



PHARMACOLOGICAL ACTIVITY AND MEDICINAL VALUE OF ANKOLA (*ALANGIUM SALVIFOLIUM* LINN.)-A REVIEW

¹Rachana Kumari Jangir, ²Chandan Singh, ³Rajendra Prasad Purvia, ⁴Manoj Adlakha

¹PG Scholar, Department of Dravyaguna Vijnana, Dr. Sarvapalli Radhakrishnan Ayurveda College, Jodhpur, Rajasthan

²Professor & Head of Department of Dravyaguna Vijnana, Dr. Sarvapalli Radhakrishnan Ayurveda College, Jodhpur, Rajasthan

³Associate Professor, Department of Dravyaguna Vijnana, Dr. Sarvapalli Radhakrishnan Ayurveda College, Jodhpur, Rajasthan

⁴Associate Professor, Department of Dravyaguna Vijnana, Dr. Sarvapalli Radhakrishnan Ayurveda College, Jodhpur, Rajasthan

Corresponding Author: rachanajangirjangir@gmail.com

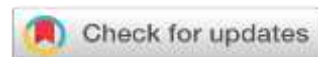
<https://doi.org/10.46607/iamj0311012023>

(Published Online: January 2023)

Open Access

© International Ayurvedic Medical Journal, India 2023

Article Received: 16/12/2022 - Peer Reviewed: 28/12/2022 - Accepted for Publication: 09/01/2023.



ABSTRACT

We all are well aware of the medicinal value of plants. They are one of the most important sources of medicine. Medicinal plants are extensively utilized throughout the world in two distinct areas of health management: the traditional system of medicine and the modern system of medicine. *Alangium salvifolium* Linn., commonly known as Ankolah (Ankola) is categorized under rare plant species. *it* has been used traditionally for the treatment of various diseases. Almost every part of *it* including roots, leaves, stems, and bark is used in the *Ayurveda* systems of medicines for the treatment of various diseases. The present review highlights the traditional uses of different parts of *A. salvifolium*, its phytochemical constituents with therapeutic activity, and the evidence-based studies on various pharmacological effects of the plant.

Keywords: *Alangium salvifolium* Linn., Alangiaceae, Ankola, Medicinal herbs, Antimicrobial, Pharmacological activity

INTRODUCTION

The medicinal plant also called medicinal herbs, has been discovered and used in traditional medicine practices since the pre-historic period medicinal plants extract pure compounds or as a derivative is being used for various therapeutic purposes. The WHO (World Health Organization) reported in 2008 that 80% of the Asian population uses herbal medicinal products for their primary health care and the data are the same for developed countries also.¹

In earlier classical ayurveda text mention that –

अङ्गोलः कटुकः स्निग्धो विषलूतादिदोषनुत् । कफानिलहरः
सूतः शुद्धिकृद्रेचनीयकः ॥ (राजनिघण्टु, प्रभद्रादिवर्ग ७५)

Ankola is Katu(pungent) in rasa (taste), Snigdha(unctuous) in Guna and also used in Luta visha (infectious bite of spider) etc., it pacifies kapha-vata dosha and also purgative in nature.

Morphology

Macroscopical evolution of the plant-



Fig.1

Alangium salvifolium Linn.(Family- Alangiaceae) is a deciduous bushy shrub or small tree, with or without spines, with young branchlets often rusty-pubescent. Bark pale brown, aromatic, with rough cracks, and exfoliating in corky scales. Leaves alternate, elliptic, or ovate, apex acute or obtuse with a pair of basal and 4–6 pairs of lateral veins. Inflorescence axillary, flowers are white or yellowish-white, bisexual, on articulated pedicels and the flowering season is between February to June. Fruit drupaceous, crowned with remnants of the calyx, 1–2 seeded, and *A. salvifolium* can be propagated by seeds and is albuminous in shape.²

Microscopical evaluation of the plant

The stomatal index and stomatal frequency of the leaves of *A. salvifolium* are 52.63 and 65/sq. mm re-

Later on, modern text described that the roots of *A. salvifolium* have been used as an astringent, emollient, anti-helminthic, and diuretic, and to treat rheumatism (Anon, 1996). Decoction of the bark has been used as an emetic in India (George, 1984). Fruits of *A. salvifolium* are used as a purgative and cooling agent (Anon, 1996). Alangium A and B from root bark, and akoline, lamarkine, alangine, akharkantine from bark, have been reported (Chopra et al., 1980).

Geographical distribution of *A. salvifolium*

A. salvifolium is widely distributed over the plains and lower mountain areas throughout India and elsewhere in East Africa to China, Indonesia, Vietnam, and New Guinea. In peninsular India, usually found in dry deciduous forests, along roadsides, and cultivated lands near villages (Hyderabad forests and Sitamata wildlife sanctuary, Rajasthan.).



Fig.2

spectively. The vein islets number is 11.4/sq. mm, and the vein termination is with an average of 13/sq. mm. The organoleptic evaluation reveals that the extracts from different plant parts are odourless and tasteless. Under fluorescent light leaf powder shows different colours in various extracts. The leaves stem and root powders with various extracts show the presence of alkaloids, phenol, tannins, and reducing sugars. It also shows the presence of chlorine, sulphur, and iron in the stem, roots, and leaves³. TS of the root bark shows outer phellem, a broad zone of irregular phellem showing the development of rhytidome, a narrow band of cortex and phloem. Phellem is well developed and 0.1–0.15 mm wide. Phellem tissue is sometimes seen in 5 or more successive layers with alternating parenchymatous tissue in be-

tween them due to the formation of phellogen at different levels in the outer phloem region of the root. The parenchymatous tissues in between two phellem layers are composed of slightly obliterated phloem elements and parenchyma cells. Some of the cells contain druse crystals of calcium oxalate measuring up to 18–30 μ in diameter. The phloem extends from the cambial zone up to the phellem tissue. The cells are usually uniformly thin-walled and regularly arranged except that the cells towards the phellem show radial divisions and are larger in size. Sclerenchyma cells are absent in the phloem region. Cambium is a narrow zone composed of 4–5 rows of thin-walled regularly arranged cells measuring 12–27 μ tangentially and 6–9 μ radially⁴.

Preliminary phytochemical studies

Preliminary phytochemical investigation reveals the presence of various primary metabolites like cephaeline, tubulosine, isotubulosine, psychotrine, and alangiside in roots. Alkaloids A & B, Alangicine, dimethylpsychotrine, marckine, marckidine, lamarckinine in root bark. Alangimarkine, ankorine, deoxytubulosine, alangiside, alangine, sterols, and three triterpenoids cepheline, N-methylcephaeline, deoxytubulosine, and alangiside in fruits and alangimarine, alamanine, alangimaridine, emetine, cephaeline, psychotrine in seeds.^{5,6,7}(fig. 3,4,5,6,7,8)

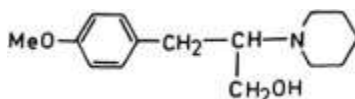


Fig. 3. Alangine.

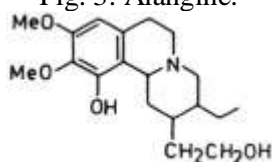


Fig. 4. Ankorine.

Fig. 5. Alangamide.

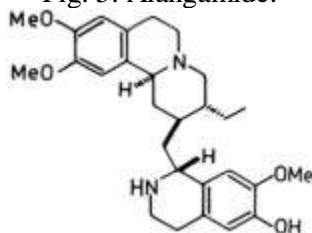


Fig. 6. Cephaeline.

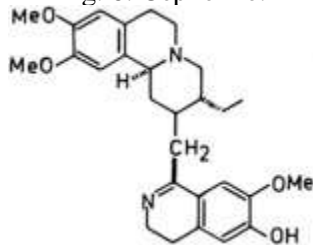


Fig. 7. Dimethylpsychotrine.

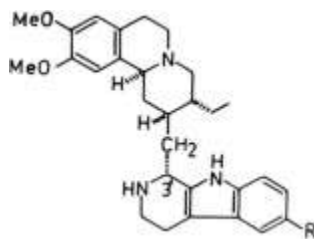


Fig. 8. Tubulosine.

Ethnomedicinal uses

अङ्गोदो दीर्घकीलः स्यादङ्गोलश्च निकोचकः । अङ्गोटकः
कटुस्तीक्ष्णः स्निग्धोष्णस्तुवरो लघुः । रेचनः
कृमिशूलामशोफग्रहविषापहः ॥139॥
विसर्पकफपित्तास्रमूषकाहिविषापहः । तत्फलं शीतलं स्वादु
श्लेष्मघ्नं बृंहणं गुरु । बल्यं विरेचनं वातपित्तदाहक्षयास्रजित्
॥140॥⁸ भावप्रकाशनिघण्टु॥

A. salvifolium has been used as traditionally laxative, antiepileptic, astringent, antiulcer, pungent, purgative, alleviates spasms, anthelmintic, emetic, antiprotozoa, hypoglycemic agent. It has been reported that it is used to cure skin diseases like leprosy, scabies and as contraceptives for pigs and cattle rearing by the tribes in Kerala.

Stem and root barks of *A. salvifolium* were screened for their helicon bactericidal activity. During the summer season, it is used for timber, fuel, and fodder because of its good nutritional value in some of the West Himalayan areas of India.

In Ayurveda, the roots and the fruits are used for the treatment of rheumatism, burning sensation, and haemorrhages. The root barks of *A. salvifolium* were used externally as an antidote against snake/scorpion, rabbit, rat, and dog bites. In the Philippines, the roots and the fruits are used for the treatment of rheumatism and hemorrhoid externally⁹. In Comoros, Africa, a decoction of the whole plant along with a fruit of coconut is used to treat boils. Leaves are used to cure asthma in China¹⁰.

Pharmacological screening of *A. salvifolium*

➤ Antimicrobial activity

To evaluate the antimicrobial activity, the agar cup plate test was used to determine the sensitivity of the samples and the well micro-dilution was used to determine the minimum inhibitory concentration. Aqueous and alcoholic extracts were tested on gram

positive (*Staphylococcus aureus* ATCC 25925, *Bacillus subtilis* ATCC 6633, *Staphylococcus epidermidis* ATCC 12228 and *Micrococcus luteus* ATCC 10240)) and gram-negative bacteria (*Enterobacter aerogens* ATCC 13048, *Escherichia coli* ATCC 25922, *Salmonella typhi* ATCC 51812 and *Shigella dysenteriae* ATCC 25931). The results of antimicrobial assays showed that all tested extracts were active against all tested microbial species including gram-positive and negative bacteria. The alcoholic extract showed direct antimicrobial activity against all tested microorganisms with minimum inhibitory concentrations ranging between 0.130 and 0.520 mg/ml, while the aqueous extract showed 0.26–2.10 mg/ml, respectively. The extract has been reported to contain phenolic compounds and flavonoids. Hence these compounds may be responsible for the antimicrobial effect by killing the bacteria by directly damaging the cell membrane.^{11, 12, 13}

➤ Antiulcer activity

The petroleum ether, chloroform, methanol, and aqueous root extracts of *A. salvifolium* at the doses of 100, 200, and 400 mg/kg were tested on pylorus-ligated Wistar rats. Among the extracts, the petroleum ether extract of *A. salvifolium* reduces the total acidity, free acidity, peptic activity, and ulcer index significantly when compared to other extracts. It has been proved that *A. salvifolium* acts by blocking the acid secretion on the H⁺-K⁺-ATPase proton pump by inhibition of H⁺-K⁺-ATPase activity of the parietal cells.^{14, 15}

➤ Antiarthritic activity

The antiarthritic activity of *A. salvifolium* stem barks was evaluated in Wistar rats using Freund's adjuvant arthritis model. The petroleum ether, chloroform, methanol, ethyl acetate, and aqueous extracts were administered at a dose of 100 mg/kg for 21 days. The

paw volume and paw thickness were measured and all the extracts of *A. salvifolium* showed potent anti-arthritis activity and the potency was in the order as follows, >chloroform > ethyl acetate > aqueous > petroleum ether > methanol. It has been reported that the steroids present in the plant extracts may be responsible for the anti-arthritis activity by inhibiting the inflammation due to the Freund's adjuvant (inflammogen).^{16,17}

➤ Anthelmintic activity

A. salvifolium bark extract of 50, 100, and 150 mg/ml were tested against earthworms (*Pheretima posthuma*) to evaluate the anthelmintic activity. The methanol and chloroform extracts exhibited significant anthelmintic activity at the highest concentration of 150 mg/ml. The possible mode of action is by increasing chloride ion conductance of the worm muscle membrane there by produces hyperpolarization hence excitability decreases, which leads to muscle relaxation and flaccid paralysis.¹⁸

➤ Antioxidant activity

The antioxidant activity of the alcoholic root extract of *A. salvifolium* was tested by using DPPH and nitric oxide radical inhibiting activity methods. In the DPPH radical scavenging method, alcoholic and aqueous extract of *A. salvifolium* root at a dose of 200 µg/ml exhibits 76.4% and 62.4% inhibition and standard drug ascorbic acid showed 88.6% inhibition, and the EC₅₀ (µg/ml) was found to be 120.48, 135.14 and 96.15 µg/ml, respectively. In the nitric oxide radical scavenging method, alcoholic extracts, aqueous extract, and ascorbic acid exhibited 74.9%, 59.7%, and 83.5% inhibition, and the EC₅₀ (µg/ml) was found to be 308.80, 450.8, and 201.32 µg/ml respectively. Among these two methods, the alcoholic extract exhibited more antioxidant activity with a low EC₅₀ value. The presence of high phenolic and flavonoid content in the *A. salvifolium* extracts has contributed directly to the antioxidant activity by neutralizing the free radicals.^{19,20}

➤ Antifertility activity

The androgenic and anti-androgenic activity of the total alkaloid fraction of *A. salvifolium* stem bark methanolic extract was performed in male wistar rats.

Oral administration of 10 and 20 mg/kg b.wt. total alkaloid fraction was administered for 7 days. The results of the study showed a significant increase in the weight of the testis, seminal vesicles, ventral prostate, and epididymis in the treated rats. The total alkaloid fraction has produced abortifacient and less anti-implantation activities²¹.

➤ Analgesic and anti-inflammatory activity

Analgesic activity of the methanolic extract of *A. salvifolium* root was performed using albino mice. The methanolic extract at doses of 100 and 200 mg/kg was administered i.p, 30 min before writhing induction. Acetylsalicylic acid at a dose of 400 mg/kg was used as standard. The study showed marked analgesic activity at a dose of 200 mg/kg (i.p), the extract possessed a slightly weaker analgesic activity than acetylsalicylic acid (400 mg/kg)²².

The anti-inflammatory study was performed using a carrageenan- induced paw edema model. The methanolic extract of *A. salvifolium* root at doses of 100 and 200 mg/kg and standard acetylsalicylic acid (400 mg/kg) were intraperitoneally injected into rats 30 min before carrageenan induction. It was found that the methanolic extract inhibited the carrageenan-induced rat paw edema at 100 and 200 mg/kg b. wt. The possible mechanism of action is that salviifoside B, the major component in the extract inhibits the production of nitric oxide, prostaglandin E₂, and tumor necrosis factor- α , which are the mediators of inflammation. Similarly, anti-inflammatory activity was also observed in the case of the root extract in the carrageenan-induced paw edema model in rats. Significant percent inhibition of paw oedema was observed within 6 h, supporting its traditional use for the treatment of inflammation²³.

➤ Diuretic activity

The benzene and ethyl acetate extracts of *A. salvifolium* root at a dose of 250 mg/kg were evaluated for diuretic activity using the Lipschitz method. The study involves the evaluation of total urine volume and Na⁺, K⁺, and Cl⁻ concentration in urine. The extract (250 mg/kg) treatment showed increased urine volume and concentration of Na⁺, K⁺, and Cl⁻ in urine. From the study, it was confirmed that the ben-

zene and ethyl acetate extracts of *A. salvifolium* root possess potent diuretic activity at a dose of 250 mg/kg b.wt. The possible mechanism of action of *A. salvifolium* is by inhibiting sodium reabsorption through another mechanism that involves neither the Na^+/H^+ exchanger nor NaKCl_2 transporter, leading to more sodium and consequently more water retention in the tubes²⁴.

➤ Antifungal activity

Aqueous leaf extract of *A. salvifolium* is reported for its growth inhibitory activity against *Trichothecium roseum*, a fungal pathogen, however, the effect was not found to be very much significant. The ethanolic extract of roots has been reported against *Aspergillus niger*, *A. fumigatus*, *A. flavus*, *Fusarium oxysporum*, *Penicillium sps.*, and *Rizopus sps.* The lyophilized powder extract of pulverized wood showed an inhibitory effect against various isolates of dermatophytes and *Candida albicans*. The inhibitory effect on dermatophytes was found to be comparable to ketoconazole in agar disc diffusion assay, however, significant differences were observed in the case of *Candida albicans*^{25,26}.

➤ Anticancer activity

In vivo anticancer potential of crude extract of *A. salvifolium* flowers was evaluated in the Ehrlich Ascites Carcinoma model in mice. Intraperitoneal administration of extract resulted in a significant reduction in tumor growth as compared with control mice. The anticancer activities of chloroform extract were also investigated which showed similar results. The study indicated a significant increase in the lifespan of the tumor-bearing mice by 32 days. Similarly, *in vitro* antitumor activity was tested against Dalton's ascitic lymphoma murine cell lines using different doses of methanolic extract. The extracts significantly decreased tumor volume, weight, and viable cells and increased non-viable cells after 14 days of oral administration. Lesser side effects were observed during the treatment. Compounds 27- *O-trans*-caffeoylcyclicodiscic acid and myriceric acid exhibited cytotoxic activity towards the MOLT-3 cell line with IC_{50} values of 5.6 and 3.9 μm , respectively, and compound 8 selectively inhibited the growth of the

HepG2 cancer cell line with an IC_{50} value of 7.1 μm ^{27,28}.

➤ Acute toxicity study

A. salvifolium extract was evaluated for acute toxicity study according to the OECD guidelines No. 425 of CPCSEA. The LD_{50} values of the extract were found to be 1000 mg/kg b. wt.²⁹

CONCLUSION

A. salvifolium is an excellent medicinal herb that has numerous bioactive phytochemicals. Almost every part of this plant has been used in Ayurveda and various other traditional systems of medicine for the treatment of various diseases. In modern scientific literatures, plant extracts have been reported to have potential efficacy against hypertension, diabetes, cancer, inflammation, ulcer, etc. Various plant parts have been found to possess biological activity more specifically towards overcoming metabolic ailments. This review illustrates the medicinal value of plant parts such as leaves, flowers, roots, root bark, stem, and stem bark.

REFERENCES

1. Araujo MC, Barcello NM, Vieira PM, Gouveia TM, Guerra MO, Peters VM, et al. Acute and sub chronic toxicity study of aqueous extract from the leaves and branches of campomanesia velutina (cambess) O Berg. J Ethnopharmacol. 2017; 201:17-25. [PubMed] [Google Scholar]
2. Pharmacognostical and pharmacological review on ayurvedic plant *ankolah*-[*Alangium salvifolium* (L.F) Wang (Alangiaceae)], World J. Pharm. Pharm. Sci., 4 (2015), pp. 516-526
3. V. Rajamanickam, V. Rajasekaran, S. Quine, S. Jesupilla i, R. Sabitha Diuretic activity of *Alangium salvifolium* sub. sp. Hexapetalum Internet J. Altern. Med., 8 (2009), p. 1
4. Saraswathy, A.K. Meena, R. Shakila, K. Sunil Kumar, S. Ariya Nathan Pharmacognostic studies on *Alangium salvifolium* (Linn.f.) Wang root bark Pharmacognosy J., 2 (2010), pp. 374-380
5. S. Jain, A. Sinha, D.S. Bhakuni The biosynthesis of beta-carboline and quinolizidine alkaloids of *Alangium lamarkii* Phytochemistry, 60 (2002), pp. 853-859
6. A. Itoh, Y. Ikuta, T. Tanahashi, N. Nagakura Phytochemical and pharmacognostical studies of the leaves of *Alangium lamarkii* J. Nat. Prod., 63 (2000), pp. 723-725

7. B.S. Tanwer, R. Vijayvergia Phytochemical evaluation, and quantification of primary metabolites of *Alangium salviifolium* Int. J. Pharm. Biosci., 1 (2010), pp. 1-6
8. Bhavprakash Nighantu- Padmshri Professor Krishnachandra Chunekar, Sampadak-Dr. Gangashaya Pandey
9. V. Rajamanickam, V. Rajasekaran, S. Quine, S. Jesupilla i, R. Sabitha Diuretic activity of *Alangium salviifolium* sub. sp. Hexapetalum Internet J. Altern. Med., 8 (2009), p. 1
10. J. Goutam Kumar, G. Anshita, D. Arpita Herbal treatment to skin diseases: a global approach Drug Invention Today, 2 (2010), pp. 381-384
11. N.K. UdayaPrakash, S. Bhuvaneswari, S. Preethy, N. Rajalakshmi, M. Saranya, J.R. Anto, S. Arokiyaraj Studies on antimicrobial, antioxidant, larvicidal, pesticidal activity and phytochemistry of leaves of *Alangium salviifolium* (L.F) Wang Int. J. Pharm. Pharm. Sci., 5 (2013), pp. 0975-1491
12. M.R. Pandian, G.S. Banu, G. Kumar A study of the antimicrobial activity of *Alangium salviifolium* Indian J. Pharmacol., 38 (2006), pp. 203-204
13. V.C. Jain, N. Patel, D.P. Shah, P.K. Patel, B.H. Joshi Antioxidant and antimicrobial activities of *Alangium salviifolium* (Lf)Wang root Global J. Pharmacol., 4 (2010), pp. 8-13
14. P.K. Mohanty, S.K. Panda, S.K. Mishra, P.K. Panda, Y. A. Jaliwala, P. Milind Study of antiulcer activity of roots of *Alangium salviifolium* Linn in pylorus ligated rats Int. J. Pharm., 2 (2011), pp. 190-192
15. P. Sreekanth, K. Sudhakara, G. Gouse Basa, K. Murali, A. Sanjeeva Kumar Antiulcer effect of *Alangium salviifolium* ethanolic leaf extract on gastric lesion induced by ethanol in rats Asian J. Pharm. Clin. Res., 4 (2011), pp. 112-114
16. S. Jubie, N. Jawahar, K. Ruby, B. Gowramma, V. Murugan, B. Suresh Anti-arthritis activity of bark extracts of *Alangium salviifolium* Wang Rasayan J. Chem., 1 (2008), pp. 433-436
17. Shivanand Arthritis an autoimmune disorder: demonstration of *in-vivo* antiarthritic activity Int. J. Pharm. Life Sci., 1 (2010), pp. 38-41
18. R.S. Pandey Anthelmintic activity of *Alangium salviifolium* bark J. Nat. Prod. Plant Resour., 2 (2012), pp. 717-720
19. R. Upadhyay, S. Trivedi, N.N. Mehrotra Phytochemical studies and antimicrobial activity of traditional medicinal plant *Alangium salviifolium* (L.f.) Wang Search Res., 2 (2011), pp. 183-184
20. C.J. Vineet, N.M. Patel, P.S. Dhiren, K.P. Paras, H.J. Bhavesh Antioxidant and antimicrobial activities of *Alangium salviifolium* (L.F) Wang root Global J. Pharmacol., 4 (2010), pp. 13-18
21. V. Murugan, H. Shareef Anti-Fertility activity of the stem bark of *Alangium salviifolium* (Linn. F) Wang in Wistar female rats Indian J. Pharmacol., 32 (2000), pp. 388-389
22. R. Zahan, L. Nahar, M.L. Nesa Antinociceptive and anti-inflammatory activities of flower (*Alangium salviifolium*) extract Pak. J. Biol. Sci., 16 (2013), p. 1040
23. H.A. Ahad, B.S. Padmaja, M. Sravanthi, P. Ramyasree, K. Kavitha Phytochemical screening and anti-inflammatory actions of *Alangium salviifolium* root extract Nat. Prod. Res., 26 (2012), pp. 1649-1653
24. M. Uthiraselvam, S. Asmathu Fathima, H. Peer Mohamed, M. Babu Selvam, G. Kavitha Pharmacognostical studies on the medicinal plant – *Alangium salviifolium* (Linn. F) Wang. (Alangiaceae) Asian J. Plant Sci. Res., 2 (2012), pp. 670-674
25. G. Thippeswamy, S. Lokesh, V. Rai Influence of some indigenous medicinal plant extracts on seed mycoflora and seedling growth of some oilseed crop species Adv. Plant Sci., 16 (2003), pp. 67-74
26. M. Wuthi-udomlert, S. Prathanturug, Y. Wongkrajang Antifungal activity and local toxicity study of *Alangium salviifolium* subsp hexapetalum Southeast Asian J. Trop. Med. Public Health, 33 (2002), pp. 152-154
27. Z. Ronok, M. Badrul Alam, M. Saiful Islam, C.S. Gopal Anticancer activity of *Alangium salviifolium* flower in Ehrlich ascites carcinoma bearing mice Int. J. Cancer (2011), pp. 1-9
28. R. Venkateswarlu, Y.V. Gopal, A.B. Raju, K.B. Prasad Antitumor activity of *Alangium salviifolium* against Dalton's ascetic lymphoma Med. Chem. Drug Discovery, 2 (2012), pp. 122-133
29. S. Ashishkumar, A. Vipin, K. Rajesh, A. Balasubramania m, M. Anurag, G. Rajiv Pharmacological studies on seeds of *Alangium salviifolium* linn. Acta Pol. Pharm. Drug Res., 68 (2011), pp. 897-90

Source of Support: Nil

Conflict of Interest: None Declared

How to cite this URL: Nabanita Basak & Vishnu Dutt Sharma: An Ayurvedic View on Guda Shareeram- A Review Article. International Ayurvedic Medical Journal [online] 2023 {cited January 2023} Available from: http://www.iamj.in/posts/images/upload/21_27.pdf