



**PHYSICOCHEMICAL STANDARDISATION AND AN OVERVIEW ON CAESALPINIA
BONDUC LINN., A WIDELY USED INDIAN TRADITIONAL DRUG**

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ABSTRACT

Caesalpinia bonduc (L) Roxb. (Family – Leguminosae;) is commonly used in Siddha, Ayurveda, and other Indian traditional systems of medicine and is considered as an important remedy for the treatment of several diseases. It is a perennial plant growing as a hedge plant up to 15 m in height and widely distributed all over the world specially in India, Sri Lanka, Burma and Andaman-Nicobar Islands. Herbal drugs are attaining a significant role in health systems worldwide as potential source of therapeutic agents for maintaining proper health as well as in diseased conditions. It is worthwhile to explore this plant on the basis of standardization parameters for the quality control of the drug as well as phytochemical, pharmacological aspects etc. In the present paper, a pharmacognostic study on Caesalpinia bonduc Linn. (leaves) based on its physicochemical and preliminary phytochemical studies were carried out to lay down the pharmacopoeial standards. The physicochemical parameters such as moisture content, total ash, acid insoluble ash, water soluble ash, water soluble extractives, alcohol soluble extractives, pH of water extract, volatile oil and fibre content were determined. The limit tests for arsenic & heavy metals were carried out and were found to be within the permissible limit which proves the safety of the drug material. The fluorescence characters of the drug in different solvents were detected in visible, short UV and long UV lights. Apart from these studies, this paper attempts to encompass the available literature on C. bonduc with respect to its geographical distribution, botanical characters, cultivation, traditional uses, phytochemical aspects and pharmacological activities.

KEYWORDS: Caesalpinia bonduc, Kazharchi, Physicochemical, Traditional Uses, Phytochemicals.

INTRODUCTION

Caesalpinia bonduc (L) Roxb. Belonging to the family Leguminosae is a prickly shrub widely distributed all over the world. Root, stem, leaves, bark, seeds and nuts are used for medicinal purposes.^[1,2] It is common in thickets scrub in the forest of the Eastern ghats. The plant is commonly known as Ivy Gourd and is an important plant used in indigenous systems of medicine against various disorders. It is commonly used as antioxidant, antidiabetic, laxative, immune system modulator and in the treatment of rheumatoid arthritis. Two Varieties of C. bonduc are found - the white variety and the black variety.^[3] The synonyms of Caesalpinia bonduc are Caesalpinia bonducella (L.) Fleming and Caesalpinia crista auct. Amer. The name of the species bonducella is derived from the Arabic word "Bonduce" meaning little ball which indicates the shape of the seed.^[4] The plant flowers during August-October and fruits during December-April.

The different vernacular names^[5,6,7] of C. bonduc are: Arab: Bunduk, Akitamak; Bengali: Nata, Nata karanja;

Tribal name: Kang Boi (Marma); Cannarese: Gajikekayi; Duke: Guchha; English: Fever Nut, Physic Nut, Molucca Bean, Bonducella Nut, Nickar bean; French: Bonduc jaune, Guilandina bonduc; Hindi: Katkaranj, Katkaliji; Kannada : Gajjaga; Malayalam: Kalanji, Kazhanchi; Oriya : Kotakoleja, Glogila; Paersian: Khayerhe-i-iblis; Sanskrit: Latakaranja, Putikaranja, Kuberakshi; Tamil: Kalarsikkodi, Kazha-shikkai, Gajega, Mulal, Kazharchi; and Telugu: Gache, Gatchkaya, Kalanju, Yalaxhi.

GEOGRAPHICAL DISTRIBUTION

It is a perennial plant growing as a hedge plant and widely distributed all over the world specially in India, Sri Lanka, Burma and Andaman-Nicobar Islands.^[8] The plant is distributed in every tropical shore worldwide, including Florida, Louisiana, Puerto Rico, the US Virgin Islands, Hawaii, Guam and American Samoa.^[9,10] The plant grows in shade as well as in open. It is found wild throughout the plains of India near the sea-coasts, especially Bengal, Bihar, Mumbai and whole of Southern India and up to an altitude of 1,000 m in the Himalayas. It is also found in the deltaic regions of western, eastern

and southern India. Found abundantly in the forests and villages of Dhaka, Chittagong, Khulna, Tangail and North Bengal.^[11]

Botanical characters of *C. bonduc*

It is a vine-like large straggling very thorny perennial shrub that reaches a length of 6 m (20 ft) and scrambles over other vegetation. Stems are covered in curved spines. Its 2 cm (0.79 in) gray seeds known as nicker nuts, are buoyant and durable enough to be dispersed by ocean currents. It is an extensive climber. Branches are armed with hooked and straight hard yellow prickles. Leaves are bipinnate, 30-60 cm long and petioles prickly. Leaflets 7-9 pairs, ovate-elliptic, 1.5-3.5 x 1-2 cm, glabrous above, pubescent below, base truncate, rotund, margin entire, apex obtuse and mucronate. Stipules are foliaceous. Peduncle is long, 3 to 4 cm, prickled, bracts long, linear-lanceolate and deciduous. Pedicel is 0.5-1.5 cm and very short in bud. Flowers are in dense terminal racemes with long peduncles and supraaxillary racemes which are close at the top and 15-25 cm long. Flowers

are 1-2 cm across, pale yellow, calyx tube campanulate, gibbous at base, sepals 5, unequal, oblong-obovate 4.5-5 x 1 mm and tomentose. Petals are oblanceolate, yellow, filaments declinate, flattened at the base and clothed with long white silky hairs. Pods are oblong, densely armed on the faces with wiry prickles. Seeds are oblong, lead-coloured and 1.3 cm long.^[12,13]



Fig 1: *Caesalpinia bonduc* (leaves)

The macroscopic characters^[13] of the leaves of *C. bonduc* is summarized in table 1.

Table 1: Macroscopic characters^[14] of *C. bonduc* (leaves)

| Sl. No. | Characters | Properties |
|---------|-------------|---|
| 1. | Shape | Elliptical |
| 2. | Size | 2-3 cm in length and 1-2 cm in wide |
| 3. | colour | Fresh leaves are green and dry ones are greyish green |
| 4. | Surface | Upper surface glabrate and lower surface hispid |
| 5. | Base | Symmetric |
| 6. | Margin | Entire |
| 7. | Apex | Obtuse |
| 8. | Venation | Unipinnate and paripinnate |
| 9. | Orientation | Coriaceous |
| 10. | Texture | Fibrous |
| 11. | Odour | Characteristic |
| 12. | Taste | Slightly pungent |

The microscopic characters^[14] of the leaves of *C. bonduc* are given in Table 2.

Table 2: Microscopic characters^[14] of *C. bonduc* (leaves)

| Sl. No. | Parameters | Range | Average |
|---------|-------------------|-------|---------|
| 1. | Vein-islet number | 5-7 | 6 |
| 2. | Oalisade ratio | 14-18 | 16 |
| 3. | Stomatal index | 10-14 | 12 |

CULTIVATION

Growth of the plant is rapid at all stages. After sowing seedlings reach 26 cm in 40 days. Plants grow a meter or more per year. Plantations could be established with potted seedlings by direct seeding scarified seeds. Control could be obtained by lopping with a machete followed by herbicide treatment of the sprouts.^[15]

Traditional Uses

C. bonduc is a common drug used for different ailments in the Siddha system of medicine.^[3] A preparation using coconut flower and *C. bonduc* leaves is used to dress the inflammatory swellings and scrotal swellings. Another

preparation using bonduc kernels, dried ginger, dried areca nut and egg white is used externally for filarial swellings. Kudineer prepared using bonduc kernels, garlic, drumstick bark, dried ginger and *Acorus calamus* is taken internally for all abdominal diseases. Seed powder mixed with asafoetida and taken internally with butter milk for abdominal diseases and gives good complexion to skin. Seed powder, dried areca nut and borax taken internally for tooth diseases. Bonduc roots are used for the preparation of kazharchiennai. Leaves of *C. bonduc* (L.) Roxb. have been used by traditional Siddha healer of Malabar region for psoriasis treatment. The seed shows stypic, purgative and anthelmintic

actions and used for the treatment of inflammations, colic, malaria, hydrocele, skin diseases and leprosy.^[2,4,6]

This plant find extensive use in folk medicines. *C. bonduc* is found to be used traditionally as antioxidant and anti-inflammatory for various disease conditions such as diabetes, asthma, splenopathy and ulcer. The seeds have a bitter taste and are valued in indigenous medicine as a tonic. It is mainly used to treat diseases like rheumatoid arthritis, as antileprotic, antidiabetic, antiperiodic, antipyretic and in immune system. The fixed oil obtained from the expressed seeds is used as a remedy for discharges in ear and also to remove freckles from the face as a cosmetic product. The root bark is emmenagogue, febrifuge, expectorant, anthelmintic and stomachic.

The seeds are one of the ingredients of the Ayurvedic drug Ayush- 64, an Ayurvedic compound formulation used for treating filariasis and malaria. They are also made into an ointment for treating hydrocele. As an infusion they are used for curing cerebral haemorrhage and infantile convulsions. In Mauritius, crushed seeds are given as an anthelmintic mixed with honey or castor oil. In West Indies, the roasted seeds are made into a kind of coffee for diabetics. The seeds are reported to be abortifacient. It is antirheumatic and compares favourably with phenylbutazone. In Katra valley (Jammu and Kashmir), the plant-juice is taken for two weeks after meals to cure intermittent fever. In Sri Lanka, the plant is used for treatment of skeletal fractures. The seeds and leaves are reported to be used in skin diseases and rheumatism. Powdered roots, taken with honey, cure leucorrhoea. In Kangra (Himachal Pradesh), the roots are used in intermittent fevers and diabetes. In Jamaica, the bark is used as a rubefacient and as a local application for sores. The seed powder is given in menstrual disorders in tribal areas of Madhya Pradesh. In Homoeopathy the plant is considered an excellent remedy for chronic fever with headache etc. The seed powder forms a household remedy for treatment of diabetes in Nicobar Island. The leaves of the plants have the activities as liver and gastric tonic, fungicidal, anticonvulsant.^[2]

Nuts and root bark are antiperiodic, antispasmodic, tonic, anthelmintic and febrifuge. Leaves are deobstruent and emmenagogue. Root is a gastric tonic. Roots have anthelmintic properties and the leaves, roots and seeds are emmenagogue and febrifuge. Fixed oil expressed from the seeds is emollient. Seeds and the root bark are valuable in simple, continued and intermittent fevers, asthma and colic.^[6]

Dose is root bark 10 to 15 grains. Powdered seed smoked in a bucca cures colic; mixed with warm butter milk and asafoetida it acts as tonic in dyspepsia. Burnt seeds with alum and burnt arecanut is a good dentifrice useful in spongy gums, gum boils etc. A cake made of 30 grains of powdered kernel and the contents of an egg fried in

ghee is a valuable remedy taken twice a day, in cases of acute orchitis, ovaritis and serofula. Ointment made from the roasted seeds with castor oil forms an excellent application to hydrocele, acute architis and glandular swellings. Seeds are useful for dispensing swellings, restraining haemorrhage and keeping off infectious diseases; are also roasted and powdered and given internally in hydrocele and in leprosy. A decoction of the roasted seeds is used against consumption and asthma. Tender leaves are efficacious in disorders of the liver and the oil expressed from them is useful in convulsions, palsy and similar nervous complaints. Tender leaves boiled with castor oil or ghee and thickly applied on painful and swollen testicles are found to be very efficacious. Root bark powder taken internally with dosage of 325 mg- 500 mg and seed powder mixed with equal quantity of pepper with dosage of 325 mg- 1000 mg.

Phytochemicals

The plant contains a number of secondary metabolites namely sitosterol, caesalpins, bonducin, caesane, flavonoids etc. Seeds contain starchy matter - 25.13 %; fixed oil - 25.13 %; natin (a non alkaloidal bitter principle) - 1.925 %; sugar - 6.83 %; Fatty oils from the seeds contain glycerides of palmitic acid and stearic acid and sitosterol. Seeds also contain saponin as bonducin, bitter substance as phytosterinin. The kernels contain homoisoflavone-bonducillin, cassane furanoditerpenoid as bonducellpin E, F and G. Phytochemical studies on the ethanolic extracts of *C. bonduc* yielded two new homoisoflavonoids, caesalpinianone, and 6-O-methylcaesalpinianone along with five known natural products, namely, hematoxylol^[16] stereochoenol A^[17], 6'-O-acetylloganic acid, 4'-O-acetylloganic acid^[18] and 2-O-β-D-glucosyloxy-4-methoxybenzenepropanoic acid.^[19] All of these compounds exhibited different levels of glutathione S-transferase (GST) inhibitory and antifungal activities. From the ethanolic extract of *C. bonduc*, one new diterpene, neocaesalpin P and six known diterpenoids, neocaesalpin H, cordylane A, caesalpinin B, bonducellpin E, caesalpinolide A and 17-methylvouacapane-8(14),-9(11)-diene were isolated.^[20] The kernels contain homoisoflavone-bonducillin, cassane furanoditerpenoid as bonducellpin E, F and G.^[21,22] In short, the chemical constituents such as fatty acids, hydrocarbons, phenolics, alkaloids, flavonoids, isoflavones, glycosides, steroidal saponins, phytosterols, amino acids, tannins, and triterpenoids are reported to be present in the plant^[1,23,24] which shows that the plant is a vast storehouse of medicinally active components. Whole plant of the *C. bonduc* contain all major chemical constituents such as steroidal saponins, fatty acids, hydrocarbons, phytosterols, isoflavone, amino acids and phenolics.^[1]

Pharmacological activities

Hypoglycemic activity

The aqueous and ethanolic extracts of the seeds of *C. bonduc* have been reported to possess in vivo

hypoglycemic effect in alloxan and streptozotocin induced type 2 diabetes in a rat model at a dose of 25 mg/kg body weight.^[25] Different extracts of seed kernels of *C. bonduc* showed hypoglycemic activity in experimental animals.^[26] The different extracts of the bark and root were tested for antidiabetic activity by glucose tolerance test in normal rats and alloxan induced diabetic rats. The extracts showed significant antidiabetic activity comparable with that of glibenclamide, standard antidiabetic drug.^[27] The different seed extracts were subjected to screening for antidiabetic activity in alloxan induced hyperglycemia and found significant antihypoglycemic action.^[28]

Antimicrobial activity

The methanolic, ethyl acetate and water fractions of crude extracts exhibit in vitro activity against the growth of an array of pathogenic bacteria and fungi.^[29]

Antioxidant activity

Earlier reports on antioxidant studies showed that chloroform extract of the plant possess DPPH free radical scavenging activity^[30], methanolic extract act on antioxidant and reactive oxygen species scavenger^[31], and ethanolic extract showed DPPH radical scavenging activity and also found to scavenge the superoxide generated by EDTA/ NBT system.^[32]

Adaptogenic activity

The seed extracts were screened for adaptogenic activity using cold stress model and swim endurance model and found that extracts proved efficient in controlling the hyperlipidaemic condition due to stress.^[28]

Antiinflammatory activity

Study of antiinflammatory activity using the formalin arthritis and granuloma pouch methods found that the activity was comparable to that of phenyl butazone.^[33,34,35]

Anthelmintic activity

The anthelmintic activity in vitro and in vivo studies show that the plant possess anthelmintic activity.^[36] The leaves of *C. bonduc* showed anthelmintic activity against *Phertima posthuma* and *Ascaridia galli*.^[37]

There are so many reports on this plant showing different pharmacological activities like antifilarial^[38], antimicrobial^[29,39,40,41], antiestrogenic^[42], antimalarial^[22,43,44], antibacterial^[45], antiproliferative^[46], antipsoriatic^[47], antitumour^[48], anxiolytic^[49], lavicidal^[50], immunomodulatory^[26,32,33,51], hypoglycaemic^[25,52,53,54], muscle contractile^[55,56], hepatoprotective^[57],

Antiamyloidogenic^[58] anti pyretic and analgesic activities.^[34]

MATERIALS AND METHODS

Plant Material

The present paper deals with a detailed pharmacognostic study on the leaves of *C. bonduc* (L.) Roxb. (Fig.1). The fresh leaves of *C. bonduc* was collected, dried and supplied by Siddha Medicinal Plants Garden, Mettur Dam. The plant material was cut, crushed and kept in airtight containers and used for all experimental purposes.

Physico-chemical parameters

The physico-chemical parameters like determination of moisture content, ash content, acid insoluble ash, water soluble ash, volatile oil, solubility in water and alcohol, pH of water extract, fibre content and test for Arsenic and Heavy metals and Organoleptic characters were carried out by standard methods.^[59,60]

Fluorescence characters

The fluorescence characters of the drug in different solvents were detected in visible, short UV and long UV light.^[61]

Preliminary phytochemical study

In order to examine the presence of different natural products in the plant, characteristic phytochemical tests for sugar, starch, poly phenols, saponin, mucilage, steroid, alkaloid and flavonoid were performed using different extractives of the plant material.^[62,63] For this the plant material was extracted using pet.ether, chloroform, ethyl acetate, methanol and water and these extracts were subjected to phytochemical tests.

RESULTS AND DISCUSSION

The analytical data of physico-chemical parameters of the leaves of *C. bonduc* obtained are given in Table 1. Total ash value of the material indicated the amount of minerals and earthy material attached to the plant material. Acid insoluble ash usually represents the amount of silica present as sand and dust. Loss on drying at 105°C was showing the presence of moisture content and volatile oil (if any) present in the drug. The water soluble extractive value indicates the presence of polar constituents such as tannin, sugar, plant acid, mucilage and glycosides. Alcohol soluble extractive is an approximate measure for their chemical constituents. The pH value indicated that the water extract of the drug was slightly acidic. These values are specific for each drug. All the parameters obtained together provide dependable standards for the drug.

Table 1: Physico-chemical parameters of *C. bonduc*

| Sl.No. | Tests | Results |
|--------|------------------------|---------|
| 1. | Foreign matter (%) | Nil |
| 2. | Moisture content (%) | 10.88 |
| 3. | Total ash (%) | 6.40 |
| 4. | Acid insoluble ash (%) | 1.28 |

| | | |
|-----|---------------------------------|-------|
| 5. | Water soluble ash (%) | 4.01 |
| 6. | Water soluble extractives (%) | 21.22 |
| 7. | Alcohol soluble extractives (%) | 16.80 |
| 8. | pH | 6.21 |
| 9. | Volatile oil (%) | Nil |
| 10. | Fibre content (%) | 20.14 |

The arsenic and heavy metals - lead, cadmium and mercury - were found to be within the permissible limit which proves the safety of the plant material. Organoleptic characters of the leaf are:- Color: Green, Texture: Smooth and powdery, Odour: Strong and

pungent and Taste: Bitter. The fluorescent characters of the plant material in different solvents were detected in visible, UV short light and UV long light and the results are given in Table 2.

Table 2: Fluorescence behaviour of *C. bonduc* leaf powder with various chemical reagents under UV (short), UV (long) and Visible lights.

| Sl.No. | Reagents | UV (short) | UV (long) | Visible light |
|--------|----------------------|-----------------|----------------|----------------|
| 1 | Powder as such | Bluish green | Light green | Green |
| 2 | Petroleum ether | Yellowish green | Light green | Green |
| 3 | Benzene | Light brown | Greenish brown | Brown |
| 4 | Acetone | Light brown | Light purple | Greenish brown |
| 5 | Ethyl acetate | Brownish yellow | Light purple | Light brown |
| 6 | Ethyl alcohol | Brownish green | Green | Green |
| 7 | Methyl alcohol | Dark green | Dark brown | Dark green |
| 8 | Distilled water | Greenish brown | Brown | Dark brown |
| 9 | 1N Acetic acid | Light blue | Light green | Light green |
| 10 | 1N Hydrochloric acid | Light blue | Light green | Light green |
| 11 | 1N Nitric acid | Bluish brown | Light brown | Light brown |
| 12 | 1N Sodium hydroxide | Dark Green | Light green | Brownish green |

The petroleum ether, ethyl acetate, methyl alcohol and aqueous extracts were subjected to preliminary phytochemical analysis for their presence of the

phytochemicals and have shown the presence of carbohydrates, polyphenols, saponins, proteins, steroids, alkaloids, flavonoids, fats and oils and tannins.

Table 3: Preliminary tests for the presence of phytochemicals (groups) in *C. bonduc* leaves

| Sl. No. | Natural products | Test performed | Inference |
|---------|------------------|--------------------------------|-----------|
| 1 | Carbohydrates | Molisch's test | +ve |
| 3 | Poly phenols | Neutral FeCl ₃ test | +ve |
| 4 | Saponins | Foaming in water | +ve |
| 5 | Proteins | Millon's test | +ve |
| 6 | Steroids | Liebermann's test | +ve |
| 7 | Alkaloids | Mayer's reagent test | +ve |
| 8 | Flavonoids | Shinoda test | +ve |
| 9 | Oils and Fats | Filter paper test | +ve |
| 10 | Tannins | Lead acetate test | +ve |

The presence of these biochemical compounds might be making *C. bonduc* medicinally important and nutritionally valuable.

CONCLUSION

C. bonduc is a herb reported in Ayurveda, the ancient medicine system of India. The plant contributes to the biodiversity of the forests where it grows, helps in protecting the soil and protects the wildlife. The seeds are used for jewellery, prayer beads, good luck stones etc^[64]. Reports show that the plant is such an important tree which is having the ability to cure so many diseases. Ethnopharmacological studies on such herbs/medicinally important plants continue to interest

investigators throughout the world. Nowadays the pharmaceutical industry is focussed towards the design and development of new plant based drugs through investigations from traditional system of medicine since they are well tested for their efficacy and generally believed to be safe. *Caesalpinia bonduc* is found to be a popular remedy among the various traditional systems for curing a number of ailments. Being such an important medicinal plant it requires more exploration in all aspects thoroughly for more therapeutically potential.

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