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Review Article

THERAPEUTIC POTENTIAL OF *ACHYRANTHES ASPERA*: PHYTOCHEMISTRY AND PHARMACOLOGICAL PERSPECTIVES

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ABSTRACT

Achyranthes aspera is an important medicinal plant widely used in traditional systems of medicine such as Ayurveda, Siddha, and folk medicine for the treatment of various diseases. The plant belongs to the family Amaranthaceae and is commonly distributed throughout tropical and subtropical regions. Different parts of the plant including roots, leaves, seeds, stems, and flowers possess significant therapeutic value due to the presence of numerous bioactive phytoconstituents such as alkaloids, flavonoids, saponins, tannins, glycosides, terpenoids, steroids, and phenolic compounds. Scientific investigations have demonstrated that *Achyranthes aspera* exhibits a broad spectrum of pharmacological activities including antioxidant, anti-inflammatory, antimicrobial, antidiabetic, antihypertensive, hepatoprotective, anticancer, antiasthmatic, wound healing, analgesic, antipyretic, and immunomodulatory effects. The medicinal properties of the plant are mainly attributed to its phytochemical composition and ability to modulate various biochemical and physiological pathways. The present review highlights the phytochemical constituents, traditional uses, pharmacological activities, and therapeutic potential of *Achyranthes aspera* along with its future prospects in herbal medicine and pharmaceutical research.

Keywords: *Achyranthes aspera*, Phytochemistry, Medicinal plant, Pharmacological activity, Antioxidant activity, Traditional medicine.

INTRODUCTION

Medicinal plants have served as an essential source of therapeutic agents since ancient times and continue to play a significant role in the healthcare systems of many countries (Srivastava *et al.*, 1996). Traditional systems of medicine such as Ayurveda, Siddha, Unani, Chinese medicine, and various folk medicinal practices have extensively utilized plant-based remedies for the prevention and treatment of numerous diseases. Herbal medicines are widely accepted because of their natural origin, easy availability, affordability, and comparatively fewer adverse effects than synthetic drugs (Karunamoorthi *et al.*, 2013). In recent decades, there has been a growing global interest in medicinal plants and phytopharmaceuticals due to the increasing prevalence of chronic diseases, rising healthcare costs, and limitations associated with conventional therapies. Scientific investigations have confirmed that medicinal plants contain a wide range of biologically active phytoconstituents that exhibit significant therapeutic activities.

The therapeutic potential of medicinal plants is mainly attributed to secondary metabolites such as alkaloids, flavonoids, tannins,

glycosides, saponins, terpenoids, steroids, phenolic compounds, and essential oils (Shakya, 2016). These phytochemicals possess various pharmacological properties including antioxidant, anti-inflammatory, antimicrobial, antidiabetic, anticancer, antihypertensive, hepatoprotective, cardioprotective, immunomodulatory, and neuroprotective activities. Plant-derived compounds have contributed significantly to the discovery and development of modern medicines, and many currently available drugs are directly or indirectly derived from natural sources (Latif and Nawaz, 2025). Consequently, medicinal plants continue to attract considerable attention in pharmaceutical, biomedical, and nutraceutical research for the development of safer and more effective therapeutic agents.

Among the numerous medicinal plants used in traditional medicine, *Achyranthes aspera* is recognized as an important therapeutic herb with a broad spectrum of medicinal applications. *Achyranthes aspera*, commonly known as prickly chaff flower, belongs to the family Amaranthaceae (Talreja and Tiwari, 2023). The plant is widely distributed throughout tropical and subtropical regions of India, Africa, Asia, Australia, and other countries. It commonly grows as a weed along roadsides, wastelands, agricultural lands, forest areas, and riverbanks. In India, the plant is popularly known as Apamarga in Sanskrit and Chirchita in Hindi. The plant has been extensively mentioned in ancient Ayurvedic texts and has long been used in traditional systems of medicine for treating various ailments (Dinakarkumar *et al.*, 2025).

Botanically, *Achyranthes aspera* is an erect annual or perennial herb that usually grows up to one to two meters in height. The plant possesses rough, branched stems with opposite leaves and greenish-white flowers arranged in long spikes. Different parts of the plant including roots, leaves, stems, flowers, and seeds possess significant medicinal value and are used either individually or in combination in various herbal formulations. Traditional healers and folk practitioners have employed different plant parts for the treatment of respiratory disorders, digestive problems, inflammatory diseases, skin disorders, urinary infections, fever, wounds, diabetes, hypertension, arthritis, and reproductive disorders (Dinakarkumar *et al.*, 2025).

The roots of *Achyranthes aspera* are traditionally used as diuretics, expectorants, anti-inflammatory agents, and laxatives. Leaf paste is commonly applied externally for wound healing, skin diseases, boils, insect bites, and ulcers. Seeds are utilized in the management of asthma, cough, digestive disorders, and urinary problems (Sharma and Chaudhary, 2015). The plant has also been reported to possess emmenagogue, antipyretic, analgesic, antimicrobial, and blood-purifying properties. In Ayurveda, *Achyranthes aspera* is believed to help balance Kapha and Vata doshas and is used in formulations intended for detoxification and rejuvenation.

The medicinal significance of *Achyranthes aspera* is mainly associated with the presence of numerous phytochemical constituents distributed throughout different parts of the plant. Phytochemical investigations have revealed the presence of alkaloids, flavonoids, saponins, tannins, glycosides, triterpenoids, steroids, phenolic compounds, amino acids,

carbohydrates, and proteins (Srivastav *et al.*, 2011). Important bioactive compounds isolated from the plant include achyranthine, ecdysterone, oleanolic acid, betaine, spinasterol, stigmasterol, and various saponins. These compounds contribute significantly to the pharmacological activities exhibited by the plant (Ghimire *et al.,* 2015).

Several scientific studies have demonstrated that *Achyranthes aspera* possesses diverse pharmacological properties including antioxidant, anti-inflammatory, antimicrobial, antidiabetic, antihypertensive, hepatoprotective, immunomodulatory, analgesic, antipyretic, wound healing, anticancer, antiasthmatic, and cardioprotective activities. The antioxidant activity of the plant helps neutralize reactive oxygen species and reduce oxidative stress, which plays a major role in the pathogenesis of chronic diseases such as diabetes, cardiovascular disorders, and cancer. Anti-inflammatory constituents present in the plant inhibit inflammatory mediators and enzymes, thereby reducing inflammation and tissue damage (Rehman *et al.,* 2018). The antimicrobial activity of the plant against various bacterial and fungal pathogens further supports its traditional use in infectious diseases.

In recent years, *Achyranthes aspera* has gained considerable attention in pharmaceutical and biomedical research due to its broad therapeutic potential and wide range of pharmacological activities. Researchers are increasingly exploring its phytochemical composition, molecular mechanisms of action, and possible clinical applications. The plant is also considered a promising candidate for the development of novel herbal formulations, nutraceutical products, and plant-based pharmaceutical preparations (Srivastava *et al.,* 2014). Furthermore, advances in phytopharmaceutical technology and novel drug delivery systems may enhance the bioavailability and therapeutic efficacy of its bioactive constituents.

Despite its extensive traditional use and promising pharmacological activities, further scientific investigations are still required to validate its therapeutic efficacy, establish safety profiles, standardize extracts, and conduct clinical trials (Ganesh *et al.,* 2021). Isolation and characterization of active compounds, detailed pharmacological studies, toxicological evaluations, and molecular mechanism investigations are necessary to fully explore the medicinal potential of the plant. Standardization of herbal formulations and quality control measures are also essential for ensuring reproducibility, safety, and therapeutic consistency (Raju *et al.,* 2022).

Therefore, the present review aims to provide a comprehensive overview of the phytochemistry, traditional uses, pharmacological activities, therapeutic potential, and future perspectives of *Achyranthes aspera*. The review highlights the medicinal importance of this valuable plant and emphasizes its potential role in the development of effective herbal medicines and pharmaceutical products for the management of various diseases.

Plant Profile

Achyranthes aspera belongs to the family Amaranthaceae and is commonly known as prickly chaff flower. The plant is an erect annual or perennial herb widely distributed in tropical and subtropical regions. It grows abundantly along roadsides, wastelands,

agricultural fields, and forest areas. In India, the plant is commonly known as Apamarga in Sanskrit and Chirchita in Hindi (Goyal *et al.*, 2008).

Taxonomically, the plant is classified under Kingdom Plantae, Division Magnoliophyta, Class Magnoliopsida, Order Caryophyllales, Family Amaranthaceae, Genus Achyranthes, and Species *Achyranthes aspera* (Singh *et al.*, 2012). The plant usually grows up to 1–2 meters in height and possesses opposite leaves, greenish flowers, and cylindrical spikes. The stem is rough and branched, while the roots are cylindrical and yellowish-brown in color.

Traditional Uses of *Achyranthes aspera*

Achyranthes aspera has been extensively used in traditional medicine systems for the treatment of various ailments. The roots are traditionally used as a diuretic, expectorant, laxative, and anti-inflammatory agent (Jagtap *et al.*, 2002). Leaf paste is applied externally for wound healing, skin diseases, and insect bites. Seeds are used in the treatment of cough, asthma, and digestive disorders. The plant is also employed for the management of fever, dysentery, piles, urinary disorders, arthritis, hypertension, and diabetes.

In Ayurveda, *Achyranthes aspera* is considered useful in balancing Kapha and Vata doshas. The plant is used in formulations intended for blood purification, detoxification, and treatment of respiratory disorders (Ramesh *et al.*, 2017). Folk healers also utilize the plant for treating snake bites, menstrual disorders, and reproductive health problems.

Phytochemical Constituents

Achyranthes aspera contains a wide variety of bioactive phytoconstituents responsible for its therapeutic activities. Different parts of the plant contain alkaloids, flavonoids, saponins, glycosides, tannins, terpenoids, steroids, carbohydrates, proteins, amino acids, and phenolic compounds (Goyal *et al.*, 2009).

Important phytochemicals isolated from the plant include achyranthine, ecdysterone, oleanolic acid, spinasterol, saponins, and various flavonoids. Polyphenolic compounds and tannins contribute significantly to the antioxidant and anti-inflammatory properties of the plant. The presence of alkaloids and terpenoids is associated with antimicrobial and antihypertensive activities (Sharma *et al.*, 2011).

The phytochemical composition of *Achyranthes aspera* may vary depending on geographical location, climatic conditions, and extraction methods. These phytoconstituents exhibit multiple biological activities and are considered responsible for the pharmacological potential of the plant.

Pharmacological Activities of *Achyranthes aspera*

Antioxidant Activity

Achyranthes aspera possesses strong antioxidant activity due to the presence of flavonoids, phenolic compounds, tannins, and saponins. Antioxidants neutralize reactive oxygen species and free radicals that cause oxidative stress and cellular damage (Shukla *et al.*, 2012) Oxidative stress is associated with the development of various chronic diseases including cardiovascular disorders, diabetes, cancer, and neurodegenerative diseases. The antioxidant activity of *Achyranthes aspera* helps protect cellular components from oxidative damage and improves overall physiological function.

Anti-inflammatory Activity

The plant exhibits significant anti-inflammatory activity by inhibiting inflammatory mediators such as prostaglandins, cytokines, and histamine. Bioactive compounds present in the plant reduce edema, vascular permeability, and inflammatory cell infiltration. Experimental studies have demonstrated that extracts of *Achyranthes aspera* effectively reduce inflammation in various animal models (Dereje *et al.,* 2021).

Antimicrobial Activity

Achyranthes aspera possesses antimicrobial activity against various bacterial and fungal pathogens (Ndhlala *et al.,* 2012). The antimicrobial effect is mainly attributed to alkaloids, flavonoids, tannins, and terpenoids present in the plant. Extracts of the plant have shown inhibitory activity against both Gram-positive and Gram-negative bacteria as well as fungal species.

Antidiabetic Activity

Several studies have reported the antidiabetic activity of *Achyranthes aspera*. The plant helps reduce blood glucose levels and improves insulin sensitivity. Flavonoids and phenolic compounds present in the plant may enhance glucose metabolism and reduce oxidative stress associated with diabetes mellitus (Rai *et al.,* 2024).

Hepatoprotective Activity

The hepatoprotective activity of *Achyranthes aspera* is associated with its antioxidant and anti-inflammatory properties. Plant extracts help protect liver tissues against toxic agents and oxidative damage. The plant has shown protective effects in experimentally induced liver injury models (Gupta *et al.,* 2015).

Antihypertensive Activity

Achyranthes aspera exhibits antihypertensive activity through vasodilation, antioxidant effects, and modulation of vascular tone. Bioactive constituents present in the plant may improve endothelial function and reduce oxidative stress, thereby contributing to blood pressure reduction (Singh *et al.,* 2020).

Analgesic and Antipyretic Activity

Extracts of *Achyranthes aspera* have demonstrated analgesic and antipyretic effects in experimental studies. The plant reduces pain sensation and fever by inhibiting inflammatory mediators and prostaglandin synthesis.

Wound Healing Activity

The wound healing property of *Achyranthes aspera* is attributed to its antimicrobial, antioxidant, and anti-inflammatory activities. Leaf paste and extracts are traditionally applied to wounds, cuts, and ulcers to promote tissue regeneration and faster healing (Pandey *et al.,* 2016).

Anticancer Activity

Recent studies suggest that *Achyranthes aspera* possesses anticancer potential due to the presence of flavonoids, saponins, and phenolic compounds (Sharma *et al.,* 2016). These compounds may inhibit proliferation of cancer cells, induce apoptosis, and reduce oxidative stress.

Immunomodulatory Activity

The plant also exhibits immunomodulatory activity by enhancing immune responses and stimulating defense mechanisms against infections and diseases. Bioactive compounds may regulate cytokine production and immune cell function (Vasudeva *et al.,* 2002).

Mechanisms of Pharmacological Action

The pharmacological activities of *Achyranthes aspera* are mediated through multiple mechanisms involving antioxidant defense, inhibition of inflammatory pathways, modulation of enzyme activity, and regulation of cellular signaling pathways (Viswanatha *et al.,* 2019).

Flavonoids and phenolic compounds scavenge reactive oxygen species and reduce oxidative stress. Anti-inflammatory activity occurs through inhibition of cyclooxygenase and lipoxygenase pathways, leading to reduced prostaglandin synthesis. Antimicrobial effects are produced by disruption of microbial cell membranes and inhibition of microbial enzymes.

Antidiabetic activity may involve enhancement of insulin secretion, increased glucose uptake, and inhibition of carbohydrate-metabolizing enzymes. Hepatoprotective effects are associated with stabilization of cellular membranes and prevention of lipid peroxidation. The antihypertensive activity may result from vasodilation, nitric oxide enhancement, and modulation of vascular resistance (Khan *et al.,* 2015).

Therapeutic Potential and Pharmaceutical Applications

Due to its diverse pharmacological activities, *Achyranthes aspera* possesses significant therapeutic potential in the management of various diseases. The plant may serve as a natural source for the development of herbal formulations, nutraceuticals, and pharmaceutical products.

Different dosage forms such as powders, decoctions, extracts, tablets, capsules, gels, and ointments can be prepared using various parts of the plant (Gupta *et al.,* 2025). The antioxidant and anti-inflammatory properties make the plant useful in the treatment of chronic inflammatory and degenerative diseases. In addition, the antimicrobial and wound healing activities contribute to its applications in dermatological and infectious disorders.

The plant also has potential applications in cardiovascular diseases, diabetes management, liver disorders, and immune system modulation. The presence of multiple bioactive compounds with synergistic effects enhances its therapeutic value.

Safety and Toxicity

Although *Achyranthes aspera* is widely used in traditional medicine, scientific evaluation of its safety profile is essential. Most experimental studies suggest that the plant is relatively safe at therapeutic doses. However, excessive consumption may produce adverse effects due to the presence of potent bioactive constituents.

Further toxicological investigations including acute, subacute, and chronic toxicity studies are required to establish safe dosage ranges and evaluate possible herb-drug interactions.

Future Perspectives

Despite extensive traditional use and promising pharmacological activities, further scientific studies are required to fully explore the therapeutic potential of *Achyranthes aspera*. Isolation and characterization of active phytoconstituents, molecular mechanism studies, and clinical trials are essential for validating its medicinal applications.

Advanced pharmaceutical approaches such as nanoparticle formulations, phytosomes, and nanoemulsions may improve the

bioavailability and therapeutic efficacy of the plant extracts. Standardization of herbal formulations and quality control measures are also important for ensuring safety and reproducibility (Boyapati 2017).

Future research should focus on large-scale clinical studies, pharmacokinetic evaluation, and development of novel herbal formulations for various therapeutic applications.

CONCLUSION

Achyranthes aspera is an important medicinal plant with significant phytochemical and pharmacological potential. The plant contains various bioactive compounds including flavonoids, alkaloids, saponins, tannins, terpenoids, and phenolic compounds that contribute to its diverse therapeutic activities. Scientific studies have demonstrated antioxidant, anti-inflammatory, antimicrobial, antidiabetic, hepatoprotective, antihypertensive, wound healing, analgesic, and anticancer activities of the plant.

The therapeutic properties of *Achyranthes aspera* support its traditional use in the treatment of various diseases and indicate its potential as a natural source for the development of herbal medicines and pharmaceutical formulations. However, further clinical and pharmacological investigations are necessary to establish its efficacy, safety, and mechanisms of action. Continued scientific exploration of this medicinal plant may contribute significantly to the discovery of novel therapeutic agents for modern healthcare.

DECLARATION OF INTEREST

The authors declare no conflicts of interests. The authors alone are responsible for the content and writing of this article.

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