Physico-Chemical Properties of Palmyrah (*Borassus flabellifer* L.) Natural and Value Added Products

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Authors’ contributions

This work was carried out in collaboration among all authors. Authors DVS, MCSR and VS designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors PA and DRSS managed the analyses of the study. Author RVS managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Palmyrah palm has great economic potential and every part of the palm is useful in one way or the other. The palm is found growing widely in southern states of India. The palmyrah products like tender fruit endosperm (*nungu*), *neera*, jaggery and tuber flour are not commercialised as the value addition in palmyrah is not standardised. Even though palmyrah is an economically important palm, it has not received proper attention from the agricultural research workers, probably on
account of the fact that it is very slow growing palm found mostly in the wild state. In this context knowing of physico chemical properties and development of value added products and popularizing the same is essential.

Keywords: Nungu; neera; jaggery; tuber flour; value addition.

1. INTRODUCTION

Palmyrah (*Borassus flabellifer* L.) belongs to the family Arecaceae and order Arecales. Palmyrah is also known as toddy palm and sugar palm. The palmyrah is a tropical palm tree that is easily cultivated but found as wild. It is a native palm to the Indian sub-continent and South-East Asia. In India, palmyrah adorns the dry landscape of the semi-arid regions of Tamil Nadu, Andhra Pradesh, Gujarat, Odisha, Bihar, Karnataka and Maharashtra. The current palm wealth of India is estimated as 102 million palms and half of them are in Tamil Nadu. Out of 51.90 million palms in Tamil Nadu, more than 50% are concentrated in the Southern district of Thoothukudi [1].

Palmyrah is referred to as the tree of life with nearly 800 uses including food, beverage, fiber, fodder, medicinal and timber. Among the various edible uses of the palm, the most popular one is to collect the sweet sap for making neera obtained by tapping the tip of the inflorescence either male or female, which is traditionally collected in hanging earthen pot and used to quench thirst. The sap so collected before the morning is a refreshing and light drink called Neera in Telugu also in Marathi and "Pathaneer" in Tamil. The sap is cold and sweet, oyster white in color, translucent, high in nutritional value and susceptible to natural fermentation at ambient temperature within a few hours of extraction. The sap collected in the evening or after fermentation becomes sour is called Tadi in Marathi. Tadi is consumed mostly by villagers as a raw alcoholic beverage. When the fruit is very young, the kernel is hollow, soft as jelly and translucent like ice and is accompanied by a watery liquid, sweetish and potable. The jelly part of the fruit is covered with thin, yellowish-brown skin. These are known to contain watery fluid inside the fleshy white body. The nutritional value of palmyrah tender fruit endosperm (Nungu), contains 43 kcal of energy, 87.6 g of water, 0.8 g of protein, 0.1 g of fat, 10.9 g of carbohydrates, vitamin B and minerals per 100 g [2]. The endosperm of the young fruit like tender coconut is a delicacy in summer.

Palm jaggery is made from the extract of palm trees in Southern India. The jaggery is processed from the unfermented palmyrah tree sap called neera. Palm jaggery consists of 65-68% sucrose and 5-15% reducing sugars, is directly used in ayurvedic preparations and is believed to reduce lung cancer. One hundred grams of palmyrah jaggery contains 0.35% g of protein, 0.17% of fat, 90.6% of carbohydrates, 24 mg of vitamin B-1, 11.0 mg of vitamin-C and 0.74% of minerals [3].

Palmyrathuber is an essential edible shoot grown in loose soil from the seed of ripe fruit. The tuber is eaten by many people directly by cooking in an open fire after peeling the outer layer. Roasted, dried tubers are ground to make flour and are blended with wheat flour for baking. The floor can be used to prepare a number of traditional foods like odiyal, consumed as a porridge called khool, and a steamed product called pittu. Odiyal made from palmyrathuber flour contains 1423 kcal of energy, 10.8 g of moisture, 3.1 g of protein, 77.1 g of carbohydrates and 5.6 g of crude fiber per 100 g [4].

Even though palmyrah byproducts are incredibly nutritious, cheap, and readily available but they are highly perishable and deteriorate fast within few minutes to few hours after production. Little attention was paid on the research aspects of palmyrah products, value addition and standardization of the postharvest management of their products. More over it is essential to know the nutritive value of any value added product to initiate research on their postharvest management. Keeping all these in view, a study was undertaken to analyze the physico-chemical properties of palmyrah natural and value added products as an initiative. Information available on the nutritional value of these products is very scanty.

2. MATERIALS AND METHODS

The procedure followed to collect/prepare palmyrah products are as given below:

2.1 Palmyrah Neera

Palmyrah neera was collected from nearby palmyrah palms with the help of neera tappers.
Initially the sap (neera) was collected in special ice box equipment and later neera from ice box was transferred to cold storage unit (PHTRS, Venkataramannagudem) of low temperature to minimize the fermentation and was used for experimental purpose.

2.2 Palmyrah Tender Fruit Endosperm (Nungu)

Palmyrah fruits with uniform size were procured from nearby palmyrah palms of local farmers. The endosperm (35-45 mm diameter) with white outer skin was separated from freshly harvested palmyrah fruits in the early morning and transferred to cold storage unit and kept at low temperature to minimize the browning.

2.3 Palmyrah Jaggery

Palmyrah neerawas collected in slacked lime treated earthen pots for experimental purpose. The cleared sap after lime sedimentation and filtration was transferred into the boiling galvanized iron pan and boiled to 110°C. Few castor beans were crushed and put into an iron pan to prevent over-boiling. During boiling, a white scum arises on the surface, which was skimmed off (removed with a ladle). Neera gets transformed into the viscous fluid at 110°C. The liquid sap was stirred continuously to avoid charring at the bottom of the vessel. Placing a few drops of fluid into cool water, the correct stage of formation of jaggery was judged. The hardening of fluid in the cold water is the indication of right stage of conversion of neera into jaggery. At this stage, jaggery fluid was poured into molds and allowed to cool, and then after sometime, liquid jaggery solidified in the molds. The solid jaggery cubes were removed from the molds and used for further studies.

2.4 Palmyrah Tuber Flour

Matured and ripened fruits of palmyrah fallen from the tree during September-October were collected. After extraction of palmyrah fruit pulp, the seeds were collected and sown in beds and the moisture level was maintained adequately to get sprouts and form tubers. The tubers were harvested after 135 days after attaining a length of 20-30 cm.

The proximate analysis to all the above products was done for moisture content, TSS, pH, browning, reducing sugars, total sugars, non reducing sugars, titrable acidity, alcohol content, phenolic content, starch content, protein content and fibre content as per the standard procedures.

2.5 Estimation of Physico-chemical Parameters of Palmyrah Neera

The moisture content of the samples was determined by using the SHIMADZU digital Infrared moisture analyser (model MOC63u). Total Soluble Solids (TSS) were determined with the help of digital refractometer by placing a drop of sample in the form of juice at room temperature. Reducing sugars and total sugars were determined by the method suggested by [5] Lane and Eyon (1965). The method described by [6] Ranganna (2010) was adopted for the determination of titrable acidity. The pH of the sample was tested by taking a direct reading on pH meter model HI 9321 (periodically calibrated with buffer solution of pH 4.0 and 7.0) according to [6] AOAC (1992). Non enzymatic browning was estimated as per the method given by [7] Ranganna (2010). Total phenol content was estimated by using Folin-Ciocalteau reagent [8] (Sadasivam and Manickam, 2005). Protein content was determined by the method suggested by [9] Lowry et al. (1951). Starch and fibre content was estimated as the method given by [8] (Sadasivam and Manickam, 2005). Alcohol content was estimated based on the formation of green colored chromate ions resulting from the treatment of ethanol and sodium dichromate as limiting reactant in presence of sulfuric acid and acetate buffer pH 4.3. The absorbance maxima for the ethanol were found to be 578 nm by the method given by [10] Sumbhate et al. (2012). All the samples were analyzed in triplicates.

**Titrable Acidity (%)**

\[
\frac{\text{Titre value x Normality of alkali x Total volume made up x Equivalent weight of citric acid}}{\text{Aliquot taken for estimation x weight of sample x 1000}} \times 100
\]
Alcohol content (%) / Percentage of ethanol in sample = \((Cs/Cu) (Au/As) \times 100\)

Where,

- \(Cs\) = Concentration of standard, \(Cu\) = Concentration of sample
- \(Au\) = Absorbance of standard, \(As\) = Absorbance of sample.

**Reducing Sugars (%)**

Per centage of reducing sugars = \(\frac{mg \ of \ invert \ sugar \times \ dilation}{titre \ value \times \ weight \ or \ volume \ of \ sample} \times 100\)

Factor for Fehling's (mg of invert sugar) = titre value \times 2.5/100

**Fibre Content (%)**

\(\frac{\text{Weight of residue before ignition} - \text{Weight of ash after ignition}}{\text{Weight of the sample}} \times 100\)

3. RESULTS

3.1 Proximate Analysis for Physicochemical Properties of Palmyrah Natural and Value Added Products

Moisture content of 9.02 and 9.32% were recorded for palmyrah jaggery and tuber flour respectively. Moisture provides a measure of the water content of the products and it matters its total solid content. It is also an index of storage stability of the palmyrah jaggery and tuber flour. Total Soluble Solids of 10.00, 8.50, 7.50 and 5.10°Brix were recorded for palmyrah neera, nungu, jaggery and tuber flour. pH of 4.28, 6.44, 5.51 and 5.54 was recorded for palmyrah neera, nungu, jaggery and tuber flour. Titrable acidity of 0.575, 0.060 and 0.400% was recorded for palmyrah neera, nungu and tuber flour respectively. pH value gives a measure of the acidity or alkalinity of the product, while the titrable acidity gives a measure of the amount of acid present in the product. The levels of these indices are used to estimate the quality of the edible products. Total sugars of 14.85, 8.83, 9.30 and 14.39% were recorded for palmyrah neera, nungu, jaggery and tuber flour. Reducing sugars of 5.16, 5.11, 5.10 and 8.50% were recorded for palmyrah neera, nungu, jaggery and tuber flour. Non-reducing sugars of 9.69, 3.72, 4.20 and 5.89% were recorded for palmyrah neera, nungu, jaggery and tuber flour. Starch content of 32.96%, fiber content of 10.20% and protein content of 10.20% respectively was recorded for palmyrah tuber flour. Phenolic content of 0.285, 0.162 and 10.43 mg were recorded for palmyrah neera, jaggery and tuber flour. Browning of 1.010% was recorded in nungu. Alcohol content of 2.00% was recorded in neera.

4. DISCUSSION AND CONCLUSION

The golden words of the elders who have lived and gone are fulfilled with current science in many ways, especially with regard to the medicinal properties of many trees on the earth. Palmyra tree is one such type of tree highly foreseen by the people.

<table>
<thead>
<tr>
<th>Physico chemical parameter</th>
<th>Neera</th>
<th>Endosperm/Nungu</th>
<th>Jaggery</th>
<th>Tuber flour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture (%)</td>
<td>9.02</td>
<td>9.32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TSS (°Brix)</td>
<td>10.00</td>
<td>08.50</td>
<td>07.50</td>
<td>05.10</td>
</tr>
<tr>
<td>pH</td>
<td>04.28</td>
<td>06.44</td>
<td>05.51</td>
<td>05.54</td>
</tr>
<tr>
<td>Titrable acidity (%)</td>
<td>00.575</td>
<td>00.060</td>
<td>--</td>
<td>00.400</td>
</tr>
<tr>
<td>Total sugars (%)</td>
<td>14.85</td>
<td>08.83</td>
<td>09.30</td>
<td>14.39</td>
</tr>
<tr>
<td>Reducing sugars (%)</td>
<td>05.16</td>
<td>05.11</td>
<td>05.10</td>
<td>08.50</td>
</tr>
<tr>
<td>Non reducing sugars (%)</td>
<td>09.69</td>
<td>03.72</td>
<td>04.20</td>
<td>05.89</td>
</tr>
<tr>
<td>Starch (%)</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>32.96</td>
</tr>
<tr>
<td>Fiber (%)</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>10.20</td>
</tr>
<tr>
<td>Protein (%)</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>02.96</td>
</tr>
<tr>
<td>Phenols (mg)</td>
<td>00.285</td>
<td>--</td>
<td>00.162</td>
<td>10.43</td>
</tr>
<tr>
<td>Browning (%)</td>
<td>--</td>
<td>00.010</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Alcohol content (%)</td>
<td>02.00</td>
<td>--</td>
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<td>--</td>
</tr>
</tbody>
</table>
A change in TSS content in palmyrah products is a natural phenomena which occur during storage and it is correlated with hydrolytic changes in starch during postharvest period. The decline in TSS can be attributed to the fact of complete hydrolysis of polysaccharides and decline in TSS is predictable as they are the primary substrates for respiration. However, utilization of sugars in respiration and degradation of total soluble substance during storage might be the reason for the decrease in TSS Wills et al. 1980 [11]. pH of palmyrah products might be due to increase in organic acids during fermentation. At low temperature, slower rate of fermentation of sugars into organic acids takes place which reduces the pH at low temperature. Titrable acidity of palmyrah products could be due to accumulation of organic acids as a respiration process Santiago-Urbina et al., 2013 [12]. Alcohol content was observed during the storage period. This might be due to accumulation of organic acids as respiratory substrates in palmyrah neera. Palmyrah jaggery contains invert sugars and minerals that are hygroscopic in nature which absorbs the moisture present in the surrounding atmosphere and deteriorate the keeping quality of the jaggery. Palmyrah tuber flour is hygroscopic in nature which absorbs the moisture present in the surrounding atmosphere and deteriorates the keeping quality of the tuber flour. Low moisture content of flour is important for good storage stability and prevents deteriorative reactions because of high hygroscopic nature. Presence of moisture in the tuber flour defects shelf life. Higher the percentage of moisture increases the attack of microorganisms like fungi Uchechukwu-Agueta et al., 2015 [13]. The increase in TSS with the increase in storage period might be attributed to the conversion of polysaccharides into soluble forms of sugars and also increase in moisture content. Due to the increase in the moisture content, the solubilisation of reducing sugars increase, which in turn leads to increase in the total soluble solids.

Tuber is a physiological energy reserve which ranges from 32-35% fresh weight. Starch is major nutrient in tuber and root crops. Palmyrah tuber flour with more than 3% fiber will serve as a good source of fibre. Fibre content decreases gradually during storage which might be due to softening of fibrous tissue and bio conversion of carbohydrates and cellulose to protein reported by Enwere, 1998 [14]. Considering the health benefits and nutritional composition of palmyrah natural and value added products post harvest treatments, packing material and storage conditions significantly increase shelf life, reduce post harvest rotting and maintain nutritional quality of Palmyrah Tender Fruit Endosperm (PTFE) as well as sap.

COMPETING INTERESTS
Authors have declared that no competing interests exist.

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