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Physico-chemical Characterization and Quality Assessment of Canistel Fruit (*Pouteria campechiana*)

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Abstract

Fruits and vegetables are fundamental components of a healthy diet, offering essential nutrients that promote overall health and wellbeing. Among the diverse range of fruits cultivated in India, canistel (*Pouteria campechiana*) is noteworthy for its medicinal properties and nutritional value. This study aims to assess the physico-chemical properties and nutritional composition of canistel fruit, commonly known as "egg fruit," which belongs to the *Sapotaceae* family. The fruit is characterized by its high carbohydrate content, vitamins, antioxidants, and potential therapeutic benefits, including support for cardiovascular health, immunity enhancement, and prevention of conditions such as diabetes and cataracts. The canistel fruit pulp was standardized and examined for a range of parameters, such as acidity, pH, total soluble solids (TSS), reducing sugars, total sugars, carbohydrates, protein, fat, energy, fibre, and vitamin C. The results indicated that Canistel fruit contains 41.44 grams per 100 gram of carbohydrates, 1.02 grams of 100 gram of protein, 4.00 grams of 100 gram of fat, 205.68 Kcal of energy, and 5.60 mg of vitamin C per 100 grams. These findings underscore the fruit's potential as a nutrient dense, locally cultivated, and economically viable addition to a balanced diet for consumption. Its rich nutrient composition, coupled with its adaptability and potential therapeutic effects, positions canistel as an important fruit in global health and nutrition discussions.

***Key words*:** Canistel, Physico chemical characteristics, Nutritional composition, Antioxidant, Under-utilize

Fruits and vegetables form the basis of a healthy diet, providing essential nutrients like fibre, vitamins, and minerals that promote the overall well-being. They are not only delicious and visually appealing but also play a crucial role in preventing and curing various illnesses [1]. India's diverse climate supports the growth of a wide variety of fruits and vegetables, with the country ranking second in global fruit production, accounting for 107.10 million metric tonnes. Among the minor fruits produced in India, canistel stands out for its medicinal properties. Canistel is a fascinating fruit that belongs to the Plant Kingdom, specifically the order Ebenales and the genus *Pouteria*. Native to the *Sapotaceae* family, canistel fruit is a unique and captivating specimen. Its flesh is colloquially referred to as "Egg Fruit" due to its striking resemblance to a hard-boiled egg yolk. With its sweet and distinctive taste, canistel fruit is not only a delight to the palate but also a nutrient rich treat. Canistel is remarkably adaptable, thriving in diverse soil types, from sandy limestone to heavy clay, and tolerating elevations of up to 1400 meters above sea level. Its exceptional adaptability makes canistel an attractive addition to various regions worldwide [6].

Pouteria campechiana is known by various names across different regions. In English, it is referred to as egg fruit, canistel, or yellow sapote. Spanish speaking countries call it *zapote*, *mamey*, *sapota*, or *amarillo*. In Sri Lanka, it is known as *Lawalu* or *lavulu*, while in Malaysia, it is referred to as *Buah kuning telur*, *buah mentega*, or *sawo mentega*. In East Africa, the fruit is commonly known as *Zaituni* [4]. Estimates from the World Agroforestry Centre suggest that a mature *Pouteria campechiana* tree can produce 136-250 kg of fruit annually. Younger trees, typically 5-6 years old, yield smaller harvests of 30-50 kg per year. In India, egg fruit is cultivated in regions such as Maharashtra, the Western Ghats, Kerala, and parts of Tamil Nadu, with occasional sightings in Auroville Gardens. Despite its potential, egg fruit is often overshadowed by its more popular relative, the sapota, and is not widely cultivated [5].

Canistel is a nutrient rich fruit, boasting high levels of carbohydrates, amino acids, carotene, vitamins A and C, and essential minerals like calcium, phosphorus, and iron. Notably, it exhibits exceptionally high antioxidant activity, phenolic, and flavonoid content, surpassing other underutilized fruits. The presence of carotene, a precursor to vitamin A, makes canistel an excellent fruit for supporting healthy vision. Additionally, canistel fruit has been traditionally used to treat various health conditions, including coronary artery disease, epilepsy, and liver disorders. Canistel fruit offers numerous health benefits, including reduced risks of diabetes, cataracts, osteoarthritis, and

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certain types of cancer. It also boosts immunity, prevents coughs and flu, supports heart health, and promotes healthy digestion, bone health, and anaemia prevention. Furthermore, canistel fruit may help mitigate the risk of coronary diseases, skin conditions, and ulcers. As a locally grown, affordable, and readily available fruit, canistel provides excellent nutritional value and health benefits, making it an attractive addition to a healthy diet.

Canistel Fruit (*Pouteria campechiana*)

MATERIALS AND METHODS

Experimental site and materials

The experiment was conducted at the Department of Community Science, College of Agriculture, Kerala Agricultural University, Vellanikkara, Kerala in the year 2024. the canistel fruits were procured from central nursery of Kerala Agriculture University, Vellanikkara, Thrissur.

Methodology

For the preparation of pulp, the fresh canistel fruit was first washed in running tap water to remove dirt and dust, then cut with a sharp knife to get bulbs after removal of seed. The bulbs were ground to paste in a grinder for three minutes at medium speed and passed through one mm stainless steel sieve in order to get uniform pulp.

Physico-chemical analysis

The physico-chemical qualities such as acidity, pH, TSS, titrable acidity, reducing sugar, total sugar, carbohydrate, protein, fat, energy, fibre and vitamin C of the canistel fruit pulp were estimated using the standard procedures.

1. *Acidity*

The acidity of the fruit was determined using the method [11]. Titratable acidity was determined by titrating the fruit extract with 0.1 N sodium hydroxide (NaOH). To make the extract, 20 g of fruit was weighed in a conical flask and then boiled in 50 mL of distilled water. The procedure's indicator is a 1% phenolphthalein solution. Titre values were taken when the solution turned pink. Titratable acidity was calculated as a percent citric acid equivalent using the formula:

$$\text{Titratable acidity (\%)} = \frac{\text{Titre value} \times \text{Normality of NaOH} \times \text{Volume made up} \times \text{Equivalent weight of acid} \times 100}{\text{Volume of sample taken for estimation} \times \text{Weight of sample taken}} \times 1000$$

2. *pH*

A digital pH meter was used to measure the pH of the fruit. The pH meter was calibrated with standard pH solutions. After selecting the measurement mode, the pH meter's electrode was immersed in the fruit, and the reading displayed in the Liquid Crystal Display was recorded.

3. *TSS*

A hand refractometer was used to determine the total soluble solids (TSS) in fruit. The values were taken at room temperature and expressed in degrees Brix [11].

4. *Reducing sugar*

In a conical flask, 25 g of fruit was mixed with 100 mL of distilled water. The mixture was then neutralized by adding a 1N sodium hydroxide solution along with phenolphthalein. To clarify the neutralized mixture, 2 mL of lead acetate was added. To remove the excess lead acetate, 2mL of potassium oxalate was added and allowed to stand for 10 minutes for the precipitate to settle. The solution was filtered using Whatman's No. 1 filter paper. After that, it was increased to 250 mL. Using methylene blue as an indicator, an aliquot of the solution was titrated against a boiling mixture of Fehling's solutions A and B. The reaction yields a brick red colour [11]. The amount of reducing sugars in the fruit was determined using the formula illustrated below:

$$\text{Reducing sugar (\%)} = \frac{\text{Fehling's factor} \times \text{dilution}}{\text{Titre value} \times \text{weight of the sample}} \times 100$$

5. *Total sugar*

The total sugar was calculated using the procedure [11]. Citric acid was added to a 50 mL cleared solution obtained from the estimation of reducing sugar. The mixture was gently boiled. After the solution was neutralized with sodium hydroxide, the volume was increased to 250 mL. This solution's aliquot was titrated against Fehling's A and B solutions. The total sugar content was represented using a percentage.

$$\text{Total sugar (\%)} = \frac{\text{Fehling's factor} \times 250 \times \text{dilution}}{\text{Titre value} \times 50 \times \text{weight of the sample}} \times 100$$

6. *Carbohydrate*

Carbohydrate content was calorimetrically determined using an anthrone reagent [12]. After hydrolyzing 0.1 mL of fruit with 5 mL of 2.5 N HCl, cooling, and neutralizing the residue with solid sodium carbonate, the fruit was rinsed out. Pipetted 4 mL of anthrone reagent, 1 mL of distilled water, and 0.1 mL of supernatant. The ingredients were heated for eight minutes before being measured at 630 nm for colour intensity, which ranged from green to dark green. The total carbohydrate content of the sample was calculated using the standard graph and represented in grams.

7. *Protein*

The protein content was determined using the method recommended [2]. A 0.5 g sample was placed in a digestion flask. 200 mL of concentrated H_2SO_4 and five grams of Kjeldahl reagent (9 parts K_2SO_4 and 1 part $CuSO_4$) were added to this. After digestion, it was diluted with distilled water and pumped with 25 mL of 40% NaOH. The distillate was collected in a receiver containing 2% boric acid, mixed with indicators, and titrated against a 40% NaOH solution with standard acid (0.2 N HCL).

$$\text{Protein (\%)} = \frac{(A - B) \times N \times 1.4007 \times 6.25}{W}$$

Where,
A = Volume (mL) of 0.2 N HCl used in the sample titration
B = Volume (mL) of 0.2 N HCl used in the blank titration
N = Normality of HCl
W = Weight (g) of the sample, 1.4007 = Atomic weight of nitrogen, 6.25 = The protein-nitrogen conversion factor

8. *Fat*

A small beaker was filled with ten grams of samples and heated on a Bunsen burner with 10 mL of concentrated hydrochloric acid. A glass rod was used to repeatedly agitate the sample until its contents turned dark brown. Subsequently, the objects were permitted to reach room temperature. The mixture was then poured into a Mojonnier fat extraction flask. First, 10 mL of ethanol was added to the beaker and then the Mojonnier fat extraction flask and thoroughly mixed.

Similarly, 25 mL of ethyl ether was corked in the Mojonnier flask and vigorously shaken for one minute. Petroleum ether was added, and the mixture was shaken again for another minute. For three minutes, the Mojonnier flask was centrifuged at 600 rpm. The extraction flask's tip and stopper were cleaned with a solution containing an equal mixture of two solvents (ethyl alcohol and ethyl ether), and the washings were placed in the weighing flask. The liquid remaining in the flask was extracted sequentially using 15 mL of each solvent. After extraction, the solvent was completely evaporated in a water bath (at a temperature that prevents sputtering or bumping).

The fat was dried in an oven at 102 ± 2°C to achieve a consistent weight. The cooled flask was weighted. After completely removing the fat from the container with warm petroleum ether, the container was weighed as before [12].

$$\text{Fat (\%) (W/W)} = \frac{100\ (W_1 - W_2)}{W_3}$$

Where,
W_1 = Weight in g of contents in the flask before removal of fat
W_2 = Weight in g of contents in the flask after removal of fat
W_3 = Weight in g of material taken for the test

9. *Energy*

The energy content of the developed fruit was computed and expressed as kilocalories, or kcal. The energy content of the sample was calculated using the following formula [7].

Energy = (4 × Protein) + (4 × Total carbohydrates) + (9 × Fat)

10. *Fibre*

Crude fibre is the organic material that remains after the sample has been broken down with sodium hydroxide and diluted sulfuric acid. Two grams of the sample (fruit) were placed in a crucible and boiled in 200 mL of H_2SO_4 for 30 minutes. After boiling, the sample was thoroughly washed in boiling water and cooked for 30 minutes with 200 cc of NaOH. Following digestion, the sample was carefully washed with boiling water and then rinsed in alcohol under vacuum. The weight difference between the dry crucible and the crude fibre in the sample determined the fibre content [3].

$$\text{Crude fibre content \%} = \frac{(A - B) \times 100}{W}$$

Where,
A = Weight of crucible with dry residue (g)
B = Weight of crucible with ash (g)
W = Weight of the sample

11. *Vitamin C*

The method used to estimate vitamin C concentration. A precisely weighed sample (approximately 5 g) was pulverized in a mortar with acid washed sand before being placed in a 100 mL graduated cylinder. The mixture was thoroughly agitated before adding either TCA reagent or metaphosphoric acid to make the volume 100 mL. It was quickly filtered through Whatman's No.1 filter paper. The final ascorbic acid concentration in the extract ranged between 10 and 15 g/mL. This filtrate was quickly titrated with 10 mL of indophenol solution. A blank titration was performed with 11 mL of reagent and water, which was sufficient to make the mixture volume equivalent to 15 mL plus the volume of the indophenol solution required for the direct titration [15].
Vitamin C content in the sample was calculated as follows:

$$\text{Vitamin C content (mg/100 g of the sample)} = \frac{(A \times B \times 1000)}{W}$$

Where,
A = Volume in mL of the indophenol solution used for titration
B = Weight in mg of the ascorbic acid equivalent to 1 mL of the indophenol solution
W = Weight in g of the sample taken for the test.

Statistical analysis

The data of different parameters recorded in the experiment were analyzed using analysis of variance (ANOVA) by completely randomized design (CRD) tabulated at 5% level of significance. The statistical analysis was conducted using KAU GRAPES (General R based Analysis Platform Empowered by Statistics) software.

RESULTS AND DISCUSSION

The results of the physico-chemical analysis of the canistel fruits are given in this section.

Physico-chemical evaluation of canistel fruit

The physico-chemical properties of canistel fruit (*Pouteria campechiana*) were investigated to determine its nutritional profile and quality attributes. The results revealed a distinct combination of physical and chemical characteristics. The parameters such as acidity, pH, TSS, reducing sugar, total sugar, carbohydrate, protein, fat, energy, vitamin C and fibre were analyzed and the details are furnished in (Table 1).

Table 1 Physico-chemical attributes of canistel fruit

Proximate composition	Concentration (100g)
Acidity (N)	2.78 ± 0.359
pH	5.06 ± 0.042
TSS (° Brix)	16.00 ± 1.00
Reducing sugar (g)	19.50 ± 0.252
Total sugar (g)	21.03 ± 0.513
Carbohydrates (g)	41.44 ± 0.970
Protein (g)	1.02 ± 0.051
Fat (g)	4.00 ± 0.200
Energy (Kcal)	205.68 ± 9.82
Vitamin C (mg)	5.60 ± 0.200
Fibre (g)	2.07 ± 0.117

Value are expressed as mean ± standard deviation (n=3)

The acidity of the canistel fruits in the study was found to be 2.78 ± 0.36 N, which is lower than the value at 3.1 N, potentially due to differences in ripeness stages, cultivar variations, or geographical factors [1]. Conversely, our finding is slightly higher than the range of 2.4-2.6 N, possibly due to variations in soil composition, climate conditions, or harvesting practices [8].

The pH value of 5.06 ± 0.04 for canistel fruits in this study is consistent with the values of 5.23 and 5.12 [8], [10]. The observed pH value of 5.06 coincides with the pH range of 5.05-5.18 [9], [14]. The pH values of 5.15 ± 0.04 and 4.92 ± 0.02 are also in a similar range [1], [13]. Variations in pH values can be attributed to differences in ripeness stages, cultivar variations, and environmental factors such as climate and soil composition.

The total soluble solids (TSS) value for canistel fruits in the study was 16.00 ± 1.00 °Brix, which is slightly higher than the 15.2 ± 0.10 °Brix reported by [8]. The TSS value of 16.00 ± 1.00 °Brix is slightly lower than that of 16.5 ± 0.20 °Brix [13]. However, it is higher than the 14.5 ± 0.30 °Brix [1]. The TSS values of canistel fruit varied significantly due to differences in ripeness stages, cultivar variations, and environmental factors such as temperature and sunlight exposure.

The reducing sugar content of canistel fruits in the study was 19.50 ± 0.25 g/100g, which was slightly greater than the 17.5 ± 0.10 g/100g reported by [1]. The sugar reduction rate of 19.50 ± 0.25 g/100g is a little lower than the 20.1 ± 0.15 g/100g [13]. Additionally, the reducing sugar content of canistel fruits in this study was slightly greater than the 18.5 ± 0.20 g/100g [9].

The total sugar content of canistel fruits in this study was 21.03 ± 0.51 g/100g, which was marginally less than the 22.1 ± 0.10 g/100g and marginally higher than the 19.2 ± 0.15 g/100g found by [1], [13]. The total sugar content of canistel fruits in this study is slightly less than the 21.9 ± 0.20 g/100g [14].

In comparison to the carbohydrate content of 39.5 ± 0.20 g/100g, the carbohydrate content of canistel fruits in this study was 41.44 ± 0.97 g/100g, which is marginally higher [9]. However, it was slightly less than the 42.1 ± 0.10 g/100g [13]. The carbohydrate content of canistel fruits in the study was slightly greater than the 38.2 ± 0.15 g/100g [1]. Variations in carbohydrate values can be attributed to differences in starch, sugar, and fibre composition.

Canistel fruits in this study had a protein content of 1.02 ± 0.05 g/100g, which is marginally higher than the 0.92 ± 0.03 g/100g and 0.82 ± 0.02 g/100g found [1], [9]. It is also marginally lower than the 1.05 ± 0.05 g/100g [13].

The fat content of canistel fruits in this study was 4.00 ± 0.20 g/100g, which was marginally higher than the 3.5 ± 0.10 g/100g, but slightly lower than the 4.2 ± 0.15 g/100g [9], [13]. Additionally, the fat content exceeded the 3.2 ± 0.05 g/100g [1].

The energy content of canistel fruits in this study was 205.68 ± 9.82 Kcal/100g, exceeding the values of 198.5 ± 5.00 Kcal/100g and 192.8 ± 4.50 Kcal/100g [1], [9]. Conversely, a slightly higher energy content of 212.1 ± 7.00 Kcal/100g [13]. These variations in energy content can be attributed to differences in macronutrient composition among the studies.

The vitamin C content of canistel fruits in this study was determined to be 5.60 ± 0.20 mg/100g, marginally exceeding the findings of 5.0 ± 0.10 mg/100g, while falling below the values of 6.1 ± 0.10 mg/100g and 4.8 ± 0.15 mg/100g [1], [9], [13]. These variations result from changes in ascorbic acid and dehydroascorbic acid levels during canistel fruit growth, ripening and senescence.

The fibre content of canistel fruits in this study was 2.07 ± 0.12 g/100g, which is marginally higher than the value of 1.85 ± 0.10 g/100g [1], but slightly lower than the 2.15 ± 0.05 g/100g [13]. Variations in fibre composition stem from differing levels of soluble fibre and insoluble fibre components, such as cellulose, hemicellulose, lignin, pectin and polysaccharides [16-17].

Variations in the nutritional values in canistel fruit can be attributed to factors such as ripeness stage, cultivar differences, climate, soil composition, agricultural practices, post-harvest handling, analytical methods, seasonal variations, geographic location, and genetic variations [18-19].

CONCLUSION

The findings of this study highlight the significant nutritional potential of canistel (*Pouteria campechiana*) fruit. With its rich composition of carbohydrates, proteins, fats, and essential micronutrients, canistel offers substantial dietary benefits. Moreover, the fruit's high fibre content may enhance the digestive health, while its vitamin C concentration can supports immune function and overall wellbeing. Its ability to thrive in diverse growing conditions, canistel represents an underutilized but promising addition to both local and global diets. Given its nutritional profile and health benefits, canistel is not only suitable for direct consumption but also has the potential to be developed into a variety of food products. This makes it an appealing option for further research and application in the food industry, particularly in the development of functional foods aimed at improving public health. Promoting the cultivation and consumption of canistel could thus contribute significantly to enhancing nutritional security and health outcomes.

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