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Evaluation of chemical parameters of sapota (*Manilkara achras* (Mill) Fosberg)

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Abstract
Sapota fruit is highly appreciated due to its pleasant flavour, sweet taste and deep orange red colour of the pulp. The fruit is a good source of digestible sugar, which ranges from 15 to 20 per cent and it is 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. Edible portion of sapota contains 73.70 g moisture, 21.40 g carbohydrates, 0.70 g protein, 1.10 g fat, 28 mg calcium, 27 g phosphorous, 2 mg iron and 6 mg ascorbic acid per 100 g of pulp. It is also rich in bio-iron required for the formation of hemoglobin. It is commercially grown for the production of chickle i.e. a gum like substance obtained from the latex mainly used for the preparation of chewing gum.

Keywords: sapota, pulp, fruit, chiku

Introduction
Sapota (*Manilkara achras* (Mill) Fosberg) is one of the most important tropical fruit belonging to the family sapotaceae. It is popularly known as *chiku* in India. It is one of the major fruit crops grown in India, Mexico, Guatemala and Venezuela (Kulkarni *et al*., 2007) [12].

The fruit is a native of Mexico and Tropical America. The area under sapota in India was 1.21 lakh hectares, with an annual production of 14.97 lakh MT during the year 2014-2015. The major sapota growing states in our country are Andhra Pradesh, Gujarat, Karnataka, Maharashtra and Tamil Nadu. Maharashtra produced 137.28 thousand MT sapota from 15.87 thousand hectares of area under cultivation in 2014-2015 (Anon., 2014) [3]. It is extensively grown in Gujarat, coastal Maharashtra and Karnataka. Kalipatti is an outstanding variety of sapota popularly cultivated in the Konkan region with a few other varieties like Bhuripatti, Dhola diwani and Cricket ball.

Sapota fruit is highly appreciated due to its pleasant flavour, sweet taste and deep orange red colour of the pulp. The fruit is a good source of digestible sugar, which ranges from 15 to 20 per cent and it is 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. Edible portion of sapota contains 73.70 g moisture, 21.40 g carbohydrates, 0.70 g protein, 1.10 g fat, 28 mg calcium, 27 g phosphorous, 2 mg iron and 6 mg ascorbic acid per 100 g of pulp (Sulladmath and Reddy, 1985) [27].

It is also rich in bio-iron required for the formation of hemoglobin. It is commercially grown for the production of chickle i.e. a gum like substance obtained from the latex mainly used for the preparation of chewing gum (Balerdi *et al*., 2005) [4].

Sapota is mainly valued for its sweet and delicious fruits. Sapota fruits are preferably consumed as fresh, although some studies have reported its use in preparation of jelly, jam, cheese and butter (Relekar *et al*., 2011) [21]. Products like sweet chutney, dried sapota pieces, sapota milk shake, nectar, blended sapota drinks, pickle, preserve and candy can also be prepared with good sensory quality (Sawant, 1989) [23]. Even wine can be prepared from sapota fruit (Gautam and Chundawat, 1998) [7]. Processed food items *viz*. jelly, jam, squashes and fruit drinks are produced from sapota after blending it with other fruits (Ghade, 2013 and Pawar, 2013) [8]. They are also canned as slices (Sulladmath and Reddy, 1985) [27].

It has been observed that when there is a bumper production of sapota, the fruit goes as waste for want of suitable preservation facilities. Thus, considering the fast increasing area under sapota cultivation, the preservation and processing technology needs to be developed in order to prevent huge post- harvest losses and regulate prices during glut period and thereby protecting the interest of the growers. Also, there are problems during rainy season, as there is glut in market during this period, it is essential to develop a new range of product, so that farmers can get an assured price for their produce all the time.

Review of litrature
1 Chemical parameters of sapota
1.1 Moisture
Laxminarayan and Subramanyam (1966) [13] reported that the mature sapota fruit contained about 80 per cent moisture.

Thapa (1980) [29] noted 70.70 per cent moisture in edible pulp of sapota fruit.

Paralkar (1985) [15] observed 75 per cent moisture in mature sapota fruit and further noticed a decrease in moisture content during storage irrespective of the grades and storage condition. Similar result was also reported by Sawant (1989) [23] in sapota fruit.

Raut (1999) [20] studied the changes in moisture content of sapota fruits Cv. Kalipatti during storage at ambient

temperature. He observed that the moisture content of fruits decreased during ripening. The mature, ripe and over ripe (end of shelf life) fruits showed 74.58, 69.52 and 66.61 per cent moisture, respectively.
Ahmed *et al*. (2011) [2] studied the chemical composition of fresh sapota and observed 70.07 per cent moisture in sapota pulp.
Pawar *et al*. (2011) [16] studied the physico-chemical parameters of sapota fruit at different maturity stages and observed 75.80 per cent moisture content in sapota fruit.
Salvi (2013) [22] observed 71.27 per cent moisture in the sapota pulp.
Raut (2015) [15] studied the chemical composition of fresh sapota and observed 76.06 per cent moisture in sapota fruit.
Gaikwad (2016) [6] recorded 76.06 per cent moisture in the kalipatti cultivar of sapota.

1.2 Total soluble solids
Chundawat and Bhuva (1982) [5] observed that kalipatti cultivar of sapota ranked first among the cultivars evaluated and recorded the highest TSS (25 ^{0}B).
Shinde (1993) [26] observed that the TSS of A, B, C and D grades was 24.16, 23.96, 23.84 and 23.80 ^{0}B, respectively at ripe stage of sapota Cv. Kalipatti.
Honde (1995) [10] prepared wine from sapota Cv. Kalipatti and he observed the TSS of sapota juice as 19.0 ^{0}B.
Raut (1999) [20] studied the changes in total soluble solids content of sapota fruits Cv. Kalipatti during storage at ambient temperature. He reported an increase in the TSS during ripening of sapota fruits, followed by a decline after reaching peak. The TSS at mature, ripe and at the end of shelf life was 18.02, 23.65 and 20.24 ^{0}B, respectively.
Ahmed *et al*. (2011) [2] studied the chemical composition of fresh sapota and observed 19.40 ^{0}B TSS in sapota pulp.
Pawar *et al.* (2011) [16] evaluated physico-chemical parameters of sapota fruits at different maturity stages and reported 23.60 ^{0}B TSS at ripe stage.
Hiremath and Rokhade (2012) [9] conducted an experiment on preparation and preservation of sapota juice and recorded 21.60 ^{0}B of total soluble solids content in sapota fruit.
Naktee (2013) observed 23 ^{0}B TSS in sapota fruit; whereas, it was 22 ^{0}B recorded by Salvi (2013) [22].
Raut (2015) [15] studied the chemical composition of sapota fruit and recorded 21.40 ^{0}B TSS level.
Gaikwad (2016) [6] observed the 23 ^{0}B TSS level in fresh sapota juice.

1.3 Titratable acidity
Selvaraj and Pal (1984) reported a decline in malic acid content from 18.95 to 17.75 mg/100 g on ripening in the sapota fruits.
Suryanarayana and Goud (1984) observed 0.38 per cent acidity in mature sapota fruits on the day of harvest which decreased to 0.18 per cent at ripe stage in Cv. Oval.
Paralkar (1985) [15] observed 0.18 per cent acidity in sapota Cv. Kalipatti.
Sawant (1989) [23] while working on sapota Cv. Kalipatti reported that the acidity of fruit decreased from 0.23 per cent (harvest stage) to 0.07 per cent (end of shelf life) during storage at ambient temperature.
Shinde (1993) [26] reported that the average titratable acidity in
A, B, C and D grades of sapota Cv. Kalipatti was 0.12, 0.11, 0.10 and 0.12 per cent, respectively.
Honde (1995) [10] while working on sapota wine observed the titratable acidity of sapota juice as 0.12 per cent.
Ahmed *et al*. (2011) [2] studied the chemical composition of fresh sapota and observed 0.15 per cent of titratable acidity in sapota pulp.
Pawar *et al*. (2011) [16] studied the physico-chemical parameters of sapota fruit at different maturity stages and reported 0.10 per cent titratable acidity at ripe stage.
Hiremath and Rokhade (2012) [9] conducted an experiment on the preparation and preservation of sapota juice and recorded 0.10 per cent titratable acidity in sapota fruit.
Naktee (2013) studied the chemical compostion of ripe sapota fruit and reported 0.12 per cent acidity. Similar acidity level of 0.12 per cent was observed by Salvi (2013) [22].
Raut (2015) [15] recorded 0.09 per cent acid level in fresh sapota juice.
Gaikwad (2016) [6] observed that the titratable acidity of sapota Cv. Kalipatti was 0.12 per cent.

1.4 Reducing sugars
Rao *et al.* (1971) [18] observed that the sapota fruits contained 3.61 per cent of reducing sugars.
Paralkar (1985) [15] reported an increase in the content of reducing sugars during maturity of sapota fruit.
The changes in chemical composition of sapota fruits during ambient temperature storage were studied by Sawant (1989) [23] and observed that the reducing sugar content increased with ripening from 8.28 per cent (at harvest) to 10.86 per cent (at ripe stage). It was further observed that the reducing sugars decreased from ripe stage to the end of shelf life (9.24 %).
Honde (1995) [10] prepared a wine from Cv. Kalipatti. During his studies, he observed the reducing sugars of sapota juice was 8.3 per cent.
Ahmed *et al*. (2011) [2] studied the chemical composition of fresh sapota and observed 4.96 per cent of reducing sugars in sapota pulp.
Pawar *et al*. (2011) [16] studied the physico-chemical parameters of sapota fruit at different maturity stages and reported 10.11 per cent reducing sugars at ripe stage.
Hiremath and Rokhade (2012) [9] conducted an experiment on preparation and preservation of sapota juice and observed 7.69 per cent reducing sugars in sapota fruit.
Salvi (2013) [22] studied the chemical composition of sapota fruit and recorded the 10.82 per cent reducing sugars; whereas, Naktee (2013) recorded 8.30 per cent reducing sugars.
Raut (2015) [15] observed 7.61 per cent of reducing sugars in fresh sapota juice.
Gaikwad (2016) [6] reported 8.30 per cent of reducing sugar content in sapota Cv. Kalipatti.

1.5 Total sugars
Laxminarayana and Subramanyam (1966) [13] observed an increase in the content of total sugars during ripening of sapota fruits with decline towards the end of shelf life.
Rao *et al.* (1971) [18] observed that the sapota fruits contained 12.0 per cent total sugars.
Shanmugavelu and Shrinivasan (1973) evaluated ten cultivars of sapota and noticed variation from 7.0 to 12.3 per cent in total sugars.
Paralkar (1985) [15] reported that in sapota, initially the content of total sugars was less which increased

substantially when the fruits were ripe, followed by decline till the end of storage period.

Joshi and Paralkar (1991) reported that the sugar content was not noticeable up to 3rd month of sapota fruit development, but later on, the reducing, non-reducing and total sugars increased till maturity.

Ahmed *et al*. (2011) [2] studied the chemical composition of fresh sapota and observed 16.07 per cent of total sugars in sapota pulp.

Pawar *et al*. (2011) [16] studied the physico-chemical parameters of sapota fruit at different maturity stages and reported 18.20 per cent total sugars at ripe stage.

Hiremath and Rokhade (2012) [9] conducted an experiment on the preparation and preservation of sapota juice and reported 13.54 per cent total sugars in sapota fruit.

Yahia and Gutierrez-Orozco (2011) studied the sapota fruit and reported 16.70 per cent total sugars.

Naktee (2013) studied the chemical composition of sapota fruit and recorded 17 per cent total sugars; whereas Salvi (2013) [22] recorded 18.67 per cent of total sugars in sapota.

Raut (2015) [15] observed 13.20 per cent of total sugars in fresh sapota juice.

Gaikwad (2016) [6] reported 17 per cent of total sugars in sapota Cv. Kalipatti.

Material and Methods

1. Chemical parameters of tamarind

1.1. Moisture

The moisture content was measured directly by using Contech moisture analyzer (model CA-123) at 100^0C temperature and expressed as per cent moisture content on electronic display directly.

1.2 Total Soluble Solids

The total soluble solids were determined by using Hand Refractometer (Atago Japan, 0-32^0B) and the values were corrected at 20^0C with the help of temperature correction chart (A.O.A.C., 1975).

1.3 Titratable acidity

A known quantity of sample was titrated against 0.1 N NaOH solution using phenolphthalein as an indicator (A.O.A.C., 1975). The sample of known quantity with 20 ml distilled water was transferred to 100 ml volumetric flask, made up the volume and filtered. A known volume of aliquot (10 ml) was titrated against 0.1N sodium hydroxide (NaOH) solution using phenolphthalein as an indicator (Ranganna, 2003) [17]. The results were expressed as per cent anhydrous citric acid.

$$\text{Titratable acidity}(\%) = \frac{\text{Normality of alkali X Titre reading X Volume made X Equivalent weight of acid}}{\text{Weight of sample taken X Volume of sample taken for estimation X 1000}} X100$$

1.4 Reducing sugars

The reducing sugars were determined by the method of Lane and Eynon (1923) as described by Ranganna (2003) [17]. A known weight of sample was taken in 250 ml volumetric flask. To this, 100 ml of distilled water was added and the contents were neutralized by 1 N sodium hydroxide. Then 2 ml of 45 per cent lead acetate was added to it. The contents were mixed well and kept for 10 minutes. Two ml of 22 per cent potassium oxalate was added to it to precipitate the excess of lead. The volume was made to 250 ml with distilled water and solution was filtered through Whatman No. 4 filter paper. This filtrate was used for determination of reducing sugars by titrating it against the boiling mixture of Fehling 'A' and Fehling 'B' solutions (5 ml each) using methylene blue as indicator to a brick red end point. The results were expressed on per cent basis.

$$\text{Reducing sugars } (\%) = \frac{\text{Factor X Dilution}}{\text{Titre reading X Weight of sample}} \text{ X } 100$$

1.5 Total sugars

For inversion at room temperature, a 50 ml aliquot of clarified deleaded solution was transferred to 250 ml volumetric flask, to which, 10 ml of 50 per cent HCl was added and then allowed to stand at room temperature for 24 hrs. It was then neutralized with 40 per cent NaOH solution. The volume of neutralized aliquot was made to 250 ml with distilled water. This aliquot was used for determination of total sugars by titrating it against the boiling mixture of Fehling 'A' and Fehling 'B' (5ml each) using methylene blue as indicator to a brick red end point. The results were expressed on per cent basis.

$$\text{Total sugars } (\%) = \frac{\text{Factor X Dilution}}{\text{Titre reading X Weight of sample}} \text{X } 100$$

Result and Discussion

1. Chemical parameters of sapota

The data related to the chemical parameters of sapota Cv. Kalipatti fruit are presented in Table 1.

Table 1: Chemical parameters of sapota juice

Sr. No.	Parameters	Sapota
1	Moisture content (%)	75.98
2	Total soluble solids (^{0}Brix)	24.20
3	Titratable acidity (%)	0.11
4	Reducing sugars (%)	10.86
5	Total sugars (%)	16.23

*Values are the average (mean) of three observations.

1.1 Moisture

Moisture content of sapota was recorded as 75.98 per cent. Closely related result for moisture content of sapota fruit was observed by Paralkar (1985) [15], Pawar *et al.* (2011) [16], Raut (2015) [15] and Gaikwad (2016) [6]. They recorded 75.00, 75.80, 76.06 and 76.06 per cent moisture content in sapota fruit, respectively.

1.2 Total Soluble Solids

The total soluble solid content of sapota was 24.20 ^{0}Brix. Identical result for the TSS i.e. 25 ^{0}Brix and 24.16 ^{0}Brix of sapota were recorded by Chundawant and Bhuva (1982) [5] and Shinde (1993) [26], respectively.

1.3 Titratable acidity

The data regarding titratable acidity of sapota presented in Table 1 revealed that the average acidity of sapota fruit was 0.11 per cent. The result in similar line was reported by Hiremath and Rokhade (2012) [9], Shinde (1993) [26] and Gaikwad (2016) [6] in sapota. They recorded 0.10, 0.11 and 0.12 per cent titratable acidity at ripe stage in sapota fruit, respectively.

1.4 Reducing sugars

The data with respect to reducing sugars of sapota Cv. Kalipatti fruit was presented in Table 1. The per cent reducing sugars of sapota fruit was recorded as 10.86 per cent. Closely related result for the reducing sugar content 10.86, 10.11 and 10.82 per cent of sapota fruit was reported by Sawant (1989) [23], Pawar *et al.* (2011) [16] and Salvi (2013) [22], respectively.

1.5 Total sugars

The data with respect to total sugars of sapota Cv. Kalipatti fruit presented in Table 1 reveals that the per cent total sugars of sapota Cv. Kalipatti fruit was 16.23 per cent. Yahia and Gutierrez-Orozco (2011) recorded 16.70 per cent total sugar content in sapota fruit. Similarly Naktee (2013) and Gaikwad (2016) [6] also recorded 17.00 per cent total sugar in sapota fruit.

Conculsion

Sapota fruits were evaluated for chemical composition and observed 75.98 per cent moisture content in sapota fruit. Total soluble solid content of sapota Cv. Kalipatti was 24.20. It was observed that the sapota fruit contained 0.11 per cent titratable acidity. The sapota fruit showed 10.86 per cent reducing sugar content. However, total sugars content of sapota was 16.23 per cent.

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