Comprehensive Phytochemical and Pharmacological studies on *Alangium salviifolium* decapetalum

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Abstract

Alangium salviifolium commonly known as sage leaved Alangium is well known medicinal plant used in Ayurveda and Siddha. The plant is known to have wide spectrum of biological activities like anti-diabetic, hepetoprotective, anti-bacterial, anti-fungal, antifertility, anthelmintic, anti-diarrhoeal, antiepileptic, anti-ulcer, wound-healing, anti-cancer, pesticidal, insecticidal, larvicidal activities. The plant was extensively studied by the researchers and therefore can be effectively used to develop therapeutic solutions in future.

Key words: *A. salviifolium* decapetalum, biological activities, pharmacognosy, phytochemistry

Introduction

Botanicals are chemical sources that directly provide ~25% of currently used crude drugs, with another ~25% derived from chemically altered natural products. (Cragg and Newman, 2001) The AIDS virus, the crisis of bacterial resistance to antibiotics, autoimmune diseases like rheumatoid arthritis, cancer, diabetes and many other recent developments have increased the value of knowledge in indigenous medicinal plants, which may hold clues for solving these deadly problems.

The family, *Alangiaceae* is distributed throughout Cambodia, India, Indonesia, Laos, Malaysia, Nepal, Philippines, Sri Lanka, Thailand, Vietnam; and South-east Africa. It comprises of 32 species which includes trees, or shrubs (sometimes spiny), or lianas (occasionally); laticiferous, self-supporting, or climbing. (Fang Wen-pei *et al.,* 1983) Only two species, namely, *A. chinense (Lour.) Harms* and *A. salviifolium* decapetalum occur in India. Both the species are important medicinal plants. *Alangium* is a small genus of dicotyledon trees in the *Alangiaceae* family. *Alangium* species are used as food plants by the larvae of some lepidoptera species including the Engrailed. Among these 22 species of the genus *Alangium* the most extensively studied species is *Alangium lamarckii* also known as Thai medicinal alangium. In this genus the species of folklore medicine are *Alangium lamarkcii, Alangium chienense, Alangium plantanifolium,* and *A. salviifolium.* The genus is rich in alkaloids; one of the important compounds of natural medicine. The present paper intends to review and evaluate various significant phytochemical and pharmacological values of *Alangium salviifolium* decapetalum.

Synonyms

The synonyms of *A. salviifolium* are *Alangium decapetalum* Lam, *Alangium lamarckii* Thw., *Alangium latifolium* Miq.ex C.B. Clarke, *Alangium mohillae* Tul., *A. 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. (Rastogi & Mehrotra, 1993).

Vernacular Names (Ambasta *et al.*, 2000)

Sanskrit	Akola, Ankodah, Ankole, Ankollaka, Ankota, Dirghakilaka, Dheergha, Talokota, Tamraphala, Guptasneha, Pitasarah
English	Hill sack tree, Sage leaf alangium, sage-leaved alangium
Telugu	Uduga, nalladugu
Hindi	Akola, dhela, dhera, ankera
Kannada	Ankola, Ankota, Guddada, Doani
Tamil	Alanji
Malayalam	Alinnil, angolam, Kara-angolam, Velittondi
Marathi	Ake
Oriya	Ankul koli
French	Alangium a' feuilles de sauge
Tibetan	agota, aketa, akota

Taxonomy (Singh *et al.*, 2000)

Biota	
Domain	*Eukaryota*
Kingdom	*Plantae*
Subkingdom	*Viridaeplantae*
Phylum	*Tracheophyta*
Subphylum	*Spermatophytina*
Infraphylum	*Angiospermae*
Class	*Magnoliopsida*
Subclass	*Cornidae*
Superorder	*Cornanae*
Order	*Cornales*
Family	*Alangiaceae*
Genus	*Alangium*
Species	*salviifolium*

Botanical Description

A. salviifolium is a deciduous, rambling shrub or tree distributed throughout East Asia. The tree grows to a height of 20m with grayish thorny branchlets. The flowering season is between February to June. 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. Flowers have 4-10 petals and 4-10 small sepals. 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. (Nadkarni, 1996; Kirtikar & Basu, 2005)

Anatomy

Leaf anatomy: Stomata present; usually anomocytic. Hairs present, or absent (sometimes with unequally 2–armed hairs). Lamina dorsiventral, or isobilateral, or centric.

Stem anatomy: Secretory cavities present. Nodes tri-lacunar. Secondary thickening developing from a conventional cambial ring. Xylem with libriform fibres; with vessels. Vessel end-walls oblique; scalariform, or simple. Wood parenchyma apotracheal (diffuse). (Fang Wen-pei *et al.*, 1983)

Fig. 1: *A. salviifolium* decapetalum plant parts A. Flower, B. Leaves, C. Thorny stem, D. Fruits

Medicinal Importance (Rastogi & Mehrotra, 1993, Rastogi & Mehrotra, 1992)

Leaves	Poultice to reduce rheumatic pains and used to cure chronic wounds.
Root	Anti-helmintic, purgative, emetic, febrifuge, antidote and used for the treatment of leprosy and other skin diseases.
Stem	Vomiting, diarrhea, antibacterial, analgesic, lowering hypertension and used both as contraceptive and abortifacient.
Fruits	Sweet, cooling, purgative and used externally to cure eye sores
Seeds	Cooling and tonic; used in the treatment of hemorrhage and as a cure for boil.

I. Preliminary Phytochemical Screening

Phytochemical screening of stem, root, seeds, leaves and flowers showed the presence of steroids, triterpenoids, alkaloids and flavanoids. In addition to these methanolic stem extract was positive for the presence of saponins, terpinoidal saponins and tannins. Similarly, methanol root extract shown the presence of saponins and glycosides. Carbohydrates are absent in seed extract. (Ashish Kumar *et al.*, 2011)

Table 1: Preliminary Phytochemical constituents of *A. salviifolium* stem, root, seeds, leaves and flowers

TESTS	Stem	Root	Seeds	Leaves	Flowers
Steroids	+	+	+	+	+
Triterpenoids	+	+	+	+	+
Saponin	+	+	-	-	-
Steroidal Saponins	-	-	-	-	-
Terpenoidal Saponins	+	-	-	-	-
Alkaloids	+	+	+	+	+
Flavonoids	+	+	+	+	+
Tanins	+	-	-	-	-
Glycosides	+	+	-	-	-
Carbohydrates	+	+	-	+	+

II. Compounds isolated from various parts of *A. salviifolium*

Various parts of *A. salviifolium* have been examined scientifically for their phytochemical constituents. The phytochemical analysis of *A. 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. (Gopinath, 2013) 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. (Pakrashi *et.al.*, 1967; Ramani, 2003) Presence of alangine A, alangine B, lamarckinine, markindine and emetine have been reported previously. Ankorine an alkaloid was isolated from the plant leaves. (Jain *et.al.*, 2002; Hung *et.al.*, 2009) Recently three phenolic glycosides, salviifosides A, salviifosides B, salviifosides C, along with three known compounds salicin, kaempferol, and kaempferol 3-O-β-Dglucopyranoside were isolated from the leaves of *A. salviifolium*. Salviifosides were also revealed to possess anti-inflammatory activity. (Hung *et.al.*, 2009)

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. (Tanwer & Vijayvergia, 2010) The differential distribution of constituents in different parts of *A. salviifolium* may be utilized for isolation of selective components. Alcoholic and aqueous extracts obtained from the aerial parts of *A. salviifolium* were used for isolation of proto emetine, cephaline, isotubulosine and alangimaridine. Various important phytochemical constituents isolated and characterized from different parts of *A. salviifolium* have been shown in table 2.

Table 2: Phytochemical compounds isolated from different parts of *A. salviifolium*

Plant part	Chemical compounds	References
Young Plant	Tryptamine, dopamine, N-deacetylisoipecoside, alangimarckine, dexyubulosine, ankorine, strictosidine, and vincoside	Jain *et al.*, 2002
Stem	Pergularinine, tylophorinidine and deoxytubulosine	Rao *et al.*, 1999
	Lamarchinine, de-Me-cephaeline, cephaeline, tubulosine, psychotrine	Pakrashi and Achari, 1970
Leaves	Choline	Dasgupta, 1966
	Ankorine	Dasgupta, 1965
	deoxytubulosine, alangimarckine, dehydroprotoemetine, alangimarckine, dehydroprotoemitine.	Sanyal *et al.*, 1965
	Stigmasta-5,22,25-trien-3 β-ol, myristic acid and D,E, cis-fused neohopane derivative, alangidiol, N-benzoyl-L-Ph-alaninol	Dasgupta and Sharma, 1966
	phenolic glycosides, salviifosides A, salviifosides B, salviifosides C, salicin, kaempferol, and kaempferol 3-O-β-Dglucopyranoside	Hung *et.al.*, 2009
Seeds	Betulinaldehyde, betuline, betulinic acid, hydroxyl lactone - A, β-sitosterol, lupeol	Pakrashi *et. al.*, 1967
Entire plant	Lactam, alangiside, loganic acid, venoterpine, disalsoline, isocephaeline.	Shoeb *et al.*, 1975

Plant part	Chemical compounds	References
Fruit	6-O-methyl-N-deacetylisoipecosidic acid, 7-O-methyl-N-deacetylisoipecosidic acid, 6,7-di-O-methyl-N-deacetylisoipecosidic acid, 6”-O-α-D-glucopyranosyl-6-O-methyl-N-deacetylisoipecosidic acid, 6’-O-α-D-glucopyranosylloganic acid	Itoh *et al.*, 2001
Fruit	1’,2’-dehydrotubulosine, tubulosine, isotubulosine, deoxytubulosine, cepheline, isocepheline, psychotrine, neocephaline, 10-O-demethylcephaline, 2’-N-(1”-deoxy-1”-beta-D-fructopyranosyl)cephaline, protoemetine, protoemetinol, salsoline, alangiside and alangine	Itho *et al.*, 2000
Root	cephaeline, tubulosine, isotubulosine, psychotrine and alangiside	Pakrashi, 1966
Root bark	Alkaloids A&B, alangisine, demethylpsychotrine, marckine, marckidine and lamarckinine	Pakrashi and Ali (1967)
Flower	1-Methyl-1H-pyrimidine-2,4- dione and 3-O-beta-D-glucopyranosyl-(24beta)-ethylcholesta-5,22,25-triene	Ramani, 2003

III. Acute toxicity study

A. salvifolium leaves, stem, root and seeds alcoholic extracts were evaluated for acute toxicity study according to the OECD (Organization for Economic Co-operation and Development) guidelines No. 420 of CPCSEA. The LD_{50} value of the extracts was found to be >1000mg/kg b. wt. (Raga Sudha, 2011; Ashish Kumar *et al.*, 2011)

IV. Antidiabetic activity

The alcoholic extracts of leaves, bark and seeds had shown significant($p<0.01$) effect in glucose tolerance. The seed and leaf extracts also inhibited diabetes induced by alloxan and streptozotocin–nicotinamide respectively. The extracts exhibited significant reduction in elevated levels of SGOT, SGPT, ALP, bilirubin, urea and creatinine levels in the rats.

These results indicate the effect of extracts may be due to their capacity to block glucose absorption through GIT, similar to acarbose and other molecules. The possible mechanism of *A. salvifolium* hypoglycemic activity is by potentiation of the insulin effect of plasma by increasing the pancreatic secretion of insulin from β-cells of the islets of Langerhans or release of β-cells from the bound form. (Ashish Kumar *et al.*, 2011; Rajesh Kumar *et al.*, 2011; Hepcy Kalarani *et al.*, 2012)

V Analgesic and Anti-inflammatory activity

In acetic acid-induced writhing in mice, the alcoholic extracts of *A. salvifolium* leaves and flowers exhibited significant analgesic activity.

The anti-inflammatory activity of Alangium salvifolium was studied by carageenan induced paw edema in rats. The alcoholic extracts of stem, root and seeds inhibited carageenan-induced rat paw edema at 500 mg/kg b. wt. when compared to the standard ibuprofen. The possible mechanism of anti-inflammatory activity is the inhibition of inflammatory mediators like histamine, serotonin from mast cells, prostaglandins and thromboxanes. (Zahan *et.al.*, 2013; Raga Sudha, 2015)

VI Anti-arthritic activity

Fruend’s adjuvant arthritis model is used to evaluate the antiarthritic activity of *A. salvifolium* stembark. The ethylacetate, petroleum ether, chloroform, methanol and aqueous extracts were administrated at a dose of 100mg/Kg for 21 days. All the extracts exhibited significant reduction of paw edema in Wister rats where maximum effect was given by the methanol bark extract. All the stem bark extracts showed potent anti-

arthritic activity and the potency of the activity follows the order standard > chloroform > ethyl acetate > aqueous > petroleum ether > methanol (Jubie, 2008)

VII Anti-bacterial activity

The bacterial sensitivity test was performed using agar-cup plate method. The hexane, chloroform, methanol extracts of *A. salvifolium* stem and root were found to be effective against *Staphylococcus aureus, Bacillus subtilis* and *Proteus vulgaris.* The chloroform extracts of both stem and root exhibited a significant zone of inhibition against Gram positive (*S.aureus, B. subtilis, B. pumulis and Micrococcus glutamicum*) Gram negative (*Echerichia coli, P. vulgaris*) bacteria. (Raga Sudha & Ganga Rao, 2008) Aqueous and alcoholic leaf extracts shown to be effective against Gram positive (*S.aureus, S.epidermidis, B.subtilis, M. luteus*) and Gram negative (*E.coli, E. aerogens, S. typhi* and *S. dysentriae*) bacteria. (Pandian *et.al.,* 2006) The methanol extract of *A salviifolium* flowers showed a wide spectrum of antibacterial activity against both gram-positive and gram-negative bacteria.(Mosaddik, *et.al.,* 2000). The antibacterial compounds 1-Methyl-1H-pyrimidine-2,4-dione and 3-O-beta-D-glucopyranosyl-(24beta)-ethylcholesta-5,22,25-triene, isolated from the flowers, showed remarkable antibacterial activities against a number of Gram-positive and Gram-negative bacterial species. (Adeeba Anjum, 2002) The antibacterial effect may be due to the phenolic compounds (leaves) and flavonoids present in the extracts.

VIII Anti-fungal activity

The ethanolic extract of roots has been reported against *Aspergillus niger, A. fumigatus, A. flavus, Fusarium oxysporum, Penicillum sps* and *Rizopus sps*. (Wuthi-udomlert, *et. al.,* 2016) The hexane, chloroform, methanol stem and root extracts were reported to be produce significant zone of inhibition against *Aspergillus niger* and *Rhizopus stolonifer* and no significant effect towards *Saccharomyces cerveceae*. (Raga Sudha & Ganga Rao, 2008) 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*. The anti-fungal activity of the stem and root extracts was performed by agar-cup plate method. (Wuthi-udomlert, *et. al.,* 2016) No significant activity against *Trichothecium roseum* was reported by aqueous leaf extract.

IX Anti-diarrhoeal activity

The antidiarrhoeal activity was determined by studying the effect on castor oil-induced diarrhea In the castor oil induced diarrheal mice, the methanolic extract and chloroform soluble fraction of the flower of *A. salviifolium*, at the dose of 50, 100 and 100 mg/kg, significantly (p 0.001) lessen the total number of faces as well as delayed the onset of diarrhea in a *A. salviifolium* flower extract/fraction exhibited significant antidiarrheal activity against magnesium sulphate-induced diarrhea. The extract/fraction at both dose levels significantly (p 0.001) reduced the extent of diarrhea and also notably delayed the onset of diarrhea in a dose dependent manner. The extract/fraction might have exerted its antidiarrheal action via antisecretory mechanism which was also evident from the reduction of total number of wet faeces (not shown separately) in the test groups in the experiment. Again, flavonoids present in the plant extract (Anjum *et al.,* 2002) are reported to inhibit release of autacoids and prostaglandins, thereby inhibit motility and secretion induced by castor oil (Hasan *et al.,* 2009).

In-vitro anti-diarrhoeal activity was reported on stem and root extracts of *A. salviifolium.* The ethylacetate, chloroform and methanol extracts were tested against diarrhea causing microorganisms namely, *E. coli, Enterobacter aerogens, E. feacalis, Bacillus subtilis, Shigella flexineria* and *Salmonella typhi.* All the extracts exhibited significant zone of inhibition towards the test organisms while, a greater effect being exhibited by the chloroform and methanol extracts. Previously reported finding on anti-diarrhoeal activity of saponins, reducing sugars, sterols, terpenes, tannins and alkaloids support the result produced in the experimental. (Raga Sudha, 2016)

X Anti-fertility activity

Antifertility activity of the ethyl acetate, chloroform, petroleum ether and aqueousextracts of *A. 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. (Murugan *et. al.*, 2000)

XI Pesticidal activity

Pesticidal activity has been reported for the leaves of *A. salviifolium* against a storage pest *Sitophilus oryzae*. At an interval of 24 and 48 hours the mortality rate of the pest was observed to be 80% and 100% 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. (Udaya Prakash *et.al.*, 2013)

XII 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. (Udaya Prakash *et.al.*, 2013) Similarly, antilarvicidal activity was observed against fourth instar larvae of *Spodoptera litura.*(Pavunraj *et.al.*, 2012)

XIII Insecticidal activity

The leaf extract of the *A. salviifolium* has been shown to be as effective insecticides against paddy infecting insect, *Mythimna separata*. It was demonstrated that the observed property is due to alangisides. (Maheswari *et.al.*, 2013)

XIV Anthelmintic activity

Anthelmintic activity of the aqueous and alcoholic extracts of roots of *A. salviifolium* was evaluated against Pheritima posthuma (Rajasekaran *et.al.*, 2007) 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. A study revealed significant anthelmintic activity of methanol and chloroform bark extracts by Pandey, in 2012.

XV Anti-hypertensive effect

A quarternary base was isolated from the watersoluble 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 pretreatment 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 (Sanyal *et.al.*, 1965)

XVI Anti-epileptic activity

Leaf extract of *A. salviifolium* has been shown to exhibit anticonvulsant activity. The antiepileptic 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 (Balakrishnan *et.al.*, 2010) 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 (Parida *et.al.*, 2010)

XVII Hepatoprotective activity

Hepatoprotective activity of methanol and aqueous extracts of leaves of *A. salviifolium* was studied in CCl4 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. (Parameshwar & Reddy, 2015)

XVIII Anti-oxidant activity

Leaf extract of *A. 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.(Kumar & Hemalatha, 2010; Sakthidevi *et.al.*, 2014; Vats, 2015)

XIX Wound–healing activity

Leaves of *A. 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.(Inayathulla *et.al.*, 2010)

XX Anti-ulcer effect

Anti-ulcer effect of ethanolic extract of *A. 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 (Monanty *et.al.*, 2011)

XXI Anti-cancer activity

In vivo anticancer potential of crude extract of *A. 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. 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. (Haque, 2011) 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. (Venkateswarlu *et.al.*, 2012)

In a study, protoberberine alkaloids were isolated, characterized and tested for in vitro anticancer properties. Nine alkaloids namely alangiumkaloids A (1) and B (2), 27- O-trans-caffeoylcylicodiscic acid (3), β-dglucopyranos-1-yl N-methylpyrrole-2-carboxylate (5), myriceric acid B (4), isoalangiside (6), alangiside (7), 3-O-demethyl-2-Omethylalangiside (8), and demethylalangiside (9) were also evaluated. Different compounds exhibited anti-oxidant activities as indicated by the IC50 values. Compounds 3, 4, and 9 scavenged DPPH free radicals with IC50 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 IC50 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 IC50 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 IC50 values of 5.6 and 3.9 µm, respectively, and compound 8 selectively. (Nahar *et.al.*, 2012)

Conclusion

A. 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, microbial infections and diarrhea. 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. However, scientific evidences of activity of the extracts alone will not create the solutions, studies should focus on developing contemporary formulations after extensive analysis of their 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 *A. salviifolium*

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