European Journal of Medicinal Plants
12(4): 1-15, 2016, Article no.EJMP.23899
ISSN: 2231-0894, NLM ID: 101583475

SCIENCEDOMAIN *international*
www.sciencedomain.org

Importance of *Alangium salviifolium* and Its Pharmacological Update

Keyur Panara[1#], Pawan K. Singh[2*], Pooja Rawat[2#], Vivek Kumar[2], Momin Maruf[2], Kanti Patel[2], R. K. Ravikumar[2] and Vipin Kumar[2]

[1]Society for Research and Initiatives for Sustainable Technologies and Institutions (SRISTI), Near Gujarat University, Navrangpura, Ahmedabad – 38009, Gujarat, India.
[2]Value Addition Research and Development- Human Health, National Innovation Foundation-India, Satellite Complex, Jodhpur Tekra, Ahmedabad -380015, Gujarat, India.

Authors' contributions

This work was carried out in collaboration between all authors. Authors Keyur Panara, PKS, PR, VK, MM, Kanti Patel, RKR and VK designed and wrote the review. Authors Keyur Panara and PR have equally contributed in this study. All authors have read and approved the final manuscript.

Article Information

DOI: 10.9734/EJMP/2016/23899
Editor(s):
(1) Marcello Iriti, Professor of Plant Biology and Pathology, Department of Agricultural and Environmental Sciences, Milan State University, Italy.
Reviewers:
(1) Antonello Santini, University of Napoli Federico II, Italy.
(2) Chun Wai Chan, The Chinese University of Hong Kong, Hong Kong, China.
Complete Peer review History: http://sciencedomain.org/review-history/13246

Review Article

Received 28th December 2015
Accepted 20th January 2016
Published 9th February 2016

ABSTRACT

Plant based traditional and indigenous medicines are used globally for the treatment of various diseases. About 80% of the world population relies on plants and their products for primary health care. The plant *Alangium salviifolium* has been in use traditionally for treatment of various ailments. Almost every part of this plant including roots, leaves, stem and bark are used in the Ayurveda and Siddha system of medicines for treatment of various diseases. In modern scientific literatures, the plant has been reported to have potential efficacy against hypertension, diabetes, epilepsy, cancer, inflammation, etc. It is reported to contain various biologically active phytochemicals such as alangine, ankorine, tubulosine, alangicine, salsoline etc.

Aims: The present review highlights traditional uses of different parts of *Alangium salviifolium*, its phytochemical constituents with therapeutic activity, translational research on the plant and the evidence based studies on various pharmacological effects of the plant.

Place and Duration of Study: Value Addition Research and Development, Division of Human

**Corresponding author: E-mail: pawan@nifindia.org;*
[#]Equal contributors

Health, National Innovation Foundation-India and Society for Research and Initiatives for Sustainable Technologies and Institutions (SRISTI), Ahmedabad, India between October, 2015 to December, 2015.

Methodology: A review of literature was carried out using several resources through online internet searches, including scientific databases such as Pubmed, Science Direct, Google Scholar, etc.

Results: *Alangium salviifolium* is a widely distributed plant with a number of reported traditional uses. Several phytochemicals including alangine, ankorine, tubulosine, alangicine, salsolin etc. have been characterized in different parts. The phytoconstituents isolated from the plant have been shown to be associated with a number of biological effects demonstrating the therapeutic potential.

Conclusion: Due to amplified acceptance and use of traditional plants, stringent scientific validation studies are being carried out worldwide, to develop evidence based phyto-medications. *Alangium salviifolium* is an excellent medicinal plant which holds numerous bioactive phytochemicals. Evidence based scientific studies have been reported against hypertension, diabetes, epilepsy, cancer, inflammation, ulcer, etc. Various plant parts have been found to possess biological activity more specifically towards overcoming metabolic ailments. Mere scientific evidences of activity of the extracts will not create the solutions, rather studies should focus on developing contemporary formulations after extensive analysis of its bioactivity, pharmacokinetics and pharmacodynamics, safety, etc. using appropriate animal models followed by clinical trials. Substantial research has already been conducted on this plant during last few decades, which can be used by scientists in developing useful therapeutic solution from *Alangium salviifolium.*

Keywords: Alangium salviifolium; alangiaceae; alangine; ankorine; salviifosides; tubulosine.

1. INTRODUCTION

Plant based healthcare products, drugs, and formulations are gaining momentum and acceptance due to their varied favorable effects. Globally, about 60% of the healthcare products available in markets are known to be derived from plant origin [1]. India contributes only about 2% (1.0 billion dollar) of the total global herbal market (62.0 billion dollars). India holds about 8% of the recorded species of the world and has 16 Agro-climatic zones which contains about 45000 different plant species and 15000 medicinal plants included in Ayurveda (7000), Unani (700), Siddha (600) and modern medicine (30). There are 1500 plants in Indian systems of medicine, of which only 500 species are frequently used in drug preparations [2]. As per Export Import Bank, growth rate of global market for medicinal plant trade is about 7% per annum which is further expected to reach $5 Trillion by 2050 [3]. Indubitably, plants are pillars of the traditional systems of medicine, continuously contributed to mankind and are potential source of delivery of new and safe remedies in future [4]. Awareness of plant based medications and therapeutics are continuously increasing worldwide and hence the acceptance and demand. *Alangium* is a small genus of flowering plants which has been used in traditional system of medicine and also being studied for their uses in healthcare by modern scientists globally. It belongs to family *Alangiaceae* comprising about 24 species of small trees, shrubs and lianas [5]. *Alangium* name has been derived from the Malayalam word *Alangi*, which, in Kerala, refers to *Alangium salviifolium* (L.f.) Wang [6]. *Alangium salviifolium* is native to various regions of South East Asia. Almost all the parts (root, bark, leaves, seeds and fruits) are known to have important therapeutic uses and are extensively used for different purpose in the indigenous herbal medicines [7]. It belongs to Kingdom Plantae, Order Cornales, Family Cornaceae (*Alangiaceae*). The synonyms of *Alangium salviifolium* are *Alangium decapetalum* Lam, *Alangium lamarckii* Thw., *Alangium latifolium* Miq.ex C.B. Clarke, *Alangium mohillae* Tul., *Alangium salviifolium* subsp. *decapetalum* (Lam.) Wangerin, *Alangium sundanum* var. *miqueliana* Kurz., *Alangium tomentosum* Lam., *Grewia salviifolia* L.f, *Karangolum mohillae* (Tul.) Kuntze and *Karangolum salviifolium* (L.f.) Kuntze. The plant has been studied widely by the researchers worldwide for its various potential biological properties. The present paper intends to review and evaluate various significant phytochemicals and pharmacological values of *Alangium salviifolium.*

2. MORPHOLOGICAL CHARACTERISTICS AND DISTRIBUTION

Alangium salviifolium is a deciduous tree with grayish branches and height ranging from 3 to 12

ft with flowering season between February to June [8]. The flowers are arranged in a cluster of 4 to 8, cream-colored, fascicled, axillary or on old wood with fragrance, few in axillary fascicles. Leaves are alternate, simple, hairy, without stipules with petiole measuring up to 1.5 cm long. The leaf blades are elliptical to obovate, oblong or lanceolate shape and size ranges from 3–23 cm × 1.5–9 cm. Fruits are of smaller size with globular shape and purplish-red coloured when ripens and encircled in white pulp rich in mucilage [9]. The bark is ash colored, coarse and slightly fissured. *Alangium salviifolium* is native to various regions of South East Asia (India, China, Philippines, Malaysia, Indonesia), Madagascar, Africa, Australia, New Caledonia and the western Pacific Ocean islands. In the African region, it is mainly distributed in eastern Kenya, Comoros and Tanzania. In India, the plant distribution is mainly in the dry regions in plains and low hills and on roadsides. Andhra Pradesh, Bihar, Chhattisgarh, Gujarat, Goa, Kerala, Karnataka, Maharashtra, Madhya Pradesh, Rajasthan, Tripura, Tamil Nadu, Uttarakhand, Uttar Pradesh, and West Bengal are the states of India which are inhabited by the plant.

3. PHYTOCHEMICAL CONSTITUENTS

Various parts of *Alangium salviifolium* have been examined scientifically for their phytochemical constituents. The phytochemical analysis of *Alangium salviifolium* flowers led to the isolation of numerous active compounds. The aqueous and ethanolic extracts were found to be rich in flavonoids, tannins, saponins, alkaloids, coumarins, phenols, quinines, cardiac glycosides, reducing sugars, steroids, and proteins. However, anthraquinones and catechin were only identified in aqueous extract [10]. The active constituents 1-Methyl-1H-pyrimidine-2,4-dione and 3-O-beta-D-glucopyranosyl-(24beta)-ethylcholesta-5,22,25-triene, isolated from flowers have shown antimicrobial activity. Seed kernels of the plant have been analyzed for the presence of non-alkaloid components which are betulinic acid, betulinaldehyde, betulin and lupeol, 3-desoxy betulonic acid (III) and hydroxylactone A of betulinic acid & β-sitosterol. Isomeric chromones have been isolated from the aerial parts [11]. Presence of alangine A, alangine B, lamarckinine, markindine and emetine have been reported previously. Ankorine an alkaloid was isolated from the plant leaves [11,12]. Recently three phenolic glycosides, salviifosides A, salviifosides B, salviifosides C, along with three known compounds salicin, kaempferol, and kaempferol 3-O-β-D-glucopyranoside were isolated from the leaves of *Alangium salviifolium*. Salviifosides were also revealed to possess anti-inflammatory activity [13]. In another study, more content of flavonoids and alkaloids was detected in the leaves as compared to bark, while as bark was found to be rich in Tannins and steroid. Primary metabolites were also analysed and it was concluded that maximum phenolic compounds are present in root in comparison to other parts [14]. The differential distribution of constituents in different parts of *Alangium salviifolium* may be utilized for isolation of selective components. Alcoholic and aqueous extracts obtained from the aerial parts of *Alangium salviifolium* were used for isolation of proto emetine, cephaline, isotubulosine and alangimaridine. Various important phytochemical constituents isolated and characterized from different parts of *Alangium salviifolium* have been shown in Fig. 1.

4. ETHNOBOTANICAL USES

Sizable number of traditional medicinal uses for different parts of *Alangium salviifolium* are well reported in the ancient and modern literatures. Parts of the plant with medicinal value include leaves, flowers, seed, bark, fruits and plant oil. Each part of the plant is reported to possess several medicinal properties. In Ayurveda, it is used for the treatment of rheumatism [15], hemorrhoid, herpes, loose stools and blood disorders [16]. Tribal of Vindhya and Satpura region use this plant in treatment of various problems such as insect and scorpion sting, dog bite, arthritis and fever. The leaves and fruit are used in diarrhoea and dysentery, while roots are used to expel intestinal worms, burning sensation, constipation [15]. Root is also used in diarrhoea, paralysis, piles, vomiting and haemorrhage [17]. Root is useful for external application (rheumatism, leprosy, inflammation) and internal application (bites of rabbit and dogs) [18]. Root of the plant have also been used in skin diseases, as astringent, anthelmintic, purgative, emetic, diaphoretic, antipyretic and anti-tubercular [16,19-21]. Leaves are useful for curing diabetes [8,22]. Decoction of bark is used as emetic in India [23]. *A. salviifolium* has various other medicinal properties such as pungent, alleviates spasms, and antiprotozoa [24]. The plant is also taken as a food by the tribal in Andhra Pradesh, India. In Comoros, Africa, a decoction of whole plant along with fruit of coconut is used to treat boils. Leaves are used to cure asthma.

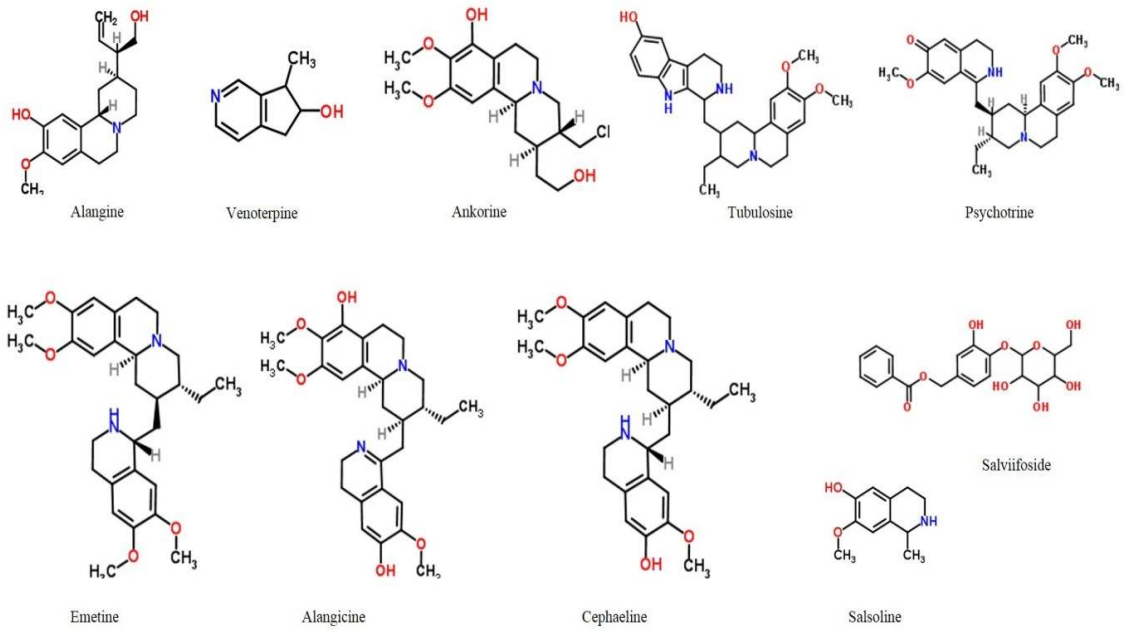

Fig. 1. Important phytochemical constituents of *Alangium salviifolium*

The fruit is used as purgative, expectorant, carminative and as an antidote for poisoning, whereas fruit juice is applied to cure eye diseases. The roots are purgative and used to expel worms, to cure piles, hypertension, fever, back pain, blood disorders, snake and rat bites, leprosy and other skin diseases. Mixture of mature fruits along with honey and rootstocks of *Acorus calamus* are used to manage pests on agricultural crops in India. The plant is reported for its use in treatment of malaria [25].

5. PHARMACOLOGICAL PROPERTIES OF *Alangium salviifolium*

Various pharmacological properties of different parts of *Alangium salviifolium* have been reported as summarized in Table 1.

5.1 Disease and Disorder Management

5.1.1 Antihypertensive effects

A quarternary base was isolated from the water-soluble fraction of the alcoholic extract of leaves. The compound was shown to cause a significant fall in carotid blood pressure in case of anesthetized dogs. It was also observed that pre-treatment with eserine blocked the hypotensive effect resulting in a rise in carotid blood pressure. However, the rise was not observed in case of pre-treatment with atropine [26].

5.1.2 Anti-arthritic activity

Anti-arthritic activity of stem bark of the plant has also been reported. The bioactive components causing this activity were isolated by extraction in different solvents. The petroleum ether extract contained steroids, saponins, and flavonoids, while ethyl acetate extract have alkaloids, steroids, and flavonoids. The chloroform extract from the plant contained alkaloids, steroids, and saponins, while alkaloids, steroids, tannins and saponins were isolated from methanolic extract and aqueous extract. All the extracts of *Alangium salviifolium* showed strong anti-arthritic activity maximum with chloroform followed by ethyl acetate, aqueous, petroleum ether and methanol. Previously, flavonoids, saponins and steroids have been reported to possess anti-inflammatory property; which might have contributed to the exhibited anti-arthritic activity [27]. In one of the recent *in-silico* studies, the analgesic compounds present in the plant have been evaluated for their anti-inflammatory property. Docking studies revealed the interaction of salviifosides A with COX-2 proteins and was suggested to be a potent source of anti-inflammatory compounds [28]. In another study, the anti-inflammatory activity of aqueous extracts of stem and leaves was evaluated, which supported the traditional

uses of the plant for treatment of inflammation [29].

5.1.3 Anti-epileptic activity

Leaf extract of *Alangium salviifolium* has been shown to exhibit anticonvulsant activity. The anti-epileptic effect was attributed to the delayed onset of pentylenetetrazol (PTZ) induced seizures and also the protection from the mortality due to seizures was observed. The active constituents involved in exhibited activity were reported as tannins, triterpene and steroids [30]. The anticonvulsant activity of methanolic extract of stem bark has been evaluated in various mice models such as maximum electroshock seizure (MES), PTZ-induced convulsion and lithium pilocarpine induced model in rats. Dose dependent study was performed and it was found that the methanolic extract of stem bark shows significant anti-epileptic activity as indicated by delay in the onset of convulsion in case of PTZ induced and lithium pilocarpine induced model. However, no such activity was observed in case of MES model [31].

5.1.4 Hypoglycemic activity

Different parts of *Alangium salviifolium* have been evaluated for their antidiabetic activity. Aqueous extracts of stem and leaves possess significant hypoglycemic and antidiabetic activity as demonstrated in Wistar albino rats [32]. Antidiabetic activity of leaf extract has also been demonstrated in type II diabetes model in rat, induced by intraperitoneal administration of Streptozotocin-Nicotinamide. Administration of leaf extract resulted in significant reduction in blood plasma glucose level, comparable to glibenclamide (10 mg/kg), restored the lipid profile and showed improvement in liver glycogen, body weight and antioxidant status in diabetic rats [33]. Similarly, bark extracts of *Alangium salviifolium* have been shown to possess hypoglycemic activity [34]. These results support the traditional usage of *Alangium salviifolium* for the control of diabetes. The antihyperglycemic activity of roots was also evaluated where oral administration of ethanolic extract to alloxan induced diabetic rat resulted in a significant reduction in the blood glucose levels up to 24 hrs. A single oral administration of alcoholic extract at doses 100, 250 and 500 mg per kg produced substantial blood glucose drop in dose dependent manner both in normal and in diabetic rats [35]. In another study, the methanolic extract of leaves exhibited significant lowering of blood glucose, total triglyceride, total cholesterol, HDL-Cholesterol, BUN and creatinine levels in diabetic rats. Histopathological investigation revealed significant effect of methanolic extract of leaves on reinstating the size and number of beta cells of islets of langerhans to the normal, as compared to the rats treated with aqueous extract [36].

5.1.5 Anticancer activity

In vivo anticancer potential of crude extract of *Alangium salviifolium* flowers was evaluated in Ehrlich Ascites Carcinoma model in mice. Intraperitoneal administration of extract resulted in significant reduction in tumor growth as compared with control mice [37]. The anticancer activities of chloroform extract was also investigated which showed similar results. The study indicated a significant increase in the life span of the tumour bearing mice by 32 days [38]. 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 [39]. In a study, protoberberine alkaloids were isolated, characterized and tested for *in vitro* anticancer properties. Alangiumkaloids A (1) and B (2), 27-O-trans-caffeoylcylicodiscic acid (3), β-d-glucopyranos-1-yl N-methylpyrrole-2-carboxylate (5), myriceric acid B (4), isoalangiside (6), alangiside (7), 3-O-demethyl-2-O-methylalangiside (8), and demethylalangiside (9) were also evaluated. Different compounds exhibited anti-oxidant activities as indicated by the IC_{50} values. Compounds 3, 4, and 9 scavenged DPPH free radicals with IC_{50} values of 21.4, 21.8, and 24.0 μm, respectively. Alangisides 7 and 9 inhibited superoxide anion radical formation in the xanthine/xanthine oxidase assay with IC_{50} values of 19.4 and 5.3 μm, respectively. Compounds 6–9 exhibited excellent anti-oxidant activity in the oxygen radical absorbance capacity assay with 12.8–24.9 ORAC units. Compounds 3 and 4 inhibited aromatase activity with IC_{50} values of 4.7 and 6.8 μm, respectively. However, weak cytotoxic activity was observed in most of the cases except compounds 3, 4 and 8. Compounds 3 and 4 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 [40].

5.1.6 Wound healing activity

Leaves of *Alangium salviifolium* have been reported to possess wound healing property. Different animal model such as; incision, excision; dead space (granulation) wound models were used for study of wound healing potential of ethanolic extract [41].

5.1.7 Anti-oxidant activity

Leaf extract of *Alangium salviifolium* has been shown to possess anti-oxidant activity. *In vitro* free radical scavenging activity was exhibited by different leaf extracts such as petroleum ether, benzene, ethyl acetate, methanol and ethanol. Various *in vitro* models were used for evaluation such as; DPPH, hydroxyl, superoxide, ABTS and reducing power. Highest reducing activity was observed in case of methanol extract. It was suggested that the plant extract can be utilized for treatment of age associated diseases as well as for dietary supplement [42-44].

5.1.8 Anti-inflammatory and antinociceptive activity

Antinociceptive and anti-inflammatory effects were studied using carrageenan and formalin induced paw edema models in mice. In mice, the methanol extract of flower exhibited significant inhibition of both the phases of formalin pain test, reduction in writhing induced by acetic acid and delayed the response to hot water thermal stimulation in tail immersion test [45]. The anti-inflammatory activities were investigated in *in vitro* lipopolysaccharide induced murine macrophage cell line. Three new phenolic glycosides, salviifosides A, salviifosides B and salviifosides C were isolated from the leaves of *Alangium salviifolium*. It was found that salviifoside B inhibits the production of nitric oxide, prostaglandin E2, and tumor necrosis factor-α, which are the mediators of inflammation [13]. Similarly, anti-inflammatory activity was also observed in case of root extract in carrageenan induced paw edema model in rats. Significant per cent inhibition of paw oedema was observed within 6 hours, supporting its traditional use for treatment of inflammation [46].

5.1.9 Anxiolytic and CNS depressant activity

The methanol and chloroform extract of the flowers were studied to assess the prospective effects in case of anxiety and CNS disorder. The extracts were found to exhibit potent anxiolytic and CNS depressant activity [47].

5.1.10 Anti-ulcer activity

Anti-ulcer effect of ethanolic extract of *Alangium salviifolium* leaves has been investigated on ethanol induced gastric lesion model in rats. The study indicated a significant anti-ulcer effect of leaf extract at a dose of 400 mg/kg and 800 mg/kg [48]. Similar study was conducted using pyloric ligation and aspirin plus pyloric ligation model of gastric ulcer in rats. It was found that the oral administration of chloroform extracts of leaves showed protective activity over ulceration. The anti-ulcer effect was observed to be dose dependent [49].

5.1.11 Hepatoprotective activity

Hepatoprotective activity of methanol and aqueous extracts of leaves of *Alangium salviifolium* was studied in CCl_4 included liver injury model in rats. It was observed that administration of the extract resulted in significant protection which was indicated by reduction in SGOT, SGPT, alkaline phosphatase and total bilirubin contents. Extract was also shown to prevent the rise in lipid peroxidases levels in liver tissue homogenate [50].

5.1.12 Diuretic activity

Diuretic activity of benzene and ethyl acetate extracts of root bark of *Alangium salviifolium* was evaluated in albino rats. Flavonoids, alkaloids and steroids were identified during phytochemical analysis in both benzene and ethyl acetate extracts and were suggested to be the mediators of observed diuretic activity [51].

5.2 Antipathogenic Property

5.2.1 Antimicrobial activity

Antibacterial activity of the aqueous, chloroform, methanol and hexane extract of *Alangium salviifolium* leaves against *Listeria monocytogenes, Pseudomonas aeruginosa, Staphylococcus aureus, Salmonella typhi* and *Vibrio cholerae* has been reported. In case of hexane extract, maximum zone of inhibition was observed against *Listeria monocytogenes*. While for *Pseudomonas aeruginosa*, *Staphylococcus aureus*, and *Salmonella typhi*, maximum zone of

inhibition was observed by using chloroform extract. Aqueous extracts of the leaves showed maximum zone of inhibition against *Vibrio cholera* [52]. Aqueous and methanol extracts of leaves and bark showed antibacterial activity against Coliforms, which supports its use as an antidysenteric. Flower extracts were also tested against gram-positive and gram-negative bacteria such as; *Bacillus anthracis, Bacillus cereus, Bacillus megaterium, Bacillus subtilis, Streptococcus agalactiae, Staphylococcus aureus, Escherichia coli, Pseudomonus aeruginosa, Shigella flexneri, Shigella boydii, Shigella dysenteriae, Proteus sp*. Differential inhibitory activity was observed for different extracts. Diethyl ether fraction was found to be active against all tested microbial species and the highest activity was shown against *Proteus sp.* with a zone of inhibition 12±0.12 mm. The chloroform fraction showed significant activity against all bacterial strains except *Bacillus megatherium* and *Pseudomonas aeruginosa*. The highest zone of inhibition was found against *Escherichia coli* (12±0.22 mm). No antimicrobial activity was observed in case of petroleum ether fractions. In another study, antimicrobial activity of alcoholic and aqueous extracts was reported against gram-positive *Staphylococcus aureus, Bacilus subtilis, Staphylococcus epidermis*, *Micrococcus luteus* and Gram-negative *Enterobacter aerogens*, *Escherichia coli, Salmonella typhi and Shigella dysenteriae* [53].

5.2.2 Pesticidal activity

Pesticidal activity has been reported for the leaves of *Alangium salviifolium* against *Sitophilus oryzae,* a storage pest. Mortality of 80% and 100% was observed at the interval of 24 and 48 hours respectively, in case of hexane extract. While, aqueous and chloroform extracts showed more than 50% larval mortality after 48 hours of exposure. Low level of mortality rate was observed in case of methanolic extract [52].

5.2.3 Larvicidal activity

The aqueous, chloroform, methanolic and hexane extracts of *A. salviifolium* leaves were evaluated for their larvicidal property. Significant larvicidal activity was observed against the larvae, *Artemia salina* as evaluated by counting the non-motile and dead larvae [52]. Similarly, antilarvicidal activity was observed against fourth instar larvae of *Spodoptera litura* [54].

5.2.4 Anthelmintic activity

Anthelmintic activity of the aqueous and alcoholic extracts of roots of *Alangium salviifolium* was evaluated against *Pheritima posthuma* [55]. Three different concentrations (50, 100 and 150 mg/ml] of crude extracts of hexane, ethyl acetate, chloroform and methanol were tested. Parameters such as; paralysis and death period of the worm were evaluated. The study revealed significant anthelmintic activity of methanol and chloroform extracts [56].

5.2.5 Insecticidal activity

Recently, insecticidal property of leaf extract of the *Alangium salviifolium* has been investigated against paddy infecting insect, *Mythimna separata*. It was demonstrated that the observed property is due to alangisides [57].

5.2.6 Antifungal activity

Aqueous leaf extract of *Alangium salviifolium* is reported for its growth inhibitory activity against *Trichothecium roseum,* a fungal pathogen, however the effect was not found to be very much significant [58]. The ethanolic extract of roots has been reported against *Aspergillus niger, A. fumigatus, A. flavus, Fusarium oxysporum, Penicillum sps* and *Rizopus sps*. The lyophilized powder extract of pulverized wood showed 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 case of *Candida albicans* [59].

5.3 Steroidal Activity

5.3.1 Androgenic activity

Preliminary investigation of effect of total alkaloid fraction from stem bark of *Alangium salviifolium* was conducted. A significant increase in the weight of testis, seminal vesicles, ventral prostate and epididymis was observed in the treated group on the eighth day of the treatment [60].

5.3.2 Antiprogesterogenic activity

Antifertility activity of the ethyl acetate, chloroform, petroleum ether and aqueous

extracts of *Alangium salviifolium* stem bark was investigated. Daily administration of petroleum ether, ethyl acetate, chloroform, methanol or aqueous extracts of *A. salviifolium* for eight days showed significant abortifacient activity in comparison to vehicle treated group. Chloroform extract was found to be least effective. The data also suggested that *A. salviifolium* possess antiprogesterogenic activity resulting in abortifacient effects [61].

6. TRANSLATIONAL RESEARCH ON *Alangium salviifolium*

Increasing interest for translational research on *Alangium salviifolium* is evident from the patent list (Table 2). *Alangium salviifolium* extract has been shown to be effective as an anti-oxidant, hyaluronic acid production accelerator, apoptosis inducer and as an antagonist to endothelin. Recent patent data indicates the use of the plant in treatment of arthritis and cerebral infarction.

Table 1. Active constituents in different parts of *Alangium salviifolium* and associated biological activity

Plant part	Active constituents	Biological activity	References
Flower	Methyl-1H-pyrimidine-2,4-dione and 3-O-b-D-glucopyranosyl-(24ß)-ethylcholesta-5,22,25-triene	Anti-inflammatory activity Antinociceptive activity Anxiolytic and CNS depressant activity Anticancer activity	[45] [45] [47] [37,38]
Leave	Alkaloids, tannins, triterpene, steroids, alangiumkaloids A & B, 27-O-trans-caffeoylcylicodiscic acid, β-d-glucopyranos-1-yl N-methylpyrrole-2-carboxylate, myriceric acid B, isoalangiside, alangiside, 3-O-demethyl-2-O-methylalangiside, and demethylalangiside, salviifoside A, salviifoside B, salviifoside C	Antioxidant Anti-epileptic activity Hypoglycemic activity Wound healing activity Larvicidal activity Insecticidal activity Pesticidal activity Antifungal activity Antimicrobial Activities Hepatoprotective activity Antihypertensive activity Anti-arthritic activity Anticancer activity Anti-inflammatory activity Anti-ulcer activity	[42,43] [30] [32,33,36] [41] [52,54] [57] [52] [58] [52] [50] [26] [29] [39,40] [13] [48,49]
Root	Flavonoids, saponins, phenols, and steroids	Hypoglycemic activity Anthelmintic activity Anti-inflammatory activity Antimicrobial activity	[35] [55] [46] [53]
Root bark	Flavonoids	Diuretic activity	[51]
Stem	Steroids, saponins, flavonoids, tannins, alangiumkaloids A & B, 27-O-trans-caffeoylcylicodiscic acid, β-d-glucopyranos-1-yl N-methylpyrrole-2-carboxylate, myriceric acid B, isoalangiside, alangiside, 3-O-demethyl-2-O-methylalangiside, and demethylalangiside	Antidiabetic activity Anticancer activity	[32] [39,40]
Stem bark	Alkaloids, steroids, saponins, flavonoids, tannins	Anti-arthritic activity Anticonvulsant activity Antidiabetic activity Androgenic activity Antiprogesterogenic activity	[27,29] [31] [34] [60] [61]

Table 2. List of patents on *Alangium salviifolium*

Application/ Patent No.	Filing/ Priority Date	Title	Summary
CN104800419A	2015-04-17	Traditional Chinese medicine composition for treating wind-cold-damp retention type scapulohumeral periarthritis	The invention discloses a traditional Chinese medicine composition for treating wind-cold-damp retention type scapulohumeral periarthritis. The traditional Chinese medicine composition is characterized by being prepared from the following medicinal materials in part by weight: 10-15 parts of *Blumea balsamifera*, 3-6 parts of *Phallus impudicus*, 20-25 parts of *Blumea riparia*, 12-15 parts of Root of Heterophyllous Wingseedtree, 3-6 parts of Root of delavay violet, 12-15 parts of Root of Shrubby Elsholtzia, 3-6 parts of *Viola delavayi*, 12-15 parts of root of Arachnoid Cyanotis, 30-35 parts of passiflora caerulea, 6-9 parts of *Alangium salviifolium*, 10-15 parts of stem of *Lithocarpus polystachyus*, 6-9 parts of *Heracleum acuminatum*, and 3-6 parts of liquorice. The traditional Chinese medicine composition is used for treating the wind-cold-damp retention type scapulohumeral periarthritis, is high in effective rate, and reliable in curative effect, and avoids relapse after curing the wind-cold-damp retention type scapulohumeral periarthritis.
CN104547391A	2015-01-14	Traditional Chinese medicine composition for treating wind phlegm and blood stasis, and blockage content type cerebral infarction, as well as preparation method	The invention discloses a traditional Chinese medicine composition for treating wind phlegm and blood stasis, and blockage content type cerebral infarction, as well as a preparation method. The traditional Chinese medicine composition is characterized by being prepared from the following medicinal materials in parts by weight: 10 parts of swidamacrophylla (wall.) sojak, 12 parts of *Blumea balsamifera* roots, 5 parts of *Phallus impudicus*, 14 parts of *Hemiphragma heterophyllum*, 12 parts of beefwood-like clubmoss herb, 10 parts of radix rubi parvifol, 13 parts of *Eleutherine plicata* herb, 10 parts of *Schefflera parvifoliolata*, 10 parts of broadleaf sedge root, 18 parts of *Celastrus flagellaris*, 10 parts of seed of long leaf xylosma, 8 parts of salviifolium (l.f.) wanger., 8 parts of *Silvervine actinidia* fruit, 7 parts of splachnum mnioides hedw., 2 parts of evening primrose oil, 8 parts of all-grass of khas aletris and 10 parts of fewleaf schnabelia herb. The traditional Chinese medicine composition is high in effective rate, reliable in efficacy, and incapable of recurrence after healing in treating wind phlegm and blood stasis, and blockage content type cerebral infarction.
JP5344866B2	2008-08-07; 2013-11-20 (Grant date)	The novel compounds and their use	To isolate a new useful compound contained in bark of *Alangium salviifolium*, and to provide a composition of the compound. Provided are a compound represented

Application/ Patent No.	Filing/ Priority Date	Title	Summary
			by general formula (I) [wherein, R<SP>1</SP>, R<SP>2</SP>and R<SP>3</SP>are the same or different and represent H or a protective group], antioxidants and skin whitening agents containing the compound as an active ingredient, and medicines, cosmetics and food compositions containing the compound.
JP2006137690A	2004-11-11	Skin external preparation and hyaluronic acid production accelerator	To provide a skin external preparation having an excellent action to accelerate the production of hyaluronic acid in human beings. The skin external preparation comprises a plant selected from *Phyllanthus parvifolius* Buch. Ham. ex D. Don, *Alangium salvifolium* Wang., *Crassocephalum crepidioides*, *Helixanthera parasitica* low, *Viola serpens* Wall, *Clitoria macrophylla*, *Macrotyloma uniflorum*, *Paspalum scorbiculatum*, *Lindenbergia indica*, *Cissampelos pareira* L., *Leucosceptrum canum*, *Mentha spicata* Linn., *Ficus palmata* Forsk., *Stephania glandulifera* Miers., *Aconogonum molle* Hara., *Oxyspora paniculata*, *Bupleurum longicaule* Wall. ex. DC., *Tanacetum cinerariaefolium* Sch., *Senecio cappa* Buch. Ham. ex. D. Don, *Jatropha gossypifolia* L. and the like or its solvent extract.
US20050084547A1	2003-09-12	Natural product based apoptosis inducers	Pharmaceutical compositions are made from extracts obtained from ethnobotanical plants for inducing apoptosis in selected cells. Therapeutically effective amounts of the composition are administered to a mammal. Assays are used to determine the efficacy of such extracts in inducing apoptosis.
US20050008710A1	2003-07-09	Method for screening for endothelin-receptor antagonist activity and for treating conditions caused by endothelin	Aliquots of extracts from ethnopharmacological plants that have activity against the effects of sarafotoxins present in snake venom are isolated and identified as antagonists of endothelin using a fluorescence-based assay. A process is provided for the identification of an antagonist of an endothelin selected from the group consisting of endothelin-1, endothelin-2, endothelin-3 and mixtures thereof. The process comprises extraction of ethnopharmacological plants with a solvent followed by evaporation of the solvent to form an aliquot containing at least one component of the extract, optionally purifying and isolating one or more component by chromatography, and subjecting the aliquot or purified component to a competitive fluorescent binding assay using biotinylated endothelin-1, wherein the plants having activity against the effects of one or more sarafotoxins present in snake venom.
JP2005023242A	2003-07-04	Antioxidant and external preparation for skin	To provide an antioxidant and an external preparation for skin inhibiting dermopathy, etc., caused by active oxygen, etc., not only capable of keeping the

Application/ Patent No.	Filing/ Priority Date	Title	Summary
			youthful skin, but excellent also in safety by including a plant extract having anti-oxidant action. The antioxidant and the external preparation for skin each comprises an extract of *Alangium salviifolium* (Linn.F.)Wang. The extract of *Alangium salviifolium* (Linn.F.)Wang has an effect of inhibiting disorders caused by active oxygen, etc., and exhibits the effectiveness on oxidation disorder, aging. etc., of the skin and can not only protect the skin, but is excellent also in safety.

7. CONCLUSION

Even in this modern technological era, plant based traditional and indigenous medications are gaining momentum and being used by more than 80% population, as preventive and curative solutions for various ailments. Due to amplified acceptance and uses, stringent scientific validation studies are being carried out worldwide, to develop evidence based phyto-medications. *Alangium salviifolium* is an excellent medicinal plant which holds numerous bioactive phytochemicals. Almost every part of this plant have been used in the Ayurveda, Siddha and various other traditional system of medicines for treatment of various diseases. In modern scientific literatures, plant extracts have been reported to have potential efficacy against hypertension, diabetes, epilepsy, 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, flower, root, root bark, stem and stem bark. It contains various biologically active phytochemicals such as alangine, ankorine, tubulosine, alangicine, salsoline, etc. Mere scientific evidences of activity of the extracts will not create the solutions, rather studies should focus on developing contemporary formulations after extensive analysis of its bioactivity, pharmacokinetics and pharmacodynamics, safety, etc. using appropriate animal models followed by clinical trials. Substantial research has already been conducted on this plant during last few decades, which can be used by scientists in developing useful therapeutic solution from *Alangium salviifolium.*

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

ACKNOWLEDGEMENTS

Authors are grateful to Prof Anil Gupta, Executive Vice Chair, National Innovation Foundation India for his honorary guidance and encouragement for carrying out research activities.

COMPETING INTERESTS

All the authors declare that they have no conflict of interest.

REFERENCES

1. Wakdikar S. Global health care challenge: Indian experiences and new prescriptions. Electronic Journal of Biotechnology. 2004;7(3):02-3.
2. Rana KK, Rana S. Review on present status and future of herbal medicine; 2014.
3. Chakraborty C. Advances in Biochemistry and Biotechnology: Daya Books; 2005.
4. Gurib-Fakim A. Medicinal plants: Traditions of yesterday and drugs of tomorrow. Molecular Aspects of Medicine. 2006; 27(1):1-93.
5. Feng C-M, Manchester SR, Xiang Q-YJ. Phylogeny and biogeography of Alangiaceae (Cornales) inferred from DNA sequences, morphology, and fossils. Molecular Phylogenetics and Evolution. 2009;51(2):201-14.
6. Quattrocchi U. CRC World Dictionary of Plant Names volume I. CRC Press: Boca Raton; New York; Washington, DC; USA London, UK ISBN. 2000;978(0):8493.
7. Jain A, Katewa S, Galav P, Sharma P. Medicinal plant diversity of Sitamata wildlife sanctuary, Rajasthan, India. Journal of Ethnopharmacology. 2005; 102(2):143-57.
8. Nadkarni KM. [Indian Materia Medica]; Dr. KM Nadkarni's Indian materia medica: with Ayurvedic, Unani-Tibbi, Siddha, allopathic, homeopathic, naturopathic & home remedies, appendices & indexes. 1: Popular Prakashan; 1996.
9. Basu BD, Kirtikar K, Blatter E. Indian medicinal plants: International Book Distributors; 1999.
10. Gopinath S. Broad spectrum antimicrobial activities and phytochemical analysis of *Alangium salviifolium* flower extract. Global Journal of Research on Medicinal Plants & Indigenous Medicine. 2013;2(3):135.
11. Ramani VA, Jagajeevanram P. Extraction and characterization of chromone from fat *Alangium salviifolium*. Asian Journal of Chemistry. 2003;15(3):1693.
12. Jain S, Sinha A, Bhakuni DS. The biosynthesis of β-carboline and quino-lizidine alkaloids of Alangium lamarckii. Phytochemistry. 2002;60(8):853-9.

13. Hung TM, Dang NH, Kim JC, Choi JS, Lee HK, Min B-S. Phenolic glycosides from *Alangium salviifolium* leaves with inhibitory activity on LPS-induced NO, PGE 2, and TNF-α production. Bioorganic & Medicinal Chemistry Letters. 2009;19(15):4389-93.
14. Tanwer BS, Vijayvergia R. Phytochemical evaluation and quantification of primary metabolites of *Alangium salviifolium*. Int J Pharm Biosci. 2010;1:1-6.
15. Plants IM. A compendium of 500 species. Orient Longman Ltd, Madras. 1995;4:48-51.
16. Kirtikar KR, Basu BD. Indian medicinal plants. Indian Medicinal Plants; 1918.
17. Pandey C, Education GE. Medicinal plants of Gujarat: Gujarat Ecological Education and Research Foundation; 2005.
18. Bakhru H. Herbs that heal. J Orient Longman Ltd. 1997;17.
19. Yoganarasimhan S. Medicinal plants of India. Volume 2. Tamil Nadu. Bangalore: The Author i; 2000.
20. Chopra RN. Supplement to glossary of Indian medicinal plants; 1969.
21. Husain A. Dictionary of Indian medicinal plants; 1992.
22. Pullaiah T, Naidu KC. Antidiabetic plants in India and herbal based antidiabetic research: Daya Books; 2003.
23. Usher G. A dictionary of plants used by man: Constable and Company Ltd.; 1974.
24. Sharma A, Agarwal VV, Sharma S, Chauhan B, Sharma A, Punia R. Antidiabetic effect Of bark Of *Alangium salviifolium* In. Journal of Global Pharma Technology. 2011;3(4):26-32.
25. Galav P, Jain A, Katewa S. Traditional veterinary medicines used by livestock owners of Rajasthan, India. Indian Journal of Traditional Knowledge. 2013;12(1):47-55.
26. Sanyal A, Dasgupta B, Gambhir S, Das P. Studies on Alangium lamarckii, Thw. II. chemical and pharmacological studies with a quaternary base from the leaves. The Indian Journal of Medical Research. 1966;54(11):1060-3.
27. Jubie S, Jawahar N, Koshy R, Gowramma B, Murugan V, Suresh B. Anti-arthritic activity of bark extracts of *Alangium salviifolium* wang. Rasayan J Chem. 2008;1(3):433-6.
28. Raju Dash M, Ahsan T, Hosen SZ, Rahman MG, Emran TB, Muhammad M, et al. Evolution of selective COX-2 inhibitor from *Alangium salviifolium*: An in silico approach. Journal of Applied Pharmaceutical Science. 2015;5(04):089-93.
29. Kalarani DH, Dinakar A, Senthilkumar N. Antidiabetic, analgesic and anti-inflammatory activity of aqueous extracts of stem and leaves of *Alangium salviifolium* and *Pavonia zeylanica*. Int J Drug Dev Res. 2012;4(4):298-306.
30. Balakrishnan N, Kumar S, Balasubramaniam A, Sangameswaran B, Chaurey M. Antiepileptic activity of *Alangium salviifolium* leaf extracts. Herbal Tech Industry. 2010;31(6):20-30.
31. Parida N, Bal S, Panda P. Anticonvulsant activity of *Alangium salviifolium* stem bark. Hamdard Medicus. 2010;53(4):15-20.
32. Kalarani D, Dinakar A, umar N. Hypoglycemic and antidiabetic activity of *Alangium salviifolium* wang in alloxan induced diabetic rats. Asian Journal of Pharmaceutical and Clinical Research. 2011;4(1):131-3.
33. Kumar R, Pate DK, Prasad SK, Sairam K, Hemalatha S. Antidiabetic activity of alcoholic leaves extract of Alangium lamarckii Thwaites on streptozotocin–nicotinamide induced type 2 diabetic rats. Asian Pacific Journal of Tropical Medicine. 2011;4(11):904-9.
34. Rajkumar S, Kumar NS. Isolation chemical characterization and hypoglycemic activity of *Alangium salviifolium* wang bark in alloxan induced hyperglycemic rats. International Journal of Pharmaceutical Sciences and Research. 2011;2(6):748-54.
35. Ahad HA, Yesupadam P, Guruprakash P, Sravanthi M, Ramyasree P. Phytochemical and hypoglycemic evaluation of *Alangium salviifolium* root extract. Journal of Scientific Research. 2011;3(2):393-402.
36. Darade SS. Phytochemical investigations of *Alangium salviifolium* linn. leaves, and screening for anti-diabetic activity; 2010.
37. Haque IE. Anticancer activity of *Alangium salviifolium* flower in Ehrlich ascites carcinoma bearing mice. International Journal of Cancer Research. 2011;7(3): 254-62.
38. Nahar L, Zahan R, Mosaddik A, Islam S, Haque A, Fazal A, et al. Antioxidant and antitumor activity of chloroform extract of *Alangium salviifolium* flowers. Phytopharmacology; 2012.
39. Venkateshwarlu R, Gopal YV, Raju AB, Prasad KB. Antitumor activity of *Alangium*

salviifolium against Dalton's ascitic lymphoma. Medicinal Chemistry & Drug Discovery. 2012;3(2):122-33.

40. Pailee P, Prachyawarakorn V, Mahidol C, Ruchirawat S, Kittakoop P. Protoberberine alkaloids and cancer chemopreventive properties of compounds from *Alangium salviifolium*. European Journal of Organic Chemistry. 2011;2011(20-21):3809-14.
41. Inayathulla KAA, Shariff W, Sikarwar M. Wound healing property of alcoholic extract of leaves of *Alangium salviifolium*. J of Pharm Res. 2010;3(2):267-9.
42. Kumar R, Hemalatha S. In vitro antioxidant activity of alcoholic leaf extract and subfractions of Alangium lamarckii Thwaites. J Chem Pharm Res. 2011;3(1): 259-67.
43. Sakthidevi G, Mohan V, Jeeva S. In vitro antioxidant activity of leaf extracts of *Alangium salviifolium* (CF) warf (Alangiaceae). Biosci Disc. 2014;5:74-81.
44. Vats S. Evaluation of antioxidant potential of *Alangium salviifolium* (Lf) Wangerin. 2015;7(2).
45. Zahan R, Nahar L, Nesa ML. Antinociceptive and anti-inflammatory activities of flower (*Alangium salviifolium*) extract. Pakistan Journal of Biological Sciences. 2013;16(19):1040.
46. Ahad HA, Padmaja BS, Sravanthi M, Ramyasree P, Kavitha K. Phytochemical screening and anti-inflammatory actions of *Alangium salviifolium* root extract. Natural product research. 2012;26(17):1649-53.
47. Ronok Z, Anamul H, Laizumari N, Ashik M, Ekramul H. Evaluation of anxiolytic and CNS depressant activity of *Alangium salviifilium* wang flowers. International Research Journal of Pharmacology. 2012;3(4):144-7.
48. Sreekanth P, Sudhakara K, Gouse Basha G, Murali K, Sanjeeva Kumar A. Anti ulcer effect of *Alangium salviifolium* ethanolic leaf extract on gastric lesion induced by ethanol in rats. Asian Journal of Pharmaceutical and Clinical Research. 2011;4(2):112-4.
49. Monanty P, Panda S, Mishra S, Panda P, Jaliwala Y, Milind P. Study of antiulcer activity of roots of *Alangium salviifolium* Linn. In pylorus ligated rats. Int Res J Pharm. 2011;2:190-2.
50. Parameshwar P, Reddy YN. Protective role, *In-vitro* Free radical scavenging activities of *Alangium salviifolium* (Linn) againest CCl4 induced hepatic damage in rats. International Journal of Pharmacy and Pharmaceutical Sciences. 2015;7(1).
51. Rajamanickam V, Rajasekaran A, Quine S, Jesupillai M, Sabitha R. Diuretic activity of *Alangium salviifolium* sub. sp. hexapetalum. The Int J Alt Med. 2009;8.
52. Udaya Prakash N, Bhuvaneswari S, Preethy N, Rajalakshmi N, Saranya M, Jasmine R, et al. Studies on antimicrobial, antioxidant, larvicidal, pesticidal activity and phytochemistry of leaves of *Alangium salviifolium* (Lf) Wang. International Journal of Pharmacy Pharmaceutical Sciences. 2013;5:86-9.
53. Jain VC, Patel N, Shah DP, Patel PK, Joshi BH. Antioxidant and antimicrobial activities of *Alangium salviifolium* (Lf) Wang root. Global Journal of Pharmacology. 2010;4(1):13-8.
54. Pavunraj M, Gabriel Pulraj M, Selva Kumar S, Rao M, Ignacimuthu S. Feeding deterrence, larvicidal and haemolymph protein profiles of an Indian traditional medicinal plant *Alangium salviifolium* (LF) Wangerin on cluster caterpillar, *Spodoptera litura* (Fabricius)(Lepidoptera: Noctuidae). Archives Of Phytopathology And Plant Protection. 2012;45(17):2066-75.
55. Rajasekaran A, Rajamanickam V, Sivagnanam G, Anandarajagopal K, Sivakumar V. Anthelmintic activity of the root extract of *Alangium salviifolium*. Journal of Tropical Medicinal Plants. 2007;8(1):39-42.
56. Pandey RS. Anthelmintic activity of *Alangium salviifolium* bark. Journal of natural product of plant resources. 2012;2(6).
57. Maheswari S, Chitra M, Sivasangari R. Isolation of insecticidal compound from *Alangium salviifolium* and its effect on Mythimna separata. Research Journal of Agriculture and Environmental Management. 2013;2(8):229-32.
58. Thippeswamy G, Lokesh S, Rai V. Influence of some indigenous medicinal plants extracts on seed mycoflora and seedling growth of some oilseed crop species. Advances in Plant Sciences. 2003;16(1):67-74.
59. Wuthi-udomlert M, Prathanturarug S, Wongkrajang Y. Antifungal activity and

local toxicity study of *Alangium salviifolium* subsp hexapetalum. Southeast Asian J Trop Med Public Health. 2002; 33(Suppl 3):152-4.

60. Murugan V, Gulhana S, Badami S, Ramanathan M, Suresh B. Androgenic activity of the total alkaloid fraction of *Alangium salviifolium* (Linn. F). Journal of Natural Remedies. 2002;2(1):66-70.

61. Murugan V, Shareef H, Ramasarma G, Ramanathan M, Suresh B. Anti-fertility activity of the stem bark of *Alangium salviifolium* (Linn. F) wang in Wister female rats. Indian Journal of Pharmacology. 2000;32(6):388.

Peer-review history:
The peer review history for this paper can be accessed here:
http://sciencedomain.org/review-history/13246