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Nutritional composition of canistel (*Pouteria Campechiana* (Kunth) Baehni)

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Abstract
The diverse underutilised crops of Malaysia are a largely unexplored potential source of food and nutritional security. This study investigated *Pouteria campechiana (Kunth) Baehni*, which is considered as a rare underutilised crop found locally. The yellow pulp fruit is commonly known as canistel or "kuning telur" by the local population. The fruits were obtained from Taman Pertanian University, Universiti Putra Malaysia. The pulp of the fruits was oven dried at 105°C until constant weight prior to the analysis for its macronutrients, sugar and vitamin C profile. The analysis found 52.96%, 40.19%, 1.16%, 4.97%, 2.12% and 0.71% of moisture, carbohydrate, protein, fat, fibre and ash content respectively. The energy reported in 100g of the fruit was 210kcal. The naturally sweet-tasting fruit contained 2.7%, 3.3% and 15.6% of fructose, glucose and sucrose respectively and had a vitamin C concentration of 6mg/100g. These superior attributes of the fruit compared with some commercially available dried fruits indicate that there is potential for it to be further explored for use in snack, bakery, confectionery and dairy industries.

Keywords: Pouteria campechiana, Canistel, kuning telur, nutritional composition, sugar profile, vitamin c

1. Introduction

In general, fruits and vegetables have abundant macro and micronutrients that are essential for a well-balanced diet and are the main drivers in achieving nutritional security (Adiyaman *et al.* 2016; Jena *et al.* 2018) [1, 17]. Many underutilised crops can also provide good sources of protein, carbohydrate, micronutrients, and vitamins to attain food security (Ashraf *et al.* 2018) [3]. Malaysia is known to be a rich source of biodiversity with a diverse range of underutilised crops that are rarely eaten, unknown or unfamiliar beyond their local communities (Ikram *et al.* 2009) [15]. Underutilised crops may be classified as not widely known outside of a specific area or region and there is a perception that they are grown mostly in rural areas. In some places consumption of these crops is not socially acceptable by some sectors of the community because they are associated with food for the poor (Jena *et al* 2018) [17]. As a result, underutilised crops have local or regional importance but generally lack national recognition and appreciation (Jena *et al.* 2018) [17]. However, many have multiple uses for their food, fibre, fodder, oil and medicinal properties (Adiyaman *et al.* 2016) [1] with potential to support food security, nutrition, health, income generation and environmental services (Jena *et al.* 2018) [17].

The earliest literature suggesting the presence of *Pouteria campechiana* in Malaysia dates from 1978 by Martin (Martin 1973) [21]. Despite its potential to address nutritional needs, this multipurpose fruit tree remains an underutilised crop (Ikram 2009; Kong *et al.* 2013) [15, 18]. Native to Central America and Mexico, it can now be found in many countries such as Sri Lanka, Philippines, Vietnam, Thailand and Indonesia (Adiyaman *et al*. 2016; Atapattu & Mendis 2013; Awang-Kanak & Bakar 2018; Chan-Zapata *et al.* 2017; de Lanerolle *et al.* 2008; Hernandez *et al.* 2008; Silva *et al.* 2009) [1, 4, 5, 6, 8, 13, 30]. It is a tropical evergreen fruit tree belonging to the Sapotaceae family yielding ovoid-shaped yellow fruits. It has been reported that it can be cultivated in tropical and subtropical climates and is well adapted to a wide range of soil conditions with moderate precipitation (Lim 2013) [20].

The ripe yellow fruit pulp resembles a hard-boiled egg yolk giving its vernacular name "egg fruit". Known as "*Buah Kuning Telur*" in the *Malay* language, it is more commonly known as canistel in many parts of the world (Awang-Kanak & Bakar 2018; Ikram *et al.* 2009; Kong *et al.* 2013; Lim 2013; Morton 1987) [5, 15, 18, 20, 26]. The ripe fruit can be eaten fresh or developed into other food products such as custards, ice creams, milkshakes, jam, and marmalade (Aseervatham *et al.* 2013; Morton 1987) [2, 26]. The pulp can be also made into pancakes, cupcakes and pies. The ripe fruits are also dried and ground to be used as a rich food additive (Lim 2013) [20]

Fig 1: Ripened Canistel

Fig 2: Canistel tree at Taman Pertanian Universiti, Universiti Putra Malaysia, Selangor

Studies show canistel is rich in carbohydrates, amino acids, carotene, antioxidants of phenolic, polyphenolics, flavonoids, carotenoids, vitamins A and C, minerals such as calcium, phosphorus and iron (Adiyaman 2016; Awang-Kanak & Bakar 2018; de Lanerolle *et al.* 2008; Lim 2013; Ragasa *et al.* 2011) [1, 5, 8, 20, 29]. Due to these properties, the fruit is used as a remedy for coronary trouble, liver disorders and epilepsy (Aseervatham *et al.* 2013) [2]

The leaves and tree bark are also found to be useful. The leaves of canistel were reported to contain six stilbenes and six flavonoid glycosides that are believed to have antimitotic activity (Hernandez *et al.* 2008) [14]. The latex of canistel tree has been used as a material in production of traditional chewing gum in Central America (Lim 2013) [20] and the tree bark can be used to produce antipyretic medications to treat fever and skin blisters (Aseervatham *et al.* 2013; Chan-Zapata *et al.* 2017; Elsayed *et al.* 2016; Morton 1987) [2, 6, 10, 26].

Studies of the chemical compositions of canistel have investigated selected phytochemical components mainly focused on antioxidants, anti-nitrosative, antimitotic and hepatoprotective molecules. To the best knowledge of the authors, there is a scarcity of information about the macronutrient and sugar profile of canistel. The aim of this study was to investigate the macronutrient, selected sugar and vitamin C profile of canistel sourced locally and compared against other commercially available dried fruits that have wide applications as snack, bakery, confectionery and dairy industries as its nutrition priorities are beneficial for these uses.

2. Materials and Methods

2.1 Raw material

Ripe canistel (*Pouteria campechiana* Baehni) fruits (Figure 1) were collected from multiple trees at Taman Pertanian Universiti, Universiti Putra Malaysia, Selangor, Malaysia (2º 58' 54.95" N latitude, 101º 42' 57.26" E longitude) (Figure 2).

2.2 Sample preparation

Ripe canistel fruits (≈2 kg) were cleaned under running tap water to remove latex and dirt. The cleaned fruits were peeled, deseeded and the pulp cut into smaller pieces (Figure 3a & 3b). The cut pulp was spread thinly on a tray and dried in an oven at 105 °C for 24 h or until it reached a constant weight (Figure 3c). The dried pulp was ground in small batches to produce a fine flour-type consistency and then stored in labelled airtight containers before analysis. The samples were stored in a refrigerator and pre-conditioned to room temperature (25°C) before commencing analysis. Triplicate analysis was carried out for moisture, crude protein, crude fat, crude fibre and total ash using methods outlined by the National Technical Working Group of Malaysia Food Composition Database (2011) [27] and as outlined in Sethuraman *et al.* (2020) [31]. Similarly, triplicate samples were analysed for sugar and vitamin C profiles of the dried sample in accordance with AOAC methods by an ISO/IEC 17025 accredited laboratory, UNIPEQ, Malaysia.

Fig 3: a) Peeled canistel; b) cut canistel pulp; c) dried and ground canistel

2.3 Proximate Composition

Moisture: Moisture content was obtained by weight loss of the sample dried in an oven. Approximately 5 g of fresh sample was dried in an oven at 105°C for 24 h or until a constant weight was achieved.

Crude Protein: Crude protein was analysed by measuring the nitrogen content and multiplying it by the factor 6.25. The analysis involved three steps, i) manual digestion, ii) automated distillation and iii) automated titration. Approximately 2 g of sample was digested with concentrated sulphuric acid (> 98 % H_2SO_4) with a mineralised catalyst for 2 h or until the solution became clear/colourless. The clear solution was then distilled with a mixture of deionised water and 32 % sodium hydroxide (NaOH) into 2% boric acid (H_3BO_3). The distillate was titrated with 0.1 M hydrochloric acid (HCl).

Crude Fat: Crude fat was determined using a continuous solvent extraction method. Approximately 2 g of dried sample wrapped in a filter paper was placed into a cellulose thimble and then placed in an extraction chamber. Petroleum ether was added into a pre-weighed flask with 2-3 pieces of boiling stone. The extraction was carried out for three hours, then the flask with the solvent was placed in a water bath (approximately 70 °C) to evaporate the solvent in a fume hood. The residual fat and stones in the flask were further dried in an oven at 105 °C for an hour. The fat content was calculated by the weight difference of the flask at the end of the drying process.

Crude Fibre**:** Crude fibre analysis involved four steps, i) de-

fatting the sample ii) removing free sugar and starch iii) removing protein and carbohydrate and finally vi) ashing the sample by drying the sample overnight at 105 °C followed by incineration in a muffle furnace at 550 °C for 4 h.

Ash: Ash was determined by incinerating the sample in a muffle furnace at 550°C for 4 h.

Carbohydrate: Carbohydrate was obtained using difference calculation, 100 – (sum of percentage in moisture, ash, protein and fat).

Energy: The total energy content was determined by adding up the crude fat, crude protein and carbohydrate multiplied with their respective factors 9.0, 4.0 and 4.0. The result was expressed in kilocalories per 100 g sample.

3. Results and Discussion

3.1 Proximate composition

Proximate composition data are presented in Table 1. The moisture content of the fruit flesh (52.96 %) was similar to the study by Morton (1987) [26] but was low in the range reviewed by Lim (2013) [20]. The fruit was observed to be quite dry with fruits generally having a moisture content of 75 % to 95 % (McLellan n.d.) [23]. The protein content range reviewed by Lim (2013) [20] was between 1.7 % and 2.5 %; in this study, we observed a lower value (1.16 %) but it was reported to be higher (4 %) in another study done by Marzuki *et al.* (2018) [22]. The fat content (4.97 %) was higher than previous studies which ranged from 0.1 % to 1 % (Lim 2013; Marzuki *et al.* 2018; Morton 1987) [20, 22, 26]. The fibre (2.12 %) and ash (0.71 %) contents were in the range observed by Lim (2013) [20]. The carbohydrate content (40.19 %) was slightly higher than previously observed which contributes to the higher energy content (210 kcal/100g) observed in this study.

3.4 Sugar and vitamin C composition

Table 2 presents fructose, glucose, sucrose and vitamin C contents. Compared to the commonly available fruits reported by FDA (3% to 33%), this fruit has higher carbohydrate (FDA 2017). Canistel was observed to be naturally sweet and the total sugar content (21.6 %) was slightly higher than that previously reported by Kubola *et al.* (2011) [19] in which fructose (2.7 %) and glucose (3.3 %) were lower but sucrose higher (15.6 %) than in the present study. The vitamin C value was significantly lower (6 mg/100g) than previously reported by Kubola *et al.* (2011) [19]. This was probably because the analysis was done on a dried sample rather than a fresh sample, and the drying process may have caused the loss of some vitamin C (Santos and Silva 2008) [30].

Table 1: Proximate Composition of *Pouteria Campechiana*

Component	This study	Morton (1987)	Lim (2013)
Moisture (%)	52.96 ± 0.30	60.6	57.20 - 60.60
Crude Protein (%)	1.16 ± 0.05	1.68	1.70 - 2.50
Crude Fat (%)	4.97 ± 0.45	0.13	0.10 - 0.60
Crude Fibre (%)	2.12 ± 0.15	ND	0.10 - 7.50
Ash (%)	0.71 ± 0.03	0.9	0.60 - 0.90
Carbohydrate (%)	40.19 ± 0.43	36.69	36.70 - 39.10
Energy (kcal/100g)	210.15 ± 2.70	138.8	138.80 - 150.57

Values in this study are expressed as mean ± standard deviation (n = 3

Table 2: Sugar and Vitamin C Composition of *Pouteria campechiana*

Component	This study	Kubola *et al.* (2011) [19]
Total Sugar* (g/100g)	21.60 ± 1.82	17.62
Fructose (g/100g)	2.70 ± 0.21	3.92
Glucose (g/100g)	3.30 ± 0.32	4.01
Sucrose (g/100g)	15.60 ± 1.30	9.69
Vitamin C (mg/100g)	6.00 ± 0.35	187.00**

Values in this study are expressed as mean ± standard deviation (n = 3); *Sum of Fructose, Glucose and Sucrose; **Fresh sample; ND - No data

Most fruits are seasonal and are not available throughout the year, hence fresh fruits are often dried for later consumption. The short shelf life of fresh fruits has also motivated the development of dried fruit. Dried fruits have the advantages of being easily stored and distributed, available throughout the year and providing a healthier alternative to salty and sugary snacks (Chang *et al.* 2016; Donno *et al.* 2019; Hernandez-Alonso *et al.* 2017) [7, 9, 13]. The varied usage of dried fruits as ready-to-consume snacks, bakery and confectionery use and dairy products has a positive effect on the dried fruit market contributing to the global production of raisins (1335.67MT); dates (1132MT) rank top two followed by prunes (211.76MT); dried cranberries (204.99MT); dried apricot (179.85) and dried figs (158.5MT) (Shahbandeh 2020) [32]. Here we have compared selected nutrients of the dried canistel as potential dried fruit snacks with some commercially available dried fruits (Table 3).

Dried fruit snacks are known as rich sources of essential nutrients and bioactive compounds and are perceived to promote health benefits - in particular against obesity, type II diabetes, osteoporosis and cancer (Hernandez-Alonso *et al.* 2017; Sohaib *et al.* 2017) [13, 34]. Vitamin C is one of many antioxidants that is essential in blocking the damage caused by free radicals that are associated with the aging process, cancer and heart disease; it also plays a role in tissue regeneration and growth (MedlinePlus, 2020; Zelman n.d.) [24, 37]. A review suggested that the unregulated sugar intake of fructose is associated with development obesity and type II diabetes (Stanhope 2016) [35]. Despite being the most important source of energy, high glucose content is not recommended for those diagnosed with diabetes (Sohaib *et al.* 2017) [34]. Significant differences between canistel and other fruits were found for carbohydrate, total sugar, fructose and vitamin C. Canistel had the highest vitamin C content among the listed dried fruits. Canistel also had the lowest energy and total sugar, with the lowest fructose compared to the listed dried fruits. Raisins have always been

used in studies related to postprandial glycaemia and insulinaemia (Hernandez-Alonso *et al.* 2017) [13]. The naturally sweet flavour of canistel and its nutritional profile may offer an alternative for the glycaemia and insulinaemia studies.

Table 3: Comparison of Selected Nutrient of Canistel with Commercial Dried Fruits

Component	This study	Raisin[1]	Dates[1]	Prune[1]	Cranberries[1]	Apricot[1]	Fig[1]
Energy (Kcal)	210.15 ± 2.70	299.00	282.00	240.00	308.00	241.00	249.00
Moisture (g/100g)	52.96 ± 0.30	15.43	20.53	30.92	15.79	30.89	30.05
Protein (g/100g)	1.16 ± 0.05	3.07	2.35	2.18	0.17	3.39	3.30
Carbohydrate (g/100g)	40.19 ± 0.43	79.18	75.03	63.88	82.80	62.64	63.87
Total Sugar (g/100g)	21.60 ± 1.82	59.19	63.35	38.13	72.56	53.44	47.92
Fructose (g/100g)	2.70 ± 0.21	29.68	19.56	12.45	26.96	12.47	26.00
Vitamin C (mg/100g)	6.00	2.30	0.40	0.60	0.20	1.00	1.20

[1]Source: USDA 2019

4. Conclusion

Underutilised crops have been highlighted to have the potential to contribute to both food and nutritional security. Epidemiological studies have shown that there are positive associations between consuming plant-based food in reducing cardiovascular diseases, certain cancers and diabetes. Previous studies show canistel is rich in both macro and micro-nutrients but there is a scarcity of information on the sugar profile and its potential for development of food products and functional foods. The lower sugar content, specifically fructose and glucose, compared with some commercialised dried fruits indicates that canistel may serve as a good raw material for food product development, especially for those diagnosed with non-communicable disease such as obesity and type II diabetes. The higher vitamin C content compared to other dried fruits indicates its potential as an effective free radical scavenger. This preliminary study on the macronutrient, sugar profile and vitamin C content of canistel has identified underdeveloped potential that can stimulate further investigation and interest in this rare fruit that can be widely grown across the humid tropics.

Data Availability Statement

All datasets generated for this study are included in the article material.

Authors Contributions

Gomathy Sethuraman: Investigation, Resources, Data Curation, Writing – Original Draft. Nur Marahaini Mohd Nizar: Resources, Data Curation, Writing - Editing. Fatin Nadia Muhamad: Resources, Data Curation. Ebrahim Jahanshiri: Funding acquisition. Peter J. Gregory: Conceptualization, Supervision, Writing - Review and Editing. Sayed Azam-Ali: Funding acquisition, Project Administration, Writing - Review and Editing.

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