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Acorus Calamus: A Review

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***Abstract*-** We found that Ayurveda, can serve as a "goldmine" for novel anti-inflammatory agents to treat chronic diseases. The current review is an attempt to provide description of one of the important ayurvedic plant and its treatment in various types of diseases. It is used in ailments like bronchitis, nervous disorders, colic, chest pain, diarrhoea, flatulence, ingestion, rheumatism, cough, fever, depression, tumors, skin diseases, acts as cryoprotective, inflammation and other nervous disorders. It is anti-microbial, anti-cancerous and also shown anti-diabetic potential. A number of active phytoconstituents have isolated and characterized from leaves and rhizomes, containing important essential oils. Its important therapeutic potentials are present in the rhizome part of the plant. Constituents, α-asarone and β-asarone are the predominant bioactive compounds found in this plant. At higher doses, genotoxicity and mutagenicity of α- and β-asarone have been reported in various studies, this limits its use. Ayurvedic plant with their active chemical components and the inflammatory pathways that they inhibit are yet clearly to understand.

***Keywords*:** Acorus, Diseases, Protection

I. INTRODUCTION

Current estimates that a billion dollar is invested to develop a drug by a pharmaceutical company. Today's Magic bullets/targeted therapies are very expensive. It has been estimated that most of the population in world cannot afford these smart therapies. Besides high cost, safety is a major issue of concern. To identify a safe, affordable and effective drug is a challenge to modern medicine today. Ayurveda is a traditional healing system originated in India approximately 6,000 years ago, Ayu means "Life" and Veda means "knowledge or science"; Ayurveda is the Science of Life. It is designed to promote good health and longevity rather than curing a disease. Three kinds of primary body constitutions or traits ("prakriti") have been defined based on three "doshas", viz, Vata, Pitta, and Kapha. Any imbalance in these dosha results into a disease. To restore the balance, the Ayurveda recommends a customized therapy based on the "prakriti" of an individual. Doshas can be influenced by the food one eats, the type of lifestyle one leads. The term "vata" comes from "vaayu" (in Sanskrit), which means air. The oxidative stress could be caused by insufficient air (vaayu) inhaled, and imbalance in metabolism (the two other tridoshas, the pitta and the kapha). Since reactive oxygen species (ROS) made in the body are composed of oxygen ions, peroxides, hydroxyl radicals, etc. One would require a combination of various types of antioxidants to quench them altogether. Plant polyphenolics though are good source of antioxidants, but they differ in their abilities to quench difference species of ROS. Therefore, there may be the need of using combination of phytochemicals to cure the disease.

Classification of *Acorus calamus*
Kingdom: Plantae
Sub-kingdom: Tracheobionta (Vascular plants)
Superdivision: Spermatophyta
Division: Magnoliophyta (Flowering plants)
Subclass: Arecidae
Order: Arales
Family: Acoraceae
Genus: Acorus L,
Spp: *griffithii* Schott,. *belangeii* Schott,. *cassia* Bertol

The Sanskrit name of Acorus calamus is Vacha (English-Sweet flag). The plants contains flavonoids, saponins, tannins, glycosides, volatile oils, mucilage and other polyphenolic compounds. Medicinal properties lie in the rhizome part of the plant.

α-pinene, Camphene, β-pinene, bornyl acetate etc are the main components found in the leaves and rhizomes of the *Acorus calamus* (Khwairakpam et al., 2018).

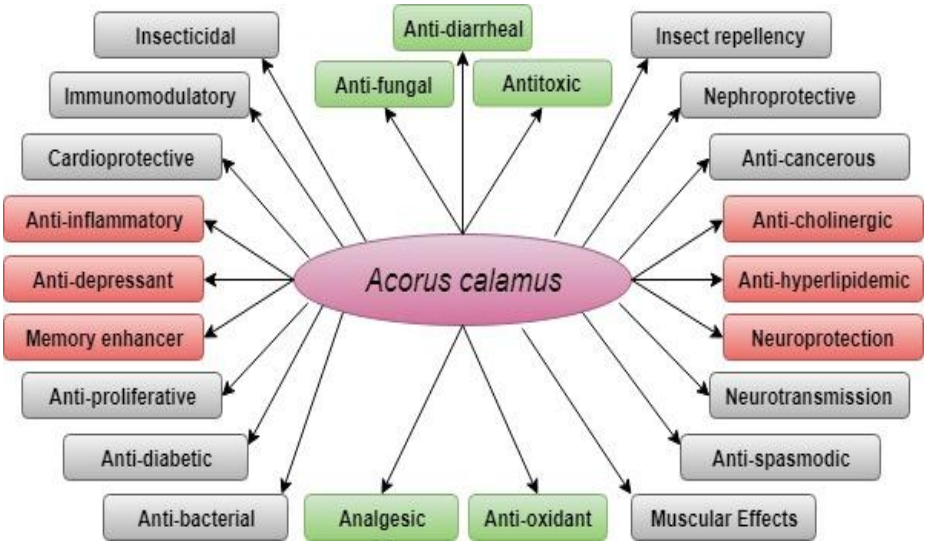

Fig 1: Uses of *Acorus calamus*

Table 1: Acorus calamus

S.No	Uses	Function
1	**Nephrology**	Extracts of Acorus calamus increases the activity of renal enzyme superoxide dismutase, glutathione peroxidase, catalase and decreases the level of mono-dialdehyde content in acetaminophen poisoning. It has showed the protective effect in acetaminophen induced necrotic tissue and renal damage in experimental rats (R. Singh, Pharm, Sharma, & Malviya, 2011).
2	**Neurology**	
	Cholinergic Neurotransmission	*Acorus calamus* extract causes 53.7+/-5.5% inhibition of acetylcholinesterase enzyme , it is more potent in inhibiting acetylcholinesterase (IC of 10.67+/-0.81µg/mL) due to β-asarone (IC of 3.33+/-0.02µM) (Feng, Yu, Qin, Gao, & Yao, 2015).
	GABAergic Neurotransmission	Petroleum ether extract of *Acorus calamus* rhizome showed promise through GABA receptors signalling through α β γ subtype (Sabitha Rani, Satyakala, Sandya Devi, & Suryanarayana Murty, 2003). It enhanced the signalling through the GABA receptor to 277+/-9.7% of control at 100µg/mL. It is mostly due to presence of β-asarone (EC of 171.5+/-34.6µM to reach 1200+/-163% of control) and (+)-dioxosarcoguaiacol (Zaugg et al., 2011).
	Neuroprotection	Acrylamide-induced neurotoxicity is reduced in rats when given a dose of 25mg/kg of a 50% ethanolic extract of the rhizome over 10 days alongside acrylamide as assessed by limb paralysis; the increase in dopamine receptor content and the reduction in glutathoine are normalized (Shukla et al., 2002).
3	**Analgesia**	The alcoholic fraction of rhizome is able to prevent 15.16% and 54.51% of the acetic acid induced writhing response with 250mg/kg and 500mg/kg of the extract respectively. The extract of the rhizome at 100-200mg/kg oral intake for 14 days alongside vincristine is able to significantly reduce neuropathic pain as assessed by Von Frey hair tests as well as the sciatic functional index with a potency comparable to pregabalin (10mg/kg) ("full-text," n.d.; Khan & Islam, 2012). This extract with the same amount of dose as above has also shown efficacy in a tibial and sural nerve transection model of neuropathic pain and a chronic constriction injury model of sciatic pain (Forouzanfar & Hosseinzadeh, 2018; Muthuraman & Singh, 2012).

4	**Depression**	50-100mg/kg of methanolic extract of Acorus calamus when injected to experimental rats for seven days showed dose-dependent anti-depressant activity with a potency comparable to 5mg/kg imipramine (Chellian, Pandy, & Mohamed, 2018; Pawar, Anup, Shrikrishna, & Shivakumar, 2011).
5	**Memory and Learning**	β-asarone's oral ingestion at a dose of 12.5-50mg/kg for 28 days is able to preserve cognition in rats with a potency as compared to 0.33mg/kg donepezil hydrochloride. Donepezil hydrochloride is associated with a reduction in hippocampal apoptosis rates (Geng et al., 2010; Zhou, Nie, & Liu, 2016).
6	**Cardiovascular Health**	
	Cardiac Tissue	An aqueous methanolic extract of rhizomes causes depressant effects on cardiac issue invitro ie 55%-60% reduction in heart rate and ventricular contractile force. Its EC value range lies in 110-130 μg/mL (A. J. Shah & Gilani, 2012).. 100-200mg/kg of the rhizome extract for 30 days alongside isoproterenol induces cardiotoxicity in animal models (ZHANG et al., 2005). It also found to be better in reducing cardiotoxicity with potency as compared to 9mg/kg amlodipine as standard drug (B. K. Singh, Pillai, Kohli, & Haque, 2011).
	Blood Flow	An aqueous-methanolic extract of the rhizome causes relaxation at an EC value of 2.5mg/mL in a manner similar to methacholine. It was alsoable to reduce precontraction induced by a high potassium concentration with an EC of 230μg/mL (Patel, Vaghasiya, Thakor, & Jariwala, 2012).
	Blood Pressure	In hypertensive experimental rats, 250mg/kg of ethyl acetate extract causes attenuation in increased systolic and diastolic blood pressure. There was also attenuation in plasma renin and oxidative biomarkers (MDA and glutathione) in the kidneys (Patel et al., 2012).
7	**Anticancer effects**	The β-asarone, has carcinogenic effects. It has shown anticarcinogenic activation of α-asarone on the human carcinoma cells as documented in some experimental reports (Das, Swamy, Koti, & Gadad, 2019b).
8	**Antihyperlipidemic effects**	It was reported that there were decrease in the concentrations of cholesterol and triglycerides and increase in the concentrations of HDL of rats who were given alcoholic or aqueous extract for 30 days at a certain dosage while takinh atherogenic diet. These effects also occurred in rats which consumed saponins from the isolates of alcoholic extract (RS Parab, 2003)..
9	**Antibacterial effects**	The rhizome showed antibacterial action (in terms of zone of inhibition of bacterial growth) in vitro against methicillin-resistant *Staphylococcus aureus* (MRSA) and strains of gram-negative bacteria (like *Escherichia coli*, *Shigella dysenteriae*, *S. sonnei* etc.) which produces β-lactamase. These antibacterial actions were related to the presence of flavonoids and phenolic compounds in the rhizome (Imam, Riaz, Azhar, Sofi, & Hussain, 2013).
10	**Anticholinesterase effects**	*In vitro* inhibition of acetylcholinesterase was found with methanolic root extract experimentation, it is due to the preence of *calamus's* essential oil. The IC_{50} for acetylcholinesterase inhibition was measurable for extract, as well as for the aqueous fraction of a partition of the rhizome in water and dichloromethylene (Mathew & Subramanian, 2014).
11	**Antidiabetic potential**	In a study it was screened that herbal extracts acts as activators of peroxisome proliferator-activated receptors as concentration dependent effect (shown in alcoholic extract of *calamus*) (Rau, Wurglics, Dingermann, Abdel-Tawab, & Schubert-Zsilavecz, 2006).
12	**Anti-diarrhoeal**	There was increase in the time of onset of diarrhea and decrease in total number of feaces and number of wet feaces in comparision to the total weight of wet feaces prior consumption of

		the rhizome extract (MD Kapadia, 2012).
13	**Antifungal effects**	In plants, β-asarone, as an isolate of *Acorus gramineus*, completely inhibited mycelial growth of some pathogenic fungi whereas in others, slight suppression was found (Lee, Lee, Yun, & Hwang, 2004). Calamus's leaves contain a class III haem peroxidase which, in the host's defense against pathogenic fungi, may inhibit hyphal growth of invasive pathogens in plants (Ghosh, 2006).
14	**Anti-inflammatory effects**	The alcoholic extract showed moderate anti-proteolytic activity with the trypsin's induction of hydrolysis of bovine serum albumin (BSA). It has also exhibited the inhibition of β-glucoronidase (Gacche & Dhole, 2006).
15	**Antioxidant effects**	The rhizome extract has sufficient amounts of vitamin C and total polyphenolic compounds. It has the potential for increasing the antioxidants capacity and function in the brain (may be due to the active anti-oxidant compound found in it ie α-asarone) (Rawat et al., 2016). Histological analysis showed normal features in the tissues of cerebral cortex from rats with daily ip of certain dose of α-asarone before exposure to noise for four hours a day upto 30 days. While in the cerebral cortex of rats that only had this exposure to noise, there was decrease in the size of neurons, as well as histological anomaly in cortical layers. Extract in combination with acrylamide, increases in the content of glutathione and the activity of glutathione-S-transferase in the striate body was found, whereas these decreased with acrylamide by itself (Bains et al., 2005).
16	**Anti-proliferative effects**	There was inhibition of growth of cells in cultures with calamus's lectins, (isolated from rhizomes extract) (Ganjewala & Srivastava, 2011). However, calamus's antiproliferative effects apparently are not specific to any cells, given that inhibition of proliferation occurred in various human and murine cell lines in cultures with an alcoholic extract of the rhizome (*Research journal of pharmaceutical, biological and chemical sciences RJPBCS.*, n.d.).
17	**Anti-spasmodic effects**	It occurred through the blockage of calcium ion channels, a particular action with fraction of n-hexane. This fraction may contain constituents that are able to block calcium ion channels so that antispasmodic action results (Gilani, Shah, Ahmad, & Shaheen, 2006).
18	**Antitoxic effects**	There was reduction in concentration of serum creatinine, low blood urea nitrogen and lesser activity of kidney ornithine decarboxylase. Renal oxidative stress diminished with prophylactic calamus. There was decrease in the content of glutathione, glutathione-S-transferase, glutathione reductase, lipid peroxidation and in generation of hydrogen peroxide (P. D. Shah et al., 2012).
19	**Immunomodulatory effects**	Inhibition occurred for proliferation of humans' mononuclear cells (from peripheral blood) in a culture with a mitogen (phytohemagglutinin [PHA]) or an antigen (purified protein derivative of tuberculin) and the alcoholic extract. There was inhibition in the production of interleukin-2 (IL-2) and tumor necrosis factor-α (TNF-α) in a culture of human T lymphocytes (mononuclear cells from peripheral blood) with the extract. PHA was used for the stimulation of production of IL-2 or lipopolysaccharide (LPS) for stimulating the production of TNF-α. Nitric oxide inhibited its production in the cell line of murine macrophages after incubation with certain concentration the extract (Ravichandiran & Vishal, 2015). However, lectins, which were constituent of another extract of rhizomes, had shown mitogenic action on T lymphocytes (Das, Swamy, Koti, & Gadad, 2019a).
20	**Insect repellency**	Calamus oil extract has shown insecticidal property (*Rhyzopertha dominica*, hence the lesser grain borer). Calamus is a potential larvacide. With exposure to an alcoholic extract of the roots, there was larvicidal action on the housefly, fleshfly (*Chrysomyia bezziana*) and culex (*Culex quinquefasciatus*) (Meenakshisundaram, Harikrishnan, Rani, & Anna, 2014).
21	**Muscular effects**	Roots/rhizomes's alcoholic extract inhibited contractions in rectus muscle and the extract produced negative inotropic and chronotropic effects (Motley, 1994).

22	**Neurologic effects**	Neural protective effects are attributable to the herb's action of modulation in the antioxidant capacity. This effect exhibited neural protection in experimental rats ingested with an extract (alcohol and water in the proportion of 1:1) of rhizomes for five days prior to and following for three consecutive days. Behavioral rating score was found to be better after 72 hours after occlusion. With the extract in combination with acrylamide, an agent that induced paralysis of the hind limbs in rats, such paralysis decreased in frequency in rats. In a culture of cortical neurons, *Acorus gramineus* (not *calamus*), an essential oil from rhizomes, evidenced neural protective effects through blockade of the activity of NMDA receptors . The essential oil's main constituent, asarone, inhibited excitotoxicity from NMDA or glutamate (Saroya & Singh, 2018).

II. CONCLUSION

Acorus calamus is used as an important ingredient in various cocktail preparations employed for the treatment and management of headache, insomnia, remittent fevers, delirium, hysteria, migraine, bodyache, neurodegenerative diseases and severe inflammatory pain. Fresh rhizome part extraction and/or its decoction are commonly used to relieve the muscle, joint, vascular and nerve injury associated severe inflammatory and neuropathic pain.

Conflict of Interest: The authors declare no conflict of interest.

Authors Contribution: Durgavati Yadav has planned and written the whole manuscript. Shivani Srivastava helped in literature search and language editing. Yamini Bhusan Tripathi has given the guidance.

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