

## Review Article

### Review on Pharmacology and Phytochemistry of *Caesalpinia bonduc*.

P.A. Shelar<sup>\*1</sup>, Y.D. Mandavkar<sup>2</sup>, A.S. Khedkar<sup>2</sup>, M.B. Thorat<sup>1</sup>, V.N. Raje<sup>1</sup>

<sup>1</sup>Gourishankar Institute of Pharmaceutical Education and Research, Limb, Satara, Maharashtra, <sup>2</sup>Department of Pharmacognosy, K.L.E.S.'s College of Pharmacy, Belgaum-10, Karnataka.

#### Abstract

Many herbal remedies have been employed in various medical systems for the treatment and management of different diseases. The plant *Caesalpinia bonduc* has been used in different system of traditional medication for the treatment of diseases and ailments of human beings. *Caesalpinia bonduc* L., commonly known as Nata Karanja, a prickly shrub found throughout the hotter parts of India, Myanmar and Sri Lanka. Plant is reported to have multiple therapeutic properties like, anti-anaphylactic, antiviral, antiasthmatic, antiamebic and anti-estrogenic. Blood sugar lowering activity of *Caesalpinia bonduc* has been primarily evaluated with significant result in rabbit and rat models. It is reported to contain various Alkaloids, Glycosides, Terpenoids and Saponins. It has been reported as anti-asthmatic, anti-diabetic, anti-inflammatory, anti-oxidant, anti-bacterial, anti-filarial, anti-tumor, anxiolytic, immunomodulatory, hypoglycemic activity. This review is an effort to compile all the information reported on its phytochemical and pharmacological activities. Therefore, this information will be helpful to create interest towards the plant and may be useful in developing new formulations.

**Keywords:** *Caesalpinia bonduc*, Traditional uses, Phytoconstituents, Pharmacological activities.

#### Introduction

India has one of the richest plant medical traditions in the world. It is a tradition that is of remarkable contemporary relevance for ensuring health security to the teeming millions. There are estimated to be around 25,000 effective plant-based formulations, used in folk medicine and known to rural communities in India. There are over 1.5 million practitioners of traditional medicinal system using medicinal plants in preventive, promotional and curative applications. It is estimated that there are over 7800 medicinal drug-manufacturing units in India, which consume about 2000 tons of herbs annually.<sup>1</sup> The present review highlights the Phytochemistry and pharmacology of *Caesalpinia bonduc*.

*Caesalpinia bonduc* Linn. Roxb is a large scandent prickly shrub, found throughout the hotter parts of India, Burma and Ceylon, particularly along the sea coast, and up to 2,500 feet on the hills. It is common in Bangal, Burma and south India.

#### Morphology

The seeds are almost globular in shape, grey in colour, hard with a smooth shiny surface. The shell, which is thick and brittle, encloses a yellowish-white, bitter, fatty kernel.

Leaves are bipinnate, large, stipules foliaceous, pinnae 7 pairs, leaflet 3-8 pairs with 1-2 small recurved prickles between them on the underside.

Flowers are yellow, in dense long peduncled supra-auxillary racemes at the top.

Fruits are inflated pods, covered with wiry prickles. Pods are oblong, densely armed with sharp wiry prickles, dehiscent. Branches are armed with recurved prickles.<sup>2,3,4</sup>

Corresponding author.

E-mail address: pshelar82@gmail.com

(P.A. Shelar)

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### Chemical constituents of plant

The seeds of the plant contain Bonducin, Proteins, Saponin, Starch, Sucrose, two Phytosterols namely Sitosterol and Heptocosane, a new Homoisoflavone-Bonducelline and Citrulline, Fatty acids such as Palmitic, Stearic, Lignoceric, Oleic, Linolenic acids. The seed kernels of the plant contain  $\alpha$ -,  $\beta$ -,  $\gamma$ - and  $\delta$ -Caesalpins, Caesalpin-F and Amino acids.<sup>5,6,7,8</sup>

### Medicinal uses of plant

Seeds are bitter, astringent, acrid, anti-inflammatory, anthelmintic, antiperiodic,

digestive, stomachic, liver tonic, expectorant, antipyretic, aphrodisiac and tonic. They are also useful in cough, asthma, leprosy, skin diseases, dyspepsia, dysentery, hepatopathy, splenopathy, diabetes and intermittent fevers. They are used externally for dispersing Inflammatory, Swelling. Oil from seeds is an Emollient, used to remove freckles from the face. Kernels are used as a Tonic in fever. The Ethanolic extracts of the defatted seed kernels of plant drug shows antimalarial activity. A decoction of the roasted seed is used in asthma. The fatty oil obtained from the nucleus of the seeds is useful in Convulsion and Paralysis.<sup>4,7,9,10</sup>



Fig. 1a: *C. bonduca* Plant

Fig. 1b: *C. bonduca* Flower

Fig. 1c: *C. bonduca* Seeds

Table 1: Pharmacological review of plant *Caesalpinia bonduca*.

Sr. No	Activity	Model	Plant part	Remark
1	Antipyretic and analgesic activity <sup>11</sup> (Archana P et al, 2005)	Acetic acid-induced writhing test in mice and Randall-Selitto assay in rats	Ethanolic extract (70%)	Ethanolic extract of seed kernel possesses potent antipyretic and analgesic activities.
2	Antidiabetic activity <sup>12</sup> (Chakrabarti S et al 2005)	Chronic type 2 diabetic model alongwith insulin secretagogue activity	Five fractions isolated from the seed kernel	Aqueous and ethanolic extracts showed potent hypoglycemic activity
3	Anticarcinogenic activity <sup>13</sup> (Gupta M, et al,2005)	Hepatocellular carcinoma induced by N-nitrosodiethylamine (NDEA).	Methanol extract	Anticarcinogenic properties of MECB may also be explained by its strong antioxidant capacity.
4	Antibacterial activity <sup>14</sup> (Raman N, et al,2000)	Extraction, characterization and antibacterial activity of <i>Caesalpinia bonducella</i> seed oil	N-hexane extract	Oil of <i>Caesalpinia bonducella</i> showed antibacterial activity against <i>Pseudomonas aeruginosa</i> .
5	Oral hypoglycemic effect <sup>15</sup> (Biswas TK, et al, 1997)	Glucose loaded, streptozotocin diabetic and alloxan diabetic model	Aqueous extract of seeds shell	Oral administration produced very significant blood sugar lowering.
6	Adaptogenic activity of seed extracts in rats <sup>16</sup> (Kannur DM, et al,	Cold stress model and swim endurance model	Seed coat as well as kernel extracts	Seed extracts showed adaptogenic activity.

	2006)				
7	Advanced studies on the hypoglycemic effect <sup>17</sup> (Chakrabarti S, et al, 2003)	Type 1 and 2 diabetes mellitus in Long Evans rats	Aqueous and ethanolic extracts of the seeds	Significant blood sugar lowering effect was observed in type 2 diabetic model.	
8	Isolates three Cassane Diterpenes and testing for their antiproliferative activity <sup>18</sup> (Yadav pp, et al, 2009)	Breast adenocarcinoma, prostate carcinoma, Cervical carcinoma and Vero (African green monkey kidney fibroblast) cells	Ethanolic extract	Showed significant activity.	
9	<i>In-vitro</i> and <i>in-vivo</i> antimicrobial activities <sup>19</sup> (Arif T, et al, 2009)	<i>In-vitro</i> - microbroth dilution assay <i>In-vivo</i> - chronic <i>Pseudomonas aeruginosa</i> , <i>Pneumonia mimicking</i> that in patients with cystic fibrosis	<i>In-vitro</i> -seed coat and seed kernel extracts <i>In-vivo</i> - hydro-alcoholic extracts	Showed potent antimicrobial activity.	
10	Phytochemical studies and isolation of two Homoisoflavonoids and testing for glutathione S transferase inhibitory, antifungal activity. <sup>20</sup> (Ata A, et al, 2009)	-	Ethanolic extract	Ethanolic extracts yielded two new Homoisoflavonoids, Caesalpinianone, and 6-O-methylcaesalpinianone and possess glutathione S transferase inhibitory and antifungal activity.	
11	Hypoglycemic, antihyperglycemic and hypolipidemic activities <sup>21</sup> (Sharma SR et al 1997)	Streptozotocin (SZ)- diabetic rats	Aqueous and 50 % ethanolic extracts	Shows significant antihyperglycemic and hypolipidemic effects.	
12	Contractile activity of uterine smooth muscle of pregnant rats <sup>22</sup> (Datte JY et al 1998)	Isometric concentrations were recorded	Leaf Extract	Extract increased the contractile force in isolated strips in a concentration dependent manner.	
13	Antitumor Activity and Antioxidant Status <sup>23</sup> (Gupta M et al 2004)	<i>Ehrlich ascites</i> carcinoma in Swiss Albino Mice	Methanol extract	Significant antitumor and antioxidant activity.	
14	Antifilarial activity <sup>24</sup> (Fatma N et al 2008)	Experimental filarial infections	Seed kernel extract and fractions	Showed Microfilaricidal, Macrofilaricidal and female-sterilizing efficacy against <i>L. Sigmodontis</i> and Microfilaricidal and female-sterilizing efficacy against <i>B. malayi</i> in animal models, indicating the potential of this plant in providing a lead for new antifilarial drug development.	
15	Isolation of New cassane butenolide hemiketal diterpenes and antiproliferative activity <sup>25</sup> (Yadav P et al 2007)	The structures of two new Cassane butenolides, Caesalpinolide A (1) and B (2), were elucidated by the	Ethanolic extract and further fractionation of the EtOH extract and column chromatographic	Compounds 1 and 2 were found to inhibit MCF-7 breast cancer cell lines.	

		analysis of spectroscopic data and relative stereochemistry was assigned on the basis of ROESY correlations. Inhibition of MCF-7 breast cancer cell lines along with the inhibition of endometrial and cervical cancer cell lines.	purification of the hexane fraction		
16	Immunomodulatory activity <sup>26</sup> (Shukla S et al 2009)	Neutrophil adhesion test, haemagglutinating antibody (HA) titre, delayed-type hypersensitivity (DTH) response, phagocytic activity and cyclophosphamide-induced myelosuppression.	Ethanollic extract	seed	Significant increase in percent neutrophil adhesion to nylon fibers as well as a dose-dependent increase in antibody titre values, and potentiated the delayed type hypersensitivity reaction induced by sheep red blood cells.
17	Antidiabetic activity <sup>27</sup> (Kannur DM et al 2006)	Diabetes induced hyperlipidemia	Seed extracts		The extracts significantly lowered the elevated cholesterol as well as LDL level. The antihyperglycemic action of the extracts may be due to the blocking of glucose absorption.
18	Isolation, partial characterization and insecticidal Properties of Plant <sup>28</sup> (Bhattacharyya A et al 2007)	Insecticidal properties of a trypsin and chymotrypsin inhibitor	Seed extracts		Showed significant insecticidal activity
19	Antibacterial activity. <sup>29</sup> (Saeed MA et al 2001)	Against both gram-positive and gram-negative bacteria.	Methanol extract of seeds		The methanol extract and four triterpenoids isolated from the seeds showed a wide range of inhibiting activity against both gram-positive and gram-negative bacteria
20	Antioxidant activity and total phenolic content of ethanolic extract of seeds. <sup>30</sup> (Shukla S et al 2009)	DPPH radical scavenging assay, Measurement of total phenolic content of the ethanolic extract was achieved using Folin–Ciocalteu reagent containing 62.50 mg/g of phenolic content	Ethanolic extract of seeds		The ethanolic extract was also found to scavenge the superoxide generated by EDTA/NBT system. Total phenolic content of extract was found significantly higher when compared to reference standard gallic acid. The ethanolic extract also inhibited the hydroxyl radical, nitric oxide, superoxide anions.

21	Leaf extract induces an increase of contractile force in rat skeletal muscle in situ <sup>31</sup> (Datte JY et al 2004)	Measurement of isometric-tension-anesthetized	Leaf extract		Stimulation of the muscle contractile activity, an effect which may be due to an activation of the cholinergic mechanism.
22	Anxiolytic activity <sup>32</sup> (Ali N et al 2008)	Stair-case model	Seed extract		Showed a significant and dose dependent anxiolytic activity by increasing the number of steps climbed, without any significant effect on rearings.
23	The antioxidant and reactive Oxygen Species Scavenging Activity <sup>33</sup> (Mandal S et al 2009)	Total antioxidant activity, scavenging activities for various ROS, ion chelating activity and phenolic and flavonoid contents.	70% methanolic extract		Showed significant antioxidant and ROS scavenging activity; which may be due to the presence of phenolic and flavonoid compounds.
24	Inhibition of protein synthesis of filarial parasites <sup>34</sup> (Somnath S et al 2001)	Glucose uptake, glycogen synthesis and succinate dehydrogenase activity.	Fractions		All fractions were found to inhibit protein synthesis which was very well correlated with <i>in-vivo</i> activity and was possibly the mechanism of Macrofilaricidal activity.
25	Anti-inflammatory, antipyretic and analgesic properties. <sup>35</sup> (Shukla S et al 2009)	Carrageenan-induced rat paw oedema, brewer's yeast-induced pyrexia, acetic acid-induced writhing and hot plate reaction time in experimental rats.	Seed oil		The paw volumes, pyrexia and writhes in experimental rats were reduced significantly ( $p < 0.05$ ) as compared to that of control, and hot plate test showed significant licking effect in rats.
26	Antidiabetic activity <sup>36</sup> (Aswar PB et al 2009)	Alloxon induced wistar albino mice.	Crude extract	ethanolic	Crude ethanolic extract exhibited statically significant hypoglycemic and antihyperglycemic activities.
27	Isolated the irritant potential of four triterpenoids. <sup>37</sup> (Saeed MA et al 2003)	Identified as alpha-amyrin, beta-amyrin, lupeol and lupeol acetate.	Seeds		Reported that the alpha-amyrin, beta-amyrin, lupeol acetate were the most potent and persistent irritant compound whereas the lupeol was the least potent and least persistent compound.
28	Isolation and identification two new cassane diterpenes. <sup>38</sup> (Peter SR et al 1998)	Two new cassane diterpenes, named caesaldekarins.	Ethanol extract of roots		The structures of caesaldekarins F and G were established by the use of 2-D NMR Spectroscopy.
29	Isolation of four cassane furanoditerpenes. <sup>39</sup> (Peter SR et al 1997)	Four cassane furanoditerpenes were isolated and identified.	Roots		The four compounds were designated as bonducellpins A, B, C and D
30	Chemical investigation of the plant <i>Caesalpinia bonducella</i> <sup>40</sup> (Mondal	Isolation of D (+) – pinitol.	Methanol extract of its defatted fruit shells		The structure and stereochemistry of D(+)-pinitol was studied by the

	DN et al 1993)			use of 2D-NMR spectroscopy.
31	Isolation of three Cassane Diterpenes. <sup>41</sup> (Yadav PP et al 2009)	Hemiketals, Caesalpinolide-C, Caesalpinolide-D, Caesalpinolide-E and one Cassane Furanoditerpene were isolated.	-	The molecular structures were elucidated using NMR spectroscopy. The isolated compounds were tested for their antiproliferative activity against breast adenocarcinoma, prostate carcinoma, Cervical carcinoma and Vero (African green monkey kidney fibroblast) cells.
32	Phytochemical studies on the ethanolic extracts. <sup>42</sup> (Ata A et al 2009)	Yielded two new Homoisoflavonoids, Caesalpinianone, and 6-O-methylcaesalpinianone along with five known natural products, namely, Hematoxylol, Stereochenol A, 6-O-Acetylloganic acid, 4-O-Acetylloganic acid, and 2-O-b-D-glucosyloxy-4-Methoxy benzene propanoic acid.	Ethanolic extracts	Structures of these compounds were elucidated with the aid of extensive NMR spectral studies. All of these compounds exhibited different levels of Glutathione S-Transferase (GST) inhibitory and antifungal activities.
33	Isolation of A new cassane diterpene. <sup>43</sup> (Zhaohua Wu et al 2007)	Isolation of Neocaesalpin, along with a known Triterpene, $\beta$ -amyrin.	Seeds	The structure and relative stereochemistry was determined by spectral methods.
34	Isolation of New cassane butenolide hemiketal diterpenes from the marine creeper <i>Caesalpinia bonduca</i> and their antiproliferative activity. <sup>44</sup> (Yadav PP et al 2007)	Two new Cassane butenolides, Caesalpinolide A (1) and B (2), Epimeric at the Hemiketal position were isolated.	Marine creeper	New cassane butenolide hemiketal diterpenes were isolated from the marine creeper & possess antiproliferative activity.
35	Chemical Studies on the Philippine Crude Drug Calumbibit (Seeds of <i>Caesalpinia bonduca</i> ) <sup>45</sup> (Kinoshita T et al 2000)	The Isolation of New Cassane Diterpenes Fused with a, b – Butenolide.	Seeds	New Cassane Diterpenes were isolated.

36	Isolation of minor seven caessane diterpenoids. <sup>46</sup> (Deon LL et al 1998)	Studied minor seven caessane diterpenoids of <i>Caesalpinia bonduc</i> including caesaldekarin A.	Roots	The <sup>1</sup> H and <sup>13</sup> C NMR spectra of all seven compounds were completely assigned by using a combination of 2-D NMR spectroscopy.
37	Identification of fatty acid triglycerides as the macrofilaricidal principles. <sup>47</sup> (Rastogi S, et al 1996)	Fatty acids comprising these triglycerides have been identified as palmitic, stearic, octadeca-4-enoic and octadeca-2,4-dienoic acids.	Seeds kernel	Fatty acid triglycerides as the macrofilaricidal principles were identified.
38	New cassane diterpenes named neocaesalpins C and D were isolated from the Philippine crude drug calumbibit botanically originating from the seeds of <i>Caesalpinia bonduc</i> . <sup>48</sup> (Kinoshita T et al . 2000)	These compounds are characterized by the presence of the a, b-butenolide moiety.	Seeds	Their structures were elucidated on the basis of the spectroscopic evidence.

## Conclusion

*Caesalpinia bonduc* possess several pharmacological activities like anti-asthmatic, anti-diabetic, anti-inflammatory, anti-oxidant, anti-bacterial, anti-filarial, anti-tumor, anxiolytic, immunomodulatory, hypoglycemic activity. It is reported to contain various Alkaloids, Glycosides, Terpenoids and Saponins. The various phytoconstituents reported in *Caesalpinia bonduc* are cassane, diterpenes, furenoditerpenes, hemiketals, homoisoflavonoids, cesalpenianone, neocaesalpin, cassane butenolides, etc. Despite the broad use of *Caesalpinia bonduc* in traditional medicine, very few systematic pharmacological and phytochemical studies are reported till date assessing its therapeutic properties. In this review article, effort has been taken to collect and compile the details regarding *Caesalpinia bonduc* which will be useful to the society to venture into a field of alternative systems of medicine.

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