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# Impact of packaging material and storage period on nutritional attributes of osmotic dehydrated ripe sapota slices

**Tapas Sarkar, Nilanjana Datta, Tejib Tripura and Madhavi Meduri**

### Abstract

The experiment was carried out with the aim to study the changes in nutritional composition of osmotic dehydrated ripe sapota slices during storage. This investigation was carried out in the College of Horticulture, Dr. Y.S.R. Horticultural University, Hyderabad, India, during the year 2014-2015. Sapota were packed in two different packaging materials (aluminium foil covers and 150-gauge polypropylene bags) and stored at two conditions (ambient and refrigerated) for the period of four months. The experiment was laid out in CRD with factorial concept with four replications. Dehydrated sapota slices packed in aluminium foil covers and stored at refrigerated condition were found to be best followed by 150-gauge polypropylene bags and stored at refrigerated condition in retaining various nutrients and quality attributes like minimal TSS, acidity, ascorbic acid, carotene, calcium and phosphorus loss and lesser microbial growth when compared to the other packaging materials and storage conditions during the four months storage period.

**Keywords:** *sapota*; osmotic dehydration; ambient temperature; refrigerated temperature; nutritional attributes

### Introduction

Sapota (*Achras zapota* L.) is one of the most important tropical fruit. Sapota fruit is a good source of digestible sugar, virtually a treasure of minerals such as iron and calcium. The fruits have an appreciable amount of protein, fat, fiber, calcium, phosphorus, iron, carotene and vitamin C and also rich in bio-iron. It is growing in an area of 177.0 thousand hectares with a production of 1744.3 million tons (Indian Horticulture Database-2014 [20], NHB). It has been observed that when there is a bumper production of sapota, the fruit goes as waste for want of suitable preservation facilities. In sapota, post-harvest losses ranged from 25-30 per cent. Sapota is generally consumed as a fresh fruit. Ripened sapota cannot be stored for more than a day or two as it is highly perishable in nature, ripens faster and becomes unfit for consumption very soon. Among the various preservation methods, drying is the most convenient and simplest method throughout the world. Besides preserving seasonal commodities, dehydrated fruit products have inherent advantages, such as prolonged shelf life, higher degree of resistance to bacterial attack and lower transportation, handling and storage costs. The methods and the variables of drying, influence both the quality and physicochemical characteristics of the dried products (Krokida and Maroulis, 1997) [8]. Osmotic dehydration has received greater attention in recent years as an effective method with retention of their initial fruit characteristics viz. colour, aroma, and nutritional compounds. Osmotic parameters like sugar gain and water loss are correlated with osmosis time. It involves the dehydration of fruit slices in two stages, removal of water using sugar syrup as osmotic agent and subsequent dehydration in the drier where osmotic content is further reduced to about 15% to make the product shelf stable.

The shelf life of dehydrated ripe sapota slices depends on different factors like packaging material and storage temperature. The extension in storage life is possible by checking increase in moisture, retention of physicochemical attributes and preventing microbial activity etc. Hence, there is a need to develop a low cost technology for processing sapota fruits into value added products. Therefore, the present investigation was carried out to study the changes in nutritional and chemical composition of osmotic dehydrated ripe sapota slices during storage.

## Materials and Methods

The investigation was carried out in the laboratory of post harvest technology, College of Horticulture, Dr. Y. S. R. Horticultural University, Rajendranagar, Hyderabad, India, during the year 2014-2015. Three Packaging materials Aluminum foil covers (T1), 150 gauge Polypropylene bags (T2), Control [without package] (C1), and two Storage conditions Ambient temperature [25±20C] (S1) and Refrigerated temperature [8 - 100C] (S2) were included in this investigation. There were altogether six treatments. The experiment was laid out in CRD with factorial concept with four replications. The observation on TSS (Obrix), Acidity (%), Ascorbic acid content (mg/100g), Carotene (mg/100gm), Calcium (mg/100g) and Phosphorus (mg/100g) were recorded at 30 days interval for 4 months. Different parameters taken are as follows

### 1. TSS (Obrix)

The total soluble solids in fresh fruits and solar dried slices were recorded by using Erma made hand refractometer. In case of fresh fruit, the pulp was crushed, extract was extracted through cheese cloth on refractometer prism and three readings were taken and average calculated out to express the TSS percentage. While, in case of dried slices, 10g of slices were soaked in 1:4 (product: water) ratio for 4 hours and then the contents were well macerated with the help of pestle and mortar. Pulp was extracted through cheese cloth and dropped on refractometer prism and observations were recorded (Ranganna 1986) [10].

### 2. Acidity (%)

The method described by Ranganna (1986) [10] was adopted. 5 grams of homogenized sample was taken and transferred to 100 ml volumetric flask and volume was made up with distilled water. The solution was well mixed and centrifuged and the clear supernatant aliquot was taken in a 100 ml conical flask. From this, 10 ml of aliquot was taken in a 50 ml beaker and titrated against standard solution of sodium hydroxide (0.1 N NaOH), using phenolphthalein as an indicator. The titrable acidity was expressed in terms of percent citric acid equivalent adopting following formula.

$$\text{Titrable} = \frac{\text{Titre} \times \text{Normality} \times \text{Total volume} \times \text{Equivalent weight}}{\text{Value of Alkali made up of citric acid}} \times 100$$

$$\text{Titrable} = \frac{\text{Acidity (\%)} \times \text{Aliquot taken for } x}{\text{Weight of } x \times 1000 \text{ Estimation sample}} \times 100$$

### 3. Ascorbic acid content (mg/100gm)

Ascorbic acid content of fresh fruit and dehydrated slices was estimated as suggested by Ranganna (1986) [10]. A sample weighing 10 grams was blended with 3% metaphosphoric acid (HPO<sub>3</sub>) and volume was made up to 100 ml with 3% HPO<sub>3</sub>. The content after shaking well was filtered through whatman No. 1 filter paper. The filtrate of 10ml was titrated against 2, 6-dichlorophenol-indophenol dye until pink colour persist for at least 15 seconds.

$$\text{Ascorbic acid (mg/100g)} = \frac{\text{Titre value} \times \text{dye factor} \times \text{volume made up} \times 100}{\text{Aliquot of extraction taken for estimation} \times \text{Wt. of sample taken for estimation}}$$

### 4. Carotene (mg/100g)

Carotene content of sample was analysed by spectrophotometer. Dried sample of 0.5g or fresh sample of 2-3g

were added to the solution content acetone: methanol (1: 1) ratio and kept in dark for 30 minutes. Then, the sample was collected in a pestle and mortar and a pinch of CaCo<sub>3</sub> was added to the sample macerated and filtered. The process was repeated until the sample becomes colourless and filtered through sintered funnel through vacuum. After getting the colourless and filtered sample volume was made up to 50 ml or 100 ml with acetone: methanol (1: 1) solution. The solution was transferred to a separating funnel by adding 30 – 50 ml of hexane. Later 5% of NaCl was added to the sample solution and was shaken vigorously to release the gas and then washing was continued until a clear separation was formed. After taking the colour solution (upper layer) the volume was made up to 50 ml with hexane and then, 10-15g of sodium sulphate was added to get the solution with no moisture. The reading was taken at 449 nm by keeping the hexane as a blank with O. D (optical density). The total carotene content was calculated by using following formula. (Delia *et al.* 2005).

$$\text{Total Carotene content } (\mu\text{g}/100\text{g}) = \frac{\text{O.D} \times \text{Volume made up} \times 100}{\text{Weight of sample} \times 250} = X$$

$$(\text{mg}/100\text{g}) = \frac{X}{1000}$$

### 5. Calcium determination (mg/100g)

Taken 0.5 g for dried and 5 g for fresh sample was ashed in muffle furnace for 5 hours at 600C. After ashing 6N HCl were added and the content was evaporated to dryness on water bath. After complete evaporation 3N HCl was added and boiled on heating mantle and was filtered with whatman filter paper in a 100 ml of volumetric flask. The above step was repeated until the clear supernatant was obtained and volume was made upto the mark with distilled water. The calcium content of the sample was analysed by atomic absorption spectrophotometer.

#### Atomic absorption standard preparation for calcium:

The standard for calcium analysis was prepared by dissolving 2.4973 g of calcium carbonate (CaCO<sub>3</sub>) in 25 ml of 1M HCl. This was added drop wise to avoid losses during the vigorous effervescence. The content was diluted to 1 liter with distilled water in volumetric flask.

#### Calculation

ppm of sample = AAS x 100/ weight of sample.

### 6. Phosphorus determination (mg/100g)

One gram samples of finely grounded dried slices were digested by using di-acid digestion i. e. 5: 1 ratio of HNO<sub>3</sub>:HClO<sub>4</sub>. After digestion, the 5 ml of clear supernatant was pipetted out into a 50 ml of volumetric flask and then 10 ml of Barton's reagent was added. The content were Shaken well and volume was made upto the mark. The content was allowed to stand for 30 minutes for yellow colour development. The intensity of the colour was read at 420 nm in a spectrophotometer. The concentration of phosphorus (X ppm) in the sample was obtained by Plotting the absorbance value in the standard graph (Y axis) against concentration of working standards (X axis). The Standard phosphorus solution was prepared by dissolving 0.219 g of analytical grade KH<sub>2</sub>PO<sub>4</sub> and was diluted to 1 liter which contains 50 μg Phosphorus/ml.

Concentration of phosphorus in colored solution = X ppm  
i. e. 1 ml of colored solution contains = X μg P

50 ml of colored solution contains =  $50 \times X \mu\text{g P}$  Which is present 5ml of the digest.

100 ml of colored solution contains =  $50 \times X \times 100/5 = X \times 1000 \mu\text{g P}$  Which was obtained from 1g digest sample.

100 gm of sample consist of =  $X \times 1000 \times 100/1$   
 =  $Y \text{ g P}$   
 =  $Y \text{ g P} \times 1000 = \text{mg P}$ .

## 7. Packaging and storage

The dehydrated sapota slices were packed in aluminium foil covers and 150-gauge polypropylene bags respectively and were sealed using heat impulse sealer. The packages were stored under ambient temperature ( $25 \pm 20^\circ\text{C}$ ) and refrigerated temperature ( $8-10^\circ\text{C}$ ) respectively for 4 months.

## 8. Statistical analysis

The data were subjected to statistical analysis as per the procedure outlined by Panse and Sukhatme (1985) [9].

## Results and Discussions

Slices were soaking in invert sugar 600Brix for 8 hours of osmotic dehydrated ripe sapota slices and stored in different packaging materials. Slices were packed in two different packaging materials (aluminium foil covers and 150-gauge polypropylene bags) storage at ambient as well as refrigerated temperature ( $8-10^\circ\text{C}$ ).

### 1. TSS (0Brix)

As it was showed in the Table 1, the TSS (0Brix) in the dehydrated slices was significantly affected by treatments, duration of storage and interactions between them.

Among the treatments, the highest mean TSS (28.34) was observed in T1S2- dehydrated slices packed aluminium foil covers stored at refrigerated temperature followed by T2S2- dehydrated slices packed in 150-gauge polypropylene bags stored at refrigerated temperature (28.10). Whereas, the lowest mean TSS was observed in C1S1- control (20.60) followed by C1S2- control (21.62).

The TSS content of dehydrated sapota slices decreased upon the storage. As a result of increase in moisture content the TSS decreased during storage which might be due to the hygroscopic nature of dried product and permeability characteristics of the packaging materials. The similar findings were made by Sra *et al.* (2014) [18] for dried carrot slices and Bailey (1990) [1] and also by Sheron and Usha (2006) [17] in bread fruit flour.

### 2. Acidity (%)

The acidity (%) in the dehydrated slices showed in the Table. 2 was significantly affected by treatments, duration of storage and interactions between them.

The results in the present investigation revealed that acidity of dehydrated sapota slices slightly decreased upon the storage. The retention of acidity was significantly higher in slices packed in aluminium foil covers as compared to 150-gauge polypropylene bags during the storage period of four months. The loss of acids might be due to low water vapour transmission rate and utilization of acids for conversion of non-reducing sugar to reducing and in non-enzymatic browning reaction (Dhabade and Khedkar 1980, Krishnavedi *et al.* 1999 and Evelin Mary *et al.* 2007) [5, 7, 6] and the similar results were also recorded by Sawant *et al.* (2013) [14] while working on apricot fruit bars.

Storage of osmotic followed by solar dehydrated sapota slices resulted significant decline in acidity.

Similar observations were reported by Sagar and Khurdiya (1998) [11] in mango slices.

### 3. Ascorbic acid (mg/100g)

The ascorbic acid (mg/100g) content in the dehydrated slices was presented in the Table 3. The data reveals that it was significantly affected by treatments, duration of storage and interactions between them.

Among the treatments, highest mean ascorbic acid (2.79) was observed in T1S2- dehydrated slices packed in aluminium foil covers stored at refrigerated temperature followed by T1S1- dehydrated slices packed aluminium foil covers stored at ambient temperature (2.63). Whereas, the lowest mean ascorbic acid was observed in C1S1- control (1.86) followed by C1S2 - control (1.93).

The dehydrated sapota slices packed in aluminium foil covers and stored at refrigerated temperature (T1S2) significantly retained relatively high amount of ascorbic acid as compared to 150-gauge polypropylene bags (T2S1 and T2S2) and corroborates with the findings of Sagar *et al.* (2000) [12] in dehydrated ripe mango slices and Sharma and Kuasal (2006) [16] in dehydrated apple rings. This may be due to better protection against oxidation by aluminium foil covers due to less permeability of the film compared to 150-gauge polypropylene bags. Similar results were reported in sapota-papaya bar by Sreemathi *et al.* (2008) [19].

### 4. Carotene (mg/100g)

The data pertaining to carotene content presented in the Table 4 showed that the carotene (mg/100g) content in the dehydrated slices was significantly affected by treatments, duration of storage and interactions between them.

Statistically significant changes were observed due to the interactions between the treatments and the duration of storage. With any given treatment, the carotene content was significantly decreased till 120 days. On 30th day of storage, the highest carotene content was observed in treatment T1S2 (41.65) which was on par with T2S2 (41.45). On the 60th, 90th and 120th day of storage the highest carotene was also observed in treatment T1S2 (41.30, 41.00 and 40.96) and it was on par with T1S1 (41.07 and 40.78) on 60th and 90th day of storage respectively but which was followed by T1S2 (40.25) on 120th day of storage, while lowest carotene content was observed in control C1S1 (39.92) on 30th day of storage which was on par with C1S2 (40.07). On 60th, 90th and 120th day of storage also the lowest carotene retention was recorded in C1S1 (35.62, 30.25 and 27.27) followed by C1S2 (36.50, 31.87 and 28.12) respectively over the other treatments.

The carotene is susceptible to oxidative loss caused by heat and light which are responsible for the losses during storage. The similar findings were reported by Sharma and Khurdiya (1999) in dehydration of dashehari mango slices and Sra *et al.* (2014) [18] in dried carrot slices. Light also may have an effect on the rate of darkening in the dehydrated product, and it has been known to cause reduction in carotene (Bolin *et al.*, 1977) [2].

### 5. Calcium (mg/100g)

The data pertaining to calcium content presented in the Table 5 reveals that the calcium (mg/100g) content in the dehydrated slices was significantly affected by treatments, duration of storage and interactions between them.

There was a significant decline in mean calcium content from the initial (11.10) to the 120th day (7.28) of storage period. As

the storage period increased, the calcium content decreased slightly irrespective of the treatment except in control which shows decrease in calcium content at an increasing rate.

The results revealed that the calcium content of dehydrated sapota slices decreased significantly upon increase in the storage period. The retention of calcium was higher in slices packed in aluminium foil covers and stored at refrigerated temperature as compared 150-gauge polypropylene bags coupled with storage temperatures (T2S1 and T2S2) and control. It might be due to nutrient (Calcium) losses during storage which is largely dependent on packaging medium. The package functions to prevent the entry and exit of matter to and from the dried product. The composition of air inside a package and outside temperature has an effect on the rate and extent of nutrient loss from dried slices which was decreased upon increase in storage period. Similar results were observed by Salunkhe *et al.*, 1991 for dried food products. Aluminium foil covers have lower permeability for water and oxygen diffusion than the 150-gauge polypropylene bags (Sreemathi *et al.* 2008) [19].

## 6. Phosphorus (mg/100g)

The data pertaining to phosphorus content (mg/100g) presented in the Table 6 reveals that the phosphorus content in the dehydrated slices was significantly affected by treatments, duration of storage and interactions between them.

There was a significant decline in mean phosphorus content from the initial (12. 61) to 120th day (8. 54) of storage period. As the storage period increased, the phosphorus content decreased slightly irrespective of the treatments except in control which shows decrease in phosphorus content at an increasing rate.

The results revealed that the phosphorus content of dehydrated sapota slices decreased significantly upon the increase in storage period. The retention of Phosphorus was higher in slices packed in aluminium foil covers and stored at refrigerated temperature as compared to 150-gauge polypropylene bags (T2S1 and T2S2) and control (C1S1 and C1S2). It might be due to nutrient (Phosphorus) losses during storage which is largely dependent on packaging medium. Similar results were observed by Salunkhe *et al.* (1991) for dried food products.

The package functions to prevent the entry and exit of matter to and from the dried product. The composition of air inside a package and outside temperature has an effect on the rate and extent of nutrient loss from dried slices which is decreased upon increase in storage period. Aluminium foil covers have lower permeability for water and oxygen diffusion than the 150-gauge polypropylene bags (Sreemathi *et al.*, 2008) [19].

**Table 1:** Effect of packaging materials and storage conditions on TSS (0Brix) of osmotic dehydrated ripespota slices during storage

Treatments	30 days	60 days	90 days	120 days	Mean
T1S1	28. 77	28. 22	27. 02	26. 50	27. 63
T1S2	29. 00	28. 57	28. 28	27. 50	28. 34
T2S1	28. 52	28. 00	26. 82	26. 50	27. 46
T2S2	28. 87	28. 42	28. 02	27. 10	28. 10
C1S1	24. 87	22. 00	18. 42	17. 12	20. 60
C1S2	25. 75	23. 75	19. 12	17. 87	21. 62
Mean	27. 63	26. 49	24. 61	23. 76	
F-test S. Em± CD at (0. 05 %)					
For treatments (T)		**	0. 062	0. 176	
For days (D)		**	0. 051	0. 143	
For D x T		**	0. 124	0. 352	

Initial value- 29. 33

**Table 2:** Effect of packaging materials and storage conditions on acidity (%) of osmotic dehydrated ripespota slices during storage.

Treatments	30 days	60 days	90 days	120 days	Mean
T1S1	0. 27	0. 26	0. 22	0. 22	0. 24
T1S2	0. 28	0. 27	0. 25	0. 25	0. 26
T2S1	0. 24	0. 24	0. 22	0. 21	0. 23
T2S2	0. 26	0. 25	0. 24	0. 23	0. 24
C1S1	0. 22	0. 21	0. 11	0. 10	0. 16
C1S2	0. 23	0. 21	0. 15	0. 12	0. 18
Mean	0. 25	0. 24	0. 20	0. 19	
F-test S. Em± CD at (0. 05 %)					
For treatments (T)		**	0. 002	0. 006	
For days (D)		**	0. 005	0. 002	
For D x T		**	0. 014	0. 004	

Initial value- 0. 31

**Table 3:** Effect of packaging materials and storage conditions on ascorbic acid content (mg/100g) of osmotic dehydrated ripe sapota slices during storage

Treatments	30 days	60 days	90 days	120 days	Mean
T1S1	2. 94	2. 66	2. 53	2. 40	2. 63
T1S2	3. 05	2. 89	2. 66	2. 58	2. 79
T2S1	2. 69	2. 56	2. 38	2. 18	2. 45
T2S2	2. 95	2. 61	2. 47	2. 28	2. 58
C1S1	2. 45	2. 05	1. 64	1. 31	1. 86
C1S2	2. 51	2. 15	1. 71	1. 34	1. 93
Mean	2. 76	2. 48	2. 23	2. 02	
F-test S. Em ± CD at (0. 05 %)					
For treatments (T)		**	0. 013	0. 039	
For days (D)		**	0. 011	0. 032	
For D x T		**	0. 027	0. 079	

Initial value- 3. 33

**Table 4:** Effect of packaging materials and storage conditions on carotene content (mg/100g) of osmotic dehydrated ripe sapota slices during storage

Treatments	30 days	60 days	90 days	120 days	Mean
T1S1	41. 25	41. 07	40. 78	40. 25	40. 84
T1S2	41. 65	41. 30	41. 00	40. 96	41. 22
T2S1	41. 12	40. 72	40. 45	40. 05	40. 58
T2S2	41. 45	40. 92	40. 65	40. 13	40. 78
C1S1	39. 92	35. 62	30. 25	27. 25	33. 26
C1S2	40. 07	36. 50	31. 87	28. 12	34. 14
Mean	40. 91	39. 35	37. 50	36. 13	
F-test S. Em ± CD at (0. 05 %)					
For treatments (T)		**	0. 063	0. 179	
For days (D)		**	0. 052	0. 146	
For D x T		**	0. 127	0. 359	

Initial value- 44. 27

**Table 5:** Effect of packaging materials and storage conditions on calcium content (mg/100g) of osmotically dehydrated ripe sapota slices during storage

Treatments	30 days	60 days	90 days	120 days	Mean
T1S1	10. 51	10. 10	9. 75	9. 63	10. 00
T1S2	10. 97	10. 55	10. 21	10. 08	10. 45
T2S1	10. 26	9. 86	9. 44	9. 24	9. 70
T2S2	10. 48	9. 92	9. 49	9. 47	9. 84
C1S1	6. 62	4. 25	2. 79	2. 30	3. 99
C1S2	7. 00	5. 00	3. 50	3. 00	4. 62
Mean	9. 31	8. 28	7. 53	7. 28	
F-test S. Em ± CD at (0. 05 %)					
For treatments (T)		**	0. 057	0. 163	
For days (D)		**	0. 047	0. 133	
For D x T		**	0. 115	0. 326	

Initial value- 11. 1

**Table 6:** Effect of packaging materials and storage conditions on phosphorus content (mg/100g) of osmotically dehydrated ripe sapota slices during storage

Treatments	30 days	60 days	90 days	120 days	Mean
T1S1	12.59	12.15	11.72	11.35	11.95
T1S2	12.62	12.24	12.02	11.74	12.15
T2S1	12.58	11.67	11.55	11.43	11.81
T2S2	12.61	12.02	11.70	11.63	11.99
C1S1	9.12	6.12	3.37	2.25	5.21
C1S2	9.75	7.25	4.62	2.87	6.12
Mean	11.54	10.24	9.16	8.54	
F-test S. Em $\pm$ CD at (0.05 %)					
For treatments (T)		**	0.055	0.155	
For days (D)		**	0.045	0.126	
For D x T		**	0.110	0.311	

Initial value- 12.61

- T1S1-** Aluminium foil covers + Storage at ambient temperature.
- T2S1-** 150 gauge Polypropylene bags + Storage at ambient temperature.
- T1S2-** Aluminium foil covers + Storage at refrigerated temperature (8-100C).
- T2S2-** 150 gauge Polypropylene bags + Storage at refrigerated temperature (8-100C). C1S1-Control without package + Storage at ambient temperature.
- C1S2-** Control without package+Storage at refrigerated temperature (8-100C).

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