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PHYTOCHEMICAL AND PHARMACOLOGICAL PROFILE OF *COCOS NUCIFERA*: AN OVERVIEW

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ABSTRACT

The coconut, *Cocos nucifera* L., has been described as "the tree of life" or the tree of plenty and nature's greatest gift to man. Coconut is a large palm (30 mts tall) and member of *Arecaceae* family with binomial nomenclature as *Cocos nucifera*. Coconut is known as Naarikela in ayurveda. The fruit, flower and root of this plant are used as ingredients for many ayurvedic preparations and it is also used in Malay traditional medicine to treat ailments such as fever, headaches, stomach upset and diarrhea. Coconut products provide food, shelter and energy to farm households and can be made into various commercial and industrial products. The husk fiber of *Cocos nucifera* has antibacterial and antiviral, antitumoral alternative for oral rehydration and intravenous hydration of patients particularly in remote regions. It may also offer protection against myocardial infarction and control of hypertension. It is also effective in the treatment of kidney and urethral stones, urinary infections and mineral poisonings. This study is an attempt to compile an up-to-date data and comprehensive review of *Cocos nucifera* that covers its overview of traditional and medicinal uses, phytochemistry and pharmacology profile.

Keywords: *Cocos nucifera*, *Arecaceae*, Naarikela, Phytochemistry.

INTRODUCTION

The coconut (*Cocos nucifera*) is the member of *Arecaceae* family (Palm family) and it is commonly referred to as Coconut or Nariyel. The plant is native to tropical eastern regions. It is grown both over the Asian continent (India, Ceylon, Indonesia) and in Central and South America (Mexico, Brazil). In Africa, the largest producing countries are Mozambique, Tanzania and Ghana (Shivkumar *et al.*, 2011). India is the third largest coconut producing country, after Indonesia and the Philippines, having an area of about 1.78million hectares under the crop. Annual production is about 7562 million nuts with an average of 5295 nuts/hectare (NMCE, 2007).

The coconut palm is a long lived plant that may live as long as 100 years. It has a single trunk which can grow up to 20-30 meters tall. Its bark is smooth and grey, marked by ringed scars left by fallen leaf bases. Unlike some other plants, the palm tree does not have tap root hairs but has fibrous root system (Shivkumar *et al.*, 2011). The flowers are unisexual, stalkless and sprout from a fleshy branched panicle or spadix in the axle of a huge, woody, fibrous bract (spathe). The fruit is a three-sided drupe. Its wall, or pericarp, consists of three distinct layers: a smooth thin rind or exocarp, which is green to begin with, but changes to brown or reddish-brown on maturity; a large brown fibrous middle region (or the mesocarp) forming the husk; and, a hard stony endocarp which forms the coconut shell, enclosing the seed inside (Naskar *et al.*, 2011). Leaves are pinnate and 4-6m long, and pinnae 60-90cm long; old leaves break away cleanly, leaving the trunk smooth. The coconut palm is grown through the tropics for decoration,

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as well as for its many culinary and non-culinary uses; virtually every part of the coconut palm can be utilized by humans in some manner. The cavity of the coconut fruit is filled with coconut water, which is sterile until opened. It mixes easily with blood, so for this reason it was used during World war-2 in emergency transfusions. Coconut water has been used as an emergency short-term intravenous hydration fluid. This is possible because the coconut water has a high level of sugar & other salts that make it possible to be used in the blood stream. Coconut water is traditionally used as a growth supplement in plant tissue culture/micropropagation (Pattigadapa *et al.*, 2011).

The coconut tree (*Cocos nucifera* L.) is known as the tree of life because of its range of environmentally sustainable uses (Foale, 2003). Among the plantation crops of tropical humid areas, coconut occupies an important position in view of the commercial value of its oil on the international market. This monocot tree crop grows well in warm humid weather with an estimated 120 sunshine hours monthly (Murry, 1977). The ideal temperature is around 27°C with a diurnal variation of 5°C to 10°C. Coconut is found in places where the annual precipitation is between 1300 and 2500 mm or above. An average monthly rainfall of 150 mm is ideal for good growth and high nut yield. A prolonged dry spell lasting from 5 to 7 months adversely affects the palms (Rajagopal *et al.*, 1990). The stomata allow gases exchange. In green leaves they occur either on both surfaces (amphistomatic leaf) or only one, either the upper (epistomatic leaf) or more commonly on lower that is hypostomatic leaf and in dicotyledonous flora of stomata are recognized such as anomocytic, paracytic, diacytic, anisocytic, parallelocytic and cyclocytic types were noted (Prveen *et al.*, 2007).

Monocotyledonous flora reveals the presence of three major types of stomata such as paracytic, tetracytic and anomocytic type and Gramineae, Cyperaceae, Palmae and Juncaceae are characterized by paracytic type (Abid *et al.*, 2007). The stomates are arranged in parallel rows as noted in leaves with parallel veins such as those of monocotyledons and some dicotyledons (Cutter, 1969). There are 200 stomata in each square millimeter of leaf surface of the coconut palm, each stoma being approximately 38u x 40u including the subsidiary cells (Menon & Pandalai, 1958). The size of the stomata either increases (*Cocos nucifera* L.) or remains more or less the same in young and adult palms. Similarly, the number of rows of inter stomatal cells and their width either increases or decreases slightly in adult. A low stomatal conductance is of consequence in the evaluation and screening of plant type for drought resistance. Higher resistance indicate reduced water loss, hence it's important in the maintenance of water status (Ghose & Davis, 1973). The

resistance to transpiration helps to maintained higher water potential of plants that imports turgidity. It was observed whether the determinations were made at different times of the day (6–18 h) or under irrigated and unirrigated conditions or in different seasons ('dry' and 'wet'). Thus, the stomatal regulation was significantly impaired in the diseased palms resulting in excessive water loss compared to the healthy palms (Rajgopal *et al.*, 2007). The drop in coconut production when soil water is deficient is mainly due to limitations at the stomatal level rather than at the non-stomatal (biochemical) level of the assimilation process, especially in mild to moderate drought conditions (Nainanayake & Morison, 2007). The effects of drought on stomatal conductance and water potential of four coconut genotypes were measured to develop an index for stomatal performance, Camron red dwarf was identified as a drought sensitive genotype compared to the rest (Chan & Elevitch, 2006).

There are various common names of *Cocos nucifera* like coconut or coconut palm (English), nariyal (Hindi), narikel (Sanskrit), nariyal (Gujrati) (Joshua *et al.*, 2010).

Table 1. Taxonomical Classification

Kingdom	<i>Plantae</i> – Plants
Subkingdom	<i>Tracheobionta</i> – Vascular plants
Super division	<i>Spermatophyta</i> – Seed plants
Division	<i>Mangnoliophyta</i> – Flowering plants
Class	<i>Liliopsida</i> – Monocotyledons
Subclass	<i>Arecida</i>
Order	<i>Arecales</i>
Family	<i>Arecaceae</i> – Palm family
Genus	<i>Cocos</i> L. – Coconut palm
Species	<i>Cocos nucifera</i> L. – coconut palm

Reported Phytoconstituents

In the coconut matures, the pulp becomes firmer, with less water and its nutrients are more of carbohydrates (6.23%), proteins (3.33%), and mineral salts, particularly magnesium, calcium and phosphorus. However, the most abundant nutrient in the coconut is fat, which makes up more than a third of its mature weight. Most (up to 94.3%) of the fatty acids that make up coconut fat are saturated (Pattigadapa *et al.*, 2011). Coconut water contains sugar, fiber, proteins, antioxidants, vitamins & minerals, & provides anisotonic electrolyte balance, making it a nutritious food source. Mature fruits have significantly less liquid (coconut water) than young immature coconuts (Zakaria *et al.*, 2006). The coconut oil obtained from the kernel consists of monolauric and lauric acid, which helps the immune system in a beneficial manner. Furthermore,

C. nucifera have also been reported to contain high amount of lauric acid, followed by myristic, caprylic, palmitic and capric acids as its major source of fatty acids the juice of *Cocos nucifera* was low in fatty acids content. Various types of compounds have been isolated and identified from the *Cocos nucifera* juice and kernel such as zeatin-O-glucoside and dihydrozeatin-O-glucoside, orthotopolin, kinein, kinetin riboside and α -Galactosidase. In addition, the endosperm of *Cocos nucifera* was reported to contain cocosin while the virgin coconut oil was found to contain polyphenol components that help in lowering lipid levels in serum and tissues and LDL oxidation by physiological oxidants. In addition high content of L-arginine and ascorbic acid are the main constituents of the juice. Two types of protein namely glutelin and prolamin, which were found in coconut milk, were also reported to be present in the juice of *Cocos nucifera* (Zakaria *et al.*, 2006). The kernel is reported to contain 36.3 g H₂O, 4.5 g protein, 41.6 g fat, 13.0 g total carbohydrate, 3.6 g fiber, 1.0 g ash, 10 mg Ca, 24 mg P, 1.7 mg Fe, and traces of beta-carotene (C.S.I.R., 1948-1976). Per 100 g, the green nut is reported to contain 77-200 calories, 68.0-84.0 g H₂O, 1.4- 2.0 g protein, 1.9-17.4 g fat, 4.0-11.7 g total carbohydrate, 0.4-3.7 g fiber, 0.7-0.9 g ash, 11-42 mg Ca, 42-56 mg P, 1.0-1.1 mg Fe, 257 mg K, trace of beta-carotene, 0.4-0.5 mg thiamine, 0.03 mg riboflavin, 0.8 mg niacin, and 6-7 mg ascorbic acid (Food Composition Tables). Coconut oil is one of the least variable among vegetable fats, i.e. 0.2-0.5% caproic-, 5.4-9.5 caprylic-, 4.5-9.7 capric-, 44.1-51.3 lauric-, 13.1-18.5 myristic, 7.5-10.5 palmitic-, 1.0-3.2 stearic-, 0-1.5 arachidic-, 5.0-8.2 oleic-, and 1.0-2.6 linoleic-acids (C.S.I.R., 1948-1976). Following oil extraction from copra, the coconut cake (poonac) contains 10.0-13.3% moisture, 6.0-26.7% oil, 14.3-19.8% protein, 32.8-45.3% carbohydrates, 8.9-12.2% fibers, and 4.0-5.7% ash. The so-called coconut water is 95.5% water, 0.1% protein, <0.1% fat, 0.4% ash, 4.0% carbohydrate. Per 100 g water, there is 105 mg Na, 312 K, 29 Ca, 30 Mg, 0.1 Fe, 0.04 Cu, 37 P, 24 S, and 183 mg choline. Leaves contain 8.45% moisture, 4.282 ashes, 0.56% K₂O, 0.25 P₂O₅, 0.28 CaO, and 0.57% MgO (James & Duke, 1983). Oil of *Cocos nucifera* (CN) is extracted from copra, which is the dried inner flesh of coconut. Coconut oil consists of about 90% saturated fat. The oil contains predominantly medium chain triglycerides, with 86.5% saturated fatty acids, 5.8% monounsaturated fatty acids, and 1.8% polyunsaturated fatty acids. Of the saturated fatty acids, coconut oil is primarily 44.6% lauric acid, 16.8% myristic acid and 8.2% palmitic acid, although it contains seven different saturated fatty acids in total. Its only monounsaturated fatty acid is oleic acid, while its only polyunsaturated fatty acid is linoleic acid

(Shrivastava & Durgaprasad, 2008).

Reported Pharmacological Activity

Bankar *et al.*, (2011); evaluated the ethanolic extract of *Cocos nucifera* Linn. endocarp for its vasorelaxant activity on isolated rat aortic rings and antihypertensive effects in deoxycorticosterone acetate (DOCA) salt –induced hypertensive rats and concluded that the vasorelaxant and antihypertensive effect of *Cocos nucifera* Linn endocarp, through nitric oxide production in a concentration and endothelium- dependent manner is due to direct activation of nitric oxide guanylate cyclase pathway, stimulation of muscuranic receptor and /or vivo cyclooxygenase pathway.

Singla *et al.*, (2011); evaluated the antioxidant and antimicrobial activities of the *Cocos nucifera* endocarp extract. The antioxidant activities, DPPH radical scavenging activities and antimicrobial activities of the ethanolic (cold percolation: RNM-01 & hot percolation: RNM-02) extracts, dry distilled extract (RNDS) and aqueous extract (hot percolation: RNA) of endocarp of *Cocos nucifera*. Agar disc diffusion method was used for in vitro antibacterial and antifungal screening.

Sivakumar *et al.*, (2011); evaluated the ethanolic soluble extract of root of *Cocos nucifera* for anti bacterial activity using disc-diffusion method in the concentration of 25µl/disc, 50µl/disc, 100µl/disc and ciprofloxacin hydrochloride 5µl/disc was selected as the standard drug. They proved that the ethanolic soluble extract of root of *Cocos nucifera* showed marked activity against all microorganisms equating to the standard and even exhibited better zone of inhibition in comparison to standard.

Ajeigbe *et al.*, (2011); evaluated the anti nociceptive and anti-inflammatory potential of coconut water in rats and mice and the anti –inflammatory property were evaluated using hot plate, tail flick, formaline-induced paw licking and acetic acid –induced writhing test and antinociceptive activity were evaluated using carrageenan-induced paw edema and proved that the coconut water possesses demonstrate analgesic and anti-inflammatory property.

Pattigadapa *et al.*, (2011); evaluated the coconut water for cardiotoxic activity on the isolated frog heart and are labeled as T1 and T2 respectively and compared with Digoxin (S1) as standard solution and proved that sample T1 (undiluted coconut water) showed better response as compared to the diluted coconut water (T2) and confirmed the cardiotoxic activity of the Coconut water.

Karadi *et al.*, (2011); evaluated the in vitro antimicrobial effect of *Musa paradisiacal* and *Cocos nucifera* on bacteria (*Escherichia coli*, *Staphylococcus*

aureus, *Bacillus subtilis*, *Pseudomonas aeruginosa*) and fungi (*Candida albicans*, *Candida tropicalis*, *Aspergillus niger*) using agar disc diffusion method and determine the inhibitory effect of both the test plants and proved that the both the plant extracts showed inhibitory effect on test organism.

Naskar *et al.*, (2011); evaluated antihyperglycemic activity of hydro-methanol extract of *Cocos nucifera* (HECN) on streptozotocin (STZ)-induced diabetic rats and proved that the hydro alcoholic extract of *Cocos nucifera* treated animals showed a significant reduction in fasting blood glucose (FBG) level as compared with diabetic control group. They concluded that hydro-methanol extract of *Cocos nucifera* (HECN) has very good antidiabetic activity with very low side effects and provides a scientific rationale for the use as an antidiabetic agent.

Al-Adhroey *et al.*, (2011); evaluated the methanolic extract of *Cocos nucifera* (coconut) for antimalarial usage in Malaysian folk medicine and proved that the extract contained some phytochemical constituents and is toxicologically safe by oral administration. The extract significantly reduced the parasitaemia by the 200 and 400mg/kg doses in the all three in vivo assessment assays and concluded that the Malaysian folkloric medicinal application of *Cocos nucifera* has a pharmacological basis.

Oliveria *et al.*, (2008); evaluated the antihelminthic activity of *Cocos nucifera* Linn against sheep gastrointestinal nematodes. The ethyl acetate extract obtained from the liquid of green Coconut husk fiber was submitted to in vitro and in vivo test. In vivo assay egg hatching and larval development tests with *haemonchus contortus* was analyzed and in vivo assay worm burden was analyzed and proved that the ethyl acetate extract showed no activity against sheep gastrointestinal nematodes.

Srivastava *et al.*, (2008); evaluated the oil of *Cocos nucifera* for burn wound healing property and to compare the effect of the combination of oil of *Cocos nucifera* and silver sulphadiazine with silver sulphadiazine alone by observing the epithelialization period and percentage of wound contraction and proved that there was significant improvement in burn wound contraction in the group treated with the combination of *Cocos nucifera* and silver sulphadiazine. The period of epithelialization also decreased significantly and concluded that oil of *Cocos nucifera* is an effective burn wound healing agent.

Koschek *et al.*, (2007); evaluated the aqueous extract of the husk fiber of the *Cocos nucifera* for invitro antitumoral activity. Cytotoxicity against leukemia cells was determined by the 3-[4,5-dimethylthiazol-2-yl]-2,5-

diphenyl tetrazolium bromide (MTT) assay and proved that it might be a very inexpensive source of new antineoplastic and anti multidrug resistance drugs that warrants further investigation.

Zakaria *et al.*, (2006); evaluated the potential of *Cocos nucifera* as antipyretic, anti-inflammatory and wound healing agents. The fresh juice and aqueous kernel extract of *Cocos nucifera* exhibited significant ($p < 0.05$) anti-inflammatory and antipyretic activities and promote wound healing with the latter producing a more effective effects in all assays used. This finding has scientifically supported the folkloric use of *Cocos nucifera* in the treatment of inflammation, pyrexia and wound.

Mantena *et al.*, (2003); evaluated the *In vitro* antioxidant properties of *Cocos nucifera* Linn. water using 1,1-diphenyl-2-picrylhydrazyl (DPPH), (2,2'-azino-bis(3-ethylbenz-thiazoline-6-sulfonic acid) (ABTS) and superoxide radicals but promoted the production of hydroxyl radicals and increased lipid peroxidation. The scavenging ability and protection of hemoglobin from oxidation may be partly attributed to the ascorbic acid, which is an important constituent of CW. As CW is a rich source of vitamins, amino acids and enzymes, *etc.*, more than one active principle may be involved.

TRADITIONAL USES

The coconut palm has a multitude of uses, in number and importance probably not exceeded by any other palm. It yields timber; food; fermented and unfermented drink; alcohol; vinegar; thatching materials; splints; strips and fiber for making baskets, mats, rope, hats, brushes, brooms and other articles; fuel; caulking material; utensils for household use, such as cups, bowls, spoons and the like; oil for food, cooking, illumination, for making soap, substitutes for butter and lard, ointments and oil cake for feeding domestic animals and for fertilizers. The palm is very ornamental and is frequently planted for decorative effect. The fresh leaves are extensively used for temporary decorations and large number of prepared young leaves is used for religious purposes on Palm Sunday. The leaflets are used for wrapping a rice confection known as suman. The most important product of the coconut palm is coconut oil. The pressed cake is valuable as a food for stock or as a fertilizer. Its value is largely due to the fact that it contains about 20 percent of protein in addition to the oil, which is not extracted. The parts of the palm used in medicine are the roots, the bark, the "bloom" of the leaf, the cabbage, the flowers and the fruit (husk, shell, water, endosperm, oil). The activities of the root include, the decoction of root is astringent and is used as mouth wash and gargle. These are also roasted, grinded and used as dentifrice. The decoction of root

promotes flow of urine and is used in the diseases of the uterus. It is given also in liver complaints, bronchitis and dysentery. The root is also used as anthelmintic. The root is also used as anti bacterial agent, in treatment for urinary tract infections and also in some skin infection .The infusion of the young roots is used as gargle for sore throat (Sivakumar *et al.*, 2011).

MEDICINAL USES

Coconut water could be used as an important alternative for oral rehydration and intravenous hydration of patients particularly in remote regions (Campbell-Falck *et al.*, 2000). It may also offer protection against myocardial infarction and control of hypertension (Anurag & Rajamohan, 2003). It is also effective in the treatment of kidney and urethral stones, urinary infections and mineral poisonings (Macalalag & Macalalag, 1987). Aside other significant and useful components in it, coconut water contain cytokinins, a class of phytohormones (Kende & Zeevaart, 1997) with significant anti-ageing,

anti-carcinogenic, and anti-thrombotic effects (Rattan & Clark, 1994). Inorganic ions and vitamins in coconut water play a vital role in strengthening the human body antioxidant system (Evans & Halliwell, 2001).

Furthermore, coconut water has been shown to attenuate ulcer formation in rats (Nneli & Woyike, 2008), thereby hypothesizing modulation of chronic pain known to be associated with inflammatory disorders of the gastrointestinal mucosa. Not only protein malnutrition but micronutrients deficiencies cause overt hypersensitivity to acute and chronic pain in laboratory animals (Ibironke *et al.*, 2009). The husk fiber of *C. nucifera* has antibacterial and antiviral (Esquenazi *et al.*, 2002), antitumoral (Kirszberg *et al.*, 2003) and antileishmanial properties (Mendonca-Filho *et al.*, 2004). This extract also exhibited in vivo and in vitro analgesic and free radical-scavenging properties (Alviano *et al.*, 2004). Preliminary study has suggested that the efficacy of the antitumoral activity of *Cocos nucifera*, typical A variety, could be extended to leukemia cells having a multidrug-resistant phenotype.

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