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Effect of Different Pretreatments on the Quality of Osmotic Dehydrated Ripe Sapota Slices

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Authors' contributions

This work was carried out in collaboration between all authors. Author TT designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors TS and MM managed the analyses of the study. Author SM managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

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 to study the effect of different pretreatments on the quality of osmotic dehydrated ripe sapota slices (var. kalipatti). The experiment comprises 9 treatments replicated thrice. The experiment was laid out in Complete Randomized Design (CRD). The data were subjected to statistical analysis as per the procedure outlined by [1]. The range of water loss, weight reduction, sugar gain, TSS, acidity, ascorbic acid, carotene, calcium, phosphorus were observed. An increase in duration of osmosis from 4 to 8 hours leads to increase in water loss, weight reduction and sugar gain and TSS of the dried, ripe sapota slices. However, osmotic pretreatment with invert sugar 60^0Brix for 8 hours resulted in highest sensory scores (7.33) while, it was lowest in slices pretreated with fructose 60^0Brix for 4 hours (5.00).

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Keywords: Sapota; sugar; fructose; sucrose; osmotic dehydration; solar drying.

1. INTRODUCTION

Sapota (*Manilkara zapota* L.), family sapotaceae is one of the most important tropical fruit. It is mainly valued for its sweet and delicious flavor. Sapota fruit is a good source of digestible sugar, protein, fat, fibre, calcium, phosphorus, iron, carotene and vitamin C [2] and also rich in bio-iron [3]. India is the largest producer of sapota followed by Mexico. 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 [4]. In sapota, post-harvest losses ranged from 25-30 per cent. Wastage of large quantities of sapota fruits is due to poor quality transportation, high ethylene evaluation and metabolic activity during storage. One effective method of reducing the huge loss would be by converting it into various commercial sapota products like slices, powder, juice, concentrate, etc*.* from the fruits before it perishes [5]. Among the various preservation methods, drying is the most convenient and simplest method. Dehydration is a cost effective and viable method brings about a substantial reduction in weight and volume; there by minimizes packaging, storage and transportation cost and also enables storability of the product under ambient temperatures especially in developing countries [6]. The methods and the variables of drying, influence both the quality and physicochemical characteristics of the dried products [7]. It is an important operation for preserving sapota. The moisture content of sapota was reduced from 76% to 10-15% (w.b.) using solar drying within 76 h with time savings of 27% over sun drying.

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 solids in concentrated aqueous solution. The driving force for water removal is the concentration gradient between the solution and the intracellular fluid. If the membrane is perfectly semi-permeable, solute is unable to diffuse through the membrane into the cell. 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 solid 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. Osmotic dehydration is a simple process; it facilitates processing of tropical fruits 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. Solar dryers are specialized devices that control the drying process and protect agricultural produce from damage by insects, dusts and rain. The study was therefore taken up to find out different pre-treatments on the quality of osmotic dehydrated ripe sapota slices and to standardize the processing technique for preparation of osmotic dehydrated ripe sapota slices.

Many researchers have studied osmotic dehydration of various fruits and vegetables, such as apple, banana, carrot, cherry, citrus fruits, grape, guava, mango, *etc.* [8,9]. The osmotic dehydration process has been studied and used as a pre-treatment prior to further processing such as convective-drying [10,11]. Very few attempts have been made to study osmotic dehydration characteristics of sapota. Therefore, a study was proposed to investigate osmotic dehydration characteristic of sapota. Osmotic dehydration was frequently done by immersing the sample in concentrated solutions of salt or sugar. It was to apply in variety of fruits by decreasing the moisture contents up to 30% [12,13].

2. MATERIALS AND METHODS

The present experiment conducted in arid sub tropical climatic zone of Hyderabad during the year 2014-2015 to study the osmotic dehydration of ripe sapota (*Manilkara zapota* L.) cv. kalipatti slices". The experiment was conducted in the laboratory of post harvest technology, College of Horticulture, (Dr.Y.S.R.H.U), Rajendranagar, with an average rainfall of 800 mm at an altitude of 542.3 m above mean sea level on 17.90° N latitude and 78.23°E longitudes laid out in CRD with assured irrigation facilities and adequate drainage facilities. Osmotic solution was prepared by taken three types of sugars were invert sugar, fructose and sucrose. Sugar syrup of 60^0Brix was prepared for all the three different sugars separately in a vessel as per the experiment requirements. Sugar syrup of 60°Brix concentration was prepared by adding the 600 g of sugar in a vessel containing 1000 ml of distilled water and the total soluble solids of prepared syrup were determined by hand refractometers of various ranges (28- 62°Brix and 58-92°Brix).

The experiment comprises 9 treatments replicated thrice viz. T_1 - Soaking in invert sugar 60°Brix for 4 hours, T_2 - Soaking in invert sugar 60°Brix for 6 hours, T_3 - Soaking in invert sugar 60°Brix for 8 hours, T_4 - Soaking in fructose 60°Brix for 4 hours, T_5 - Soaking in fructose 60°Brix for 6 hours, T_6 - Soaking in fructose 60°Brix acid for 8 hours, T_7 - Soaking in sucrose 60°Brix for 4 hours, T_8 - Soaking in sucrose 60°Brix for 6 hours, T_9 - Soaking in sucrose 60°Brix for 8 hours. All the treatments contain 0.1% KMS + 0.5% Citric acid + 0.2% Ascorbic acid. The sapota variety kalipatti fruits were graded, sliced and pretreatments such as blanching and soaking in osmotic agents like invert sugar, fructose and sucrose. Sugar syrup of 60°Brix was prepared for all the three different sugars separately. Total soluble solids of prepared syrup were determined by hand refracto meters of various ranges (28-62°Brix and 58-92°Brix). The outer skin of the blanched fruits was peeled off manually and cut into slices. Later they were dried in a solar drier. Solar dried sapota slices were analysed for quality attributes.

2.1 Osmotic Dehydration

The prepared samples (sapota slices) were weighed to 500 g for each treatments and immersed in the sugar syrup (60^0Brix invert sugar, fructose and sucrose solution) contained in a plastic container separately for each treatment. The containers were placed inside the laboratory at ambient temperature and immersed for 4 hrs, 6 hrs and 8 hrs respectively to facilitate osmotic dehydration. After the completion of dipping time, the samples were taken out from the container followed by draining with cool water to remove the adhering sugar syrup from the soaked samples. Thereafter, the samples were weighed and their moisture contents were determined. The water loss and solid gain were calculated based on mass balance. All the treatments were replicated thrice and results reported were from average value of three replications.

2.2 Solar Drying

The osmotic dehydrated samples were further dried using a solar dryer. The dehydrated samples were uniformly distributed on the trays by a line arrangement of slices individually. During drying, at 1 hr interval the individual slices were turned upside down which gives uniform drying. To measure the temperature, a thermometer was used. The drying process continued until a constant weight in the trays containing the slices was achieved. The yield of the process was calculated. The dehydration was performed in triplicate and three samples were analysed for physico-chemical analysis in each treatment as per the experiment concerned.

3. RESULTS AND DISCUSSION

3.1 Effect of Pretreatments on Physico-chemical Composition of Osmotic Dehydrated Ripe Sapota Slices

The observations recorded in (Table 1) on physico-chemical composition of sapota fresh fruits such as an average fruit weight of 94.30 g, moisture 83.70%, carbohydrates 20.30 g, fiber 2.40 g, TSS 17.90°Brix, acidity 1.60%, ascorbic acid 13.80 mg/100 g, carotene 95mg/100 g, calcium 25.50 mg/100 g and phosphorus 68.90 mg/100 g.

Table 1. Physico-chemical composition of fresh ripe sapota fruit, cv. Kalipatti

Average fruit Weight (g)	94.30
Moisture (%)	83.70
Carbohydrates(g)	20.30
Fibre (g)	2.40
TSS (^{0}Brix)	17.90
Acidity (%)	1.60
Ascorbic acid (mg/100 g pulp)	13.80
Carotene (mg/100 g of pulp)	95.00
Calcium (mg/100 g of pulp)	25.50
Phosphorus (mg/100 g of pulp)	68.90

3.2 Effect of Pretreatments on Drying Time (hour) and Recovery (%) of Osmotic Dehydrated Ripe Sapota Slices

The final moisture content to which the osmotic dehydrated sapota slices were further dried was 8.00% for all treatments. The data pertaining to drying time (hours) in the (Table 2) indicates that there were no significant changes on drying time in the solar dryer, however the lowest drying time (10 h) were recorded in T_3- fruit slices soaking in invert sugar 60°Brix for 8 hours and the highest drying time (12 h) was recorded in T_7- fruit slices soaking in sucrose 60°Brix for 4 hours and Osmotic drying followed by solar drying, produced higher quality dried product and reduces drying time.

Statistically there were no significant differences in the recovery (%) of osmotically dehydrated ripe sapota slices among different pretreatments after solar drying (Table 2). However the highest recovery (31) was recorded in T_3 - fruit slices in invert sugar 60°Brix for 8 hours and lowest recovery (29) were recorded in T_7 - fruit slices soaking in sucrose 60°Brix for 4 hours.

Table 2. Effect of pretreatments on drying time (hour) and recovery (%) of osmotic dehydrated ripe sapota slices

Treatments	Drying time (hour)	Recovery (%)
T_1	11.00	30.10
T_2	10.30	30.50
T_3	10.00	31.00
T_4	11.30	29.50
T_5	11.00	30.00
T_6	10.30	30.50
T_7	12.00	29.00
T_8	11.30	30.00
T_9	11.00	30.40
F. test	**NS**	**NS**
S.Em±	**-**	-
CD at 0.05%	**-**	-

T_1-Soaking in invert sugar 60°B for 4 hours
T_2- Soaking in invert sugar 60°B for 6 hours
T_3- Soaking in invert sugar 60°B for 8 hours
T_4- Soaking in fructose 60°B for 4 hours
T_5- Soaking in fructose 60°B for 6 hours
T_6- Soaking in fructose 60°B for 8 hours
T_7- Soaking in sucrose 60°B for 4 hours
T_8- Soaking in sucrose 60°B for 6 hours
T_9- Soaking in sucrose 60°B for 8 hours

3.3 Effect of Pretreatments on Water Loss (%), Weight Reduction (%) and Sugar Gain (%)

Statistically significant differences were observed among treatments with respect to the water loss in (Table 3). The highest water loss, weight reduction and sugar gain (43.01, 14.44 and 13.32, respectively) was recorded in treatment T_3 - soaking in invert sugar 60°Brix for 8 hours followed by T_6 - soaking in fructose 60°Brix for 8 hours (38.49, 13.43 and 12.70, respectively). The lowest water loss (23.70, 4.21 and 6.51, respectively) was recorded in T_7 - soaking in sucrose 60°Brix for 4 hours significantly compared to all other. It is observed that the water loss increased with duration of osmosis over the entire dehydration process. The similar findings were reported for other fruits like [14] in peaches, [15,16] in banana and [17,18] in carrot.

It was also observed that the water loss increases in a non linear manner with durations for all the treatments. Water loss is faster in the initial period of osmotic dehydration and then the rate decreases. The same results were reported in osmotic concentration of fruit slices prior to freeze dehydration [19] the rapid removal of water in the early stage of osmosis was reported for apple [20,21] in carrots. The sugar gain also increased with duration of osmosis over the entire dehydration process. The similar findings were reported for other fruits ([14] in peaches, [15] in banana).

The ripe sapota slices treatments with invert sugar syrup caused more changes in water content, loss of mass and solid incorporation than the sucrose syrup. The similar findings were observed by [22] in osmotic dehydrated mango slices.

3.4 Effect of Pretreatments on Chemical Composition of Osmotic Dehydrated Ripe Sapota Slices

3.4.1 TSS (°Brix)

The effect of different treatments on the sapota slices expressed that there were significant differences among treatments with respect to the TSS (°Brix). The highest TSS (29.33 ^{0}Brix) was recorded in treatment T_3 – soaking in invert sugar 60°Brix for 8 hour. Soaking in sucrose 60 ^{0}Brix for 4 hours (T_7) has recorded significantly lowest TSS (16.67 ^{0}Brix) compared to all other treatments (Table 4). The TSS content of osmotic dehydrated slices followed by solar drying was increased significantly in all treatments as compared to initial content (17.90) which was ranged from 16.67 (T_7) to 29.33 (T_3). This might be due to variation in rate of water loss and solid gain during osmotic dehydration.

3.4.2 Acidity (%)

The highest acidity (1.03%) was recorded in treatment T_7 – soaking in sucrose 60^{0}Brix for 4 hour followed by T_8 – soaking in sucrose 60^{0}Brix for 6 hours (0.80%). Soaking in invert sugar 60^{0}Brix for 4 hours (T_3) recorded significantly lowest acidity (0.31) compared to all other treatments followed by T_2 –soaking in invert sugar 60°Brix for 6 hours (0.41%) (Table 4).

Table 3. Effect of pretreatments on physical parameter of osmotic dehydrated ripe sapota slices

Treatments	Water loss (%)	Weight reduction (%)	Sugar gain (%)
T_1	24.27	5.51	8.52
T_2	37.43	12.59	11.75
T_3	43.01	14.44	13.32
T_4	24.85	7.56	8.63
T_5	34.67	11.02	11.17
T_6	38.49	13.43	12.70
T_7	23.70	4.21	6.51
T_8	28.67	7.08	9.00
T_9	32.70	9.43	10.83
F. test	*	*	*
S.Em±	0.33	0.15	0.15
CD at 0.05%	0.97	0.44	0.45

T_1-Soaking in invert sugar 60°B for 4 hours; T_2- Soaking in invert sugar 60°B for 6 hours
T_3- Soaking in invert sugar 60°B for 8 hours; T_4- Soaking in fructose 60°B for 4 hours
T_5- Soaking in fructose 60°B for 6 hours; T_6- Soaking in fructose 60°B for 8 hours
T_7- Soaking in sucrose 60°B for 4 hours; T_8- Soaking in sucrose 60°B for 6 hours
T_9- Soaking in sucrose 60°B for 8 hours

Table 4. Effect of pretreatments on chemical composition of osmotic dehydrated ripe sapota slices

Pretreatments	TSS (^{0}Brix)	Acidity (%)	Ascorbic acid (mg/100 gm)	Carotene (mg)	Calcium (mg)	Phosphorous (mg)
T_1	21.17	0.46	4.40	47.70	9.08	10.30
T_2	26.50	0.41	3.60	45.40	9.48	12.37
T_3	29.33	0.31	3.33	44.27	11.10	12.61
T_4	18.50	0.48	4.63	47.20	8.52	10.13
T_5	25.50	0.43	4.03	46.03	9.46	10.67
T_6	29.00	0.43	3.47	42.20	10.17	11.32
T_7	16.67	1.03	5.00	44.87	8.60	10.84
T_8	23.33	0.80	4.27	44.27	9.30	11.20
T_9	25.00	0.52	3.67	43.07	9.37	11.39
F.test	*	*	*	*	*	*
S.Em±	0.26	0.009	0.04	0.12	0.15	0.08
CD at 0.5%	0.78	0.02	0.12	0.33	0.44	0.24
Initial value	17.90	1.60	13.80	95.00	25.50	68.90

T_1-Soaking in invert sugar 60°B for 4 hours; T_2- Soaking in invert sugar 60°B for 6 hours
T_3- Soaking in invert sugar 60°B for 8 hours; T_4- Soaking in fructose 60°B for 4 hours
T_5- Soaking in fructose 60°B for 6 hours; T_6- Soaking in fructose 60°B for 8 hours
T_7- Soaking in sucrose 60°B for 4 hours; T_8- Soaking in sucrose 60°B for 6 hours
T_9- Soaking in sucrose 60^0B for 8 hours

Results showed that the acidity content of osmotic dehydrated slices followed by solar drying was slightly reduced significantly in all treatments as compared to initial content (1.60) which was ranged from 0.31 (T_3) to 1.03 (T_7). This reduction might be attributed to leaching of acid from fruit slices to hypertonic solution through a semi-permeable membrane with respect to immersion time, which has caused decrease in titratable acidity. The similar results were made by [23] in osmotic dehydration of canned plum.

3.4.3 Ascorbic acid (mg/100 g)

The highest ascorbic acid (5.00 mg/100 g) was recorded in treatment T_7 – soaking in sucrose 60°Brix for 4 hour followed by T_4 – soaking in fructose 60^0Brix for 4 hours (4.63 mg/100 g). Soaking in invert sugar 60°Brix for 8 hours (T_3) recorded significantly lowest ascorbic acid (3.33 mg/100 g) compared to all other treatments followed by T_6 –soaking in fructose 60^0Brix for 8 hours (3.47 mg/100 g) (Table 4). Results showed that the ascorbic acid content of osmotically dehydrated slices followed by solar drying was reduced significantly in all treatments as compared to initial content (13.80 mg/100 g). Ascorbic acid is a water soluble vitamin and its loss in processed sample was mainly due to leaching in syrup, oxidation as well as thermal dehydration. [24] reported that ascorbic acid was around 20-35% of the original value in osmotically dehydrated guava slices. The loss of ascorbic acid was reported in Allahabad safeda and Pink flesh varieties of guava due to osmotic dehydration. This results are confirmative with [25,26] in cantaloupe and [27] in cashew apples.

3.4.4 Carotene (mg/100 g)

There were significant differences among treatments with respect to the carotene (Table 4). The highest carotene (47.70 mg/100 g) was recorded in treatment T_1 – soaking in invert sugar 60°Brix for 4 hour followed by T_4 – soaking in fructose 60°Brix for 4 hours (47.20 mg/100 g). Soaking in fructose 60^0Brix for 8 hours (T_6) has recorded significantly lowest carotene (42.20 mg/100 g) compared to all other treatments followed by T_9 –soaking in sucrose 60^0Brix for 8 hours (43.07 mg/100 g). The carotene content decreased drastically in all treatments which ranges from 47.70 (T_1) to 42.20 (T_6). Similar results of decrease in total carotenoids content were reported by [28] for mango. Carotene content loss was related to the loss of moisture and exponentially related to the treatment time during osmotic dehydration. Similar result was reported by [29] in osmotic dehydration pretreatment in drying fruits and vegetables. Reduction of carotene at solar drying could be due to increased oxidation rate of its highly unsaturated chemical structure. The similar findings were reported by [28] for mango and also by [30-32] in relatively high temperature drying food.

3.4.5 Calcium and phosphorus content (mg/100 gm)

The highest calcium and phosphorus (11.10 mg/100 g and 12.61 mg/100 g) were recorded in treatment T_3 – soaking in invert sugar 60^0Brix for 8 hour and the lowest calcium and phosphorus (8.52 mg/100 g and 10.13 mg/100 g) was recorded soaking in fructose 60°Brix for 4 hours (T_4) significantly lowest compared to all other treatments (Table 4).

The calcium and phosphorus content losses during osmotic dehydration may be attributed to the leaching due to the cell wall membrane permeability and leakage from the product to the osmotic solution during the osmotic process and chemical degradation during subsequent drying. The similar findings in case of calcium were recorded by [33] in osmotic dehydration of grapefruit and in case of phosphorus this result supported by [34] in potato.

3.5 Effect of Pretreatments on Organoleptic Evaluation of Osmotic Dehydrated Ripe Sapota Slices

The data pertaining to organoleptic evaluation of osmotically dehydrated slices showed that there were significant differences among treatments for all sensory attributes (colour, appearance, texture, taste, flavour and overall acceptability) (Table 5).

The data pertaining to colour attribute recorded that there were significant differences among treatments, the best score in case of colour, appearance, texture, taste, was recorded in treatment T_3 – soaking in invert sugar 60°Brix for 8 hour (7.67, 7.33, 6.67 and 8.00, respectively). Soaking in fructose 60^0Brix for 6 hours (T_5) recorded significantly lowest score (5.00, 5.00, 5.33 and 4.33, respectively) compared to all other.

The best score for flavor was recorded in treatment T_6 – soaking in fructose 60^0Brix for 8 hour (7.00). However the treatment T_8 and T_9 have recorded significantly lowest score (5.33) compared to all other treatments.

The best score for overall acceptability was recorded in treatment T_3 – soaking in invert sugar 60^0Brix for 8 hour (7.33). The treatment T_7 has recorded significantly lowest score (5.33) compared to all other treatments.

The results of sensory evaluation in all attributes such as colour, appearance, texture, taste, flavor and overall acceptability reveals that the score was increased as the immersion time increases from 4 hours to 8 hours in all treatments. This may be due to variation in water loss and solid gain during osmotic dehydration. The similar findings were observed by [35] in osmotic dehydration of ripe banana slices.

The ripe sapota slices osmo-dehydrated with invert sugar syrup for 8 hours had acceptance scores in overall sensory attributes due to its low inversion rate than the sucrose syrup. The similar findings were suggested by [22] in osmotic

Table 5. Effect of pretreatments on organoleptic evaluation of osmotic dehydrated ripe sapota slices

Pretreatments	Colour	Appearance	Texture	Taste	Flavour	Overall acceptability
T_1	5.67	6.67	6.00	5.67	6.33	6.00
T_2	6.67	6.33	6.33	6.67	6.33	6.33
T_3	7.67	7.33	6.67	8.00	6.67	7.33
T_4	5.33	5.33	6.00	5.33	6.33	6.00
T_5	5.00	5.00	5.33	4.33	6.33	5.00
T_6	7.00	6.67	6.33	7.00	7.00	6.50
T_7	6.67	6.00	6.00	5.00	6.67	5.33
T_8	6.67	6.33	6.33	5.67	5.33	6.33
T_9	5.33	6.33	5.67	6.33	5.33	6.00
F.test	*	*	*	*	*	*
S.Em±	0.33	0.40	0.50	0.39	0.44	0.44
CD at 0.5%	0.98	1.17	1.47	1.14	1.28	1.28

Score: 9- Like Extremely, 8- Like very much, 7- Like moderately, 6- Like slightly, 5- Neither like nor dislike, 4- Dislike slightly, 3- Dislike moderately, 2- Dislike very much, 1-Dislike extremely

dehydration of mango slices and [35] in banana slices.

The immersion of ripe sapota slices in osmotic medium before solar drying was helpful for improving the final product quality and sensory scores since acidity of slices reduced and prevents the oxidative browning. Similar results were reported by [36].

3.5.1 Organoleptic evaluation

Dried slices prepared under varied pretreatments was evaluated for sensory characteristics *viz.*, colour, appearance, texture, flavour, taste and overall acceptability at Hedonic 9- point rating scale [37]. Each attribute was given a separate score of 9 points. From the quality point of view, higher product scoring was treated as more acceptable. The sensory attributes were evaluated as per the format of hedonic 9- rating scale given below.

3.5.2 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±2℃) and refrigerated temperature (8-10℃) respectively for 4 months.

4. CONCLUSION

The physico-chemical properties and organoleptic quality of the product were evaluated during and at the end of the experiment. There were no significant differences in the drying time (hours) and recovery (%) of osmotic dehydrated ripe sapota slices followed by solar drying, whereas other physico-chemical properties showed significant differences with respect to pretreatments. The range of water loss (23.70-43.01%), weight reduction (4.21-14.44%), sugar gain (6.52-13.32%), TSS (16.67-29.33°B), acidity (0.31-1.03%), ascorbic acid (3.33-5.00 mg/100 g), carotene (42.20-47.70 mg/100 g), calcium (8.52-11.10 mg/100 g), phosphorus (10.13-12.61 mg/100 g) were observed. An increase in duration of osmosis from 4 to 8 hours leads to increase in water loss, weight reduction and sugar gain and TSS of the dried, ripe sapota slices.

However, It may be concluded that osmotic pretreatment with invert sugar 60°Brix for 8 hours resulted in highest sensory scores (7.33) while it was lowest in slices pretreated with fructose 60°Brix for 4 hours (5.00).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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