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Review Paper

The Cannonball Tree: A Tree of Beauty and Mystery

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Abstract

The Cannonball tree is a deciduous plant indigenous to the tropical forests of Central and South America. It is also grown in various other tropical areas for its ornamental and medicinal properties. The tree belongs to the family Lecythidaceae and has various regional names such as shivlingam, kailashpati, and ayahuma. The tree is characterized by its large, spherical fruits that resemble cannonballs, and its fragrant, colourful flowers that are borne in long racemes. The tree has been used in traditional medicine systems such as Ayurveda, Siddha, and Unani for treating various ailments such as gastritis, scabies, bleeding, piles, dysentery, scorpion poison, toothache, and cancer. The tree is also a source of timber, dye, and perfume. The cannonball tree is considered sacred by Hindus and Buddhists, who use its flowers for religious ceremonies and offerings. The cannonball tree has many unique features that make it stand out among other plants.

Keywords: Cannonball tree, Naglinga plant, Couroupita guianensis, Anticancer, antidiabetic activity.

Introduction

The cannonball tree ***(Couroupita guianensis)*** belongs to the family *Lecythidaceae*, which is a group of flowering plants that are mostly native to the tropical regions of the Americas. The Lecythidaceae family comprises approximately 25 genera and around 300 species. In India, the tree holds cultural and religious importance as well, where it is associated with Lord Shiva and Goddess Parvati. The tree is considered sacred and auspicious, and its flowers are offered to the deities in temples. The tree is also a source of timber, dye, and perfume. Couroupita guianensis is a valuable plant with multiple uses and benefits, and deserves further attention and conservation. The name for this species was given upon the name of the famous botanist J.F. Aublet. It is also referred to as the 'cannonball tree' due to the resemblance in size and shape of its fruits to a cannonball.

Figure-1: Couroupita guianensis[1].

Pharmacognosy of cannonball tree: According to certain ecologists, the existence of Couroupita serves as an indicator of the well-being of an ecosystem, where it plays a crucial role in sustaining ecosystem services. Over an extended period, botanists have been drawn to the species because of its remarkable morphological features.

Table-1: Scientific Classification

Scientific name	Couroupita Guianensis Aubl
Synonym	Couroupita Acreensis R. knuth, Couratari Pedicellaris Rizzini, Nagalinga, Kailaspati, Mallikarjuna, Nagamalli, Shiva Linga
Class	Dicotylodonae
Order	Ericales
Family	Lecythidaceae

Tree: The C. guianensis tree is visually striking during its flowering and fruiting phases[2]. A fully grown tree typically reaches a height of approximately 25 meters, featuring a dense crown adorned with leaves clustered at the branch tips[2]. The trees exhibit simultaneous blooming and fruit-bearing[2]. Buds, flowers, and fruits emerge directly from the main trunk, with thick, entangled branches extending about 1 meter, completely

covering the trunk[2]. These branches, bearing flowers and fruits, are easily distinguishable from those carrying leaves[2].

Flower: The flowering season for C. guianensis is from March to September[2]. Flowers, having a diameter of 7-8 cm, look very fascinating due to a blending of pale yellow, white and pinkishred colours[2]. A flower remains attached to the tree only for 10 to 12 hours, and then falls down. The flower has six thick petals that are bowl- shaped[2].

Figure-3: Flower of Cannonball tree[4]

Pollination: C. guianensis attracts a diverse array of visitors, including several insect species, with honeybees and carpenter bees identified as the primary pollinators[2]. The floral attributes, encompassing shape, color, and fragrance, collectively serve as attractants for these pollinators[2]. Despite lacking nectar, the flowers of C. guianensis offer pollen as a reward to pollinators seeking food[2]. During this process, fertile pollens from the staminal disc are transferred to the next flower, promoting effective cross-pollination[2]. In cases where cross-pollination does not occur, the arrangement of the two types of stamens in the flower allows for a limited degree of self-pollination[2]. The vibrant petals, white-colored hood, and yellow-colored stamen appendages also captivate pollinators by reflecting ultraviolet light[2].

Figure-4: Pollination method by bees[5].

Fruit: The fruits of C. guianensis are remarkably appealing, and the name"cannonball tree" is derived from the rusty appearance of these fruits[2].Regionally, the species is also known as 'ayahuma,' meaning 'Heads of spirits,' due to the distinctive shape of its fruits[2]. These lightbrown, spherical fruits, measuring about 20 centimeters in diameter, take approximately 12 months to mature and become soft uponripening[2]. The quantity of fruits per plant mayrange from 50 to 150, with a single fruit containing up to 300 small seeds surrounded by an unpleasant pale-yellow pulpthat possesses toxic properties[2]. At the conclusion of the fruiting season, thetree undergoes a brief period of leaf shedding. However, this leafless stage istransient, as new leaves start to reappear after about a week[2].

igure-5: Fruits of Cannonball[6].

Organoleptic character

A sizable, semi-deciduous tree, it originates from the tropical rainforests of Central and South America. The tree is known for its large, globose fruits, which resemble rusty-brown cannonballs when ripe. The fruits can weigh up to 50 pounds and contain hundreds of seeds.

The cannonball tree is a valuable timber tree and is also used in traditional medicine. The fruits are edible, but they should be cooked before eating because they can be toxic when raw.
Here is a simpler explanation of the given description-The cannonball tree is a large tree that sheds its leaves once or twice a year. It produces large, round fruits that look like rusty-brown cannonballs. The fruits take 18 months to ripen and are edible when cooked.

Figure-6: Organoleptic Character[7].

Here are some other extra features of the cannonball tree: i. The tree is fast-growing and can reach heights of over 100 feet. ii. The tree is a source of food for birds and other animals. iii. The wood of the cannonball tree is strong and durable, and it can be used to make furniture, tools, and other items.

Table-2: Organoleptic Characters.

Character	Description
Colour	Flower - yellow or red. Fruit - the fruit is white and turns blue on oxidation[1]
Odour	Strongly scented
Taste	Sour taste and a strong odor
Extra features	The fruits are woody and have a diameter 25 cm. The flowers emerge in racemes, reaching up to 80 cm in length, directly sprouting from the trunk. Each flower is composed of six petals.

Microscopic characters: i. The leaf epidermis has a thick cuticle and stomata on both surfaces. The stomata are surrounded by four to six subsidiary cells. The epidermal cells are polygonal and have straight or slightly sinuous walls. The leaf surface is covered with simple, unicellular hairs. ii. The flower petals have a single layer of epidermal cells, which are elongated and papillose on the inner surface. The outer surface has a thin cuticle and no hairs. The stamens have two types of pollen grains: spherical and ellipsoidal. The spherical pollen grains have three colpi and a reticulate exine, while the ellipsoidal pollen grains have six colpi and a striate exine[8]. iii. The fruit pericarp consists of three layers: an outer sclerenchymatous layer, a middle parenchymatous layer, and an inner fibrous layer. The sclerenchymatous layer has thick-walled cells with lignified secondary walls. The parenchymatous layer has thin-walled cells with intercellular spaces and starch grains. The fibrous layer has elongated cells with lignified walls and pits[9]**.**

Geographical distribution

Couroupita guianensis is a tropical tree which is native to northeastern South America, but also cultivated in other regions such as Central America, North America, Africa, Asia, and Australia. It grows in humid and warm climates and prefers moist and well-drained soils[10].

It can reach heights of up to 35 meters (110 feet) and produces large, spherical fruits that resemble rusty cannonballs[11]. The flowers are fragrant and colourful, and grow directly from the trunk in long racemes[11]. The tree has medicinal and cultural uses in some countries[12].

The cannonball tree shares a familial connection with the Brazil nut and other members of the Lecythidaceae family. While it shares similarities with Xylocarpus granatum, another tropical tree known for its woody fruits but belongs to the Meliaceae family. The cannonball tree is also known by other common names, such as nagalinga (in India), sala (in Sri Lanka), and ayahuma (in Ecuador). The cannonball tree is present in different parts of India, especially in the southern and eastern regions. Some of the states where the tree is found are Tamil Nadu, Kerala, Karnataka, Andhra Pradesh, Telangana, Odisha, West Bengal, Bihar, Jharkhand, Chhattisgarh, and Assam.

Figure-7: Cultivation and collection[13].

The environment required for growing a cannonball tree is a humid and warm environment and a site that receives full sun or partial shade. The tree is not frost-tolerant, so it should be grown where temperatures do not drop below freezing[14]. i. The soil of pH 6.0 to 7.0 and well-drained is suitable for the growing of the tree. If your soil is not suitable, you can prepare a mixture of equal parts compost, peat moss, and perlite or sand[14]. ii. Plant the tree by either sowing seeds or transplanting a small tree. Excavate the hole of the size of root ball and insert the tree in it. Fill the hole with soil and water the tree thoroughly[14]. iii. Water and fertilize the tree regularly. The tree needs deep watering once a week or more often if the soil is dry. Fertilize the tree with a balanced fertilizer once a month during the growing season[14]. iv. The tree can reach heights of up to 35 meters (110 feet) and produce more than 1000 flowers and over 150 fruits per year. The maturing of the fruit may last as long as 12 months to 18 months[14]. v. For collecting fruits, you need to wait until they ripen and fall on the ground, bursting open. The fruits are brownish grey and have a woody shell. On oxidation the flesh of the fruit turns blue to white due to air. They contain many seeds that can be used for propagation or for medicinal purposes[14]. vi. To collect the flowers, you need to pick them when they are fully open and fresh. They have diameter of 6 centimetres (2.5 inches), which are typical brightly coloured of six petals, ranging in pink and red shade at the base and yellowish to the top.

The flowers have a couple of stamens: a ring at the centre, and modified arrangement of stamen into the hood. These flowers can be used for decoration, perfume, or medicine[14].

Figure-8: Invitro germination of cannonball tree[15].

Phytoconstituent

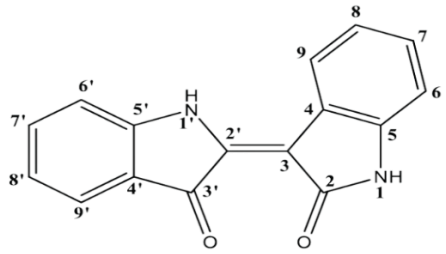

Figure-9: Indirubin Pink pigment extracted from fruit of couroupita guinanensis[16].

Couroupita guianensis (The cannonball Tree) is a tropical plant that has various phytoconstituents in different parts of the tree. According to some sources, the phytoconstituents of the cannonball tree are as follows: i. The flowers contain essential oils, keto steroids, glycosides, couroupitine, indirubin, isatin and phenolic substances[17]. ii. The leaves contain flavonoids, tannins, saponins, steroids, alkaloids, terpenoids, phenols, glycosides and anthraquinones[17]. iii. The fruits contain saponins, tannins, flavonoids, alkaloids, terpenoids, phenols and glycosides[17]. iv. The stem bark contains flavonoids, tannins, steroids, saponins, glycosides, amino acids, phenols, anthraquinones and triterpenoids[17]. v. The seeds of the cannonball tree contain various fatty acids, including linoleic acid, oleic acid, palmitic acid, and stearic acid[17]. vi. The phytoconstituents found in the cannonball tree seeds exhibit diverse biological activities, including antibacterial, antifungal, anti-inflammatory, antioxidant, antidiabetic, anticancer, and more[18]. vii. The cannonball tree holds a place in traditional medicine where it is utilized for treating a variety of elements, including colds, fever, headaches, skin infections, wounds, ulcers, snake bites, and more[18]. viii. The cannonball tree is also considered sacred in some cultures, especially in India, where it is associated with Shiva and Vishnu[18].

Uses: i. The extract from the cannonball tree is employed in traditional medicine to address conditions such as stomach aches, colds, malaria, pain, hypertension, tumours, and inflammation[18]. ii. The juice from the leaves is used to treat skin diseases, toothache, and bronchitis[18]. iii. The pulp from the fruits is used to disinfect wounds, feed animals, and cure dogs of mange[18]. iv. The fragrant aroma of the cannonball tree flowers makes them suitable for enhancing the scent of cosmetics and perfumes[18]. v. The fruits have hard shells that can be used as utensils or containers[18]. vi. The wood from the cannonball tree finds application in crafting various items, including boxes, toys, rackets, parquet blocks, light artifacts, and casting molds[18]. vii. In India, the cannonball tree holds cultural and religious significance, being associated with Shiva. It is frequently planted near temples. viii. In Sri Lanka, the cannonball tree is known as the Sal tree, and there is a common misconception that it is the tree under which Buddha attained enlightenment.

Advantages: i. The cannonball tree has many advantages as a tropical plant. It is ornamental, aromatic, sacred, and medicinal. (a) Ornamental value: The cannonball tree is a beautiful tree with large, glossy leaves and pink flowers. Used as an Ornamental plant for plantation in parks and gardens. (b) Edible fruit: Cannonball fruit is edible and can be eaten raw or cooked. It has a sweet and tangy taste and is a good source of vitamins and minerals. (c) Medicinal properties: The cannonball tree has several medicinal properties. The bark, leaves, and fruit are all used in traditional medicine to treat a variety of conditions, including inflammation, wounds, infections, and respiratory disorders. (d) Timber: The wood of the cannonball tree is strong and durable, and is used to make furniture, tools, and other items. ii. It can be grown in parks, gardens, or along roadsides as a decorative tree[14]. iii. It can also provide shade, timber, firewood, and fodder[14]. iv. It can attract bees and other pollinators to enhance biodiversity[19].

Disadvantages: However, the cannonball tree also has some disadvantages. i. It is rare, endangered, and invasive. It is threatened by habitat loss, overexploitation, and climate change[14]. ii. It can also become invasive in some areas where it is introduced[14]. iii. It can compete with native plants for space and resources[14]. iv. It can also pose a hazard to humans and animals due to its falling fruits[14]. v. The fruits can cause injuries or damage to property if they hit someone or something[14]. vi. The fruits can also create a mess and a bad smell when they rot on the ground[14].

Ayurvedic formulation of cannonball: Naga Linga has several health benefits and is also used as a medicinal herb. It is used in many Ayurvedic formulations, it is used in ayurvedic formulation such as: i. Yogaraj Rasayana: A polyherbal formulation that rejuvenates and boosts immunity[20]. ii. Nagalinga Taila: An oil preparation that heals wounds, ulcers, infections, and skin diseases[21]. iii. Nagalinga Churna: A powder preparation that relieves toothache, stomachache, and cold[21].

It is important to note that Nagalinga is a potent herb with some contraindications and side effects. It is always best to consult a qualified Ayurvedic practitioner before using any Nagalinga-based formulations.

Here are some additional key points: i. Nagalinga is a heat-producing herb, so it should be used with caution by people with hot constitutions or conditions such as inflammation or fever. ii. Nagalinga can interact with certain medications, such as blood thinners and diuretics. iii. Nagalinga should not be used by pregnant or breastfeeding women. Overall, Nagalinga is a safe and effective herb when used appropriately. However, it is important to be aware of its potential contraindications and side effects before using it.

Cannonball tree case study

In a 2023 study published in the journal *Nature*, researchers investigated the medicinal properties of the cannonball tree. They found that extracts from the tree's bark, leaves, and fruit have anti-inflammatory, antioxidant, and anticancer properties. The researchers also found that the extracts are effective against a number of infectious bacteria and fungi.

The results of this study suggest that the cannonball tree has the potential to be used to develop new treatments for a variety of diseases, including cancer, inflammation, and infection. The researchers are currently conducting further studies to evaluate the safety and efficacy of the tree's extracts in humans.

Antidiabetic: According to the Indo American Journal of Pharmaceutical Research**,** Couroupita guianensis flower shows antidiabetic activity and suggesting the potential for further research in clinical applications. The study found that daily oral dosing of both aqueous and methanolic extracts of the flowers (100mg/kg body weight) in diabetic mice the result showed decreased blood sugar i.e. blood glucose level[22].

In addition, Morankar et al also stated that the Couroupita guianensis flowers also shows antidiabetic activity in animals at normal level. The plant has also been approved for its antidiabetic activity in homeopathy medicine containing in leaf extracts stated by Devi Rajeswari and Swapnalatha.

Anti-inflammatory: As per the findings in the Indo American Journal of Pharmaceutical Research, both the flowers and bark of Couroupita guianensis exhibit analgesic and anti-inflammatory properties, suggesting the potential for further investigation in clinical applications. The study revealed that extracts from C. guianensis demonstrated significant analgesic and anti-inflammatory effects. The flower extracts displayed the peak analgesic effect after 1 hour, while the bark extracts showed their maximum effect after 2 hours. The extracts collectively exhibited the highest reduction in inflammation after 3 hours[25].

Moreover, Gousia et al. documented the anti-inflammatory activity of Couroupita guianensis elements, attributing it partly to the reduction in cell migration and the inhibition of cytokines and inflammatory mediators' production[26]. Morankar et al. specifically highlighted the anti-inflammatory activity of C. guianensis flowers, and Devi Rajeswari et al. reported moderate anti-inflammatory effects in the ethanolic extract of cannonball tree leaves, linked to the reduction in cell migration and the inhibition of cytokines and inflammation mediator production (27). Sundarrajan et al. further supported these findings by noting anti-inflammatory activities in benzene and ethanolic extracts derived from the flowers, bark, and leaves of the tree.

Anticancer activity: In terms of anticancer activity, the flowers of Couroupita guianensis contain istain, a compound and its derivatives that shows cytotoxic effects against human carcinoma cells. The methanolic extract from C. guianensis flowers exhibits anticancer activity against HeLa, NIH3T3, and HepG2 cell lines[28]. Notably, isatin, found in C. guianensis, demonstrates cytotoxic activity against human promyelocytic leukemia HL60 cells, reaching 50% cytotoxicity. Additionally, the ethanolic and ethyl acetate extracts of C. guianensis flowers show in vitro cytotoxic activity against MCF-7 cell lines when compared to the standard tamoxifen. The presence of isatin in C. guianensis flowers underscores its potential to exhibit activity against human carcinoma cells.

Finding and analysis: i. The cannonball tree belongs to the same family as the Brazil nut, which is Lecythidaceae. ii. The cannonball tree produces edible fruits that have an earthy and bitter taste. However, the fruits are not widely consumed by humans, as they have a strong smell and can cause skin irritation. iii. The cannonball tree has medicinal uses for treating various ailments, such as skin infections, headaches, colds, stomach problems, and snake bites. The flowers, leaves, bark, and seeds are used in different ways, such as poultices, decoctions, infusions, and oils. iv. The cannonball tree is culturally and religiously significant in India, where it is known as Nagalinga or Shivalinga. The flowers resemble the hood of a cobra and the lingam of Shiva and are offered to the Hindu god in temples and shrines. v. The cannonball tree is relatively easy to grow and care for, as it requires a warm, humid climate and well-draining soil. It can also tolerate some drought and salt spray. It can also tolerate some drought and salt spray.

Conclusion

Cannonball tree (Couroupita guianensis) is a unique and fascinating plant that has both aesthetic and practical value. Its stunning, fragrant flowers and huge, spherical fruits are eye-catching and intriguing. Its origin and distribution are mysterious and controversial, as it is native to the Amazon rainforest but also widely grown in other tropical regions of the world. Its medicinal and cultural uses are varied and impressive, as it has been used for treating various ailments and honouring different gods by various peoples. Medicinally it is also used as anti-inflammatory, antidiabetic, anticancer etc. more research is going on its medicinal uses and mystery will be resolved soon. The cannonball tree is a splendid example of the beauty and

diversity of nature, and a source of curiosity and admiration for those who see it.

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