



## ACHYRANTHES ASPERA L: PHYTOCHEMICAL AND PHARMACOLOGICAL ASPECTS

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### ABSTRACT

*Achyranthes aspera* L. (Amaranthaceae) has long been used in different systems of medicine in the treatment of cancer, leprosy, asthma, fistula, piles, arthritis, wound, insect and snake bite, dandruff, hepatitis, renal disorders, dermatological disorders, gynecological disorders, gonorrhoea, malaria, fever, cough, diabetes, pyorrhoea, dysentery, ophthalmia, rabies, hysteria, toothache etc. The plant has been used as antimicrobial, larvicidal, antifertility, immunostimulant, hypoglycemic, hypolipidemic, anti-inflammatory, antioxidant, diuretic, cardiac stimulant, antihypertensive, anti-anasacra, analgesic, antipyretic, antinoiceptive, prothyroic, antispasmodic and hepatoprotective. The current review deals with the enormous amount of scientific research and reports available in different aspects of this plant involving phytochemistry and pharmacology. This review also includes reports on morphology, anatomy, ecology, plant pathology, tissue culture, chromosome study and medicinal uses of the plant.

**Keywords:** *Achyranthes aspera*, Phytochemistry, Pharmacology.

### INTRODUCTION

*Achyranthes aspera* L. (Amaranthaceae) is distributed as weed throughout India, tropical Asia and other parts of the world. Ayurvedic, Yunani practitioners and Kabirajes use different parts of the plant to treat leprosy, asthma, fistula, piles, arthritis, wound, insect and snake bite, renal and cardiac dropsy, kidney stone, diabetes, dermatological disorders, gynecological disorders, gonorrhoea, malaria, pneumonia, fever, cough, pyorrhoea, dysentery, rabies, hysteria, toothache etc. The plant is a popular folk remedy in traditional system of medicine throughout the tropical Asian and African countries. The plant is reported to be used as antimicrobial, larvicidal, antifertility, immunostimulant, hypoglycemic, hypolipidemic, anti-inflammatory, antioxidant, diuretic, cardiac stimulant, antihypertensive, anti-anasacra, analgesic, antipyretic, antinoiceptive, prothyroic, antispasmodic and hepatoprotective. Phytochemical investigations revealed the presence of sterols, alkaloids, saponins, sapogenins, cardiac glycosides, ecdysterone etc from different parts of the plant. Some other species of the genus *Achyranthes* viz. *A. fauriei*, *A. bidentata*, *A. japonica*, *A. ferruginea* etc. have also been investigated for their active constituents and pharmacological potential. This review incorporates different aspects of *A. aspera* cited from the existing literature emphasizing on its phytochemistry and pharmacology.

### MORPHOLOGY AND ANATOMY

It is a stiff erect perennial herb, commonly found in waste places of 1-3 feet with simple elliptic leaves<sup>1</sup>. Dedoublement of stamens<sup>2</sup>, embryology<sup>3</sup>, seed dormancy imposed by covering structures<sup>4</sup>, anomocytic stomata<sup>5</sup> and introse type of anther<sup>6</sup> in this species have been reported.

Anatomical studies on the plant were performed by several authors<sup>7-10</sup>. The original home of *A. aspera* was discussed on the basis of medullary rays in the vascular bundle<sup>9,11</sup>. Medullary bundles<sup>12</sup> and ontogeny of cambium<sup>13</sup> have been reported. The herbicide 2, 4-D induced proliferation of cambium in the hypocotyl and stem of *A. aspera* was found<sup>14</sup>.

### DISTRIBUTION

It grows throughout the tropical and warmer regions of the world<sup>15-16</sup>. The weed is also found in many other countries of Asia as well as Africa, America, Europe and Australia<sup>17-18</sup>. It was reported as an invasive alien species in northern Bangladesh<sup>19</sup>. It was found to be the most prevalent herb in Shivbari sacred grove of Himachal Pradesh, India<sup>20</sup> and an exotic medicinal plant of district Lalitpur, Uttar Pradesh, India<sup>21</sup>.

### ECOLOGY

Ecological observations<sup>22-23</sup>, autecological study<sup>24</sup>, spatial and seasonal distribution patterns<sup>25</sup> have been noted in this plant species. Structure, composition and pattern in *A. aspera* dominated vegetation in the suburbs of Karachi, Pakistan were reported<sup>26</sup>. Form and function of *A. aspera* under air pollution stress<sup>27</sup> and impact of magnum paper mill industry effluent on germination and early growth performance of *A. aspera* were mentioned<sup>28</sup>. Distribution and ecology<sup>29</sup> and population variation in *A. aspera* var. *aspera*<sup>30</sup> in Alwar district of Rajasthan, India have been studied.

### PLANT PATHOLOGY

Gall induced by whitefly *Bemisia tabacci* (Homoptera) was reported in this plant<sup>31</sup>. Galls were circular, fleshy, granular and red or pinkish patches of solid parenchyma of 1-5 mm in diameter<sup>32</sup>. Scarlet red patch induced by *Bemisia tabaci* Gennadius on undersurface of leaf of *A.*



*aspera* was studied histologically<sup>33</sup>. *Cercospora achyranthina*, a foliicolous fungi imperfecti from Jabalpur, India was found to infect *A. aspera*<sup>34</sup>. *Pyrenochaeta achyranthidis* infecting *A. aspera* has been reported<sup>35</sup>. *A. aspera* var. *prophyristachya* was found to be infested by *Meloidogyne javanica*, the root-knot nematode<sup>36</sup>. Metabolic characteristic at enzymatic levels of leaves infected with white rust was studied<sup>37</sup>. An attempt has been made to reduce bean common mosaic virus (BCMV) infectivity by crude leaf extract of *A. aspera*<sup>38</sup>. Petiole and vein galls were also reported<sup>39</sup>. The plant was evaluated against orange banded blister beetle *Zonabris pustulata*<sup>40</sup>. *Candidatus Phytoplasma asteris* with yellows of *A. aspera* in India was also found<sup>41</sup>. Phytoseiid mites were found to be associated with this plant<sup>42</sup>.

### TISSUE CULTURE

The species is a widespread weed and the author did not find many reports on its *ex-situ* conservation or tissue culture. The plant had not been exploited largely by *in vitro* propagation. Callogenic response from leaf segments of *A. aspera* was studied with different concentrations of 2,4-D alone and in combination with NAA, BAP, IAA, IBA and Zeatin in MS medium<sup>43</sup>.

### CHROMOSOME NUMBER

Naturally occurring polyploidy in *A. aspera* was reported<sup>44-45</sup>. Sporophytic count was happened to be 42 from Punjab, India, Cameroon Mountain and New Zealand<sup>46-48,17</sup>. Gametophytic count was happened to be 21<sup>49-50</sup>, 24, 48<sup>45-46</sup>. Mitotic count was reported to be 2n=42 from seedling root tip<sup>51</sup>. In another study n=21 and 42 were reported<sup>52</sup>.

### OTHERS

Pharmacognostical, pharmacological and phytochemical studies on this plant were performed<sup>53-59</sup>. Toxicity of the plant has been reported by many authors<sup>60-62</sup>. Comparative photosynthesis and levels of metabolites in leaves and chloroplasts of sun and shade-adapted plant were measured<sup>63</sup>. Teratology<sup>64</sup>, antisecretory properties<sup>65</sup> and mosaic<sup>66</sup> of *A. aspera* have been mentioned. Effect of Sodium arsenite on this weed was also studied<sup>67</sup>. Methylene blue bioadsorption potential of the plant was reported<sup>68</sup>.

### MEDICINAL

Apamarga (*Achyranthes aspera*) has been used as diuretic in the treatment of dropsy in Ayurvedic medicine<sup>69</sup>. The leaves are used in dermatological disorders<sup>70</sup>. The plant is used in gynecological disorders by the ethnic people<sup>71-72</sup>. The paste of the roots is applied to external genitalia to induce labor pains<sup>73</sup>. It is also useful to treat cough, renal dropsy, fistula, scrofula, skin rash, nasal infection, chronic malaria, impotence, fever, asthma, piles and snake bites<sup>74</sup>. The root is reported to have application in infantile diarrhea and cold<sup>75</sup> and dry leaves are employed against asthma<sup>76</sup>. It was recommended in menstrual disorder<sup>77</sup>. Roots are used as astringents to wounds, in

abdominal tumor and stomach pain<sup>78</sup>. Yunani doctors and local kabiraj use the stem, leaves and fruits as a remedy for piles, renal dropsy, pneumonia, cough, kidney stone, skin eruptions, snake bite, gonorrhoea, dysentery etc<sup>79</sup>. The plant is used in diabetes mellitus, renal and cardiac dropsy<sup>43</sup>. The whole plant decoction is diuretic, ecobolic and useful for treating renal dropsy. The juice of the plant is used in ophthalmia and dysentery. The paste made from the roots with buttermilk is taken internally as an anti-fertility drug. The paste of grinded inflorescence with water applied to external genitalia to induce abortion. To terminate pregnancy, the decoction of the fresh roots is introduced into the vagina<sup>73</sup>. The boiled root decoction is given after menstruation to induce sterility in women<sup>80</sup>. The plant is used in bleeding, renal complications, scorpion and snakebite<sup>81</sup>. The juice of the plant is used in the treatment of boils, diarrhoea, dysentery, haemorrhoids, rheumatic pains, itches and skin eruptions, pyorrhoea and toothache, diarrhoea and dysentery, rabies, nervous disorders, hysteria, insect and snake bites<sup>82</sup>.

### PHYTOCHEMICAL

27-Cyclohexylheptacosan-7-ol and 16-hydroxy-26-methylheptacosan-2-one<sup>83</sup>, a long chain alcohol and 17-pentatriacontanol<sup>84</sup>,  $\beta$ -sitosterol<sup>83,85</sup>, spinasterol a<sup>85</sup>, 3-Acetoxy-6-benzoyloxyapangamide<sup>79</sup>, Strigmasta-5, 22-dien-3- $\beta$ -ol, trans-13-docasenoic acid, n-hexacosanyl n-decaniate, n-hexacos-17-enoic acid and n-hexacos-11-enoic acid and a new aliphatic acid, n-hexacos-14-enoic acid<sup>86</sup>, a new aliphatic dihydroxyketone, characterized as 36,47-dihydroxyhenpentacontan-4-one and tritriacontanol<sup>87</sup>, 4-methylheptatriacont-1-en-10-ol and tetracontanol-2<sup>88</sup>, hexatriacontane, 10-octacosanone, 10-triicosanone and 4-triacontanone<sup>89</sup>, betain, betalaine and achyranthine<sup>90-94</sup>, flavonoids and alkaloids<sup>95</sup>, oleanolic acid<sup>96-97</sup>, a number of oleanolic acid based saponins<sup>98-100</sup>, saponin A and saponin B characterized as  $\alpha$ -L-rhamnopyranosyl (1 $\rightarrow$ 4)- $\beta$ -D-glucopyranosyl (1 $\rightarrow$ 4)- $\beta$ -D-glucuronopyranosyl(1 $\rightarrow$ 3)-oleanolic acid and  $\beta$ -D-galactopyranosyl (1 $\rightarrow$ 28) ester of saponin A<sup>101</sup>,  $\beta$ -D-glucopyranosyl ester of  $\alpha$ -L-rhamnopyranosyl (1 $\rightarrow$ 4)- $\beta$ -D-glucuronopyranosyl (1 $\rightarrow$ 3)-oleanolic acid and  $\beta$ -D-glucopyranosyl ester of  $\alpha$ -L-rhamnopyranosyl (1 $\rightarrow$ 4)- $\beta$ -D-glucopyranosyl (1 $\rightarrow$ 4)- $\beta$ -D-glucuronopyranosyl (1 $\rightarrow$ 3)-oleanolic acid, saponins<sup>102-103</sup>, sapogenin<sup>104</sup>, alkaloids<sup>105</sup> and saponins<sup>106</sup>, bisdesmosidic triterpenoid saponins like  $\beta$ -D-glucopyranosyl 3 $\beta$ -[O- $\alpha$ -L-rhamnopyranosyl-(1 $\rightarrow$ 3)-O- $\beta$ -D-glucopyranuronosyloxy]machaerinate and  $\beta$ -D-glucopyranosyl 3 $\beta$ -[O- $\beta$ -D-galactopyranosyl-(1 $\rightarrow$ 2)-O- $\alpha$ -D-glucopyranuronosyloxy]machaerinate<sup>107</sup>, ecdysterone<sup>108-110</sup>, cardiac glycosides<sup>111</sup> from different organs like leaves, shoots, roots, fruits, seeds and inflorescence have been reported. Three bisdesmosidic saponins, 20-hydroxyecdysone, and quercetin-3-O- $\beta$ -D-galactoside were isolated from the methanol extract of the aerial parts of *A. aspera* and their structures were elucidated on the basis of spectroscopic analysis by NMR<sup>112</sup>. Phytochemical investigations in this plant were carried out by different authors<sup>89,113</sup>. Seasonal variation in



chemical composition has been reported<sup>114</sup>. Carbohydrate, proteins, phenols and enzymes) in gall (induced by *Bemisia tabaci*) and normal tissues of the plant had been reported<sup>32</sup>. Fatty acid composition of seeds showed presence of lauric, myristic, palmitic, stearic, arachidic, behenic, oleic and linoleic acids<sup>115</sup>. *A. aspera* has been reported as one of the best suited plants for Leaf Protein Concentrate (LPC) preparation as a food supplement to be used by the rural poor. Different fractions like chloroplast and cytoplasmic proteins were analyzed for crude protein contents<sup>116</sup>. A validated HPLC method for the quantification of oleanolic acid in the roots and marketed formulation was carried out<sup>117</sup>. Densitometric HPTLC method for analysis of oleanolic acid in *A. aspera* was also mentioned<sup>118-119</sup>. Concentration of trace elements (Zn, Cu, Cr, Ni, Co, Cd, Pb, Mn, Fe, K, Na, Ca and Mg) in the plant was measured<sup>120</sup>. Heavy metals like Pb, Cu, Zn, Cr, Fe and Ni were found to be accumulated by the plant<sup>121</sup>. Several phytochemical tests were performed for carbohydrates, tannins, terpenoids, saponins, flavonoids and alkaloids<sup>122</sup>.

## PHARMACOLOGICAL

### Antimicrobial

Several works have been carried out to evaluate the plant's antimicrobial<sup>123-129</sup> and antifungal<sup>130-131</sup> potential. The plant has been reported as a potent antibacterial agent<sup>132-138,111,139</sup>. Antibacterial activity of seeds<sup>124</sup>, ethyl acetate extract of the stem<sup>79</sup>, leaf extracts<sup>140</sup>, ethanol and methanol extracts of the leaf and stem<sup>141</sup>, ethanolic extract of the leaves and stem<sup>142</sup>, aqueous flower extract<sup>143</sup> have been reported. Antifungal essential oil has been found<sup>84</sup>. Both antibacterial and antifungal activity of petroleum ether, chloroform and methanol extracts of dried leaves have been reported<sup>82</sup>. The plant was found to have antibacterial property against hospital origin gram positive bacteria<sup>144</sup>. It is used as herbal antimicrobial finish for cotton fabric in healthcare textiles<sup>145</sup>. The plant was evaluated against dental pathogens<sup>146</sup>. Antibacterial activity of the plant could be due to tannins, saponins, flavonoids and alkaloids<sup>122</sup>.

### Larvicidal

Root extract was found to have pronounced insect molting hormonal activity<sup>110</sup>. Ethanol crude extract showed high larvicidal activity on the tick larvae against *Boophilis microplus*<sup>147</sup>. Larvicidal saponins from leaf extracts have been tested against *Aedes aegypti* and *Culex quinquefasciatus*<sup>148</sup>. Ethyl acetate leaf extract was found to be active against *Aedes subpictus* mosquito larvae<sup>149</sup>. The plant was mentioned to have activity in controlling mosquito larvae<sup>150</sup>. Bioactivity of essential oils of leaf and stem extracted by steam distillation were found to be active larvicidal against *Aedes aegypti* and *Culex quinquefasciatus*<sup>151</sup>. Leaf extracts of the plant have been reported to be active against *Aedes aegypti*<sup>152</sup>.

### Antifertility

The plant has been reported extensively as an antifertility agent<sup>153-158</sup>. Whole plant extracts has shown abortifacient effect in mice with maximal activity was in the benzene extract<sup>123</sup>. The aerial parts of the plant were reported to prevent pregnancy in adult female rats<sup>159</sup>. The extracts of leaves, roots, and seeds of the plant have been used for control of fertility, in placental retention, and in postpartum bleeding<sup>160</sup>. The benzene extract of the stem bark shows abortifacient activity in the rat<sup>161</sup>. The ethanol extract of the root was found to be reproductively toxic and had spermicidal action *in vitro* and *in vivo* studies<sup>162</sup>. *In vitro* contraceptive spermicidal activity of composite extract of *A. aspera* and *Stephania harnandifolia* on human semen has been reported<sup>163-165</sup>. Root of *A. aspera* was found to contain a protein showing spermatotoxicity when administered orally to Swiss male albino mice<sup>166</sup>. The 58kDa Achyranthes protein (Ap) was isolated and studied *in vitro* for spermicidal action<sup>167</sup>. Post-coital antifertility activity of the roots has been reported<sup>168</sup>. The roots were found to have estrogenic and pregnancy interceptory activity<sup>169</sup>. Effect of *A. aspera* on fetal abortion, uterine and pituitary weights, serum lipids and hormones has been reported<sup>1</sup>. Alkaloidal fraction of *A. aspera* showed antifertility effect on male albino rats (*Rattus norvegicus*) on dose dependent manner<sup>170</sup>.

### Anti cancerous

The plant has been reported to have cancer chemopreventive activity and antitumor property<sup>171</sup>. Non alkaloid fractions of the plant were found to be valuable antitumour promoters<sup>172</sup>. Leaves extracted in methanol were found to have inhibitory activity against human pancreatic cancer cells indicating its anti-proliferative and anti-cancer properties<sup>173</sup>. Swiss albino mice induced by intraperitoneal injection of mineral oil was used to screen anti-cancerous efficacy of *A. aspera*<sup>174</sup>. Brine shrimp lethality (BSL) bioassay was performed in the plant to select the secondary metabolites with cytotoxic effect<sup>175</sup>. Whole plant extract was found to inhibit N-nitrosodiethylamine (NDEA) and Carbontetrachloride (CCl<sub>4</sub>) induced hepatocarcinogenesis in rats<sup>176</sup>.

### Immunostimulant

Immunomodulatory activity of the plant on elicitation of antigen-specific murine antibody response has been reported<sup>177</sup>. Same activity of the roots and potentiating antibody production in the fish, *Labeo rohita* was reported<sup>178</sup>. Enhanced anti-proteases in *Labeo rohita* was found when aqueous root extract of *A. aspera* was incorporated<sup>179</sup>. The seed of the plant was reported to enhance immunity of *Cyprinus carpio*<sup>180</sup>. The plant has been an Immunostimulant and enhancer of the antigen clearance in *Catla catla*<sup>181-182</sup>. Immunostimulatory compounds in seed were found to increase immunity and survival of *Labeo rohita* infected with *Aeromonas hydrophila*<sup>183</sup>. The hydroalcoholic extract of *A. aspera* was reported to stimulate cell mediated immune system by increasing phagocytic function<sup>184</sup>.



### Hypoglycaemic

Powdered whole plant and certain aqueous and methanolic extracts, when orally administered showed hypoglycemic in normal and alloxan-diabetic rabbits. The authors concluded that there is a possibility that the plant could act by providing some necessary elements like calcium, zinc, magnesium, manganese and copper to the beta-cells<sup>185</sup>. Redox and oxidative status in plasma and other tissues of rats fed with high doses of fructose were studied after applying seeds of the plant<sup>186</sup>.

### Hypolipidemic activity

The alcoholic extract of *A. aspera* was found to lower serum cholesterol (TC), phospholipid (PL), triglyceride (TG) and total lipids (TL) in triton induced hyperlipidemic rats<sup>187</sup>. In sesame oil feed rats, hypolipidemic efficacy of the plant was tested<sup>188</sup>. The plant's activity on sesame oil induced lipid peroxidation has been reported<sup>189</sup>.

### Antiinflammatory

Anti-inflammatory activity of *A. aspera* has been reported<sup>190</sup>. Alcoholic plant extract was found to be the most active in most of the reports<sup>191-193</sup>.

### Antioxidant activity

The plant has shown antioxidant activity in different investigations<sup>194-195</sup>. Antioxidant potential of the methanol extract of the leaves and roots of the plant was evaluated by using *in vitro* 1, 1-diphenyl-2-picrylhydrazyl (DPPH) scavenging assay<sup>196</sup>. Antioxidant activity of the aerial parts of *A. aspera* var. *porphyristachya* has been reported<sup>197</sup>. Free radical scavenging activity *in vitro* was shown by *A. aspera* var. *rubrofusca*<sup>198</sup>. Antioxidant and DNA protection potential of *A. aspera* have been reported<sup>199</sup>. The plant was screened for antioxidant property along with some other Indian medicinal plants<sup>200</sup>.

### Anti asthmatic

Apamarga *A. aspera* Antardhooma Bhasma on cases of Tamaka Shwasa bronchial asthma was found to be effective<sup>201</sup>. Effect of the plant on bronchial asthma was reported<sup>202-203</sup>. Toluene diisocyanate (TDI) induced occupational asthma in Wister rats were found to be protected by ethanolic extract of the plant<sup>204</sup> indicating its bronchoprotective activity.

### Anti spasmodic

The plant was reported to have anti spasmodic property<sup>205</sup>.

### Diuretic

While discussing Cystone®-a vegetable diuretic, the plant has been mentioned<sup>206</sup>. Antagonistic effect of *A. aspera* on uterine contractility induced by oxytocin was reported<sup>207</sup>. Saponins from the plant have shown diuretic activity<sup>208-209</sup>. The active compound responsible for the plant's diuretic property is achyranthine, marketed as Cystone®, a polyherbal formulation<sup>210-211</sup>. Effect of

Cystone® on glycolic acid-induced urolithiasis in rats was investigated<sup>212</sup>.

### Renal disorders

Mineralization of urinary stones (calculi) like calcium oxalate, calcium carbonate and calcium phosphate were found to be inhibited by *A. aspera*<sup>213</sup>. Methanolic extracts were found to prevent lead induced nephrotoxicity in albino rats<sup>172</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>214</sup>. As an approach to antilithiasis, Inhibitory effect of hydroalcoholic extract of the plant on crystallization of calcium oxalate in synthetic urine was studied<sup>215</sup>.

### Antileprotic

Effect of *A. aspera* in the treatment of leprosy has been studied<sup>216-217</sup>. The plant was also reported for its effectivity against lepromatous leprosy<sup>218</sup>.

### Anti fistula-in-ano and piles

*A. aspera* is one of the ingredient of Ksharsutra- an Ayurvedic para-surgical measure is used in the treatment of fistula-in-ano<sup>219-228</sup>. Ksharsutra can be used as a non-operative treatment of high rectal fistula<sup>222</sup>. The plant juice and ash were mentioned to be used to treat bleeding piles<sup>229</sup>.

### Anti-arthritis

Anti-arthritis activity of Achyranthine from *A. aspera* has been reported<sup>230</sup>. Ethanolic plant extract has shown anti-arthritis activity<sup>191</sup>. The plants efficacy in rheumatoid arthritis was also reported<sup>231</sup>.

### Wound healing activity

The plant has shown wound healing activity<sup>232-233,195</sup>. There has been a report on comparative protein profile of granulation tissues of burn, diabetic and immunocompromised wounds treated with 5.0% (w/w) ointment of methanol extract of the plant<sup>234</sup>.

### Anti-dandruff activity

Methanolic leaf extract of *A. aspera* as a constituent of a polyherbal hair oil (PHO) showed anti-dandruff activity<sup>235</sup>.

### Neuropharmacological activity

Methanol extract of the plant was reported to have neuropharmacological (central nervous system depressant) activity<sup>236</sup>. Its antidepressant<sup>237</sup> and anxiolytic<sup>238</sup> activity were reported. The plant was screened *in vitro* for anti-hypertensive effect<sup>239</sup>.

### Anti snake venom activity

Anti snake venom activity of the plant has been reported experimentally supporting its widespread ethnic use against poisonous bite<sup>240-242,81,199</sup>.



### Cardiac activity

Cardiac stimulant activity of the saponin of *A. aspera* seed has been observed when it was found to cause increase in force of contraction of isolated and intact hypodynamic heart<sup>243</sup>. Leaf decoction was reported for cardiovascular toxicity<sup>244</sup>. Achyranthine, the water soluble alkaloid showed lowering of blood pressure, depression of heart and increase in rate and amplitude of respiration in anaesthetized dogs<sup>57</sup>. Effect of saponin of *A. aspera* on phosphorylase activity of rat heart was noted<sup>245</sup>. In tropical West Africa, the plant was found to have activity on cardiovascular system<sup>246</sup>.

### Anti hepatitis

Efficacy of the plant was tested as an ingredient of a formulation in patients of acute viral hepatitis<sup>247</sup>.

### Hepatoprotective

Hepatoprotective activity of the plant was also observed<sup>248</sup>.

### Anti anasacra

A clinical trial of the plant in cases of shoth (general anasarca) was reported<sup>249</sup>.

### Analgesic, antipyretic and antinociceptive

Methanolic plant extract<sup>235</sup> and leaf and root extract<sup>250</sup> showed analgesic activity. Leaves were reported to be analgesic, antipyretic<sup>251</sup> and antinociceptive<sup>252-254</sup>.

### Prothyroidic

Leaf extracts were reported to have prothyroidic and antiperoxidative properties. In rats, the plant extract induced changes in thyroid hormone concentration and decrease hepatic lipid peroxidation<sup>255</sup>.

### Anthelmintic activity

The crude extract from leaves was preliminary screened for anthelmintic activity when tested against earthworms (*Pheretima posthuma*)<sup>256</sup>.

### Anti obesity

The plant was clinically investigated against obesity and showed positive results<sup>257</sup>.

### Veterinary

*A. aspera* was reported to have diuretic activity in goats<sup>258</sup> and diarrhea preventive activity in piglets<sup>259</sup>. Therapeutic efficacy of herbal preparation involving the plant in induced hepatopathy in sheep was tested<sup>260</sup>.

### Anti plant pathogen activity

Treatment of infested banana fruits by aqueous leaf extracts of *A. aspera* showed minimum loss in fruit weight and also a delay in appearance of the first disease symptom<sup>261</sup>. Inhibitory effect on *Alternaria* leaf spot on *Vicia faba* was noted when fresh leaf extract was applied<sup>262</sup>. Seed-borne fungi of wheat were inhibited by aqueous extracts of leaves of the plant with an increase in

seed germination<sup>263</sup>. Antifeedant effect of *A. aspera* on cauliflower borer (*Hellula undalis*), fruit and leaf borer of cauliflower (*Spodoptera litura*) and Brinjal fruit borer (*Leucinodes arbonalis*) was also reported<sup>264</sup>. Effect of *A. aspera* on *Helicoverpa armigera*, a moth which feed on a wide range of plants was reported<sup>265</sup>.

## DISCUSSION

Phytochemical and pharmacological investigations carried out in the plant reveals its multidisciplinary usage. The plant was found to be very useful in ethnomedicine to treat sexual and gynecological disorders like menstrual problems, gonorrhoea, impotence etc. The species is a potent anti fertility agent and abortifacient which was supported by experiments. Spermicidal activity of the plant can be used to generate male contraceptives. This property can be exploited in contraception and control population explosion in third world countries. Naturally occurring polyploids and different gametophytic and sporophytic ploidy levels have made the species an interesting cytological smaple. Widespread ethnic use of the plant against snakebite makes it a potent anti venomous plant. The plant is an ingradients of Ksharsutra-an Ayurvedic preparation used in the treatment of fistula-in-ano. Antitumour and cytotoxic potential are the exciting aspects of the plant. The plant is a potent immunostimulat too. Several investigators have reported the plant as a valuable antibacterial, antifungal, larvicidal and active against other plant pathogens. Insect moulting hormone is another interesting constituent of the plant. Its antileprotic potential can be exploited in the tropical countries of Asia and Africa where leprosy is a major cause of concern. Presence of wide range of phytochemicals indicates its promise in herbal medicine. Next level of investigations involving modern instruments like HPLC, HPTLC and NMR must be carried out in order to isolate and elucidate the active principles present in different fractions as an aid to the preliminary phytochemical analysis. The pharmacological experiments performed in the plant must be extended to the next level of clinical trial to generate novel drugs. This might prove helpful to use its immense therapeutic efficacy as a potent phytomedicine.

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