INTERNATIONAL JOURNAL OF PHARMACEUTICAL SCIENCES
[ISSN: 0975-4725; CODEN(USA): IJPS00]
Journal Homepage: https://www.ijpsjournal.com

OPEN ACCESS

Review Paper

Ethnopharmacology, Phytochemistry, Pharmacological Activities AND Therapeutic Potential OF *Cocos Nucifera L.* Inflorescence: A Review

Balan P*, Muvendhiran S, Dhanasridevi S, Hari Priya R, Viswa R, Divya R

Department of Pharmaceutical Chemistry, The Erode college of Pharmacy, Erode, Tamil Nadu, India.

ARTICLE INFO

Published: 05 Sept 2026
Keywords:
Cocos nucifera L.; coconut inflorescence; ethnopharmacology; phytochemistry; proanthocyanidins; pharmacological activities.
DOI:
10.5281/zenodo.22332518

ABSTRACT

Cocos nucifera L. (Arecaceae) is a multipurpose tropical palm with considerable nutritional, cultural and medicinal importance. Although coconut water, kernel, oil and husk have been widely investigated, the inflorescence remains comparatively underexplored as a distinct medicinal material. This review critically compiles the available evidence on the botanical characteristics, traditional uses, pharmacognostic features, phytochemical composition, pharmacological activities and safety of C. nucifera inflorescence. Traditional preparations of the inflorescence and flowers have been associated with backache, women's health, postnatal care and menorrhagia. Phytochemical investigations indicate the presence of phenolics, flavonoids, tannins and other secondary metabolites, while epicatechin- and epiafzelechin-based proanthocyanidins represent the most extensively characterized constituents. Preclinical studies have demonstrated antioxidant, antihyperglycemic, pancreatic-protective, anti-inflammatory, antinociceptive, hepatoprotective, reproductive, endocrine and cytotoxic effects. Available toxicological findings suggest that the tested preparations are generally well tolerated; however, safety conclusions cannot be generalized across differently prepared extracts and fractions. Interpretation of the evidence is limited by variation in coconut variety, developmental stage, plant material, extraction procedure and chemical standardization. Pharmacokinetic, bioavailability and controlled clinical data are also lacking. Future research should prioritize authenticated raw materials, standardized preparations, quantitative chemical markers, mechanistic validation, longer-term safety assessment and clinically relevant studies to determine the therapeutic potential of coconut inflorescence.

INTRODUCTION

Cocos nucifera L. belongs to the family Arecaceae and is one of the most economically, nutritionally

***Corresponding Author:** Balan P
Address: *Department of Pharmaceutical Chemistry, The Erode college of Pharmacy, Erode, Tamil Nadu, India.*
Email ✉: balan.p@ecp.ac.in

Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

and culturally important palms of the tropical world. The coconut palm has been integrated into the daily life of tropical communities for centuries, supplying food, beverages, oil, fibre, construction materials and traditional remedies. Its extensive utility has resulted in descriptions such as the "Tree of Life", "Tree of Abundance" and *Kalpavriksha*. Historical and literary records indicate a long association of coconut with food, agriculture, religious practices and traditional medicine, particularly in South and Southeast Asia. [1], [2], [3]

Phytochemical and pharmacological investigations of *C. nucifera* have predominantly focused on coconut water, kernel, oil, husk fibre and other fruit-derived materials. A previous whole-plant review documented antioxidant, antimicrobial, anti-inflammatory, antinociceptive, hypoglycemic, hepatoprotective and several other activities and emphasized that the chemical composition and pharmacological properties of *C. nucifera* differ substantially among plant parts. [2] Consequently, evidence obtained from coconut water, kernel or husk cannot be directly extrapolated to its reproductive tissues. [4], [5]

The inflorescence is a particularly interesting but less systematically reviewed component of the coconut palm. It is a complex reproductive structure containing the rachis, rachillae and developing staminate and pistillate flowers. Its prolonged development and substantial structural changes during maturation make botanical definition important when interpreting medicinal studies.[3] In the available literature, terms such as "young inflorescence", "immature inflorescence", "flowering inflorescence", "coconut flower" and "staminate flower" have been applied to different experimental materials.[6], [7], [8], [9], [10]

The inflorescence also has ethnomedicinal importance. Traditional practices in southern India and Sri Lanka describe the use of coconut inflorescence or flowers in preparations associated with backache, reproductive health and postnatal care, while the immature inflorescence of *C. nucifera* var. *aurantiaca* has a documented place in Sri Lankan traditional medicine for menorrhagia.[4,8–12,26] Scientific studies subsequently investigated the phytochemistry and biological properties of these materials, creating an emerging body of evidence distinct from the much larger literature on coconut fruit products. [10], [11], [12], [13], [14], [15]

Despite these investigations, no focused critical synthesis comparable with the existing whole-plant reviews has adequately integrated the botany, traditional uses, phytochemistry, pharmacological evidence and safety of coconut inflorescence as a distinct medicinal material. The present review therefore compiles and critically assesses the available evidence concerning *C. nucifera* inflorescence, with particular attention to the relationship between traditional use and modern pharmacological investigation, and to the factors influencing its future development as a standardized medicinal or health-related product. [4], [5]

2. Botanical description and characteristics of the inflorescence

2.1. Botanical Identity

C. nucifera is the only generally recognized species of the genus *Cocos* and is a diploid palm with 2n = 32 chromosomes. It is widely distributed throughout tropical and subtropical regions and is particularly important in coastal regions of Asia, Oceania, Africa and the Americas. Considerable genetic diversity occurs among coconut populations, including tall, dwarf and intermediate forms. [2], [6], [16]

Botanical variety is relevant to medicinal interpretation. For example, investigations from Sri Lanka concerning menorrhagia predominantly used orange-colored *C. nucifera* var. *aurantiaca*,

whereas several Indian studies of glucose homeostasis employed West Coast Tall material. The available pharmacological literature should therefore be interpreted in relation to the specific coconut material investigated rather than treating every cultivar as chemically identical. [13], [17], [18]

2.2. Inflorescence Development and Floral Organization

The coconut inflorescence develops in the axil of the leaf and remains enclosed within a protective spathe during its immature stages. Reproductive development is prolonged and involves sequential differentiation of the inflorescence axis, floral buds and sexual structures. The complete reproductive developmental sequence extends for more than two years, with floral morphogenesis occupying approximately one year and sex determination occurring over a comparatively short period.

A mature inflorescence contains numerous rachillae borne on the main rachis. Pistillate flowers are primarily positioned in floral triads near the basal region of the rachilla, where one female flower is accompanied by two functional staminate flowers. Staminate flowers occur in much larger numbers and are distributed further along the rachilla. [6]

These developmental characteristics have direct relevance to medicinal research. An entire immature inflorescence contains structural tissues and developing flowers in proportions that differ markedly from isolated staminate flowers or a fully opened inflorescence. Accordingly, plant material should be described precisely when comparing phytochemical or pharmacological studies. [6], [7]

3. Local, traditional and ethnopharmacological uses of *C. nucifera* inflorescence

The coconut palm occupies an important place in South Asian cultural and traditional medicine systems. A field-based ethnobotanical investigation conducted in Kollam and Pathanamthitta districts of southern Kerala documented numerous medicinal, social, religious and cultural uses of coconut. The inflorescence itself is used in ceremonial practices, including Hindu wedding ceremonies and the ritual known as *Parayeduppu* [2].

Young coconut inflorescence has also been reported in Indian traditional medicine for backache [8]. In Kerala, flower-containing preparations and tonics have been associated with women's health and postnatal care [9,12]. These traditional dietary and medicinal practices reflect the food–medicine continuum characteristic of many plant products used in Ayurveda and local healthcare traditions [2], [7], [18].

The most specific ethnopharmacological application is reported from Sri Lanka. Ayurvedic and traditional practitioners employ a decoction of the immature inflorescence of *C. nucifera* var. *aurantiaca* for menorrhagia. [17], [19].

Table 1. Summary of reported traditional and cultural uses of *C. nucifera* inflorescence

Reported use	Material/preparation	Region/tradition	Reference
Menorrhagia	Decoction of immature var. *aurantiaca* inflorescence	Sri Lankan Ayurveda/traditional medicine	[19]
Backache	Young inflorescence/inflorescence preparation	Indian traditional medicine, Kerala	[18]

Reported use	Material/preparation	Region/tradition	Reference
Women's/postnatal care	Coconut-flower-containing traditional preparations	Kerala traditional/Ayurvedic practice	[7], [20]
Wedding ceremony	Whole inflorescence	South Kerala	[21]
Parayeduppu ritual	Inflorescence	South Kerala	[21]
Sap/toddy production	Sap collected from unopened inflorescence	South Kerala and other coconut-growing communities	[21], [22]

The table has intentionally been restricted to uses traceable identifiable sources rather than compiling every therapeutic claim repeated in secondary coconut literature.

4. Pharmacognostic characterization and phytochemistry

4.1. Pharmacognostic Characterization

Pharmacognostic standardization of coconut flowers has received considerably less attention than their biological activity. A detailed pharmacognostic investigation performed macroscopic, microscopic, powder, histochemical, fluorescence, physicochemical and HPTLC examination of staminate flowers according to pharmacopoeial approaches. The male flowers were described as pale yellow, sessile, actinomorphic and trimerous with six tepals and six fertile stamens.

Powder microscopy demonstrated fibres, oil globules, calcium oxalate crystals and simple and compound starch grains. Physicochemical examination provided values for moisture, ash and extractive parameters, while an HPTLC system consisting of toluene: chloroform: ethanol (4:4:1, v/v/v) generated six prominent bands at Rf 0.12, 0.37, 0.48, 0.52, 0.67 and 0.91. These observations provide useful authentication criteria for staminate flowers, although they should not be directly applied to whole immature inflorescences without separate validation [23].

4.2. Preliminary Phytochemical Composition

Qualitative phytochemical studies indicate the presence of several primary and secondary metabolites in coconut inflorescence. Methanolic and ethanolic extracts of immature inflorescence have been reported to contain phenolic compounds, flavonoids, tannins, alkaloids, resins and carbohydrates. Macronutrient examination further indicated carbohydrates, proteins and fibre, while HPLC analysis demonstrated the presence of several amino acids.

Phenolic constituents have received particular attention because they occur across several inflorescence preparations. An acetone extract of flowering inflorescence contained measurable total phenolic and flavonoid contents. However, quantitative values reported by different investigators cannot be directly compared because the studies differ in botanical stage, extraction solvent, analytical method and the units used to express total phenolic or flavonoid content [8], [11].

4.3. Proanthocyanidins

The most extensively characterized phytochemical fraction of *C. nucifera* inflorescence is the ethyl-acetate-soluble proanthocyanidin fraction obtained from immature var. *aurantiaca*. The

inflorescence was extracted with acetone/water, and the proanthocyanidin-rich fraction was separated using Sephadex LH-20 chromatography. Acid-catalyzed cleavage, thiolysis and NMR studies showed that the fraction consisted of flavan-3-ol units derived from epicatechin and epiafzelechin, with epicatechin representing the predominant monomeric unit. ESI-MS demonstrated oligomers with degrees of polymerization of approximately 2–5, together with mixed epicatechin–epiafzelechin structures. This combined chromatographic, spectroscopic and spectrometric characterization gives the proanthocyanidins considerably greater structural confidence than constituents identified solely by untargeted library-based profiling [17].

4.4. GC-MS And LC-MS Profiling

GC-MS analysis has substantially expanded the number of compounds reported from coconut flowers. A flower extract evaluated in an experimental polycystic ovarian disease study contained a series of volatile and semi-volatile constituents, including phenolic and fatty-acid-related compounds [10]. A later investigation reported 152 GC-MS assignments from an ethanolic flower extract, including phytosterol-related constituents and compounds annotated as quercetin derivatives, eugenol, catechol, stigmasterol and campesterol [24].

LC-MS has provided complementary information concerning more polar constituents. Numerous LC-HRMS features were reported in an acetone inflorescence extract, including tentative assignments such as chlorogenic acid, apiin, emodin-8-glucoside and dihydromyricetin[8]. More recently, 39 assignments were reported in an aqueous flower extract, including nicotiflorin, myristoyl glycerol, glucofrangulin B and other compounds [25].

These broad chromatographic profiles demonstrate substantial chemical diversity; however, library-assisted GC-MS and LC-MS annotations should be interpreted as putative unless identity has been confirmed using authentic standards or complementary structural methods [8], [10], [24], [25].Developmental stage may also influence the chemical or functional characteristics of the material. Comparison of West Coast Tall inflorescences harvested at four stages demonstrated markedly different DPPH radical-scavenging activity, with material harvested 5–6 months before opening showing the highest activity in that study [12][20]. Although obtained from thesis work rather than a peer-reviewed pharmacological investigation, the finding supports consideration of developmental stage in future raw-material standardization [12][20].

5. Biological and pharmacological activities

5.1. Antioxidant Activity

Antioxidant activity is one of the most frequently investigated properties of coconut inflorescence. Methanolic and ethanolic immature-inflorescence extracts have been evaluated using DPPH and superoxide radical-scavenging assays. The methanolic extract produced DPPH and superoxide IC50 values of approximately 40.5 and 120.0 µg/mL, respectively, and was slightly more active than the corresponding ethanolic extract [11]. The purified EASPA fraction showed stronger activity in comparable chemical assays. DPPH and superoxide IC50 values of 11.02 ± 0.60 and 26.11 ± 0.72 µg/mL, respectively, were reported, although the fraction was less active than the reference antioxidants used in the study[12].

Antioxidant effects were also observed within animal disease models rather than only in cell-free assays. Inflorescence supplementation in diabetic animals improved endogenous antioxidant enzyme activities and reduced indices of lipid peroxidation. Such findings provide stronger

biological relevance than radical-scavenging assays alone[13].

5.2. Antihyperglycemic And Pancreatic-Protective Activity

Antidiabetic activity represents one of the most extensively investigated pharmacological properties of inflorescence. West Coast Tall young inflorescence administered as 20% of the diet in alloxan-treated rats reduced hyperglycemia, restored hepatic glycogen and modified the activities of enzymes involved in glycolysis and gluconeogenesis. Pancreatic histology indicated amelioration of alloxan-induced islet injury [18].

A related 45-day investigation reported improved blood glucose, glucose tolerance, glycosylated haemoglobin and serum lipid parameters in alloxan-diabetic animals receiving the inflorescence-containing diet. Antioxidant-enzyme activities and pancreatic morphology also shifted toward control values [13].

A methanolic immature-inflorescence extract was subsequently examined in streptozotocin-induced diabetes. Oral administration at 100, 200 and 400 mg/kg reduced hyperglycemia and improved insulin status, with 200 mg/kg producing the most favorable antihyperglycemic response under the conditions of the experiment [11].

An ethanolic inflorescence extract has also been administered alone or together with metformin. Extract doses of 250 and 500 mg/kg reduced plasma glucose and improved pancreatic histology. Combination with metformin produced a greater overall antidiabetic response than extract alone in the experimental model [14].

Taken collectively, these studies provide consistent preclinical support for an effect on glucose homeostasis and pancreatic injury. The evidence is notable because it extends beyond simple enzyme inhibition and includes biochemical, metabolic and histopathological outcomes in both alloxan- and streptozotocin-based models [11], [13], [13], [19].

5.3. Anti-Inflammatory And Antinociceptive Activity

Anti-inflammatory activity has been evaluated using both purified proanthocyanidins and crude inflorescence extract. The EASPA fraction produced an IC50 of 10.31 ± 1.11 µg/mL in an oxidative burst chemiluminescence assay, compared with 11.20 ± 1.90 µg/mL for ibuprofen under the same experimental conditions [12].

A substantially more detailed mechanistic investigation was performed using a phenolic-rich acetone extract. In LPS-stimulated RAW264.7 macrophages, the extract inhibited COX and 5-LOX activity and reduced iNOS, NO, PGE2 and the pro-inflammatory cytokines IL-1β, IL-6 and TNF-α. Down-regulation of inflammatory gene expression and inhibition of IκB-α and NF-κB p65 phosphorylation suggested involvement of the NF-κB signaling pathway.

The same extract produced anti-inflammatory activity in carrageenan- and formalin-induced paw oedema models and showed antinociceptive effects in acetic-acid writhing and hot-plate tests. These complementary cellular and animal experiments currently provide one of the most developed mechanistic pharmacology datasets for coconut inflorescence[15].

An ethanolic flower extract also inhibited egg-albumin denaturation. This assay provides additional screening evidence, although its pharmacological specificity is lower than that of the cellular and animal studies[24].

5.4. Hepatoprotective Activity

An acetone extract of flowering inflorescence has been evaluated in acetaminophen-induced hepatotoxicity. Pretreatment with 100, 200 or 400 mg/kg prevented elevations in serum ALT, AST

and ALP and attenuated changes in hepatic antioxidant defense systems. Elevated malondialdehyde was also suppressed, and biochemical observations were supported by histopathological examination.

The findings indicate protection against chemically induced hepatic injury and are consistent with the phenolic-rich composition and redox activity of the extract. The study is therefore supportive of a hepatoprotective effect rather than merely an in-vitro antioxidant response[8].

5.5. Reproductive And Endocrine Effects

The reproductive pharmacology of coconut inflorescence is particularly relevant to its traditional use. Purified EASPA from immature var. *aurantiaca* inflorescence was administered to female rats for 28 days. Treatment did not significantly change reproductive-cycle length, vaginal cytology or oestrogen concentration, but progesterone levels increased significantly compared with controls.

The importance of this investigation lies in the direct connection between a traditional indication, a chemically characterized fraction and a measurable endocrine response. It provides a plausible pharmacological basis for the traditional Sri Lankan use in menorrhagia without itself establishing clinical efficacy [19].

A coconut-flower extract has also been investigated in a letrozole-induced polycystic ovarian disease model. Treatment improved estrous cyclicity, glucose and lipid abnormalities, uterine antioxidant status and ovarian histology. The study also reported reversal of changes in reproductive-organ weights. These data indicate activity in a complex reproductive–metabolic model and broaden the potential relevance of coconut flowers to female reproductive health[10].

5.6. Cytotoxic And Other Preliminary Activities

The EASPA fraction has been evaluated against HeLa and PC3 tumor cell lines. The fraction showed an IC50 of 18.78 ± 0.90 µg/mL against HeLa cells and a weaker response against PC3 cells, with an IC50 of approximately 44.2 µg/mL. Ethanolic flower extract also produced concentration-dependent inhibition of A549 lung-cancer-cell viability, with a reported IC50 of 90.2µg/mL. These results are appropriately considered cytotoxic or antiproliferative evidence rather than demonstrated anticancer efficacy[12], [24].

A recent methanolic-flower investigation reported DPPH scavenging, α-amylase inhibition, brine-shrimp lethality and anthelmintic activity. The anthelmintic response was substantially weaker than the reference drug, while the α-amylase assay suggested enzyme-inhibitory potential. These findings expand the range of preliminary activities associated with coconut flowers but remain at an exploratory level[26].

6. Toxicology and safety

Safety studies have been conducted using both crude inflorescence extracts and the purified EASPA fraction. An acute oral toxicity study of acetone inflorescence extract reported no mortality or overt toxicity at doses up to 5000 mg/kg in mice, resulting in a reported LD50 above 5000 mg/kg [8].

An ethanolic young-inflorescence extract was similarly administered at 2000 mg/kg in an OECD 423 acute-toxicity study, with no overt signs of toxicity or significant changes in body weight, food intake or water consumption during the observation period[14].

The most comprehensive toxicological evaluation concerned EASPA from immature var. *aurantiaca* inflorescence. Acute and 28-day repeated-dose studies were conducted according to OECD guidelines 423 and 407. A single 2000 mg/kg dose produced no mortality or clinical signs of toxicity, and the LD50 was estimated to exceed 2000

mg/kg. In the repeated-dose experiment, 1.75, 3.5, 7 and 14 mg/kg/day were administered for 28 days. Overall body weight, major biochemical indices, gross organ examination and most hematological parameters remained comparable with controls.

A noteworthy observation occurred at the highest repeated dose. Mild swelling of renal tubular epithelial cells was observed in a few tissue sections from animals receiving 14 mg/kg, which was considered indicative of early, potentially reversible tubular injury. Thus, EASPA appears to have been generally well tolerated over the tested period, while the renal observation warrants consideration when interpreting the safety margin[17].

This safety findings apply to the specific preparations tested. They should not be generalized indiscriminately to all aqueous, alcoholic or whole-flower preparations because extraction and fractionation alter chemical exposure[8], [14], [17].

7. Discussion and critical appraisal of research gaps

The available evidence indicates that coconut inflorescence is pharmacologically more interesting than its relatively limited literature might initially suggest. Multiple animal studies support effects on glucose homeostasis and pancreatic injury, while the anti-inflammatory investigation provides mechanistic evidence involving inflammatory mediators and NF-κB-associated signaling. The var. *aurantiaca* research programme is especially coherent because it progresses from a defined traditional use to phytochemical characterization, endocrine pharmacology and toxicological evaluation. Nevertheless, the evidence base remains considerably less mature than would be required for therapeutic translation[12], [13], [15], [17], [18], [19], [27].

A major limitation is the heterogeneity of the botanical materials investigated. Whole young West Coast Tall inflorescence, immature var. *aurantiaca* inflorescence, flowering inflorescence, individual female or staminate flowers and purified proanthocyanidin fractions have all been described under the broad terminology of coconut "flower" or "inflorescence" [6], [8], [10], [13], [18], [19], [23]. This becomes particularly important because developmental stage may influence biological properties; marked variation in radical-scavenging activity has been observed among WCT inflorescences harvested at different stages. Environmental and genetic variables may additionally contribute to this variation [16], [20].

Chemical standardization is similarly incomplete. The epicatechin/epiafzelechin proanthocyanidins are supported by relatively strong structural evidence, whereas several recent GC-MS and LC-MS investigations predominantly rely on database-assisted compound annotation. A large number of chromatographic assignments should therefore not be interpreted as an equivalent number of definitively identified active compounds. Direct links between specific constituents and the observed antidiabetic, hepatoprotective or anti-inflammatory effects remain limited [8], [10], [12], [24], [25].

The pharmacological evidence also differs greatly in maturity. Diabetes has been investigated repeatedly in whole-animal models, and inflammation has received molecular as well as in-vivo evaluation. By contrast, the cancer-related evidence is mainly based on cell viability, while α-amylase and anthelmintic findings remain preliminary[11], [12], [13], [15], [18], [24], [26]. Some recent work also contains internal reporting problems. In one recent flower study, the concentration associated with 65.75% α-amylase inhibition differs between the abstract and main results, and the reported IC50 units are difficult to reconcile with the experimental concentration range[15]. The

publication metadata itself also contains inconsistent received, accepted and publication dates. Such discrepancies reduce the value of quantitative cross-study comparison.

Another important issue is the concentration of evidence within a small number of research groups. Several diabetes studies originated from related investigations[11], [13], [18], while the proanthocyanidin characterization, reproductive pharmacology and toxicity studies form a connected Sri Lankan research programme[12], [17], [19]. Independent replication using standardized material would therefore substantially strengthen confidence in these observations.

Finally, pharmacokinetics, bioavailability, metabolism and clinically relevant herb–drug interactions remain poorly characterized. No controlled human efficacy investigation of an inflorescence-specific preparation was identified in the literature assembled for this review. Long-duration safety data are also limited[17]. Thus, the principal research gap is not a lack of preliminary biological activity but the absence of a continuous development pathway connecting botanical authentication, chemical standardization, mechanism, pharmacokinetics, comprehensive safety and clinical evaluation.

8. FUTURE PERSPECTIVES

Future investigations should initially focus on defining the medicinal raw material rather than screening additional poorly characterized extracts. Coconut variety, developmental stage, anatomical material, harvesting conditions and extraction procedure should be specified, followed by chromatographic fingerprinting and quantitative marker analysis. The epicatechin/epiafzelechin-containing proanthocyanidins provide an appropriate starting point for marker-based studies, while modern metabolomic approaches may help determine how developmental stage and cultivar influence phytochemical composition[6], [16], [23], [28].

Among the therapeutic areas investigated, two pathways deserve particular attention. The immature var. *aurantiaca* inflorescence represents a strong ethnopharmacology-driven candidate because traditional use for menorrhagia has been followed by chemical, hormonal and toxicological investigations. Diabetes and inflammation, in contrast, possess comparatively substantial preclinical efficacy and mechanistic evidence and may provide suitable indications for standardized-extract development [11], [12], [13], [14], [15], [17], [18], [19].

Once reproducible preparations are obtained, future work should emphasize pharmacokinetics, bioavailability, longer-term safety, independent replication and clinically relevant efficacy rather than repeated preliminary antioxidant or enzyme-screening studies. Such an approach could determine whether coconut inflorescence is best developed as a standardized nutraceutical, botanical preparation or source of defined pharmacologically active constituents [5], [14], [16], [17], [20].

CONCLUSION

The present review summarizes the botanical characteristics, traditional uses, phytochemical constituents, pharmacological properties and toxicological evidence available for *Cocos nucifera* inflorescence. The inflorescence contains several classes of phytochemicals, of which proanthocyanidins are presently the most thoroughly characterized. Experimental studies indicate relevant antidiabetic, anti-inflammatory, hepatoprotective and reproductive effects, while antioxidant, cytotoxic and other activities provide additional evidence of biological potential.

The relationship between traditional use and experimental investigation is particularly noteworthy for the immature inflorescence used in women's health. However, the existing literature

involves different varieties, developmental stages and preparations, and these differences presently limit direct comparison and therapeutic standardization. Most evidence remains preclinical and clinical efficacy has not yet been established. Further work using authenticated and chemically standardized preparations, together with appropriate safety and clinical evaluation, is required before the therapeutic potential of *C. nucifera* inflorescence can be fully defined.

REFERENCES

1. Ahuja SC, Ahuja S, Ahuja U. Coconut—history, uses, and folklore. Asian Agri-History. 2014;18(3):221–248.
2. M. Akshaya, R. Renuka, K. K. Kumar, M. Mohanalakshmi, N. Thavaprakaash, and K. Hemaprabha, "Ethnobotany of coconut: A review on its traditional, cultural and economic significance," Plant Sci. Today, Nov. 2025, doi: 10.14719/pst.11221.
3. Su Yin Chan, Coconut Handbook. Tetra Pak South East Asia Pte Limited, 2016.
4. E. B. C. Lima et al., "Cocos nucifera (L.) (Arecaceae): A phytochemical and pharmacological review," Braz. J. Med. Biol. Res., vol. 48, no. 11, pp. 953–964, Nov. 2015, doi: 10.1590/1414-431x20154773.
5. B. Vatakkeel, R. Mythreyi, and E. N. Siju, "Cocos nucifera Linn.: A Promising Candidate for Drug Development," J. Nat. Remedies, pp. 27–35, Jan. 2024, doi: 10.18311/jnr/2024/34866.
6. P. I. P. Perera, V. Hocher, L. K. Weerakoon, D. M. D. Yakandawala, S. C. Fernando, and J.-L. Verdeil, "Early inflorescence and floral development in Cocos nucifera L. (Arecaceae: Arecoideae)," South Afr. J. Bot., vol. 76, no. 3, pp. 482–492, Aug. 2010, doi: 10.1016/j.sajb.2010.03.006.
7. Dr. S. Prasad et al., "Pharmacognostic and Phytochemical Evaluation of Staminate Flower of Cocos nucifera L," J. Nat. Remedies, pp. 1117–1124, May 2024, doi: 10.18311/jnr/2024/33215.
8. "Cocos nucifera L. inflorescence extract: An effective hepatoprotective agent," Indian J. Tradit. Knowl., vol. 19, no. 1, Dec. 2019, doi: 10.56042/ijtk.v19i1.30852.
9. R. R S, C. A M, and T. Rajamohan, "Cytoprotective, antihyperglycemic and phytochemical properties of Cocos nucifera (L.) inflorescence," Asian Pac. J. Trop. Med., vol. 6, pp. 804–810, Oct. 2013, doi: 10.1016/S1995-7645(13)60142-X.
10. V. Soumya, Y. I. Muzib, P. Venkatesh, and K. Hariprasath, "GC-MS analysis of Cocus nucifera flower extract and its effects on heterogeneous symptoms of polycystic ovarian disease in female Wistar rats," Chin. J. Nat. Med., vol. 12, no. 9, pp. 677–684, Sep. 2014, doi: 10.1016/S1875-5364(14)60103-5.
11. R. Renjith, A. Chikku, and T. Rajamohan, "Cytoprotective, antihyperglycemic and phytochemical properties of Cocos nucifera (L.) inflorescence," Asian Pac. J. Trop. Med., vol. 6, no. 10, pp. 804–810, Oct. 2013, doi: 10.1016/S1995-7645(13)60142-X.
12. C. Padumadasa, D. Dharmadana, A. Abeysekera, and M. Thammitiyagodage, "In vitro antioxidant, anti-inflammatory and anticancer activities of ethyl acetate soluble proanthocyanidins of the inflorescence of Cocos nucifera L.," BMC Complement. Altern. Med., vol. 16, no. 1, p. 345, Sep. 2016, doi: 10.1186/s12906-016-1335-2.
13. R. S. Renjith and T. Rajamohan, "Young inflorescence of Cocos nucifera contributes to improvement of glucose homeostasis and antioxidant status in diabetic rats," Int. J. Diabetes Dev. Ctries., vol. 32, no. 4, pp. 193–198, Dec. 2012, doi: 10.1007/s13410-012-0088-9.

14. G. Kaur, H. Sankrityayan, D. Dixit, and P. Jadhav, "Cocos nucifera and metformin combination for modulation of diabetic symptoms in streptozotocin induced diabetic rats," J. Ayurveda Integr. Med., vol. 11, no. 1, pp. 3–9, Jan. 2020, doi: 10.1016/j.jaim.2017.02.006.
15. M. A. Chithra, T. P. Ijinu, H. Kharkwal, R. K. Sharma, P. Pushpangadan, and V. George, "Phenolic rich Cocos nucifera inflorescence extract ameliorates inflammatory responses in LPS-stimulated RAW264.7 macrophages and toxin-induced murine models," Inflammopharmacology, vol. 28, no. 4, pp. 1073–1089, Aug. 2020, doi: 10.1007/s10787-019-00620-6.
16. I.-F. Ignacio and T.-S. Miguel, "Research opportunities on the coconut (Cocos nucifera L.) using new technologies," South Afr. J. Bot., vol. 141, pp. 414–420, Sep. 2021, doi: 10.1016/j.sajb.2021.05.030.
17. C. P. Ekanayake, M. G. Thammitiyagodage, S. Padumadasa, B. Seneviratne, C. Padumadasa, and A. M. Abeysekera, "Acute and Subacute Toxicity Studies of the Ethyl Acetate Soluble Proanthocyanidins of the Immature Inflorescence of Cocos nucifera L. in Female Wistar Rats," BioMed Res. Int., vol. 2019, pp. 1–12, Dec. 2019, doi: 10.1155/2019/8428304.
18. R. Renjith and T. Rajamohan, "Protective and curative effects of Cocos nucifera inflorescence on alloxan-induced pancreatic cytotoxicity in rats," Indian J. Pharmacol., vol. 44, no. 5, p. 555, 2012, doi: 10.4103/0253-7613.100368.
19. C. Padumadasa, D. Dharmadana, A. M. Abeysekera, and M. G. Thammitiyagoda, "Effect of ethyl acetate soluble proanthocyanidins from cocos nucifera l. Inflorescence on progesterone and oestrogen levels in female rats".
20. K. Chandran, "INFLORESCENCE BASED DIETARY SUPPLEMENT".
21. N.P. Rajith et al., "Ethnobotanical studies on coconut palm (Cocos nucifera L.) with special reference to South Kerala," Ethnobotany, vol. 21, pp. 32–40, 2009.
22. M. R. F. B, M. N., S. M. T., and K. T., "Coconut (Cocos nucifera) Inflorescence Sap Nutritional Characteristics and Health Effects," J. Basic Appl. Res. Biomed., vol. 6, no. 1, pp. 50–52, Jan. 2022, doi: 10.51152/jbarbiomed.v6i1.9.
23. S. B. Prasad et al., "Pharmacognostic and Phytochemical Evaluation of Staminate Flower of Cocos nucifera L," J. Nat. Remedies, pp. 1117–1124, May 2024, doi: 10.18311/jnr/2024/33215.
24. V. M. Berlin Grace and M. M, "In Vitro Evaluation of Anti-Inflammatory and Anti-Cancer Activities of the Cocos nucifera Flower Extract and the Phytochemical Identification by Gas Chromatography/Mass Spectrometry Analysis," Indian J. Pharm. Sci., vol. 84, no. 2, 2022, doi: 10.36468/pharmaceutical-sciences.928.
25. B. Vatakkeel and R. Mythreyi, "LC-MS ANALYSIS OF PHYTOCONSTITUENTS IN AQUEOUS EXTRACT OF Cocos nucifera Linn. FLOWERS FROM SOUTHERN INDIA," RASAYAN J. Chem., vol. 18, no. 01, pp. 93–97, 2025, doi: 10.31788/RJC.2025.1819120.
26. - Al-Amin et al., "Pharmacological Potential of Cocos nucifera L. Flowers: Phytochemical, Cytotoxic, Antioxidant, Anthelmintic and Anti-Diabetic Insights," Asian J. Biol. Sci., vol. 19, no. 1, pp. 40–50, Mar. 2026, doi: 10.3923/ajbs.2026.40.50.
27. C. Padumadasa, D. Dharmadana, A. Abeysekera, and M. Thammitiyagodage, "In vitro antioxidant, anti-inflammatory and anticancer activities of ethyl acetate soluble

proanthocyanidins of the inflorescence of Cocos nucifera L.," BMC Complement. Altern. Med., vol. 16, no. 1, p. 345, Dec. 2016, doi: 10.1186/s12906-016-1335-2.

28. L. Lu, Y. Zhang, Z. Dong, W. Yang, and R. Yu, "Integrated Metabolomic and Transcriptomic Profiles Provide Insights into the Molecular Mechanisms in Modulating Female Flower of Coconut (Cocos nucifera L.)," Agriculture, vol. 15, no. 22, p. 2336, Nov. 2025, doi: 10.3390/agriculture15222336.

HOW TO CITE: Balan P, Muvendhiran S, Dhanasridevi S, Hari Priya R, Viswa R, Divya R, Ethnopharmacology, Phytochemistry, Pharmacological Activities AND Therapeutic Potential OF *Cocos Nucifera L.*. Inflorescence: A Review, Int. J. of Pharm. Sci., 2026, Vol 4, Issue 9, 637-648, https://doi.org/10.5281/zenodo.22332518