



Commercial Importance, Medicinal Value and Therapeutic Potentials of Chaff Flower (*Achyranthes aspera*) – A Review

Rafia Rehman¹, Dalel Melki², Aamir Shehzad¹, Farwa Nadeem^{1*} and Talha Khalid¹

¹Department of Chemistry, University of Agriculture, Faisalabad-38040-Pakistan and ²Technical Center of Organic Agriculture CTAB and National Institute of Applied Sciences and Technologies Sciences INSAT; Tunisia

Abstract

Chaff flower (*Achyranthes aspera*) is an annual herb belonging to Amaranthaceae family. It has traditionally been used in number of medicinal practices for thousands of years and upto some extent in food industry also. The genus *Achyranthes* of chaff flower contains approximately 8 to 15 species all of which varies from each other in terms of morphological pattern, growth habitat, chemical composition and colour of flowers and leaves. Chaff flower undergoes self-pollination for reproduction and known with different names in different regions all across the globe. Although, *Achyranthes aspera* can properly grow in variety of climatic specifications and environmental conditions, but the optimum conditions are found in countries having warm climate. Proper warmth, intense sunlight and appropriate moistures are key ecological features that are essentially required for the cultivation of this plant. *Achyranthes aspera* is an aromatic plant thus abundantly used as herb and irritant smelling. This plant is known to have high caloric and nutritional value owing to the presence of vitamin c, minerals, sodium, calcium, magnesium, potassium, chloride and phosphorus. Essential oil extracted from leaves of this plant has number of important chemical constituents that possesses strong prophylactic potentials and anti-cancer, anti-microbial, anti-diabetic, diuretic, hepatoprotective, antioxidant, anti-inflammatory, anti-arthritis, cardio-protective, immuno-modulatory and prothyroidic activity thus used in several medicinal formulations to treat severe illnesses.

Key words: Chaff flower, Amaranthaceae, self-pollination, vitamin c, biological activities, medicinal uses, nutraceutical potentials

Full length article *Corresponding Author, e-mail: farwa668@gmail.com

1. Botany

1.1 Introduction

Chaff flower (*Achyranthes aspera*) is an annual herb belonging to Amaranthaceae family. It has been used for thousands of years in medicinal practices and to some extent as food constituent also. The genus *Achyranthes* contain 8 to 15 species [1]. The exact number of species of the genus *Aspera* is uncertain because of huge variability among the constituent species. Variability is prevalent in morphology, growth habit, flower color, leaves, stems and chemical composition. Chaff flower can cross pollinate easily and they also reproduce by self-pollination [2]. The name of this plant is different in different regions of the world. It is called as "Chaff Flower" in English [3]. *Achyranthes aspera* is known by different names in different parts of the world. In English it is called "Chaff Flower", "prickly chaff flower" and "devil's horsewhip", it is called "snake's tail" in Kenya, "Adhoghanta", "Adhvashalya", "Aghamargava", "Aghata", "Apamarga", "Apangaka",

"Chamatkara", "Dhamargava" in Sanskrit, "Apang", "Chirchra", "Chirehitta", "Latjira" and "Onga" in Hindi, "Kharevazhun" in Persian, "Kutri" in Punjabi, "Jarong" in Indonesia and "Grootklits" in African countries. Probably the most common *Achyranthes aspera* is chaff flower; however this has a wide range of varieties and cultivars which vary in flavour and uses.

There are more than 10 cultivars available. Popular examples include *Achyranthus aspera aspera*, *Achyranthus aspera borbonica*, *Achyranthus aspera pubescens*, *Achyranthus aspera rubrofusca*, *Achyranthus aspera velutina*, *Achyranthus aspera late ovata*, *Achyranthus aspera nigro olivacea*, *Achyranthus aspera porphyristachya* and *Achyranthus aspera villosior*. Scents and flavour can vary from borbonica, pubescens and rubrofusca to villosior. *Achyranthes aspera* can be herbaceous, rarely can it be shrubby and its height ranges from 1m to 2m depending upon the species. Leaves can be thick, ovate, elliptic or obovate. Flower colour ranges from greenish to white. Most

common varieties of chaff flower are treated as perennial and some varieties are annual [3]. The essential oil content of chaff flower is equally variable between cultivars and species and is thought to be related to growing conditions, geographic origins, harvesting time and difference in nutritional status of plants. Huge variation was found in characteristics of chaff flower growing in different parts of the world. This variability was found when 10 cultivars of chaff flower were examined in different investigations. The chemical analysis of the cultivars also shows some similarities in morphological characters. One cultivar is *Achyranthes aspera red* with limonene chemo types. The majority of essential oil was concentrated in stem and seeds, while small amounts of essential oil were present in leaves and roots too [4].

1.2 History/Origin

Achyranthes aspera is native to South-east Asia where it has been grown from ancient times. The generic name, *Achyranthes* comes from two ancient Greek words "Achyro" meaning "chaff or husk" and "anthas" meaning "flower". The word *aspera* also comes from Greek language and the meaning of *aspera* is "rough", as the stem and leaves of this herb are very rough so it is called "*aspera*". The suggested origin for the name of this herb is uncertain but some authors stated that herb has been given this name because its symmetry is above the plan. The history of chaff flower is steeped in legend. It is thought to have been brought to Greece by Alexander the Great (356-323 B.C.E). The *aspera* was brought to France and USA in 1700s from South Asia. Culpeper, Gupta and Sharma mention *aspera* in the respective herbals. Sharma praised chaff flower as a remedy for many disorders but Baraik warned that excessive use of chaff flower is not safe for health. Pradeep Singh claimed that chaff flower can cure snake bite. Garima Mishra reported that chaff flower can be used to cure insects stings [5].

1.3 Demography/Location

Although *Achyranthes aspera* grows in variety of climatic and environmental conditions, the optimum conditions are found in the countries with a warm climate. Warmth, light and moistures are the key ecological requirements for the cultivation of chaff flower. It is grown widely in following countries: Afghanistan, Bhutan, India, Indonesia, Pakistan, Jordan, Laos, Malaysia, Myanmar, Philippines, Singapore, Sri Lanka, Syria, Africa, Algeria, Cameroon, Kenya, Lesotho, Mauritius, Namibia, Tanzania, Tunisia, Uganda, Zambia, Zimbabwe, Mexico, Florida, Hawaii, Bahamas, Caribbean, Cuba, Saint Lucia, Bolivia, Colombia, Peru, Italy, Spain, Australia, Cook Islands, Fiji and Guam [3]. The global statistics for the production of essential oil of chaff flower are not available. A large amount of the world production is not sold internationally as it is generally consumed locally. However the major

producer country is India and major consumer country is Indonesia.

1.4 Botany/Morphology/Ecology

Achyranthes aspera is an erect herb, 0.2m-2.0m high with square stems and branches often with tinged purple colour. Leaves are elliptic, ovate or broadly rhombate and are simple and oppositely arranged on stem. They are 5cm-22cm long, 2cm-5cm broad and adpressed pubescent. The inflorescences are 8-30 cm long, with many single, white or red flowers, 3-7 mm wide.[1]. The petiole is 1.2cm-3cm long. The leaves have numerous oil glands which exude strongly scented volatile oil. The inflorescence is usually long upright; the terminal spikes are usually much longer than the lateral ones. The bracts are stalked, shorter than the calyx, ovate and acute. Calyx is 4 mm long, enlarging in fruit. The fruit has a short pedicel. The calyx lower lip has two central teeth and is longer than the upper lip. *Achyranthes aspera* does not produce corolla but produces scale like tepals. Nutlets are about 2 mm long, ellipsoid, black and pitted. Sepals of flower are five and remain fuse into a two lipped calyx. Ovary is superior and fruit consists of four achenes.



Fig 1 Leaves of *Achyranthes aspera*

Achyranthes aspera requires mediterranean conditions. Optimum temperature for germination is 20°C, with growing temperatures of 10-30°C. The plant develops best in long day and full sun conditions. *Achyranthes aspera* like moist conditions but it can also withstand drought. *Achyranthes aspera* grows in disturbed lands having good organic matter content. It grows well in soil with pH ranging from 4 to 8.2 and an optimum pH of 6.2. *Achyranthes aspera* has long, deep roots and a high water requirement [3].

2. Chemistry

Achyranthes aspera is an impressively aromatic plant used as an herb and irritant smelling. Large number of chaff flower has been described on the basis of their colour, taste and other phenotypic characters. Chaff flower has varied leaf colour from green to purple and plant may grow from 1m-2m in height depending on the type of species. Chaff flower has bitter taste; while some other offer unique flavors e.g. *Achyranthus aspera borbonica*, *Achyranthus aspera pubescens*, *Achyranthus aspera rubrofusca*, *Achyranthus aspera velutina* carry particular flavour representing their names. The distinctiveness of fragrance and aroma in many chaff flower species is due to presence

of essential oil in leaves, flowers and other parts of plants. Mostly chaff flower contains oleanolic acid and linalool contents. The extent of each of these chemical constituents varies depending upon the type of species and cultivars. For example methyl chavicol provides a sweet flavour that has been compared to French tarragon, linalool produces a floral scent and eugenol is reminiscent of cloves. *Achyranthes aspera* acquire their bitter taste from the presence of large amount of eugenol. Other aromas come from thymol (thyme), trans-methyl cinnamate (cinnamon) and geraniol(rose) [3].

2.1 Chemical Composition

Chaff flower contains low amount of fat contents and less caloric value. It is also known as a good source of vitamin c and minerals. Chaff flower contains sodium 1119.67 mg/kg, calcium 5385.2 mg/kg, magnesium 5446.08 mg/kg, potassium 1343.6 mg/kg, chloride 675888.73 mg/kg and phosphorus 1447.5 mg/kg. It also contains mixture of vitamin B. It contains vitamin B 440 mg/kg. It also contains smaller amounts of other vitamins, minerals, proteins, carbohydrates and fiber. It contains 294 kcal of energy per kilogram. Its seeds are rich in dietary fiber. Chaff flower is also known for flavonoids and antioxidant properties. Chaff flower is on the GRAS (Generally Recognized as Safe) list of USDA to be used at less than 2000 mg/kg but because of the presence of carcinogenic compounds, few advocates that its use is not safe for health if used in large doses and it is also recommended not to use chaff flower during pregnancy. The amount of essential oil that is recommended is very small and it is not to take chaff flower oil large amount internally [6].

2.2 Phytochemistry

Chaff flower has characteristic irritant odour because of the existence of volatile oil which is mainly confined in seeds and roots [7]. The volatile oil chiefly comprises of tritriacontane, betaine, 6-pentatriacontane, achyranthine, oleanolic acid and long chain alcohols. While oil extracted from seeds, is named fixed oil and is mainly composed of fatty acid contents. Beside the essential or fixed oil, plant also include tannins, alkaloids and saponins, reducing sugars, steroids, flavonoids, cardiac glycosides and terpenoid [8]. The following compounds are present in chaff flowers essential oil; 3-acetoxy-6 benzoyloxyapangamide, β -sitorol, trans-13-docasenoic acid, n-hexacos-14-enoic acid, hexatriacontane, 10-octacosanone, saponin A and saponin B characterized as α -L-rhamnopyranosyl (1 \rightarrow 4)- β -D-glucopyranosyl (1 \rightarrow 4)- β -D-glucuronopyranosyl (1 \rightarrow 3)-oleanolic acid and β -D-galactopyranosyl (1 \rightarrow 28) ester of saponin A101, n-hexacos-17-enoic acid and n-hexacos-11-enoic acid and a new aliphatic acid, 4 methylheptatriacont-1-en-10-ol and tetracontanol-2, Strigmasta-5, 10-triicosanone and 4-triacontanone, a number of oleanolic acid based saponins, 27-cyclohexylheptacosan-7-ol and 16-hydroxy-26-methylheptacosan-2-one, 22-dien-3- β -ol, n-

hexacosanyl n-decaniate, a long chain alcohol and 17-pentatriacontanol, betain, betalaine and achyranthine, 47-dihydroxyhenpentacontan-4-one and tritriacontanol, flavonoids and alkaloids, hexatriacontane, oleanolic acid, three bisdesmosidic quercetin-3-O- β -D-galactoside, 20-hydroxyecdysone and saponins were isolated from the methanol extract of the aerial parts of chaff flower saponins, bisdesmosidic triterpenoid saponins like β -d-glucopyranosyl 3 β -[O- α -l-rhamnopyranosyl-(1 \rightarrow 3)-O- β -d-glucopyranuronosyloxy]machaerinate and β -d-glucopyranosyl 3 β -[O- β -d-galactopyranosyl-(1 \rightarrow 2)-O- α -dglucopyranuronosyloxy]machaerinate, β -D-glucopyranosyl ester of α -L-rhamnopyranosyl (1 \rightarrow 4)- β -D-glucuronopyranosyl (1 \rightarrow 3)-oleanolic acid and β -D-glucopyranosyl ester of α -L-rhamnopyranosyl (1 \rightarrow 4)- β -D-glucuronopyranosyl (1 \rightarrow 4) β -D-glucuronopyranosyl (1 \rightarrow 3)-oleanolic acid, ecdysterone, sapogenin, saponins and saponins, cardiac glycosides from different organs like leaves, shoots, roots, fruits, seeds and inflorescence have been reported [3]. The presence of various types of fatty acids in *Achyranthes aspera* is presented in table 1.

Table 1: Fatty acid composition in *Achyranthes aspera*

Fatty Acid	<i>Achyranthes aspera</i>
Myristic acid	10.6
Palmitic acid	10.6
Stearic acid	10.0
Arachidic acid	1.6
Behenic acid	0.6
Oleic acid	17.5
Linoleic acid	59.1

3. Postharvest Technology

Conventionally the best harvesting time for chaff flower is in the noon at the time of open sun when temperature starts increasing. It flowers from July to September, and the seeds ripen in October. It has been observed that essential oil activity increases in the morning. However many contrary findings reported that there is no contrast between fresh and dried parts of chaff flower in relation to flavor contents. The fresh leaves have a flavor complexity and intensity that is greatly lost in the dried leaves. Chaff flower can be store nearly for a week when it is wrapped in several layers of paper towels and placed in air tight bag and stored at low temperature. It is difficult to store chaff flower in succulent conditions for longer term storage purpose; therefore it is advised to dry the part of herb appropriately for longer term storing. While drying the parts of herb should not be broken or shredded because broken parts will show reduced flavor due to loss of essential oil contents. Chaff flower should be dried in shady places instead of drying in sun light. Otherwise it will lose aroma due to essential oil volatility. Dried chaff flower can be stored for 1.5 years if kept in closed jars away from light and heat at a temperature of -80°C. Another preferred long term handling could be the freeze storage. But freezing

induces changes in the flavor contents and bacterial growth may also start in freeze parts of chaff flower. To avoid this problem, it is important to follow food safety instructions. It also can be stored by spraying FAA (formalin acetic acid) and 70 percent ethyl alcohol on the part of herb which is to be stored and then is dehydrated with a graded series of tertiary butyl alcohol (TBT) [9].

3.1 Processing

Chaff flower like other herbal plants is consumed in variety of ways and various purposes. In addition to its fresh parts, other common processed forms of chaff flower include whole dry plant, freezing, powdered leaves and extracted essential oils. Whole plant can be stored frozen with and without oils, to be used for extended time beyond its fresh shelf life. Alternative traditional methods for preserving chaff flower include storage in salt and in the form of oil concentrations. Chaff flower is traditionally dried by hanging washed bundles inverted in a dry and shaded place or placing whole spread part between two sheets of papers to prevent oxidation and discoloration. Forced warm air drying is used for industrial production. Chaff flower should be dried immediately after harvest because they darken if exposed to open air for extended period of time. Drying should be done at temperature not exceeding 40°C to minimize loss of volatile compounds. Dried form of chaff flower can be stored for one year when stored protected from heat, light and moisture. Essential oil can be extracted from chaff flower in two forms i.e. herbal oil that originate from the leaves (0.1-0.25%) and a superior quality floral oil that is collected from the stem (0.4%). In India and also in other parts of the world, this plant is harvested once with approximate yield of about 12-13kg/ha. In Syria, plants are harvested when half of the plants have flowers and the fresh annual yield is 35 tons/ha that produces 80-100kg/ha essential oil yield. Similar distillation process is used for chaff flower oil extraction as the one commercially used for other herb plants and last for about one hour from freshly harvested leaves.

3.2 Value Addition

The crushed seeds of chaff flower can be combined with variety of other herbs including basil, sage and rosemary and can be used in daily meals. Soft woody stems can be used to add flavor in drinks. Chaff flower is used in both forms either fresh or dried. It is universally used both by the domestic and the industrialized producers. Seeds soaked in yogurt or water the whole night and grind it into emulsion the next morning heals bilious complaint. Mixture of chaff flower seeds and water of rice for bleeding hemorrhoids and seeds mixed with milk for brain diseases. Pills formed by mixing chaff flower leaves and black pepper or jiggery are used for fever, cough, insect bite and bee sting. Juice of the leaves is applied to skin for overexposure to sun. Chaff flower is used for diuretic, stomach ache, hemorrhoids, boils and skin eruptions. When mixed with

honey or rock candy is used for primary stage of diarrhoea and dysentery. The storage length of dried chaff flower is far more than that of fresh chaff flower, which can be stored only for a short time [10].

4. Uses

Many herbs and spices contribute significantly to health despite the low amount of consumption, as they are full of antioxidants and certain mineral compounds. It is not evident that how much chaff flower should be used to gain its health benefits. Researchers do not have any particular recommendations about precise amount of use; nevertheless, chaff flower is full of antioxidants, in addition to this it is also a good source of certain minerals and dietary fiber. Chaff flower has bitter taste, so it is not used in food. It is used to prepare a special type of medicine called "kshara" which is particularly used in surgical treatments [11].

4.1 General Uses

Chaff flower has many uses ranging from culinary to religious; its uses are often steeped in ritual. There are many curious beliefs associated with the historical use of chaff flower. In India, people consider chaff flower as guarantee for the acceptance of prayers and keep this plant with them while going to temples for worship. It is also grown at home in various parts of world including Syria, Nepal and India with this belief that this plant save from the evil spirits. It is one of the 21 leaves used in the "Ganesh Patra Pooja" done regularly on "Ganesh Chaturthi Day". Historically, some warriors used to keep a part of chaff flower with them and consider it the sign of good luck and fear over enemies [12]. Nepali women use this plant in haritalika barat. They have to use the stem of this plant as tooth brush on this barat day. Sheva pooja is performed with the leaves of chaff flower [13]. Going beyond the ritualistic uses, chaff flower is also used in food some time. Its crushed seeds are mixed with different herbs and are being used to add compliment to flavors. It is easily blended with other herbs like basil. Many alcoholic beverages, for example bitters contain chaff flower. Instead of stem, seeds of chaff flower are used as an ingredient of alcoholic liquors like bitters. The essential oil of chaff flower has significant commercial value. It is used in a range of commercial products, dental products, soaps, perfumes, prepared foods and beverages. The essential oil of chaff flower is used in commercial antioxidant materials [14].

The antifungal activity of chaff flower stem, extracts essential oils and their components is frequently studied. Three different extracts including methanol, ether and petroleum extracts of chaff flower were obtained by infusion method and were tested for their possible antifungal activity. The agar-solid diffusion method was used to test the extracts. Seventeen different types of fungal strains were used for this experiment. Their results revealed that chaff flower has significant potential against fungal diseases [15]. In another report, it is mentioned that the oil of chaff flower

also shows significant antifungal activity [16]. There is evidence indicating that chaff flower contains potent insecticidal properties. Because many synthetic insecticides have strong negative effects and are expensive, efforts have been focused on development of alternative, more environment friendly insect repellents. Chaff flower has been studied along with many others in this respect. The essential oil extracted from the stem (2% in acetone) showed good repellency against the house fly, *Musca domestica* [17]. Inhaling the fume of *Achyranthes aspera* mixed with *Smilax ovalifolia* roots is suggested to improve appetite and to cure various types of gastric disorders. Chaff flower has an extensive list of traditional medical uses. Chaff flower has over 70 medicinal uses from analgesic to vermifuge and is reported to treat over 100 conditions, including stomach ache and fungal infections [18].

The following are just a small sample of traditional medicinal uses. Chaff flower has been used in traditional Indian medicine since ancient time especially in gynecology, obstetrics and for the treatment of malaria. This plant is highly praised by traditional healers and use in the treatment of cold, cough and renal complications. The essential oil of chaff flower is considered to possess antioxidant, anti-parasitic, hypoglycemic activity and hepatoprotective activity [19]. In Jordan, an infusion of chaff flower is considered to be anti-helminthic and anti-diarrheal. The leaves of chaff flower are used against malaria, stomach ache and diarrhea. In homeopathy the leaves of chaff flower are used to treat blood dysentery, inflammation and kidney diseases. The roots of chaff flower are used to treat skin eruptions [20]. Ash of the plant is applied externally for ulcers and warts. Due to mucilaginous and cooling effect, an infusion of chaff flower is used to treat chronic dysentery. There is a long list of traditional chaff flower remedies in the literature and folklore. For snake bites the ground root is given with water until the patient vomits and regains consciousness. As we have seen, its uses are medically and geographically diverse [21]. The following section examines some of the pharmacological qualities of chaff flower and explores a sample of current research. Chaff flower is found effective against many infections from fungi, viruses, bacteria and other microbes. The leaves of chaff flower are specific for many fevers, cough, flu, asthma and diarrhea, cold and antistress agents. Crushed plant is boiled in water and is used to cure pneumonia. Chaff flower seeds are mucilaginous and relieve indigestion, sore throat, constipation and diarrhea [22]. The plant is useful in liver complaints, rheumatism, scabies and other skin diseases. It also possesses tranquillizing properties [23].

4.2 Pharmacological Uses

Chaff flower is known to have strong antioxidant properties. Many researches have shown that oil contains potent anti-cancer, anti-fertility and spermicidal properties.

Antioxidants are an important part of maintaining a healthy and balanced lifestyle, chaff flower is very important source of these essential compounds [14]. However despite these reputed properties, it is important to be aware that basil contains some carcinogenic compounds which if used in excess may prove toxic to health. That is the reason why chaff flower is not recommended to pregnant women and children [24]. There is extensive diversity in the phytochemical constituents of chaff flower; these constituents vary significantly with time, cultivation process and storage. The nutritional and pharmacological properties of the whole herb in natural form, as it has been traditionally used results from the interactions of different active phytochemicals, consequently the overall benefits of chaff flower cannot be completely duplicated using single isolated constituent [25]. There is very little data relating to a standardized dosage available by traditional practitioners, which is problematic to chemists and pharmacists, which raises the issue that there needs to be a greater communication between traditional and orthodox medicine in order to improve our understanding of phytochemicals components and their interactions [26].

Researches into medicinal properties and effect of chaff flower have been conducted at various levels. Methanolic extract of *Achyranthes aspera* was assessed for its analgesic activity in mice. Extract of the plant was administered orally (@300, 600 and 900mg/kg, body weight) produced significant analgesic activity in comparison with standard drug piroxicam 10mg/kg [27]. N. Vasudeva and S.K. Sharma (2006) reported the ethanolic extract of the root of *Achyranthes aspera* shows post coital antifertility activity in female albino rats. The said extract exhibited 83.3% anti-implantation activity when given orally at 200 mg/kg body weight. The oil of *Achyranthes aspera* was found to contain significant anti-ulcer activity [27]. In recent years, an increased methodical interest in plant phytochemicals (fruits, vegetables, herbs and spices) health benefits has been an important subject of plant based nutritional research. Although, the study of plant compounds is not new, scientists are only now started the characterization of bioactive compounds to explore their impact on human health and disease. In animal and cell culture studies, chaff flower has been found to show anti-inflammatory, anti-oxidant and anti-microbial properties [28]. Fresh leaves of chaff flower are chewed to cure Herpes zoster. It is also useful in blood clotting [29].

4.2.1 Prophylactic Agent

Decoction of chaff flower leaves is used against the microbial diseases including malaria, fever and dysentery, root decoction with honey is drunk as abortifacient within one month of conception [30]. Chaff flower essential oil show larvicidal properties. Leaf decoction of chaff flower is also used against diabetes [20]. Chaff flower show anti-plasmodial activity because of the presence of alkaloids, it

also has anti-malarial properties and eugenol is the main constituent responsible for its mosquito repellent property [31]. The paste of the leaves of chaff flower is very effective against the ringworm infection and to clear marks on face [32]. Chaff flower is highly beneficial in healing wounds, cuts, ulcers, removing parasites and worms and to treat skin diseases [33]. Chaff flower is a good source of antioxidants and offer generous fortification against free radical induced damage. Oxygen free radicals are natural physiological products, containing one or more unpaired electrons. Reactive oxygen species may harm important membrane lipids, DNA, proteins and carbohydrates. This damage results in several diseases such as atherosclerosis, cancer and diabetes etc. Chaff flower is very effective in curing such type of diseases [34]. Chaff flower antioxidants help in maintaining good health and prevent the chances of degenerative diseases because stress is the hallmark of such diseases [35]. The information available about the chemical properties of chaff flower leaves and seeds are centered on the numerous studies which have been conducted in various parts of the world. Therefore, it is expected that chemical ingredients of chaff flower may differ due to geographical influences. Diverse chaff flower cultivars representing varied range of chemical compositions are found in different parts of the world.

4.2.2 Anti-Cancer Activity

The anti-cancer activity of chaff flower has been proved and cited by several investigators. The anti-tumor potential of chaff flower was tested in Swiss albino mice after treated with mineral oil. Different extracts of chaff flower leaves were tested for possible anti-tumor activity. Different doses of ether extract (3 mg/ml and 1.5 mg/ml) were given to mice and results showed that the ether extract of the leaves of chaff flower has the greater anti-cancer potential among all extracts at the concentration of 3 mg/ml. The leaves of chaff flower has the greater anti-cancerous activity and non-alkaloid fractions were responsible for this activity [36].

4.2.3 Anti-Microbial Activity

Volatile oil commonly known as essential oils having hydrophobic nature is responsible for the biochemical activities of spices and herbs. To test the anti-microbial activity of chaff flower, petroleum, ether and methanol extracts of chaff flower oil was prepared in dimethyl sulfoxide (DMSO, W/V) at different concentrations (50-200 µg/100µl) and tested by well plate assay method. Root extracts of methanol and chloroform showed weak anti-microbial activity against *Shigella* sp. and *Escherichia Coli* and better anti-microbial activity against Gram negative *Klebsiella* sp. All the extracts of root and shoots showed anti-fungal effect against *Fusarium* species. While methanol extract was active against species of *Alternaria*. All the extracts showed anti-microbial activity significantly different from each other but the chloroform

extract of roots of chaff flower showed best anti-microbial and anti-fungal activity against tested micro-organisms. Anti-microbial activity was because of the presence of tannins, alkaloids and saponins [37].

4.2.4 Anti-Diabetic Activity

Chaff flower was being used to treat diabetes mellitus from the ancient times but there was no scientific evidence for its anti-diabetic activity [38]. Hence, to evaluate the efficiency of chaff flower against diabetes mellitus, ethanol extract was prepared and tested against alloxan induced diabetic Swiss albino mice. The level of blood glucose level was found to be increased by 123% and 128% on fifteenth and thirteenth day of exposure. From the result it was evident that ethanol extract of chaff flower show significant anti-diabetic activity [37].

4.2.5 Diuretic Activity

The acute toxicity profile and diuretic activity of chaff flower was determined by using Albino rats of either sex and were treated with the crude aqueous extract at different doses of 10, 30 and 50mg/kg by intra-peritoneal route respectively. The results of the experiments showed that chaff flower has significant diuretic effects. It also was evident from results that aqueous extract of chaff flower increase urine volume in a dose dependent manner [39].

4.2.6 Hepatoprotective Activity

By using carbon tetrachloride induced liver damage model in rats, ethanolic extract from seeds of *Achyranthes aspera* were tested for their possible hepatoprotective activity. Results demonstrated that there was significant inhibition in serum level in the rats treated with ethanolic extract of chaff flower (100mg/kg p.o) and results were same as of standard drug silymarin (100mg/kg p.o). This proved the efficiency of chaff flower in liver protection [40].

4.2.7 Antioxidant Activity

The unique health benefits of chaff flower are mainly due to its very high antioxidant agents. In the case of chaff flower, antioxidants (e.g. phytochemicals and vitamins) contribute to disease prevention. Along with many other herbal plants, the antioxidant ability of chaff flower was also evaluated in many experiments and findings demonstrated that the chaff flower show significant antioxidant potential. In an investigation the antioxidant ability of methanolic extract of roots and leaves of chaff flower was evaluated by and by using *in vitro* 1, 1-diphenyl-2-picrylhydrazyl (DPPH) scavenging assay. The findings testified chaff flower as antioxidant agent and phytochemicals responsible for this activity were flavonoids [41].

4.2.8 Anti-Inflammatory Effects

Acute inflammation is a normal, protective process that relieves the body to deal with infections, tissue injury and immune infections. Chaff flower has been used traditionally to treat inflammatory disorders since long ago. To evaluate the anti-inflammatory effect of chaff flower, many

investigations has been carried. In an investigation the ethanolic extracts of chaff flower at different doses of 50, 100 and 200mg/kg were tested for their efficiency against chronic inflammation induced in rats. Chaff flower stopped these inflammations at doses of 100-200 mg/kg. The findings demonstrated that chaff flower has significant anti-inflammatory effect [18]. Alcoholic extract of chaff flower was most active according to many reports [42].

4.2.9 Anti-Arthritic Activity

To evaluate the anti-arthritic activity of ethanolic extract of chaff flower, protein inhibition assay method was used. Different concentrations (10, 50, 100, 200, 400, 800, 1000 µg/ml) of ethanolic extract and diclofenac sodium were used in this experiment. The extracts showed significant anti-arthritic activity in comparison with standard drug diclofenac sodium at concentration of 800-1000 µg/ml. Findings of this investigation demonstrate that chaff flower show significant anti-arthritic activity. Tannins and flavonoids compounds are responsible for this activity [13].

4.2.10 Cardiovascular Disease

To evaluate the potential of chaff flower against heart disorders, effect of saponin of chaff flower was noted on phosphorylase activity of rat heart. Achyranthine, water soluble alkaloid showed lowering of blood pressure, depression of heart and increase in rate of respiration in anaesthetized dogs. Findings showed that chaff flower has significant cardiovascular activity [30].

4.2.11 Immuno-Modulatory Activity

The chaff flower has been reported to have immune-modulatory activity in many investigations. In an experiment, the extract of chaff flower was found to increase the induction of OVA-specific antibody response in a dose dependent manner. The hydro-alcoholic extract of chaff flower was reported to stimulate cell mediated immune system by increasing phagocytic function. The extracts of roots and seeds possess higher immune-modulatory activity [28].

4.2.12 Prothyroidic Activity

Leaf extracts of chaff flower were reported to have prothyroidic and anti-peroxidative properties. In rats, the plant extracts caused variation in thyroid hormone concentration and decrease hepatic lipid peroxidation. This activity of plant could be due to tannins and saponins present in seed of chaff flower [43].

5. Summary

Chaff flower (*Achyranthes aspera*) is an annual to perennial herb belonging to Amaranthaceae family. It has been used throughout the world from ancient times due to its medicinal importance. Phytochemical and pharmacological investigations carried out in the plant reveals its multidisciplinary usage. Presence of wide range of phytochemicals reveals its importance in medicine. Mostly chaff flower contains linalool, arachidic and behenic contents. The extent of these chemical constituents varies

depending upon the type of species or cultivars. It is an essential component of pharmaceutical industry. More uses and applications of chaff flower are continuously being added. Further research on extraction method of chaff flower oil and on its preservation method is needed, particularly in the developing world where it's harvesting and post-harvest methods are traditional. The pharmacological investigations performed on chaff flower must be extended to next level of clinical trial.

References

- [1] B. Baraik, P. Jain, H. Sharma. (2014). *Achyranthes aspera* L.: As a Source of Bio-fungicide. American Journal of Advanced Drug Delivery. 2(6): 686-696.
- [2] J. Gonsalvez, Integrated Community Food Production. A Compendium of Climate-resilient Agriculture Options. In 2016.
- [3] S. Srivastav, P. Singh, G. Mishra, K. Jha, R. Khosa. (2011). *Achyranthes aspera*-An important medicinal plant: A review. J Nat Prod Plant Resour. 1(1): 1-14.
- [4] Y.V. Rao, B. Das, P. Jyotirmayee, R. Chakrabarti. (2006). Effect of *Achyranthes aspera* on the immunity and survival of *Labeo rohita* infected with *Aeromonas hydrophila*. Fish & Shellfish Immunology. 20(3): 263-273.
- [5] R. Dastur. (1925). The Origin and Course of Vascular Bundles in *Achyranthes aspera*, L. Annals of Botany. 39(155): 539-545.
- [6] A. Dey. (2011). *Achyranthes aspera* L: phytochemical and pharmacological aspects. International journal of pharmaceutical sciences review and research. 9(2): 72-82.
- [7] B.R. Singh, S. Yadav, S. Singh, L. Brind. (2012). Pharmacognostic investigations of *Achyranthes aspera* Linn. International Journal of Ayurvedic Medicine. 2(4).
- [8] V. Sharma, U. Chaudhary, R. Singh, A. Agarwal. (2013). *Achyranthes aspera*: Phytochemical estimation. Am J Pharmtech Res. 3: 242-51.
- [9] R. Thangamani, P. Viji, B. Govindarajan. (2014). ANTIBODY RESPONSE OF *ACHYRANTHES ASPERA* LINN. TO *AEROMONAS HYDROPHILA* IN *OREOCHROMIS MOSSAMBICUS*. Asian Journal of Pharmaceutical Science & Technology. 4(4): 173-177.
- [10] V. Gupta, C. Krishna, P. Bansal, S. Kumar, G. Prasad. (2010). Phytochemistry and pharmacological potential of *Achyranthes aspera*-A review. International Journal of Ayurvedic Medicine. 1(1).
- [11] S. Hasan. (2014). Pharmacological and medicinal uses of *Achyranthes aspera*.

- [12] S. Jain, S. Kapoor. (2007). Divine botany-universal and useful but under explored traditions.
- [13] K. Sujatha, K. Kavitha, S. Manoharan. (2014). Assessment of invitro anti-arthritic activitiy of *Achyranthes aspera* linn.
- [14] P.S. Kumar, S. Sucheta, V.S. Deepa, P. Selvamani, S. Latha. (2008). Antioxidant activity in some selected Indian medicinal plants. African Journal of Biotechnology. 7(12).
- [15] R. Londonkar. (2011). Potential Antibacterial and Antifungal Activity of *Achyranthes aspera* L. Recent Research in Science and Technology. 3(4).
- [16] T.N. Misra, R.S. Singh, H.S. Pandey, C. Prasad, B.P. Singh. (1992). Antifungal essential oil and a long chain alcohol from *Achyranthes aspera*. Phytochemistry. 31(5): 1811-1812.
- [17] K.J. Singh, A.K. Thakur. (2014). Medicinal Plants of the Shimla hills, Himachal Pradesh: A Survey. International Journal of Herbal Medicine. 2(2 Part C): 118-127.
- [18] A. Gokhale, A. Damre, K. Kulkarni, M. Saraf. (2002). Preliminary evaluation of anti-inflammatory and anti-arthritic activity of *S. lappa*, *A. speciosa* and *A. aspera*. Phytomedicine. 9(5): 433-437.
- [19] A. ASPERA. ACHYRANTHES ASPERA: A POTENT IMMUNOSTIMULATING PLANT FOR TRADITIONAL MEDICINE.
- [20] R. Girach Aminuddin, S. Khan. (1992). Ethnomedicinal Uses of *Achyranthes sapera* L. in Orissa (India). International journal of pharmacognosy. 30(2): 113-115.
- [21] M. Alam, M. Karim, S.N. Khan. (2009). Antibacterial activity of different organic extracts of *Achyranthes aspera* and *Cassia alata*. Journal of scientific research. 1(2): 393-398.
- [22] R. Chakrabarti, R.Y. Vasudeva. (2006). *Achyranthes aspera* stimulates the immunity and enhances the antigen clearance in Catla catla. International Immunopharmacology. 6(5): 782-790.
- [23] W. Shibeshi, E. Makonnen, L. Zerihun, A. Debella. (2006). Effect of *Achyranthes aspera* L. on fetal abortion, uterine and pituitary weights, serum lipids and hormones. African health sciences. 6(2): 108-112.
- [24] V. Sharma, A. Agarwal, U. Chaudhary, M. Singh. (2013). Phytochemical investigation of various extracts of leaves and stems of *Achyranthes aspera* Linn. Int J Pharm Pharm Sci. 5(Suppl 1): 317-20.
- [25] C. Priya, G. Kumar, L. Karthik, B.R. KV. (2012). Phytochemical composition and in vitro antioxidant activity of *Achyranthes aspera* Linn (Amaranthaceae) leaf extracts. Journal of Agricultural Technology. 8(1): 143-156.
- [26] W. Shibeshi, E. Makonnen, A. Debella, L. Zerihum. (2006). Phytochemical, contraceptive efficacy and safety evaluations of the methanolic leaves extract of *Achyranthes aspera* L. in rats. Pharmacologyonline. 3: 217-224.
- [27] H. Kumar, D. Singh, S. Kushwaha, A. Gupta. (2009). Comparison of leaf and root extract of *Achyranthes aspera* for its analgesic activity. Der Pharmacia Lettre. 1(2): 193-198.
- [28] R.Y. Vasudeva, G.R. Duddukuri, B.G. Sunil, R.R. Athota. (2002). Immunomodulatory activity of *Achyranthes aspera* on the elicitation of antigen-specific murine antibody response. Pharmaceutical Biology. 40(3): 175-178.
- [29] A. Amuamuta, Z. Mekonnen, E. Gebeyehu. (2015). Traditional therapeutic uses and phytochemical screening of some selected indigenous medicinal plants from Northwest Ethiopia. African Journal of Pharmacology and Therapeutics. 4(3).
- [30] A. Bagavan, A.A. Rahuman, C. Kamaraj, K. Geetha. (2008). Larvicidal activity of saponin from *Achyranthes aspera* against *Aedes aegypti* and *Culex quinquefasciatus* (Diptera: Culicidae). Parasitology research. 103(1): 223-229.
- [31] U.A. Bhosale, R. Yegnanarayan, P. Pophale, R. Somani. (2012). Effect of aqueous extracts of *Achyranthes aspera* Linn. on experimental animal model for inflammation. Ancient science of life. 31(4): 202.
- [32] K.K. Mishra, H.J. Dhongade, N.B. Banarase, D.S. Rajput. (2012). Evaluation of antifungal activity of roots of *Achyranthes aspera* for ring worm infection. International Journal of Herbal drug research. 1(3): 4-7.
- [33] N. Gupta, U.K. Jain. (2011). Wound healing potential of methanolic extract of leaves of *Achyranthes aspera* Linn. Der Pharmacia Sinica. 2(2): 256-262.
- [34] S. Shakeel, A.K. Sharma, M. Sohail, V. Sharma. (2015). ACHYRANTHES ASPERA HAVE THE POTENTIAL ANTIOXIDANT PROPERTY IN SCAVENGING FREE RADICALS PRODUCED AS A RESULT OF OXIDATIVE STRESS INDUCED BY ARSENIC.
- [35] C.L. Priya, G. Kumar, L. Karthik, K. Bhaskara Rao. (2010). Antioxidant activity of *Achyranthes aspera* Linn stem extracts. Pharmacologyonline. 2(2): 228-237.
- [36] P.R. Subbarayan, M. Sarkar, S. Impellizzeri, F. Raymo, B.L. Lokeshwar, P. Kumar, R.P. Agarwal, B. Ardalan. (2010). Anti-proliferative and anti-cancer properties of *Achyranthes aspera*: specific

- inhibitory activity against pancreatic cancer cells. *Journal of ethnopharmacology*. 131(1): 78-82.
- [37] M. Kaur, Y. Thakur, R. Rana. (2005). Antimicrobial properties of *Achyranthes aspera*. *Ancient science of life*. 24(4): 168.
- [38] K.C. Naidu. (2003). Antidiabetic plants in India and herbal based antidiabetic research. Daya Books: pp.
- [39] M. Asif, Q. Jabeen, M. Atif, A.M.S.A. Majid, M. Qamar-Uz-Zaman. (2014). Diuretic Activity of *Achyranthes aspera* Linn Crude Aqueous Extract in Albino Rats. *Tropical Journal of Pharmaceutical Research*. 13(12): 2039-2045.
- [40] B. Manjunatha, N. Abhilash, V. Hegde, M. Suchitra, S. Vidya. (2012). Hepatoprotective potency of *Achyranthes aspera*: An in-vivo study. *International Journal of Pharmaceutical and Phytopharmacological Research*. 1(1): 387-390.
- [41] A. Beaulah, M. Sadiq, J. Santhi. (2011). Antioxidant and antibacterial activity of *Achyranthes aspera*: An in vitro study. *Annals of Biological Research*. 2(5): 662-670.
- [42] T. Vetrichelvan, M. Jegadeesan. (2003). Effect of alcohol extract of *Achyranthes aspera* Linn. on acute and subacute inflammation. *Phytotherapy research*. 17(1): 77-79.
- [43] A.V. Khan, A.A. Khan. (2005). Ethnomedicinal Uses of *Achyranthes aspera* L. (Amarantaceae) in Management of Gynaecological Disorders in Western Uttar Pradesh (India). *Ethnobotanical Leaflets*. 2005(1): 11.