A review on critically endangered species of Acanthacea: *Justicia beddomei* (Clarke) bennet: An immune booster

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Abstract

*Justicia beddomei* (Clarke) Bennet, a member of Acanthaceae, is endemic to the Southern Western Ghats. This plant shows remarkable similarities with *J. adhatoda* L., and the only morphological difference is the smaller size of both leaves and inflorescence. *J. beddomei* has an abundance of phytochemicals and widely used in traditional medicinal systems such as Ayurveda, Siddha and Unani. The phytochemicals present in the species possess immense anti-bacterial, cytotoxic, anthelmintic, analgesic, antioxidant activities. Vasicoline, a major phytochemical proved for the treatment for Covid 19. At present, the plant is listed under IUCN Red List as Critically Endangered category. Protecting species from extinction, enhancing ecosystem services and protecting biological diversity are important for maintaining a healthy ecosystem. The review reveals the importance of conservation of this plant for the fitness of the ecosystem and the development of traditional medicine for the future.

Keywords: Adathodai, critically endangered, conservation, substitute, Vasaka

Introduction

India’s traditional medicinal system flourished because of the diversity and abundance of medicinal plants. These plants and their derived parts play a key role in the treatment of several ailments of human beings. Nearly 1500 and 1200 species of plants are used in drug preparation for Ayurveda and Siddha respectively [1]. Acanthaceae is a large family of dicotyledonous plants comprising of more than 4300 species and distributed worldwide having a lot of medicinally important plants [2]. The largest member of this family is *Justicia* which comprises about more than 600 species distributed in the tropical and pantropical regions, nearly 50 species occur in India and are distributed in the temperate regions [3,5].

*J. beddomei* is endemic to the Southern Western Ghats in locations like Kerala, Valparai (South Arcot), Akkamalai (Coimbatore) and Mahendragiri (Kanniayakumari) [6]. It is included in the IUCN Red List category as Critically Endangered Species [7]. The plants are commonly known as Malabar Nut because of the resemblance with *J. adhatoda*. It is morphologically similar to *J. adhatoda* and the only visible difference is the smaller size of leaves and terminal spike inflorescence with more tailed anthers [8]. *J. beddomei*, very commonly used in the traditional medicinal systems like Ayurveda, Siddha and Unani as diuretic, antispasmodic, expectorant, anti-arheumatic, febrifuge, styptic and tonic [9]. The leaves are very effective for the treatment of irritable cough, diarrhea and haemoptysis [10]. The medicinal properties of plants are broadly used for the treatment of leprosy, blood disorders, heart troubles, thirst, fever, vomiting, cough, asthma [11], diseases of eyes, bleeding diarrhoea, dysentery, bronchitis, inflammation, jaundice, tumours, mouth-troubles, sore-eye, gonorrhoea, tuberculosis, haemorrhage and haemorrhoids [12].

The prevailing status of this plant reveals that the unconstrained use of natural products inversely affects the balance of the ecosystem. Crucial conservation of the ecosystem is important for the healthy existence of each member.

Scientific classification

Kingdom: Plantae
Division: Angiosperms
Pharmacological activities

*J. beddomei* has a predominant role in the traditional medical systems in India. The pharmacological activities are studied for the further development of drug research. The following activities of the plant are studied.

### Anthelmintic activity

The anthelmintic activity of ethanolic as well as chloroform extract of *J. beddomei* leaves was tested against Indian earthworms. Different doses of 10 mg/ml, 20 mg/ml and 50 mg/ml of each extract were tested and compared with the...
standard drug Piperazine citrate. The result observed that the death/paralysis of the worms increased with increasing concentration. Effectiveness of the extracts was inversely proportional to the time taken for paralysis of the worms. The 50 mg/ml ethanolic extract was more efficient than the chloroform extract for the killing of worms. The current study suggested that the ethanolic extract may be effective against the worms in human [52].

**Analgesic activity**

The analgesic activity of different concentration of ethanolic extract of *J. beddomei* leaves was evaluated in albino rats using Eddy’s hot plate method [54]. The activity of the 100 mg/kg and 50 mg/kg was compared with the standard 15 mg/kg morphine sulphate. The result showed that the 90 minutes administration of test extract of 100 mg/kg possesses significant analgesic activity. Due to the presence of alkaloids, carbohydrates and tannins, the extract engenders noticeable analgesic effect. The exact modes of action of the biologically active compound responsible for the activity are not studied, which minimise the efficacy of the results [51].

**Antioxidant activity**

The powdered aerial parts of *J. beddomei* were extracted using petroleum ether, chloroform, ethyl acetate and methanol. Standard protocols followed for screening the preliminary phytochemicals. The tests like DPPH, hydroxyl radical, superoxide anion radical scavenging abilities, β-carotene-linoleic acid model, reducing power ability, nitric oxide scavenging assay of all the extracts were evaluated for analyzing their potential antioxidant activities. The results were compared with ascorbic acid, Butylated hydroxytoluene and catechin standards and the concentration and efficacy were directly proportionate. Because of the presence of phenolic and flavonoid, all the extracts showed strong antioxidant activity [16, 21].

**Anti-cancer and XOI activities**

*In vitro* anticancer and xanthine oxidase inhibitory (XOI) activities were investigated with the methanolic extract of dried aerial parts of *J. beddomei* which was compared with the standard 2.4-40 µg/ml Allopurinol. The extract was exposed to MTT colourimetric assay in HeLa and MCF-7 cell lines for XOI activity and cytotoxic activity. Increased dosage of the methanolic extract showed increased anticancer and XOI activities (200 µg/ml and 40 µg/ml respectively). The presence of flavonoids and phenolic compounds of the extract contributed towards the inhibitory activities against cancer and Xanthine Oxides [41].

**Anti-diabetic activities**

Whole plant ethanolic extract induced to the alloxan-induced diabetic rats showed a reduction of diabetes in rats. Further studies needed for the identification of specific phytochemicals involved in this [35].

**Cytotoxic activity**

Endophytes are known for their cytotoxic activities. The endophytes found in *J. beddomei* were tested for its cytotoxicity. Ethyl extracts of the plant *J. beddomei* and its endophytic fungi showed cytoxic activity. The preliminary phytochemicals were screened out and the MTT assay of the extract was carried out on lung adenocarcinoma cells. The results revealed that the bioactivity was three times than that of the host plant. Endophytes are known for the production of novel secondary metabolites with a broad spectrum of activity according to their host. *Aspergillus fumigates* found in *J. beddomei* increased the cytotoxicity [56].

**Other activities**

The pharmacologically active phytochemicals present in this plant revealed important activities like antiyptic, anti-inflammatory, antihelmintic, antisepctic, antidiabetic, blood coagulant, a bronchodilator, disinfectant, antioxidant, hepatoprotective, anti-jaundice, expectorant and has many other medicinal applications [57, 60]. The unavailability and the increasing demand of the plant may have reduced further studies.

**Molecular studies**

The morphological characters of *J. adhatoda* and *J. beddomei* are almost similar. It is very difficult to distinguish them based on the taxonomic or phenotypic characters. Analyzing the molecular aspects is the correct identification strategy in such cases. PCR-RFLP of selected nuclear ribosomal ITS amplicon along with sequence variability was used for the molecular studies. The already sequenced *J. adhatoda* was reported in NCBI as 687 bp and the direct sequencing of the gel-purified ITS amplicon yielded a 624 bp sequence for *J. beddomei*. It is clear that through the phylogenetic tree *J. beddomei* and *J. adhatoda* were sister groups and distinct species with common ancestors. The ITS sequences of *J. beddomei* and *J. adhatoda* contained unique recognition sites for specific restriction enzymes for which all the species were distinct in their PCR-RFLP patterns. When the ITS amplicons of the four selected Justicia species were subjected to restricted digestion with EcoRI or SfoI, it yielded the expected restricted products. The ITS sequences and PCR-RFLP were successful in resolving the ambiguity that existed among the species of *Justicia* [61].

**Propagation**

Seed germination and stem cutting are the main propagules for *J. beddomei*. Studies showed that seed germination and propagation through stem cutting are very low [62]. Micro-propagation ways like tissue culture are the easiest way to propagate these type of plants. Rapid propagation through nodal explants in MS medium supplemented with BAP achieved shoot multiplication. Increasing concentration of BAP resulted in an increase in shoot development and IAA and NAA concentration affected the root development. It was suggested that hardening of the plant in an organic supplemented soil environment will get the better result [63]. Clonal propagation of explants was achieved through callus free axillary meristem proliferation in SH medium from the stem node explants. Shoot multiplication increased by the result of cytokinin along with the synergistic effect of auxin. Five to 10 shoots was obtained in 5 to 6 weeks with the effect of 3.0 mg.1-1 BAP, 0.5 mg.1-1 2-ip and 1.0 mg.1-1 IAA. Rooting was obtained in the medium containing 0.2 mg.1-1 IBA or IAA. Hardening the plants in humidity chamber showed 95% of survival rate. They flowered in 15 months with no cytological defects shows a good result of micropropagation [64].

**Discussion**

*J. beddomei*, the plants are medicinally very important and its presence is inevitable. The detailed pharmacological activities about the phytochemicals found in *J. beddomei* are absent or insufficient. Primary phytochemical studies revealed the
presence of several chemicals. Most of these chemicals are similar to *J. adhatoda*, which are efficient for the treatment of various disorders. Molecular studies revealed that these two plants emerged from a common ancestor, so shows the remarkable similarities. Recently in traditional medicine, *J. adhatoda* acquired its position. The unavailability of *J. beddomei* makes limited studies and restricted use in medicinal fields. The distribution of the plant is restricted at the elevation of 1000 m, overexploitation for the medicinal and research purpose leads to the rapid depletion of this important plant from its natural habitat. From 1998 the plant is listed in IUCN Red List as endangered and again the count is reduced to become critically endangered. The conservation of the plants is very important for the development of the traditional medicinal system. Recent studies show that the phytochemicals found in *J. beddomei* are used against viral infected diseases such as COVID 19. The propagation of the plants is very difficult, so we have to develop new propagation strategies like tissue culture. The ecosystem is balanced because of the equal distribution of flora and fauna. The involvement of human being makes a disturbed ecosystem which will adversely affect the whole. The plant *J. beddomei*, not used as an adulterant or substitute, shows its effect on the medicinal field confronts adverse riddles from the ecosystem. The extinction of these types of medicinally important plants will lead to developing new strategies to conserve them.

**Conclusion**

From the current review, we concluded that the conservation of *J. beddomei* could be useful for the development of commercial as well as traditional drugs on a detailed exploration of phytochemicals and pharmacological actions after needful mass cultivation is practised.

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**Reference**

1. Jain SK. Ethnobotany: its scope in various subdisciplines. In: A manual of Ethnobotany, Scientific Publishers, Jodhpur 1987, 1-11.
2. Sharma A, Kumar A. Acanthaceae: Taxonomy and uses in traditional medicinal system. World Journal of Pharmaceutical Research 2016;5(7):403-12.
3. Durkee LH. Family# 200. Acanthaceae. Flora Costaricensis (ed. W. Burger). Fieldiana, New Series 1986.
4. Mabberley DJ. The plant-book: a portable dictionary of the vascular plants, Cambridge university press 1997.
5. Rajasekhar D, Vanisree M, Subbaraju GV. Justicia Lignans: Two new aryl naphthalidilignans from Justicia neesii Ramamoorthy. Indian Journal of Chemistry. 1999;38:713 17.
6. http://envis.frht.org/plantdetails/16e5fd73518f2062f0af28ee1d7f2f2ddca1f74303cff8d8edd37461156a1f accessed on 17.04.2020
7. Rao CK, Geetha BL, Suresh GE. Red list of threatened vascular plant species in India. Botanical Survey of India, Kolkata 2003.
8. https://plants.jstor.org/stable/10.5555/al.ap.specimen.k000884079 accessed on 17.04.2020
9. Warrier PK, Nambiar VPK, Ramankutly C. Indian Medicinal Plants. Vol3. Orient Longman Pvt. Ltd., Chennai 1994, 268.
10. Asolkar LV, Kakkar KK, Chakre OJ. Second supplement to Glossary of Indian Medicinal Plants with Active Principles”, part-1. National Institute of Science Communication (CSIR), New Delhi 2000.
11. Gupta A, Prajapati PK. A clinical review of different formulations of vasa (*Adhatoda vasica*) on Tamakawasas (asthma). AYU 2010;31(4):520-524.
12. Ignacimuthu S, Shannumugham N. Antimycobacterial activity of two natural alkaloids, vasicine acetate and 2acetyl benzylamine, isolated from Indian shrub *Adhatoda vasica* Nees leaves. Journal of Bioscience 2010;35(4):565-570.
13. https://keralaplants.in/keralaplantdetails.aspx?id=Justicia__beddomei accessed on 15.04.2020
14. Sasidharan N. (Dr. B P Pal Fellow), Kerala Forest Research Institute, Peechi.
15. Patil AM, Patil DA. Occurrence and significance of cystoliths in Acanthaceae. Current Botany 2011.
16. Srinivasan M, Padmaja B, Nair S. GC-MS profiling and in vitro radical scavenging effect of *Adhatoda beddomei*. Journal of Pharmacognosy and Phytochemistry 2014;2(5).
17. Hanbone IRB. Introduction to Ecological biochemistry. Edn 3. A cademic press, London 1988, 10-15.
18. https://herbs.indianmedicinalplants.info/index.php/a/1334-adhatoda-beddomei-medical-uses-morphology-images-side-effects-pharmacology accessed on 15.04.2020
19. Jain MP, Srivastava TN. Preliminary phytochemical studies on *Adhatoda beddomei*. Fitoterapia 1986.
20. Panigrahi J, Gantait S, Patel IC. *Justicia beddomei*, a source of comprehensive vasicinine production. Israel Journal of Plant Sciences 2019;1:1-7.
21. Marathakam A, et al. Studies on phytochemical and In-Vitro antioxidant potential of *Justicia beddomei* (Clarke) Bennett. Free Radicals and Antioxidants 2012;2(4):26-31.
22. Krishnan K, Mani A, Jasmine S. Cytotoxic activity of bioactive compound 1,2-benzene dicarboxylic acid, mono 2-ethylhexyl ester extracted from a marine derived Streptomyces sp. VITSJK8. International journal of molecular and cellular medicine 2014;3(4):246.
23. Mehreen A, et al. Phytochemical, Antimicrobial, and Toxicological Evaluation of Traditional Herbs Used to Treat Sore Throat. Biomed Research International. 2016.
24. Latha, M et al. Biocompatibility and antibacterial activity of the Adathoda vascino Linn. extract mediated silver nanoparticles. Microbial pathogenesis 2016;93:88-94.
25. Gupta A, Prajapati PK. A clinical review of different formulations of Vasa (*Adhatoda vasica*) on Tamakawasa (asthma). AYU 2010;31(4):520.
26. Swain SS, Sahu MC, Padhy RN. In silico attempt for adduct agent (s) against malaria: combination of chloroquine with alkaloids of *Adhatoda vasica*. Computer Methods and Programs in Biomedicine 2015;122(1):16-25.
27. Armanian AM, et al. Prophylactic aminophylline for prevention of apnea at higher-risk preterm neonates. Iran Red Crescent Medical Journal 2014;16(8).
28. Farquhar JW, Sokolow M. Response of serum lipids and lipoproteins of man to beta-sitosterol and safflower oil: a long-term study. Circulation 1958;17(5):890-9.
29. Berman J, et al. Nutrionally important carotenoids as consumer products. Phytochemistry Reviews 2014;14:727-743.
30. Harasym J, Oledzki R. Fruit and vegetable antioxidants on total antioxidant capacity of blood plasma. Nutrition 2014;30:511-517.
31. Zhang ZQ, et al. Greater serum carotenoid concentration associated with higher bone mineral density in Chinese adults. Osteoporosis International 2016;27:1593-1601.
32. Calderon MJ, et al. A review on the dietary flavonoid kaempferol. Mini reviews in medicinal chemistry. 2011;11(4):298-344.
33. Jemal A, et al. Cancer statistics, CA: A Cancer Journal for Clinicians 2007;57:43-66.
34. Bajgar J. Time course of acetylcholinesterase inhibition in the medulla oblongata of the rat by O-ethyl S-(2-dimethylaminoethyl) methylphosphonothioate in vivo. British Journal of Pharmacology 1972;45(2):368.
35. Santos CC, et al. Antinociceptive and antioxidant activities of phytol in vivo and in vitro models. Neuroscience 2013.
36. Ryu KR, et al. Anti-scratching behavioral effect of the essential oil and phytol isolated from Artemisia princeps Pamp. in mice. Planta Medica 2011;77:22-26.
37. Lim SY, et al. Phytol-based novel adjuvants in vaccine formulation: 1. assessment of safety and efficacy during stimulation of humoral and cell-mediated immune responses. Journal of Immune Based Therapies and Vaccines 2006;4:6.
38. Huang ZR, Lin YK, Fang JY. Biological and pharmacological activities of squalene and related compounds: potential uses in cosmetic dermatology. Molecules 2009;14(1):540-54.
39. Ferrer A, et al. Emerging roles for conjugated sterols in plants. Progress in lipid research 2017;67:27-37.
40. Cabral CE, Klein MR. Phytoestrogens in the treatment of hypercholesterolemia and prevention of cardiovascular diseases. Arquivos Brasileiros de Cardiologia 2017;109(5):475-482.
41. Avula B, et al. Quantitative determination of vasicine and vasicinone in Adhatoda vasica by high performance capillary electrophoresis. Die Pharmazie-An International Journal of Pharmaceutical Sciences 2008;63(1):20-22.
42. Soni S, et al. Validation of different methods of preparation of Adhatoda vasica leaf juice by quantification of total alkaloids and vasicine. Indian Journal of Pharmaceutical Science 2008;70(1):36.
43. Amin AH, Mehta DR. A bronchodilator alkaloid (vasicine) from Adhatoda vasica Nees. Nature 1959;184(4695):1317.
44. Mehta DR, Naravane JS, Desai RM. Vasicinone. A bronchodilator principle from Adhatoda vasica Nees (NO Acanthaceae). Journal of Organic Chemistry 1963;28(2):445-8.
45. Bag A, Bag A. Treatment of COVID-19 patients: Justicia adhatoda leaves extract is a strong remedy for COVID-19 – Case report analysis and docking based study. Chem Rxiv 2020.
46. Rizvi S, et al. The role of vitamin E in human health and some diseases. Sultan Qaboos University Medical Journal 2014;14(2):e157.
47. Padayatty SJ, et al. Vitamin C as an antioxidant: evaluation of its role in disease prevention. Journal of the American College of Nutrition 2003;22(1):18-35.
48. Prieto JM, Recio MC, Giner RM. Anti-inflammatory activity of β-sitosterol in a model of oxazolone induced contact-delayed-type hypersensitivity. Latin American and Caribbean Bulletin of medicinal and aromatic plants 2006;5:57-62.
49. Ovesna Z, Vachalkova A, Horvatthova K. Taraxasterol and beta-sitosterol: new naturally compounds with chemoprotective/chemopreventive effects. Neoplasma 2004;51:407-14.
50. Zak A, et al. Beta-sitosterol in the treatment of hypercholesterolemia. Casopis lekaru cesky 1990;129:1320-3.
51. Bouic PJ, et al. Beta- Sitosterol and beta-sitosterol glucoside stimulate human peripheral blood lymphocyte proliferation: implications for their use as an immunomodulatory vitamin combination. International Journal of Immunopharmacology 1996;18:693-700.
52. Srinivasa U, et al. Anthelmintic activity of leaves of Justicia beddomei. Ancient science of life 2007;26(3):1.
53. Srinivasa U et al. Algesic activity of Justicia beddomei leaf extract. Ancient science of life 2007;27(2):14.
54. Marathakam A, Kannappan N. In vitro anticancer activity and xanthine oxidase inhibitory properties of Justicia beddomei. Journal of Pharma Research 2013;8(1):5370.
55. Srinivasa U, et al. Antidiabetic activity of Justicia beddomei leaves in alloxan induced diabetic rats. Journal of Research and Education in Indian Medicine 2008, 458.
56. Prabavathy D, Vali Nachiyar C. Cytotoxic potential and phytochemical analysis of Justicia beddomei and its endophytic aspergillus SP. Asian Journal of Pharmaceutical and Clinical Research 2013;6(5):159-161.
57. Patel VK, Venkatakrishna-Bhatt H. In vitro study of antimicrobial activity of Adhatoda vasika Linn.(leaf extract) on gingival inflammation--a preliminary report. Indian Journal of Medical Sciences. 1984; 38(4):70-2.
58. Chakraborty A, Brantner AH. Study of alkaloids from Adhatoda vasica Nees on their anti-inflammatory activity. Phytotherapy Research 2001;15(6):532-4.
59. Wakhloo RL, et al. Safety of vasicine hydrochloride in human volunteers. Indian Journal of Pharmacology 1980;13:129.
60. Marathakam A, Kannappan N, Santhiagu A. Evaluation of hepatoprotective activity of methanolic extract of Justicia beddomei (Clarke) Bennett against INH and Rifampicin induced hepatotoxicity. American Journal of Pharm Tech Research 2014;4(1):869-78.
61. Chrungoo NK, et al. Establishing taxonomic identity and selecting genetically diverse populations for conservation of threatened plants using molecular markers. Current Science 2018;114(3):539.
62. Mathew AS, Patel KN, Shah BK. Investigation on antifeedant and anthelmintic potential of Adhatoda vasica Nees. Indian Journal of Natural Products and Resources 1998;14(1):11-6.
63. Panigrahi JJ, Patel IC. Micropropagation of Adhatoda beddomei using nodal explant. European Academic Research 2014;2(9):12194-204.
64. Sudha CG, Seeni S. In vitro multiplication and field establishment of Adhatoda beddomei CB Clarke, a rare medicinal plant. Plant Cell Reports. 1994; 13(3-4):203-7.
65. Aiyer KN, Kolamal MM. Pharmacognosy of Ayurvedic drugs. Edn 1, Vil. VII Dept. of Pharmacognosy, University of Kerala, Trivandrum 1963, 102-105.