ETHNOPHARMACOLOGICAL ASPECT OF *ACORUS CALAMUS*: A REVIEW

Neha Tiwari[a]*, Anil Chaudhary[b], Ashutosh Mishra[c]

a* Siddhartha Institute of Pharmacy, Dehradun- 248001,Uttarakhand India.
b Cadila Pharmaceuticals Ltd, Jammu, India.
c A.N.D College of Pharmacy, Gonda, U.P., India.

Summary

Acorus calamus (Acoraceae), also known as Calamus or Sweet flag is commonly used as a herbal medicine in Ayurvedic system. Sweet flag has long been known for its medicinal value. The plant is found in the northern temperate and subtropical regions of Asia, North America, and Europe. The plant was initially distributed from its native range through trade and commerce. The leaves are long, slender, sword-shaped and simple, arising alternately from the horizontal rhizomes. *Acorus* rhizome and its constituents, particularly α and β-asarone, possess a wide range of pharmacological activities such as antiulcer, cytoprotective, antispasmodic, hypolipidemic, anticonvulsant, antibacterial, analgesic, CNS depressant, insecticidal, antioxidant, memory enhancing, immunosuppressive, antidiarrheal activity and anticancer activities. It is also use in the treatment of cough, fever, bronchitis, depression and other mental disorders, tumors, haemorrhoids, skin diseases, numbness and general debility. This review is an effort to explore the different phytochemical constituents and pharmacological activities of *Acorus calamus*.

Key words- *Acorus calamus*, β-asarone, antioxidant, antispasmodic, hypolipidemic.

Corresponding Author: Neha Tiwari
Siddhartha Institute of Pharmacy, Dehradun- 248001,Uttarakhand India.
Tel.: 91-121-2575091; Fax No.:91-121-2575724.
E-mail address: neha_pharmaco@rediffmail.com

Introduction

Bach or sweet flag botanically known as *Acorus calamus* Linn. is great valued as herbal medicine in Ayurveda (1). These plants will grow almost anywhere as long as there are adequate amounts of water present, and ample, full sunshine (2). Sweet flag is an uncommon but very widespread, semi-aquatic, (3) perennial herb with a creeping and much branch aromatic rhizome (1). Calamus (fig.1) was also known to many early American settlers and used for a number of folk remedies. Walt Whitman even wrote poetry about his beloved herb in "Leaves of grass" (3). Chemical constitute from sweet flag used as a medicinal agent or food additives is usually refer to as a “calamus”. The “flag” in the name is refers to the pleasantly aromatic odour. Recent taxonomic studies based upon morphological, anatomical, and molecular data suggest that *Acorus* be placed in its own monotypic family (4).

Figure1. *Acorus calamus* with spadix and sympodial leaf

Traditional Applications

There is a great demand for herbal medicines in the developed as well as developing countries because of their wide biological activities, higher safety margin than the synthetic drugs and lesser costs. Since herbal medicines are prepared from materials of plant origin they are prone to contamination, deterioration and variation in composition (5).

History

One of the earliest record of sweet flag is the calamus of the Bible. Calamus was also one of the plant s said to grow in the gardens of Solomon. Some researchers believe that the calamus of the Bible actually refers to beard grass or to lemon grass. Sweet flag was also used by the early Greeks and Romans. Hippocracts (460-377 B.C.) used the plant medicinally and in early herbals of the first century Dioscorides and Pliny refferd to a plant called *acoron*, which appears to be sweet flag (3).

Morphology

Sweet flag is a grass-like, rhizome forming; perennial that can grow to 2 meters high, resembling an iris (2). It is a semi-aquatic or marshy, perennial herb with indefinitely branched rhizome creeping in mud. Rhizomes are cylindrical or may be compressed about 1.5 cm in diameter, smooth and pinkish in colour (6). The thick, erect leaves are very similar in appearance to those of an iris, but with edges that are crimped (2). Plants very rarely flower or set fruit, but when they do, the flowers are 3-8 cm long, cylindrical in shape, greenish brown and covered in a multitude of rounded spikes. The fruits are small and berry like, containing few seeds (4).

Distribution

Acorus is a small genus of herb of the monocotyledonous family Araceae. It other species are *Acorus calamus* Linn. and *Acorus gramineus* Soland (7). *A. calamus* L. var. calamus, syn. Var. vulgaris L. is a sterile distributed throughout Europe, temperate India, and the Himalayan region. *A. calamus* var. angustatus Bess, comprises the tetraploids variety is found in eastern and tropical Southern Asia (8).

Cultivation

Acorus calamus is propagated through rhizomes. Clayey loams alluvial soils are suitable for its cultivation. The field is irrigated and ploughed with green manure before planting. The growing ends or tops of the previous year's crop are planted at 30 cm apart, leaving the leafly portion well above the ground. The crop is ready for harvesting in about a year. The plants are dugout and tops of the stocks are kept for next plantation. The rhizome are dried in sun, before they are marketed (6).

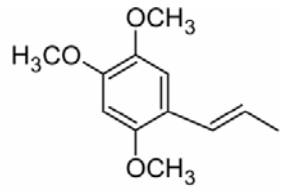
Chemical Investigation

The plant Sweet flag Linn. is well known for its medicinal uses. Phenylpropanes, monoterpenes are the major constitutes found in essential oil of *Acorus calamus.* A total of 184 volatile components were detected from European calamus including 67 hydrocarbons, 35 carbonyl compounds, 56 alcohols, 8 phenols, 2 furans and 4-oxido compounds where as from Indian *Acorus calamus*, 93 volatile compounds and some amino acids (table 1) were detected out of which α-asarone (1), β-asarone (2) and γ-Asarone (3) was found to be the major components. June is the best season for its cropping. It was notice that the major components of its volatile oil in the same part of the plants from different producing areas have the same chemical structure (1Kumar *et al*., 2000). The other constituents shown in (fig. 2 and fig. 3) include Methyl isoeugenol (4), Isoeugenol (5), Eugenol (6), Calameone (7), Asaronaldehyde (8), Terpinolene (9), Camphor (10), α-Caryophyllene (11), β-Pinene (12), Azulene (13), Diterpene (14), α-Pinene (15), Acoramone (16), Isoshyobunone (17), Elemene (18), Isocalamendiol (19), Shyobunone (20), Acorone (21) (9). Composition of calamus oil depends upon several factors such as chemotype of the plant, part of the plant, its stage of growth, condition of soil, ploidy level of plant and its geographical location. There are three essential oils are distinguished in *A. calamus* which are given below:

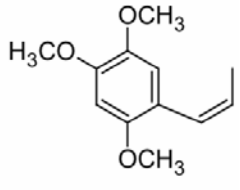
Type 1: found in rhizomes of diploid genotypes and is characterized by absence of β-asarone and other phenyl propane derivatives.

Type 2: found in European triploid chemotype with rhizome oil comprising β-asarone, shyobunone like sesquiterpenoids and unidentified compound.

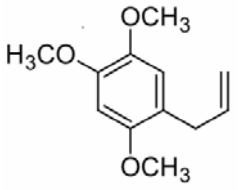
Type 3: found in tetraploids and variegated plants characterized by appreciable amount of β-asarone and cis-methyl iso-eugenol in rhizome and leaf oil. Besides essential oil, *A. calamus* rhizomes have also been examined for other chemical constituents such as protein, carbohydrates, sugars fatty acids, amino acids, iron, fat and calcium (7).



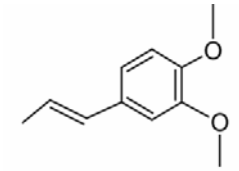
α-Asarone (1)



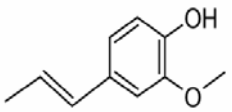
β-Asarone (2)



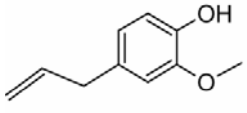
γ-Asarone (3)



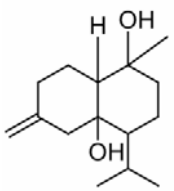
Methyl isoeugenol (4)



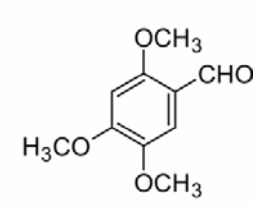
Isoeugenol (5)



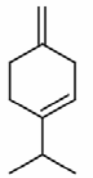
Eugenol (6)



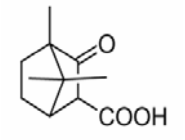
Calameone (7)



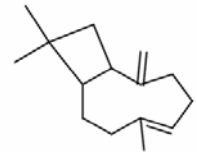
Asaronaldehyde (8)



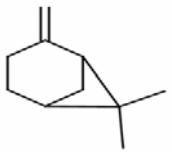
Terpinolene (9)



Camphor (10)

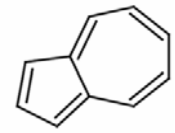


α-Caryophyllene (11)

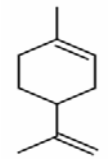


β-Pinene (12)

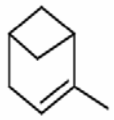
Figure 2. Phytoconstituents of *Acorus calamus* L. (9)



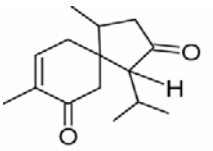
Azulene (13)



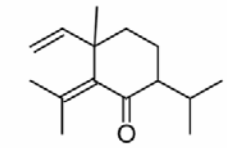
Diterpene (14)



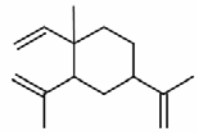
α-Pinene (15)



Acoramone (16)



Isoshyobunone (17)



Elemene (18)

Figure 3. Phytoconstituents of *Acorus calamus* L. (9)

Table-1 Composition of leaves and Rhizomes of *Acorus calamus*

S.No.	Constituents	Rhizomes	Leaf	References
1.	Amino Acids(%) • Arginine • α-Alanine • Aspargine • Aspartic acid	 0.22 0.66 0.68 0.90	 - - - -	(10)
2.	Ash(%)	2.09	-	(10)
3.	Calcium(%)	0.25-2.29	0.18-2.80	(10)
4.	Carbohydrates(%)	6.53	-	(10)
5.	Choline(%)	0.26	-	(2)
6.	Fat(%)	0.71	-	(10)
7.	Iron(%)	10.0	-	(10)
8.	Sugar(%) • Fructose • Glucose • Maltose	 79.1 20.7 0.2	 - - -	(11)
9.	Oil(%)	0.67-8.37	0.10-0.89	(12)
10.	Vitamin-C (mg%)	25.1-36.9	407.7-628.04	(10)

Toxicology

Sweet flag is poisonous under certain conditions, causing disturbed digestion, gastroenteritis, persistent constipation, followed by diarrhoea and passage of blood into feces. In 1968 the U.S. Food and Drug Administration reported that the use of sweet flag was unsafe, based upon cancerous tumours found in laboratory animals treated with the plant (4).

Etymology

A variety of names has been associated with sweet flag. The larger number of names attributed to this plant attests to its rich history and use by many cultures in the past. Some of the English folk names includes calamus, sweet rush, sweet root, sweet cane, gladdon , sweet myrtle, myrtle grass, myrtle sedge, cinnamon sedge, flagroot, myrtle flag, sweet cinnamon, beewort, pine root, drug sweet flag, water flag, yellow flag, rat root and sweet calomel. (3).

Pharmacological Activities

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 (13).

Antispasmodic activity

Experiments on the ileum, uterus, bronchial muscles, tracheal chain and blood vasculature showed the relaxant and antispasmodic activity of β -asarone and the essential oil of the rhizome (14).

Hypolipidemic activity

Administration of the ethanol (50%) extract of the rhizomes of *Acorus* as well as saponins isolated from the extract demonstrated significant hypolipidemic activity. On the contrary, the aqueous extract showed hypolipidemic activity only at a dose of 200 mg/kg. α-asarone obtained from *Acorus* rhizomes was also reported to possess hypolipidemic activity in mice (9).

Anticonvulsant activity

A poly herbal compound containing rhizome of Acorus calamus as one of the ingredients has been reported clinically to reduce epileptic attacks in patients by up to 50%. Treatment continued for 6 months resulted in cure in 66 out of 88 patients and no repeat episodes were reported after two year of the treatment (15).

Antibacterial activity

Growth of cultured Gram-positive and gram-negative organisms was inhibited significantly by an extract of the rhizome consistent and gradual decrease in replication of standard cultures of *Staphylococcus aureus, Escherichia coli* and *Shigella flexneri* was observed after treatment with essential oil (16).

Analgesic activity

The essential oil and alcoholic extract of rhizome were shown to possess analgesic properties and also mild hypotensive and sedative action (4).

CNS depressant activity

The effect of the ethanol extract of *Acorus* was studied on spontaneous electrical activity and monoamine levels of the brain. The serotonin level was increased in the cerebral cortex but decreased in the midbrain. Similarly, the dopamine level was increased in the caudate nucleus and midbrain but decreased in the cerebellum (17Hazra and Guha, 2003).

Insecticidal activity

Acorus calamus has also attacted attention for its insecticidal activity. It is a cheap, effective and simple to handle insecticide with no adverse effects on stored grains, domestic animal and human being (7).

Antioxidant activity

In vitro antioxidant activity by DPPH scavenging at three different concentrations (0.2, 0.1, and 0.01 g/mL) showed a maximum activity of 86.43% at 0.2 g/mL. The ethyl acetate and methanol extracts of *Acorus* protected most of the changes of oxidative stress status in the rat brain induced by noise-stress (18).

Memory-enhancing effect

In Ayurveda, herbal medicines with rasayana effects are believed to be restorative, to attain longevity, intelligence, and freedom from age-related disorders. *Acorus calamus* is regarded in Ayurvedic medicine as promoting rasayana effects and has been used to treat memory loss (19).

Immunosuppressive activity

The in vitro immunomodulatory property of the ethanol extract of *Acorus calamus* rhizome was evaluated. The extract was found to inhibit antigen (purified protein derivative) stimulated human peripheral blood mononuclear cells. Intracytoplasmic interferon-c (IFN-c) and expression of cell surface markers, CD16 and HLA-DR, on human peripheral blood mononuclear cells were not affected on treatment with *Acorus calamus* extract, but CD25 expression was down regulated (20).

Antidiarrheal activity

A study was undertaken to evaluate the effect of aqueous and methanol extracts of *Acorus calamus* rhizome for its antidiarrheal potential against castor oil–induced diarrhea in mice. The methanol plant extract was more effective than the aqueous plant extract against castor oil–induced diarrhea. The methanol extract significantly reduced induction time of diarrhea and total weight of the feces (21).

Anticancer activity

Two lectins purified from the rhizomes of two sweet flag species, namely *Acorus*, by affinity chromatography, showed potent antimitogenic activity toward mouse splenocytes and human lymphocytes. Both lectins also significantly inhibited the growth of J774, a murine macrophage cancer cell line and, to a lesser extent, WEHI-279, a B-cell lymphoma (22).

Conclusions

Sweet flag has had a long history and numerous traditional economic and ethnobotanical applications. Its story dates back to the time in the Bible when Moses used the plant in a holy anointing oil. Sweet flag was included in many of the early herbals and has a rich history in the Chinese and Indian cultures. Very few plants have gained such widespread use in diverse cultures. This suggests that the pleasantness of aromatic constituents or the positive medicinal attributes associated with sweet flag had enough validity to allow its use to surpass cultural barriers and gain widespread usage. The plant exhibits polyploidy, and the composition of the essential oil obtained from the plant rhizome depends on the karyotype. Phytoconstituents reported from Acorus rhizomes, a-asarone and b-asarone are the predominant bioactive constituents. Various pharmacological activities of *Acorus* rhizome such as antiulcer, cytoprotective, antispasmodic, hypolipidemic, anticonvulsant, antibacterial, analgesic, CNS depressant, insecticidal, antioxidant, memory enhancing, immunosuppressive, antidiarrheal activity and anticancer activities have been reported by different workers. Thus, this rhizome is well-known as a CNS active herb from Ayurvedic tradition and requires further research to establish the molecular mechanisms of evaluate its activity.

References

1. Kumar VS, Srivastava RK, Krishna A, Tomar VKS, Singh AK, Kumar S. Cultivation, chemistry, biology and utilization of bach (*Acorus calamus*). J med and aro plant sci 2000; 22:338-348.
2. Anonymous 2001. *The Wealth of India A Dictionary of Indian Raw Materials & Industrial Products: First Supplement Series (Raw Materials)*. Vol. I. New Delhi, India, National Institute of Science Communication, 2001:28–30.
3. Motley TJ. The ethanobotany of sweet flag, *Acorus calamus* (Araceae). Econ Bot 1994; 48:397.
4. Ernest S, Paul MC. Canadian Medicinal Crops; NRC research press 1999; 15.
5. Shrikumar S, Ravi TK. Approaches towards Development and Promotion of Herbal Drugs. Pharm Reviews 2007; 1(1):180-181.
6. Chauhan NS. Medicinal and aromatic plants of Himachal Pradesh. New Delhi, Indus publishing company,1999:72-75
7. Singh C, Jamwal U, Singh P. *Acorus calamus* (sweet flag): an overview of oil composition, biological activity and usage. J med and aro plant sci 2001; 23:687-708.
8. Cavazza G. Les chimiotypes parmi les plantes aromatiques cas du calamus polyploide. Ann Fals Exp Chins 1976; 69:833–844.
9. Mukherjee PK, Kumar V, Mal M, Houghton PJ. *Acorus calamus*: scientific validation of ayurvedic tradition from natural resources. Pharm Bio 2007. 45(8): 651–666.
10. Rafatullah S, Tariq M, Mossa JS, Al-Said MS, Ageel AM. Anti-secretagogue, anti-ulcer and cytoprotective properties of *Acorus calamus* in rats. Fitoterapia 1994; 65: 19.
11. Das PK, Malhotra CL, Dhalla NS. Spasmodic activity of asarone and essential oil of *Acorus calamus* Linn. Arch Inter Pharmacodyn 1962; 135:167.
12. Narayan J, Pandit BSV, Rangesh PRMD. Clinical experience of a compound Ayurvedic preparation on epilepsy. Ayur Vignyana 1987; 9(5):7.
13. Day D, Das MN. Pharmacognosy of anti-dysenteric drugs of Indian medicines. *Acta Bot indica* 1988; 16:216.
14. Hazra R, Guha D. Effect of chronic administration of *Acorus calamus* on electrical activity and regional monoamine levels in rat brain. Biogenic Amines 2003; 17:161–169.
15. Manikandan S, Srikumar R, Jeya Parthasarathy N, Sheela Devi R. Protective effect of *Acorus calamus* Linn on free radical scavengers and lipid peroxidation in discrete regions of brain against noise stress exposed rat. *Biol Pharm Bull* 2005; 28: 2327–2330.
16. Kirtikar KR, Basu BD. Indian Medicinal Plants. Vol. IV. Dehradun, India, M/s Bishen Sing, Mahendra Pal Sing Publishers, 1987; 1229–1230.
17. Mehrotra S, Mishra KP, Maurya R, Srimal RC, Yadav VS, Pandey R, Singh VK. Anticellular and immunosuppressive properties of ethanolic extract of *Acorus calamus* rhizome. Intl Immunopharmacol 2003; 3:53–61.

18. Shobha FG, Thomas M. Antidiarrhoeal activity of four medicinal plants in castor oil induced diarrhoea. J Ethnopharmacol 2001; 76:73-76.
19. Bains SJ, Dhuna V, Singh J, Kampoj SS, Nijjar KK, Agrewala NJ. Novel lectins from rhizomes of two *Acorus* species with mitogenic activity and inhibitory potential towards murine cancer cell lines. Inter Immunopharmacol 2005; 5:1470-1474.
20. Vashist VN, Handa KL. A chromatographic investigation of Indian calamus oil. Soap Perfum Cosmet 1964; 37:135-139.
21. Athanassova, Shopova S, Roussinov K. Pharmacological studies of Bulgarian plants with a view to their anticonvulsive effect comptes Rendus. Academic Bulgare des Sciences 1965; 18:691-694.
22. Abel G. Chromosomenschadigende Wirkung Von β-asaronein menschlichen lymphocyten. Plant Med 1987; 3:251-253.