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Sweet flag: (*Acorus calamus*)-An incredible medicinal herb

N Umamaheshwari and A Rekha

Abstract

Acorus calamus Linn. (Araceae), commonly known as ‘‘sweet flag’’ or ‘‘calamus’’, is a semiaquatic, perennial, aromatic herb with creeping rhizomes. The plant is found in the northern temperate and subtropical regions of Asia, North America, and Europe. The plant exhibits polyploidy. Many ethnomedicinal and ethnobotanical uses have been ascribed to the rhizomes of the plant. *A. calamus* Linn. (AC) has been used as traditional Chinese and Indian prescriptions for its beneficial effects on memory disorder, learning performance, lipid peroxide content, and anti-aging and anticholinergic activity. Moreover, pharmacological studies have revealed that *Acorus* rhizome and its constituents, particularly a- and b-asarone, possess a wide range of pharmacological activities such as sedative, CNS depressant, behavior modifying, anticonvulsant, acetylcholinesterase inhibitory, memory enhancing, anti-inflammatory, antioxidant, antispasmodic, cardiovascular, hypolipidemic, immuno-suppressive, cytoprotective, antidiarrheal, antimicrobial, anthelmintic, insecticidal, adulticidal, diuretic, antioxidant, genotoxic, and mutagenic activities. This review is an effort to explore the different phytoconstituents and pharmacological activities of *Acorus calamus*.

Keywords: *Acorus calamus*, anticonvulsant activity, a-asarone, b-asarone, essential oil, rhizomes, sweet flag

1. Introduction

Sweet flag (*Acorus calamus*) is commonly known drug in traditional system of medicine. It is a tall perennial wetland monocot plant from the *Acoraceae* family. The scented leaves and rhizomes of sweet flag have been traditionally used as a medicine and the dried and powdered rhizome has a spicy flavour and is used as a substitute for ginger, cinnamon and nutmeg for its odour [1]. Due to varied uses, there has been demand for the plant. The herb rarely produces seeds and is mainly propagated by vegetative means. *In vitro* method of vegetative multiplication of *Acorus calamus* would have considerable benefits for the medicinal trade and germplasm conservation. It has been long known for its medicinal value, it is wild or cultivated throughout Himalayas at an altitude ascending up to 6000 feet. The rhizomes of *Acorus calamus* contain aromatic oil that has been used medicinally since ancient times and has been harvested commercially. The rhizomes are considered to possess antispasmodic, carminative, anthelmintic, aromatic, expectorant, nauseate, nervine, sedative, stimulant properties and also used for the treatment of epilepsy, mental ailments, chronic diarrhoea, dysentery, abdominal pain [2].

2. Distribution

Acorus calamus is a native of Central Asia and Eastern Europe and also it is indigenous to the marshes of the mountains of India. It is cultivated throughout India, ascending to an altitude of about 2200 metres. It is also found in marshy tracts of Kashmir, Shirmaur (Himachal Pradesh), Manipur and in Naga Hills. It is regularly cultivated in the koratagere taluka of Karnataka state in peninsular India [4].

3. Taxonomical classification

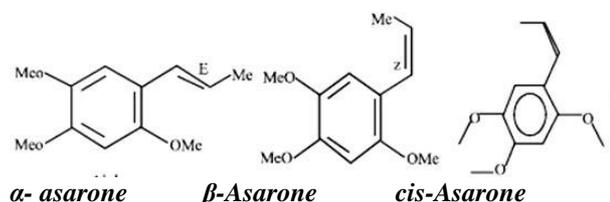
Kingdom: Plantae
Subkingdom : Tracheobionta
Super division : Spermatophyta
Division : Magnoliophyta
Class : Liliopsida
Subclass : Arecida
Order : Arales
Family : Acoraceae
Genus : *Acorus L.*
Species : *Calamus* [5].

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4. Vernacular name

Arabic: Vaj, Vash, Oudul Vaj; Sanskrit: Bhadra, Bhutanashini, Vacha; Arabic Hindi: Bach, Ghorbach, Safed bach; Gujarati: Gandhilovaj, Godavaj; Kashmir: Vachi, Vaigandar; Persian: Agar, Agarturki, Kannada: Baje, Vasa; English: sweetflag, *Acaruscalamus*, Myrtle grass; Urdu: Bach, Vaj; Tamil: Vashambu, pullai valathi; Nepali: Bojho; Ayurvedic: Vacha; Unani: Vaj turki, Bacch; Italy: Plant of Venus.⁶

5. Botanical description



Three important chemical constituents of *Acorus Calamus*

6. Parts used

The parts used in most of the experimental studies are the leaves, roots and stem of the plant. The dry rhizome contains some of the yellow aromatic oil 1, calamus oil that are responsible for their medicinal and insecticidal properties. Studies were also done on their rhizome part and in its oils in order to identify the active constituents and its medicinal values [7].

Rhizome

A. calamus is a perennial plant with creeping and extensively branched, aromatic rhizome, cylindrical, up to 2.5 cm thick, purplish-brown to light brown externally and white internally. At the rhizome forming, perennial that can grow to 2 meters resembling an iris.



Root It consists of long creeping roots which spread out just below the surface of the soil.



Leaves

The leaves are thick, erect and are very similar in appearance to the iris but edges are crimped. The leaves of *A. calamus* has a single prominent mid vein and then on both sides slightly

raised secondary veins and many, fine tertiary veins. This makes it clearly distinct from *Acorus americanus*. The leaves are between 0.7 and 1.7 cm wide, with average of 1 cm. The sympodial leaf of *a calamus* is somewhat shorter than the vegetative leaves the leaves are free, alternate, green and wavy. 1-3 in seeded having a thin testa which is cylindrical in shape and green in colour.

Flower

Flower is very rarely grown in this plant if grown than it is 3-8 cm long, cylindrical in shape, greenish brown in color and covered with the multitude of rounded spikes. The flowers are small, sessile and densely packed and 5-10 cm of spadix. The spadix, at the time of expansion, can reach a length between 4.9 and 8.9 cm. Flowers from early to late summer depending on the latitude, grows wild in marshy places up to 2000 m altitude in the Himalayas, Manipur, Naga Hills and in some parts of south India.

Fruit

The fruits are small and berrylike c-diglucoside; chemical constituents vary in ecotypes and containing few seeds. Flowering and fruiting occurs in July. The other species in this genus is *Acorus gramineus* native to eastern Asia commonly called as Japanese sweet flag, Japanese rush, grassy-leaved sweet flag, dwarf sweet flag is an aquatic or wetland perennial with semi evergreen grass like foliage. It has narrow, 6 to 14 in (15 - 35.6 cm) glossy leaves and looks like thick, lush grass. The leaves are carried in two ranks, like opposing fans. They are flat, about a 0.5 in (1.3 cm) wide and tend to flop over. The insignificant flowers, shaped like little horns, are produced in midsummer on erect hollow stems. Usually, only plants grown in water produce flowers [1, 14].

7. Cultural aspects

Cultivation

Sweet flag comes up in almost all types of soil with sufficient moisture or irrigation. This can also be grown in waterlogged or marshy soils. Tropical to subtropical climate is suitable for this crop. Such field is irrigated and tilled with green manure before planting. The rhizome (previous year's) along with bud is cut into pieces (Cut without affecting bud). The cut pieces of rhizome with bud is planted in the fine sand mixed soil at 0.3 m apart, leaving the leafy portion little bit above the soil so that the bud can be seen from outside. Weeding: The crop is weeded once every month from the first four to five months.

Fertilizers

Chemical fertilizers of 45:12.5:12.5 kg NPK (Nitrogen, Phosphorous and Potash) per hectare.

Harvesting

The crop is ready for harvesting in about a year after cultivation. The leaf tip begin to turn yellow this is the indication of crop maturity. The rhizomes are usually collected during autumn (September - October) till early spring (March - April) seasons.

Yield of the Crop

The average yield of rhizome is 40 quintal per hectare. [8, 9]

8. Major chemical constituents

Studies revealed that the volatile constituents of *Acorus calamus* obtained in gas chromatography and mass

spectrometry has 184 compounds in the oil of the triploid European *A. calamus* var. *calamus* and 93 compounds in the oil of the tetraploid Indian *A. calamus* var. *angustatus*, with f-asarone as the major constituent. The chemical constituents are of 67 hydrocarbons, 35 carbonyl compounds, 56 alcohols, eight phenols, two furans and four oxido compounds also detected, in an alcohol extract of *A. calamus* var. *calamus*, 243 volatile components, 45 of which were new records from sweet flag. Based on the oil the chemical compound varies in *A. Calamus* based on ploidy level of the taxon.¹⁰ β -Asarone (isoasarone) is usually the major constituent.¹¹⁵ And its concentrations vary markedly among the oils from the three varieties. β -asarone (90-96%) is highly present in tetraploid plants and also contains α -asarone. In triploid plants, β -asarone (5%) in their oil and the diploid plants lack β -asarone, but it has high amount of geranylacetate. The percentage of chemical components varies depending on the part of the plant from which the oil extracted. α -Asarone, elemicine, cis-isoelemicine, cis and trans isoeugenol and their methyl ethers, camphene, P-cymene, β -gurjunene, α -selinene, β cadinene, camphor, terpinen-4-ol, α -terpineol and α -calacorene, acorone, acorenone, acoragermacrone 2-deca-4, 7- dienol, shyobunones, isohyobunones, calamusenone, linalool and pre isocalamendiol are also present. *Calamus* has the constituent such as alkaloids, falvanoids, gums, lecithins mucilage, phenols, quinine, saponins, sugars, tannins and triterpenes. Sugars composition were indicated by densitometer as maltose (0.2%), glucose (20.7%) and fructose (79.1%).¹Lectins present in plant have mitogenic action on mononuclear cells of human cells (macrophages of murine spleen). Lectins have inhibitory effect on the growth of some neoplastic cell lines from mice. Saponins showed effects against hyperlipidemia in rats. Especially α and β - asarone are highly active in antioxidant, antilipidemic, antimicrobial, anticancer, immunosuppressive, antidiabetes activities.

Medicinal uses

Calamus is a herb used for the appetite and as an aid to the digestion. It is used for fevers, stomach cramps and cholic.¹ Their rhizomes were used for toothache and powdered rhizome for congestion. The rhizome part is also used to treat several diseases like asthma and bronchitis and asedative. Native tribes treated cough by making a decoction of the plant as a carminative and also for cholic. It is a main medhya drug, which has the property of improving the memory power and intellect. *Acorus calamus* is used in the conditions of vata and kapha, dysmenorrhoeal, nephropathy, calculi, stragury.³¹ *Acorus calamus* leaves, rhizomes and its essential oil has many biological activities like antispasmodic, carminative and also used for treatment of epilepsy, mental ailments, chronic diarrhea, dysentery, bronchial catarrh, intermittent and tumors. It also has the insecticidal, antifungal, antibacterial¹³. Tranquilizing, anti-diarrhoeal, anti-dyslipidaemia, neuro protective, antioxidant, anticholinesterase, spasmolytic, vascular modulator activities¹⁶. The various extract of *Acorus calamus* is traditionally used for the antidiabetes, antiproliferative, immunosuppressive, hypolipidemic, mitogenic and anticarcinogenic activity towards human lymphocytes. The different extract forms possess the antispasmodic, anthelmintic, antifungal, antibacterial, fish toxin, insecticidal, anti-diabetes, anti-proliferative, immunosuppressant, antidiarrhoeal, and antioxidant and hypo lipidemic activities. The rhizomes and leaf part were found to possess the mitogenic and anticarcinogenic activity towards

human lymphocytes³¹. The rhizomes are also used for treatment of epilepsy, mental ailments, chronicdiarrhea, dysentery, intermittent fevers, cough, throat irritations, bronchitis, as expectorant, and tumors^{12, 13}. The extract were used in the traditional Chinese prescription and its beneficial effects on memory disorders, on learning performance, lipid peroxidase content and anti- aging effect in senescence have been reported¹⁷. *Acorus calamus* is also combined with *Polygala* root to help maintain mental and intellectual health of the elderly¹¹¹. When powdered, it can be of avail for depressed psychosis and dementia. Further indications include the loss of consciousness, confusion of the mind, forgetfulness, anorexia and epilepsy and as a traditional ayurvedic medicine to treat memory loss¹⁸. *Acorus calamus* is registered in the Pakistani Materia Medica where both the roots and rhizomes are used for nervous diseases and disorders, whereas the rhizome is especially indicated in cases of neurological symptoms to the brain¹⁹. *Acorus calamus* shows neuroprotective effect against stroke and chemically induced neurodegeneration in rats. Specifically, it has protective effect against acrylamide induced neurotoxicity¹⁷. *Acorus calamus* extract is also used in traditional Chinese prescription and its beneficial effects on memory disorder and learning performance, by decreasing brain lipid peroxide content have been reported.²³

9. Pharmacological action

9.1. Antibacterial activity

Growth of cultured Gram-negative organism was inhibited significantly by an extract of the rhizome. A standard cultured of staphylococcus aureus, Escherichia coli and shigella flexneri was observed after treatment with the essential oil.²⁰ The leaf and rhizome part of *Acorus Calamus* is found to possess the antibacterial activity. The methanolic extract of *Acorus Calamus* showed the inhibitory action against the bacterial strains of *Salmonella typhi*, *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, and *Staphylococcus aureus*²¹. The third fraction of the crude methanolic extracts has been found to show the highest inhibition against *S. aureus*, *E. coli* and the fraction is confirmed as β -asarone¹³. β -asarone compound of *Acorus Calamus* has the highest inhibitory effect against *E. coli* strain at various concentration. The ethanolic and aqueous extract of *Acorus Calamus* also showed the inhibitory effect against the above organisms.²³

9.2. Anti-fungal activity

β -asarone compound fraction obtained from the crude methanolic extract of *Acorus Calamus* rhizomes has been reported to possess the antifungal activity against the yeast strain of *Candida Albicans*, *Cryptococcus Neoformans*, and *Saccharomyces Cerevisae*¹³ and also against *Aspergillus Niger*. The α - and β - asarone compound which were isolated from the different extracts of *Acorus calamus* has been found to show the inhibition on the fungi strains of *Pencilium Chrysogenum*, *Aspergillus Niger*, *Aspergillus Flavus*, *Microsporium Canis* and yeast strain of *Cryptococcus Gastricus* and *Candida Albicans*.⁴⁰

9.3. Antiulcer and cytoprotective activity:

The ethanolic extract of the rhizome was studied in rats, for protection of the gastroduodenal mucosa against injuries caused by indomethacin, reserpine and cysteamine, and also in a pyloric ligation model. The extract produced a marked reduction in the volume and acidity of basal gastric secretions

and ulcer index and helped to protect against chemically induced lesions. [24, 4]

9.4. Anti-ischemic Heart Disease Activity

In the clinical trial on 45 patients of ischemic heart disease at the OPD of S.S Hospital BHU, the efficacy of the drug *Acorus calamus* was tested. The patient was divided randomly in the three groups. To the first group the trial drug in a dose of 1.5 g/day in divided dose for three month was given. The second group was given purified 'guggulu' while the third group which was the control group was given a capsule containing lactose powder. There was an encouraging improvement in the first and second groups. The drug was found to be effective in the improvement of chest pain, dyspnoea on effort, reduction of body weight index, improving in ECG decreasing serum cholesterol, decreasing SLDL (serum low density lipoproteins) and increasing SHDL (serum high density lipoproteins). [25]

9.5. Anti-inflammatory activity

An extract of the rhizome was studied in acute, chronic and immunological model of inflammation; including carrageenan- induced rat paw edema, and compared with the activity of the hydrocortisone. The extract showed significant anti-inflammatory activity with the reduction of 44%. The essential oil is also an effective anti-inflammatory agent and coconut oil extract of the rhizomes produced a 45% inhibition of carrageenan-induced rat paw edema and 61% inhibition using the granuloma pouch method. [16, 26] *Acorus calamus* is a traditional remedy for the inflammation problems but their biological function in the human skin cells not well characterized. *Acorus calamus* has been found to inhibit the expression of poly I: C-induced IL-6 and IL-8 which indicates their inhibitory effect on the expression of the cytokines which were likely to be in association with the suppression of NF- κ B activation and phosphorylation of IRF3 that shows the *Acorus calamus L.* may be used as a promising immunomodulatory agent in the inflammatory skin diseases. [26] *Acorus calamus* have been found to show the inflammatory activity in the tested rat model of vincristine induced painful neuropathy and chronic constriction injury induced neuropathic pain in rats. [26, 27]

9.6. Anti-oxidant activity

Phenolic compounds present in the plants is well known for their ability of scavenging free radical which shows antioxidant activity. [12] The *Acorus calamus* extract showed a remarkable increased and decreased levels of certain parameters due to the exposure to noise-stress which ultimately proves their antioxidant activity *Acorus calamus* has been found to render the protection against γ -radiation induced oxidative stress. [28] Exposure of rats to acrylamide caused hind limb paralysis in 58% of the animals on day 10 and decreased behavioural parameters, namely distance travelled, ambulatory time, stereotypic time and basal stereotypic movements compared with the control group. These rats also had a decrease in the reduced glutathione (GSH) content and glutathione-S-transferase (GST) activity in the corpus striatum and an increase in striatal dopamine receptors, as evident by an increase in the binding of 3Hspiperone to striatal membranes. Treatment with the ethanol: water (1:1) extract of the rhizomes of *A. calamus* increased the glutathione content and glutathione-S transferase activity in the corpus striatum while insignificant changes were observed in other parameters. Rats treated with

acrylamide and *A. calamus* extract in combination had a lower incidence of paralysis (18%) compared with those treated with ACR alone on day 10 of the experiment. The rats also showed a partial recovery in other behavioural parameters. The levels of GSH content and GST activity increased in the corpus striatum, while the dopamine receptors decreased compared with the ACR treated rats. The results suggest that the neuro behavioural changes produced by ACR may be prevented in the following treatment with *A. calamus* rhizomes (Pradeep *et al.*, 2002). Epieudesmin has been shown to have antineoplastic activity against the murine P388 lymphocytic leukemia cell line and several human cancer cell lines (BXPC-3, MCF-7, SF268, NCI-H460, KM20L2, and DU-145) Galgravin has demonstrated activity in preventing neuronal death and stimulating neurite growth. Structurally, similar lignans have also shown neuroprotective activity in *in vitro* models for Alzheimer's and Parkinson's disease⁶. Both epieudesmin and galgravin were identified in the methanolic extracts of *A. calamus* leaves by liquid chromatography electron impact mass spectrometry.

9.7. Bronchodilatory effect

Acorus calamus has been found to be a famous remedy for the respiratory disorders due to the unique combination of airways relaxant constituents that were found in the crude extract of *Acorus calamus* such as papaverine-like dual inhibitor of calcium channels and phosphodiesterase in the hexane fraction and anticholinergic, rolipram-like phosphodiesterase-4 inhibitor in the ethyl acetate fraction and finally the associated cardiac depressant effect that has provided a pharmacological basis for the traditional use of *Acorus calamus* in the treatment of the disorders of airways such as asthma. [44] Treatment of tracheal preparation with ethyl acetate fraction caused a rightward parallel shift in carbachol response curve at lower concentration (0.003mg/mL) similar to atropine and non-parallel shift at higher concentrations (0.01mg/mL), with reduction of maximum response, similar to rolipram [29].

9.8. Antidiabetic activity

Acorus calamus, is widely used in the treatment of diabetes in the traditional folk medicine of America and Indonesia. Four fractions obtained from the radix of *Acorus calamus* were used for insulin releasing or alpha-glucosidase inhibitory action²⁹. The ethyl acetate fraction of *Acorus calamus L.* has been found to possess hypoglycemic, hypolipidemia and other beneficial effects through the mechanism of insulin sensitizing and hence possess the great potential for the treatment of diabetes and other cardiovascular complications without any body weight gain [47]

9.9. Anticellular and immunosuppressive activity

The ethanolic extract of *A. calamus* rhizome has been found to possess anticellular and immunosuppressive potential. *A. calamus* extract inhibits the proliferation of various cell lines such as monocytic, lymphoblastoid, fibroblast, erythroleukemic of mouse and human origin which demonstrates that the effect is not cell specific. Effect of *A. calamus* extract on the IL-2 production and their inhibition in the levels of TNF- α production also proved. The inhibition of mitogen and antigen-stimulated lymphocyte proliferation of *A. calamus* has been reported. *A. calamus* extract prevents the cell activation that proved their anticellular and immunosuppressive effect in it. [48]

9.10. Insecticidal activity

Rhizomes of sweet flag possess the insecticidal properties against a variety of insect pests. The powder and extracted oil of rhizomes has been found to act as stomach contact poison, anti-feedant and as the repellent. The observation of the toxic and sterilizing effect of vapours of rhizome oil against certain insect pests has been proved^[31]. Asarones (2, 4, 5-trimethoxypropenyl-benzenes) isolated from the essential oil of *A. calamus* L. rhizomes, are potent growth inhibitors and anti-feedants to the variegated cutworm. Cis-Asarone added to artificial diet significantly inhibited growth and feeding by first-, third-, and fourth-instar larvae, whereas the Trans isomer produced an anti-feedant effect alone. The insecticidal activities of compounds derived from the rhizomes of *A. gramineus* against four agricultural insect pests were examined using direct contact application method. The biologically active constituents of *A. gramineus* rhizomes were characterized as the phenylpropenes, *cis*- and *trans*-asarones by spectroscopic analyses. Potencies varied according to insect species, compound, and dose. In a test with female adults of *Nilaparvata lugens*, *cis*-asarone caused 100, 83 and 40% mortality at 1,000, 500 and 250 ppm, respectively, whereas 67% mortality was achieved at 1,000 ppm of *trans*-asarone. Against 3rd instar larvae of *Plutella xylostella*, *cis*-asarone gave 83 and 50% mortality at 1,000 and 500 ppm, respectively, whereas *trans* asarone at 1,000 ppm showed 30% mortality. Against female adults of *Myzus persicae* and 3rd instar larvae of *Spodoptera litura*, *cis*- and *trans*-asarones both were almost ineffective at 2,000 ppm.^[1]

9.11. Antidiarrheal activity

The mice which ingested with castor oil showed the rapid onset of diarrhea within the period of four hours. Meanwhile, the mice which were given the extract (methanol or water) of the rhizome showed the decreases in total number of feces, number of wet feces, and total weight of wet feces. When the large doses of the methanol extract were given, diarrhea is not found to occur.^[10] *Acorus calamus* in dose 15mg, aqueous and methanolic extract in combination with other drug aqueous and methanolic plant extracts of *Acorus calamus* rhizome, *Pongamia glabra* leaves, *Aegle marmelos* unripe fruit and *Strychnos nux-vomica* root bark for their antidiarrhoeal potential against castor-oil induced diarrhoea in mice. The methanolic plant extracts were more effective than aqueous plant extracts against castor-oil induced diarrhoea. The methanolic plant extracts significantly reduced induction time of diarrhoea and total weight of the faeces. The result obtained establish the efficacy of these plant extracts as antidiarrhoeal agents.^[32]

9.12. CNS activity

The methanol and acetone extract of the plant possess certain psychoactive substances that are found to be depressant in nature. The extract produced alterations in the general behavioral pattern and does not induce any disturbances in the motor co-ordination. The methanol and acetone extract of the leaves of the plant possess CNS depressant activity which can be further utilized for its anticonvulsant research. Most studies proved that the roots and rhizomes of the plant possess the most CNS depressant activities.^[33]

9.13. Murine cancer

Two novel lectins were purified from rhizomes of two sweet flag species, namely *Acorus calamus* (Linn.) and *Acorus gramineus* by affinity chromatography on mannose linked

epoxy-activated Sepharose. *Acorus* lectins readily agglutinated rabbit, rat and guinea pig erythrocytes. Both ACL and AGL also reacted with RBCs from sheep, goat and human ABO blood groups after neuraminidase treatment. ACL and AGL were inhibited by mannose/glucose and their derivatives. These lectins showed potent mitogenic activity towards mouse splenocytes and human lymphocytes. Both ACL and AGL also significantly inhibited the growth of J774, a murine macrophage cancer cell-line and to lesser extent WEHI-279, a B-cell lymphoma. D.^[34]

9.14. Anti-anxiety

Three drugs i.e. Brahmi, Vacha and Shankhapuspi used in combination as ratio 10:3.8:0.2 exhibits a significant anti-anxiety activity.^[35] Both the poly herbal formulations having *A. calamus* as an ingredient namely, Prasham (100mg) and P-tabs significantly provides a good relief against insomnia, stress excitement and irritability^[35, 36]

9.15. Insulin sensitizing

Ethyl acetate fraction of *Acorus calamus* (12.5 and 25_g/ml) increased glucose consumption mediated by insulin in L6 cells. ACE (100 mg/kg) significantly reduced serum glucose, triglyceride, reinforce the decrease of total cholesterol caused by rosiglitazone, and markedly reduced free fatty acid (FFA) levels and increased adiponectin levels as rosiglitazone did. Serum insulin was decreased but not significantly. In addition, ACE decreased the intake of food and water, and did not increase body weight gain whereas rosiglitazone did. Due to the insulin sensitizing ability, ACE has the potential to be useful for the treatment of diabetes and cardiovascular complications without body weight gain.^[37]

9.16. Antihepatotoxic activity

The Antihepatotoxic activity of the ethanolic extract of the plant is due to the increase in the level of the serum level of hepatic enzymes such as glutamate oxaloacetate transaminase (GOT), glutamase pyruvate transaminase (GPT), alkaline phosphatase (ALP) and total bilirubin levels in the tested models which has in turn showed their hepatocellular damage in the hepatotoxicity induced animal model⁵⁸. This indicates that the ethanol extract brings the anti-lipid peroxidation and / or adaptive nature of the systems against the free radicals damaging effect. *Acorus calamus* at two dose level 250mg/kg and 500mg/kg show hepatoprotective activities on acetaminophen induced hepatotoxicity in rat. ethanol extract of *A. C* confers hepatoprotective activities. Activities of *acorus calamus* compare to standard drug silymarin.^[3]

9.17. Anti-rheumatitis

Vachadi gana, which consists of six plants including *A. Calamus* was found to be effective in case of Rheumatoid arthritis with pain, swelling and functional disability^[4]

9.18. Anti-schizophrenia

GK022, an herbal mixture containing *A. calamus* (100mg) as a constituent was reported to be significant in cases of Schizophrenia.^[38]

9.19. Tranquilizer

The aqueous extract was also supposed to counteract the effect of mental stress by tranquilizing action as mentioned in ayurvedic texts.^[42]

9.20. Anti-viral and Anti-anginal activity

The alcoholic extract of *A. calamus* exhibited potent antiviral activity against herpes virus i.e. HSV-1 and HSV-2. [25] *A. Calamus* in dose of 1.5-3gm/day was found effective against ischaemic heart disease, improvement in chest pain, instable angina, dyspnoea reduction of body weight, improving in ECG, decreasing serum cholesterol, decreasing SLDL and

increasing SHDL. *A. calamus* being a constituent in polyherbal drug namely Haritaki vati (HT), which reduced the anginal frequency and decreases the serum cholesterol and serum triglyceride Levels. [39]

10. Marketed Formulations of Buch plant Guidelines on use of *acorus calamus*

Formulations	Company
1.Scavon Vet cream42	
2.Acorus calamus Herbal Extract43	
3.Ayurvedic and Herbal Chemicals of Acorus calamus44	
4.Bulk Drugs of Acorus calamus45	
5.Varch oil47	
6.Ayurvedic tablets48	
7.Anxi- 649	
8. Manufacturer and Exporter of Medicinal Herbs of Acorus calamus50	Himalaya Drug Company, Makali, Banglore, India. Vidya Herbs Private Limited, Banglore, Karnataka, India. Jenson Enterprises Private Limited, Chengalpattu, India.
9.Herbal preparations of Acorus calamus51	Hindustan Pharmaceuticals, Amritsar, India. Herbotech Pharmaceuticals, Amritsar, India. Krishna Herbal Company, Chandigarh, India.
10.Ayurvedic Preparations of Acorus calamus52	Kalhan Pharmaceuticals Private Limited, Jalandhar, Punjab, India. Karthik Enterprises, Arokiapura Shanmugapura, Chottaian Thoppu, Tuticorin, Tamil Nadu. Sydler Remedies Private Limited, Mumbai, India. Kebee Pharmachemie Private Limited andheri, Mumbai, India.
11.Perfumes, Vach oil, Alcoholic Drinks,toothpastes52	Ram Prakash Company, Khari Baoli, New Delhi. Coimbatore, Tamil Nadu Agricultural University and Bhuvicare Private Limited, Tirunelveli.
12.Botanical Insecticide (Vasambu)53	Tripti Herbal and Plantation Services, Jabalpur, Madhya Pradesh. Salem Impex, Salem, Tamil Nadu.
13.Wholesale suppliers of Acorus calamus herbs54	
14.Nervine tonic, Antispasmodic55	Universal Pharmaceuticals Limited, Chennai, TN Modern Natural Products, Mumbai.
15.Stresnil56	The Pioneer Enterprises, Raudat Tahera, Mumbai. Bhagat Aromatics Limited, New Delhi.
16.Calamus Oil57	Katyani Exports, Pitam Pura, New Delhi. Ajinkya Chemtech Private Limited, Pune. Prakruti Remedies Pvt. Ltd Karnataka (India). Kangra Herb Private Limited, Kangra, HP
17.Spices, Herbs, Essential oil and Natural products of Acorus calamus58	Herbs forever, Los Angeles, California, U.S.A.O Eco Pure Naturals, Fairport Harbor, OH 44077.
18.Natural oil of Vacha 59	
19.Calamus Essential Oil60	
20.Insecticides61	
21.Krush capsules62	
22.Brainokan63	
23.Mahavishgarba Oil64	
24.Herbal Skin Cream65	

The FDA interdicted the utilization of sweet flag owing to the potential carcinogenic effects of its essential oil, with particular reference to β -asarone [FDA, 1974]. β -Asarone has been demonstrated to be responsible for carcinogenic effects involving duodenal tumour induction, unscheduled DNA synthesis in hepatocytes [66] as well as anti-proliferative and immunosuppressive, [67] central nervous system inhibitory [68] sedative and hypothermic effects. Wichtl says "It is not clear whether the observed carcinogenic effects in rats are relevant to the human organism" [69]. However, most sources advise caution in ingesting strains other than the diploid strain. In reality β -asarone is not actually a carcinogen but it is a pro-carcinogen that is neither hepatotoxic nor directly hepatocarcinogenic. It must first undergo metabolic 1'-hydroxylation in the liver before achieving toxicity. Cytochrome P450 in the hepatocytes is responsible for secreting the hydrolyzing enzymes that convert β -asarone into genotoxic epoxide structure. Even with the activation of these metabolites, the carcinogenic potency is very low due to the rapid breakdown of epoxide residues with hydrolase which leaves these compounds inert. Additionally, the major metabolite of β -asarone is 2, 4, 5-trimethoxyninnamic acid, a derivative which is not a carcinogen.

11. Conclusion

A. calamus, the versatile medicinal plant is the unique source

of various types of compounds having diverse biological activities. Its phytochemical constituents such as α -, β and γ -asarone, sesquiterpenes and acorenone showed many biological activities. The compounds were found to be highly active in antimicrobial, anti-inflammatory, antioxidant, antidiarrheal, antiulcer, antispasmodic, immunosuppressant and mitogen inhibitor activity. Hence it has been proved from the different literature reviewed that *Acorus calamus* can be explored successfully for various marketed formulation.

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