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Review Article

A Comprehensive Review of Achyranthes Aspera Root: Pharmacognosy, Phytochemistry, And Therapeutic Potential

Kaviya Ganesan*, Muthusamy Periyannan, Vijaya Bharathi Raj Kishore, Sangeetha Narasimhan, Radha Ramalingam

Department Of Pharmacognosy, College of Pharmacy, Madras Medical College, Chennai.

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ABSTRACT

Achyranthes aspera (Prickly Chaff Flower) has gained immense ethnopharmacological importance as a medicinal plant and is incorporated among various traditional medicinal system globally. It is a member of Amaranthaceae family. Although almost every part of the plant is used in traditional medical systems, the seeds, the roots and shoots comprise particularly important medicinal components. Chemical compounds such as lignin, alkaloids, saponins, tannins, flavonoids, terpenoids, protein, glycosides and carbohydrates. It is used traditionally for astringent, anti-fertility, ophthalmia, cancer, stomach issues and spermicidal. In this review, our main objective is to collect and discuss the available literature addressing the various categories of secondary metabolites from A. aspera roots, which have great potential in the development of effective pharmaceuticals.

INTRODUCTION

Nature is a well-documented source of therapeutic molecules and drugs, known to humans since ancient times and still providing the foundation for novel therapeutic agents. In recent years, use and production of health products derived from plants has gained traction in both industrialized and developing countries. This surge has led to exponential growth in the market for herbal products. The World Health Organization (WHO) has quantified the effort, identifying a staggering 22,000 species of medicinal plants worldwide. A WHO survey showed that as many as 80% of individuals in impoverished countries use traditional herbal therapy as a tool for medical needs. [1] The exploration of phytochemical components in plants and subsequent pharmacological assessments serve as the basis for potential candidates in the development of new therapeutic agents. Many of the life-saving drugs used in modern-day medicine are derived from plants. [2] The traditional healer's interest in the

***Corresponding Author:** Kaviya Ganesan
Address: *Department Of Pharmacognosy, College of Pharmacy, Madras Medical College, Chennai.*
Email ✉: kaviyaganesh16@gmail.com
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medicinal plant Achyranthes aspera commonly known as "Prickly Chaff Flower" has attracted the public attention from modern researchers due to its therapeutic application.[3] This herbaceous perennial plant is a member of the Amaranthaceae family and an herb that has been traditionally used for thousands of years in different cultures globally. It has been an important commodity in traditional medicine systems for centuries.[4] It is considered a plant with many properties: antimicrobial, larvicidal, immunostimulant, low blood pressure, hypolipidemic, anti-inflammatory, antioxidant, diuretic, cardiotonic, analgesic, antihypertensive, antipyretic, antinociceptive, prothyroid, antispasmodic and hepatoprotective [5].

Synonyms: [6]

1. *Achyranthes argentea Lam*.

2. *Aspera var. indica L.*

3. *Aspera var. obtusifolia (Lam.) Suess.*

4. *Achyranthes indica (L.) Mill.*

5. *Achyranthes obtusifolia Lam.*

Plant description: [6,7,8,10]

It is a medicinal herb used worldwide called Achyranthes aspera, a perennial herb with shrubby growth, reaching 1.2 m high. The leaves are simple and 1-3 feet from the stem with numerous covering structures. Also found were cambium and vascular and medullary bundles. [9]

Foliage: leaf 1.5-7 cm long, 0.4-4 cm wide. Each side of them has hair.

Stems: Stem of luminous smooth and curved embryos with the albuminous covering with a lot of fuzzy hairs with the four-sided body.

Flower: The 10-30 cm long, initial erect, spike inflorescence bends backward after blossoms. Bracts as green or crimson, bracteate or nonbracteate, spike-shaped.

Leaf: Simple, silky, oven, elliptic, opposite.

Fruits: A utricle holds dry fruits. A utricle is a dry, indehiscent fruit with a loose, papery, bladder-like covering. It bears oblong-shaped fruits (2.5–3 mm) and one brown, oval-shaped seed (2 mm).

Seeds: Albuminous, facets and coils embryos.

Root: The main root is thick, long and cylindrical; secondary and tertiary ones are yellowish brown and a little ribbed in appearance; taste slightly pleasant and mucilaginous, circular, with a diameter of 1.0 cm. Subsidiary and tertiary roots are separated into two sections.

Gynoecium: superior ovary with two syncarpous

Androecium: five stamens with corolla lobes

Fig No: 1 *Achyranthes aspera* whole plant

Fig No: 2 Stem

Fig No: 3 Leaves

Fig No: 4 Seeds

Fig No: 5 Flower

Taxonomic Classification:[10] Kingdom – Plantae

Subkingdom – Tracheobionta Super Division – Spermatophyta Division-Magnoliophyta

Class – Magnoliopsida Subclass –Caryophyllidae **Order –** Caryophyllales Family – Amaranthaceae **Genus –** Achyranthes Species – aspera Common Names [10,11]

Tamil: Nayurivi, Shiru kadaladi

Kannada- Uttharanee

Latin: Achyranthes aspera

English: Red chaff tree, rough chaff tree, and prickly chaff flower

Sanskrit: Aghata ,Apamarg

Hindi: Latjira, Chirchira Gujarati: SafadAghedo , Agadha Telugu: Uttaraene

Malayalam: Kadalad, Kalalat Punjabi: Kutri

Bengali: Apang Marathi: Agadha Unani: Chirchitaa

Ayurvedic: Apamarga, Chirchitaa, Shikhari, Shaikharika.

Geographical Distribution: [12]

In India, it can be found growing as a weed along roadsides, field borders and waste areas at altitudes up to 2100 meters above sea level, including the South Andaman Islands. Also, it is widely distributed in Africa, Australia, America, Tropical Asia, Baluchistan and Ceylon. It is reported to be an invasive alien species in northern Bangladesh. It was identified as a rare medicinal plant in the district of Lalitpur, Uttar Pradesh, India, and as the

most widely utilized herb in the Shivbari sacred grove in Himachal Pradesh.

Ethanomedicinal claim: [13]

The plant is valued in traditional medicine. It is said to have astringent, diuretic and pungent properties. Used as an emmenagogue, for piles and skin eruptions. It forms, although juice or infusion also ecbolic, they have a decoction of the plant is used in pneumonia and renal dropsy in large dose. The juice of the plant is said to be used for the treatment of ophthalmia and dysentery.

The abortifacient effect of the stembark benzene extract was highly significant. These alkaloids (betaine and achyranthine) are found throughout the plant. Water-soluble alkaloid achyranthine has been shown to depress the heart and dilation blood vessels and was found tolower blood pressure and short and more breathing, spasmodic effects, diuretic and purgative effects.Large quantities of potash are produced from the ashes of the plant. They are used to treat asthma, dropsy and cough. And pollen can cause allergies. Heated sap is used to treat tetanus, leprosy is treated with the extract of the leaves termed “Achyrol”, while gonorrhea and excess perspiration are treated with the leaves itself. The alcoholic and aqueous extracts of the leaves exhibited antibacterial activities against Micrococcus aureus, Micrococcus pyogenes and Escherichia coli. The plant’s roots have an astringent action, and their assemblage is employed as a hemostatic resource for injuries and corneal opacity. It has also been shown to be effective against cancer. The roots are employed in a decoction for digestive ailments and as an infusion for bladder stones. The roots also have oleanolic acid and ecdysterone, a hormone that shapes insects.

The coconut flowers are crushed to make a medicine, mixed with sugar and curd, which is called amenorrheic medicine. Bloom tops are allegedly utilized as a remedy for rabies.

Biliousness is treated with emetic powdered seeds soaked in buttermilk.

Macroscopic characteristics:

Roots:[14]

The cylindrical, yellowish-brown, tap-root roots were 0.1–1 cm thick, had secondary and tertiary roots, and had scars on the roots.

Microscopic characteristics Roots:

The layers of roots are of different types. The outermost layer is made up of three to five layers of long, thin-walled, rectangular cork cells. [14] If viewed in section, the roots look round, and the epidermis is composed of cells that are small and tightly packed together. The arrangement of cork cells in radial rows is a sign of periderm formation. The cork is several layers of phelloderm right behind. The secondary cortex reveals six to eight rows of oval, slim-walled parenchymatous cells with stone cell clusters. These layers are interspaced by six disparate rings of extra thickening of abnormal nature composed of vascular tissues. Presence of phloem fibres, stone cells, crystals of oxalate and starch grains in ground tissue indicates a rich nutrition storage. A lot of secondary growth and a lot of xylem is seen.[15] Medullary rays 1-3 cells broad, facilitate the movement of nutrients within the root. The xylem vessels in the veins show helical thickening and simple, bordered pits, while the cortex consists of 4–6 layers of conjunctive parenchymatous tissue. There are tracheids, with tapered end walls and their roots show no pith.[16]

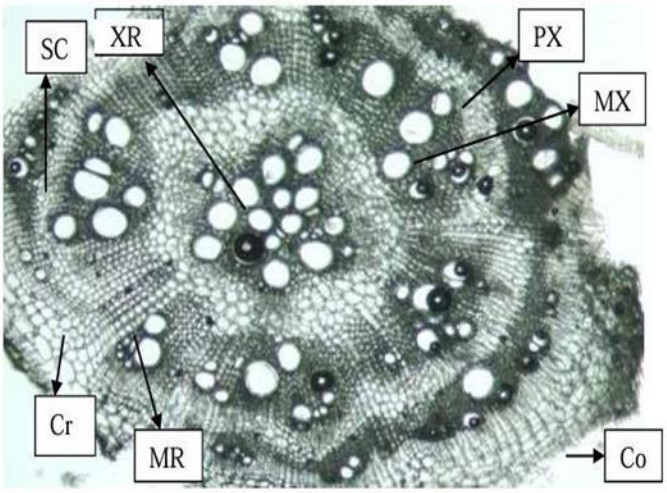

Fig No: 7 Anatomy of roots

Transverse section of root (entire view) (Co= Cork; Cr= Cortex; MR= Medullary rays; SC= Stone cells; XR= Xylem ring; PX= Protoxylem; MX= Metaxylem).[14]

Phytochemistry:

Table No: 1 phytochemical

S. No	Parts	Constituents	Reference
1.	Root	Phytoecdysteroid 20-Hydroxyecdysone , aliphatic acid n-hexacos-14-enoic acid, strigmasta-5, trans-13- docasenoic acid, 22-dien-3-E-ol, n-hexacosanyl n- decaniate, n-hexacos-17-enoic acid, 0.54% oleanolic acid and n-hexacos-11-enoic acid,phytosterol strigmasta-5, 22-dien-3-E-ol(colorless crystalline material) sterols, answer the Liebermann Burchard test.	**[17]**
		The root contains ecdysterone.	**[18]**
		Ursolic acid, Corrosolic acid, and Achyrantheric acid - FTIR, 1D, and 2D NMR verified these compound's existence.	**[19]**
		Ecdysone	**[20]**
		Rutin, kaempferol-3-O-glucoside, isoquercetin, apigenin-7-O-hexuronide-4'-O-rhamnoside, kaempferol-3-O-neohesperidoside, kaempferol-3-O- rutinoside, and tiliroside were isolated	**[21]**

Phytochemical screening of root extract: [22]

Table No: 2 Chemical Tests

S. No	Tests	Hexane	CHCl3	Ethyl acetate	Ethanol
1	Alkaloids	-	+	+	+
2	Carbohydrates	+	-	+	-
3	Glycosides (Cardiac glycosides)	-	-	-	+

4	Saponins	+	-	+	+
5	Phytosterols	-	+	+	-
6	Phenols	-	-	-	+
7	Tannins	-	+	+	+
8	Flavonoids	+	+	+	+
9	Proteins	-	-	+	+
10	Diterpenens	+	+	+	+

HPTLC Estimation of Achyranthes aspera root: [23]

Major spots at various Rf before and after derivatization were identified at 254 nm and 366 nm, respectively, using the HPTLC profile of a methanol extract of Achyranthes aspera Root and toluene: ethyl acetate (7:5v/v) as the mobile phase. Secondary phytoconstituents were identified using the standard biomarkers stearic acid, quercetin, and ferulic acid. The presence of a ferulic acid phenolic compound is visible in the root extract of Achyranthes aspera at 254 nm prior to derivatization. The two spots have Rf values of 0.29 (light black) and 0.28 (light black), which are comparable to standard Rf values. Achyranthes aspera stem extract at 254 nm exhibits a single spot with Rf values 0.8 (light black), which is comparable to standard Rf values, indicating the presence of the phenolic compound quercetin. On the other hand, an Achyranthes aspera leaf extract at 254 nm reveals the presence of stearic acid with two spots that have Rf values of 0.28 (light black) and o.8 (light black), which are comparable to standard Rf values. Achyranthes aspera's densitometric analysis was carried out in reflectance mode at 366 nm. The ferulic acid marker compounds had Rf values between 0.3 and 0.6. While the Rf values of the stearic acid marker compounds were not found, those of the quercetin marker compounds fell between 0.1 and 0.9. Two spots with Rf values of 0.6 (reddish brown) and 0.9 (blue), which are comparable to standard Rf values, were visible on the plates when they were examined at 366 nm following derivatization. At 366 nm, the stem extract of Achyranthes aspera exhibits two spots with Rf values of 0.7 (blue black) and 0.9 (sky blue), which are comparable to standard Rf values, indicating the presence of the phenolic compound quercetin. On the other hand, an Achyranthes aspera leaf extract at 366 nm reveals the presence of stearic acid with a single spot that has Rf values 0.9 (reddish), which is comparable to standard Rf values. Ferulic acid and quercetin were identified as phenolic phytocomponents in the methanolic extract of Achyranthes aspera roots and stem by HPTLC fingerprinting.

Table No: 3 Rf values of HPTLC fingerprints profile of Achyranthes aspera at 254nm.

Rf Value	Ferulic acid	quercetin	Stearic acid	Root	Stem	Leaf
Rf_1	0.28	0.77 light black	ND	0.29 light black	0.8 light black	0.8 light black
Rf_2	0.77 light black	0.8 blue black	ND	0.28 light black	-	0.28 light black

Table No: 4 Rf values of HPTLC fingerprints profile of Achyranthes aspera at 366nm.

Rf Value	Ferulic acid	quercetin	Stearic acid	Root	Stem	Leaf
Rf_1	0.3 blue	0.9 reddish brown	ND	0.6 reddish brown	0.7 blue black	0.9 reddish

Rf_2	0.6 sky blue	0.1 black	ND	0.9 blue	0.9 blue	ND

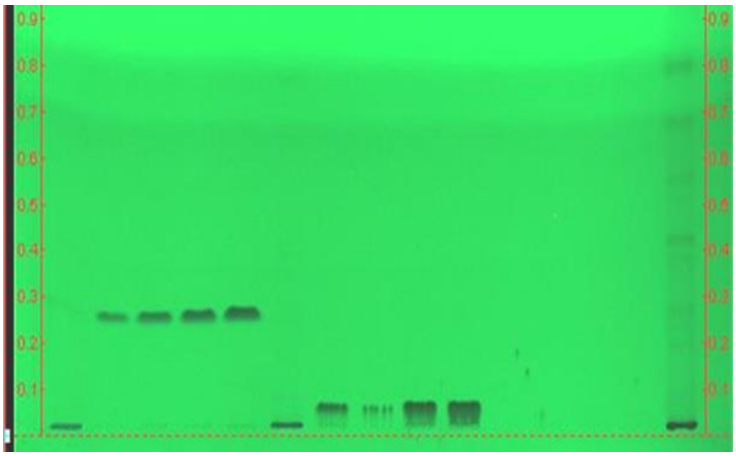

Fig No: 8 TLC profile of test solution of *Achyranthus aspera* at 254nm before derivatization

Track 1: Test solution of ***Achyranthus aspera* root**; **Track 2-5:** Ferullic acid standard; **Track 6:** Test solution of ***Achyranthus aspera* stem; Track 7-10:** Stearic acid; **Track 11-14:** Stearic acid standard; **Track 15:** Test solution of ***Achyranthus aspera* leaf.**

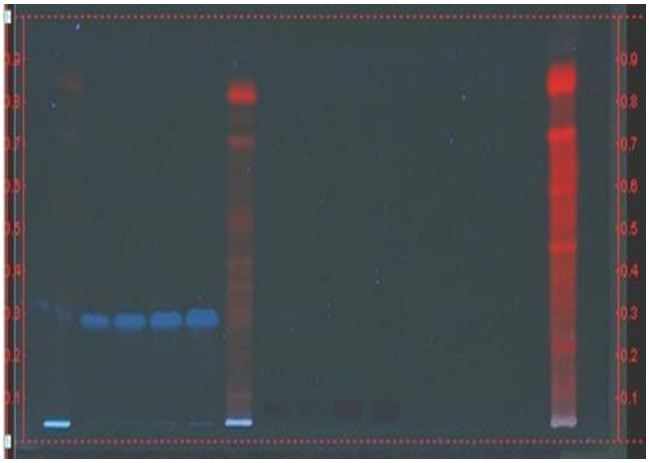

Fig No: 9 TLC profile of test solution of *Achyranthus aspera* at 366nm after derivatization.

Track 1: Test solution of ***Achyranthus aspera* root**; **Track2-5:** Ferullic acid standard; **Track 6:** Test solution of ***Achyranthus aspera* stem; Track 7-10:** Stearic acid; **Track 11-14:** Stearic acid standard; **Track 15:** Test solution of ***Achyranthus aspera* leaf.**

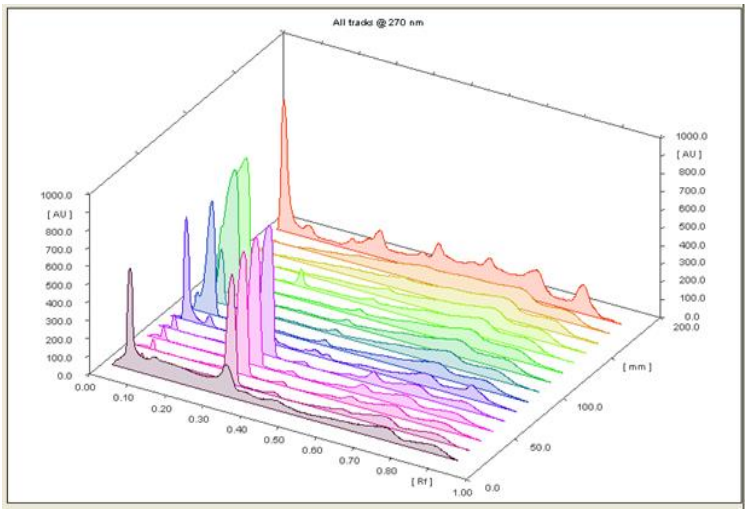

Fig No: 10 3D Graph-Densitometric HPTLC chromatogram of standards Quercetin, Ferulic acid & Stearic acid of Achyranthus aspera root, stem and leaf methanolic extracts

Pharmacological activity:

Anticonvulsant activity: [24]

A. aspera methanolic root extract exhibited a potent anticonvulsant effect which is likely mediated by GABAergic mechanism and validates the application of A. aspera roots in folklore medicine for the management of epilepsy.

Antibacterial activity:[25]

The petroleum ether root extracts of Achyranthes aspera were antagonistic against the Gram positive Bacillus subtilis, while the chloroform and methanol root extracts were found to exhibit considerable antibacterial potential against the Gram negative Klebsiella sp.

Petroleum ether and methanol root extracts showed antifungal effect against a pythium and Alternaria species.

Human Colon Cancer Cell (COLO-205): [26]

Achyranthes aspera, an aqueous plant extract on the proliferation and mortality in the colon cancer cells. The potential mechanism action of AAA could be associated with inducing apoptosis through mitochondrial-mediated pathway and blocking COLO-205 cells at the S phase of cell cycle.

Anti-inflammatory activity: [27]

Achyranthes aspera alcohol extract exerts a significant(p 0.05) and pronounced inhibition (34.6%) of granuloma weight and offers promising anti-inflammatory activity against acute (exudative phase) and chronic (proliferative phase) inflammation.

Post- coital antifertility activity: [28]

The anti-implantation activity is expressed as the percentage of animals showing absence of implantation in uteri when laparotomised on day 10 of pregnancy. The 200 mg/kg body weight doses of ethanol and chloroform extracts prevented all rats from becoming pregnant. Whereas, the both doses of petroleum ether and distilled water extract showed no effect on the number of implantation sites as compared with control rats. By this, it seemeth come out that ethanol and chloroform extract have estrogenic activity but did not show antiestrogenic activity at the same dose.

Analgesic and Anti-pyretic activities:[1]

Acetyl lissmarican, which is a hydroalcoholic extract obtained from the leaves and roots of Achyranthes aspera, exhibited central action in male albino rats (adult) through the tail flicking, hot plate, and aspirin-induced peripheral analgesic activity methods of assessing peripherally operated analgesic action.

Renal Disorders: [8,29]

It was evaluated whether a plant root can prevent nucleation and growth of calcium oxalate crystals in vitro as well as protect NRK-52E (kidney epithelial model) from oxalate-induced damage. Additionally, the hydroalcoholic extract of this plant was studied for its effects on the crystallization of calcium oxalate in artificial urine, which showed negatively for the possibility of kidney stone formation and positively for other minerals such as calcium phosphate, calcium carbonate, calcium oxalate, etc.

Toxicity Studies:[30]

The female mice received oral doses of 175, 550, and 2000 mg/kg body weight of the methanolic root extract of A. aspera. Up to 48 hours after drug administration, mice were monitored for the occurrence of mortality or any other indications of toxicity. Actophotometers were used to measure locomotor activity. Following a 30-minute treatment, each animal was placed in an activity meter, and the total number of activities was recorded for five minutes. Total photobeam interruption counts per 5 minutes were used to express the locomotor activity.

During a 48-hour study period, it was discovered that oral administration of A. aspera root extract to animals was non-toxic up to 2000 mg/kg body weight. No common signs of toxicity, like ataxya or convulsions, were displayed by the animals.

CONCLUSION:

Overall, Achyranthes aspera root seems to have ample potential as an important medicinal plant, considering its wide variety of documented pharmacological actions and rich ethnomedicinal background. Study of these macroscopic features and demographics as well as underlying microscopic features provide clues as to the species as well as possibility for therapeutic value. Phytochemical analysis unveils a complex profile of bioactive chemicals responsible for its several therapeutic effects ranging from alkaloids, saponins, flavonoids, steroids, terpenoids. The pharmacological studies confirm the traditional claims associated with its use, which reveal its use as an anti-inflammatory, anticonvulsant, post-coital antifertility agent, and lithiasic agent. Achyranthes aspera is an intricate plant that deserves further investigation and study, particularly given its possible medicinal benefits and therapeutic applications.

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