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Phytochemical Constituents and Nutritional Potential of Palmyra Palm: A Review

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Abstract: *Palmyra palm (Borassus flabellifer L.) is a species under the arecaceae family. It is also known as toddy palm, Asian palm, wine palm, lontar palm, and longer palm. It is a tree with numerous applications, including food, drinks (alcoholic and non-alcoholic), fibre, medicine, and timber. Immature fruit are tender as the endosperm is soft, sweet and gelatinous. The tender endosperm of palm is not only good source of carbohydrate, protein, ash, crude fiber and calories but also possess many pharmacological activities like anti-inflammatory, ant arthritic, cytotoxic, antibacterial, analgesic, hypoglycemic, antipyretic and antioxidant activity. Different types of products prepared from palmyra pulp such as Neera , Nungu, Jaggery, Toddy, Palmyra Vinegar, Wine, Cola, Spread, Yoghurt, Sugar, Toffee, Jelly, Chocolate & some ready to serve products (RTS) from Palmyra pulp. The tender palmyra fruit has a very short life and a soothing soft taste that turns fibrous as it matures and get ripen. The nutritional potential and phytochemical constituents of tender palmyra fruit have been studied for value added products that may induce significant changes in chemical composition, influencing the concentration and retention of bioactive components in fruits. This study gives a brief knowledge on the economical, medicinal and phytochemical importance of palmyra palm.*

Keywords: Bioactive Components, Nutritive Value, Palmyra Palm, Value Added Product

1. Introduction

Palmyra pulp is a tropical fruit usually popular as toddy palm, wine palm, longer palm, palmyra, in English whereas Taad (Hindi), Talam (Tamil), Tatichettu (Telugu), Karimpana (Malayalam), Taal (Bengali), Tala (Odia) (Nesbitt, 2005; Panda et al., 2018). The name is derived from the Greek words "Borassus" and "flabellifer," which mean, respectively, "fruit with leather wrapping" and "fan-bearer" (Kurian et al., 2017). It is believed to have originated in Africa, made its way to South Asia, and finally it migrated into Southeast Asia through the development of cultures and trade networks. (Pipatchartlearnwong et al., 2017). It is an indigenous fruit of tropical Africa, Indian subcontinent and Southeast Asia (Nesbitt, 2005 ; Krishnaveni et al., 2020). The most economically prominent species of palmyra palm, *Borassus flabellifer* L. may be found in tropical regions of Asia and Africa. These regions include countries such as India, Nepal, Bangladesh, Myanmar, Sri Lanka, Indonesia, and Thailand. It is also grown in Laos, Vietnam, Malaysia, Indonesia, Burma, and Cambodia (Golly et al., 2017; Sankaralingam et al., 1999). Palmyra palm is widely cultivated throughout India in different soil types and climate zones, including the coastal strip, agricultural margins, and wastelands of Karnataka, Kerala, Maharashtra, Madhya Pradesh, Andhra Pradesh, Chhattisgarh, West Bengal, Bihar, and Odisha. Among all Tamilnadu is the largest producer of palmyra fruit in India (Aman et al., 2018, Asmussen et al., 2006).

Scientific classification of palmyra palm:

Kingdom: Plantae Sub-Kingdom: Tracheobionta Super division: Spermatophyta Division: Magnoliophyta Class: Liliopsida Subclass: Arecidae Order: Arecales Family: Arecaceae Genus: *Borassus* L. Species: *Borassus flabellifer* L.	

Figure1: The Palmyra Fruit

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The palmyra tree has a massive trunk, and is covered in leaves at top. It is a perennial plant that grows to a height of 30 metres and has a lifespan of up to 100 years. The plant starts fruiting from 15 years in the area with plenty of water source and about 25 years in arid regions (Veilmuthu, 2020). The palmyra tree has 20–40 fresh, grey–green leaves that are 1-3 m broad, fan-shaped, folded along the midrib towards the top of the trunk. The flowering and fruiting of the dioecious plant typically take place from March to April each year (Panda et al., 2018). Only the female plant produces the edible by products, such as immature endosperm, matured fleshy mesocarp, and tuberous seedling (Vengaiah et al., 2017). However the male plant's inflorescence is used to harvest the delicious sap (Bondya & Bodra, 2014; Pipatchartlearnwong et al., 2019).

Palmyra fruits are considered as drupes and are highly variable in many morphological characteristics. They are most commonly utilized as a source of therapeutic agents. Palmyra fruits are coconut like structure having three seeds, oval in shape with 12-15 cm wide and capped at the base with overlapping sepals (Morton, 1988). The palmyra palm fruit has been used in both forms (tender and matured). At an early stage the tender endosperm part is edible, while after ripening, the yellow colored fibrous mesocarp squeezed to collect the pulp. The ripe fruit pulp contains beta-carotene and has anti-inflammatory effects. Traditionally the matured pulp is used for making *pitha* and fermented drink preparations (*toddy*) (Nadkarni, 1954; Vaidyaratnam, 1994). Traditional cuisines have been employed the fruit pulp of *Borassus flabellifer* L. and the sap that was collected from the flower section as a sweetener for diabetes patients. Proteins, lipids, carotenoid, vitamin B complex, ascorbic acid and other minerals are found in the palmyra apart from sugars. Besides all palmyra fruits are also rich in immunosuppressive effects (Kapoor, 2000).

2. Uses of Palmyra Tree

2.1. Traditional Uses of Palm tree

Leaves can be woven into mats, knitted into baskets, used to produce hand-fans, hats, umbrellas, buckets, sandals, and even used to thatch roofs. In addition to this, leaves can be utilized as a source of fuel while cooking. The trunk of the palmyra is substituted for wooden poles in the construction of sheds and fencing purpose. The trunk of an older tree is utilized for both long walking sticks and shorter convenient sticks for elderly people who go for regular walks. Its trunk also used to make the drums and takudis that are so common in Indian music. Due to the strength, durability and length the petiole fibre is frequently utilized in the production of rope. The fibre extracted from the petiole and the leaf blades are used to create various products like brushes, brooms, ropes etc. (Krishnaveni et al., 2020). The natural fibre that is taken from the palmyra palm is used for construction of thatched homes, baskets, winnowing fans (Kula), and fences (Panda et al., 2018).

The Palmyra fruit is jelly like structure at early young stage (i;e endocarp) and it is eaten as raw. After that the ripe matured mesocarp is utilized to make different food products. Large amount of vitamins and minerals are found in undeveloped tender palmyra pulp. This tender palm nectar is used in production of wine, palm Jaggery and vinegar. Asian palm sugar or *neera* or *palm jaggery* has a unique taste and produces less energy than cane sugar. The natural food coloring substance can be extracted from matured ripe husk or mesocarp of palmyra (Selvakumar and Thanapaul, 2020). Also the palmyra is used for production of chemicals such as pectin, cellulose, hemicelluloses, pentosan-polysulfates, polyphenols, and lignin from the paste of male inflorescence (Balamurugan et al., 2018; Panda et al., 2018). The community of “Chamar” members extracts the sap from the male flower to make a fermented alcoholic beverage known as "*Tadi*". When the sap is not fermented, it was referred as "Neera" and was said to be beneficial for health and wealth status. In a lesser degree, the sap was also used to make Jaggery or palm candy. (Panda et al., 2018).

2.2. Nutritional Potential of Palmyra Palm

Neera is the sap extracted from the inflorescence of the palmyra, which is high in iron, calcium, phosphorus and vitamins such as carotenoid, vitamin B complex like thiamin, riboflavin and niacin. The jelly-like endosperm of young palmyra fruit (60 - 70 days) is very nutritive. It is a refreshing juice perfect for the summertime. Peeled seeds of immature endosperms of palmyra are eaten fresh or sun-dried, raw or cooked in a variety of ways. They also produce a pulpy extract, which is used to make porridge with rice, herbs, chilli, peppers and other ingredients. Ripe fruit was sweet and was eaten raw, or its juice was extracted and mixed with rice flour to make '*Pitha*' or porridge (*bara*) (Vengaiah et al., 2015; Vengaiah et al., 2017; Panda et al., 2018; Siju & Babu, 2020).

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Mature ripe fruit is rich source of carbohydrates. The ripe fruit has a soft orange-yellow mesocarp rich in carotenoid and ascorbic acid. The fibrous outer layer of ripen palm fruits can be eaten raw or boiled (Krishnaveni et al., 2020). Palmyra pulp is combined with other fruits to make jam, cordial, fruit leather and other products (Sankaralingam et al., 1999). The nutritional composition of different parts of the plant is presented in Table.1.

Table 1: Nutritional Composition of Palmyra Tree

	A	B	C
	Immature endosperm of palmyra palm	Palmyra Fruit Pulp	Palmyra root powder
Energy (kcal)		102.83	118.42
Moisture(g)	9.27- 12.4	74-77	62.38
Carbohydrate(g)	59.73-73.80	22.5	23.53
• Crude Fiber	4.29-7.79		7.29
• Reducing sugars			
• Total Non-reducing sugar		13	
• Starch		12.6	
• Maltose			
Crude Protein(g)	5.20-13.46	1.24	8.54
Crude Fat(g)	0.60-1.40	0.8	0.6
Ash(g)	2.80-9.40	1.2	4.95
Calcium(mg)	0.17-0.48	8.76	
Phosphorus(mg)	0.18-0.50		
Copper(mg)	0.16-3.98		
Zinc(mg)	0.87-0.94		
Magnesium(mg)	0.08-0.23		
Sodium(mg)	52.35-92.57		
Potassium(mg)	154.91-368.71		
Iron	0.56-0.82mg		1.38ppm
Strontium(ppm)			0.14
Copper (ppm)			0.09
Manganese(ppm)			0.11
Zinc(ppm)			0.08
Aluminum(ppm)			0.48

Sources: A- Rahman et al., 2021; B- Vengaiah et al., 2015; C- Sahni et al., 2014

2.3. Phytochemical Potential of Palmyra Palm

The phytochemicals like alkaloids, flavonoids, terpenes, glycosides, saponins, phenolic, tannin, steroids, and sterols are found in palmyra fruit. These compounds are well-known for their cardio-tonic properties, antimicrobial properties, and use in herbal medicines and cosmetics. Flavanoids and tannin are phenolic compounds that act as primary antioxidants and have antimicrobial, anti-inflammatory, anti-allergic, anticancer, anti-neoplastic, and anti-neoplastic activity, as well as the ability to treat intestinal disorders. Saponins are also therapeutically important due to their hypolipidemic and anticancer activity. Saponins are also required for cardiac output activity. The astringent flavor fruits are rich in tanin. Sahni et al., 2014 reported intestinal problems like diarrhoea and dysentery can be treated using palm fruit. It contains 1.61g/100gm alkaloids, 0.63g/100g saponin, 36.3-99.34µg/100mg of total phenolic content, 98.48-222µg/100mg of total flavonoid content. The presence of Dimethyl Sulfoxide, Dimethyl sulfone, 5-methyl-2-Furancarboxaldehyde, 1,3,5-Benzenetriol, 2-Furancarboxaldehyde, 9-Octadecene, 1-Tridecene, 9-Eicosene, 4-Pyridinecarboxamide, D-Allose, Altrosan, Hydroxy-4-methoxybenzoic acid, Cyclododecane, Methyl alpha.-d-Ribopyranoside, ethyl octadecyl ester Phthalic acid, Campesterol, Stigmasterol, beta-Sitosterol, gamma.-Sitosterol, alpha.-Amyrin, beta.-Amyrin compounds were confirmed in dry roots of palmyra palm. The presence of these phenolics, alkaloids and phytosterol compounds were used in ayurved as they have anti-inflammatory, antiarthritic, cytotoxic, antibacterial, analgesic, antipyretic, hypoglycemic

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and antioxidant activity. Again some authors reported the presence of 2-Furanmethanol, Propane, 1-(1-methylethoxy)2-Cyclopenten-1-one, 2,4-Dihydroxy-2,5-dimethyl-3(2H)-furan-3-one, Glycerin, 1H-Imidazole-4-carboxamide and Butane in ethanolic extract of palmyra palm root (Salvemini et al., 1996 ; Turner et al., 1971). Whereas the presence of vitamins A and C, Flabelliferrins (steroidal saponins), vitamin B-complex were found in fresh pulp of palmyra palm (Nadkarni, 2002). The plant has several medicinal uses, including antihelminthic and diuretic, in various regions. Traditional recipes often include fruit pulp, and the sap has been employed as a sweetener for diabetic people (Selvakumar and Thanapaul, 2020). The medicinal properties of different parts of the palm tree were shown in table 2.

Table 2: Medicinal Property of Different Part of Palmyra Palm

Plant part	Property	References
Seed coat	Antimicrobial activity	Jana and Jana, 2017
Male inflorescence	Anti-inflammatory activity	
Young roots	Diuretic and anthelmintic	
Roots	Cooling, curative and diuretic	Arunachalam et al., 2011
Bark decoction with salt	In mouth wash	Morton, 1988
Bark Charcoal	Powder for teeth cleaning	
Palm fruit	Anti-inflammatory and antioxidant	Pramod et al., 2013
Ripe fruit pulp	Prevents skin inflammations, treat nausea, vomiting, worm infestation, helps to clear mucus in trachea, acts as liver tonic, to treat digestive problems, acts as a laxative	Jerry, 2018
Ash of the spadix	Relief heartburn and enlarged spleen and liver	Krishnaveni et al., 2020
Neera and toddy	Control gastric disease and ulcers	Theivendirarajah and Chrystopher, 1987
Sap from the flower	tonic, stimulant, laxative diuretic agents, antiphlegmatic and amebicide	Krishnaveni et al., 2020

3. Value Added Products from Palmyra

Value addition denotes the change in physical form of the food material resulting a greater acceptability, extend availability, increase market viability and improve cost benefit (Srivastava et al., 2017). The value added products from Palmyra palms are *Neera , Nungu, Jaggery, Toddy, Palmyra Vinegar, Wine, Cola, Spread, Yoghurt, Sugar, Toffee, Jelly, Chocolate & some ready to serve products (RTS)* (Mani et al., 2018).

3.1. Neera

It is the sap extracted from the inflorescence of Palmyra palm is very sweet and delicious. It can be consumed in liquid form or may be processed to sugar or Jaggery. Neera is free of sucrose; hence it does not cause diabetes (Ghosh et al., 1998; Venkataswamy, 1967). It is good source of calcium, phosphorus, iron and vitamins (Krishnaveni et al., 2020).

3.2. Jaggery

Jaggery is prepared from unfermented palmyra sap. It is a good source of both nutraceutical and nutritional factors. It has a characteristic pleasant taste and is similar to chocolate. It contain an elevated content of potassium (K+) and hence good for diabetic and hypertension patients (Shanmugavelu et al., 2012). Palmyra Jaggery is a good source of calcium, low in sodium and is used to treat oedema caused by heart and liver disease. It is also desirable during diabetic acidosis, post-operative convalescence, and diuretic. (Kurian & Peter, 2007).

3.3. Toddy

Toddy is a fermented product prepared from sap. The tip of the flower that has not yet bloomed is sliced off in order to collect the sap. The sap will eventually ooze out and be collected in a small pot (made of earth or metal) that has been tied underneath. Usually the pot is pre-inoculated with small amount of toddy for fermentation process. During the production of toddy, the sugary sap is fermented using yeasts and bacteria to produce alcohol. Alcohol content in toddy is estimated to be in the range from 4 to 6%. Sucrose, glucose

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and fructose are major sugars present in toddy converted ethyl alcohol during fermentation (Savarimuthu et al., 1980; Shanmugavelu et al., 2012). It is also helpful to cure all kinds of ulcer (Jana and Jana, 2017).

3.4. Palmyra Vinegar

Vinegar from palmyra is prepared by acetic acid fermentation of palmyra sap. Palmyra vinegar is very good source of carotene, vitamins and minerals besides carbohydrates and proteins. This product can be used to cure the bladder infection, urinary tract infection, skin diseases, headaches and body pains, Further it is reported to improve memory (Srivastava et al., 2017).

3.5. Palm Wine

Palm wine is an alcoholic beverage which is made from sap of palm trunk. A small incision is made in the back of the palm about 15 cm from the top of the trunk. Sap is collected every day and sterilized. The sterilized unfermented sap shall have to be fermented with suitable stains of yeast to produce palm wine. The wine is clear white in colour and is very sweet in taste with a robust smell (Srivastava et al., 2017).

3.6. Palm Cola

It is an aerated soft drink which is prepared from sap with 11% of palm sugar. The other ingredients being cola concentrate, citric acid and food colour were added. The palm sugar is heated to 110-115 °C. Cola essence was added to the mixture after cooling at the rate of 250ml per 1000L bottles of palm cola (Maheshwaram and Shivalingan, 1983).

3.7. Palm Spread

For every 1kg of palm pulp, 1kg of sugar, 100g of skim milk powder, four small cardamom pods, and 5g of citric acid are required to make palm spread (Chaurasiya et al., 2014).

3.8. Palmyra Yoghurt

Palmyra fruit yoghurt was prepared and reported by Sangeeta et al. 2014. The lifespan of the product was found 18 days with 40 C without any preservative. They found it is rich in dietary fibers and phytonutrients.

3.9. Palmyra Sugar

Palmyra sugar can be prepared from *neera* with adition of a little amount of superphosphate. After the formation of the crystalline sugar it is followed by drying and stored in powder form at moisture free atmosphere (Krishnaveni et al., 2020).

3.10. Palm Toffee

The ingredients that used for making palm toffee includes 500g fruit pulp, with equal amount of sugar, 200g skim milk powder, 50g glucose, 50g maida or refined wheat flour and 100g starch. The process of making palm toffee involves combining fruit pulp with the other essential components, stirring the mixture constantly for forty minutes, and then heating it to a temperature of 70º C. After performing a drop test in water, the end point was analyzed and stopped cooking. The toffee mixture is finally spreaded on aluminium tray that has been well greased with oil or butter, cut into 31.5 cm squares, wrapped in butter paper, and kept at room temperature. (Chaurasiya et al., 2014). However Hasan et al., 2022 made toffee from palm fruit that contains the ideal proportions of many ingredients, including ripe palm pulp, sugar, cream, glucose, and skim milk powder.

3.11. Palm Gummy Jelly

Gummy jelly is prepared from palmyra palm fruit juice with glucose syrup, sucrose, high methoxyl pectin, sodium citrate, fructose, water, palmyra palm juice, citric acid (Sumonsiri et al., 2021).

3.12. Palm Chocolates

It was formulated by palmyra palm Jaggery, cocoa mass, butter, milk powder, xanthan gum, water and vanilla essence (Manisha et al., 2022).

3.13. Palmyra Fruit Pulp RTS Drink

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The ready to serve drink was prepared with mixing of ingredients like sugar, water, citric acid, and pectin with palmyra pulp. (Kajan et al., 2018).

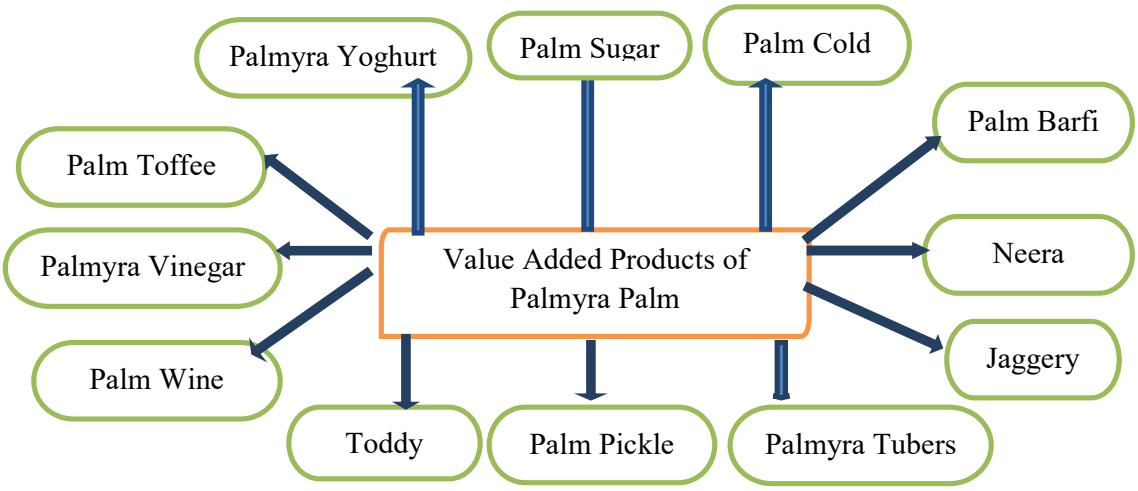

Figure 2: Value added products from Palm

4. Conclusion

Palmyra fruits are available in abundance and alternative season to other tropical fruits. Palm fruits have limited cultivation, consumption and trade. A large number of these fruits can grow under adverse conditions and are also known for its nutritive value and can satisfy the demands of the health conscious consumers as it has numerous health benefit properties. Hence there is a need to concentrate on research in diversification and popularization of palmyra fruits. Thus, the phytochemical rich raw palmyra palm fruit pulp can be exploided for the further drug development and value added product.

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