ISSN: 0975-8585

Research Journal of Pharmaceutical, Biological and Chemical Sciences

REVIEW ARTICLE

A Pharmacognostic and Pharmacological Overview on *Caesalpinia bonducella*

Khan Nazeerullah*[1], Kumar Sunil[2,5], Singh Rishi Pal[3], Dhankhar Neelam[4,5]

[1]Department of Pharmacognosy, Dr. K N Modi Institute of Pharmaceutical Education and Research, Modi Nagar, Dist. Ghaziabad, Uttar Pradesh, India.
[2]Department of Pharmaceutical Sciences, Dr. K N Modi Institute of Pharmaceutical Education and Research, Modi Nagar, Dist. Ghaziabad, Uttar Pradesh, India.
[3]Department of Biotechnology , Dr. K N Modi Institute of Pharmaceutical Education and Research, Modi Nagar, Dist. Ghaziabad, Uttar Pradesh, India.
[4]Department of Pharmaceutical Sciences, Ch. Devi Lal College of Pharmacy, Jagadhari, Dist. Yamuna Nagar, Haryana, India.
[5]Department of Pharmaceutical Sciences, National Institute of Medical Sciences University, Jaipur, India.

ABSTRACT

Caesalpinia bonducella (L.) Fleming (Syn. *Caesalpinia bonduc* (L.) Roxb, Syn. *Caesalpinia crista*Linn.), belonging to the family Caesalpiniaceae, is a prickly shrub widely distributed all over the world specially in India, Sri Lanka and Andaman and Nicobar Islands, in India specially found in tropical regions. All parts of the plant have medicinal properties so it is a very valuable medicinal plant which is utilized in traditional system of medicine. The plant has been reported to possess anxiolytic, antinociceptive, antidiarrhoeal, antidiabetic, adaptogenic, anthelmintic, antiestrogenic, anti- inflammatory, antimalarial, antimicrobial, antifungal, antispasmodic, antioxidant, antiproliferative, antipsoriatic, antitumor, larvacidal, muscle contractile, hepatoprotective, anticonvulsant and antifilarial activities. Phytochemical analysis of seeds of *Caesalpinia bonducella* has revealed the presence of alkaloids, flavonoids, glycosides, saponins, tannins and triterpenoids.
Keywords: *Caesalpinia bonducella,* review, Fever nut, Kantikaranja, *Caesalpinia bonduc*

Corresponding author
Email: nazeerhamdard@gmail.com

ISSN: 0975-8585

INTRODUCTION

Medicinal plants as potential source of therapeutic aids has attained a significant role in health system all over the world for both humans and animals not only in diseased condition but also as potential material for maintaining proper health. However there is need to know which constituents in the medicinal herb are responsible for therapeutic uses. Therefore the need arises to extract, isolate and identified the phytoconstituent responsible for its therapeutic use. Plant drug extraction is mainly carried out by using solvents. The conventional methods of extraction which has been use include Maceration, Percolation, Decoction, Digestion, Hot continuous extraction etc. In recent times, focus on plant research has increased all over the world and a large body of evidence has collected to show immense potential of medicinal plants used in various traditional systems. Today, we are witnessing a great deal of public interest in the use of herbal remedies. Furthermore, many western drugs had their origin in plant extract. There are many herbs, which are predominantly used to treat cardiovascular problems, liver disorders, central nervous system, digestive and metabolic disorders. Given their potential to produce significant therapeutic effect, they can be useful as drug or supplement in the treatment / management of various diseases. Herbal drugs or medicinal plants, their extracts and their isolated compounds have demonstrated spectrum of biological activities. Such have been used and continued to be used as medicine in folklore or food supplement for various disorders.

Caesalpinia bonducella (L.) Fleming (Syn. *Caesalpinia bonduc* (L.) Roxb, Syn. *Caesalpinia crista*Linn.), belonging to the family Fabaceae / caesalpiniaceae, is a prickly shrub widely distributed all over the world specially, in India, Sri Lanka and Andaman and Nicobar Islands, in India specially found in tropical regions [1&2]. All parts of the plant have medicinal properties so it is a very valuable medicinal plant which is utilized in traditional system of medicine [3]. The plant has been reported to possess anxiolytic, antinociceptive, antidiarrhoeal and antifilarial activities. Phytochemical analysis of seeds of *Caesalpinia bonducella* has revealed the presence of alkaloids, flavonoids, glycosides, saponins, tannins and triterpenoids [4&5].

"Bonducella" the name of the species is derived from the Arabic word "Bonduce" meaning a "little ball" which indicated the globular shape of the seed [6].

The seeds are grey coloured and resemble eyeballs, which explains the Sanskrit name kuberakshi, meaning eyes of kubera, the Hindu God of wealth [7].

The plant was much confused with *Caesalpinia bonducella* (Syn. C. bonduc) and was described under the same [8-14]. Beside this species like C. nuga [9, 10, 15- 17] and C. jayoba are also sometimes wrongly designated as synonyms for C. crista. In fact, C. jayoba is an adulterant of C. crista [12].

Fever nut cost is 1 kg : $28.95 [18]

ISSN: 0975-8585

Pharmacognostic Studies

An extensive climber, with branches finely grey and downy, armed with both hooked and straight, hard yellow prickles. The leaves are bipinnate, 30-60 cm long with short prickly petioles, the stipules a pair of reduced pinnae at the base of the leaf each furnished with a long mucronate point. There are 7 pairs of pinnae, and each with 3-8 pairs of leaflets with 1-2 small recurved prickles between them on the underside. each 5.0-7.5 cm long, with a pair of hooked stipulary spines at the base. Leaflets 6-9 pairs, 2.0-3.8 cm long and 1.3-2.2 cm wide, membranous, elliptic to oblong, obtuse, strongly mucronate, glabrous above and more or less puberulous beneath. Flowers produced in dense terminal racemes (usually spicate) with long peduncles and supraaxillary racemes which are close at the top, looser downwards, 15-25 cm long. The pedicles are very short in the buds, elongating to 5 mm in flowers and 8 mm in fruits, brown and downy, bracts squarrose, linear, acute, reaching 1 cm long. The calyx is 6-8 mm long, fulvous and hairy, lobes obovate-oblong and obtuse. Petals oblanceolate, yellow, filaments declinate, flattened at the base, clothed with long white silky hairs. Pods shortly stalked, oblong, 5.0-7.5 by about 4.5 cm, densely armed with wiry prickles. The hard and shiny seeds are 1-2,oblong,upto 1.3 cm long green, turning grey.They are used for jewellery. [6, 10, 19, 20, 21].

Synonyms [10, 15, 22]

Hindi Name: Kantkarej, Kantikaranja, Sagar Gota.

English: Fever nut, bonduc nut, nicker nut, nicker seed

Sanskrit Name : Kakachika, Kantakikaranja, Kantakini, karanja, Krakachika, Kuberaksah, Kuberakshi, Kuberaksi, Latakaranja, Prakiriya, Prakirnah, Putikah, Putikaranja, Putikaranjah, Putikaranji, Tinagachhika, Tirini, Valli, Varini, Vitapakaranja.

Urdu: Akitmakit

Persian Name: Khayahe-i-iblas

Tamil Name: Kalarci ver, Kalarcik Koluntu, Kalarcip paruppu, Kazharchikkaai, Kalachikai, Kalichikai,Kazarci.

Kannada Name: Gajjiga, Kiri gejjuga, Gajikekayi.

Malayalam Name: Ban-karetti, Kaka-moullou, Kazhanji,Kalanci, Kajanchikkur.

Telgu Name: Mulluthige,Gaccakayai.

Geographical Distribution:

An armed liana, up to 15 m in height, found up to an altitude of 1,000 m in Himalaya and wild throughout the plains of India and; it is also found in deltaic region of western, eastern and Southern India [15]. Found particularly along the seacoast throughout the hotter parts of India, Burma and Sri Lanka [19].

Useful part of the plant: [19, 20] whole plants are used for medicinal purpose, such as nuts, root, bark and leaves.

Ayurvedic Description [18-20]

Properties: Rasa: Tikta (bitter), kashaya (astringent)
Guna: Laghu (light), ruksha (dry), tikshna (sharp)
Veerya:Ushna(hoG Vipaka: Katu (pungent)
Dosha: Pacifies tridosha

Action and Uses: Kapha, vat samak, sotha har, badana sthapan, dipan, anuloman, krimighan, rakt sodhak, swashar, mutral, jwaraghan.

Dosage [23]

Powdered seed: 1-2 g
Powdered root: 1-2 g
Leaf infusion: 12-20 ml

Traditional and Modern Uses

The seed is claimed to be styptic, purgative and anthelmintic and cures inflammations, useful in colic, malaria, hydrocele, skin diseases and leprosy. In Madras (Chennai) an ointment is made from the powdered seeds with castor oil and applied externally in hydrocele and orchitis [6, 15, 19, 20, 24]. The seeds are considered tonic, ferifuge, anthelmintic, antiblennorrhagic, and specific in the treatment of hydrocele. The oil from the seeds is used in convulsions and paralysis. In Guinea, the pounded seeds are considered vesicant. The powdered seeds were mixed with equal part of pepper powder to malaria patients and were found to posses feeble antiperiodic properties. In malignant malaria, they did not do any good. The seeds are ground in water and given internally in snake-bite. The seeds are not an antidote to snake-venom [10, 24]. Seed and long pepper powders taken with honey gives good expectorant effect. Burnt seeds with alum and burnt arecanut are a good dentifrice useful in spongy gums, gum boils, etc. In West Indies, the roasted seeds are used as anti diabetic [15, 26].

The kernel of the seed is very useful and valuable in all ordinary cases of simple, continued and intermittent fevers. The kernel powder mixed with equal parts of black pepper is taken thrice a day in a dose of 15-30 grains by adults and 3-4 grains by children. It was made

official in the Indian Pharmaceutical Codex 16 the dose of the powder being 15-18 grains. It is said to produce lots of perspiration, leading to the reduction of fever. Kernel powder with sugar and goat milk gives good result results in liver disorder [25]. Decoction of roasted kernels was used in asthama. Children unable to digest mother's milk were given the extract of the kernel or its powder along with ginger, salt and honey to get good stomachic effect. Paste prepared from kernel gives relief from boils and other such swellings.

A cake made of 30 grains of powdered kernels, fried in ghee taken twice a day is a valuable remedy in cases of acute orchitis, ovaritis and scrofula. Root [6, 15, 20, 24, 26] in La Reunion and Madagascar, the roots are considered febrifuge and anthelmintic, they are much used as an astringent in leucorrhoea and blennorrhagia. In Guinea, a decoction of the root is prescribed in fever. The root-bark is good for tumours and for removing the placenta after child birth [10]. Bark of root possesses number of properties like febrifuge,intestinal worms,amenorrhoea, cough, and anthelmintic etc. In Jamaica, it is used as rubifacient and as a local application for sores. Flowers are used in treating ascites and fruits in treating urinary disorder, leucorrhoea, piles and wounds.

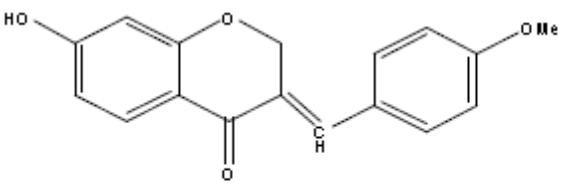
Leaves and twigs are traditionally used for the treatment of tumors, inflammation and liver disorder. They have also been applied for treatment of toothache. Leaves and juices have been used traditionally for elephantiasis and smallpox.

Ethnoveterinary Usage

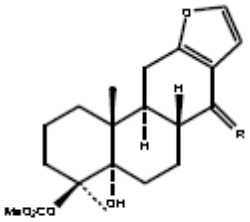
The seeds, leaves and roots are used for the treatment of tachycardia, bradycardia, tuberculosis, tympanitis, pain in the abdomen, fever, cold and cough and liver fluke in ruminants [23].

Phytochemicals [6, 19, 20, 23, 27-34, 71]

Whole plant of *Caesalpinia bonducella* contain all major chemical constituents such as Steroidal Saponin, Fatty Acids, Hydrocarbons, Phytosterols, Isoflavones, Aminoacids, and Phenolics,



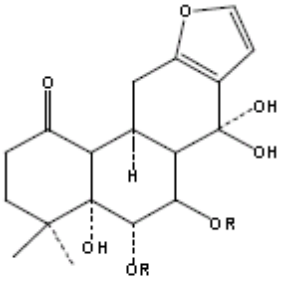
Bonducellin



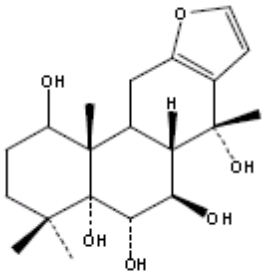
R=H
R=CH2

Caesalpinin

ISSN: 0975-8585



R= Ac Alpha caesalpin
R= H Beta caesalpin



1,5,6,7,14- VOUACAPANEPENTOL

Safety Profile

The maximum tolerated dose of the 50% ethanolic extract was found to be more than 1000 mg / kg body weight when tested in adult male albino mice [23].

Pharmacological Activities

Antidiabetic activity

Seed extract of *Caesalpinia bonducella* were subjected to screening of antidiabetic activity in alloxan induce hyperglycemia.The antihyperglycemic action of the extractmay be due to blocking of glucose absorption. The drug has the potential to act as antidiabetic as well as antihyperlipidemic [35].

Both the aqueous and ethanolic extracts showed potent hypoglycemic activity in chronic type 2 diabetic model. Both fractions could increase secretion of insulin from isolated islet [36].

Adaptogenic activity

Caesalpinia bonducella seed extracts were screened for adaptogenic activity using cold stress model and swim endurance model, the seed coat as well as kernel extracts showed significant antistress activity when administered orally at a dose of 300 mg / kg [37].

Anthelmintic activity

Jabbar A, et *al.,* has first time reported anthelmintic activity in *Caesalpinia bonducella* by in vitro and in vivo, they justified their use in the traditional medicine system of Pakistan [38].

Antiascarid activity of *Caesalpinia cristas*eeds,popularly known as Karanjwa was evaluated in chikens of the Fumi breed,suffering from artificially induced Ascaridia galli infection. *Caesalpinia cristas*eed powder its equivalent methanolic extract and piprazine are equieffctive in treating the ascarid infection of poultry [39].

Anthelmintic activity of leaves of *Caesalpinia bonducella* were investigated for their anthelmintic activity against Phertima posthuma and Ascardia galli.Various concentration were used in bioassay.Both extracts showed significant anthelmintic activity [40].

Antifilarial activity

Caesalpinia bonducella seed kernel extract and fractions showed microfilaricidal, macrofilaricidal and female sterilizing efficacy against L.sigmodontis and microfilaricidal and female sterilizing efficacy againsts B.malayi in animal models, indicating the potential of this plant in providing a lead for new antifilarial drug development [41].

Antiestrogenic activity

Kanchan R,*et al.,* results suggested that alcohol seed extract of *Caesalpinia bonducella* has antiestrogenic property,possibly acting via inhibition of estrogen secretion [42].

Antiinflammatory activity

The antiinflammatory activity was studied in rats using the formalin arthritis and granuloma pouch methods. At a dose of 250 mg/kg the extract was found to be effective in the granuloma pouch model and compared favourably with phenylbutazone. The seeds showed a 50% inhibitory activity against carrageenan-induced oedema in the rat hind paw, at an oral dose of 1000 mg/kg, when given 24 hours and 1 hour prior to carrageenan injection (IP). The activity (66.67% inhibition) was comparable to that of phenylbutazone at a dose of 100 mg/kg [43-45].

Antimalarial activity

Kalauni SK, *et al.,* has reported antimalarial activity of cassane and norcassane type diterpenes from *Caesalpinia crista*and their structure-activity relationship [46].

Linn T Z, *et al.* have been reported cassane and norcassane type diterpene from *Caesalpinia crista*of Indonesia and their antimalarial activity against the growth of plasmodium falciparum [47].

Three new cassane furanoditerpenoids (1-3) together with known cassane diterpenes were isolated from the seed kernels of caesalpinia bonduc.Compounds 1-3 exhibited good antimalarial activity against multidrug resistant K1 strain of plasmodium falciparum [48].

Antimicrobial activity

Sagar K, *et al.,* reported Antimicrobial activity of α-(2-hydroxy-2-methylpropyl)-ω-(2-hydroxy-3-methylbut-2-en-1-yl) polymethylene from *Caesalpinia bonducella* (L.) Flem [49].

Simin K, *et al.,* reported antimicrobial activity of seed extractsand bondenolide from caesalpinia bonduc(L.) Roxb [50].

Arif T, *et al.,* reported in vitro and in vivo antimicrobial activities of seeds of *Caesalpinia bonduc* (Lin.) Roxb [51].

Antibacterial, Antifungal, Antispasmodic activity

Khan HU, *et. al.,* have been reported antibacterial, antifungal, antispasmodic and Ca++ antagonist effects of *Caesalpinia bonducella* [52].

Saeed MA and Sabir AW. reported antibacterial activity in *Caesalpinia bonducella* seeds [53].

Antidiarrhoeal activity

The fruits were found to have significant antidiarrhoeal activity in mice [31].

Antioxidant activity

Nikhil kumar, *et al.,* has reported antioxidant activity in chloroform extract of *Caesalpinia bonducella* seed [54].

Mandal S, *et al.,* gives the assessment of the antioxidant and reactive oxygen species scavenging activity of methanolic extract of *Caesalpinia crista*Leaf.. It may be concluded that 70% methanol extract of C. crista leaves acts as an antioxidant and ROS scavenger; which may be due to the presence of phenolic and flavonoid compounds [55].

Shukla S, *et al.,* has been reported antioxidant activity and total phenolic content of ethanolic extract of *Caesalpinia bonducella* seeds. The results obtained in this study clearly indicate that C. bonducella has a significant potential to use as a natural antioxidant agent [56].

Antiproliferative activity

Yadav pp, *et al.,* isolated Cassane diterpenes from *Caesalpinia bonduc*. The isolated compounds were tested for their antiproliferative activity against MCF-7 (breast adenocarcinoma), DU145 (prostate carcinoma), C33A (Cervical carcinoma) and Vero (African green monkey kidney fibroblast) cells [57].

Antipsoriatic activity

Muruganantham N, *et al.,* screening of *Caesalpinia bonduc* leaves for antipsoriatic activity. Leaves of *Caesalpinia bonduc* (L.) Roxb. have been used by traditional Siddha system healer of Malabar region for psoriasis treatment [58].

Antitumor activity

Gupta M, *et al.,* reported antitumor activity and antioxidant status of *Caesalpinia bonducella* against Ehrlich ascites carcinoma in Swiss albino mice. The methanol extract of *Caesalpinia bonducella* Fleming leaves (MECB) were evaluated for antitumor activity against Ehrlich ascites carcinoma (EAC)-bearing Swiss albino mice, report indicate that MECB exhibited significant antitumor and antioxidant activity in EAC-bearing mice [59].

Anxiolytic Activity

Altaf Ali, *et al.,* have been reported anxiolytic activity of seed extract of *Caesalpinia bonducella* (Roxb).in laboratory animals. The present study was aimed to explore the anxiolytic activities of seed extract of *C.bonducella* in experimental animals, mice and rats. In Stair-case model, all the three doses i-e low, medium and high 400, 600 and 800mg/kg of PECB had showed a significant and dose dependent anxiolytic activity by increasing the number of steps climbed, without any significant effect on rearings by all these three doses. Similarly in EPM model medium and high doses, but not the low dose of PECB had significantly enhanced both number of entries and time spent in open arms and decreased in number of entries and time spent in closed arms. The result recorded with above experimental models confirms the anxiolytic activity of PECB [60].

Larvicidal activity

Saravanan KS, *et al.,* reported Mosquito larvicidal properties of various extract of leaves and fixed oil from the seeds of *Caesalpinia bonduc* (L) Roxb. A preliminary laboratory trial was undertaken to determine the efficacies of petroleum ether, ethanolic, aqueous extracts of dried leaves and fixed oil from the seeds of *Caesalpinia bonduc* (L). Roxb at various concentrations against the fourth instar larvae of Culex quinquefasciatus by WHO guidelines. Hundred per cent mortality was observed in 1% concentration of petroleum ether and ethanolic extract of leaf, whereas it was 55% in 2.5% concentration of aqueous extract and 92.6% in 2.5% concentration of fixed oil. The active constituent responsible for the mortality is to be isolated to come up with a promising larvicidal agent, which will be economic, non pollutant and ecofriendly [61].

Immunomodulatory activity

Shukla S*, et al.,* studies in vivo immunomodulatory activities of the aqueous extract of bonduc nut *Caesalpinia bonducella* seeds. This study evaluated the in vivo immunomodulatory activities of the aqueous extract of *Caesalpinia bonducella* Fleming seeds. C. bonducella is a plant widely used in the traditional medicinal systems of India. In the present investigation, the aqueous extract of C. bonducella seeds was tested for its effect on cell mediated and humoral components of the immune system in rats. Administration of C. bonducella seed extract produced an increase of 93.03 +/- 4 mean hemagglutinating antibody (HA) titer and a change of 0.56 +/- 0.058 mm in delayed type hypersensitivity (DTH) as compared to control at a dose of

400 mg/kg body weight. Thus, the results of this study indicate that C. bonducella extract could be a promising immunostimulatory agent [62].

Shukla S, *et al.,* investigated Immunomodulatory activities of the ethanolic extract of *Caesalpinia bonducella* seeds. The results obtained in this study indicate that *Caesalpinia bonducella* possesses potential immunomodulatory activity and has therapeutic potential for the prevention of autoimmune diseases [63].

Hypoglycemic activity

Chakrabarti S, *et al.,* reported advanced studies on the hypoglycemic effect of *Caesalpinia bonducella* F. in type 1 and 2 diabetes in Long Evans rats. *Caesalpinia bonducella*, widely distributed throughout the coastal region of India and used ethnically by the tribal people of India for controlling blood sugar was earlier reported by us to possess hypoglycemic activity in animal model. This prompted us to undertake a detail study with the aqueous and ethanolic extracts of the seeds of this plant in both type 1 and 2 diabetes mellitus in Long Evans rats. Significant blood sugar lowering effect ($P < 0.05$) of *C. bonducella* was observed in type 2 diabetic model. Special emphasis was given on the mechanistic study by gut absorption of glucose and liver glycogen [64].

Sharma SR, *et al.,* reprted hypoglycaemic, antihyperglycaemic and hypolipidemic activities of *Caesalpinia bonducella* seeds in rats. Hypoglycaemic, antihyperglycaemic and hypolipidemic activities of the aqueous and 50% ethanolic extracts of *Caesalpinia bonducella* Fleming seeds were studied in normal and streptozotocin (SZ)-diabetic rats. In normal rats, both the extracts exhibited hypoglycaemic activity as early as 4 h after administration at a lower dose of 100 mg/kg. The hypoglycaemia produced by the aqueous extract was of prolonged duration as compared to ethanolic extract. In diabetic rats, both the extracts produced significant ($P < 0.01$) antihyperglycaemic effect from day 5 onwards. Aqueous extract also exhibited antihypercholesterolemic and antihypertriglyceridemic effects in SZ-diabetic rats. These results suggest that C. bonducella seeds possess an antidiabetic principle and can be useful for treatment of diabetes [65].

Moshi MJ and Nagpa V. reported effect of *Caesalpinia bonducella* seeds on blood glucose in rabbits. The seeds of *Caesalpinia bonducella* are sold in shops in Dar es Salaam, Tanzania, for the treatment of diabetes mellitus. A suspension of the powdered seed kernel in 0.5% carboxymethylcellulose (CMC) was tested for ability to lower blood glucose in fasted and glucose-fed normal albino rabbits. Following administration of 0.2, 0.4 and 0.8 g/kg body weight of the powder there was no difference in areas under the fasting blood glucose and oral glucose tolerance test (OGTT) curves as compared to controls given CMC (P > 0.05). Similarly, 0.2 g/kg body weight of the powder administered for 7 consecutive days had no effect on either fasting blood glucose or the clearance of a glucose load from the blood. However, 0.1 g/kg body weight chlorpropamide significantly decreased the area under the fasting blood glucose and OGTT curves as compared to controls given CMC ($P = 0.05$). Thus, contrary to a

previous report, we could not detect any hypoglycaemic activity in the seeds of *Caesalpinia bonducella* growing in Dar es Salaam [66].

Biswas T.K. *et al.,* reported oral hypoglycemic effect of *Caesalpinia bonducella*. The blood sugar lowering efficacy of the aqueous extract of *Caesalpinia bonducella* F. (seed shell) was evaluated in fasted, fed, glucose loaded, streptozotocin diabetic, and alloxan diabetic rat models. The extract was administered orally at a dose of 250 mg/kg of rat body weight. It produced very significant blood sugar lowering (at least $P < 0.005$) in glucose loaded, streptozotocin diabetic, and alloxan diabetic models. However, effects were not so pronounced in fasted and fed models. As a whole, *Caesalpinia bonducella* can be regarded as a good oral hypoglycemic agent in rat [67].

Muscle contractile activity

Datté JY, *et al.,* Leaf extract of *Caesalpinia bonduc* Roxb. induces an increase of contractile force in rat skeletal muscle in situ. The pharmacological properties of *Caesalpinia bonduc* Roxb. are not well known, but it is used traditionally to treat snake bite. In the present study, the mechanism through which *Caesalpinia bonduc* extract (Cebo) affects gallamine-induced relaxation in rat tibial muscle contractility were studied via measurement of isometric-tension-anesthetized, 10-12-week-old, male rats. Isometric twitch contractions of the indirectly-stimulated anterior tibia muscle of the right hindleg were recorded in situ. Cebo administered intravenously increased twitch contractions in a dose-dependent manner. The ED50 value is 2.75 x 10(-4) g/kg body wt. Similar results were obtained using the anticholinesterase neostigmine. In contrast, gallamine (a non-depolarizing muscle relaxant) or the venom of the puff adder Bitis arietans reduced the force of contraction. Treatment with Cebo or neostigmine, however, reversed the relaxation induced by either gallamine or puff adder venom. In conclusion, Cebo stimulates the muscle contractile activity, an effect which may be due to an activation of the cholinergic mechanism [68].

Datté JY, *et al.,* reprted effects of leaf extract of *Caesalpinia bonduc* on the contractile activity of uterine smooth muscle of pregnant rats. The calcium dependency and the cholinergic effect of the leaf extract of *Caesalpinia bonduc* Roxb. was studied in isolated pregnant rat myometrium preparations. Isometric contractions were recorded. The extract (Cebo) increased the contractile force in the isolated strips in a concentration-dependent manner. The effects were comparable to those obtained with acetylcholine. Contractions induced by Cebo or acetylcholine were inhibited in the presence of atropine. The stimulating action of Cebo on the contractile responses of isolated myometrium preparations inhibited by atropine may be mediated by cholinergic receptors. In calcium-free solution Cebo induced a tonic contraction (contracture) of the muscle. Moreover, in high-potassium calcium-free solution Cebo caused contracture of the uterine smooth muscle. Cebo was still able to elicit contractions in calcium-free solution containing EDTA or EGTA. These findings suggest the existence of cholinergic receptors sensitive to Cebo which could influence the influx of calcium (phasic contraction) and mobilization of calcium from cellular stores (tonic contraction), both of which are responsible

for the increase of contractile activity and development of the contracture of uterine smooth muscle [69].

Hepatoprotective activity

R. Sambath Kumar, *et al.,* study was carried out to evaluate the hepatoprotective and antioxidant effect of the methanol extract of *Caesalpinia bonducella* in wister albino rats. Hepatoprotective and antioxidant effects of *Caesalpinia bonducella* on carbon tetrachloride-induced liver injury in rats. The present study was carried out to evaluate the hepatoprotective and antioxidant effect of the methanol extract of *Caesalpinia bonducella* (MECB) in Wistar albino rats. The different groups of animals were administered with carbon tetrachloride (CCl4) (30 % CCl4, 1 ml/kg b. wt. in liquid paraffin 3 doses (i.p.) at 72 h interval). The MECA at the doses of 50, 100 and 200 mg/kg and silymarin 25 mg/kg were administered to the CCl4 treated rats. The effect of MECB and silymarin on serum glutamyl pyruvate transaminase (SGPT), Serum glutamyl oxalacetic acid transaminase (SGOT) Serum alkaline phosphatase (SALP), bilirubin, uric acid and total protein were measured in the CCl4 induced hepatotoxicity in rats. Further, the effects of the extract on lipid peroxidation (LPO), enzymatic antioxidant (superoxide dismutase (SOD) and catalase (CAT)), and non enzymatic antioxidant (glutathione (GSH), vitamin C and vitamin E) were estimated. The MECB and silymarin produced significant ($p < 0.05$) hepatoprotective effect by decreasing the activity of serum enzymes, bilirubin, uric acid, and lipid peroxidation and significantly ($p < 0.05$) increased the levels of SOD, CAT, GSH, vitamin C, vitamin E and protein in a dose dependent manner. From these results, it was suggested that MECB possess potent hepatoprotective and antioxidant properties [70].

Anticonvulsant activity

A. Ali, *et al.,* reported anticonvulsive effect of seed extract of *Caesalpinia bonducella (Roxb..)* For assessing anticonvulsant activity, pentylenetetrazole, maximal electro shock, strychnine- and picrotoxin-induced convulsions models were used. Diazepam was used as a standard reference for all models except maximal electro shock model, wherein phenytoin was used as standard reference. Seed kernels of *C. bonducella* were powdered and subjected to successive extraction with solvents like petroleum ether (PE), ethanol, methanol and water using soxhlet apparatus. All the extracts were administered as suspension in 2% gum acacia in all the experiments. Preliminary phytochemical investigation of petroleum ether extract of *Caesalpinia bonducella* revealed the presence of saponins, glycoside, starch, sucrose, proteins, sterols and reported constituents like homoisoflavone (bonducillin) and a non alkaloid bitter principle (natin). It was found to be non-toxic even up to the dose level of 3000mg/kg (LD50). In pentylenetetrazole, maximal electro shock, strychnine- and picrotoxin-induced convulsion models medium and high doses (600 and 800mg/kg) of the extract showed significant anti-convulsant activity. The present investigation revealed that the PECB possessed anticonvulsant activity which may be contributed to the presence of phytoconstituents such as saponins, proteins, homoisoflavone (bonducillin), carbohydrates and sterols present in the drug, as these are already reported for their anxiolytic and anti-convulsant activities [71].

Anti-amyloidogenic activity

Ramesh BN, *et al.,* reported anti-amyloidogenic property of leaf aqueous extract of *Caesalpinia crista*. Amyloid beta (Abeta) is the major etiological factor implicated in Alzheimer's disease (AD). Abeta(42) self-assembles to form oligomers and fibrils via multiple aggregation process. The recent studies aimed to decrease Abeta levels or prevention of Abeta aggregation which are the major targets for therapeutic intervention. Natural products as alternatives for AD drug discovery are a current trend. We evidenced that *Caesalpinia crista*leaf aqueous extract has anti-amyloidogenic potential. The studies on pharmacological properties of C. crista are very limited. Our study focused on ability of C. crista leaf aqueous extract on the prevention of (i) the formation of oligomers and aggregates from monomers (Phase I: Abeta(42)+extract co-incubation); (ii) the formation of fibrils from oligomers (Phase II: extract added after oligomers formation); and (iii) dis-aggregation of pre-formed fibrils (Phase III: aqueous extract added to matured fibrils and incubated for 9 days). The aggregation kinetics was monitored using thioflavin-T assay and transmission electron microscopy (TEM). The results showed that C. crista aqueous extract could able to inhibit the Abeta(42) aggregation from monomers and oligomers and also able to dis-aggregate the pre-formed fibrils. The study provides an insight on finding new natural products for AD therapeutics [72].

A trypsin and chymotrypsin inhibitor activity

Bhattacharyya, Arindam, *et al.,* reported a trypsin and chymotrypsin inhibitor from *Caesalpinia bonduc* seeds: Isolation, partial characterization and insecticidal properties. Evolution of proteinase inhibitor diversity in leguminous plants of tropical rainforests is under immense pressure from the regular upregulation of proteolytic machinery of their pests. The present study illustrates the isolation and bioinsecticidal potency of a serine proteinase inhibitor from the seeds of *Caesalpinia bonduc* (CbTI), inhabiting Great Nicobar Island, India. Following initial fractionation by ammonium sulfate precipitation, CbTI was purified to homogeneity by ion exchange, gel filtration and trypsin affinity chromatography. SDS-PAGE of gel filtrated CbTI showed a couple of proteins CbTI-1 (~16 kDa) and CbTI-2 (20 kDa) under non-reducing conditions, which subsequent to trypsin affinity chromatography yielded only CbTI-2. Both Native PAGE as well as iso-electric focusing showed 2 iso-inhibitors of CbTI-2 (pI values of 5.35 and 4.6). CbTI exhibited tolerance to extremes of temperatures (0-60 degree C) and pH (1-12). A 1:1 stoichiometric ratio was noted during CbTI-2etrypsin complex formation, which was absent on binding with chymotrypsin. Further, SDS-PAGE analysis also showed that CbTI-1 has affinity only towards chymotrypsin, whereas both trypsin and chymotrypsin formed complexes with CbTI-2. Dixon plot analysis of CbTI-2 yielded inhibition constants (Ki) of 2.75 X 10 -10 M and 0.95 X 10 -10 M against trypsin and chymotrypsin activity respectively. Preliminary investigations on the toxicological nature of CbTI revealed it to be a promising bioinsecticidal candidate [73].

Antiviral activity

An ethanolic extract of the root and stem exhibited activity against the Vaccinia virus [74].

Toxicity Studies

Preeja G. Pillaia and P. Suresh reported evaluation of acute and sub-acute toxicity of methanolic extract of *Caesalpinia bonducella* (L) Fleming was evaluated in Albino mice. The acute toxicity studies were conducted as per the OECD guidelines420 where the limit test dose of 2000mg/kg used. Observations were made and recorded after treatment at 2 hrs, 4 hrs, 8 hrs and then for seven days regularly for respiration rate, heart rate, and behavioural signs like apathy, reduced locomotor activity as well as licking. For the sub-acute toxicity, three groups of 6 mice were received distilled water (control), 200 and 400 mg/kg of extracts every 24 hr orally for 28 days. No significant variation in the body and organ weights between the control and the treated group was observed after 28 days of treatment. Hematological analysis and clinical blood chemistry revealed no toxic effects of the extract. Pathologically, neither gross abnormalities nor histo pathological changes were observed. No mortality was recorded in 28 days [75].

Kumar RS, *et al.,* reported investigation deals with the hematology and hepatorenal function of *Caesalpinia bonducella* Flem. and *Bauhinia racemosa* Lam. The tribal people of Kolli Hills, Tamil Nadu, India, use the leaves of *Caesalpinia bonducella* and the stem bark of *Bauhinia racemosa* in combination with some other herbs for the treatment of various tumors, liver disorders, inflammation and some other diseases. In ancient Ayurveda medicine these plants were mentioned to possess antitumor agents. Since there are no scientific reports regarding the toxicological aspects of these plants, the present investigation deals with the sub-chronic toxicity studies of a methanol extract of *Caesalpinia bonducella* (MECB) leaves and *Bauhinia racemosa* (MEBR) stem bark in Swiss albino mice. The MECB and MEBR were administered intraperitoneally to Swiss albino mice twice a week for thirteen weeks. No significant alterations in hematological, biochemical and histopathological parameters were observed in the MECB- and MEBR-treated groups at the doses of 100 and 200 mg/kg body weight. Administration of MECB and MEBR at the dose of 400 mg/kg body weight elevated the levels of serum enzymes and altered the hematological parameters. Our results suggested that MECB and MEBR at doses 100 and 200 mg/kg body weight did not induce any toxic effects in the mice. Adverse effect was noted at the dose of 400 mg/kg body weight [76].

REFERENCES

[1] Asolkar LV, Kakkar KK, and Chakre OJ. Second Suppl. To Glossary of Indian Medicinal Plants with Active Principles, PID-CSIR, New Delhi, 1992: Part 1,150.

[2] White R. Legume web [Internet]. version 10.01. Cardiff (UK): Cardiff University, School of Computer Sciences. c 2005– [Revised 2005 Nov 1; cited 2008 Sep 23]. Available from: http://www.ildis.org/Legumeweb

[3] Kirtikar KR, Basu BD. Indian medicinal plants. 2nd ed. Dehradun: International Book Distributors; 1988: 839-902.

[4] Gaur RL, Sahoo MK, Dixit S, Fatma N, Rastogi S, Kulshreshtha DK, Chatterjee RK, Murthy PK. Indian J Med Res 2008; 128: 65–70.

[5] Gupta AK, Sharma M, Tandon N. Quality standards of Indian medicinal plants. Vol–2. New Delhi: Indian Council of Medical Research. 2005: 25-33.
[6] Handa SS. and Kaul MK., Supplement to Cultivation and Utilization of Medicinal Plants, RRL, Jammu-Tawi, 1996: 727-737.
[7] Jha NK, and Pandey IK. Phytopharm 2011: 5-21.
[8] The Wealth of India, Raw material, Publication and Information Directorate, CSIR, New Delhi,1950: 2, 3.
[9] Asolkar LV, Kakkar KK and Chakre OJ. Second Suppl. To Glossary of Indian Medicinal Plants with Active Principles, PID-CSIR, New Delhi, 1992: Part 1,150.
[10] Kirtikar KR, Basu BD, Indian Medicinal Plants, 2nd ed, BSMP Singh and Periodical Experts, New Delhi, 1975: 2, 842.
[11] Blagoveshehenski AV, Aleksandrova EG, Biokhim A, Filog VR, 1st ed, 1981: 3.
[12] Gamble JS. Flora of the Presidency of Madras 2, 278.
[13] Ram P, Rastogi and Mehrotra BN. Compendium of Indian Medicinal Plants, CDRI, Lucknow and PID CSIR, New Delhi, 1991: 1: 67.
[14] Shah GL, Flora of Gujarat State 1978, Part 1, 264.
[15] The Wealth Of India, Raw material, Ca-Ci, Revised Ed, Publication and Information Directorate, CSIR, New Delhi, 1992; 3: 6-8.
[16] Hooker JD. The Flora of British India, L Reeve and Co Ltd, Kent 1879: 2: 254.
[17] Watson R and Fowden I. Photochemistry 1973: 12(3): 617.
[18] http://www.doctorayur.com/index.php?option=com_content&view=article&id=96:caesalpinia-bonducella
[19] Kapoor LD. Hand of Ayurvedic Medicinal Plants, CRC Press 88.
[20] Elizabeth M. Williamson Major Herbs of Ayurveda, Churchill 83-86.
[21] Sharma BM and Singh P. J. Res. Indian Med 1972; 7: 8.
[22] Kapoor LD. Hand of Ayurvedic Medicinal Plants, CRC Press 87.
[23] "Gray Nickarbean or Sea Pearl Caesalpinia bonduc". A Seabean Guide. seabean.com. http://www.seabean.com/guide/Caesalpinia_bonduc/. Retrieved 2010-12-07.
[24] Kirtikar and Basu, Indian Medicinal Plants, 2nd ed, BSMP Singh and Periodical Experts, Dehra Dun 1993;2: 844-845.
[25] Khan SS, Chaghtai SA and Oommachan M. J Sci Res 1982; 43: 185.
[26] Komal Moon, SS Khadabadi, UA Deokate, SL Deore. Report and Opinion 2010; 2(3): 83-90.
[27] Phytochemical Dictionary of the Leguminoseae, LDIS and CHCD, 1993: Chapmann and Hall, U.K.
[28] Willaman JJ and Li HL. J Nat Prod Suppl 1970: 33(3A).
[29] Ghatak NG. Proc Indian Acad Sci 1934; 4: 141.
[30] Bhaduri K. Proc Chem Soc 1912; 28: 53.
[31] Iyenger MA and Pendse GS. Indian J Phar 1965; 27: 307.
[32] Puri HS, Bull Med Ethnobot Res 1980; 1: 384.
[33] Dymock, Warden, and Whooper, Pharmacographica Indica, 1st ed., Educ Soc Press, Bombay, 1890: 1: 496.
[34] Tummin Katti MC. J Indian Chem Soc 1930; 7: 207.

[35] Kannur DM, Hukkeri VI, Akki KS. Antidiabetic activity of Caesalpinia bonducella seed extracts in rats. Fitoterapia 2006; 546-549.
[36] Chakrabarti S, Biswas TK, Seal T, Rokeya B, Ali L, Azad Khan AK, Nahar N, Mosihuzzaman M, Mukherjee B. J Ethnopharmacol 2005: 117-22.
[37] Kannur DM, Hukkeri VI, KS Akki. J Ethnopharmacol 2006; 6: 327-331.
[38] Jabbar A., Muhammad AZ, Zafar I, Yaseen M, Shamim A. J Ethnopharmacol 2007; 114: 86-91.
[39] Javed I, Akhtar MS, Rahman ZU, Khaliq T and Ahmad M. Acta Veterinaria Hungarica 1994: 103—109.
[40] Ganesh H Wadkar, Suraj Mulani, Alamshah Pathan, Shrinivas Mohite. J Pharmacy Research 2010; 3: 926-927.
[41] Gaur RL, Sahoo MK, Dixit S, Fatma N, Rastogi S, Kulshreshtha DK, Chatterjee RK. Indian J Med Res 2008; 128: 65–70.
[42] Salunke, Kanchan R, Nazeer AR, Marigoudar, Shambanagouda R. L. J Basic and Clinical Physiology and Pharmacology 2011; 22:49-49.
[43] Shukla S, Mehta A, Mehta P, Vyas SP, Shukla S, Bajpai VK. Food Chem Toxicol 2010; 28: 61-4.
[44] Archana P, Tandan SK, Chandra S, Lal J. Phytother Res 2005; 28: 376-81.
[45] Devi R.Aruna, Tandan SK, Kumar D, Dudhgaonkar S, Lal J. Pharmaceutical biology 2008; 46: 668-672
[46] Kalauni SK, Awale S, Tezuka Y, Banskota AH, Linn TZ, Asih PB, Syafruddin D, Kadota S. Biol Pharm Bull 2006; 29: 1050-1052.
[47] Linn TZ, Awale S, Tezuka Y, Banskota AH, Kalauni SK, Attamimi F, Ueda JY, Asih PB, Syafruddin D, Tanaka K, Kadota S. J Nat Prod 2005; 68: 706-710.
[48] Pudhom K, Sommit D, Suwankitti N, Petsom A. J Nat Prod 2007; 70: 1542-1544.
[49] Sagar K, Vidyasagar GM. Indian J Pharm Sci 2010; 72: 497-500.
[50] Simin K, Kaliq-uz-Zaman SM, Ahmad VU. Phytotherapy Research 2001: 437–440.
[51] Arif T, Mandal TK, Kumar N, Bhosale JD, Hole A, Sharma GL, Padhi MM, Lavekar GS, Dabur R. J Ethnopharmacol 2009; 129: 177-80
[52] Khan HU, Ali I, Khan AU, Naz R, Gilani AH. Nat Prod Res 2011; 25: 444-449.
[53] Saeed MA, Sabir AW. Fitoterapia 2001; 72: 807-9.
[54] Sachan NK, Verma S, SachanAK and Arshad H. Annals of Pharmacy and Pharmaceutical sciences 12010: 88-91.
[55] Mandal S, Hazra B, Sarkar R, Biswas S, Mandal N. Evid Based Complement Alternat Med 2009; :13.
[56] Shukla S, Mehta A, John J, Singh S, Mehta P, Vyas SP. Antioxidant activity and total phenolic content of ethanolic extract of Caesalpiniabonducella seeds. Food Chem Toxicol 2009; 47: 1848-51
[57] Yadav PP, Maurya R, Sarkar J, Arora A, Kanojiya S, Sinha S, Srivastava MN, Raghubir R. Phytochemistry. 2009; 70(2): 256-61.
[58] Muruganantham N, Basavaraj KH, Dhanabal SP, Praveen TK, Shamasundar NM, Rao KS. J Ethnopharmacol 2011; 27: 897-901.
[59] Gupta M, Mazumder UK, Kumar RS, Sivakumar T, Vamsi ML. J Pharmacol Sci 2004; 92: 177-84.

[60] Ali A, Rao NV, Shalam M, Gouda TS, Babu JM and Shantakumar S. The Internet Journal of Pharmacology 2008; 5: 1531
[61] Saravanan KS, Periyanayagam K, Ismail M. J Commun Dis 2007; 39: 153-157.
[62] Shukla S, Mehta A, Mehta P, Vyas SP, Shivaprasad HN. Pharm Biol 2010; 48: 227-30.
[63] Shukla S, Mehta A, John J, Mehta P, Vyas SP, Shukla S. J Ethnopharmacol 2009; 125:252-6.
[64] Chakrabarti S, Biswas TK, Rokeya B, Ali L, Mosihuzzaman M, Nahar N, Khan AK, Mukherjee B. J Ethnopharmacol 2003; 84: 41-6.
[65] Sharma SR, Dwivedi SK, Swarup D. J Ethnopharmacol1997; 58: 39-44.
[66] Moshi MJ, Nagpa V. Pharm Biol 2000; 38: 81-86.
[67] Biswas TK, Bandyopadhyay S, Mukherjee B. Pharmaceutical Biology Formerly International Journal of Pharmacognosy 1997; 35: 261-264.
[68] Datté JY, Yapo PA, Kouamé-Koffi GG, Kati-Coulibaly S, Amoikon KE, Offoumou AM. Phytomedicine 2004; 34: 235-41.
[69] Datté JY, Traoré A, Offoumou AM, Ziegler A. J Ethanopharmacol 1998; 60(2): 149-55.
[70] Sambath RK, Kumar AK, Venkateswara.MN. International Research J Plant Science 2010; 1: 062-068.
[71] Ali A, Rao NV, Shalam MD, Gouda TS and Kumar SM. Int J Pharmacy Tech 2009; 8: 51-55.
[72] Ramesh BN, Indi SS, Rao KS. Neurosci Lett 2010; 475: 110-4.
[73] Bhattacharyya, Arindam Rai, Shruti, Babu CR. Plant Physiol Biochem 2007; 45: 169-77.
[74] Dhar ML, Dhar MM, Dhawan BN, Mehrotra BN, and Ray C. Indian J Exp Biol 1968; 6: 232.
[75] Preeja G, Pillaia and Suresh P. European J Scientific Research 2011; 53: 462-469
[76] Kumar RS, Gupta M, Mazumdar UK, Rajeshwar Y, Kumar TS, Gomathi P, Roy R. J Toxicol Sci 2005; 30: 265-74.