Chemical constituents from some plants of genus Achyranthes : A mini-review

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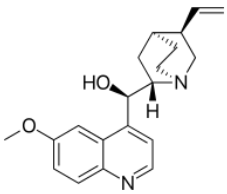
***Abstract* - This paper contains review on isolated compounds from some plants of genus Achyranthes. Plants from this genus were used in traditional medicine in India, Kenya and Australia and other countries. Achyranthes aspera is used in several medicinal activities like ophthalmia, cutaneous disease, hydrophobia, and also useful in scorpion bites. Triterpenoid saponins and ecdysterone and long chain alcohols are the main chemical constituents in the Achyranthes aspera.**

***keywords* - Achyranthes aspera; Traditional medicine; Ophthalmia; Saponines; Ecdysterone;**

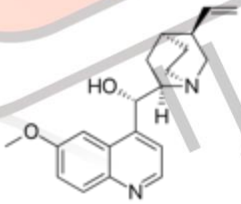
INTRODUCTION

Nature is the basic resources of therapeutic agents from thousands of years. A very large number of biologically active agents have been isolated from natural resources (**Cragg, 2001**). India is a country with rich biodiversity. The total number of lower and higher plants in India is about 45,000 species (**Jain, 1994**). The hurbs, shrubs, plants and trees are source of medicines since very primordial times. The Ayurvedic system of medicine uses about 700 species, Unani 700, Siddha 600, Amchi 600 and modern medicine around 30 species (**Rabe and Staden, 1997**). The drugs are derived either from the whole plant or from different parts of the plant, like leaves, stem, bark, root, flower, seed, etc. Some drugs are prepared from exudates of plants such as gums, resins and latex. Even the allopathic system of medicine has adopted a number of plant-derived drugs which form an important part of the modern pharmacopoeia. Potentially active important chemical intermediates required for manufacturing the recent drugs are also obtained from plants e.g. diosgenin, solasodine, β-ionone. Plants continue to be an important source for new drugs since the inception of drug discovery program and the progression is continued till date. According to World Health Organization, 80% of the population in the world depends on traditional medical prescription for their medicinal needs. The study also demonstrated the wide occurrence of active compounds in higher plants (**Hughes, 1952**).

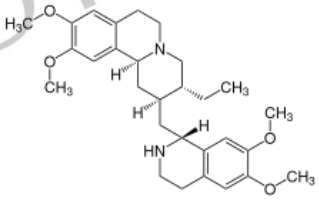
Plants containing therapeutic agents were used previously and continually using them as raw resources for extraction of pharmacologically active agents in pure form e.g. alkaloids like quinine and quinidine from *Cinchona* bark, emetine isolated from *ipecacuanha* root, glycosides isolated from *Digitalis* leaves, and sennosides from *Senna* leaves. Valerian, liquorice and Ginseng roots are part of the health food and herbal market, along with the fragrance, food flavours, and cosmetic industries.



Quinine



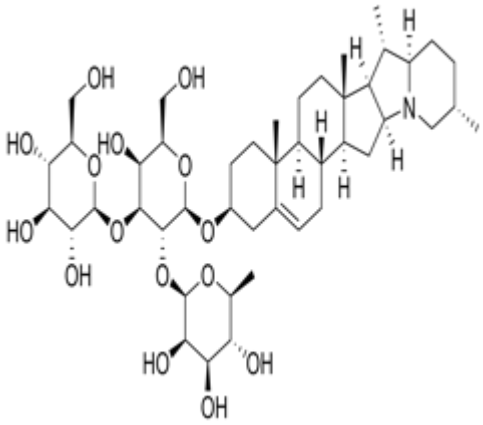
Quinidine



Emetine

Bioactive principles are present in different parts of the plant like root, stem, bark, heartwood, leaf, flower, fruit or plant exudates. These bioactive principles are separated by different processes; the most common being extraction followed by chromatographic separations (**Paroda, 1993**). In the list of medicinal plants genus *Achyranthes* also plays a very important role. The plant *Achyranthes aspera* belongs to *amaranthaceae* family and *Achyranthes genus*. *Achyranthes aspera* is in traditional use from an ancient time.

Flower spices (*A. aspera*)*



Saponines

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Achyranthes aspera root has marked therapeutic applications. Therefore it was thought worthwhile to study the structure of the polysaccharide present therein. According to **Smith, 1981** *Achyranthes aspera* found probably indigenous to south-east Asia and Africa regions.

GENUS *ACHYRANTHES*

Plants of ***Achyranthes*** are erect or ascending herbs or shrubs; leaves are opposite, entire bladed; terminal and axillary inflorescences, spicate. ***Achyranthes*** are many-flowered plants; becoming elongate, all floweres doesn't opens at same time, some are closed and some are open; hermaphrodite type flowers, solitary in axils of acute, membranous, persistent bracts, subtended by 2 bracteoles, deflexed after anthesis, the bracteoles consisting of a long spine and bearing on each side of base a shorter, membranous, nerveless wing; tepals 5, spreading during anthesis, before and after anthesis erect, membranous or herbaceous, 1- or more-nerved, acute, sometimes pungent in fruit; stamens 5, much smaller than perianth, filaments are proximally connate into a short cup, free parts are alternating with short, broad pseudo staminodes, anthers are oblong, 2-celled (4-loculed); glabrous ovary, one ovule, pendent from a long funicle, the style filiform, short, the stigma capitate, utricle falling off together with perianth and bracteoles, ellipsoid, indehiscent, 1-seeded, with truncate or depressed apex, thin-walled, the seed erect (**Bhandari, 1990**).

HABITAT/ECOLOGY

It frequently occurs in unutilized lands, and along roadsides, foot paths, railroads and sand dunes. It often infests fence rows, open woodland, and the boarders of forests and coffee fields. It has adapted to a wide range of environments. In Ayurveda, two varieties, red and white are mentioned. An abundant weeds in dry places and wastelands, from the seashore to 2100m high (**The Wealth of India, 2005**). In 'Nighantas' it is described as pungent, purgative, digestive, a remedy for inflammation in piles, itch, in the internal organs, enlarged cervical glands and abdominal enlargements. Hindus used ashes for preparing caustic alkaline preparations. The diuretic properties of the plant are well known to the natives of India and European physicians. Different parts of the plant forms ingredients in many native prescriptions in combination with more potent remedies. Found throughout tropical Asia, Africa, Australia and America.

TAXONOMIC CLASSIFICATION OF *ACHYRANTHES ASPERA*

Kingdom:	Plantae
Subkingdome:	Tracheobinota
Super Division:	Spermatophyta
Division:	Mangoliophyta
Class:	Mangoliophsida
Subclass:	Caryophyllidae
Order:	Caryophyllales
Family:	Amaranthaceae
Genus:	Achyranthes
Species:	Aspera

Achyranthes aspera Linn. is a common herb plant of abundantly available in wastelands. It is knows by different names in different languages like in English as "Prickly chaff flower" and "*Apamarga*" "*Chirchita*", "*Onga*", or "*Latjeera*" in local language and dialects. It is an annual, stiff erect herb, and found commonly as a weed throughout India and used by traditional healers for the treatment of fever, dysentery and diabetes (**Girach, *et al.* 1992**). Leaf decoction of the plant for cardiovascular toxicity has been reported (**Han, 2003**). The crude ethanol extract showed high larvicidal activity on the tick larvae against *Boophilis* microplus (**Chungsamarnyart, 1991**). The root extract is well reputed for its pronounced insect molting hormonal activity (**Banerji, *et al.* 1970**). The ethanolic extract of the leaves and stem of the plant inhibits the growth of *Bacillus subtilis* and *Staphylococcus aureus* bacterial strains.

ETHANOBOTANICAL USES

Apamarga (**Singh, A et al., 2018)** is pungent and bitter in taste (rasa), pungent in the post digestive (vipaka) and has cold potency. It alleviates kapha and vata dosas. It possesses light (laghu), dry (ruksa) and sharp (tiksna) attributes. It is diuretic, astringent and a blood purifier. It is useful in the diseases, like obesity, piles, vomiting, abdominal pain, pruritus. For medicinal purposes its whole plant can be used and sometimes it roots, leaves, seeds, and pancanga ksara are used. The paste of its leaves applied on wounds, alleviates the pain, swelling and disinfects them effectively. The fresh juice of its leaves arrests the bleeding from the wounds and ulcer. In snake and scorpion bites the pulp of the leaves is applied on the site of lesions. Bath with apamarga decoction is strongly recommended for skin diseases related with concentrated or extreme itching. Medicated oil of *A. aspera* is salutary in deafness, tinnitus and to control the ear ache. The seed powder is used as a sirovirecana which is prescribed for use nasally to alleviate migraine, and heaviness in the head due to kapha dosa. Ksara-an alkali of apamarga, is benevolent in some vaginal diseases.

Root powder of A. apsera is extremely useful to cleanse the teeth and to prevent caries. Medicated threads (ksara sutra) of apamarga are hygienic in anal fistula. Topical application of apamarga seed powder is also useful in the bleeding in piles. In the treatment of corneal opacities anjana, an ophthalmic preparation of apamarga roots is valuable. The plant is highly esteemed by traditional healers and used in treatment of asthma, renal complications, scorpion bite, snake bite and skin diseases and others etc. Traditional healers claim that addition of *A. aspera* would enhance the efficacy of any drug of plant origin, the plant medicinally to treat malaria (**Bussmann, *et al.* 2006**). Roots are used as astringents to wounds, in abdominal tumor and stomach pain (**Ghani, *et al.* 2003**). The benzene extract of the stem bark shows abortifacient activity in the rat (**Bhattarai, *et al.* 1994**). Leaf extracts were reported to possess thyroid stimulating and antiperoxidative properties (**Tahiliani, 2000**). The aqueous and methyl alcohol extracts of the plant also decreased blood glucose levels in normal and alloxan diabetic rabbits (**Akhtar, *et al.* 1991**). According to **Gokhale, *et al.* 2002, A. apsera** is reported to contain alkaloids, flavonoids, saponins, steroids and terpenoids. Only a small fraction of natural resources have been systematically investigated for the presence of bioactive compounds. Evidences based on natural product drug discovery track record, coupled with the continuing threat to biodiversity, provides a compelling argument in favor of expanded exploration of *Achyranthes aspera* as a source of novel leads for drug and other valuable bioactive agents.

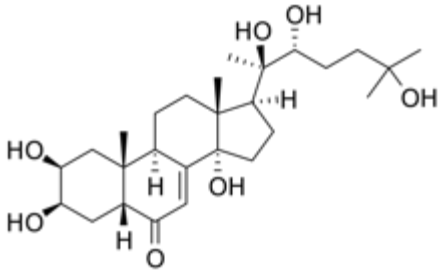
CHEMICAL CONSTITUENTS

Compounds in seeds of *A. aspera* are the saponins A and B. They are glycosides of oleanolic acid. *A. aspera* also contains carbohydrate components like the sugars D- glucose, L- rhamnose, D-glucuronic acid. The structure of saponin A and saponin B (**Hariharan, 1970**). In the shoots an aliphatic dihydroxyketone 36, 37-dihydroxyhenpentacontan-4-on and triacotanol could be found (**Batta, 1973**). A decoction of the roots, mixed with other plants is drunk against gonorrhea. The roots of *Achyrenthes aspera* are used externally for treatments of tumors, sleeping sleekness, snake biting as homicidal poison and an expectorant. A hot water extract of the root is used as an abortifacient, to expel a dead foetus and as an emmenagogue. It is reported to be useful in cancer (**Jain, 1966**). **A**ntioxidant activity on leaves and roots also reported by **Devi, S. G., et al. (2009)** also reported. Activity of the methanolic extract of the aerial parts of *A. aspera* reported by **Bafna, A.R. & Mishra, S.H. (2004)** and it shows hepatoprotective activity on rifampicin induced hepatotoxicity in albino rats. Methanolic extract showed dose dependent decrease in the levels of SGPT, SGOT, ALKP and total bilirubin. The leaf extract from *Achyranthes aspera* collected in different areas of the United Arab Emirates was tested against gram positive bacteria. It showed inhibition against *Staphylococcus aureus*, *Bacillus subtilis*, *E.coli* and *Aspegillus terreus*, respectively. The root extract was less active (**Bashir, 1992**). The methanolic leaf extract of *A. aspera* possesses antifertility activity. In overectomized rats the methanolic extract showed abortifacient activity and increased pituitary and uterine wet weights. It did not influence serum concentration of the ovarian hormones and various lipids (**Shibeshi, 2006**). **Malarvili, T and Gomathi, N. (2009)** reported antioxidant activity on seeds of the plant *Achyranthes aspera* is well documented for the presence of phytoactive constituents. **Edwin, S. *et al*. (2008)** reported free radical scavenging activity of the ethanolic and aqueous extracts. Both extracts were assessed using two methods, DPPH radical scavenging activity, and superoxide scavenging activity. The plant exhibited good antioxidant effect by preventing the formation of free radicals in the two models studied. Seeds are to use treat snake bites hydrophobia, itching, as an emetic and for application to inflamed and enlarged glands, these are boiled with milk and taken to cure hunger without loss of weight. The saponin fraction of seeds has positive ionotrophic effect on the heart of rabbit, guinea pig and frog. The chloroform extract has weak inhibiting effect on germination of *Amaranthus spinosus* (**Chopra, 1956**).

The following table indicates the different chemical constituents isolated from *Achyranthes* genus:

S. No.	Name of species	Used Part	Chemical Constituents	Reference
1	*Achyranthes aspera*	Inflorescences	β- D-glucopyranosyl-3β[O-α-L-rhamno pyranosyl-[1→3)-O-β-D-glucopyran uronosyloxy]oleanolate, β-D-glucopyranosyl3-β-[O-β-D-galacto pyranosyl (1→2)-O-β-D-glucopyranurono syloxy] oleanolate, β-D- glucopyranosyl 3β-[O-β-D-glucopyran uronosyloxy] oleanolate	Michl, G. *et al*. (2000)
		Shoots	Triacontanol , 36, 47-dihydroxyhenpentacontan-4-one	Misra, T.N. *et al*. (1991)
			27-cyclohexylheptacosan-7-ol and 16-hydroxy-26-methylheptacosan-2-one	Misra, T.G. *et al*. (1993)

			17-pentatriacontanol	Gariballa , Y. *et al.* (1983)
		Leaves	p-benzoquinone, hydroquinone, spathulenol, nerol, α-ionone, asarone and eugenol	Rameshwar, D. (2007)
			36,37-dihydoxy-henpentacontan-4-one	Batta, A.K. and Rangaswami, S. (1973)
			16-hydroxy-26-methyl heptacosan-2-one, 27-cyclohexyl heptacosan-7-ol	Mabberley DJ. 1997
			β-sitosterol, 28-hydroxy pentatriaconaten-7-one	Caius, JF. 1986
			4-methyl-heptratriaconate-1-en-10-ol,tetracontanol-2	Dressler, R.L. 1981
		Stem	10-octacosanone	Rastogi, RP and Mehrotra, BN., 1991
		Seed	Pentatriacontane	Somdeva and Naithani HB. 1986
			Hexatriacontane, Triacontane, Hentriacontane	Rastogi, RP and Mehrotra, BN. (1991)
			Linoleic acid, Oleic acid, Palmitic acid, Stearic acid ,Behenic acid, Arachidic acid, Myristic acid, Lauroic acid	Tanino, *et al*. (1969)
		Fruit	Saponin A, B, C, and D	Varies, P.S. *et al.* (1996)
		Root	Ecdysterone	Banerji A. *et al.* (1970);Gao, X. Y, *et al* (2000)
			Ecdysone	Batta,A.K. and Rangaswami, S. (1973)
			Achyranthin	Neogi, N.C. *et al.* (1970)
			Oleanolic acid	Khastgir, H.N. *et al.* (1958)
			n-hexacos-14-enoic acid, strigmasta-5, 22-dien-3-β-ol, trans-13-docasenoic acid, n-hexacosanyl, n-decaniate, n-hexacos-17-enoic acid and n-hexacos-11-enoic acid	Sharma, S.K. *et al.* (2009)
2	*Achyranthes bidentata*	Root	Bidentatoside I	Mitaine-Offer AC, 2001
			Bidentatoside II, Chikkusetsusaponin V methyl ester	Mitaine-Offer AC, 2001
3	*Achyranthes fauriei*	Leaves	Ecdysterone	Yoshida, T. *et al.* (1970)
		Root	Chikusetsusaponin Iva	Yoo, H.H. *et al.*(2006)
			Glucuronid Saponins (Achyranthosides G And Achyranthosides H)	Hidehiro, A. *et al.*, **(2008)**



Ecdysterone (20-hydroxyecdysone)

Wu *et al* (1995) 50g of the water extract applied to gonarthritis' patient 30 min/time for 2times/day. The patient recovered for treatment after ten days. **Jiangxu *et al*. (1996)** reported that *Achyranthes bidentata* polysaccharide (ABPS), 0.3 mg/kg reduced blood pressure of rabbit. ABPS could reduce blood coagulation time (CT) and PT after oral administration for 1 hour. This means it can improve blood circulation for non-wounded mouse. **Zhu *et al.* (1987)** study the five days after fetation, ABPS 500 mg/kg had anti-implantation effect on mice. But ABPS 250 and 500 mg/kg (po) had no anti-procreation effect on mouse. Fetation

of 2 g/kg/day (po) for 14-19 days had no anti-procreation effect on mouse. ABPS 0.5 mg/ml (po) to rabbit. After 1-4 minutes, the contraction of uterus was vigorous but released after 25 minutes. **Li Hai quan (2004)** seen the reducing blood glucose level ABPS 1.0, 0.5, 0.25 mg/kg/day (po) for 14 days had no significant effect on the blood glucose of normal mice, but could markedly decreased blood glucose at alloxan-induced and adrenalin-induced diabetic mellitus mice and increased the amount of hepatic glycogen of alloxan mice. **Peng *et al.* (2008)** found the polysaccharide sulfate (ABPS) was a sulfated derivative polysaccharide which was isolated and identified from Chinese herb *Achyranthes bidentata.* The anti human immunodeficiency virus type 1 (HIV-1) activities were studied in vitro and in vivo. ABPS was found to inhibit HIV-1 reverse transcriptase and integrase with the 50% inhibiting conc. (IC50) of (2.948- 0.556) mol/L-1 and (0.155 - 0.030) mol/L-1 respectively, but the parent compound. ABPS was not effective. ABPS inhibited HIV-1 P24 antigen with IC50 of (0.082 - 0.044) mol/L-1 and selective index (SI) of > (358-148) in MT-4 cell cultures acutely infected with HIV-1 IIIB virus but there was no activity even at its conc. of 500mol/L-1 in latent infection of H9/ HIV-1 IIIB cell cultures. Five percent Sera taken from rats after i.p. injected with ABPS 125 mg/kg-1 once or mice with 3 mg/kg-1 qd for 20 days effectively inhibited HIV-1 P24 in MT-4 cell cultures, but those had no inhibitory effect when given orally. The results suggested that ABPS is a promising HIV-1 inhibitor, which is active on HIV-1 reverse transcriptase, integrase in vitro and HIV-1 P24 antigens in cell cultures, and it was well absorbed by i.p. injection but poor in oral bioavailability **Chen *et al.* (2009)** noticed the acquired immunity is underdeveloped at 3-4 week of age when piglets are usually weaned on com. farms, and weaning is associated with compromised immunity. Dietary supplementation with immunomodulatory phytochemicals may enhance immune responses in the weaned piglets. This study is conducted to investigate the effects of dietary supplemental *Achyranthes bidentata* polysaccharide (ABP) on proliferation activity of lymphocytes, and production of antibodies, complements and cytokines in weaned piglets. Results showed that lymphocyte proliferation activity in piglets fed diets supplementing with 1000 and 1500 mg/kg ABP increased ($P < 0.05$) on days 14 and 28 compared with the non-additive piglets, as well as serum contents of IgG, IgA, IgM, C3, C4, IL (interleukin)-2 and IFN (interferon). The ABP had dose-dependent immunomodulatory activity and the dose of 1500 mg/kg presented the strongest stimulating activity in vivo. The proliferation activity of peripheral T cells and splenic lymphocytes in 400 microgm/mL of ABP group arrived at their peak values, as well as the production of IL-2 and IFN at 72 and 12 h after the treatment. Collectively, these findings suggested that dietary supplementation with ABP to weaned piglets enhances cellular and humoral immune responses, and ABP addition to culture medium also increases the proliferation activity and cytokine production of lymphocytes cultured in vitro, which indicate that dietary supplementation with the herbal polysaccharide may offer an effective alternative to antibiotics for weaned piglets. **Ning *et al.* (2005)** were studied the activated effects of *Achyranthes bidentata* polysaccharides (ABPS) on human monocytes The effects of ABPS (1.250 mg/mL) on phagocytosis, lysosome of human monocytes by neutral red test, and no-specific lipase staining and electron microscopy respectively. After the monocytes were cultured with 0.312, 1.250, 5.000 mg/mL ABPS-RPMI1640 for 12 h in vitro, the expression levels of tumor necrosis factor alpha (TNF) and interleukin-6 (IL-6) in the monocytes were detected by ELISA. Results showed that the phagocytosis and number of lysosomes were increased in the monocytes induced by ABPS, and ABPS could significantly induce the expression of TNF and IL-6 in the monocytes. It was conclusion that ABPS can activate the monocytes. Jin *et al*. (2007) report here the investigation on the effects of *Achyranthes bidentata* polysaccharides (ABPS) against Lewis lung cancer (LLC) in C57BL/6 mice. Depending on its doses administered in vivo, ABPS was shown to have inhibitory as well as stimulative effects on tumor growth in LLC-bearing C57BL/6 mice. ABPS at low dose could significantly inhibit LLC growth, while high dose treatment of ABPS stimulated, rather than inhibited, LLC growth in C57BL/6 mice. Tumor cell cycle analysis revealed that more tumor cells arrested at G2/M phase after daily low dose i.p. injection of ABPS for consecutive 15 days. The spleen wt. increased markedly in LLC-bearing C57BL/6 mice treated with high dose of ABPS. However, the spleen cytotoxicity activity was significantly despaired in mice of high dose treatment of ABPS. The expressions of IL-6 mRNA and TNF- mRNA were markedly up-regulated in spleens from mice treated with a high dose of ABPS by RT-PCR reactions, suggesting that the low dose of ABPS inhibits tumor growth via its effect on tumor cell cycle distribution, rather than activation of NK activity as previously suggested. We postulate that the stimulation of tumor growth by high dose of ABPS is associated with dysfunction of NK cell and up-regulation of IL-6 mRNA and TNF-γ mRNA expression in murine spleen. **Zheng *et al.* (1996)** studied the application of tissue culture technique using human-embryo muscle-skin monolayer cells for type I herpes simplex virus (HSV-I) inhibiting actions *Achyranthes bidentata* polysaccharide sulfate (Abpss) were used. The efficacy index were listed in the following order: Abpss A-6(2.17) > cyclocytidine (CC) (2.11) > phosphoacetic acid (PAA) (2.04) > Abpss C-7 (1.32) > Abpss B4 (0.84) > Abpss C-6 (0.80). **Yu and Zhang (1995)** reported that the *Achyranthes bidentata* polysaccharides (ABP) inhibit tumor growth by 31%.approxymatly 40%. Combination of cyclophosphamide and ABP increased the rate of tumor growth inhibition to 58%. ABP 50 and 100% mg/kg i.p. could potentiate LAK cell activity and increase the Con A (5 µg/mL) induced production of tumor necrosis factor from *murine splenocytes*. We also found that ABP 1.apprx.2 µg/mL strongly inhibited the proliferation of S180 and K562 cells in vitro. The S180 cell membrane content of sialic acid was increased and phospholipid decreased after ABP acting on cells for 24 h. The changes were significantly different from the control group ($P < 0.05$ or $P < 0.01$), but the membrane cholesterol content and membrane mobility indexes (Ch/PI) were not affected. The results suggest that the antitumor mechanism of ABP may be related to potentiation of the host immuno surveillance mechanism and the change in cell membrane features. **Deng *et al.* (2003)** investigate the inhibiting effects and mechanism of *Achyranthes bidentata* polysaccharide (ABP) and *Lycium barbarum* polysaccharide (LBP) on nonenzyme glycation in D-galactose induced mouse aging model. Decreased levels of serum AGE, hydroxyproline concentration in mouse skin and spontaneous motor activity in D-galactose mouse aging model were detected after treated with ABP or LBP, while lymphocyte proliferation and IL-2 activity, learning and memory abilities, SOD activity of erythrocytes, were enhanced. ABP and LBP could inhibit nonenzyme glycation in D-galactose induced mouse aging model in vivo and ABP has a better inhibiting effect than LBP.

CONCLUSION

In view of the above discussion it is clear that he polysaccharide isolated from Achyranthes bidentata is known for its immunomodulatory, antioxidant, antiviral, analgesic and anti HIV, antitumor, Antiagaing, activities. It is expected that the wide range of activities of the *Achyranthes aspera* may be due to the polysaccharide present therein. A number of secondary metabolites have been isolated from genus *Achyranthes*.

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