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Review Article

A Review on *Acorus Calamus* Linn

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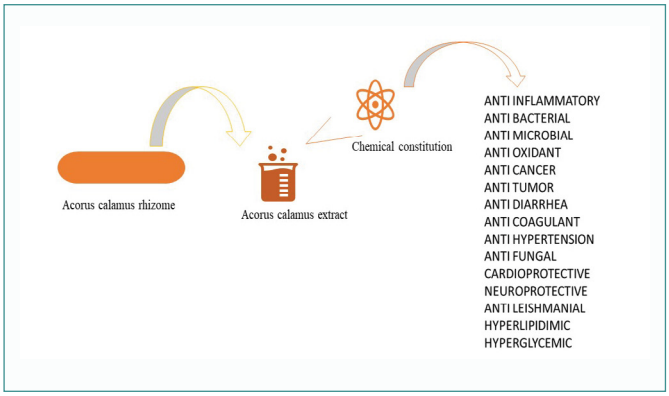
Abstract



Introduction

Acorus Calamus Linn the botanical family Acoraceae, which is referred as a semiaquatic perennial, known as "sweet flag" or "calamus". A creeping rhizome herb that has a fragrant aroma [1]. The underground stems and fragrant leaves of sweet flag have been used. It has historically been common practice to use it as a remedy, and it is typically dried out before use. The rhizome has a spicy taste when it is dried and it is an alternative to ginger, cinnamon, and nutmeg due to its odor [2]. The leaves are simple, sword-shaped and elongated. Emerging alternatively from the rhizomes that are parallel to the ground. The surface of the object is grooved in a longitudinal manner and nodes are present. Internally, it is spongy and compressed in a vertical manner [3]. The family *Acoraceae* includes the genus Acorus, which is typically made up of roughly 110 other genera and 1800 species. Within the genus Acorus, there are approximately 40 different species, including *A. Calamus* [4]. The prevalence of it is extremely high in Manipur, the Naga Hills, and along the borders of bodies of water. It is widely distributed across India, both cultivated and natural habitats, such as plains and lowlands, Elevations that reaches up to 2200 m in the Himalayan region [5].

Many Native American tribes were aware of the *A. Calamus*. This substance was used as a numbing agent for cranial and dental pain. It was used by the Chinese people in the past to treat constipation and inflammation. The mystical root was used by the Indian Ayurvedic medical tradition as a general sedative and to treat a variety of illnesses such as Asthma, fever, bronchitis. The plant is thought to have aphrodisiac properties according to folk botany traditions of Arabic, Roman, and later European cultures. According to Dioscorides, a cough can be cured by inhaling a drug's smoke orally while using a funnel. The rhizome possesses pleasant and fragrant scent has strong anticonvulsant properties [6]. Saponins, flavonoids, and essential oils are among the constituents of the *A. Calamus* Rhizome. According to records, essential oil derived from *A. Calamus* has properties that repel insects, inhibit feeding, and sterilize chemically [7].

The rhizomes are believed to have antispasmodic, carminative, anthelmintic, aromatic, nauseating, expectorant, and sedative, nervine and stimulating qualities. They are also applied in the management of epilepsy, psychological disorders, long term diarrhea, bronchial catarrh, glandular issues, dysentery, periodic fevers, and abdominal tumors [2].

Taxonomical classification [8]

- Kingdom: Plantae
- Subkingdom: *Tracheobionta*
- Super division: *Spermatophyta*
- Division: Magnoliophyta
- Class: *Liliopsida*
- Subclass: Arecida
- Order: Arales
- Family: Acoraceae
- Genus: *Acorus*
- Species: *Calamus*

Vernacular names

Arabic: Vaj, Vash, OudulVaj; Sanskrit: Bhadra, Bhutanashini, Vacha; Hindi: Bach, Ghorbach, Safedbach; Kashmir: Vachi, Vaigandar; English: Sweet flag, Calamus, Myrtle grass; Gujarati: Gandhilovaj, Godavaj; Persian: Agar, Agartuki; Kannada: Baje, Vasa; Tamil: Vasambu, Pullai-valathi; Urdu: Bach, Vaj; Nepali: Bojho; Ayurvedic: Vacha; Unani: Vaj Turki, Bacch; Italy: Plant of Venus [9].

Botanical description

The Vacha plant is a tall, perennial, wetland monocot that grows up to 1-4 feet tall and is member of the Acoraceae family.

Rhizome

Rhizomes which are thick and tangled shallow branches make up the root system. There are spots along these rhizomes where groups of basal leaves can be found, Underfoot, rough, fibrous roots are

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growing. The rhizome is a smooth, long, branching stem that is either pinkish or pale green in color and lacks a distinct length. The rhizome is whitish-pink on the inside and has a pleasant citrus scent; however, it tastes sour [10].

Leaves

The upright, sword like basal leave are similar to iris leaves. Their edges are flattened and appear smooth. The leaves are sparse and arranged alternately in a distichous pattern, measuring between 0.7 cm and 1.7 cm in width and having an average size of 1 cm. The length of the sympodial leaf of *A. Calamus* is a smaller than the length of its vegetative leaves. On either side of the leaf, there are no other major veins except for a solitary midrib. Secondary veins are slightly elevated and numerous tertiary veins are present in a fine manner. The edge of the margin has a wavy or rippled appearance. A distinction is made by botanists among *A. Calamus* Linn being identified by the number of leaf veins as *A. Calamus* has only one [10].

Fruits

The fruits are tiny and have a very limited number of seeds. In July, the flowers bloom, and then the fruiting process begin. Fruit has thick, grass like leaves that are thin, glossy, and measure 6 to 14 in (15 cm-35.6 cm). The leaves develop in two tiers, resembling competing fans. Herb fruits are typically flat and range in width from 0.5 inches (1.3 cm) [11].

Distribution

It is widespread in the tropics and subtropics, particularly in India and Sri Lanka. It can be found in marshes, either natural or man-made, rising up to 1800 m in Sikkim in the Himalayas. In swampy areas of Kashmir, Sir Moor, Naga Hills and Manipur, it is in great abundance. In the Karnataka taluk of Koratagere, it is routinely grown. The plant is grown in light alluvial soil and clayey loams along riverbanks. In most English-speaking nations, it can now be seen growing wild along riverbanks and pounds [12].

Parts used

The plant's leaves, roots (rhizomes), and stem are the primary components used in experimental investigations. Rhizomes are mostly used in traditional medical systems [13].

Cultural Aspects

Soil and climate

This herb may grow in both tropical and subtropical climates. *A. Calamus* needs enough sunlight during its growing phase and after it has harvested its rhizomes. The ideal climate ranges from 10°C to 38°C with yearly precipitation of 10 cm to 250 cm. Since the growing of this herb requires water, it should not be grown in areas with improper irrigation systems. Alluvial, clay, and sandy loams are the ideal soil types for growing the herb. The soil's PH level must be between 5 to 7 [14].

Land preparation

A. Calamus fields are prepared similarly to how rice fields are prepared for cultivation. Water ought to be spread around the field. Farmyard manure and green manure must be combined with the water, and then the soil must be finely tilled. Beginning of the monsoon season is the only time to plant [4].

Propagation

Rhizomes are typically used for Acorus reproduction, the rhizomes harvested from a previous planting. The soil must be moist since these rhizomes are retained beneath it. Cutting the rhizomes into tiny pieces prepares them for planting. The sprouting rhizomes are planted at a spacing of 30 cm × 30 cm. About 4 cm is the depth of the plantation. Early monsoon is the ideal time for Acorus cultivation [15].

Harvesting

Six to eight months after the crop's cultivation, it can be harvested. The crop is mature and ready for harvesting when the leaf tips have turned yellow and are beginning to dry out. To make digging easier before harvesting, the soil must be dried [11].

Crop yield

Around 40 quintal of rhizome is produced per hectare [11].

Phytochemical Constituents

The rhizomes of *A. Calamus* have been found to contain a large number of different chemical components. The chemical components of the oil from *A. Calamus* rhizomes have been examined by a variety of researchers [16].

The oil of *A. Calamus* Linn contain concentrations of a-asarone, b-asarone, c-asarone, calamine, calamenenol, calameone, a-pinene, b-pinene, camphene, p-cymene, eugenyl acetate, eugenol, isoeugenol, methyl isoeugenol, calamol, azulene, eugenol methyl ether, dipentene, methyleeugenol, asaronealdehyde, terpinolene, 1,8-cineole, camphor, a-caryophyllene, and hydrocarbons [1]. Thirteen amino acids were discovered to be present in the root, of which arginine, lysine, phenylalanine, threonine, and tryptophan were necessary amino acids. A-alanine, asparagine, aspartic acid, glutamic acid, norvaline, proline, and tyrosine were the other amino acids found [17].

Glycosides, sterols, and terpenoids were discovered in the rhizome's ethanol (50%) [18]. Sweet flag oil was used to isolate two sesquiterpenic ketones of the guanine-type calamusenone and its isomer. In addition to calameone, sesquiterpenes were recovered from *A. Calamus*, including shyobunone, isoshyobunone, isocalamendiol, dehydroxyisocalamendiol, and epishyobunone. Shyobunone, a sesquiterpine of the element type, was thermally isomerized to produce preisocalamendiol, a substance of the germacrone type, and acorone [19] (Table 1 and 2).

Toxicity

The presence of and asarones has been credited with most of the biological activities of sweet flag. Recent research has demonstrated that beta-asarone has the ability to improve cognitive impairment by stifling neuronal death. Alpha-asarone is also recognized to lessen the excitatory activity by promoting glutamate uptake and inhibiting excitatory neurotransmitter transporter mediated current.

Specifically, it has been shown that some chemical components of sweet flag asarone have harmful side effects include extended vomiting, hallucinogens, carcinogenic, and genotoxic action in a dose-dependent way.

Asarone's low concentration can only be used therapeutically, and the decoction procedure can reduce its concentration. Although there is a lot of research supporting the therapeutic value of sweet flag in treating a variety of diseases, there is relatively scant information supporting its acute and sub-acute toxicity.

The hydro alcoholic extract of *A. Calamus* (HAE-AC) was evaluated

Table 1: Uses described in folklore medicine of Acorus calamus.

Rhizome	Emetic, kill lice, nervous system diseases, throat and diarrheal diseases, anti-tumour agent, small pox, ringworm, snake bite, respiratory and gastrointestinal tract diseases, gout, dysmenorrhea, rheumatism, dental disorders, jaundice.	[1]
Leaves	Kill worms.	[1]
Stem	Cough cold and toothache.	[1]
Root	Intermittent fever, antipyretic, Antitussive, stomach ache.	[1]
Root bark	Antidote to snakebite.	[1]

Table 2: Pharmacological properties of various compounds present in Acorus calamus Linn.

Sr No.	Compound	Pharmacological Properties	Reference
1	®-asarone	Antibacterial, Anthelminthic activity, Antifungal activity and Anticancer activity.	[4]
2	a-asarone	Antiplatelet activities, Neuroprotective effect, Induced anxiety effect, Cognitive enhancing effect.	[4]
3	Camphene	Insecticidal activity, Antitumor activity, Anti-Mycobacterium tuberculosis activity.	[4]
4	Elemicin	Analgesic, Antimicrobial activity, Anticonvulsant effect.	[4]
5	Eugenol	Antioxidant, Antifungal activity, Anti-inflammatory and Anticancerative activity.	[4]
6	Methyl isoeugenol	Anxiolytics and Antidepressant effects, Insecticidal and Antimicrobial activity.	[4]
7	Pcymene	Antioxidant, Anti-inflammatory, Antinociceptive effect.	[4]
8	Acorone	Antimicrobial, Antioxidant activity.	[4]
9	Shyobunones	Insecticidal activity and antimicrobial activity.	[4]
10	⟨-selinene	Antioxidant activity	[4]
11	®-gurjunene	Hypoglycaemic effect	[4]
12	®-cadinene	Antibacterial activity and Antifungal activity, Flavour compounds	[4]

for its acute and sub-acute oral toxicity profile by Muthuraman et al. [20] in 2012. The HAE-AC 2500-10000 mg/kg dose given orally once caused an increase in general behavioural abnormality in mice. With increasing dosage, the mortality rate similarly increased (median lethal dose; LD50=5070.59 mg/kg). Overall, the results of this study show that HAEAC is non-toxic and has a modest but tolerable toxicity potential at large dose.

The pharmacokinetic investigations of α-asarone and β-asarone have shown that they have a poor oral bioavailability and a short plasma half-life in rodents, according to the information from the literature search. Additionally, cytochrome-P450 pathways account for the majority of the metabolism of α-asarone and β-asarone also interacts with a variety of molecular targets to exert a wide range of pharmacological effects, including those that are antidepressant, antianxiety, anti-Parkinson's, anti-Alzheimer's, antiepileptic, anticancer, antihyperlipidemic, anticholestatic, antithrombotic, and radio protective. Importantly, toxicological research showed that both α-asarone and β-asarone can cause hepatomas and may have mutagenic, genotoxic, and teratogenic properties [21].

Traditional Medicinal Uses

The rhizomes of *A. Calamus* are regarded in the Ayurvedic medical system as having aromatic, stimulant, bitter tonic, emetic, expectorant, emmenagogue, aphrodisiac, laxative, diuretic, antispasmodic, carminative, and anthelmintic properties. They are used to treat a wide range of illnesses, including mental conditions like epilepsy, schizophrenia, and memory problems, chronic diarrhea and dysentery, bronchial catarrh, intermittent fevers, tympanites, colic, otitis media, cough, asthma, and glandular abdominal tumors. In the past, they were also prescribed for chronic dyspepsia and flatulent colic (Figure 1). Rheumatism, eczema, and problems with the liver and kidneys are also treated with them. Hemostatic properties are reportedly present in the rhizome skin. In addition to being used in ghee preparations, the rhizomes are also used as a powder, balms, enemas, pills [1].

The rhizomes decoction is consumed by the indigenous people of the Garhwali region of the Himalayas as a non-alcoholic beverage. To avoid becoming drunk from alcohol, chew the fresh rhizomes. Children with gastroenteritis also receive the decoction for cure and

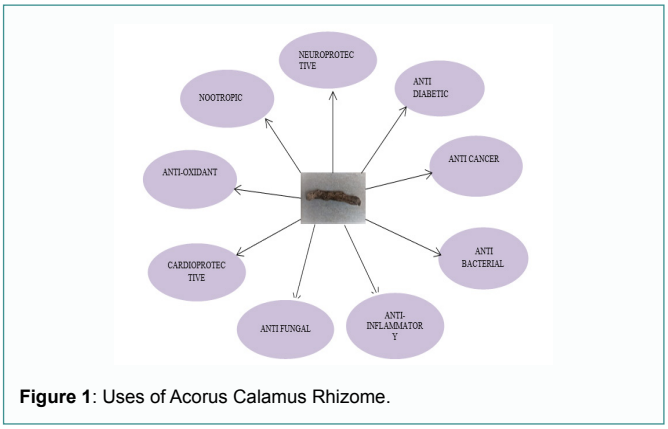

Figure 1: Uses of Acorus Calamus Rhizome.

the pieces of rhizome are knotted around the belly for the cure of jaundice [22]. Additionally, Tirumala Hills locals treat tooth issues using the rhizomes [23].

Helps in brain rejuvenation

Vacha has been said to refresh the brain and relax the nervous system, which reduces excitement and eases concerns. In addition, it benefits those who have epilepsy. 4 g of vacha powder with honey can be taken without risk once daily to alleviate anxiety and epileptic attacks [24].

Helps in curing respiratory diseases

Vacha is particularly helpful for treating throat conditions like sore throat, strep throat, hoarseness, asthma and the symptoms related to them. Additionally, it is helps with sinus infections and colds. The patient keeps the small bits of betel nut-sized roots under his or her tongue. The severity of the assault will be quickly lessened [24].

Helps in voice clarity

Take 1 g-2 g of vacha powder with honey and apply it to the tongue for an efficient treatment. It will improve voice quality, pitch and speech ability. Singers, Executives, and other professionals who frequently talk will find it to be of great use [24].

Helps in managing hernia

An organ may move from its original location in the lower belly,

under the naval, or even down in the testicles, causing a hernia, which affects the nearby weaker tissues. A patient with this illness feels pain and edema. Hernias can be treated by putting a vacha powder and neem seed meal mixture to the affected area with pressure and tying it with a cotton cloth. By rebuilding them, it will make the weaker tissues and muscles stronger. Vacha is beneficial in early stages of hernia and also prevent its recurrence [24].

Helps in curing rat bites

Rat bites can be successfully treated with vacha. Take 4 g of vacha powder daily for about seven days together with rice water, which can be made by simply soaking rice in water for an hour. All of the rat bite symptoms will improve as a result, and the dangerous pathogens that rat's saliva contains will also be eliminated [24].

Helps in management of obesity

In the management of obesity, vacha is widely utilized. In order to lose weight, take 2.5 g to 5 g of vacha powder with lukewarm water in the morning and the evening [24].

Joint swelling

Blend flaxseed oil with vacha powder and apply it gently to the affected joints will help to reduce joint discomfort and swelling for those who have arthritis [24].

Ear infection

Water should be added after grinding the plant's roots. Apply 1-2 drops to a cotton bud and use it as an eardrop, allowing the drops to linger in the place for a while and it reduces the ear ache and infection [24].

As natural mosquito repellent

To keep mosquitoes away, plant vacha in gardens and even also burn the sweet flag sticks inside home. Even snakes will stay away from the house because of the smoke being released [24].

Pharmacological Actions

Antidepressant activity

A. Calamus (500 mg at a dose of 2 tablets three times a day after meals with water) was administered for six weeks to fifty instances of depression at the OPD of S.S. Hospital BHU, Varanasi. The results showed a reduction in the intensity of the depression and improved rehabilitation. The evaluation based on the Hamilton Depression Rating Scale's symptom ratings likewise showed a considerable improvement [25].

Anti diabetic activity

Normal rats underwent the Oral Glucose Tolerance Test (OGTT). Male albino rats were given STZ (40 mg/kg, ip) to make them diabetic. In order to estimate several biochemical parameters and determine the anti-hyperglycaemic efficacy, 200 mg/kg of *A. Calamus* extract was orally fed to diabetic rats for 21 days. Results indicated that the levels of blood glucose had significantly improved. When compared to diabetic controls after 21 days of treatment, blood sugar, lipid profile, glucose 6 phosphatase, fructose 1, 6 bis phosphatase levels, and hepatic indicators were all decreased. When compared to diabetic controls, plasma levels of glucose-6-phosphate dehydrogenase, tissue glycogen, and insulin were all considerably higher. Histopathology analysis of pancreas revealed comparable regrowth by extract after STZ-induced necrosis [26].

Anti-HIV activity

HIV-1 reverse transcriptase was tested on 40 traditional Asian medicinal herbs. According to the findings, the crude extracts of the plants *Cinnamomum loureiroi*, *Quercus infectoria*, *Plumbago indica* L. and *A. Calamus* Linn (rhizomes) had potent inhibitory effects on HIV-1 reverse transcriptase. 50% inhibitory concentrations (IC50) were used to measure the anti-HIV 1RT activity's efficacy. This demonstrated the strong efficacy against HIV-1 RT of the hexane crude extracts from *A. Calamus* L. and *heterophyllus Lam* [2].

Cytotoxic affect

Using *A. Calamus* plant methanolic and aqueous extract, and further investigated its cytotoxic impact. From the entire study, they came to the conclusion that it might have time and concentration-dependent anti-cytotoxic effects [2].

Nootropic activity

The elevated plus maze and the Morris water maze were used to test the neuropsychopharmacological effects of the polyherbal formulation Brahmi Ghrita (BG) on learning and memory functions in rats and mice. It has *Acorus calamus* in it. Its impact on memory and learning has been studied. A supportive adjuvant in the therapy of impaired memory functions, brahmi grita acts on the formulation of memory enhancers [8].

Antihypertensive effect

In rats with HFD- induced hypertension, the antihypertensive effects of *A. Calamus* were examined on their own, in isolation, and in combination with *Gymnema sylvestre*. The average Systolic Blood Pressure (SBP), which was administered the HFD for 4 weeks, dramatically increased. At a dose of 200 mg/kg, *A. Calamus* and *G. sylvestre* significantly lowered SBP and heart rate. Compared to using the two herbs separately *A. Calamus* and *G. sylvestre* had a synergistic effect [8].

Neuromodulatory effect

Mice were pre-treated with *A. Calamus* Methanolic Extract (ACME) and Acetone Extract (ACAE) at various doses to prevent Apomorphine (APM)-induced stereotyped behaviour and haloperidol-induced catalepsy. When given before 6 hours after APM, ACME (20 mg/kg, 50 mg/kg BW p.o.) significantly reversed the stereotype that was brought on by APM. Additionally, it was discovered that giving mice ACME (50 mg/kg body weight) and ACAE (20 mg/kg, 50 mg/kg body weight) considerably increased their resistance to the catalepsy that haloperidol causes in mice [8].

Anti-obesity effect

Animal studies on the anti-obesity effects of the asarone chemical isolated from the rhizome were conducted. Adipokine variation, increased cholesterol, glucose intolerance, and weight loss were all suppressed in the asarone treated adipose rats, in addition to metabolic changes. The pancreatic lipase percentage (28.73%) was inhibited by the *A. Calamus* aqueous extract in an *in vitro* study, demonstrating lipid-lowering action [8].

Antispasmodic and antidiarrhoeal activity

With respective EC50 values of 0.42.0.06 mg/mL and 0.13.0.04 mg/mL, the crude extract AC, which tested positive for the presence of alkaloid, saponins, and tannins, inhibited spontaneous and high K+ (80 mm) induced contractions in rabbit jejunum preparation,

demonstrating spasmolytic activity that may be mediated by Calcium Channel Blockade (CCB). These findings suggest that the presence of CCB- like constituents, which are concentrated in the n-hexane fraction, mediated the plant extract's spasmolytic effect, and this study provides a strong mechanistic basis for its common use in gastrointestinal disorders like colic pain and diarrhoea [12].

Antioxidant activity

The DPPH (2, 2diphenyl-1-picrylhydrazyl) radical scavenging assay, nitric oxide scavenging assay, superoxide radical scavenging assay, ferrous chelating assay, reducing power assay, and phosphomolybdenum assay were used to measure the antioxidant activity of the aqueous extract of *A. Calamus*. Strong dose-dependent reducing activity was demonstrated by the aqueous extract. The findings demonstrated that *A. Calamus* possesses reducing power, metal chelating properties, and free radical scavenging abilities [12].

Anti-inflammatory activity

Polyinosinic: Polycytidylic acid and peptidoglycan treatment of human keratinocyte cells caused the inflammatory responses. RT-PCR, ELISA assay, immunoblotting, and immunofluorescence staining were used to study the anti-inflammatory effects of ACL. The interleukin 8 (IL8) and/or interleukin 6 (IL6) pro-inflammatory cytokines were expressed by the HaCaT cells after treatment with polyl: C or PNG, according to the results, after poly I: C or PNG, according to the results. After poly I: C treatment, ACL reduced the expression of IL-8 and IL-6 at the RNA and protein levels, as well as activation of NF-B (nuclear factor kappa light chain enhancer of activated B cells) and IRF3 (interferon regulatory factor 3). Additionally, ACL prevented the production of IL-8 and the activation of NF-B after PGN induction [12].

Antifungal activity

A number of phytopathogenic fungi have been examined for antifungal activity by ethanol extracts of 40 higher plants from 23 different families. The two most active herbs with significant antifungal activity were Piper betel and *A. Calamus*. The greatest antifungal activity of *A. Calamus* rhizome extract totally (100%) inhibited the mycelial development of all six test pathogens. Most of the test fungus showed more than 50% inhibition when piper betel was used. Many higher plants' ethanolic extracts could be employed as an alternate source of antifungal medicines to safeguard plants or crops against fungal infestation [12].

Antibacterial activity

The antibacterial efficacy of the *A. Calamus* aqueous and methanolic extracts against clinically significant microorganisms including *Bacillus subtilis* (MTCC 441), *Staphylococcus aureus* (MTCC 96), *Escherichia coli* (MTCC 443), *Proteus mirabilis* (MTCC 1429), and *Pseudomonas aeruginosa* (MTCC 424) was assessed. The agar well diffusion method was used to test the in-vitro antibacterial activity. While aqueous extract of *A. Calamus* was completely inactive against the studied gram negative bacterial strains (*E. coli, P. mirabilis,* and *P. aeruginosa*) and showed only moderate antibacterial activity against gram positive bacteria *B. subtilis* and *S. Aureus* at high concentration (200 ml), methanolic extracts of *A. Calamus* were effective against all of the investigated bacterial strains [24].

Immunosuppressive activity

A. Calamus methanolic extract was tested for its anti-cellular and immunosuppressive properties by Mehrotra et al. [27] *A. Calamus* rhizome's methanolic extract exhibited ant proliferative and immunosuppressive qualities. The proliferation of mitogen, antigen-stimulated peripheral blood mononuclear cells in humans, nitric oxide, and interleukins 29s inhibited by this extract, which also promotes tumour necrosis.

Analgesic and anticonvulsant activity

In contrast to the anticonvulsant activity, which was assessed using pentylenetetrazol-induced convulsion methods, the analgesic activity of methanolic root extracts of the plant was determined using two major methods: the acetic acid-induced Writhing reaction and the Rat caudal immersion method. Oral treatment at concentrations of 0.1 g/kg and 0.2 g/kg demonstrated protective activity against the pain models in mice. The latency time of mouse seizures brought on by the medication Pentylenetetrazol (PTZ) was dramatically lengthened by methanolic root extract [28].

Using Maximal Electroshock Seizure (MES) and Pentylenetetrazol (PTZ)-induced seizure models on albino (Wistar strain) rats, researchers examined the anticonvulsant properties of an ethanolic extract of roots. The study's findings demonstrated that extract treatment decreased the time required for tonic hind limb extension in the MES model, and that convulsion latency and occurrence increased with the PTZ model [29].

Bronchodilatory activity

The traditional usage of the *A. Calamus* in disease of the airways was investigated pharmacologically. For this reason, isolated guinea pig trachea and atria were suspended in carbogen-filled organ baths, and various parameters were used to identify the mechanisms. The finding that *A. Calamus* crude extract was more efficient than carbachol in producing relaxation of high K+ (80 mM) reconstruction, similar to verapamil, suggests that calcium channels are blocked [30].

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