Influence of sugar concentration on physicochemical properties and sensory attributes of sapodilla jam

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Abstract

Sapodilla has many uses from medicinal to dietary utilization. In recent years emphasis is focused on product diversification by development of value added sapodilla products to enhance its economic value. This study was carried out to investigate the effect of sugar concentration on the physiochemical properties like pH, moisture, ash, total acidity, viscosity, soluble solids, ascorbic acid and consumer acceptability of the product through sensory evaluation. Four samples S_1, S_2, S_3 and S_4 were formulated containing 550g, 600g, 650g and 700g sugar respectively. There was no significant difference observed in physiochemical properties of all sample due to sugar concentration. But among all samples S_2 and S_3 scored highest for color (7.7 and 7.9), flavor (7.6 and 7.7), taste (7.6 and 7.8), texture (7.2 and 7.9) and overall acceptance (7.5 and 7.7) which shows that jam with 550g and 600g sugar is best jam with good sensory attributes.

Keywords: Physiochemical properties Sapodilla, Sensory, sugar concentration

INTRODUCTION

Sapodilla (*Manilkara zapota)* commonly known as chiku in the sub-continent (Pakistan & India) is believed to be native to Yucatan and possibly other nearby parts of southern Mexico, as well as northern Belize and Northeastern Guatemala (Morton, 1987). Sapodilla fruit is round to egg shaped and 2-4 inches in diameter and 75-200g in weight (Mickelbart, 1996). It is climacteric fruit (Lakshminarayana, 1979), sweet when ripened and posses 3-5 black seeds. It is available twice a year from January to February and then again in May to July.

It is widely used in the eastern medicines. Flower and fruit blend is used for different pulmonary problems. The extract of young fruit is beneficial in diarrhea. Crushed seeds paste is helpful to remove the stones from kidney, give relief when applied on stings and bites from venomous animals (Hamza *et al.,* 2013; Kulkarni *et al.,* 2007*).* The

leaf extract possesses antibacterial effect against 10 gram positive and 12 gram negative bacteria (Nair and Chanda, 2008). Sapodilla Fruit or its fresh juice has also proved to be effective against cancer (Manzoor *et al*., 2012). Aqueous leaf extracts of *Manilkara zapota* acts as repellent against the housefly (Kamaraj *et al.,* 2011).

In Pakistan it is cultivated in 570 hectare with the total production of 2,018 metric tons. Sapodilla is widely grown in Winder town of Baluchistan, Pakistan (Hamza *et al.,* 2013). In India sapodilla is mainly cultivated for its edible fruit, while in Mexico, Guatemala and Venezuela it is grown for the chicle gum, resinous latex which is obtained from its bark (Sawant and Patil, 2013).

Beside its medicinal use sapodilla can also be processed into value added products like sapodilla jam. Pectin can be extracted from the peel of fruit. Pectin and fruit pulp can be utilized to make sapodilla jam (Siddique *et al*., 2015). It can also be processed into Clarified juice (Sin *et al*., 2006). In some regions canning and drying techniques are utilized for its preservation. (Ganjyal *et al*., 2003)

Sugar is one of the most important ingredients deciding the rheological properties of jam. It renders it shelf stable enhances taste and improves the texture of the product. The re-crystallization of sugars in jam is considered major imperfection which is usually caused by high amount of sugar in the recipe. Therefore it is necessary to choose a suitable sugar that has less potential of re-crystallization. Here, Sucrose is considered a better option for jams as compared to glucose because it has low tendency to re crystallize (Javanmard and Endan, 2010). At low pH during manufacturing process sucrose is converted into glucose and fructose, it is desirable because it reduces the potential of sugar to form crystals (Cancela *et al.,* 2005).

The current study was carried out to observe the influence of sugar concentration on the rheological attributes of sapodilla jam and its potential effect on the sensory attributes of the finished product.

MATERIALS AND METHODS

Procurement of raw material fruits

White sugar and mature ripened sapodilla fruit was procured from local market. While, food grade pectin, citric acid, and preservative (sodium benzoate) was purchased from Sigma Aldrich, Germany.

Extraction of pulp

The sapodilla fruit was washed and peeled off. After peeling it was cut into pieces and seeds were removed. The fruit pieces were boiled in water to inactivate the enzymes responsible for browning and to make the fruit pieces soft. The fruit pulp was obtained by blending it in a blender Black & Decker model FX 1000. The pulp so obtained was filtered through a sieve of 0.58 mesh size.

Physicochemical analysis of pulp

Physiochemical analysis like pH, Total acidity, Total Soluble Solids, Ash%, Moisture% and Vitamin C of pulp was carried out through recommended methods of AOAC (2007).

Processing of sapodilla jam

Different treatments of sapodilla jams were prepared by following the treatment plan given in table. 1. Sapodilla pulp and white sugar was taken in a cooking pan, and heated on a gas burner, meanwhile pectin and citric acid was mixed in 100 ml water by using Black & Decker blender model FX 1000. The mixture was added to the recipe and cooked until the brix reached 67^{o}. No color or flavor was added it was all natural. The preservative at the rate of 0.2% was used to make the jam shelf stable. The finished product was poured into glass jars while hot.

Table 1. Treatment plan for sapodilla jam **(1kg)**

Ingredients	S1	S2	S3	S4
Pulp (g)	450	400	350	300
Sugar (g)	550	600	650	700
Pectin (g)	5	5	5	5
Citric Acid (g)	5	5	5	5

Physic-o-chemical analysis of jam

Determination of pH

For pH determination 50g sapodilla jam was taken in beaker and digital pH meter was used according to the method described in AOAC, 2007.

Determination of moisture

The moisture in the jam sample was determined according to the method followed by Ashaye *et al*., 2009. Sample was measured in a weighted crucible. The crucible containing the sample was then transferred into hot air oven which was set at 100^{0}C for 24 hours over night. After 24 hours it was removed from oven and then transferred into desiccator for ten minutes and weighted.

$$\textbf{\% Moisture} = \frac{W1-W2}{W1-W0} \times 100$$

Where W_0 is weight of empty crucible, W_1 is weight of crucible plus sample. W_2 weight of sample plus oven dried sample.

Determination of ash

Ash was determined by the method described in AOAC, 2007.

Determination of total acidity

Total acidity was determined through method of AOAC, (2007) by taking 10g sample of sapodilla jam dissolving in 100mL and then titrate it against 0.1 N NaOH solutions till the appearance of pink end point.

Determination of viscosity

Brookfield DV-E Viscometer using t-shaped spindle at 20rpm was used to measure the viscosity at 25^0C (AOAC, 2007)

Determination of soluble solids

Soluble solids was measured at 20^oC by Hand held Refractometer ATC, that was expressed in Brix (AOAC, 2007)

Determination of ascorbic acid

Vitamin C is also known as ascorbic acid which is an antioxidant. It was measured through the method followed by Sawant and Patil (2013) using 2, 6 dichlorophenol indophenol dye.

The blue color of dye was reduced to colorless in the presence of ascorbic acid. The amount of Ascorbic acid in mg/100gml was calculated by the following formula

$$\mathbf{A_a} = \frac{\mathbf{Tr \times Df \times Vm \times Vs}}{\mathbf{Ve \times Wt}} \times \mathbf{100}$$

Where,

$\mathbf{A_a}$= Ascorbic acid;

$\mathbf{T_r}$= Titer value;

$\mathbf{D_f}$ = Indophenol dye factor;

$\mathbf{V_m}$= Volume of solution which is made;

$\mathbf{V_s}$= Volume of sample;

$\mathbf{V_e}$= Volume of extract;

$\mathbf{W_t}$= Weight of sample taken.

Sensory evaluation

The sapodilla jam was judged for sensory attributes like Color, Flavor, Taste, Texture, Overall acceptance by trained panel of 20 members. The samples were Scored on the base of 9 point hedonic scale (1= extremely dislike to 9= extremely like) *(*Lawless and Heymann, 1998*)*. Four jam samples with different sugar concentrations (S_1, S_2, S_3, and S_4) with same TSS 67% were evaluated. The samples were presented to the panelists under normal conditions at room temperature in cups coded with two digit random number.

Statistical analysis

The sensory scores were statistically analyzed using Minitab 16 and the results were properly tabulated for means (Steel *et al.,* 1997)

RESULTS AND DISCUSSION

Physicochemical properties of pulp

Fresh sapodilla pulp was analyzed for Moisture, ash, TSS, total acidity on percentage basis and Vitamin C in mg/100ml. In present study moisture (69.24), Ash (1.12), pH (5.08), acidity (0.18%) TSS (17.34) and vitamin C (7.63 mg) of sapodilla pulp are observed. These values are quite comparable with the results of Ahmed *et al.* (2011) who observed moisture (70.07%), Ash (1.40%), pH (5.10), acidity (00.15%) and Total soluble solids (19.4).

Physicochemical properties of jam

The jam samples were analyzed for Physiochemical properties like pH, Moisture, Ash, total acidity, viscosity, soluble solids and ascorbic acid. The Physiochemical attributes of different formulations of jam are presented in table 2.

pH

The values of pH observed in different samples are given in table. 3, the data revealed that the pH of different formulations of sapodilla jam ranged from 3.19 to 3.39 which are in the prescribed limits of FAO. However, the sample which got high score in sensory evaluation showed pH 3.35. The pH value is most important factor that should be monitored and controlled in jam processing. Pectin had no significant effect on the pH of jam (Afoakwa *et al.,* 2006).

Moisture

Moisture content in any food commodity plays key role in deciding its shelf life (Fellows, 2000). Usually, high sugar content makes the moisture unavailable for the growth of microorganisms, thus improving the shelf life of food (Afoakwa *et al.,* 2006). Activity of microbes and enzymes may also be responsible for the fluctuation in moisture content (Ashaye *et al*., 2006). The moisture content in present study was found to be in range from 36.44 to 32.53. However, 36.44%, 35.23%, 33.42 and 32.53 moisture content were observed in S_1, S_2, S_3 and S_4 respectively which shows that all products potentially possessed good shelf life.

Ash

Ash content represents minerals like calcium, phosphorus and iron. Value of ash indicates the stability of products. Ash content can become lower due to the utilization of minerals by microorganisms for their

growth (Ashaye *et al.,* 2006). Table 2 shows that ash% of sapodilla jam was progressively increased with an increase in sugar concentration. Ash% calculated in present study ranged from 1.79-1.88% which makes it shelf stable.

Total Acidity

Acidity gives imperative effect on the gelation property of pectin (Mizrahi, 1979).The total acidity values in present study showed that increase in sugar concentration decreases the total acidity. The value of total acidity ranged from 1.11 to 0.98 which is in line with the standard value of good quality jam. The S_1 formulation containing 500g sugar showed 1.11 % acidity. S_2 sample having 550g sugar exhibited 1.05%, However 0.98%, 1.01 % acidity was observed in samples S_4 and S_3. Present studies shows that there was no significant difference in total acidity between four treatments S_1 (550g sugar), S_2 (600g sugar), S_3 (650g sugar) and S_4 (700g sugar) and it was found that lowest percentage acidity (0.98%) was exhibited by S_4.

Viscosity

Viscosity depends upon factors like pectin concentration and temperature. Pectin solutions act like pseudoplastic, which depends on the raw materials; any alteration in this causes changes in viscosity (Yoo *et al.,* 2009). Earlier studies also showed that sugar type is important for pectin solutions and observed that sucrose formed the most rigid gels that give better texture to product (Raphaelides *et al.,* 1996). Sucrose increases the viscosity of pectin solutions (Chen and Josylen, 1967). Change in viscosity was due to the presence of sugar (Javanmard and Endan, 2010). Viscosity may also be reduced due to higher concentration of enzymes (Sin *et al.,* 2006). Present study results show that viscosity gradually increases with the increase in sugar concentration which means that sugar concentration plays an important role to maintain the viscosity. It was observed that S_1 sample containing 550g sugar had 69cp while increasing trend in viscosity was observed in S_4 containing 700g sugar where it showed 78cp.

Soluble solid

One of the most important constituent of fruits is sugar which acts as a natural food preservative (Ayub *et al*., 2010). In this study the TSS was maintained at 67^0Bx for all samples. In some studies the gradual increase in total soluble solids of sapodilla jam were also observed (Koli *et al.,* 2004).To retard the microbial growth Brix of 68 ± 0.71 is recommended (James 2002)

Ascorbic acid

The naturally occurring antioxidants were significantly decreased during heating (Anese *et al*., 2002). The vitamin C content recorded was in range from 17.04 to 16.77 as shown in Table 2 are in line with the reported values of Siddique *et al.,* 2015. This study shows that by increasing amount of sugar the vitamin C content was slightly decreased. It is due to the fact that increased concentration of sugar results in the increase in cooking temperature owing to the presence of high amount of dissolved solids.

Table2. Effect of different sugar concentrations on the physicochemical properties of jam.

Treatment	Moisture %	Ash %	pH	Acidity %	Viscosity cp*	Vitamin C mg
S1	36.44	1.79	3.19	1.11	69	17.04
S2	35.23	1.80	3.27	1.05	72	16.74
S3	33.42	1.84	3.35	1.01	75	16.79
S4	32.53	1.88	3.39	0.98	78	16.77

***cp= centipoises**

Sensory evaluation

The four samples with different concentrations of sugar were presented for the hedonic test. The mean scores of color, flavor, taste, texture and overall acceptance are given in table 3. Sensory evaluation indicated that S_2, and S_3 samples scored higher, for overall acceptance. The S_1 formulation with 500g sugar, scored 7.3, 7.3 and 6.4 for Flavor, Taste and Texture respectively but got low score 5.6 for color. It is due to the fact that low level of caramelized brown color was observed in S_1 due to low concentration of sugar. The scores of S_2 are quite comparable with S_3 where they scored 7.7 & 7.9 for color, 7.6 & 7.7 for flavor, 7.6 & 7.8 for taste and 7.2 & 7.9 for texture respectively. The S_4 sample was scored lowest for color (4.8), flavor (7.2), taste (6.7), texture (5.5), and overall acceptance (5.3).

Table 3. Scores for sensory test for sapodilla jam by 9-point Hedonic Scale

Treatment	Color	Flavor	Taste	Texture	Overall acceptance
S1	5.6	7.3	7.3	6.4	6.0
S2	7.7	7.6	7.6	7.2	7.5
S3	7.9	7.7	7.8	7.9	7.7
S4	4.8	7.2	6.7	5.5	5.3

* 1= Extremely poor, 2= Very poor, 3= Poor, 4= Below fair above poor, 5= Fair, 6= Below good above fair , 7= Good, 8= Very good, 9 =Excellent.

Conclusion

This project was designed to determine the effect of sugar concentration on the acceptability of the sapodilla jam. The outcomes of the current studies suggest that S_2 and S_3 formulations containing 600g (60%) and 650g (65%) sugar respectively proved as best product in terms of color, flavor, taste, texture and overall acceptance.

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