RESEARCH ARTICLE

ANTIOXIDANT ACTIVITY AND PHYSICOCHEMICAL ANALYSIS OF COCONUT, KITHUL AND PALMYRAH PALM TREACLE

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ABSTRACT

Treacle from the palm trees of coconut, palmyra, and kithul exhibits antioxidant and medicinal properties as mentioned in Sri Lankan ethnomedicine however the research regarding the nutritional, physicochemical, sensory, and functional properties of palmyrah treacle are limited and the treacle remains underutilized compared to coconut and kithul treacle. The purpose of this study is to compare the antioxidant activity and physicochemical properties of coconut, kithul, and palmyra treacle and to provide comparative facts for the betterment of the palm treacle industry. Pooled sap samples of coconut, kithul, and palmyra were collected from respective collecting center and the treacle was prepared and kept in refrigerators for further analysis. Physicochemical properties, antioxidant activity, microbial quality, and sensory analysis were performed using triplicates from each sample. Significantly highest (p<0.05) total sugar (67.90%) and ash content [0.075(±0.002)] %was obtained for palmyrah treacle, while protein content was significantly highest for kithul [0.570 (±0.0120)] than coconut [0.410 (±0.0040)] and palmyrah [0.028 (±0.0070)] %. Total phenolic content was significantly highest for coconut [278.02 (±1.35)] while there were no significant differences between palmyrah [191.02(±4.80)] and kithul [190.23 (±2.71)] mg GAE/100g. DPPH's scavenging ability with the IC values of palmyrah, coconut, and kithul were 1.69 (±0.13), 2.91 (±0.04), and 2.21(±0.14) mg/mL respectively. This study could be useful to disseminate knowledge and create awareness among people on different treacle varieties and their antioxidant properties. This finding will uplift the utilization of palm treacle or the in-cooperation of palm treacle in other food products such as sweeteners.

Keywords: *Antioxidant activity, Coconut Treacle, Kithul Treacle, Palmyra Treacle, Physicochemical properties*

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1. INTRODUCTION

Treacle is a thick dark syrup or viscous un-crystalized liquid produced by heating the sweet toddy to about 1/6th of its original volume. Sweet toddy/ sap from the palm trees is a water solution of sugar; the preparation of treacle is considered to be a process of concentrating the sugar by heat

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treatment through evaporation of water. Treacle can be produced from many different plants such as palmyrah, coconut, kithul, and sugar cane. In Sri, Lanka treacle is produced from three different palms such as palmyrah (*Borassus flabellifer*), coconut (*Cocos nucifera*), and kithul (*Caryota urens*). Coconut treacle is known to be a sugar-rich food that consists of nearly 65-75 % sugars and water content could be 25 - 30 % with other allied constituents for instance proteins, organic acids, minerals, vitamins, phenol compounds, and amino acids [1]. Coconut sap is known to be rich in antioxidants and the sugar syrup exhibited inhibitory activity against α- amylase thus known as low glycemic index food which is used as a therapeutic agent in treating type II diabetes mellitus [2]. Kithul treacle was suggested as sugar for diabetic patients because of its low glycemic index [3]. Kithul treacle consists of different variety of simple sugars such as sucrose, glucose, and fructose [4]. It is stated that free amino acid profiles of kithul treacle can be used to explain some of the traditional claims on the health benefits [4] and *C.urens* treacle exhibits antioxidant and anti-hyperglycemic properties as mentioned in Sri Lankan ethnomedicine. Palmyra treacle is rich in calcium, magnesium, and iron content with 62% of total solid content [5]. Treacle produced from different palms could be a sweetening agent for cake, curd, tea, and coffee. Even though the treacle from different palm exhibits nutritional and functional properties, a comparative study on the coconut, palmyrah and kithul treacle has not been done yet and the research regarding the nutritional, physicochemical, sensory, and functional properties of palmyrah treacle are limited and the palmyrah treacle remains underutilized compared to coconut and kithul treacle. Therefore, this study aims to fill the research gap regarding the palmyrah treacle and try to compare the antioxidant activity and physicochemical properties of palmyrah, coconut, and kithul treacle through which the properties of different palm treacle can be communicated among people.

2. MATERIAL AND METHODS

The study was conducted at Palmyrah research institute Jaffna and calibrated equipment was used for the analysis.

2.1 Sap collection

Pooled sap of palmyrah, coconut, and kithul was obtained from different sources of palm development societies and sap collecting centers.

2.2 Treacle preparation

The collected sap was used to prepare the treacle. Palmyra sap was delimed and heated at 105±1 ℃. Coconut sap was delimed and heated at 105±℃ and kithul sap was heated at 105± ℃ to get the treacle. The treacle was then allowed to cool and hot-filled into sterilized bottles and stored in refrigerators. Above three treacle samples were used for the physicochemical, antioxidant properties, and sensory analysis.

2.3 Physicochemical analysis

- *Estimation of ash content*: Ash content was analyzed by the method mentioned in Sri Lanka Standards for treacle SLS 772 [6].
- *Estimation of moisture content*: moisture was measured by the oven drying method as described in AOAC (2019) [7].
- *Determination of acid-insoluble ash***:** Acid insoluble ash was measured by the method mentioned in Sri Lankan standards for treacle SLS 772 [6].

- *Determination of acidity*: Acidity was calculated by the method elaborated in Sri Lankan standards for treacle SLS 772 [6].
- *Brix/ Total soluble solids*: Total soluble solids (TSS) were measured directly by using a refractometer (HSR500, Japan) at room temperature and expressed in terms of Brix value.
- *pH*: Homogenized sample (25mL) was taken in a clean beaker (25mL) and the pH was determined with a digital pH meter (Model -Sension PH 31-Spain) at room temperature.
- *Total sugar content*: Determined by AOAC method of analysis (2019) [7].

2.4 Estimation of protein

Protein was estimated by the method AOAC analysis (2019) [7].

2.5 Determination of total phenolic content

Analyzed using gallic acid as a standard concerning the method [8].

2.6 Estimation of Antioxidant activity

Determined using DPPH Radical scavenging activity [9].

2.7 Sensory evaluation

Determined with 5 points hedonic scale using 30 semi-trained panelists.

2.8 Determination of Na and K levels

The flame photometric method was used [10].

2.9 Determination of microbial count

Determined by the method of Sri Lankan Standard of SLS 516 part 1[11].

2.10 Determination of yeast and mould count

Determined by the method of Sri Lankan Standard of SLS 516 part 2 [12].

2.11 Determination of browning intensity

The diluted treacle (1:25 v/v with distilled water) was centrifuged at 3000 rpm for 15 min and the browning intensity was measured by obtaining the absorbance at 420 nm using a UV-Vis spectrophotometer.

2.12 Statistical analysis

Data were statistically analyzed by one-way ANOVA. Mean values were considered significant at $p < 0.05$. Simple regression correlation analysis was performed to correlate the antioxidant potential and the total phenolic content.

3. RESULTS AND DISCUSSION

Physicochemical properties of the palmyra, coconut, and kithul treacle significantly differ from each other. Palmyra treacle showed significantly higher mean values for the parameters of total ash, moisture content, acidity, total sugar, and pH than coconut and kithul treacle (Table 01). Higher total ash content in the palmyrah treacle indicates higher mineral content [13]. Coconut treacle exhibited significantly higher acid insoluble ash than palmyrah and kithul. All the physicochemical properties of palmyrah, kithul, and coconut treacle (Table 01) obey the Sri Lankan standards for treacle SLS 772 [6] (Table 02) while there were significant differences among the parameters of each treacle.

Table 01: Physicochemical properties of different palm treacle

Parameters	Palmyrah	Coconut	Kithul
Total ash (g/100g)	0.0755 ± 0.002^{a}	0.0592 ± 0.0038^{b}	0.0142 ± 0.0024^{c}
Moisture content (g/100g)	26.8476 ± 0.056^{a}	24.2434 ± 0.0956^{b}	24.5617 ± 0.6921^{b}
Acidity (g/100g)	0.294 ± 0.0084^{a}	0.144 ± 0.0169^{b}	0.204 ± 0.0311^{b}
Acid insoluble ash (g/100g)	0.0016 ± 0.0025^{b}	0.0080 ± 0.0096^{a}	0.0021 ± 0.0047^{b}
Total sugar (g/100g)	67.902 ± 0.0025^{a}	66.8105 ± 0.0002^{b}	65.5123 ± 0.0001^{c}
pH	5.97 ± 0.12^{a}	3.86 ± 0.14^{c}	4.52 ± 0.07^{b}
Total soluble solids (Brix)	69.34 ± 0.33^{b}	73.96 ± 0.22^{a}	74.26 ± 0.18^{a}

Data were recorded as mean ± standard deviation and the rows sharing the different alphabetical letters are significantly different at $p<0.05$.

Table 02: SLS 778 Specifications for treacle

Parameters	SLS 772 Specifications (% by mass)
Moisture content	30 (maximum)
Total sugar	65 (minimum)
Acidity	0.5 (maximum)
Total ash	1.5 (maximum)
Acid insoluble ash	0.15 (maximum)

Table 03: Protein and Na, K level of different palm treacle

Parameters (mg/100g)	Palmyra	Coconut	Kithul
Protein	0.2883 ± 0.0070^{c}	0.4103 ± 0.0040^{a}	0.5703 ± 0.0120^{b}
Na	33.5	not detected	not detected
K	87.16	not detected	not detected

Data were recorded as mean ± standard deviation and the rows sharing the different alphabetical letters are significantly different at $p<0.05$.

Palmyra treacle is rich in sodium and potassium content and kithul is protein-rich treacle than palmyrah and coconut (Table 03).

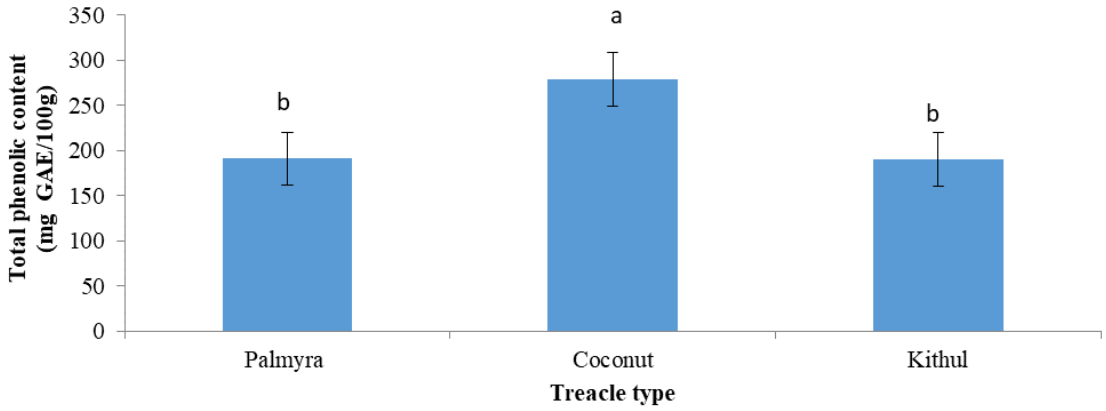

Figure 1: Total phenolic content of different palm treacle. Means sharing the different alphabetical letters are significantly different *at p<0.05.*

TPC activity is the indication of the phenolic content amount in the samples. Phenolic compounds normally pose redox properties, which make them act as an antioxidant [14]. Total phenolic content was significantly highest for coconut [278.98(±1.35)] while there were no significant differences between palmyrah [191.02(±4.80)] and kithul [190.23 (±2.71)] mg GAE/100g, therefore coconut treacle is expected to exhibit good result in antioxidant activity. However, the kithul and palmyrah treacle also pose a good antioxidant potential. Furthermore, phenolic compounds reflect altered biological functions that are mainly related to the prevention of cancer [15].

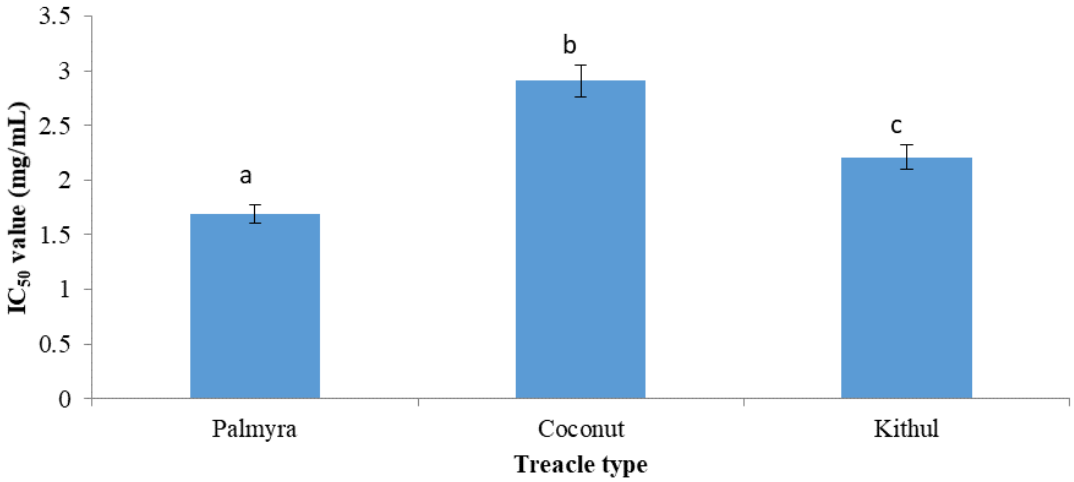

Figure 2: DPPH scavenging ability with IC50 values of different palm treacle. Means sharing the different alphabetical letters are significantly different at p<0.05.

The IC_{50} value is used to measure the antioxidant activity of the test samples. It is considered "the concentration of antioxidants needed to decrease the initial DPPH concentration by fifty percentage" [16] and the lower IC_{50} value indicates higher antioxidant activity. Palmyra treacle shows the lowest IC_{50} value, thus the Palmyra treacle is significantly higher in antioxidant activity followed by Kithul. However, all the palm treacle exhibited antioxidant activity within the range of 1.5 – 3 mg/mL in terms of IC_{50} value.

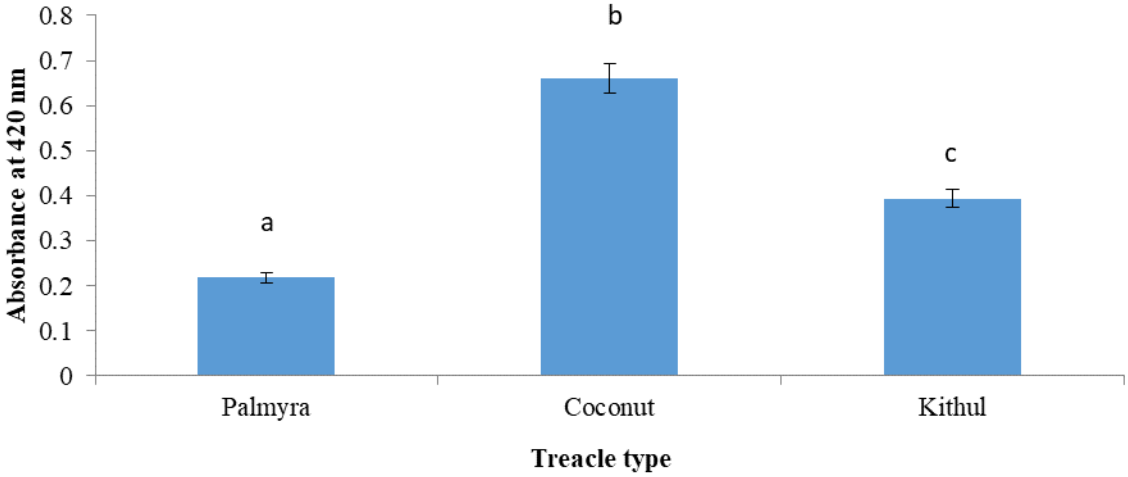

Figure 3: Browning intensity of different palm treacle Means sharing the different alphabetical letters are significantly different at $p<0.05$.

The major reactions that occurred during the heating process of sugar-riched products are non-enzymatic browning reactions for instance Maillard reaction and caramelization [17] which might influence the browning intensity of the treacle, and Marzocco and others 2011 stated that "The *browning reaction that witnessed during the heating of coconut sap is the non-enzymatic browning predominantly the Maillard reaction*" [18]. Coconut treacle showed significantly higher browning intensity than kithul and palmyrah.

Table 04: Total plate count of different palm treacle

Sample	Total Plate Count (microorganisms per milliliter)	Yeast and Mould count
Palmyrah	microorganisms present but less than 4	not detected
Coconut	microorganisms present but less than 4	not detected
Kithul	3.6×10^{-2}	not detected

The total plate count and yeast mold count (Table 04) showed less than 300 colonies. The combination of low moisture content, acidic pH, and the higher sugar content (Table 1) of the treacle might make them less susceptible to microbial spoilage.

Kithul treacle scored higher mean values for the attributes of taste, color, and overall acceptability whereas coconut treacle scored higher mean values for the sensory attribute of flavor meanwhile Palmyra treacle scored lower mean values for the attributes of flavor and taste which might be due to the inherent property of slight bitterness in palmyrah.

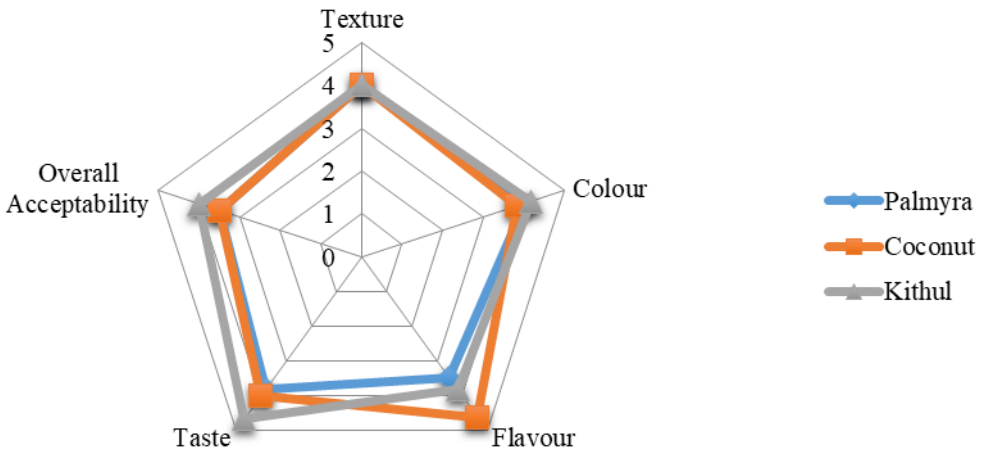

Figure 4: Sensory scores of different palm treacle

CONCLUSION

All the palm treacle exhibited antioxidant activity while there were significant differences among the values and the palmyrah treacle showed the highest amount of minerals and antioxidant activity whereas coconut treacle exhibited higher total phenolic content compared to palmyrah and kithul. It can be recommended to in-cooperate this treacle as sweeteners in confectionary or other related food products. The research findings can help to empower the palmyrah treacle industry which is underutilized compared to coconut and kithul. Applications of palm treacle into the osmotic dehydration of fruits as a preservation method need to be analyzed in the future.

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