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ACHYRANTHES ASPERA: A COMPREHENSIVE REVIEW

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ABSTRACT

Achyranthes aspera, commonly known as prickly chaff flower, is a widely distributed herb belonging to the family Amaranthaceae. It is an important medicinal plant in Ayurveda, Siddha, Unani, and various folk traditions throughout Asia and Africa. The plant is reputed for diverse pharmacological properties including anti-inflammatory, analgesic, antimicrobial, antidiabetic, antihyperlipidemic, diuretic, and immunomodulatory activities. These effects are largely attributed to a rich phytochemical profile comprising saponins, alkaloids, flavonoids, phenolic compounds, steroids, and glycosides. This review summarizes the taxonomy, morphology, traditional and therapeutic uses, chemical constituents, extraction processes, pharmacological activities, and medical value *of Achyranthes aspera*. It also critically examines previous experimental and clinical studies, highlighting gaps in knowledge and future perspectives for drug development and standardized herbal formulations.

KEYWORDS: Achyranthes aspera, antimicrobial, immunomodulatory activities.

INTRODUCTION

Medicinal plants represent a cornerstone of traditional health systems and continue to play a significant role in modern drug discovery. *Achyranthes aspera* has attracted scientific interest because of its wide ethnomedicinal use and broad spectrum of biological activities. It grows abundantly as a weed in tropical and subtropical regions and is easily accessible to rural communities, making it a practical resource for primary healthcare.[1] Traditional healers use Achyranthes aspera to manage conditions such as cough, asthma, fever, dysentery, skin diseases, snakebite, reproductive disorders, and metabolic ailments. Over the last few decades, extensive phytochemical and pharmacological investigations have attempted to validate these uses and elucidate underlying mechanisms. Nonetheless, the information is often scattered and not systematically integrated. This review aims to provide an educational and detailed synthesis of current knowledge on *Achyranthes aspera*. Emphasis is placed on its botanical and taxonomical aspects, phytochemistry, pharmacological activities, extraction methods, and evidence-based medical value. The objective is to support researchers, clinicians, and students in understanding the therapeutic potential and limitations of this plant.[2]

Taxonomical Classification

Achyranthes aspera is a well-defined species with the family Amaranthaceae position is summarized below for clarity.

TAXONOMICAL RANK	CLASSIFICATION
Kingdom	Plantae
Sub kingdom	Tracheobionta
Super division	Spermatophyta
Division	Magnoliophyta
Class	Magnoliopsida

Order	Caryophyllales
Family	Amaranthaceae
Genus	Achyranthes
Species	*Achyranthes aspera L.*

Common vernacular names include prickly chaff flower (English), Apamarga (Sanskrit), Chirchita (Hindi), Aghada (Marathi), Nayurivi (Tamil), and Uttarene (Kannada). These regional names reflect its long-standing integration into traditional medicine systems.[3]

Plant Morphology

Accurate identification of Achyranthes aspera is essential for quality control of herbal materials. The plant is an erect or sometimes straggling herb that can attain a height of 0.5 to 1.5 meters, depending on environmental conditions.

Macroscopic Features

- **Habit:** Erect, perennial or sometimes annual herb with a woody base and branched stems covered with fine hairs
- **Stem:** Cylindrical, green to purplish, ribbed, and slightly rough due to the presence of trichomes.
- **Leaves:** Simple, opposite, ovate to obovate, entire margins, acute apex, densely pubescent on both surfaces; petiole short; leaves are soft and somewhat thick.
- **Inflorescence**: Long, terminal or axillary spikes with numerous small flowers arranged closely along the axis.
- **Flowers:** Greenish-white, bisexual, actinomorphic, with persistent, stiff, and hooked bracts that become conspicuous in fruiting stage.
- **Fruit:** A small, indehiscent, one-seeded utricle enclosed within the persistent perianth and bracts.
- **Seeds:** Subcylindrical to ellipsoid, brown, smooth, and shining.
- **Root:** Taproot system, pale brown, cylindrical, with secondary branches; often used medicinally.[4,5]

Microscopic Features

Leaves show dorsiventral structure with a single-layered epidermis, glandular and non- glandular trichomes, and palisade and spongy parenchyma. Stems have a distinct epidermis, collenchymatous hypodermis, well-developed cortex, and a ring of collateral vascular bundles around a central pith. Roots display typical dicotyledonous features with secondary growth, including cork, cortex, secondary phloem, and xylem.[6]

Plant Image

The visual appearance of *Achyranthes aspera* helps distinguish it. From related species and potential adulterants.

Chemical constituents

The pharmacological potential of *Achyranthes aspera* is largely driven by its diverse secondary metabolites. Multiple classes of compounds have been isolated from different parts of the plant, especially the roots, leaves, and seeds.[7]

Major Phytochemical Classes

- **Saponins:** Oleanane-type triterpenoid saponins such as achyranthosides, which contribute to anti-inflammatory, immunomodulatory, and anti-hyperlipidaemic effects.
- **Alkaloids:** Various nitrogenous compounds considered responsible for some central nervous system and cardiovascular effects.
- **Flavonoids**: Including quercetin, kaempferol and their glycosides, known for antioxidant and anti-inflammatory activity.
- **Phenolic compounds:** Simple phenols and phenolic acids that contribute to radical scavenging properties.
- **Steroids and triterpenoids:** Ecdysterone-like compounds, betaine-related constituents, and other steroids with adaptogenic and anabolic potential.[8,9]

Therapeutic Uses

Achyranthes aspera is used in various traditional medicine systems for a wide range of conditions. While many of these uses are supported by preclinical evidence.

Traditional Therapeutic Uses

- **Respiratory disorders**: Decoction of whole plant or roots used for cough, asthma, bronchitis, and sore throat.
- **Gastrointestinal complaints:** Powder or infusion employed in dysentery, diarrhea, dyspepsia, and intestinal worms.
- **Fever and infections:** Used as an antipyretic and to support recovery from common infections.
- **Musculoskeletal conditions:** Paste or poultice applied to swellings, sprains, and joint pain.
- **Skin diseases:** Topical preparations for eczema, pruritus, boils, and chronic ulcers.
- **Metabolic disorders:** Traditionally indicated in diabetes, obesity, and hyperlipidemia in some

systems.

- **Reproductive health:** Seeds and roots used as abortifacient, antifertility agents, and in menstrual disorders, with caution.
- **Renal and urinary issues:** Decoctions used as diuretic and to relieve dysuria and kidney ailments.
- **Snakebite and toxic conditions:** Root paste administered orally and applied locally as a first-aid measure in some folk practices.[10 -13]

Pharmaceutical and Pharmacological Activities

Experimental studies on Achyranthes aspera have demonstrated multiple pharmacological activities that correlate with its traditional uses. Most findings are based on in vitro assays and animal models, with limited human data.

Major Pharmacological Activities

- **Anti-inflammatory and analgesic activity:** Extracts have been shown to reduce carrageenan-induced paw edema and acetic acid-induced writhing in rodents, suggesting both peripheral and possibly central analgesic effects.
- **Antimicrobial and antifungal activity:** Different solvent extracts exhibit inhibitory Effects against bacteria such as Staphylococcus aureus, Escherichia coli, and fungi including Candida species.
- **Antioxidant activity:** Methanolic and ethanolic extracts present strong radical scavenging properties in DPPH and FRAP assays, related to flavonoid and phenolic content.
- **Antidiabetic and antihyperlipidemic effects:** Studies demonstrate reduction in blood glucose levels in alloxan- or streptozotocin-induced diabetic rats, along with improvements in lipid profiles.
- **Antihypertensive and cardioprotective effects:** Certain fractions may cause vasodilation and reduction in blood pressure in experimental models, possibly through modulation of nitric oxide or calcium channels.
- **Immunomodulatory activity:** Saponin-rich fractions have been reported to enhance humoral and cell-mediated immune responses.
- **Antifertility and contraceptive effects:** Seed and root extracts show anti-implantation and spermatogenic suppression in animal models, indicating potential for contraceptive use but also a need for safety caution.
- **Wound healing properties:** Topical application of leaf extracts accelerates wound contraction and epithelialization in experimental wound models.[14 - 17]

Extraction Process

The extraction of bioactive constituents from *Achyranthes aspera* is fundamental for standardizing its pharmacological evaluation and developing dosage forms. Various techniques and solvents have been employed.

Common Extraction Methods

- **Maceration:** Dried and powdered plant material (roots, leaves, or whole plant) soaked in solvents such as methanol, ethanol, or water for several days with intermittent shaking, followed by filtration and concentration.
- **Soxhlet extraction:** Continuous hot extraction using organic solvents including petroleum ether, chloroform, ethyl acetate, ethanol, or methanol to obtain successive fractions of increasing polarity.
- **Aqueous decoction:** Traditional method where plant material is boiled in water for a specified duration and then filtered, often used in ethnomedicinal practice.
- **Hydroalcoholic extraction:** Mixtures such as 70 percent ethanol in water used to solubilize both polar and moderately nonpolar constituents.
- **Fractionation:** Crude extracts partitioned with solvents (e.g., n-hexane, chloroform, ethyl acetate, n-butanol) to enrich specific classes like saponins or flavonoids.[18,19]

Illustrative Extraction Workflow

A generalized laboratory-scale procedure for obtaining a hydroalcoholic extract of Achyranthes aspera can be outlined as follows: Collect and authenticate whole plants or specific parts (e.g., roots), wash and shade-dry. Grind dried material to a coarse or moderately fine powder. Weigh appropriate quantity (for example, 100 g) and macerate with 70 percent ethanol in water in a suitable container. Agitate intermittently for 48 to 72 hours at room temperature. Filter through muslin cloth and then Whatman filter paper; repeat extraction if needed. Combine filtrates and concentrate under reduced pressure using a rotary evaporator. Dry the concentrated extract to constant weight and store in airtight containers at low temperature.

Medical Value and Clinical Relevance

The medicinal value of Achyranthes aspera is founded on a combination of long-standing traditional use and emerging scientific evidence. However, translation into standardized medical products requires careful consideration of efficacy, safety, and quality control.

Potential Medical Applications

- **Adjunct in inflammatory and pain conditions:** Due to notable anti-inflammatory and analgesic effects, standardized extracts may serve as adjuvant therapy in mild musculoskeletal disorders.
- **Supportive care in metabolic disorders:** Hypoglycemic and hypolipidemic actions suggest potential as complementary therapy in type 2 diabetes and dyslipidemia, subject to clinical validation.
- **Topical use for skin and wound conditions:** Antimicrobial and wound-healing properties support use in minor cuts, ulcers, and dermatoses under traditional guidelines.
- **Immunomodulatory support:** Saponin-rich extracts enhance immune function, though optimal

dosing and long-term effects are not fully defined.
- **Reproductive health interventions:** Antifertility effects indicate potential for contraceptive development, but human safety data are currently inadequate.

Safety Considerations
- **Toxicity profile:** Acute toxicity studies generally indicate a wide safety margin at traditional doses, but high doses may cause gastrointestinal irritation or reproductive toxicity.
- **Reproductive effects:** Demonstrated antifertility activity in animal studies necessitates avoidance in pregnancy and in individuals seeking conception.
- **Drug interactions:** Theoretical interactions with antidiabetic, antihypertensive, and anticoagulant drugs require caution and clinical monitoring.
- **Quality and contamination: As** a common weed, the plant may be exposed to pesticides or heavy metals; proper sourcing and quality control are crucial.

Previous Studies
Over the past decades, numerous in vitro and in vivo studies have examined the pharmacological properties of Achyranthes aspera. While methodologies vary, some consistent patterns of activity have emerged.

Summary of Key Research Themes
- **Phytochemical profiling:** Multiple studies have identified and quantified saponins, flavonoids, and steroids using chromatographic and spectroscopic techniques, including HPLC and GC-MS.
- **Anti-inflammatory and analgesic research:** Different solvent extracts have repeatedly shown significant reduction in experimental inflammation and pain models, often in a dose-dependent manner.
- **Metabolic and cardiovascular studies:** Experimental evidence indicates improvements in glucose tolerance, lipid profiles, and blood pressure metrics in animal models, pointing to cardiometabolic benefits.
- **Reproductive and antifertility investigations:** Controlled animal studies report decreased fertility indices with specific seed and root extracts, confirming ethnomedicinal claims.
- **Antimicrobial and wound healing work:** Laboratory assays document inhibition of bacterial and fungal growth and enhanced wound repair, supporting topical traditional uses.

CONCLUSION
Achyranthes aspera is a versatile medicinal plant with a broad array of traditional and experimentally supported therapeutic applications. Its rich phytochemical composition, particularly triterpenoid saponins, flavonoids, and steroids, underpins significant anti-inflammatory, antioxidant, antidiabetic, antimicrobial, immunomodulatory, and antifertility activities. The plant is widely available, relatively inexpensive, and deeply embedded in the pharmacopeia of numerous traditional medicine systems. However, to translate its potential into safe and effective modern herbal medicines, several challenges must be addressed.

These include the need for standardized extracts, robust quality control, elucidation of mechanisms of action, comprehensive toxicity profiling, and well-designed clinical trials. Special attention should be given to reproductive effects and possible interactions with conventional drugs, especially in patients with metabolic and cardiovascular diseases. Future research should focus on bioactivity-guided fractionation to identify lead compounds, pharmacokinetic and pharmacodynamic characterization, and multicenter clinical studies to validate efficacy for prioritized indications such as inflammatory disorders, metabolic syndrome, and wound care. With rigorous scientific investigation and appropriate regulation, *Achyranthes aspera* has the potential to contribute significantly to integrative and evidence- based phytotherapy.

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