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Review Paper

The Science of *Cocos Nucifera*: Insights into Its Nutritional and Medicinal Applications

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ABSTRACT

The coconut tree (*Cocos nucifera* L.) is often called the “tree of life” due to its many uses in industry, medicine, and nutrition. Native to Southeast Asia and Melanesia, this versatile, adaptable palm grows well in tropical and subtropical climates. Coconut fruit consists of three layers surrounding the nutrient-rich kernel and coconut water: the epicarp, mesocarp, and endocarp. Rich in such bioactive substances as flavonoids, tannins, phenols, and essential vitamins. Fruits, leaves, husks, and roots of *C. nucifera* have long been employed in traditional medicine because of their antibacterial, antioxidant, anti-inflammatory, hepatoprotective, and antidiabetic properties, as proven by modern studies, suggesting their great therapeutic potential. Area phytochemicals contribute to heart health by lowering blood pressure and improving lipid profiles. Coconut water is a natural source of electrolytes, while coconut oil, derived from the dried kernel, contains lauric acid, which has both anti-bacterial and immune-boosting properties. Based on previous studies *C. nucifera* also has been reported as a potential candidate in the management of metabolic disorders, wound healing, and indications at dermatological levels. Apart from its pharmaceutical merits, the plant is of ecological and economic value due to its application to food, cosmetics and biofuel. This review provides the most updated information on the taxonomy, phytochemistry, pharmacology and its therapeutic potential and emphasises the importance of this sustainable natural resource, *C. nucifera* with extensive industrial and healthcare applications.

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INTRODUCTION



Figure 1: Coconut tree

Plant *Cocos nucifera* Linn. (Arecaceae) is a type of fruit that is commonly known as coconut. Every part of the Coconut plant is useful, that is why it is called as the “tree of life”. Coconut palm is known as "tree of life" also called, "Kalpavriksha. Various coconut trees have been grown by humans across the globe.¹ Coconut has a diverse use giving enough food, household products and money.² The coconut originated in the littoral zone of Southeast Asia (Malaysia, Indonesia, Philippines) and Melanesia.³ *Cocos nucifera* native to the Arecaceae family has great significance in the Indian traditional medicinal system.⁴ The coconut palm of ancient the humid tropics, is one of the most useful multipurpose palms with a high, trunk with a cluster of long green pinnate leaves and fruit bunches are borne on the basis of axils.⁵ *C. nucifera* a commonly used in diet is one of the promising herbs for the treatment of various diseases. *C. nucifera* one of the promising herbs for the treatment of various diseases and *C. nucifera* fruit have therapeutic efficiency in cardio-metabolic disorders. It ascends to 30 m high and features a glabrous trunk. It mainly occurs in a tropic and sub tropic region and has numerous hard promoting effects like antidotal, antiseptic, antitumour, bactericidal, depurative, anti-helminthic, aphrodisiac, astringent, diuretic, refrigerate, stomachic, styptic, suppurative, vermifuge and antioxidant, vasorelaxant and antihypertensive.⁶

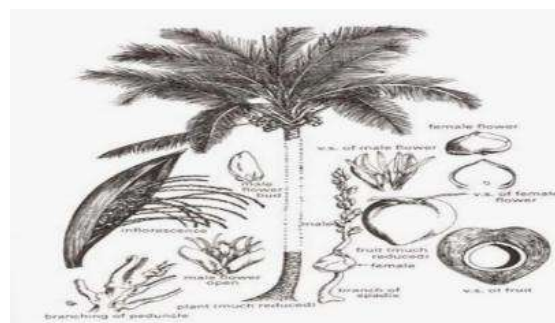


Figure 2: Various parts

The coconut tree has many uses for leaves, inflorescence, fruit, trunk, and root. The composition of coconut fruit is as follows: 38.5% shell, 51.7% kernel, 9.8% water.⁷ It is largely seen in Southeast Asia and the Pacific islands. It serves as sustenance for inhabitants of these regions. The coconut fruit consists of an outer epicarp, a mesocarp, and an inner endocarp. The outer skin of the fruit (epicarp) and the heavy, fibrous, and tanned mesocarp when dry, have numerous industrial applications. The endocarp is its dark, hard core. On the inside, there's an edible white kernel (meat) that's a solid white albumen of varying thickness (depending on the age of the fruit) and an oily pulp consistency and a liquid albumen called coconut water that's thick, sweet and a bit acidic.⁸ Coconut palms are unique in having an inflorescence with both male and female flowers.⁹ Medicinal plants have been used as traditional treatments for various human diseases for thousands of years in many regions of the world. Medicinal plants possess the natural products that are good source of biologically active compounds. Consequently, the natural products from medicinal plants can serve as effective source of alternative medicines.¹⁰

METHODOLOGY

This systematic search targets on *Cocos nucifera* (coconut), taxonomical studies, botanical distribution, scientific importance, their nutritional value and pharmacological activities. Included are the articles published between 2000 and 2024. Data extraction, analysis, and discussion are

carried out. No ethical approval is needed. The results will be disseminated through peer-reviewed journals, conferences, and among stakeholders in the medical and research communities.

Taxonomy ¹¹

Scientific Name	<i>Cocos nucifera</i> L
Kingdom	Plantae
Order	Arecales
Family	Areaceae
Class	Monocotyledonae
Genus	Cocos
Species	<i>Cocos nucifera</i>

Vernacular Names ¹¹

English	Coconut palm, Coconut tree
Sanskrit	Kalpavriksha ,Uchchataru
Tamil	Narikel
Hindi	Nariyal
Kannada	Tengu
Malayalam	Thenga

INTERNATIONAL COMMON NAMES¹³

English: Coconut palm, Copra

Spanish: Coco de agua, Cocotero, Palma de coco, Palmera cocotera, Palmera de coco

French : Coco, Cocotier, Cocoyer, Noix de coco

Distribution ¹¹

Though the history of coconut is unknown, it was said to be over 80 million years old. India is the second largest producer of coconut in the world. The origin of coconut is assumed to be very old as 80 million years which may be due to the landmass of the Southern Hemisphere, Gondwana. It's when the Earth tectonic plates got displaced, the land surfaces that make up Australia, way up North and Northeast of New Zealand, Madagascar to Africa and Southern America and the countries of South Asia, especially India, Bangladesh and Pakistan moved. Despite the mystery surrounding its first use, humans began utilizing this remarkable fruit a half-million years ago. It was about 4000 years ago that colonizing mariners ventured eastwards from the Southeast Asiatic coast to the archipelagos of the South Pacific, traversing 10,000 km from New

Guinea to Tahiti and to the southern coastal region of India and Sri Lanka.

Coconut Varieties ¹⁴

Thus, while the number of *C. nucifera* varieties is not defined, it is widely agreed that all coconut varieties today come from that one species. Three main varietal groups have emerged via natural and artificial selection: tall or typical; dwarf or nana; and hybrids. Tall varieties (e.g., Jamaican and East and West coast varieties) can grow to 15 – 24 m in height. At six to ten years post-germination they produce fruit of medium to large size which contain high-quality kernels commonly used in coconut oil production. They can produce nuts for eighty or more years. The dwarf varieties (e.g., Malayan, Fiji, Brazilian green, Macapuno and Cameroon Red, among others) are shorter in height (5 – 18 m), produce smaller fruit and begin fruit are harvested 3-5 years after planting. As for dwarf varieties, the primary source of fresh coconut water is the fruit from these dwarfs. Although certain varieties such as Makapuno and Lono are more desirable due to the flavor produced by their gelatinous endosperm which is great for desserts. Hybrid varieties such as Maypan are crosses between Malayan Yellow Dwarf (MYD) and Panama Tall (PNT) types. They tend to produce more fruit than their parental types, which are moderate in size relative to the progenitors. Hybrids initiate fruit production at three to six years, and the color in any of the varieties is most frequently green or yellow; however, it can also be red, orange, or mixtures of orange-red and green-yellow.

Botanic Description ¹⁵

Plants: The trunk of a *cocos nucifera* tree is fairly smooth with an average diameter of 30-40 cm at eye level. It is crowned by a tuft of leaves and has a light grey-brown color, and the tree itself can grow anywhere from 24-30 meters tall. In addition, dwarf varieties are also available. The tree trunk is thin and slightly bloated towards the



base and is typically erect - although the trunk can lean or curve as well.

Leaves: The Coconut leaves are tapered at both ends, with the broadest section being 1-1.5m. With an impressive length of 4-7m, these leaves are feathered. Leaf stalks 1-2 cm in length and thornless.

Flower: Flowers are found in axillary clusters composed of male and female flowers. The male flowers, which outnumber the females, are much smaller in size and are light yellow in color. They also bloom together in clusters from canoe-shaped sheaths that are found among the leaves. The larger and spherical female flowers are around 25 mm in diameter but are less common and sometimes may be completely absent.

Fruit: The fruit appears to grow out of a relatively thick outer fibrous covering that is roughly ovoid in shape and has a soft bristlelike surface. What appears to be, a somewhat spherical nut contained within the husk, measures 2-2.5 cm in diameter and 3-4 cm in length. The ovoid fruit is said to grow around 5 cm in length and 3 cm in width. The nut contains three 'eyes', which are soft tissue 'holes' located on one end. The interior of the nut has a watery substance known as coconut milk, while the shell is lined with a thin white covering known as 'the meat', partially filled with a jelly-like substance. The meat becomes firm as the nut matures. During the untimely period of the fruit, coconut milk can be found in abundance. This over time is consumed as the fruit matures. The meat of the nut transforms from soft to jellylike when immature and firm with a ripe nut. Varieties of the fruit also alter color with the green variation of the fruit turning brownish, meanwhile, the yellow falls to the surface. The generic name appears to have been influenced by the Portuguese term 'coco', which means 'monkey.'

Stem and root: The root of the coconut system is fasciculated. The stem is an unbranched type, and

at its apex, a tuft of leaves protects a single apical bud.¹⁶

Coconut Components

Coconut husks, leaves, flowers, copra, shells, and husks are some of the major parts of a coconut. As a drink, the fragile coconut water is used until the coconut is opened. This makes it easier to consume and carry. In addition, coconut water is used in the production of the jelly-like dessert "Nata De Coco".¹⁷ The immature white fleshy section of a coconut can be scraped and pressed through a cloth to obtain a milk-like cream that can be used on a variety of foods and dishes. The fleshy part of the coconut also has a custard-like taste and texture, making it edible and delightful. In contemporary times, coconut shells are also used as construction materials. Coconut husks are also referred to as coir pith, and comprise 75% fiber and 25% fine particles. It is also referred to as coir pith. Coir fiber, coco husk chips, coco peat, and coco crush are all derived from the husks. Coco peat has long served as a gardening fertilizer.¹⁸ Coconut leaves are employed for thatching. These leaves also serve as fencing and roofing materials for small huts. The blossoms of coconut can be consumed. Like many foods, it was blended with 'curd' and given to diabetics as a medicinal concoction during ancient times.¹⁹

Active Constituents /Phytochemicals

These agents function as active components in the plant. Phytochemicals are substances found in plants or fruits that can serve medicinal purposes. It would seem that secondary metabolism indicates that phytochemicals are generated in small quantities and with limits.²⁰ Parts of the *Cocos nucifera* (L) plant contain phytochemical compounds that are distributed throughout the plant. It is possible to create therapeutic agents from phytochemical compounds generated by secondary metabolism. A wealth of scientific research indicates that carotenoids, phytoestrogens, nondigestible carbohydrates,



flavonoids, and prebiotics have a significant effect on health.²¹

The phytochemical analysis of the fruit extract identified the presence of phyto ingredients such as alkaloids, flavonoids, saponins, tannins, diterpenes, triterpenoids, glycosides, and phenols.²² The vitamins, along with leucoanthocyanidin, triterpene, sterol, polyphenol, catechin, epicatechin, vitamin B compounds such as nicotinic acid, pantothenic acid, riboflavin, and biotin, folic acid, trace elements of vitamins B1 and B6, C and pyridoxine, thiamine, amino acids

like L-arginine and auxin. Additionally, included are 13 diphenylurea plant hormone, cytokinin, and various enzymes such as acid phosphatase, catalase, dehydrogenase, diastase, peroxidase as well as RNA polymerases and growth factors. Moreover, the oil extracted from solid albumen mainly consists of lauric acid and alpha-tocopherol. Other compounds found in leaf epicuticular wax included skimmiwallin, [3 beta methoxy 25 ethyls 9,19 cyclolanost 24(241) ene] isoskimmiwallin and lupeol methyl ether.²³⁻²⁶

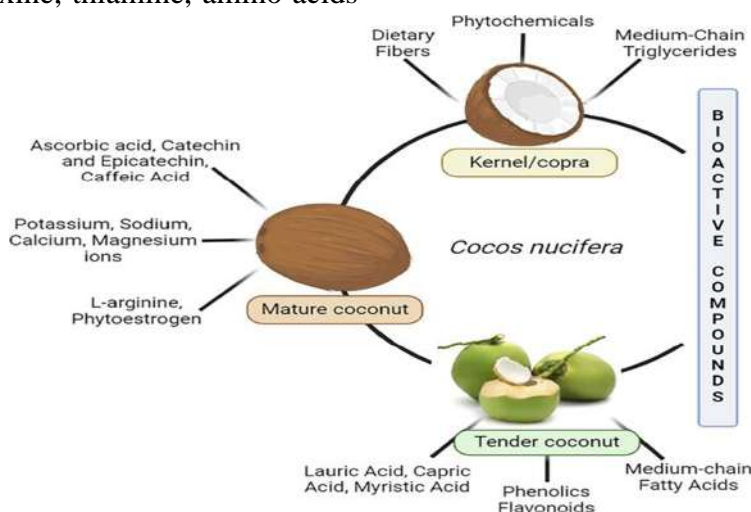


Figure 3 Bioactive compounds

MEDICINAL USES:

Coconut trees are unique sources of many different natural products that can be used in the treatment of various diseases, as well as in the manufacture of different industrial products. Some parts of its fruit such as coconut kernel and tender coconut water provide various medicinal properties including antibacterial, antifungal, antiviral, antiparasitic, antidermatophytic, antioxidant, and hypoglycemic. hepatoprotection, immune stimulation. Water and fresh coconut are rich in microminerals and nutrients necessary for human physiology, this explains why people in tropical countries use coconut as food.

BENEFITS OF COCONUT

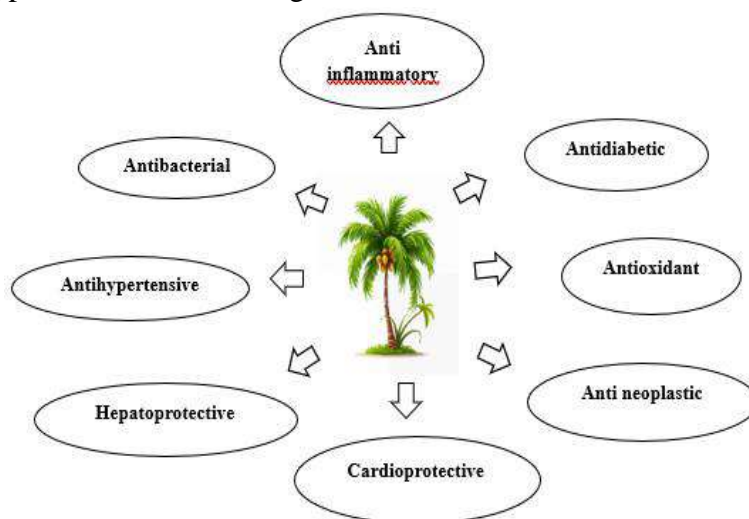
Skin and Hair Care³¹

- Coconut oil is commonly used for sound growth of hair.
- It has been historically utilized to treat baldness, dandruff, and head lice.
- Coconut oil can also be used topically for wounds and burns in order to lubricate skin and protect it from infections.
- It lessens symptoms of psoriasis, eczema and dermatitis.
- It assists in smoothing the skin and soothing flaking and dryness.
- Soothes age spots and wrinkles.
- Coconut is additionally applied as a protector against the effects of UV exposure from the sun.

Pharmacological Activity

There have been various research studies on the active molecules in coconut and their potential pharmacological and biological properties. Different extracts, fractions, and isolated compounds from different parts of the coconut fruit were tested indicating different activities, including antihypertensive; analgesia;

vasodilation; protecting kidney, heart, and liver functions; protection against ulcers; anti-inflammatory, anti-oxidant, anti-osteoporosis, antidiabetes, antineoplastic, bactericidal, antihelminthic, antimalarial, leishmanicidal, antifungal and antiviral activities.¹⁶



Antioxidant Activity:

Phenolic compounds are important for the health of both consumers and the food industry, which can help to develop functional foods based on rich phenolic diets. Among the oils obtained from the coconut, the virgin coconut oil has the maximum amount of phenols.³²

Asan Electrolyte:

The tender coconut water (TCW) contains large amounts of inorganic ions like potassium 290 mg%, sodium 42 mg %, calcium 44 mg %, magnesium 10 mg %, and phosphorus 9.2 mg%. These inorganic electrolytes create an osmotic pressure comparable to plasma and do not alter plasma coagulation.³¹ The TCW is rich in potassium which helps to lower blood pressure. It was also demonstrated that the ethanolic extract of *C. nucifera* endocarp exerts vasorelaxant and antihypertensive effect in a concentration and endothelium-dependant manner via nitric oxide production, by direct activation of nitric oxide /guanylate cyclase pathway, stimulation of

muscarinic receptors or via cyclooxygenase pathway.³³

Antidote Effect:³³

Tender coconut water is also reported to detoxify mineral poisoning and alleviate drug-induced overdose toxicity. Similar to fructose coupled with quicker absorption into cells and the body TCW helps quick absorption of the drug and makes peak concentration in the blood is much simpler by its electrolytic effect.

Anti-Inflammatory Effects:

In general, coconut oil has been used on burn wounds. Coconut oil may also enhance the immune system response. Coconut oil feeding completely abolishes enteric immune factor responses expected upon challenge with endotoxin and impairs both constitutive and stimulated production of proinflammatory cytokines. Recently, the biological activity of virgin coconut oil (VCO) has gained significant interest. Lauric acid was identified in VCO as a potential needed compound. Monolaurin is derived from its

precursor, lauric acid and has been reported to modulate immune cell proliferation and provide antimicrobial action.³⁴

Antidiabetic Effect

Several research studies were conducted on various parts of the *C. nucifera* plant and demonstrated its antidiabetic activity both in vivo and in vitro. The in-vitro study includes the inhibitory potential of different extracts of *C. nucifera* against alpha-amylase and alpha-glucosidase, the enzymes responsible for the breakdown of carbohydrates to glucose. The in-vivo studies depict the antihyperglycemic action of extracts in either STZ or alloxan-induced diabetic animals. These diabetogenic agents act by destructing the beta cells of the pancreas causing the deficiency of insulin.³⁵

Anti-Bacterial, Antifungal, And Anti-Viral Activities

Coconut husk strands are used to brush the teeth by marker of oral hygiene among rural folks in South India.³⁶ In this sense, the antimicrobial actions of alcoholic extracts of the husk against prevalent oral-pathogens were measured using the agar well diffusion procedure.³⁶ Ethanolic (cold and hot percolation), dry-distilled, and aqueous extracts of coconut endocarp were studied against methicillin-resistant *Staphylococcus aureus* (MRSA), methicillin-sensitive *S. aureus*, *Pseudomonas aeruginosa*, *Escherichia coli*, *Klebsiella pneumoniae*, *Acinetobacter baumannii*, *Citrobacter freundii*, *Enterococcus*, *Streptococcus pyrogens*, *Bacillus subtilis*, and *Micrococcus luteus* using the Kirby-Bauer disc diffusion method.³⁸

Antihypertensive Activity

The anti-hypertensive activity of an ethanolic extract of *C. nucifera* endocarp (EEC) using the deoxycorticosterone acetate (DOCA) salt-induced model of hypertension was observed. Administering EEC significantly reduced the

mean systolic blood pressure in DOCA salt-induced hypertensive rats (from 185.3±4.7 to 145.6±6.1 mm Hg). This effect was attributed to the direct activation of the nitric oxide/guanylate cyclase pathway as well as stimulation of muscarinic receptors and/or the cyclooxygenase pathway. These activities can be explained by the presence of phenolic compounds and flavonoids in the extract used.³⁹

Hepatoprotective Activity

The hepatoprotective effect of tender coconut water was investigated in carbon tetrachloride (CCl₄)-intoxicated female rats. The animals were divided into three groups: normal control rats, CCl₄-treated control rats, and tender coconut water-pretreated rats intoxicated with CCl₄. Carbon tetrachloride caused elevated serum glutamate oxaloacetate transaminase and glutamate pyruvate transaminase levels and also led to liver necrosis and fatty liver, while rats pretreated with coconut water showed decreased activities of these enzymes.⁴⁰

Antimalarial Activity

Antimalarial activity of different crude methanol extracts (50, 100, 200, and 400 mg/kg, treated orally) was investigated *in vivo* against *Plasmodium berghei* (NK65) in mice during early, established, and residual infections. Chloroquine (20 mg/kg) and pyrimethamine (1.2 mg/kg) were used as reference drugs. The methanol white flesh extract of *C. nucifera* produced a dose-dependent chemotherapeutic activity in all three *in vivo* assessment models. In the established malaria infection, there was a significant (P<0.05) decrease after treatment with the extract (200 and 400 mg/kg) compared to the reference drug for the treatment of the disease.⁴¹

Cardioprotective Activity

An important biological action of coconut was demonstrated using an experimental model of myocardial infarction induced by isoproterenol in



rats. Feeding these animals with tender coconut water (West Coast Tall variety) protected against the induction of myocardial infarction and decreased mitochondrial lipid peroxidation.⁴²

Analgesic Activity

Crude husk-fiber extract and two aqueous extract fractions of molecular weights less than (F1) and greater than (F2) 1 kDa were studied for their analgesic activity by acetic acid-induced abdominal writhing, tail-flick, and hot plate tests in mice. All three extracts induced peripheral and central antinociceptive activity.⁶

DISCUSSION

The coconut tree, or *Cocos nucifera* (L.), is a very valuable plant because of its many industrial, medical, and nutritional uses. The many pharmacological characteristics of coconut are influenced by its phytochemical makeup, which includes flavonoids, phenols, tannins, and lauric acid. It is an important natural treatment for a number of illnesses, with scientific research confirming its antibacterial, antioxidant, anti-inflammatory, hepatoprotective, and cardioprotective properties. *C. nucifera*'s therapeutic potential is especially pertinent to metabolic conditions like diabetes, high blood pressure, and heart disease. Its therapeutic usefulness is further increased by its function in wound healing and dermatitis. Coconut is essential for nourishment in addition to its therapeutic uses. Healthy fats and proteins abound in the kernel, and vital electrolytes are supplied by the coconut water, providing it's a great way to stay hydrated. *C. nucifera* is important economically for a number of businesses, including as food, cosmetics, pharmaceuticals, and biofuels. Its sustainability and capacity to adapt to tropical climes increase its significance on a global scale. To completely investigate its potential uses in contemporary biotechnology and medicine, more study is necessary.

CONCLUSION

Cocos nucifera is a multipurpose plant with enormous economic, medical, and nutritional significance. Its phytochemical makeup promotes antibacterial, antioxidant, and cardioprotective qualities, among other health advantages. Both modern and traditional medicine have acknowledged its potential in managing and preventing disease. To optimize its advantages for industry, environmental sustainability, and health, more research, and sustainable growing methods should be promoted in light of its numerous applications.

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