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Development of intermediate moisture sapota slices by osmotic dehydration

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Abstract
Sapota is one among the highly perishable fruit and hence marketing the fresh fruits to different places is quite very difficult. Therefore, it is necessary to convert the fresh produce into a value added product that can retain color, flavor and nutrients provided with extended shelf life. Various studies have indicated that pretreatment of fruits prior to osmotic dehydration improved the quality of the end product. Hence an attempt was made to study the effect of various pretreatments in the quality characteristics of osmo dried sapota fruits. The process for osmo drying of sapota involves washing, peeling, de-stoning and cutting into slices. The slices were then given two pretreatments *viz*., soaking the fruit slices in the solution of citric acid + sodium benzoate and ascorbic acid + sodium benzoate for 30 min. After pretreatment the fruit slices were soaked in the osmotic agent (sugar syrup) for 16 hrs followed by dehydration, cooling and packing. The dried fruit slices were packed in metalized polypropylene packs and subjected to shelf life studies for a period of 180 days. Analysis of the physicochemical qualities, microbial and sensory qualities of the fruit slices during storage, indicated that the osmo dried sapota samples pretreated with ascorbic acid had retained highly acceptable qualities.

Keywords: Sapota, pretreatment, sugar, osmotic agent, temperature, dehydration

Introduction

India is the largest producer of sapota with thirty to forty thousand hectares area and is one of the best loved fruit of the country. In India, Maharashtra leads the table with highest area, production and productivity followed by Karnataka and others states (National Horticultural Board, 2008) [11].

Sapota is delicious, nutritive and commercially grown mainly for fresh consumption. Postharvest life of sapota is very short due to its highly perishable nature and other many reasons such as quick ripening, faster senescence, rapid loss of moisture, microbial spoilage and fruit sensitivity to cold storage. To maintain and/or increase the shelf life of sapota, proper postharvest management is required (Siddiqui *et al*., 2014) [10].

To increase the shelf life of these fruits many methods or combination of methods had been tried out of which, osmotic dehydration is found to be one of the best and suitable method to increase the shelf life of fruits. This process is preferred over others due to their vitamin and minerals, color, flavor and taste retention property (Yadhav *et al*., 2012) [3]. There are many studies on osmotic dehydration for fruits and vegetables, such as apple, banana, carrot, cherry, citrus fruits, grapes, guava (Mehta *et al*., 2013; Pisalkar *et al*., 2011) [9, 12].

Osmotic dehydration is one of the low energy intensive techniques compared to air or vacuum drying process; it can be conducted at low or ambient temperature. It is the process of removal of water by immersing water containing cellular solids in concentrated aqueous solution. The driving force for the process is the concentration gradient between the solution and the intercellular fluid. If the membrane is perfectly semi permeable, solute is unable to diffuse to 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 solute penetration in food material is less initially, but increases with increase in time. The solute penetration (sugar) in the food directly affects the quality i.e. both flavor and taste of the end product.

Osmo dried fruits serve as an excellent snack food and are very handy. These can also be used in bakery products as food adjuncts. Moreover, dried fruits are nutritious as they are highly concentrated sources of sugar, vitamins and minerals (Shah *et al*., 2000) [15]. Studies of Amitabh *et al* (2000) [1] Sudhagar (2001) [16], Vijayakumar (2002) [18] and Gupta *et al*. (2002) [5] have indicated that pretreatment such as blanching or soaking in a solution containing citric acid or KMS improved the quality of osmo dried sapota, mango, papaya and pear.

Hence, the present research work was undertaken to study the different pretreatment processing on the quality attributes of osmo dried sapota slices.

Methodology
Ripened sapota of uniform size and color with firm texture from widely grown variety of sapota (PKM 1 (V_1) and cricket ball variety (V_2)) was selected for the osmotic dehydration experiment using food grade sugar as an osmotic agent.

Pretreatments of sapota
The food grade chemicals were purchased from the market and were used for the present study. Aqueous solutions of citric acid + sodium benzoate and ascorbic acid + sodium benzoate were prepared, filtered to remove any debris which would otherwise affect the quality of the product. The filtered solutions were used for pretreatments of sapota. The Table 1 depicts the sapota pretreatments.

Table 1: Pretreatments of Sapota

Variety (V)	Treatment (T)	
	T_1	T_2
V_1	$V_1 T_1$	$V_1 T_2$
V_2	$V_2 T_1$	$V_2 T_2$

V_1 - PKM 1, V_2 - Cricket ball, T_1 - Citric acid (0.5%) + sodium benzoate (0.5%),
T_2 - Ascorbic acid (0.5%) + sodium benzoate (0.5%)

Preparation of osmotic agent
The proportion of ingredients used for the preparation of osmotic agent is given in the table below.

Table 2: Preparation of osmotic agent

Ingredients	40^o bx	50^o bx	60^o bx
Sugar (g)	400	500	600
Water (ml)	600	500	400
Citric acid / ascorbic acid (g)	15	15	15
Sodium Benzoate (g)	2.5	2.5	2.5

Sugar was added to water and mixed thoroughly well. After adding sugar the contents were heated to 100 ^{0}C. The citric acid was added to sugar syrup while boiling to purify the syrup. The brix of the syrup was checked using hand refractometer. The syrup was filtered through a clean muslin cloth and cooled up to 60 ^{0}C and the temperature was maintained by placing them in the water bath.

Osmotic dehydration
Selected fruits were thoroughly washed under tap water before slicing to remove adhering impurities. The outer skin of the fruit was carefully peeled off manually using sharp stainless steel knife without damaging the pulp, destoned and cut into slices (6x2 cm). The fruit slices (1000 g) were soaked for 30 minutes in citric acid (0.5%) + sodium benzoate (0.5%) / ascorbic acid solutions (0.5%) + sodium benzoate (0.5%) (1000 ml) respectively. The fruit slices that were not given any pretreatment served as control.
The treated and control fruit slices were soaked in the osmotic agent separately. The fruit slices (1kg) to osmotic agent (1litre) ratio were 1:1 During the process of osmosis three levels of concentration (40, 50 and 60^o Brix) and temperature of the osmotic agent were maintained at 60 ^{o}C by placing them in the water bath for the first two hours to facilitate effective osmosis. The sugar syrup was stirred manually at regular intervals in order to maintain uniform temperature. The fruit slices were then allowed to remain in the osmotic agent for a period of 16 hrs for effective osmosis to take place. After 16 hrs, the sugar syrup was drained and the fruit slices were arranged in trays and dried in a cabinet drier at a temperature of 60 ^{o}C for 6 hrs. The product after dehydration was cooled and packed in metalized polypropylene packs and stored at room temperature for further shelf life studies.

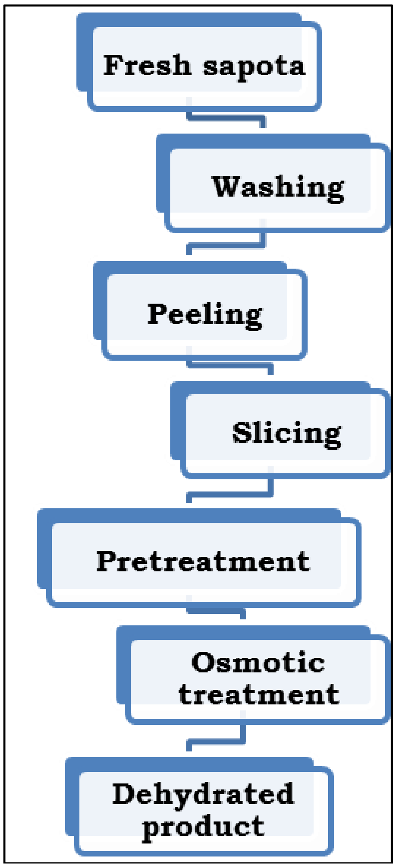

Fig 1: Flow diagram for Osmotic dehydration

Quality analysis
Moisture, carbohydrates, protein, fat, calcium, phosphorus, iron, titrable acidity, total sugars and ascorbic acid were analyzed using standard methods AOAC, 2007 [2].
The nutritional, microbial and sensory qualities were periodically analyzed at regular intervals throughout the storage period of 180 days. The following qualities of the stored osmo dried slices were periodically (once in 30 days) evaluated. The total plat0065 count was determined by serial dilution technique and plating method as given by Istavan Kiss (1974). The osmo dried fruit slices were assessed for color, texture, flavor, taste and over all acceptability by a panel of 15 semi trained panelists using nine point hedonic scale (Watts *et al*.1989) [19]. All experiments were replicated thrice and average values were reported

Results and Discussion
Composition of Fresh Sapota Fruit
The following observations recorded in below table on composition of fresh sapota fruit of two variety V_1 and V_2 such as moisture 73.2g and 72.1g, carbohydrates 21.8g and 20.45g, protein 0.9g and 0.8g, calcium 27.8mg and 25.2mg, phosphorus 25.1mg and 24.5mg, iron 1.9mg and 1.5mg, ascorbic acid 5mg and 3.5mg respectively.

Table 3: Composition of Fresh Sapota fruit (Per 100g)

Constituents	Variety	
	V_1	V_2
Moisture (g)	73.2	72.1
Carbohydrates (g)	21.8	20.45
Protein (g)	0.9	0.8
Fat (g)	1.0	0.9
Calcium (mg)	27.8	25.2
Phosphorus (mg)	25.1	24.5
Iron (mg)	1.9	1.5
Ascorbic acid (mg)	5	3.5

V_1 - PKM 1, V_2 - Cricket ball

Quality Characteristics of osmo dried sapota slices during storage

The osmo dried sapota slices dried using 60°bx was found to have the highly acceptable sensory qualities and therefore was taken for further storage studies. The changes observed in the nutrient content of the osmo dried fruit slices during storage are presented in Table 4.

Table 4: Quality Characteristics of osmo dried sapota slices during storage (per 100g)

Nutrients	Storage period	V_1			V_2		
		T_0	T_1	T_2	T_0	T_1	T_2
Moisture (g)	0 days	23.59	23.51	23.48	23.07	23.96	23.76
	180 days	24.98	23.85	23.78	23.39	23.15	23.03
Titrable Acidity (%)	0 days	0.168	0.214	0.292	0.180	0.256	0.307
	180 days	0.175	0.225	0.305	0.189	0.342	0.318
Total sugars (g)	0 days	61.85	62.48	62.19	62.50	63.28	63.52
	180 days	61.00	62.13	62.08	62.28	63.08	63.48
Ascorbic acid (mg)	0 days	4.57	5.92	7.58	4.95	4.62	6.78
	180 days	4.26	5.23	7.10	4.15	4.20	6.22

V_1 - PKM 1, V_2 – cricket ball, T_0 - Control, T_1 - Citric acid, T_2 - Ascorbic acid

It could be inferred that the initial moisture content ranged from 23.59 to 23.48 for V_1 and 23.03 to 23.96 for V_2 (g per 100g respectively). After 180 days of storage a slight increase in moisture was observed in all the samples irrespective of the treatment and variety. Among the treatments the highest moisture level was observed in the T_o followed by T_1 and T_2 for both the varieties.

In all the experiments the rate of water loss was more in the beginning of process and decreased gradually with the increase of duration of osmosis and approaches equilibrium. Similar results were reported for osmotic dehydration of bananas by Sagar (2001) and also in various other fruits and vegetables (Ertekin *et al*., 1996; Karathano *et al*., 1995; Lazarides *et al*., 1995; Pokharkar *et al*., 1998) [4, 6, 8, 13].

A significant difference existed in the acid content among the treatments, varieties and storage period as it is evident from the Table 4. The highest acidity was exhibited by the samples treated with ascorbic acid followed by citric acid in both the varieties during the initial storage period. The acidity of the control samples was found to be lesser than the treated samples irrespective of the variety.

A similar study was also carried out by Tripura *et al*., 2017 [17], the highest acidity (1.03%) was recorded in treatment soaking in sucrose 60^0 Brix for 4 hours.

The total sugar content ranged from 61.85 to 62.19 g per 100 g initially in V_1. Similarly for V_2 the initial and final total sugars ranged from 62.50 to 63.48g per 100 g respectively. A significant difference was observed in the reduction of total sugars between the treatment, varieties and packaging materials.

Amitabh *et al* (2000) [1] reported that the osmo dried fruit slices had the total sugars in the range from 60 to 65 mg / 100 g. They also observed a loss in the total sugars during storage. A similar trend was observed in the present study also.

The retention of ascorbic acid during processing of the osmo dried sapota slices as seen from Table 4 shows that the highest ascorbic acid was exhibited by T_2 while the lowest was in T_0 in both the varieties, which might be due to the difference in the pretreatments given. The same trend was maintained throughout the storage period.

The highest ascorbic acid (5.00 mg/100 g) was recorded in treatment soaking in sucrose 60°Brix for 4 hours (Tripura *et al*., 2017) [17]. The present study also coincide with the result of Tripura *et al*., 2017[17].

Table 5: Microbial load of osmo-dried sapota slices during storage (cfu/ g)

Microbial load	Storage period	V_1			V_2		
		T_0	T_1	T_2	T_0	T_1	T_2
Bacteria × 10^{-6}	Initial	0	0	0	0	0	0
	Final	3.2	2.8	1.0	3.5	3.0	2.2
Fungi × 10^{-3}	Initial	0	0	0	0	0	0
	Final	1.2	1	0	1.3	1	1
Yeast× 10^{-2}	Initial	0	0	0	0	0	0
	Final	1	0.80	0	1	0.80	0.50

V_1 - PKM 1, V_2 – cricket ball, T_0 - Control, T_1 - Citric acid, T_2 - Ascorbic acid

Table 5 gives information on the bacterial, fungal and yeast load of the osmo dried sapota slices during storage. Initially there was no microbial load in all the treatments and varieties including the control. After 180 days of storage there was a slight increase in the bacterial load in all the samples, while no fungal and yeast colonies was found in T_1 and T_2 in both the varieties.

Table 6: Mean organoleptic scores of osmo dried sapota slices

Quality attributes	Storage period	V_1			V_2		
		T_0	T_1	T_2	T_0	T_1	T_2
Color	Initial	8.0	8.0	9.0	8.0	8.0	9.0
	Final	7.0	7.5	8.9	7.0	7.3	8.8
Texture	Initial	8.0	8.5	9.0	8.0	8.5	9.0
	Final	7.2	8.0	8.8	7.0	7.8	8.7
Flavor	Initial	8.0	8.0	9.0	8.0	8.0	9.0
	Final	7.2	7.8	9.0	7.0	7.6	8.8
Taste	Initial	8.0	8.5	9.0	8.0	8.0	9.0
	Final	7.0	7.3	9.0	7.0.	7.5	9.0
Overall acceptability	Initial	8.0	8.0	9.0	8.0	8.0	9.0
	Final	7.0	7.5	9.0	7.0	7.5	9.0

The mean organoleptic scores of the osmo dried sapota slices are given in Table 5. During the initial storage period, the color was bright for the samples of T_1 to T_2 and dull without browning for T_0 of V_1. For V_2 the color of T_1 to T_2 was bright and for T_0 it was dull without browning. Among the treatments the samples of T_2 obtained the maximum score for color in both V_1 and V_2, which was maintained throughout the storage period.

During storage there was a loss of the color appeared in the control samples and in both the varieties. There was a reduction in the scores for color during storage and the highest reduction was for T_o and lowest in T_2 for both V_1 and V_2.

The treated osmo dried samples of both the varieties had soft and pliable texture which was highly acceptable, while the control samples were firm. During storage the highly acceptable texture was maintained only by the treated samples while the control samples became soggy irrespective of the variety. The highest scores for flavor and taste was obtained by T_2 in both the varieties, which was maintained throughout the storage period. The samples of T_2 had highly acceptable sweet malty flavor. The results of the sensory evaluation revealed that osmo dried fruit slices of V_1 were more acceptable than V_2.

The unit cost of osmo dried sapota slices (10g) was Rs. 1.85, which was cheaper than sugar boiled confectioneries and chocolates.

Conclusion

The study concluded that PKM1 variety of sapota is more suitable for osmotic dehydration than cricket ball variety. The best pretreatment for osmotic dehydration of sapota was found to be ascorbic acid than citric acid at it retains the nutritional properties of the sapota during storage. The product that of ascorbic acid treated sapota (PKM1 variety) had highest score for sensory attributes of appearance, color, flavor and overall acceptability.

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