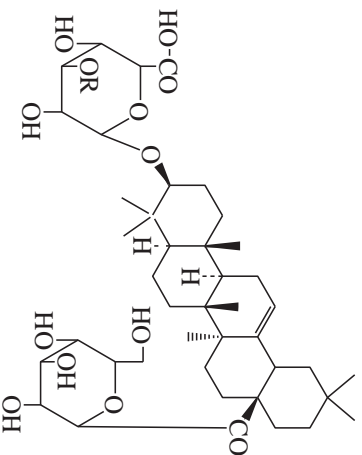
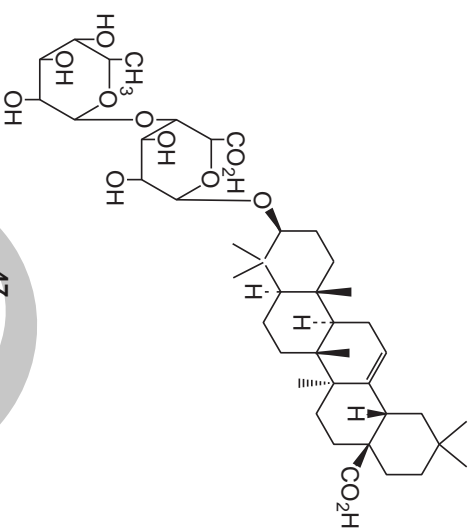


Table 9. Saponins and/or sapogenins of *Achyranthes aspera* L.

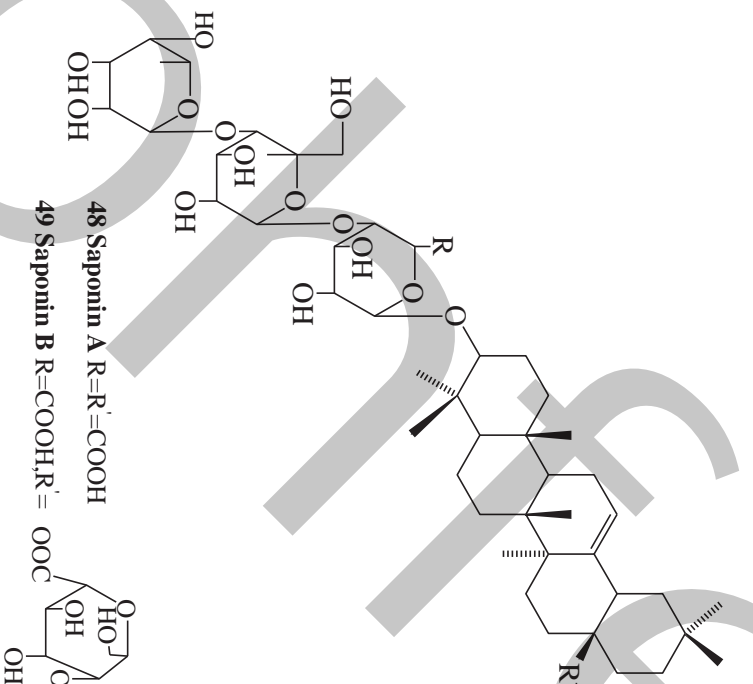
Plant part	Saponins	References
1. Aerial parts	Three bisdesmosidic saponins (44-46), β -D-glucopyranosyl 3β -[O- α -L-rhamnopyranosyl-(1 \rightarrow 3)-O- β -D-glucopyranouronosyloxo] machaerinate, β -D-glucopyranosyl 3β -[O- β -D-galactopyranosyl- (1 \rightarrow 2)-O- α -D-glucopyranouronosyloxo]- machaerinate, 3β -D-glucopyranosyl 3β -[O- α -L-rhamnopyranosyl-(1 \rightarrow 3)-O- β -D-glucopyranouronosyloxy] oleanolate, β -D-glucopyranosyl 3β -[O- β -D-galactopyranosyl-(1 \rightarrow 2)-O- β -D-glucopyranouronosyloxy] oleanolate and β -D-glucopyranosyl 3β -[O- β -D-glucopyranouronosyloxy] oleanolate	Kunert <i>et al.</i> (2000); Michl <i>et al.</i> (2000)
2. Inflorescences	β -D-Fucopyranosyl-(1 \rightarrow 4)-(β -D-glucopyranosyluronic acid-(1 \rightarrow 3)-oleanolic acid (47)	Srivastava <i>et al.</i> (2002)
3. Unripe fruits	Saponins C and D	Seshadri <i>et al.</i> (1981)
4. Seeds	Saponin A (α -L-rhamnopyranosyl (1 \rightarrow 4) β -D-glucopyranosyl (1 \rightarrow 4)- β -D-glucopyranosyl (1 \rightarrow 3) oleanolic acid) (48), saponin B (β -D-galactopyranosyl (1 \rightarrow 28) ester of saponin A (49), maslinic acid, α -L-rhamnopyranosyl-(1 \rightarrow 4)-(β -D-glucopyranosyluronic acid)-(1 \rightarrow 3)-oleanolic acid, α -L-rhamnopyranosyl-(1 \rightarrow 3)-oleanolic acid-28-O- β -D-glucopyranoside saponin (50) and α -L-rhamnopyranosyl-(1 \rightarrow 4)-(β -D-glucopyranosyl-(1 \rightarrow 4)-(β -D-glucopyranosyluronic acid)-(1 \rightarrow 3)-oleanolic acid-28-O- β -D-glucopyranoside saponin (51)	Hariharan and Rangaswami (1970); Batta and Rangaswami (1973); Rashmi <i>et al.</i> (2007)
5. Roots	Oleanolic acid glycosides.	Khastgir and Sen Gupta (1958)



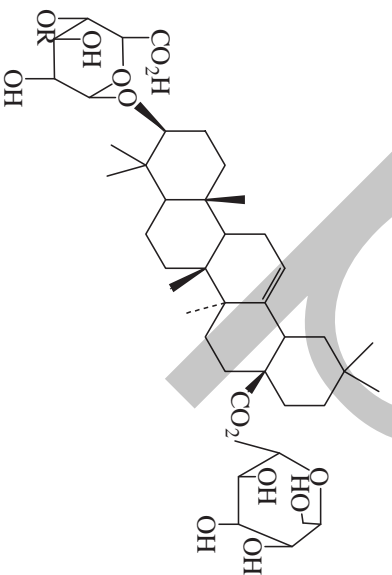
- 44 R = α -L-rhamnopyranosyl
 45 R = β -D-galactopyranosyl
 46 R = H



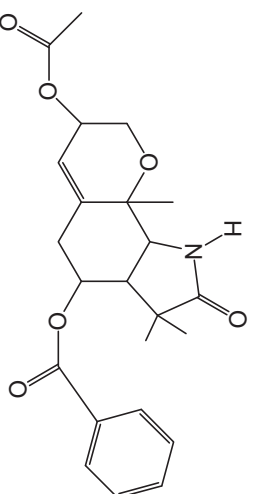
47



- 48 Saponin A R=R'=COOH
 49 Saponin B R=COOH,R'=OOC



- 50 Saponin C R = α -L-rhamnopyranosyl
 51 Saponin D R = α -L-rhamnopyranosyl-
 (1 \rightarrow 4)- β -D-glycopyranosyl



52

for the relief of "stitch" and the leaf as a remedy for boils and abscesses. The root and herb, which have been regarded as causing enteritis are used as a digestive and stomachic in India, Egypt and Australia, as a remedy for piles in India and as a diuretic in many parts of the world. In India the plant is used for the treatment of renal dropsy and bronchial infections. The leaf and seed are used as an emetic in the Philippines and in India as an application to inflamed and enlarged glands. The juice of the plant is reported from the Philippines to dissipate opacity of the cornea and to relieve toothache, dysentery and other bowel complaints (Watt and Breyer-Brandwijk, 1962).

Achyranthes aspera is an indigenous medicinal plant of Asia, South America, and Africa that is commonly used by traditional healers for the treatment of fever, especially malarial fever, dysentery, asthma, hypertension and diabetes (Girah and Khan, 1992; Chakraborty *et al.*, 2002). The root extract is well reputed for its pronounced insect molting hormonal activity. A decoction of the whole plant is described to have diuretic properties and the aqueous extract is given for pneumonia. The dried herb is used to treat children for colic and also as an astringent in gonorrhea treatment (Misra *et al.*, 1991). The roots of *Achyranthes aspera* are reported to have application in infantile diarrhea and cold (Borthakur and Goswami, 1995) while dry leaves are employed against asthma (Singh, 1995). The seeds are regarded as having emetic and hydrophobic properties (Batta and Rangaswami, 1973). Leaf extracts are reported to possess hypoglycemic, thyroid-stimulating and antiperoxidative activities (Akhtar and Iqbal, 1991; Tahitani and Kar, 2000). *Achyranthes aspera* leaves have been assessed for chemopreventive activity. The MeOH extract, alkaloid, non-alkaloid and saponin fractions exhibited significant inhibitory effects (concentration 100 µg) on the Epstein-Barr virus early antigen activation induced by the tumor promoter 12-O-tetradecanoylphorbol-13-acetate in Raji cells. In this *in vitro* assay the non-alkaloid fraction containing mainly non-polar compounds showed the most significant inhibitory activity (96.9%; 60% viability). In the *in vivo* two-stage mouse skin carcinogenesis test the total methanolic extract possessed a pronounced anticarcinogenic effect (76%). This study suggests that *Achyranthes aspera* leaf extract and the non-alkaloidal fraction are valuable antitumor promoters in carcinogenesis (Chakraborty *et al.*, 2002).

The seeds of *Achyranthes aspera* are used in Indian medicine as a cure for renal dropsy (Hartharan and Rangaswami, 1970). The unripe fruits are used in respiratory diseases treatment (Seshadri *et al.*, 1981). The aqueous extract of the plant reduces oxalate-induced renal tubular epithelial (NRK-52E) cell and inhibits calcium oxalate crystallization and can prove to be a potent candidate of phytotherapy against urolithiasis (Aggarwal *et al.*, 2010). The plant extract has shown abortifacient and contraceptive properties. The *n*-butanol fraction of aerial parts of the plant prevented pregnancy in adult female rats when administered orally at 75 mg/kg on days 1-5 postcoitum, but was ineffective in hamsters at \leq 300 mg/kg. In ovariectomized immature female rats, the extract exhibited potent estrogenic activity at the contraceptive dose but was devoid of any antiestrogenic activity. A 100% uterine weight gain was achieved at 1/15th of the contraceptive dose. A significant uterotrophic effect was discerned even at 1/20th of the contraceptive dose. Taking 100% increase in uterine weight as the parameter, estrogenic activity of the extract was 1/2750 that of ethinylestradiol (Wadhwa *et al.*, 1986). The *n*-butanol extract of the aerial parts showed significant anti-implantation activity in female rats (Tatke and Gabhe, 1999). The root has been reported to have anticoagulant activity (Raman *et al.*, 1996). *Achyranthes aspera* saponin extract has both hypolipidemic and weight reducing effects of high fat diet fed rats (Latha *et al.*, 2011a,b).

The essential oil of the plant showed antifungal activity against *Aspergillus carneus* (Misra *et al.*, 1992). The ethanol extract and the alkaloid AM-1 were inhibitory toward *Bacillus subtilis*, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, and *Shigella dysenteriae*.

The alkaloid AM-2 was active against only *Bacillus subtilis* and *Staphylococcus aureus*. Compared to ampicillin, the extract and the alkaloids were found to have little effect (Raman *et al.*, 1996).

The leaves of prickly chaff (*Achyranthes aspera*) are reported as natural antimicrobial (Bhoomika *et al.*, 2007), and the alcoholic extract of the plant is used for skin diseases (Kumar and Singh, 1990). The antimicrobial activity of the different extracts and of some compounds isolated from the plant have been reported (Sharma *et al.*, 2009). Due to the antimicrobial properties of prickly chaff, an innovative approach was made to utilize this eco-friendly and renewable source for microbial resistant fabric. The fabric samples treated with the methanol extract of the plant possess better antimicrobial activity against *Staphylococcus aureus* than *Escherichia coli*. Hence, the treated cotton fabric can be used for making healthcare textiles (Thilagavathi and Kannaiyan, 2008).

The leaves powder as well as the methanol extract of *Achyranthes aspera* were found to be nontoxic (Sadashiv and Krishna, 2011).

Achyranthes aspera is one of the Chinese medicinal compositions (containing other plant species) for the treatment of many diseases. Table 10 summarises the folk remedies and traditional uses of the plant, either alone or in the Chinese medicinal preparations. Moreover, *Achyranthes aspera* is used with other plants in Chinese medicinal preparations for preventing and treating poultry and animal diseases (e.g. Lai, 1996; Kauchabhi and Mavajubhai, 2009; Patel, 2009; Singh, 2011). It has the advantages of reduced feeding cost, controllable epidemic situation, and increased meat quality (Lai, 1996) and egg productivity (Wang and Tian, 2010) The immunostimulatory and growth promoting effect of the plant in carps have been proved (Rao and Chakrabarti, 2005; Chakrabarti *et al.*, 2012).

10. Folk remedies and traditional uses of *Achyranthes aspera*

Use	References
1. Analgesic	Zhu (2008)
2. Antidiabetic	Kumar <i>et al.</i> (2009 a-c); Panchal <i>et al.</i> (2010)
3. Antifertility	Dwivedi <i>et al.</i> (2008)
4. Anti-inflammatory	Chen (2004); Zhou (2008); Gokaraju <i>et al.</i> (2009)
5. Antipyretic	Zhu (2008)
6. Antiviral	Kumar <i>et al.</i> (2009 a-c)
7. Beriberi	Dwivedi (2004)
8. Bone injury	Zhang (2005)
9. Cholelithiasis, renal calculus, urinary tract calculus cholecystitis, cholelithiasis	Liao (2002); Lai <i>et al.</i> (2010); Raiyani <i>et al.</i> (2010)
10. Cough, bronchial infection, bronchial asthma, pneumonia	Mukherji and Gupta (1959); Murali (2003, 2009); Murali <i>et al.</i> (2006); Dwivedi <i>et al.</i> (2008); Muthuswamy (2008); Zhong (2008); Zhu (2008); Gokaraju <i>et al.</i> (2009); Sankaranarayanan <i>et al.</i> (2010); Tabuti <i>et al.</i> (2010); Zhao (2010); Deng (2011a); Wu <i>et al.</i> (2011)

10. Folk remedies and traditional uses of *Achyranthes aspera* (cont.)

Use	References
11. Diarrhea	Qureshi and Bhatti (2009); Raiyani <i>et al.</i> (2010)
12. Diuretic	Kadam <i>et al.</i> (2007); Dwivedi <i>et al.</i> (2008); Goswami <i>et al.</i> (2010)
13. Dysentery	Panchal <i>et al.</i> (2010)
14. Emetic	Chopra <i>et al.</i> (1956); Qureshi and Bhatti (2009)
15. Expectorant	Dwivedi <i>et al.</i> (2008); Zhao (2010)
16. Gonorrhoea	Dwivedi <i>et al.</i> (2008); Raiyani <i>et al.</i> (2010)
17. Hemorrhoid	Odukoya <i>et al.</i> (2009)
18. Hepatitis B, jaundice	Guo and Zhou (2007); He (2009); Kumar <i>et al.</i> (2009a)
19. Hydrophobia	Raiyani <i>et al.</i> (2010)
20. Leprosy	Ojha <i>et al.</i> (1966); Barbosa-Filho <i>et al.</i> (2007); Dwivedi <i>et al.</i> (2008)
21. Leucoderma	Balakrishnan <i>et al.</i> (2009)
22. Lumbodysnia	Deng (2011b)
23. Menorrhagia	Dwivedi <i>et al.</i> (2008)
24. Nephritis	Mei (2009)
25. Oral spray	Ye <i>et al.</i> (2006)
26. Periodontal diseases	Adler (2006)
27. Pharyngolaryngitis, acute pharyngitis, tonsillitis	Wen <i>et al.</i> (2005 a,b); Long (2006); Zhu (2008); Wu (2011)
28. Prostatitis	He (2009)
29. Rabies	Raiyani <i>et al.</i> (2010)
30. Rheumatism, rheumatoid arthritis, osteoarthritis, rheumatic arthritis	Chen (2004); Zhang (2005); Deng (2011a)
31. Skin care, skin diseases	Gokaraju <i>et al.</i> (2009); Yadav <i>et al.</i> (2009)
32. Snakes and reptiles bite	Dwivedi <i>et al.</i> (2008); Raiyani <i>et al.</i> (2010)
33. Tonic	Mo (2002); Mo and Mo (2003)
34. Toothach	Dwivedi <i>et al.</i> (2008); Padmavathy and Anbarashan (2011)
35. Traumatic injury	Yan <i>et al.</i> (2007)
36. Wound healing	Barua (2008)

There are several studies and/or reviews on the traditional uses and the pharmacological actions of *Achyranthes aspera*, reported as a magic herb in folk medicine (e.g. Gambhir *et al.*, 1965; Goyal *et al.*, 2007; Ayyanar and Ignacimuthu, 2008; Dwivedi *et al.*, 2008; Panchal *et al.*, 2010; Raiyani *et al.*, 2010; Verna *et al.*, 2010; Dey, 2011; Srivastav *et al.*, 2011; Shukla *et al.*, 2011). The different pharmacological and biological activities of *Achyranthes aspera* are summarized in Table 11.

Table 11. The pharmacological and biological activities of *Achyranthes aspera*

Activity	References
1. Abortifacient	Pakrashi and Bhattacharya (1977); Dwivedi <i>et al.</i> (2008)
2. Analgesic	Alam <i>et al.</i> (2008); Sutar <i>et al.</i> (2008)
3. Antiallergic	Seibu and Nanami (2000); Dwivedi <i>et al.</i> (2008); Dair <i>et al.</i> (2009)
4. Antiarthritic	Gokhale <i>et al.</i> (2002)
5. Antibacterial	Oshima and Soda (2000); Yamahara (2000); Kumar <i>et al.</i> (2003); Kaur <i>et al.</i> , (2005); Thilagavathi <i>et al.</i> (2005); Sharma <i>et al.</i> (2006); Saravanan <i>et al.</i> (2008); Alam <i>et al.</i> (2009); Manjula <i>et al.</i> (2009); Samanta <i>et al.</i> (2010); Tullanithi <i>et al.</i> (2010); Abi <i>et al.</i> (2011); Neeta <i>et al.</i> (2011); Ramesh <i>et al.</i> (2011); Ahmed and Nahor (2012); Rama <i>et al.</i> (2012); Ranwan and Yadav (2012); Reddy <i>et al.</i> (2012)
6. Anticancer (antitumor)	Chakraborty <i>et al.</i> (2002); Subbarayan <i>et al.</i> (2010); Kartik <i>et al.</i> (2010); Adnyana <i>et al.</i> (2012); Reddy <i>et al.</i> (2012); Subbarayan <i>et al.</i> (2012)
7. Anticatalaptic	Dair <i>et al.</i> (2011)
8. Antidandruff	Kumar <i>et al.</i> (2010e)
9. Antidiabetic	Li <i>et al.</i> (2010); Samanta <i>et al.</i> (2010); Reddy <i>et al.</i> (2012)
10. Antidepressant	Barua <i>et al.</i> (2010a)
11. Antifungal	Khosa and Dixit (1971); Misra <i>et al.</i> (1992); Kumar <i>et al.</i> (2003); Saravanan <i>et al.</i> (2008); Ramesh <i>et al.</i> (2011); Mathur <i>et al.</i> (2011)
12. Antihistaminic	Dair <i>et al.</i> (2011)
13. Anti-inflammatory	Gokhale <i>et al.</i> (2002); Vetrichelvan and Jegadessan (2003); Reddy <i>et al.</i> (2012)
14. Antileprotic	Reddy <i>et al.</i> (2012)
15. Antibiose	Latha <i>et al.</i> (2011a); Malarvili <i>et al.</i> (2011)
16. Antinociceptive	Barua <i>et al.</i> (2010b)

Table 11. The pharmacological and biological activities of *Achyranthes aspera* (cont.)

Activity	References
17. Antioxidant	Priya and Krishnakumari (2007); Surveswaran <i>et al.</i> (2007); Gayathri Devi <i>et al.</i> (2009); Malarvili and Gomathi (2009); Hussain <i>et al.</i> (2010); Patel and Patel (2010); Priya <i>et al.</i> (2010); Tami <i>et al.</i> (2010); Abi <i>et al.</i> (2011); Babu and Elango (2011); Rama <i>et al.</i> (2012)
18. Antiproliferative	Subbarayan <i>et al.</i> (2010)
19. Antipyretic	Sutar <i>et al.</i> (2008)
20. Antispasmodic	Reddy <i>et al.</i> (2012)
21. Apoptosis	Subbiah (2005)
22. Anxiolytic	Bhosale <i>et al.</i> (2011); Barua <i>et al.</i> (2012a)
23. Cardiovascular	Ram <i>et al.</i> (1971); Gupta <i>et al.</i> (1972); Han and Un (2003); Dwivedi <i>et al.</i> (2008)
24. CNS depressant	Alam <i>et al.</i> (2011); Bhosale <i>et al.</i> (2011)
25. Contraceptive	Pakrashi <i>et al.</i> (1975); Kanboj and Dhawan (1982); Prakash (1986); Wadhwa <i>et al.</i> (1986); Sandhyakumary <i>et al.</i> (2002); Paul <i>et al.</i> (2006, 2010); Shibeshi <i>et al.</i> (2006); Vasudeva and Sharma (2006a,b); Sharma <i>et al.</i> (2009); Anuja <i>et al.</i> (2010); Maiti <i>et al.</i> (2010); Anuja <i>et al.</i> (2011)
26. Diuretic	Reddy <i>et al.</i> (2012)
27. Gastroprotective	Das Ashish <i>et al.</i> (2012)
28. Hepatoprotective	Katewa and Arora (2001); Sharma <i>et al.</i> (2009)
29. Hypolipidemic	Krishnaumari and Priya (2006); Malarvili <i>et al.</i> (2011)
30. Immunity stimulant	Rao <i>et al.</i> (2004); Rao and Chakrabarti (2004); Vasudeva and Chakrabarti (2004); Vasudeva <i>et al.</i> (2006); Chakrabarti and Vasudeva (2006); Sharma <i>et al.</i> (2009)
31. Insecticide	Bagavan <i>et al.</i> (2008); Chandel <i>et al.</i> (2011); Khandagle Abhay <i>et al.</i> (2011); Kumar <i>et al.</i> (2012)
32. Nephroprotective	Jayakumar <i>et al.</i> (2009); Aggarwal <i>et al.</i> (2012)
33. Parasite control	Zahir <i>et al.</i> (2009)
34. Purgative	Dwivedi <i>et al.</i> (2008)
35. Spasmodic	Dwivedi <i>et al.</i> (2008)
36. Wound healing	Raj <i>et al.</i> (2007); Edwin <i>et al.</i> (2008); Uniyal and Joshi (2010); Barua <i>et al.</i> (2011, 2012b); Gupta and Jain (2011); Iqbal <i>et al.</i> (2011)