## **Review Article**



# Ethnobotanical and Pharmacological Benefits of Achyranthes aspera Linn.: An overview

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## ABSTRACT

Achyranthes aspera commonly known as Apamarga is herbal medicinal plant distributed throughout India and is used traditionally in wound healing, piles, skin diseases and dental problems. Different constituents are present in different parts of Achyranthes aspera like saponin, oleanic acid, achyranthine, ecdysterone, alkaloids, flavonoids, steroids and terpenoids. The review reveals that a large number of phytochemical constituents have been isolated from the plant which possesses several ethnobotanical uses as well as pharmacological activities like antibacterial, antifungal, antipyretic, diuretic, purgative, laxative, antiasthmatic, hepatoprotective and anti-allergic.

Keywords: Achyranthes aspera, medicinal properties, pharmacological activities, chemical constituent, traditional medicine.

#### **INTRODUCTION**

bout 3.4 billion peoples in the developing world depend on plant based traditional medicines. Natural products have been an integral part of the ancient traditional medicine systems (e.g. Chinese, Egyptian and Ayurvedic)<sup>1-3</sup>. Plants have unlimited ability to synthesize secondary metabolites such as tannins, terpenoids, alkaloids, glycosides and phenols which possess antimicrobial properties. It has been estimated that 14-28% of higher plant species are used in medicinal purposes and that 74% of pharmacologically active plant derived components were discovered after following ethnobotanical uses of the plants<sup>4,5</sup>.

Achyranthes aspera commonly known as "chirchira or chirchita" belongs to family Amaranthaceae. From the ancient times the tribal and rural people use this herb in a variety of disorders. Chirchira has occupied a pivotal position in Indian culture and folk medicine. It has been used in almost all the traditional systems of medicine viz., Ayurveda, Unani and Sidha. According to Ayurveda, it is bitter, pungent, laxative, stomachic, carminative and useful for the treatment of vomiting, bronchitis, heart disease, piles, itching, abdominal pain, ascites, dysentery, blood disease etc.<sup>6-8</sup>. Different parts of the plant are used as ingredient in many native prescriptions in combination with more active remedies<sup>9</sup>. Although it has many medicinal properties, it is particularly used as spermicidal<sup>10</sup>, antipyretic<sup>11</sup>, abortifacient activity <sup>12</sup>, antibacterial<sup>13-15</sup>, antifungal<sup>16,17</sup>, wound healing<sup>18</sup>, antiparasitic <sup>19</sup>, anti-helmintic [20] and anti-hepatic activities.

## Taxonomy

Kingdom-Plantae

Division-Magnoliophyta

Class- Magnoliopsida Subclass-Caryophyllidae **Order-Caryophyllales** Family-Amaranthaceae Genus-Achyranthes Species-aspera Vernacular Name Hindi-Latjira, Chirchira, Chirchita Sanskrit-Apmarga, Aghata English-Prickly Chaff flower, Rough chaff tree, Red chaff tree Gujarati-Safad Aghedo Tamil-Shiru – Kadaladi Telgu-Uttaraene Punjabi-Kurti Malyalam-Kadaladi Unani-Chirchitaa French-Collant Bengali-Apang, uputhlengra Assam-Apang **Geographical distribution** 

*A. aspera* is found on road sides, field boundaries and waste places as a weed throughout India up to an altitude of 2100 m and in South Andaman Islands. The plant is also widespread in Baluchistan, Sri Lanka, Tropical Asia, Africa, Australia and America<sup>22,23</sup>.

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### **Botanical description**

A. aspera is an erect herb, ranging between 0.3 to 0.9 m height, stem stiff, branched stems are angular, ribbed and simple or branched from the base, often with tinged purple colour, and branches are quadrangular with thick leaves.

Leaves are opposite, velvety, tomentose and obovate, margins wavy, surface covered with whitish hair. Petiole shows crescent shaped outline, having single layered epidermis with thick cuticle. Midrib shows a single layered epidermis, and on both surfaces, epidermis followed by 4-5 layered collenchyma on upper side and 2-3 layered on lower side.

The flowers are bisexual, greenish-white and are arranged in a spike form. The bracts surround the flower in the fruiting stage and have sharp pointed tips making the head spiny to touch. Stamen 2-5, filament filiform, monoadelphous, alternating with quadrate. Style slender, stigma small capitate and ovary is with pendulous ovule.

Stem shows 6-10 ridges, which diminish downward to the base where it become almost cylindrical, epidermis single layered, covered by thick cuticle having uniseriate, 2-5 celled covering trichomes. Cortex is 6-10 layered, composed of parenchymatous cells. A distinguishing feature in both the root and stem is the anomalous secondary growth.

Fruits are indehiscent dry utricle enclosed within persistent, perianth and bracteoles. It has one seeded nut or utricle <sup>24-26</sup>.

### ETHNOMEDICINAL USES

*A. aspera* is highly esteemed by traditional healers and used in treatment of asthma, bleeding, in facilitating delivery, boils, bronchitis, cold, cough, colic, debility, dog bite, dysentery, ear complications, headache, leucoderma, pneumonia, renal complications, scorpion bite, snake bite and skin diseases <sup>28</sup>.

Crushed plant is boiled in water and is used in pneumonia. Infusion of the root is used in bowel complaints. Decoction prepared from the whole plant is given for inflammatory conditions of the body. Root decoction is helpful to cure abdominal disorders. The dried leaf powder (2-5 gm) is taken with honey for diarrhea. Leaf juice is useful remedy for skin diseases like prutitis and scabies. Leaf paste is applied externally for toxic bites. Whole plant ash is a good remedy for bleeding piles and abdominal problems. Root of *A. aspera* is used to clean the mouth and to cure halitosis. Infusion of twig is also used as a wash for toothache. Root extract is used as an eye drop at bed time for night blindness<sup>27</sup>.

The flowering spikes or seeds, ground and made into a paste with water, are used as external application for bites of poisonous snakes and reptiles. *A. aspera* is also used in night blindness and cutaneous diseases<sup>29</sup>. For snake bites the ground root is given with water until the

patient vomits and regains consciousness. Inhaling the fumes of *A. aspera* mixed with *Smilax ovalifera* roots is suggested to improve appetite and to cure various types of gastric disorders<sup>30</sup>. It is useful in haemorrhoids, leaves and seeds are emetic, hydrophobia, carminative, resolve swelling, digestive and expel phlegm. Ash of the plant is applied externally for ulcers and warts. The crushed leaves are rubbed on aching back to cure strained back<sup>31</sup>.

Paste of the roots in water is used in ophthalmia and opacities of the cornea. Paste of fresh leaves is used for allaying pain from bite of wasps<sup>23</sup>. The plant is useful in liver complaints, rheumatism, scabies and other skin diseases. It also possesses tranquillizing properties<sup>32</sup>.

We have conducted an ethnobotanical survey on gujjar communities inhabiting Rajaji National Park, Uttarakhand (India) and found that A. aspera is being used for treating toothache, wound healing, asthma etc. Gujjars inhabiting Raiaii National Park use fresh stem of the plant to cure toothache. Leaves are crushed and applied on wounds. One teaspoon of crushed root is given with water sugar to infant thrice a day to cure diarrhea. Seeds are boiled in milk and eaten for few days to control blood pressure. One teaspoon powder of roasted seeds is given orally in asthmatic condition till cured. One table spoon of root powder is given twice a day to cure urinary tract infection. 20 gm seeds of A. aspera are cooked with milk and sugar, taken 1 cup twice a day for 2 to 3 weeks causing weight loss and control of obesity. Decoction of 15 gm. root powder is given twice a day for 3 days to get relief from cholera. 1 teaspoon of powdered roasted seeds is given orally in asthmatic condition till cured. Chilli powder is sprinkled on bite place, after half an hour the paste prepared from leaves and roots is applied for treating dog bite and animals bite. Paste of roots and leaves are applied externally on insect bite and scorpion sting.

#### PHARMACOLOGICAL ACTIVITIES

### Hepatoprotective activity

Bafna and Mishra (2004)<sup>33</sup> reported that the methanol extract of the aerial parts of *A. aspera* shown hepatoprotective activity on rifampicin induced hepatotoxicity in albino rats. Methanol extract also showed dose dependent decrease in the levels of SGPT, SGOT, ALKP and total bilirubin.

#### Antiviral activity

Chakraborty *et al.*,  $(2002)^{34}$  reported the *in vitro* assay of the methanol leaves extract of *A. aspera* (100 µg) which revealed significant inhibitory effects on the Epstein-Barr virus early antigen induced by the tumor promoter 12-O-tetradecanoylphorbol-13-acetate in Raji cells. The fraction containing mainly non-polar compounds showed the most significant inhibitory activity (96.9 % and 60 % viability). In the *in vivo* two stage mouse skin carcinogenesis test the total methanol extract reported a pronounced anticarcinogenic effect. The total extract and



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the fraction are believed to be valuable anti-tumors promoters in carcinogenesis.

### Anti-inflammatory activity

The alcohol extracts of leaves and seeds of *A. aspera* shown anti-inflammatory activity in rats using carrageenin-induced paw edema method and formalin model. Ethanol extract of *A. aspera* at the doses of 50, 100, and 200 mg/kg were screened for their effect on acute and chronic inflammation induced in mice and rats using carrageenin and freund's complete adjvant model  $^{35}$ .

### Anti-arthritic activity

Neogi *et al.,* (1969)<sup>36</sup> the water soluble alkaloid achyranthine was screened for its anti-inflammatory and antiarthritic activity against carragennin induced foot odema, granuloma pouch, formalin induced arthritis and adjuvant arthritis in rats.

### Spermicidal activity

Ethanol extract of root of *A. aspera* showed post coital antifertility activity in female albino <sup>37</sup>. Root extract of *A. aspera* shown spermicidal activity in human and rat sperms<sup>10</sup>. Pakrashi and Bhattacharya (1977)<sup>38</sup> reported that the benzene extract of the whole plant of *A. aspera* shown abortifacient activity in mice. Shibeshi *et al.,*  $(2006)^{12}$  also reported the spermicidal effects of methanolic extract of the leaves.

### Anti-fertility activity

Prakashi and Bhattacharya  $(1977)^{38}$  reported that the benzene crude extract have abortificient effect in mice. The alcoholic extract of root bark of *A. aspera* inhibit the response of oxytocin in isolated rat uterus but this fraction did not inhibit the responses to serotonin and acetylcholine in the rat uterus <sup>39</sup>.

#### Antioxidant activity

Antioxidant activity of *A. aspera* crude root extract was evaluated in a series of *in vitro* assay 1,1-diphenyl-2-picrylhydrazyl (DPPH) and Hydroxyl Radical Scavenging method were determined <sup>40,41</sup>.

### Antidiabetic and Hypoglycemic activity

Aqueous and methanol extracts of the powdered whole plant of *A. aspera*, showed hypoglyceamic activity. Blood glucose levels of normal and Alloxan induced diabetic rabbits were determined after oral administration of various doses <sup>42</sup>. The ethanol extract of *A. aspera* seed exhibited significant hypoglycemic activity in streptozotocin induced diabetic rats <sup>43</sup>.

Akhtar *et al.*,  $(1991)^{42}$  reported the aqueous and methanol extracts of the powdered whole plant of *A. aspera* shown hypoglycemic activity. Blood glucose levels of normal and Alloxan induced diabetic rabbits were determined after oral administration of various doses.

#### Larvicidal activity

Ethanol crude extract of *A. aspera* showed high larvicidal activity on the tick larvae against *Boophilis microplus*<sup>44</sup>. Larvicidal saponins from leaf extracts of *A. aspera* have been tested against *Aedes aegypti* and *Culex quinquefasciatus*. Ethyl acetate leaf extract was found to be active against *Aedes subpictus* mosquito larvae<sup>19</sup>. *A. aspera* was mentioned to have activity in controlling mosquito larvae<sup>45</sup>. Essential oils of leaf and stem extracted by steam distillation were found to possess larvicidal activity against *Aedes aegypti* and *Culex quinquefasciatus*<sup>46</sup>. Leaf extracts of the *A. aspera* have been reported to be active against *Aedes aegypti*<sup>47</sup>.

### Anti-dandruff activity

Suresh *et al.,*  $(2010)^{48}$  reported that the methanol leaf extract of *A. aspera* as a constituent of a poly herbal hair oil (PHO) showed anti-dandruff activity.

### Neuropharmacological activity

Methanol extract of the *A. aspera* was reported to have neuropharmacological activity <sup>49</sup>. It possesses antidepressant <sup>50</sup> and anxiolytic <sup>51</sup> activities. The plant was screened *in vitro* for anti-hypertensive effect <sup>52</sup>.

### **Renal disorders**

Mineralization of urinary stones like calcium oxalate, calcium carbonate and calcium phosphate were found to be inhibited by *A. aspera* <sup>53</sup>. Methanol extracts were found to prevent lead induced nephrotoxicity in albino rats <sup>54</sup>. Efficacy of the roots of the plant was tested on calcium oxalate crystal nucleation and growth *in vitro* and on oxalate induced injury in NRK-52E (rat renal tubular epithelial) cells <sup>55</sup>.

# Antiobesity activity

Mangal *et al.,*  $(2009)^{56}$  reported that the plant was clinically investigated against obesity and showed positive result.

### Veterinary uses

*A. aspera* was reported to have diuretic activity in goats <sup>57</sup> and diarrhoea preventive activity in piglets. Therapeutic efficacy of herbal preparation involving the plant in induced hepatopathy in sheep was tested <sup>58</sup>.

# **Prothyrodic activity**

Tahilani *et al.,* (2000)<sup>59</sup> reported leaves extracts of *A. aspera* to have prothyroidic and antiperoxidative properties. In rats, the plant extract induced changes in thyroid hormone concentration and decrease hepatic lipid peroxidation.

#### Anti-hepatitis

Efficacy of the *A. aspera* was tested as an ingredient of a formulation in patients of acute viral hepatitis  $^{21}$ .



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### Immunomodulatory activity

A. aspera showed immuno-stimulant action in *Catla catla*. A. aspera has significantly (P < 0.05) enhanced the BSA (bovine serum albumin) specific antibody titers than the untreated control group throughout the study period. Immunomodulatory activity of *A. aspera* seed was investigated by incorporating it in the diets of *Labeo rohita* and *Rohu fingerlings*. Superoxide anion production, serum bactericidal activity, lysozyme, serum protein. Albumin: globulin ratio was enhanced in *A. aspera* treated groups. Higher cumulative mortalities were observed in the control group this gradually decreased with increasing dose of *Achyranthes* indicating that *A. aspera* stimulates immunity and increases resistance to infection in *Labeo rohita*<sup>60, 61</sup>.

## Antiallergic activity

Datir *et al.*,  $(2009)^{62}$  reported the petroleum ether extract (200 mg/kg, i. p.) of *A. aspera* shown significant antiallergic activity in both milk induced leukocytosis and milk induced eosinophilia in mice. Thus the antiallergic activity of *A. aspera* may be due to non-polar constituents.

### **Diuretic activity**

Gupta *et al.,*  $(1972)^{63}$  reported a saponin isolated from the seeds of *A. aspera* which shown significant diuretic effect in adult male albino rats. The optimum oral dose of the saponin was 10 mg/kg in rat increased urine output which was comparable to 10 mg/kg oral dose of acetazolamide.

## Broncho-protective activity

Goyal *et al.*, (2007)<sup>64</sup> reported that the ethanol extract of *A. aspera* shown broncho-protective effect in toluene diisocyanate (TDI) induced occupational asthma in Wistar rats. The total and differential leucocytes were counted in blood and bronchoalveolar (BAL) fluid. Liver homogenate was utilized for assessment of oxidative stress and lung histological examination was performed to investigate the inflammatory status of airway.

### Hypolipidemic activity

The alcohol extracts of *A. aspera* at 100 mg/kg dose lowered serum cholesterol (TC), phospholipid (PL) triglyceride (TG) and total lipids (TL) levels by 60, 51, 33 and 53% respectively in triton induced hyperlipidemic rats. The chronic administration of this drug at the same doses to normal rats for 30 days, lowered serum TC, PL, TG and TL by 56, 62, 68 and 67% respectively followed by significant reduction in the levels of hepatic lipids <sup>65</sup>.

### **Cardiovascular activity**

Neogi (1970)<sup>66</sup> reported that the achyranthine, a watersoluble alkaloid isolated from *A. aspera*, decreased blood pressure and heart rate, dilated blood vessels, and increased the rate and amplitude of respiration in dogs and frogs. The contractile effect of the alkaloid at 0.5 mg/ml on frog rectus abdominal muscle was less than that of acetylcholine (0.1 mg/ml), and its spasmogenic effect was not blocked by tubocurarine.

## Wound healing activity

Edwin *et al.*, (2008)<sup>18</sup> reported the ethanol and aqueous extracts of leaves of *A. aspera* possess wound healing activity by using two wound models, excision wound model and incision wound model.

## Antibacterial activity

The various extracts of leaves and callus of the plant showed antimicrobial activity<sup>14</sup>. The ethanol and chloroform extract of seeds of A. aspera showed antibiotic activity against Bacillus subtilis, E. coli and Pseudomonas aeruginosa<sup>13</sup>. Alcoholic extract showed the presence of teriterpenoid saponin with dose dependent inhibitory activity against Staphylococcus aureus<sup>15</sup>. Ethanol extract of leaves and stem of plant inhibited Bacillus subtilis and Staphylococcus bacterial strains <sup>67</sup>. The seed grown on cattle dung heaps revealed antibacterial activity against bacterial strains of B. subtilis, S. typhimurium and Pseudomonas cichori<sup>68</sup>. Meera et al., (1999)<sup>69</sup> reported the extract of the leaves was found to be active against the isolated bacteria E. coli and S. citri. The aqueous solution of the achyranthine as well as the entire plant showed antibacterial activity against Staphylococcus aureus, B. typhosus and S. haemolyticus <sup>70</sup>. Alcoholic and aqueous extract of the leaves showed antibacterial activity against S. aureus and E. coli<sup>71</sup>. The in vivo investigations of aqueous leaf extract shown antibacterial activity against Proteus vulgaris. The extract was inactive against Klebsiella aerogenes, P. aeruginosa and E. coli<sup>8</sup>. In comparative study of herbal agents used for fumigation in relation to formalin, the plant reduced the microbial colony counts in air samples considerably <sup>72</sup>. Methanol leaf extract of A. aspera reported as potent inhibitor of Gram positive S. aureus with a minimal inhibitory concentration of 5000 µlml<sup>-1</sup><sup>73</sup>. Prabhat *et al.*, (2005, 2010)<sup>74,75</sup> reported broad spectrum antibacterial activities of methanolic extract of A. aspera against Staphylococcus aureus, Streptococcus mutans, S. salivarius, S. sanguis, Lactobacillus acidophilus, Bacillus subtilis, and E. coli. Phytochemical analysis of plant showed the presence of biologically active constituents which exerted synergistic antimicrobial effect. Patil et al., (2012)<sup>76</sup> reported *in vitro* antibacterial activity of dry stem extracts against dental caries causing microbes. Saravanan et al., (2008)<sup>77</sup> reported the solvent leaf extracts were tested for antibacterial activities against E. coli, P. aeruginosa, P. vulgaris, S. aureus, Klebsiella species.

# Antifungal activity

The essential oil isolated from shoot was reported to have antifungal activity against *Aspergillus cameus* at various concentrations. Ethanol extract of leaves of *A. aspera* showed high antifungal activity against *Candida kefyr*, *Cryptococcus neoformans*, *Aspergillus niger* and *A. flavus* 



Available online at www.globalresearchonline.net © Copyright protected. Unauthorised republication, reproduction, distribution, dissemination and copying of this document in whole or in part is strictly prohibited. <sup>16</sup>. Ethanol extract showed growth inhibition against *A. terreus*<sup>17</sup>. Mishra *et al.,* (1993)<sup>16</sup> reported 17-pentatriacontanol as a chief constituent isolated from essential oil of the shoots of plant, the oil shown antifungal activity against *Asperigillus carneus*.

## Anti-parasitic activity

Zahir et al., (2009)<sup>19</sup> reported that the ethyl acetate extracts of A. aspera showed antiparasitic activity (dried leaf, flower and seed extract) against the larvae of cattle tick Rhipicephalus (Boophilus) microplus (Acari: Ixodidae), sheep internal parasite Paramphistomum cervi. The acetone, chloroform, ethyl acetate, hexane and methanol leaf extracts of A. aspera were active against the early fourth instar larvae of Aedes aegypti and Culex quinquefasciatus. The larval mortality was observed after 24 hours exposure. All extracts showed moderate larvicidal effects; however, the highest larval mortality was found in the ethyl acetate extract of *A. aspera*. Bioassay-guided fractionation of A. aspera led to the separation and identification of a saponin as a potential mosquito larvicidal compound, with  $LC_{50}$  value of 18.20 and 27.24 ppm against A. aegypti and С. quinquefasciatus, respectively. Bagavan et al., (2008)78 reported the mosquito larvicidal activity of the saponin from the ethyl acetate extract of A. aspera.

### Antihelmintic activity

For preliminary evaluation of antihelmintic activity test samples of the aqueous extract of stem was prepared at the concentration of 2.5, 5, 10, 20 mg/ml in Tween 20 (1%) solution diluted with normal saline and 6 worms of *Pheretima posthuma* of 8-10cm were placed in Petri dish containing 30 ml of above test solutions of extracts. Albendazole (2.5, 5, 10, 20 mg/ml) was used as reference standard and normal saline with Tween 20 (1%) is used as negative control <sup>20, 79</sup>.

#### **Analgesic activity**

Kumar *et al.*, (2009)<sup>80</sup> reported the hydro alcoholic extract of the roots and leaves of *A. aspera* shows centrally acting analgesic activity in adult male albino rats using tail flick, hot plate and acetic acid induced writhing method for peripherally acting analgesic activity using aspirin as standard drug. The doses administered were 200 mg/kg and 400 mg/kg. The animal that administered with a dose of 400 mg/kg leaf extract has shown the maximum analgesic activity <sup>66</sup> reported that achyranthine a water soluble alkaloid had a slight antipyretic activity in rats. The leaves and seeds of *A. aspera* showed analgesic activity <sup>81</sup>.

### Antipyretic activity

The methanol extract of leaves showed antipyretic activities by using hot plate and brewer's yeast induced methods using aspirin as a standard drug. Both leaves and seeds showed analgesic activity in mice by using acetic acid induced writhing response and hot plate method <sup>11</sup>.

#### PHYTOCHEMISTRY

*A. aspera* seeds contain saponin A and B. Saponin A is known as D-Glucronic Acid and Saponin B is known as  $\beta$ -D-glactopyranosyl ester<sup>82</sup>. Stem contain Pentatrianotane, Hexatriacontane and Tritriacotane<sup>83</sup>. Sponin C isolated from fruit <sup>84</sup>, whole plant contain ecdysterone <sup>85</sup>. Seed contain oleanic acid <sup>86</sup>. *A. aspera* yield water soluble base achyranthine and chloroform soluble base betaine<sup>70</sup>. The root contains oleanolic acid in a glycone form<sup>86</sup>. Root also contain saponins and alkaloids <sup>87</sup>. In another study, the root was reported to contain alkaloids, flavanoids, saponins, steroids and terpenoids. A new cyclic fatty acid was isolated from seeds of *A. aspera*<sup>88</sup>. Ecdysterone isolated from root of plant <sup>89</sup>.

## CONCLUSION

The literature revealed that A. aspera is a very important plant due to its large number of medicinal properties as well as medicinally important chemicals like ecdysterone, achyranthine, betaine, pentatriaontane, 6pentatriacontanone, hexatriacontane and tritriacontane. The plant shown many pharmacological activities like anti-allergic, cardiovascular, spermicidal, nephroprotective, antiparasitic, hypoglyceamic, analgesic and antipyretic. Many traditional uses are also reported like antiasthma, anticholera, purgative and laxative, in various types of gastric disorders and in urinary tract infections which are being studied till today and there is ample scope of research. Thus, A. aspera is a quite promising multipurpose medicinal plant and so clinical trials should be performed to prove its efficacy.

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