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Bhavanee KND
College of Horticulture, Dr. Y.S.R. Horticultural University, Venkataramannagudem, Andhra Pradesh, India

Rajasekhar M
Sri Konda Laxman Telangana State Horticultural University, Telangana, India

Rajya Lakshmi R
College of Horticulture, Dr. Y.S.R. Horticultural University, Parvathipuram, Andhra Pradesh, India

Vengaiah PC
Horticultural Research Station, Pandirimamidi, Rampachodavaram, Andhra Pradesh, India

Corresponding Author:
Bhavanee KND
College of Horticulture, Dr. Y.S.R. Horticultural University, Venkataramannagudem, Andhra Pradesh, India

Studies on the preparation of jackfruit osmo-dehydrated slices

Bhavanee KND, Rajasekhar M, Rajya Lakshmi R and Vengaiah PC

Abstract
Osmotic dehydration, a method of preservation has the advantage of being very easy to perform for home and small scale processing. Preservation of jackfruit (*Artocarpus heterophyllus* Lam.) by osmotic dehydration method has been standardized to reduce the post-harvest losses. Osmo-dehydrated slices were prepared using 50, 60 and 70% sugar, 0.2 and 0.4% of citric acid as preservatives. After drying, jackfruit slices were packed and stored at ambient temperatures for a period of 90days and evaluated for different quality characters at every 15 days interval. Osmo-dehydrated slices prepared using 60% sugar, 0.4% citric acid and dried in electrical dehydrator showed better retention of quality, nutritionally rich and more acceptable even at 90th day of storage. It was observed that TSS, total sugars and reducing sugars showed increasing trend whereas titratable acidity and β-carotene content exhibited decreasing trend during the storage period of 90 days. It can be inferred from the study, that the flavour, taste and nutritional quality of fruit bar and osmodehydrated slices prepared in electrical dehydrator were good with acceptable colour where as the products prepared in solar dryer turned brown by 60th day.

Keywords: Utilization, preservation, osmosis, shelf life, acceptance

1. Introduction
Fruits are nature's wonderful gift to the mankind; indeed, they are life-enhancing medicines packed with vitamins, minerals, anti-oxidants and many phyto-nutrients that help human body free from diseases and keep it healthy. Jackfruit (*Artocarpus heterophyllus* Lam.) belongs to the family Moraceae and it is the world's largest fruit called by a variety of names *viz*., *kathal, panasa, jaca, nangka, kanoon* and *mit*, etc and it is the national fruit of Bangladesh (Siddique and Azad, 2010) [1]. Fruits are botanically called as sorosis and develop during spring and summer. The tender fruits come to market from March onwards and continue till August.The fruits become ready for harvest in May-June. In addition to regular bearing season (March-June), where as Palur-1 produces fruits during off season also (October- December).

The interior of the fruit contains large fleshy sweet bulbs which may be crispy or soft and yellow to brownish when ripe. Pulp is rich in vitamin-A, B, C, K, minerals calcium, iron and proteins and carbohydrates. Due to high levels of carbohydrates, jackfruit supplements other staple foods in times of scarcity in some regions (APAARI, 2012) [2].

Jackfruit has short storage life even under low temperature conditions and reported that the post-harvest losses of fruits to be as high as 30-40%, which invariably results in loss of potential income and nourishment. The fruit has a delicious taste, captivating flavour, attractive colour an excellent quality, which make it suitable for processing and value addition (Krishnaveni *et al.*, 2000) [3]. Processing reduces post-harvest losses, increases the shelf life of the fruit, add value and increase income. The fruit processing industry in India is now able to utilize only less than 2% of the produce annually and about 35-40% of fruits and vegetables are lost due to improper post-harvest handling, which is estimated to the tone of Rs 40,000/- crores per year (Chadha, 2009) [4].

There is no tradition of jackfruit processing in Andhra Pradesh. In this context, the present investigation was planned for the utilization and value addition of jackfruit by preparing osmodehydrated slices. Food preservation has an important role in the conservation and better utilization of fruits. In order to avoid glut and utilize the surplus during the season, it is necessary to employ methods to extend storage life, for better distribution, to preserve them for utilization in the off-season both in large scale and home scale.

Teles *et al*. 2006 [5] reported that the osmotic dehydration represents a technological alternative to reduce post-harvest losses of fruit. Osmotic dehydration, a method of preservation has the advantage of being very easy to perform for home and small scale processing.

Now a day, there is a huge demand for dried fruit products both in domestic as well as in foreign markets. Osmotic dehydration if optimized will reduce losses, improve availability and allow diversification of processed product. It will also add value to the most abundant fruit of Bangladesh (Rahman m *et al*. 2012) [6]. Jackfruit is gaining importance as a fruit crop relished by all but the period of availability is small. Hence an experiment was planned to standardize the method to prepare dehydrated jackfruit slices.

2. Materials and Methods

Jackfruit cv. Palur. 1 were used for investigation, which were procured from jackfruit orchard located at Horticulture Research Station, Venkataramannagudem. The annual yield per tree is about 80 fruits weighing around 900 kg. The average fruit weight is 12 kg containing 115-120 flakes. The fruit quality is good with attractive golden yellow firm flakes. The flakes are very sweet with high consumer appeal and good keeping quality. The seeds are also edible with high palatability. TSS is 19 ^{O}brix.

2.1 Preparation of osmodehydrated slices

Fully matured firm harvested jackfruits were harvested for preparing osmo-dehydrated slices. The fruits were washed with clean water and cut along their longitudinal axis with the help of a sharp sickle. The central core and flakes were then carefully separated from the fibrous mesocarp and the flakes were longitudinally sliced manually with the help of knife to a thickness of about 8mm after removing the seeds. Sugar solution of three different concentrations *viz.*, 50, 60 and 70% were prepared with 0.2% and 0.4% citric acid concentrations to which 0.2% potassium meta bisulphite was added (Figure 1).

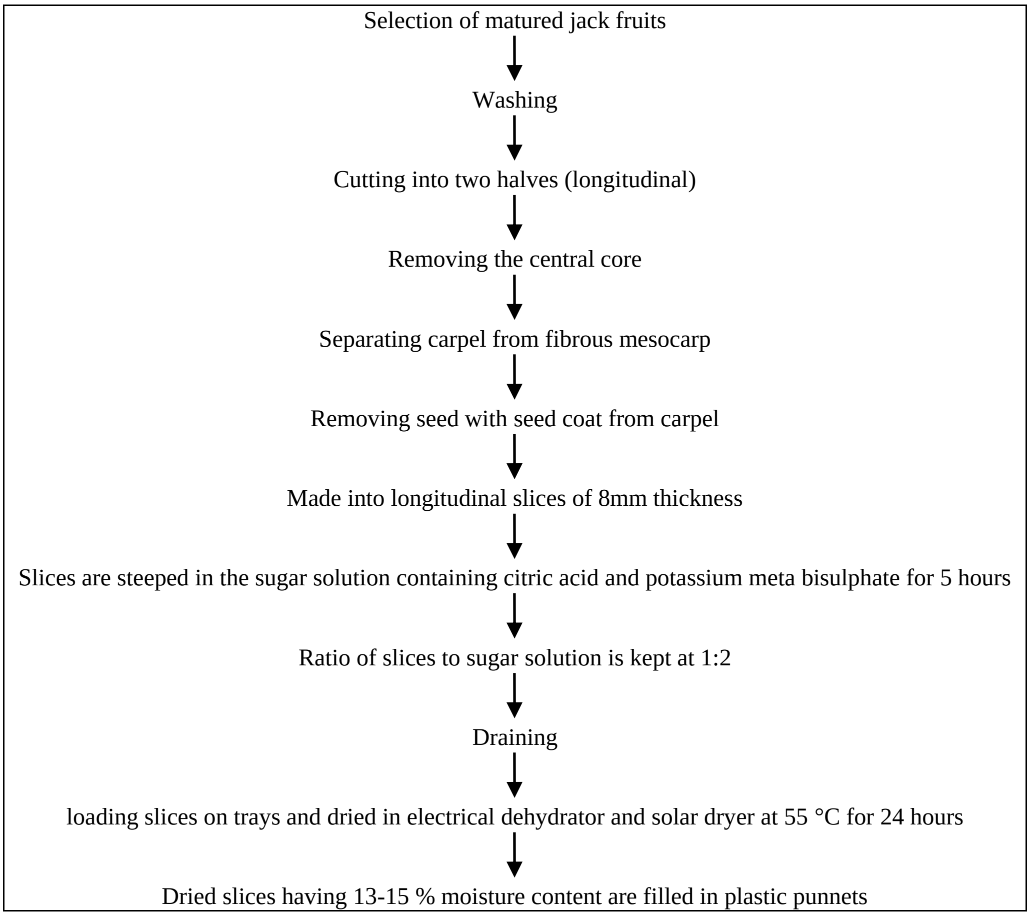

Fig 1: Flow chart for preparation of osmo-dehydrted jackfruit slices

During dehydration, the places of trays were changed at intervals of time to get uniform drying. The details of treatment combinations are furnished here under.

Treatment combinations

T_1-S_1C_1D- 50% sugar + 0.2% citric acid + electrical dehydrator
T_2-$S_1C_2D_1$ - 50% sugar + 0.4% citric acid + electrical dehydrator
T_3-$S_2C_1D_1$ - 60% sugar + 0.2% citric acid + electrical dehydrator
T_4-$S_2C_2D_1$ - 60% sugar + 0.4% citric acid + electrical dehydrator
T_5-$S_3C_1D_1$ - 70% sugar + 0.2% citric acid + electrical dehydrator
T_6-$S_3C_2D_1$- 70% sugar + 0.4% citric acid + electrical dehydrator
T_7-$S_1C_1D_2$- 50% sugar + 0.2% citric acid + solar drying
T_8-$S_1C_2D_2$- 50% sugar + 0.4% citric acid + solar drying
T_9-$S_2C_1D_2$- 60% sugar + 0.2% citric acid + solar drying
T_{10}-$S_2C_2D_2$- 60% sugar + 0.4% citric acid + solar drying
T_{11}-$S_3C_1D_2$- 70% sugar + 0.2% citric acid + solar drying
T_{12}-$S_3C_2D_2$- 70% sugar + 0.4% citric acid + solar drying

Chemical as well as sensory evaluation was carried out at initial, 15, 30, 45, 60, 75 and 90 days of storage.

2.2. Determination of Total soluble solids
Percentage of total soluble solids was determined by using a digital refractometer by placing pulp on the prism of the refractometer and observing the reading on the scale and expressed as ^{O}Brix.

2.3. Determination of Ascorbic acid (mg 100 g^{-1})
The ascorbic acid was determined by 2, 6-dichlorophenol indophenol`s visual titration method as followed by Ranganna (1986) [7] and expressed in mg 100 g^{-1}.Ten grams of freshly ground sample was blended with 3 per cent metaphosphoric acid and made up to 50 ml with 3 per cent HPO_3. The contents are filtered through Whatman No.1 filter paper. 10 ml of the HPO_3 extract was taken and titrated against standard 2, 6-Dichloro phenol indophenol dye to a pink end point (Ranganna, 1986) [7].

$$\text{Ascorbic acid (mg /100 g)} = \frac{\text{Titre value} \times \text{Dye factor} \times \text{Volume made up}}{\text{Volume taken} \times \text{Weight of the sample}} \times 100$$

2.4. Determination of reducing sugar
Reducing sugars in the osmodehydrated slices were determined by the method of Lane and Eyon (1923) [8]. Twenty five ml of fruit juice was taken in a 250 ml volumetric flask. Two ml of lead acetate solution (45%) was added to flask for precipitation of colloidal matter and 2ml potassium oxalate (22%) was added to this solution to precipitate the excess lead and the volume made up to 250 ml using distilled water.
The contents were then filtered through Whatman No. 1 filter paper after testing a little of filtrate for its freedom from lead by adding a drop of potassium oxalate. Reducing sugars in the lead free solution was taken in burette and titrated against 10 ml of standard Fehling's solution mixture of A and B (1: 1) using methylene blue as an indicator till the end point was indicated by the formation of brick red precipitate. The titration was carried out by keeping the Fehling's solution boiling on the heating mantle.

$$\text{Reducing sugars (\%)} = \frac{\text{Factor} \times \text{volume made up}}{\text{Titre value} \times \text{Weight of the sample}} \times 100$$

2.5. Determination of total sugars
Total sugars were determined following the method described by Lane and Eyon (1923) [8]. A quantity of 50 ml lead free filtrate was taken in a 100 ml volumetric flask to which, 5 ml of concentrated HCl was added, mixed well and then kept for 24 hours at room temperature. Acid was then neutralized with NaOH using a drop of phenolphthalein as an indicator till the pink colour persisted for at least few seconds. Then volume was made up to 100 ml. Total sugars were then estimated by taking this solution in a burette and titrating it against standard Fehling's solution mixture of A and B (1:1) using methylene blue as an indicator taking brick red colour as an end point.

$$\text{Total sugars (\%)} = \frac{\text{Factor} \times \text{Volume made up}}{\text{Titre value} \times \text{weight of sample}} \times 100$$

2.6. Determination of β-carotene (μg/100 g)
β carotene content was estimated by spectrophotometric method. 1g sample was taken and extracted with 20-25 ml of 85% acetone. The extract was centrifuged using Remi Centrifuge (Model no. R24) at 8000 rpm and the supernatant was taken in a separating funnel. 25 ml petroleum ether was added in separating funnel followed by 50 ml distilled water, shaken well and kept for 10-15 minutes until two clear layers were formed. The lower layer was discarded and again washed 3-4 times with distilled water. Ether fraction was collected from separating funnel and volume was made up to 50 ml. Again ether fraction was taken in a separating funnel; 5 ml of 20 per cent alcoholic potassium hydroxide (KOH) was added to separate β carotene from chlorophyll and allowed to stand for 30 min. Then it is washed with distilled water to remove alcoholic KOH till the solution became colorless in the presence of phenolphthalein indicator. Yellow color ether fraction was collected and dry anhydrous sodium sulphate was added until it becomes free from moisture and was made up to 50 ml with petroleum ether. Absorbance of the solution was recorded using UV/VIS spectrophotometer (Model: SP-3000 plus) at 452 nm against blank (petroleum ether). The β-carotene content was calculated using the formula.

$$\beta\text{-carotene (}\mu\text{g/100g)} = \frac{3.857 \text{ x O.D x volume made-up}}{\text{Weight of the sample}} \text{ x } 100$$

2.7 Scoring of colour
The score card was prepared keeping in view of quality characters of the product i.e., colour and overall acceptability. Nine point hedonic scale was adopted to score attribute with high score (9) for highly acceptable and lowest score (1) for least acceptable (Ranganna, 1986) [7].

2.8 Statistical analysis
The data were subjected to statistical analysis as per the procedure out lined by Panse and Sukhatme (1985) [9]. The design was Completely Randomized Design with factorial concept.

3. Results
3.1 Total soluble solids (^{O} Brix)
Significant differences were observed among the interaction and the total soluble solids (TSS) contents recorded higher values respectively at 70% concentration of sugar. Maximum total soluble solid content was recorded in osmodehydrated slices prepared with 70% sugar, 0.2% citric acid, dried in the solar dryer and slices prepared with 60% sugar, 0.4% citric acid, dried in the electrical dehydrator (44.14) while minimum was recorded in 50% sugar, 0.4% citric acid, dried in the solar dryer (41.91) (Table 1). This may be associated with higher water mass transfer facilitating more concentrated residual mass of segments representing elevated constituent amount on comparative dry weight basis. According to Priya and Khatkar (2013) [10] the total soluble solids increased gradually during the storage period. This might be due to conversion of polysaccharides into soluble sugars and the reduction in moisture content during storage. The same findings were observed in karonda candy by Manivasagan *et al*. (2006) [11], Sharma *et al*. (2006) [12] in apricot.

3.2. Ascorbic acid (mg 100 g^{-1})

The data pertaining to ascorbic acid predicted in table 1 and it shows significant differences among interaction. The osmo dehydrated slices prepared with 60% sugar, 0.4% citric acid and dried in the electrical dehydrator had the highest ascorbic acid content (11.76) which was on par with osmo dehydrated slices prepared with 60% sugar 0.4% citric acid dried in solar dryer (11.70) followed by osmo dehydrated slices prepared with 70% sugar 0.4% citric acid dried in solar dryer (11.67) while the osmo dehydrated slices prepared with 60% sugar 0.2% citric acid and dried in the electrical dehydrator recorded lowest ascorbic acid content (8.47). In comparison to fresh slices, it was observed that ascorbic acid content in osmotically dehydrated jackfruit slices decreased in dried slices and gradually decreases during storage. Ascorbic acid content reduced considerably due to thermal degradation during the osmotic process. According to Labuze (1981) [13], temperature and oxygen availability are the critical factors with respect to loss of vitamin C. The reduction in ascorbic acid content might be due to oxidation during storage at high ambient temperature. The loss of vitamin 'C' was reported in guava due to osmotic dehydration and also during storage as reported by Anitha and Tiwari (2007) [14].

3.3. Total sugars

There was a slight increase in the total sugar content during storage at ambient conditions and it was maximum in the osmodehydrated slices prepared with 70% sugar, 0.2% citric acid, dried in the solar dryer on 90th day of storage (41.11), the osmo dehydrated slices prepared with 50% sugar, 0.4% citric acid and dried in electrical dehydrator recorded lowest total sugars (37.60) and the data was predicted in table 2. The increment of total sugar content was due to the solute gain action during osmosis (Giraldo *et al*., 2003) [15].

3.4. Reducing sugars

As seen in the table 2, the osmo dehydrated slices prepared with 60% sugar, 0.4% citric acid and dried in electrical dehydrator had the highest reducing sugars (31.98), the osmo dehydrated slices prepared with 70% sugar, and 0.4% citric acid dried in electrical dehydrator had the lowest reducing sugars (27.95) on 90th day of storage. An increase in reducing sugar content was observed during storage period in all the treatments. This was due to rapid hydrolysis of polysaccharides and their subsequent inversion to reducing sugars and moisture removal (Sneha *et al*., 2013) [16].

3.5. β-Carotene (µg/100g)

Data recorded on β-carotene content in the osmodehydrated slices of jackfruit varied significantly (Table 3). The osmo dehydrated slices prepared with 60% sugar, 0.4% citric acid and dried in electrical dehydrator recorded highest β-carotene (255.79) and lowest was recorded in the osmo dehydrated slices prepared with 50% sugar, 0.2% citric acid and dried in electrical dehydrator (172.27). There is a gradual degradation of β-carotene was observed during storage. The degradation could be due to thermo labile and photosensitive nature and oxidation of carotenoids during storage. These results are concurred with the findings of Roopa *et al*. (2014) [17] in carambola and Mir and Nath (1993) [18] in fortified mango bars.

3.6. Colour (score)

The retention of colour was more in the osmodehydrated slices prepared with 60% sugar, 0.4% citric acid and dried in the electrical dehydrator (8.26) whereas lower in the osmo dehydrated slices prepared with 50% sugar, 0.2% citric acid, dried in solar dryer (7.19) (Table 3). The colour of the dried products was very good and it was due to absorption of sugar during osmosis. As the days of storage progressed the colour degraded at ambient conditions. The decrease in the colour scores of samples may also be attributed to the presence of residual activity of the polyphenolases and oxidative type of deterioration resulting from chemical interactions (Sharma *et al*., 2006) [12].

3.7. Shelf life (Days)

It was evident from the data presented in the table 4 significant differences were observed among different treatments. Maximum shelf life (86.66) was observed in the osmodehydrated slices prepared with 60% sugar, 0.4% citric acid dried in electrical dehydrator which was on par with osmodehydrated slices prepared with 70% sugar, 0.4% citric acid dried in electrical dehydrator without considerable loss in quality whereas lowest (75.00) was recorded in osmodehydrated slices prepared with 50% sugar, 0.2% citric acid dried in electrical dehydrator. Addition of sugar, citric acid, potassium meta bi sulphite and removal of moisture might have aided in the storability of the slices. The drying process substantially helped in reducing the microbial count of slices by reducing the water activity results in providing safety for consumption and enhancing shelf life of the product. Similar findings have been reported in different varieties of apricot by Sharma *et al*. (2004) [19] and Roopa *et al*. (2014) [17] in carambola.

It was revealed that osmodehydrated slices prepared using 60% sugar, 0.4% citric acid and dried in electrical dehydrator had better retention of quality, nutritionally rich and acceptable and they could be stored significantly for a period of 90 days at ambient conditions without much loss of sensory and nutritional qualities of the product.

Table 1: Effect of drying method sugar and citric acid concentration on TSS (^{O} Brix) and ascorbic acid (mg 100 g^{-1}) of jackfruit osmodehydrated slices

TSS						ASCORBIC ACID					
	D1		D2		Mean		D1		D2		Mean
	C1	C2	C1	C2			C1	C2	C1	C2	
S1	42.46	41.99	42.43	41.91	42.20	S1	11.45	11.38	10.11	10.89	10.96
S2	42.20	44.14	42.27	42.88	42.87	S2	8.47	11.76	8.73	11.21	10.04
S3	44.10	43.91	44.14	44.11	44.07	S3	8.58	9.58	11.70	11.67	10.38
Mean	42.92	43.35	42.95	42.97		Mean	9.50	10.91	10.18	11.26	
CD at 5%	0.357					CD at 5%	0.263				

*S1: 50% sugar, S2: 60% sugar, S2: 70% sugar, C1: 0.2% citric acid, C2: 0.4% citric acid, D1: Electrical dehydrator, D2: Solar dryer

Table 2: Effect of drying method sugar and citric acid concentration on reducing sugars and total sugars (%) of jackfruit osmodehydrated slices

Total sugars						Reducing sugars					
	D1		D2		Mean	RS	D1		D2		Mean
	C1	C2	C1	C2			C1	C2	C1	C2	
S1	39.74	37.60	38.78	38.28	38.60	S1	31.63	28.50	28.78	29.18	29.52
S2	39.98	39.55	39.65	40.14	39.83	S2	31.24	31.98	30.00	30.90	31.03
S3	40.00	39.80	41.11	39.92	40.21	S3	31.89	27.95	31.85	31.88	30.89
Mean	39.91	38.98	39.85	39.45		Mean	31.59	29.48	30.21	30.65	
CD at 5%	0.404					CD at 5%	0.631				

*S1: 50% sugar, S2: 60% sugar, S2: 70% sugar, C1: 0.2% citric acid, C2: 0.4% citric acid, D1: Electrical dehydrator, D2: Solar dryer

Table 3: Effect of drying method sugar and citric acid concentration on β-carotene (µg/100g) and colour (score) of jackfruit osmodehydrated slices

β-CAROTENE						COLOUR					
	D1		D2		Mean		D1		D2		Mean
	C1	C2	C1	C2			C1	C2	C1	C2	
S1	173.47	172.27	178.93	183.15	176.96	S1	7.19	7.38	7.31	7.64	7.38
S2	197.18	255.79	177.17	206.05	209.05	S2	7.21	8.04	7.52	8.26	7.76
S3	240.92	235.28	244.89	184.25	226.34	S3	8.07	7.69	8.04	7.73	7.88
Mean	203.86	221.11	200.33	191.15		Mean	7.49	7.70	7.62	7.88	
CD at 5%	3.644					CD at 5%	NS				

*S1: 50% sugar, S2: 60% sugar, S2: 70% sugar, C1: 0.2% citric acid, C2: 0.4% citric acid, D1: Electrical dehydrator, D2: Solar dryer

Table 4: Effect of drying method, sugar and citric acid concentration on shelf life (days) of jackfruit osmodehydrated slices at ambient conditions.

Treatments		Shelf life (Days)
T_1 -$S_1C_1D_1$	50% sugar + 0.2% Citric acid + electrical dehydrator	81.66
T_2 - $S_1C_2D_1$	50% sugar + 0.4% Citric acid + electrical dehydrator	75.00
T_3 –$S_2C_1D_1$	60% sugar + 0.2% Citric acid + electrical dehydrator	78.33
T_4 -$S_2C_2D_1$	60% sugar + 0.4% Citric acid + electrical dehydrator	86.66
T_5 –$S_3C_1D_1$	70% sugar + 0.2% Citric acid + electrical dehydrator	81.66
T_6 –$S_3C_2D_1$	70% sugar + 0.4% Citric acid + electrical dehydrator	85.00
T_7 -$S_1C_1D_2$	50% sugar + 0.2% Citric acid + solar drying	80.00
T_8 -$S_1C_2D_2$	50% sugar + 0.4%Citric acid + solar drying	83.33
T_9 –$S_2C_1D_2$	60% sugar + 0.2% Citric acid + solar drying	76.66
T_{10} –$S_2C_2D_2$	60% sugar + 0.4% Citric acid + solar drying	83.33
T_{11} –$S_3C_1D_2$	70% sugar + 0.2% Citric acid + solar drying	85.00
T_{12} –$S_3C_2D_2$	70% sugar + 0.4% Citric acid + solar drying	80.00
CD at 5%		4.894

*S1: 50% sugar, S2: 60% sugar, S2: 70% sugar, C1: 0.2% citric acid, C2: 0.4% citric acid, D1: Electrical dehydrator, D2: Solar dryer

Selection of sound and ripe jackfruit

Cutting into two halves

Separation of segments

Preparation of slices

Immersion of slices in sugar solution

Osmosed slices

Slices dried in electrical dehydrator	Slices dried in Solar dryer	Packed in plastic punnets

Plate 2: Flow chart for preparation of jackfruit osmodehydrated slices

4. Conclusion

The experiment revealed that among the three (50%, 60% and 70%) concentrations of sugar 60% and among citric acid (0.2% and 0.4%) concentrations 0.4% is best for preparation of osmodehydrated slices. Among the drying methods electrical dehydrator is best than the solar dryer. Among the treatments, osmodehydrated slices prepared with 60% sugar, 0.4% citric acid dried in electrical dehydrator was found to be best. Solar dryers can be proved to be most useful device from energy conservation point of view. It not only save energy but also save lot of time, occupying less area, improves quality of the product, make the process more efficient but the major drawback of this method is it result in the browning of the product. Upto 60 days of storage solar dried products were good after that browning was increased. Hence it can be concluded that electrical dehydrator is better over solar dryer. The jackfruit osmodehydrated slices thus prepared were nutritionally rich, superior in quality attributes and highly acceptable even at three months of storage.

5. References

1. Siddique MA, Azad AK. Prioritization of Research for Horticultural Crops. Final Report of a Study, BARC, New Airport Road, Dhaka; c2010. p. 56.
2. APAARI. Jackfruit Improvement in the Asia-Pacific Region– A Status Report. Asia-Pacific Association of Agricultural Research Institutions, Bangkok, Thailand; c2012. p. 182.
3. Krishnaveni A, Manimegalai G, Saravanakumar R. Wine preparation form jack fruit. Beverage and Food World. 2000;27(3):22-23.
4. Chadha KL. Handbook of Horticulture. IARI Publications, New Delhi; c2009.
5. Teles UM, Fernandes FAN, Rodrigues S, Lima AS, Maia GA, Figueiredo RW. Optimization of osmotic dehydration of melons followed by air-drying Inter. J. Food Sci. Technol. 2006;41(6):674-680.
6. Rahman MM, Miaruddin M, Chowdhury MGF, Khan MHH, Muzahid-e-Rahman M. Preservation of jackfruit (Artocarpus heterophyllus) by osmotic dehydration. Bangladesh Journal of Agricultural Research. 2012;37(1):67-75.
7. Ranganna S. Handbook of analysis and quality control for fruit and vegetable products. Tata Mc. Graw hill Publishing Compony Ltd., New Delhi; c1986.
8. Lane JH, Eynon L. Determination of Reducing Sugars by Fehling’s Solution with Methylene Blue Indicator. N. Rodger, London; c1934.
9. Panase VS, Sukhatme PV. Statistical methods for Agril. Workers, Indian Council of Agriculture Research, New Delhi; c1985. p. 70-72.
10. Priya MD, Khatkar BS. Effect of processing methods on keeping quality of aonla (Emblica officinalis Gaertn.) preserve. International Food Research Journal. 2013;20(2):617-22.
11. Manivasagan S, Rana GS, Kumar S, Joon MS. Qualitative changes in karonda (*Carissa carandas* Linn.) candy during storage at room temperature. Haryana Journal of Horticultural Sciences. 2006;35(1):19-21.
12. Sharma HR, Pooja, Verma R. Organoleptic and chemical chemical evaluation of osmotically processed Apricot wholes and halves. Natural product Radiance. 2006;5(5):350-56.
13. Labuze TP. Prediction of moisture protection requirement for foods. In: Cereal Food World; c1981. p. 345.
14. Anitha P, Tiwari RB. Studies on osmotic dehydration of guava (*Psidium guajava* L.). Thesis submitted to University of Agricultural Sciences, Bangalore; c2007.
15. Giraldo G, Talens P, Fito P, Chiralt A. Influence of sucrose solution concentration on kinetics and yield during osmotic dehydration of mango. Journal-of-Food-Engineering. 2003;58:33-43.
16. Sneha S, Bahadur V, Yadav K, Gourishranganath K. Valueaddition of pineapple slices through osmo convective dehydration. Trends in Biosciences. 2013;6(4):384-88.
17. Roopa N, Chauhan OP, Raju PS, Das Gupta DK, Singh RKR, Bawa AS. Process optimization for osmo-dehydrated carambola (Averrhoa carambola L) slices and its storage studies. Journal of Food Science and Technology. 2014;51(10):2472-80.
18. Mir MA, Nath Nirankar. Storage changes in fortified mango bars. Journal of Food Science and Technology. 1993;30(4):279-282.
19. Sharma KD, Kumar R, Kaushal BNL. Mass transfer characteristics, yield and quality of five varieties of osmotically dehydrated Apricot. Journal of Food Science and Technology. 2004;41(3):264-275.