foundthat there is difference between the rehydration characteristics of dried products with different treatments even when the products were dried by the same drying method. The experiment show that the rehydration characteristics in Tables 4 to 7 (Vikrant *et al.*, 2019).

Conclusion:

It can be concluded that the slices which are treated with 65 °Brix osmotic solution at 55 °C temperature and cabinet drying at 60 °C temperature in hot air oven dryer shows the better rehydration characteristics along with nutritional compounds retention.

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