Section A-Research paper

A Comprehensive Review of the Phytochemistry, Pharmacological, Ethnobotany, and Traditional Uses of *Caryota urens*

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Abstract

Indian native *Caryota urens* belong to the family Arecaceae and are the most significant herbal medicinal plant. These trees are nutrient-dense herbal plant sources with good bioactive chemical contents, vital components, and numerous uses. *Caryota urens*, known as Kithul, is a versatile and neglected palm primarily found in lowland tropical Asia. It has been regarded as a significant plant that supports Sri Lankan villagers' life because of its many uses. Every component of the plant is valued medicinally in some way or another. Today, it is regarded as a significant source of several innovative items for medicines against various ailments, for example, hair tonics, antioxidant, anti-fungal, antibacterial, anti-inflammatory, anti-diabetic, and remediating actions of *Caryota urens* which have already been studied, which emphasizes the need for further research into the information that is now accessible. All of the research studies conducted earlier signify the importance of *Caryota urens* and establishes it to be a highly valued medicinal plant, indicating that we conserve this family of palm on a broader basis. *Caryota urens* have promising compounds and pharmacological effects.

Keywords: *Caryota urens*, Anti-inflammatory, Antibacterial, Antioxidant, Anti-diabetic

1. Introduction

A palm tree belonging to the PALMAE family is called *Caryota urens (C. urens)*. This shrub is indigenous to Nepal, India, and Sri Lanka (Ayurveda Aushadha Sangrahaya 1971). The first time saw this tree was in Cambodia (Paranavithana M, 2006). Tradition has it that *Caryota urens* are harvested for their sap, which is used to make sweet syrup (treacle), sugar (jaggery), and alcoholic drinks (toddy). In Sri Lanka, treacle and sugar are highly prized for cooking (Yvonne Everett, 1995). The tall, unarmed *Caryota urens* have a cylindrical, annulated trunk between 13 and 20 meters tall and 0.3 minutes in diameter. When it is fully grown, the axils of the leaves start to flower at the top and move progressively downward, with large, densely packed leaves (Jayaweera D.M.A, 2006). In addition to being referred to regionally as "Kithul,"

Caryota urens is also known by the Sanskrit terms "Krushna Kantha" and "Sthulathala" in addition to the Hindi terms "Heenthala" and "Tobby palm, Jaggery palm" in English. The palm sugar concentration of the flower juice makes up the chemical makeup of *Caryota urens*. (Meera) (Ayurveda Aushadha sangrahaya 1971). The shrub *Caryota urens* is very valuable both nutritionally and medicinally. The Kithul flowers, harvested from the Kithul tree and mainly made from Kithul treacle, jaggery, and flour, are the most significant functional foods. Fermented toddy, treacle, jaggery, and flour made from flowers (Meera), bark, and plants are the medicinal ingredients in this mixture. Given its therapeutic benefits, it increases appetite. This improves Agni (digestive fire), the digestive energy and relieves constipation, and makes defecation easier. (Osuthuru wisithuru, volume 16) Rheumatic swellings and snake bite toxins are treated with the root bark and cabbage of the palm tree (Jayaweera D.M.A, 2006). The inflorescences are harvested to make the toddy, treacle, and sugar. Timber is employed in construction. The glucose produced by the pith is consumed. Commercially, Kithul fibre is made from tree leaves (Jayaweera D.M.A, 2006). Elephants eat the cabbage of this plant before it flowers. For medical purposes, it treats stomach ulcers (Jayaweera D.M.A, 2006). The root treats tooth issues, the bark and seed treat boils, and the delicate flowers encourage hair development (Jayaweera D.M.A, 2006). The pharmacological effects of *C. urens*, such as its anti-inflammatory, antioxidant, antimicrobial, anti-diabetic, and anticancer properties, have been highlighted in numerous research papers. The objective of this study was to give a thorough overview of the pharmacological actions, therapeutic advantages, and conventional medicinal formulae of *C. urens.* The treatments for many illnesses rely heavily on the preparations described in traditional texts. As a result, it is crucial to examine the therapeutic properties of *C. urens* to plan for future treatments because doing so will benefit the healthcare system greatly. It would be advantageous for people in society to understand the therapeutic properties of *C. urens* and the disease conditions for which it can be used to get rid of them, as the correct use of this plant can be used as a remedy for many ailments. In order to discover the formulas and consider the facts mentioned above, this study was carried out using Ayurvedic and Western medical techniques. Table no. 1 shows the taxonomical classification and synonyms of *Caryota urens*.

Table 1. Taxonomical classification and synonyms of *Caryota urens*

S.No.	Taxonomy		Language	Synonyms
1	Domain	Eukaryota	Gujarati	Shivjata
2	Kingdom	Plantae	Telugu	Jeelugu
3	Phylum	Spermatophyta	Kannada	Bagani
4	Subphylum	Angiospermae	Tamil	kondapanei
5	Class	Monocotyledon	Malayalam	Chuntappana

6	Family	Arecaceae	Marathi	Bherlimaad
7	Genus	*Caryota*	Chhattisgarhi	Salfi, Bastar
8	Species	*Caryota urens L*	Sinhala	Kithul

Characteristic of *Caryota urens*

A tall, beautiful evergreen shrub with a 12–20 m height range and a 30 cm width is called *Caryota urens*. It is a palm with one boot encircled by bands of scarred leaves. Bipinnate leaves with triangular shapes and vibrant deep green hues are supported by long petioles. There is a white flower that grows at each node of the foliage. Eventually, round, golden fruits will change. The leaves are large, intricate, bipinnate, bright to deep green, 24-28 centimetres, 6-8 cm long, and supported by 60 cm long petioles. The so-called "fishtail palm" leaves have a praemorse apex, are triangular, wedge-shaped, irregularly cut, and truncated at an angle. The border continues with a pattern resembling a fish's tail and dorsal fin. They have a smooth and fibrous maturing leaf sheath.

Flowers: - Each inflorescence has a blossom that is open for six weeks and is a 3 m long spadix that hangs freely from the palm. It generates a cluster of the single, white blossom. Per inflorescence, unisexual blooms produce between 35000 and 40000 seeds.

Fruits: - Round and yellow in appearance, the fruits eventually mature into red drupes about 1 centimetre wide and contain a single seed. Fruit bats and palm civets disseminate seeds.

Trunk and bark: - Smooth trunk with an annular leaf wound. The mature wood is durable, robust, and heavy. The stem provides wood used for rafting, roofing, partitioning, fencing, planking, and flooring, particularly in traditional structures. Additionally, it serves as a food supply. Table no. 2 shows Traditional medicine indications of *Caryota urens* according to their used part.

Table 2: Traditional medicine indications of *Caryota urens* according to its used part

Used part	Indication	Chemical constitutions	References
Leaves	Burning sensation, General weakness	Alkaloid	Paranavithana M., Subasetha (2014)
Bark	Grind the bark and take the juice. Pour into the ear – relieves earache	Flavonoids	Osuthuru wisithuru, (1984)
Root bark	For rheumatic swelling, snake bite poisoning	Flavonoids	Jayaweera D.M.A, (2006)
Seeds	Boils	Alkaloid,	Jayaweera D.M.A, (2006)
Flower	Promotes hair growth (tender	Saponins	Jayaweera

	flowers)		D.M.A, (2006)
Treacle	Kamala (Jaundice)	Sucralose	Kumarasinghe. A., (1984),
Jaggery	Pandu (Anemia), Kamala (Jaundice), Rathpita (Bleeding from various parts of the body)	oleic acid	Kumarasinghe. A., (1984),
Toddy	Constipation, Increased digestive power	Alcoholic beverage	Paranavithana M, (2006)
Starch	Haemorrhoids	Sucralose	Osuthuru wisithuru,(1984)

2. Ethnomedicinal and pharmacological properties of *Caryota urens*

2.1. Anti-inflammatory properties

By analyzing the Nitric Oxide (NO) production mediated by Inducible Nitric Oxide Synthase (iNOS), Balaji et al. investigated the anti-inflammatory effects of *C. urens*. They found that the hydroalcoholic leaf extract of *C. urens* (CULHA) can be developed as a new therapeutic agent against inflammatory diseases (Balaji S., Ganesan K. K., 2020). The results of a study by Sujitha et al. on the ability of umbelliferone and rutin, two of the active ingredients in *C. urens* leaf hydroalcoholic extract (CULHA), to inhibit rheumatoid arthritis by blocking TNF-alpha suggested that the presence of these compounds in *C. urens* may be the cause of its anti-inflammatory activity (Sujitha B., Kripa K. G., (2020).

2.2. Antioxidant properties

The antioxidant activity of immature fruit and leaf extracts produced higher activity than its fruit skin. According to research on the plant's antioxidant properties, the bioactive compounds of *C. urens* could be ascribed to their antioxidant properties (Ananth et al., 2013) (Arora et al., 2022). According to Sharmin et al.'s evaluation of the antioxidant activity of *C. urens* fruit extract using the total phenolic content, the fruit extract has a substantial amount of antioxidant activity (Sharmin et al., 2020), (Kumar et al., 2022),(Kumar et al., 2022).

2.3. Anti-microbial effects

Ananth et al. showed that *C. urens* has antibacterial properties against the pathogens E. coli, Vibrio cholera, Salmonella typhoid, Staphylococcus aureus, and Shigella flexneri, and they concluded that *C. urens* fruit epidermis and immature fruit have more potent antibacterial properties than its leaves do (Ananth et al.,2013). According to Sharmin et al.'s analysis of the antimicrobial activity of *C. urens* samples against five-gram positive and eight-gram harmful bacteria using the disc diffusion technique, the model with the largest zone of inhibition against Shigella dysenteriae measured 13.0 mm (Salekin S., Nahar K., 2020) ,(Dutta et al.,2022).

2.4. Anti-parasitic effects

The research evaluated the larvicidal potential of *C. urens* against the Aedes aegypti dengue vector. (A. aegypti). Vanaja et al. investigated the larvicidal activity of methanol leaf extracts of *C. urens* for that purpose. The findings showed that *C.*

urens could be a potential larvicidal agent against the dengue vector A (Egypt Vanaja D. 2017).

2.5. Anti-diabetic effects

According to Ferreres et al., *C. urens* inflorescence extract has anti-diabetic properties. It may help create novel functional foods with -glucosidase-inhibitory activity (Andrade C. et al., (2021). Wimlasiri et al. assessed the anti-diabetic effects of *C. urens* flour using alpha-amylase and alpha-glucosidase enzyme inhibition assays. They concluded that these effects were not particularly pronounced (Wimalasiri G. E. M. et al., 2016).

2.6. Anti-cancer properties

El-Akad et al. evaluated the possible cancer chemopreventive activity of *C.urens* and C.mitis by examining the leaf and fruit metabolites of both varieties El-Akad R. H, et., al.,2021) (Kathpalia et al.,2022).

2.7. Analgesic effects

Patel et al. used the Hot plate technique and Tail flick method to examine the analgesic effect of *the C. urens* methanol extract of leaves. Their findings indicated that the phytosterols, terpenoids, tannins, flavonoids, and phenolic compounds present in *C. urens* extracts were what caused the analgesic effects (Patel M. R., Saluja A. K.,2012).

2.8. Neuroprotective effects

In a study by Ravindran, the effects of *C. urens* on memory and cognition were demonstrated in Alzheimer's disease-induced mice using a variety of memory retention tests, including the Morris water maze, the Y maze, and passive avoidance, among others. It was found that *C. urens* has a notable impact on memory enhancement in this disease (Ravindran C., 2018), (Prashant et al.,2013).

3. Phytochemical analysis of different parts of *C. urens*

In flower, this phytochemical is present: Alkaloids, glycosides, carbohydrates, flavonoids, saponin, phenolics, lignin, serpentine, tannin, triterpenoid, phytosterol, fixed oil and fats, gums/ mucilage. Ash, organic carbon, nitrogen, potassium, phosphorus, calcium, magnesium, sulfur, zinc, copper, iron, manganese, boron, cobalt, molybdenum, and sodium (Charles et al.,2011).

In fruits, phytochemical is Flavanoid, phenolic compound, carbohydrate, alkaloid, oxalic acid, malic acid and inorganic compounds (Vaishnavi et al.,2013).

Moreover, in leaves, phytochemical is alkaloid, terpenoid, saponin, steroid, triterpenoid, glycosides, cardiac glycoside, gums and mucilage, phenol, tannin, flavonoid, oxalic acid, phytosterol, resin (Kavitha et al.,2017).

4. Cultivation of *Caryota urens*

Plants thrive in humid tropical climates with an average yearly rainfall of 1,500mm or more, minimum monthly precipitation of 25mm, and temperatures that never drop

below 10°C. They can also thrive in dry, warm temperate regions with yearly rainfall as low as 250 mm and at least one month of precipitation below 25 mm. Temperatures of 5 °C or lower can kill mature vegetation. Even as young plants, plants do well in full sunlight; they prefer a damp, shady environment and a pH between 6 and 7.5, allowing between 5.8 and 8. a slowly expanding shrub. A monocarpic species that can go for a long time without blooming before passing away after flowering. It takes 10 to 15 years to reach its maximum size; after that, it takes another five or more years to flower. The plant dies when the final berry on the bottom inflorescence reaches maturity. It blooms from the top down. The daily sap production per tree for wine and sugar can range from 20 to 27 gallons. The inflorescence is stimulated to create juice when flowering starts; the inflorescence is then bound into a "candle" shape and repeatedly sliced off for its sweet juice. Before the tree dies, a tapping time may last between 10 and 15 years. Primarily wild and semi-wild communities are harvested for sago and other uses. The trunk yields 100 - 150 kilos of starch. Timber harvests typically occur when the tapping time is over (Ranasinghe P. et al., 2011).

5. Remediation activity of *Caryota urens*

A novel bio-absorbent known as *C. urens* seeds (CUS) has been found to have the ability to remove hexavalent chromium Cr (VI) from aqueous solutions. The new biosorbent *C. urens* inflorescence waste biomass (CUIWB) removes Cr (VI) from aqueous solutions. The Redlich-Peterson isotherm and Langmuir isotherm models were used to explain the equilibrium bioabsorption phenomena. The bioabsorption rate for hexavalent chromium determined using Langmuir isotherms was 100 mg/g. Both activated carbon from *C. urens* plant seeds (ACSCU) and the active carbon in calcium alginate pellets (CABCU) have been tested as sorbents for Pb (II) from water. It is discovered that ACSCU and CABCU have different adsorption capacities of 42.9 mg/g and 86.9 mg/g. Interestingly, the adsorption capacity almost doubles when active carbon is embedded in Ca-alginate beads.

Table 3: "Remediation property of *C. urens*"

Heavy metals	Biosorbant	Biosorption capacity (mg/g)	References
Cr (VI)	Caryota urens inflorescence	100	S. Rangabhashiyamet al., 2015
Cr (VI)	C. urens seed	52.63	Suganyaet al.,2016
Pb (II)	ACSCU	89%	Ravulapalli et al., 2018
Pb (II)	CABCU	96%	Ravulapalli et al., 2018

6. Biodiesel production

The non-edible seed *Caryota urens* was used to obtain the bio-oil, which was then further analyzed for moisture content, pH, specific gravity, density, viscosity, saponification value, refractive index, peroxide value, acid number, free fatty acid, and

iodine value. Hexane was used as the organic solvent for the Soxhlet extraction process. The dominant fatty acids in *Caryota urens* seed oil are readily transformed into their corresponding methyl esters during transesterification. It was discovered that the concentrations of palmitic acid and oleic acid were very high, at about 41.24% and 28.48%, respectively. It was evident that most of the fatty acids were saturated, which can be used to make high-quality biofuel. The next step was to undergo a transesterification process to turn this bio-oil into biodiesel. The analysis revealed that the bio-oil concentration was 21.57%, with palmitic and oleic acids being the primary fatty acids. The biodiesel yield was estimated at 82% after the bio-oil from the plant seeds was transformed into fuel using a KOH catalyst (Srinivasan GR et al., 2018).

7. Discussion

A palm tree is known as *Caryota urens* (Kitul). Although it is generally believed that palm trees have little medicinal value, study shows that Kitul, Thal palm, and coconut have numerous therapeutic advantages. One of the most potent multifunctional medicinal herbs is *C. urens*. Every component of the plant is functional medicinally in some way. According to the data gathered, *C. urens* is frequently used to treat diseases caused by vitiated Pitta dosha, including Daha (burning sensation), Brama (dizziness), Rathpita (bleeding from different parts of the body), and Pandu (anaemia). According to C. urens' characteristics, the sweet taste of Madura improves the Rasa (essence part shortly after digestion), Raktha (blood), Mansa (muscle), Meda (fat), Asthi (bone), Majja (bone marrow), and Ojas. (Essence in every tissue). It also has Balakaraka (increases bodily strength) and Bhagna Shankara (heals fractures) effects. The sheetha veerya (cold strength) contributes to the Pittadosha's sedation. All qualities strengthen the body and calm the Pitta and Vata doshas. Antibacterial, antiparasitic, antioxidant, anti-inflammatory, anticancer, and analgesic qualities are all present in *C. urens*. It also appears to have neuroprotective effects while lowering blood sugars and serum cholesterol levels. It affects various bodily systems in numerous ways, helping to alleviate many illnesses, including diarrhoea, migraine migraines, poisoning from a snake bite, rheumatic swellings, Alzheimer's disease, etc.

8. Conclusion

Therefore, *C. urens* is a plant that is very helpful in traditional medicine for treating various illnesses. In addition, it is a valuable natural source that can be used to acquire multiple therapeutic effects in treating and preventing diseases. It is a powerful dietary item and a medication that people of all ages can use. The medicinal plant evergreen *C. urens* is underutilized. It has larvicidal, anti-diabetic, antibacterial, anti-inflammatory, and antioxidant properties. It also has remediation effects. Pharmacological action has only been determined through in vitro studies up to this point. Therefore, research into work done in vivo is essential. It also required the identification of brand-new substances with potent medicinal capabilities. The anticancer ability of this plant needs to be improved. A study is necessary to make an underutilized valuable plant to people as medicine. Plant microorganisms still need to be thoroughly studied. Identifying new endophytes from plant sources and evaluating their therapeutic potential is also necessary.

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10.References

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