Review Article

Couroupita guianensis Aubl: An updated review of its phytochemistry and pharmacology

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Abstract

Medicinal plants have been used in virtually all cultures as a source of medicine. Assurance of the safety, quality, and efficacy of medicinal plants and herbal products has now become a key issue in industrialized and in developing countries. Whole plant of *Couroupita guianensis* keeps several biological activities such as the antimicrobial, antiulcer, anti-inflammatory, antinociceptive, anthelmintic, antiulcer, antioxidant, antipyretic, antiarthritic, immunomodulatory, antibacterial, antistress, antidiarrheal, insectidial, anxiolytic, hypolipidimic, ovicidal, antidepressant, antifertility, antibiofilm, neuropharamacological, woundhealing, vermicopositng, allopathic and hepatoprotective and antifertility activities. Furthermore, it has been extensively used in traditional medicines to treat varied ailments such gastritis, scabies, bleeding piles, dysentery, scorpion poison and many. Therefore, based on the above-mentioned deliberation, this article reviews the most updated information of the phytochemical properties and pharmacological effects of *Couroupita guianensis*, including its miscellaneous uses.

Keywords: *Couroupita guianensis*, hepatoprotective, antimicrobial activities, immunomodulatory activity

Introduction

The term of medicinal plants include a various types of plants used in herbalism and some of these plants have a medicinal activities. Medicinal plants are the "backbone" of traditional medicine, which means more than 3.3 billion people in the less developed countries utilize medicinal plants on a regular basis (Davidson-Hunt, 2000). These medicinal plants consider as a rich resources of ingredients which can be used in drug development and synthesis. Besides that these plants play a critical role in the development of human cultures around the whole world. The Indian sub-continent has a very rich diversity of plant species in a wide range of ecosystems. There are about 17.000 species of higher plants, of which approximately 8.000 species are considered medicinal and used by village communities, particularly tribal communities, or in traditional medicinal systems, such as the Ayurveda (UNESCO, 1996).

Couroupita guianensis Aubl. (cannon-ball tree), originating in tropical north-eastern South America, especially the Amazon rainforest, belongs to the Lecythidaceae family and is widely planted as a botanical curiosity in tropical and subtropical regions of the world (Lim, 2012; Al-Dhabi et al., 2012). It is a fast growing deciduous tree, and almost all of the parts of this species, namely leaves, fruit, flowers, stems, roots, and seeds, have been reported to contain chemical constituents, such as triterpenes, phenolics, couroupitine, indirubin, isatin, and oils (Begum et al., 2009; Gousia et al., 2013).

Plant description

Couroupita guianensis is a large evergreen tree growing to a height of 20 meters. Leaves are alternate, oblong-obovate, up to 20 centimeters long, entire to slightly serrate and hairy on the veins beneath. Inflorescence is racemose, arising from the trunk and other large branches. Flowers are reddish with a yellow tinge on the outside, fragrant, with stamens borne on an overarching androphore. Fruit is a large, reddish-brown globose, 15 to 24 centimeters, with a woody

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capsule, and each containing 200 to 300 seeds. Pollination is done by bees and bats. The tree bears, also directly on the trunk and main branches, large globose woody fruits; they look like big rusty cannonballs hanging in clusters, like balls on a string. The fruit contains small seeds in a white, unpleasant smelling edible jelly, which are exposed when the upper half of the fruit goes off like a cover. The long dangling fruity branches give the tree an unkempt appearance (Philippine Medicinal Plants).

Table 1. Botanical classification of *Couroupita guianensis*

Kingdom	**Plantae-Plants**
Subkingdom	Tracheobionta-Vascular plants
Superdivision	Spermatophyta-Seed plants
Division	Magnoliophyta-Flowering plants
Class	Magnoliopsida-Dicotyledons
Subclass	Dilleniidae
Order	Lecythidales
Family	Lecythidaceae- Brazil-nut family:
Genus	*Couroupita* Aubl
Species	*Couroupita guianensis* Aubl.

(National Tropical Botanical Garden)

Chemical Constituents

It is very rich with medicinal values; almost all part of the tree contains API. Flowers yield an alipathic hydrocarbon, stigmasterol, alkaloids, phenolics and flavonoids. It contains active principles isatin and indirubin which are vital to its antimicrobial activity. Extraction of the dried fruits from the cannon ball tree, *Couroupita guianensis* Aubl yielded 6,12-dihydro-6, 12-dioxoindolo[2,1-b]quinazoline (tryptanthrin),1aas well as indigo (CR et al., 2013) indirubin (8a) and isatin. Compound1acould readily be synthesized by condensation of isatin with isatoic anhydride (Geetha et al., 2004) in pyridine (Bergman, 2014). Some studies had provedthe presence of α-amirin, β-amirin, β-sitosterol, tannins (Bergman,2014) ketosteroids and terpenoids, alkaloids, carbohydrates, proteins (CR et al., 2013). Among the flowers, it completely was getable to recognize eugenol, volatile oil and (E, E)- arnesol Whereas triterpenoid esters of fatty acids as β-amirin palmitate were categorized among the leaves of *Couroupita guianensis* and dyes like indigo and indirubin.(Eknat , 2009) Associate in nursing compound stigmasterol and campesterol were isolated from fruit of *Couroupita guianensis.* (Rastogi , 1995) one also isolated linoleic acid, nerol,tryptanthrin etc., from flowers, seeds, fruits, and leaves of *Couroupita guianensis*.The tree is also rich in providing anthocyanin, flavanoids, volatile constituents like eugenol and farsenol. The stem extracts of this plant is known to contain flavonoids, tannins, steroids, saponins, glycosides, amino acids, phenols, anthraquinones and triterpenoids (Manimegalai and Rakkimuth , 2012).

Figure 1. Photograph of *couroupita guianensis* Aubl.

Traditional Uses

The fruit pulp, bark and flowers area unit used for varied medicative applications. The pulp of the fruit of the cannon ball tree is rubbed on the infected skin of animal disease dog (Sanz et al., 2009). The within of the fruit will make clean wounds and young leaves cure odontalgia (Kumar et al.,2011).Traditionally leaves as used as antiseptic and odontalgia. Juice made up of the leaves is employed to cure skin ailments, and shamans of South America have even used tree components for treating protozoal infection. Historically, the leaves of this plant are utilized in the treatment of skin diseases, stomach ache, and enteral gas formation, antithrombotic and vasodilatory actions (Golatkar et al., 2001; Elumalai et al., 2012). Historically, the leaves of this plant are utilized in the treatment skin diseases(Satyavathi et al., 1976).Leaves and flowers of *Couroupita guianesis* unit used for healthful applications like upset, tumors, pain and inflammatory processes (Sanz et al.,2009), cold, enteric gas formation and abdomen ache (Elumalai et al., 2012). The trees unit accustomed cure colds and abdomen aches. The volatile oils from the flowers show antibacterial and antifungal properties. It's one in every of the ingredients within the several preparations that cure redness, hemorrhage,piles, scabies, dysentery, scorpion poison (Shah et al., 2012).

Pharmacological utility

Antimicrobial activities

In 2011 kavitha et al reported the methanol and aqueous extract of the *C. guianensis* leaf were screened against six human pathogenic bacteria and four fungal pathogens to check antibacterial and antifungal activities by well diffusion method. The maximum activity (31mm) was recorded from 200mg of methanol extract of *C. guianensis* against *Salmonella typhi* followed by 29mm against *E.coli* and minimum (12mm) against *Streptococcus aureus* at 50mg level whereas, the aqueous extract showed the maximum activity (30mm) was recorded from 200mg of

leaf extract against *E.coli* and minimum (12mm) by 50mg of extract against the above bacteria. Methanol extract was better than the aqueous extract against bacteria as well as fungal pathogens.

Anticancer activities

Mariappan Premanathan et al (2012) has studied the flowers of *Couroupita guianensis* consists of compound isatin .The derivatives of this compound is known to have cytotoxicity in contradiction of human carcinoma cell lines. Isatin started the apoptosis process with fragmentation of DNA. Apoptosis induced by isatin was confirmed by flow cytometry to further elucidate the extent and causes of apoptosis. isatin was isolated from the floral parts and it exhibited cytotoxicity against HL60 cells.

Anti ulcer activity

Very first in 2012 Elumalai *et al* documented the anti ulcer activity in ethanolic extract of *Couroupita guianensis* at a dose of 150 and 300mg/kg produced significant inhibition of the gastric lesions induced by pylorus ligation induced ulcer and ethanol induced gastric ulcer. Ethanol induced gastric lesion formation may be due to stasis in gastric blood flow which contributes to the development of the hemorrhage and narcotic aspects of tissue injury.

Anti inflammatory Activity

The anti inflammatory activity in the ethanol extract of *Couroupita guianensis* by the method of animal spent licking the formalin-injected paw in first and second phases. Only the higher doses (30 and 100 mg/kg) were able to inhibit the leukocyte migration into the peritoneal cavity later carrageenan injection. At the same time the 100 mg/kg dose almost abolished the cell migration.The outcomes display that *Couroupita guianensis* fractions have anti-inflammatory effect, partly due to a reduction on cell migration and inhibition on cytokines and inflammatory mediators production (Mariana et al., 2013).

***In vitro* Anti-inflammatory Activity**

Sumathi and Anuradha (2016) have studied the invitro anti-inflammatory activity of *Couroupita guianensis* flower was assessed using human red blood cell membrane stabilization. The percentage of membrane stabilization for CGEF (*Couroupita guianensis* ethanolic flower) extract, CGMF (*Couroupita guianensis* methanolic flower) extract and diclofenac sodium were done at different absorptions. The extreme membrane stabilization was detected in CGMF extract then CGEF extract and standard drug.

Anti-stress activity

In 2013, Vinod et al the methanolic extract of antistress activity was studied by victimization cold restrain stress (RS). Animals treated with methanolic extract of *Couroupita guianensis* 100mg/kg and 250 mg/kg, 500mg/kg doses considerably let down in the least the 3 doses in a very dose dependent manner as related to stress control. Cold restrain stress caused an increase within the weight of adrenal glands at advanced dose.

Antidiarrheal action

Antidiarrheal action of *Couroupita guianensis* leaves on Castroloil influenced diarrhea in unusual person rats In Castroloil persuaded diarrhea each the methanolic and liquid extracts beside common place loperamide showed vital reduction in diarrheic episodes. 100mg/kg of methanolic extract and 100mg/kg of liquid extract of *Couroupita guianensis* dried leaves are used for antidiarrheal activity (Elumalai et al.,2013).

Antidepressant activity

In 2009, Wankhede et al presented the antidepressant activity in methanolic extract of *Couroupita guianensis* root focused by tail suspension check (TST), forced swim check (FST) and antihypertensive antagonism in mice. It indicated that noticeably decrease within the immobility time in TST and FST, almost like that of the imipramine (10 mg/kg).

Antifertility activity

Benzene, ethyl alcohol and water extracts of bark and flowers of *C. guianensis* showed antifertility activity was studied for assorted stages of estrus cycle in female person rats and on the number implantation sites within the pregnant rats. The ethyl alcohol extract of *C. guianensis* bark and every one the extracts of its flower condensed the quantity of implantations (Geetha et al., 2005).

Neuropharmacological action

In 2012 Vinod et al studied the methanolic extract of *Couroupita guianensis* flowers in mice showed numerous neuropharmacological actions. Spontaneous motor activity, rotarod performance and sodium thiopental sleeping time in mice were measured. The methanolic extract (100, 250 and 500mg/kg) of *Couroupita guianesis* exhibited vital reduction in spontaneous motor activity. The extract contained secondary degree mediator that has pivotalrole on each central and peripheral nervous system.

Wound healing activity

Umachigi *et al*., (2007) showed wound healing activity in ethanolic extract of *Couroupita guianesis* whole plant (barks, leaves, flowers and fruits). Many parameters like incision wound, epithelization amount, scar area, enduringness and amino alkanoic acid(hydroxyl proline)

measurements beside wound contraction, were accustomed assess the impact of *Couroupita guianensis* on wound healing.

Hepatoprotective activity

The hepatoprotective activity of ethanolic leaf extract of *Couroupita guianensis* against CCL_4 persuaded liver damage in rats. Actions of liver marker enzymes, serum glutamate oxaloacetate transaminase ,serum glutamic pyruvic transaminase ,asparate aminotransferase ,alkaline phosphatase , total bilirubin , and total protein , visible a considerable hepatoprotective effect in evaluation with the drug of silymarin (Elumalai et al., 2013).

Hypolipidimic activity

In 2013, Ramyasai et al reported the methanolic extract of *Couroupita guianensis* Abul flowers was orally run in High cholesterol fed diets rats. Treatment with methanolic extract of *Couroupita guianensis* Aubl Flowers significantly declined total serum cholesterol, triglycerides, low density lipoproteins, very low density lipoproteins and enhanced the high density lipoproteins in obese rats and was comparable with that of standard atorvastatin. **Antinociceptive**

Patricia Dias Fernandes and coworkers in 2010 reported the CEE (crude ethanol extract) and fractions significantly inhibited the number of contortions induced by acetic acid. All fractions showed antinociceptive activity in the tail flick model, being the hexane and ethyl acetate the most potent and long acting fractions. In the hot plate method the highest effect observed was at the dose of 100mg/kg from allfractions.Administration of naloxone inhibited the antinociceptive effect of fractions.The most prominen effect was identified in the antinociceptive activity initiated by CEE and butanol fraction.

Anthelmintic

The chloroform, acetone and ethanolic flower extracts of *Couroupita guianensis* for anthelmintic activity against adult earth worm, *Pheritima posthuma.* The alcholic extract was the most effect in an activity comparable with piperazine citrate (Philippine Medicinal Plants).

Antioxidant activity

In 2016 Sumathi and Anuradha reported the antioxidant activity of methanolic extract of *Couroupita guianensis* flower was intended for different *in vitro* models. The methanolic extract of *Couroupita guianensis* flowers were influenced a strong antioxidant activity in the method of DPPH radical scavenging action when paralleled with ascorbic acid.

The antioxidant efficacy of ethanolic extract of *Couroupita guianensis* leaves and flower (CGLE and CGFE). In-vitro antioxidant activity such as Reducing power ability, NBT reduction assay, Deoxyribose degradation assay was performed and was concluded that the ethanolic extract of leaves and flowers of *Couroupita guianensis* showed significant antioxidant activity (Stalin, 2012).

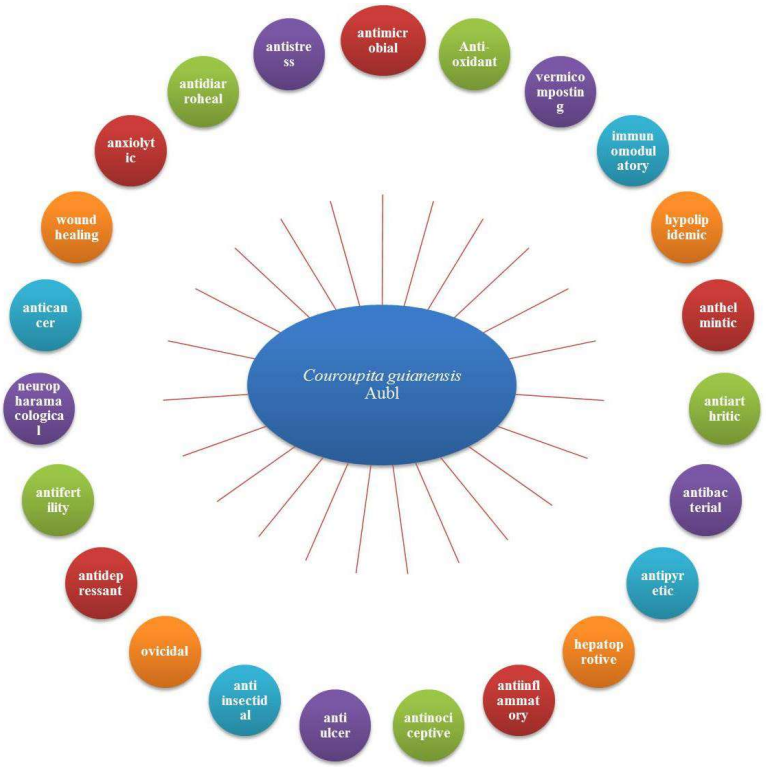

Figure 2. Activities of *Couroupita guianensis* Aubl

Antipyretic activity

Usman and coworkers in 2012 reported the antipyretic activity of flower and bark a part of *Couroupita guianensis* in chloroform, ethanol, water, ether, petroleum ether extracts was done by victimization yeast induces febrility methodology.The antipyretic action of all the extracts was reflective; chloroform, ethanol, water extracts have vital onset of action on fall of temperature (within 30minutes) almost like that of paracetmol (30 minutes).

Antiarthritic activity

Elumalai et al., (2012) investigated the antiarthritic activity of *Couroupita guianesis* leaves in methanolic extract by the technique of Protein denaturation methodology. The activity of extract was increased depends upon the concentration.

Immunomodulatory activity

In 2009, the immunomodulatory activity (Invitro polymorpho nuclear white corpuscle operate test) in acetone, benzene, petroleumether, chloroform, methanol and water extracts of *Couroupita guianesis* flowers by victimization rat as an animal model was given by Pradhan et al. Hypersensitivity, hemagglutinations reactions were calculated by victimization sheep red blood cells (SRBC) as matter. Within the in-vivo studies, the continual fuel extract was found to exhibit a dose connected increasing within the hypersensitivity, to the SRBC matter at concentration of one hundred and two hundred mg/kg in animal studies. The methanolic extract was found to stimulate cell mediate and antibody mediate immune responses in rats

Antibacterial activity

Shah et al.,(2012) was investigated the antibacterial activity of fruit pulp of *Couroupita guianensis* ethyl alcohol extract was studied against gram-positive microorganism(*Staphylococcus aureus, Bacillus subtilis*) and gram-negative bacteria (*Escherichia coli, Pseudomonas aeruoginosa*). Compared to doxycyclin, ciprofloxacin and fluconazole, vital activity was found against *B. subtilis* at concentration 4mg as compare to further tested organisms.

The methanolic extract of *Couroupita guianensis* flowers were subjected to preliminary antimicrobial activity by agar well diffusion method and found to be active against both Gram-negative *Escherichia coli* as well as Gram-positive methicillin-sensitive and methicillin-resistant *Staphylococcus aureus* strains (Snehali Majumder et al., 2014).

Couroupita guianensis, Silver nanoparticles synthesis of plant extract were confirmed by UV-vis and FTIR and followed by antioxidant properties. The *Couropita guinanensis* flower extract mediated nanoparticles showed absorbance peaks at 318--323nm region in the spectral analysis. The clear inhibitory zone appeared against *Pseudomonas aeroginosa* ,*Bacillus subtilis* ,*Staphylococcus aureus* ,*Klebsiella pneumonia* and *E.coli* (Sivakumar *et al.,* 2015).

Ovicidal activity

Baskar et al., (2013) investigated the ovicidal activity in hexane, chloroform and ester extracts of *Couroupita guianensis* plant on the eggs of *Helicoverpa armigera*. All the extracts showed ovicidal activity, and among them alkane extract exhibited additional ovicidal activity.

Antimicrobial, antimycobacterial and antibiofilm Properties

Al-Dhabi et al., (2012) showed antimicrobial, antimycobacterial and antibiofilm properties in chloroform extract of fruit of *Couroupita guianensis*. Chloroform extract of *Couroupita guianensis* fruit showed sensible antimicrobial and antibiofilm forming activities however it showed less antimycobacterial activity. Chloroform extract showed effective antibiofilm activity against gram-negative microorganism referred to as genus *Pseudomonas aeruginosa* ranging from two mg/mL biofilm repressive concentration (BIC), with 52 inhibition of biofilm formation. Ramalakshmi et al., 2013 conjointly showed antimicrobial property of methanolic extract *Couroupita guianensis* flowers. The results of the antimicrobial activity showed effective repressing activity against *Plesiomonas Shigelloides, Cocci aureus, Vibrio mimicus,* and *Proteus vulgaris*. Moderate antimicrobial activity was recorded against *E.coli, Klebsiella pneumonia* and *Salmonella typhi.*

Vermicomposting

In 2014, Jayanthi has studied the composting potential of two epigeic worms *Eudrilus eugeniae* and *Eisenia fetida* were inoculated into the *Couroupita guianensis* vermibed. The reproductive potential and nutrient status were estimated by both species formed vermicompost.

Insecticidal activity

The aqueous extract of *Couroupita guianensis* plant was reflected for insecticidal activity against eggs, nymphs and adults of *Bemisia tabaci,* on tomato plant grown in the greenhouse condition. The aqueous extracts of *C. guianensis* leaves show high insecticidal effects on nymphs and adult flies although low effect on the eggs of *B. tabaci* as paralleled to control (Yadav Anu and Mendhulkar, 2015).

Anxiolytic activity

The aqueous and methanolic extract of *Couroupita guianensis* for its anxiolytic activity in mice. The elevated plus maze (EPM), light and dark (LD), and Open field test (OFT) models were used. Both the aqueous and methanolic extracts of CG showed an anxiolytic activity linked to vehicle control in EPM, LD, and OFT model in mice (Gupta *et al.,* 2013).

Conclusion

Nevertheless, the determined research studies are going on, and it would be at ease to develop new drugs after wider studies on pharmacological and biological activities. Therefore, there is a need for more *invitro* and in vivo research to evaluate and confirm the efficiency and safety of various herbs in the current era of evidence-based medicine. This is likely to open new horizons in therapeutic medicine. The present endeavor provides information which may generate interest among researchers to explore such natural resources.

Conflict of interest

There is no conflict of interest in the present study.

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