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Review

Bidens pilosa L.: Agricultural and pharmaceutical importance

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Bidens pilosa **is a cosmopolitan, annual herb which originates from tropical and Central America. Its hardiness, explosive reproductive potential, and ability to thrive in almost any environment have enabled it to establish throughout the world. Generally introduced unintentionally through agriculture or sometimes intentionally for ornamental purposes, *B. pilosa* is a major crop weed, threat to native fauna, and a physical nuisance. It is considered one of the most noxious annual weeds in East Africa. *B. pilosa* had strong allelopathic effects which is beneficial in enhancing its capacity in interspecific competition and to promote its invasion. It is used as a folkloric medicine for the treatment of various diseases and used extensively by indigenous people, especially in Africa, for the treatment of a variety of ailments. Various compounds with biological activity, mainly, polyacetylenes and flavonoids have been isolated and identified in all parts of the plant. Pharmacognostic studies and phytochemical screenings of *B. pilosa* had also shown the presences of other compounds with biological activities which include terpenes, essential oils, tannins, polysaccharides, phenols, amino acids, ascorbic acid and organic acids. These plants are ingested as decoctions, teas and juice preparations to treat respiratory infections as well as various other ailments. Aqueous extract of the leaves is used by the Zulu tribe in South Africa for treating dysentery, diarrhea and colic. Juice preparations are also made into a poultice and applied directly on the infected wounds or burns. The widespread use of *B. pilosa* both in Africa and the rest of the world indicate that this plant may yield valuable drugs to treat a variety of different ailments such as malaria. Although considered an invader in many countries, the potential benefit may outweigh the risks that the weed poses to the environment.**

Key words: *Bidens pilosa*, medicinal properties, black jack.

INTRODUCTION

Wildlife of flora is a gem of different plant species which is of immense significance to humans globally. Holmstedt (1991) noted that there is an increasing desire in the use of herbs in the living hood set-ups. Benli et al. (2008) stated that the world is trying to keep away from synthetic drugs and as a result natural products from several plant species have been isolated. There are 200 species of weeds in South Africa. These non-native invasive plant species labeled as exotic pest plants and invasive exotics grow in native plant communities. Among such plants is the genus *Bidens* (Asteraceae: Heliantheae) that comprises about 240 species and that is known for its invasive nature. *Bidens pilosa* L. is one of the species that stands out in this genus due to the many natural characterized products and the biological activities reported from its extracts, fractions and compounds (Lima et al., 2011).

Origin and geographic distribution

Bidens pilosa is a cosmopolitan weed, originating from South America and common in all tropical and subtropical areas of the world climates (Geissberger and Séquin, 1991; Alvarez et al., 1999). Its hardiness, explosive

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reproductive potential, and ability to thrive in almost any environment have enabled it to establish throughout the world. Generally introduced unintentionally through agriculture or sometimes intentionally for ornamental purposes, *B. pilosa* is a major crop weed, threat to native fauna, and a physical nuisance.

In Africa, *B. pilosa* is recorded as a weed in many countries and it is likely to occur in all countries, including the Indian Ocean islands. It is reported as a vegetable or potherb, among others, in Sierra Leone, Liberia, Côte d' Ivoire, Benin, Nigeria, Cameroon, Democratic Republic of Congo, Kenya, Uganda, Tanzania, Malawi, Botswana, Zambia, Zimbabwe and Mozambique (Karis and Ryding, 1994). *B. pilosa* is a weed in both field and plantation crops and is recorded as troublesome in about 30 crops in more than 40 countries, including about 20 African countries. It is considered one of the most noxious annual weeds in East Africa (Grombone-Guaratini et al., 2005). It often becomes dominant after the eradication of perennial grasses, and displays allelopathic effects on a number of crops (Lima et al., 2011).

Although the plant is an invader and is generally regarded as a nuisance in most countries outside South America, it may possess medicinally importance compounds that can be used to treat a variety of ailments. The medicinal role of *B. pilosa* will be discussed as well as determining whether the medicinal importance outweighs the detrimental role that this plant plays in the environment. In many resource poor countries, financial constraints prevent effective management of the environment. However, the medicinal role of weeds such as *Bidens* may curtail its spread and help to limit its effect on pristine ecosystems.

METHODOLOGY

Most of the literature was based on secondary sources and information was gathered from the internet as well as from relevant case studies. In all instances, work was duly acknowledged. Information regarding the economic implications of *B. pilosa* was carefully studied in order to give a balanced perspective of the weed. Case studies dealing with antibacterial and antifungal effects were carefully studied as well as articles dealing with the detection of compounds from crude extracts of the plants. These themes were broadly classified under agricultural and pharmaceutical importance and dealt with at length. Content analysis and discourse analysis were therefore used as methods of analysis as the work was secondary data based and qualitative in nature.

Sampling and interview of traditional healers

Due to the low education level or lack of understanding of English of most traditional healers, structured questionnaires based on the use of *B. pilosa* were discussed on an individual basis and explained by an interpreter. The results were then transcribed by the interpreter as some traditional healers could not write.

Common names and uses of *B. pilosa*

B. pilosa is known by various names in different countries (Table 1). It is used as a folkloric medicine for the treatment of various diseases (Horiuchi and Seyama, 2006) and used extensively by indigenous people, especially in Africa, for the treatment of a variety of ailments (Table 2). *B. pilosa* showed negative results in the bacterial reverse mutation test, suggesting that it is potentially safe to use as medicinal plant supplements even at high doses (Hong et al., 2011). A study carried out to examine the possibility of using *B. pilosa* for weed and plant fungus control suggested that the wide distribution of the plant might be due to its antifungal activity against phytopathogens (Deba et al., 2007; Strobel, 2003).

Carotinoids have been detected in the seeds (Kiokias and Gordon, 2003). The dried aerial parts of *B. pilosa* L. were extracted with petrol ether, chloroform, methanol, and methanol/water. The petrol ether and the methanol/water extracts showed some antimicrobial activity. Fractionation of the extracts yielded well known substances, most of which have, however, not yet been described as constituents of *B. pilosa* (Geissberger and Séquin, 1991). The detection of these compounds in extracts from *B. pilosa* may rationalize the use of this plant in traditional medicine in the treatment of wounds, against inflammations and bacterial infections of the gastrointestinal tract. An endophytic fungus (*Botryosphaeria rhodina*) that is known for its anti-inflammatory, antiseptic and antifungal effects was isolated from the stems of the *B. pilosa*. Additionally, endophytes have been recognized as a prolific source of a wide array of new pharmacologically active secondary metabolites that might prove suitable for specific medicinal or agrochemical applications (Strobel and Daisy, 2003).

Livestock browses on the plants in many parts of Africa and in South Africa *B. pilosa* has been used as a fodder for pigs. However, dairy cattle are discouraged from browsing on it because the aromatic oil present in the plant has an objectionable smell that can taint milk. Consumption of the leaves, as in South Africa, has been found to promote the development of oesophageal cancer, and dried leaves of *B. pilosa* have a co-carcinogenic action for oesophageal tumors induced in rats.

In addition to the acetylenes, other compounds such as phytosterols (β-sitosterol), triterpenes (friedelin and friedelan-3β-ol) and caffeic acid(s) are also reported from *B. pilosa* (www.database.prota.org). The main flavonoids from leaf extracts are aurones and chalcones. Since

Table 1. Common names of *B. pilosa* in different countries.

Species	Common name	Country
Bidens pilosa	Kinehi / Ko'oko'olau	Hawaii
	Xian Feng Cao ("Abundant Weed"), Gui Zhen Cao ("Demon Spike Grass" or "Ghost Needle Weed")	China
	Amor Seco	Peru
	Beggars Tick / Spanish Needle / Needle Grass	United States of America
	Black Jack	South Africa
	Cobblers Peg, Farmer's Friend	Australia
	Fisi 'Uli	Tonga
	Has Kung Chia, Han Feng	Taiwan
	Ottrancedi	India
	Picao preto, Cuamba	Brazil
	Piripiri	Cook Islands
	Sanana Vinillo, Saytilla, Natilluna	Bolivia
	Spanish Needle, Needle Grass	Barbados
	Z'Herbe Zedruite	Caribbean
	Te de Coral	Mexico
	Z'Herbe Zedruite, Z'Herbe Z'Aiguille	Dominican Republic
	Fisi'uli [Tonga]	Tonga
	Uqadolo	southern Africa

friedelin and friedelan-3β-ol, as well as several flavonoids have anti-inflammatory properties, their detection in extracts from *B. pilosa*, together with the presence of the described acetylenes, may explain the use of *B. pilosa* in traditional medicine, especially for treating wounds, against inflammations and against bacterial infections of the gastrointestinal tract (www.database.prota.org).

Agricultural benefits

B. pilosa had strong allelopathic effect which is beneficial in enhancing its capacity in interspecific competition and to promote its invasion (Mao et al., 2010). Aqueous extracts of *B. pilosa* with low concentrations of up to 20 mg/ml had some facilitating effect on bud growth of pasture *Trifolium repens* and *Medicago sativa*, while high concentrations of 100 mg/ml or greater had a considerable inhibitory effect on seed germination and seedling growth. The allelopathic inhibitory effects generally increase with the increase of concentrations (Mao et al., 2010). Cui and He (2009) reported that soil biota and nutrient availability are drivers of the plant invasions. *B. pilosa* was observed to grow better in rich soil from under shrubs than in poor soil from spaces between the shrubs. Sterilization had greater negative effects on the growth of *B. pilosa* than *Saussurea deltoidea* indicating that mutualists appear to have stronger effects on the invasive than on the native plant. In contrast, *B. pilosa* had greater total biomass in non-sterile shrub soil than in non-sterile gap soil. The indication was that positive invasive capacity of *B. pilosa* is due to the effect of soil biota thus its habitat association seems to be closely linked to soil biota, but not soil nutrients. Antifungal activity against a range of pathogenic fungi such as *Aspergillus terreus* (MIC 26.03 lM for botryorhodine A and 49.70 lM for B) and the plant pathogen *Fusarium oxysporum* (MIC 191.60 lM for botryorhodine A and 238.80 lM for B) had been noted (Abdou et al., 2010).

Pharmaceutical benefits

In developing countries particularly, in Colombia, low income group such as farmers, people of small isolated villages and native communities use *B. pilosa* for treating common infections. These plants are ingested as decoctions, teas and juice preparations to treat respiratory infections (Gonzalez, 1980). They are also made into a poultice and applied directly on the infected wounds or burns (Rojas et al., 2006). It is use as pain killer in Brazil and the Chinese use it for tea and for treating conditions such as diabetes, inflammation, enteritis, dysentery and pharyngitis, diuretic and anti-rheumatic (Brandão et al., 1997; Brandão et al., 1998,

Table 2. Uses of *B. pilosa* in Africa (modified from Pozzi, 2010).

Country	Plant part/preparation	Treatment
Uganda	Crushed leaves	Blood clotting agent
	Leaf decoction	Headache
	Crushed leaves	Ear infection
	Decoction of leaf powder	Kidney problems
	Herbal tea	Flatulence
Zimbabwe (Manyika)	Leaf tea	Stomach/mouth ulcers
		Diarrhea
		Headaches
		Hangovers
South Africa (Zulu)	Suspension of powdered leaves	Enema for abdominal pain
	Concoction of leaf	Arthritis/ malaria
Congo	Concoction of whole plant	Poison antidote
		Ease child delivery
		Relieve pain from hernia
Cote d' Ivoire	Crushed leaves	Jaundice/dysentery
Tanzania	Leaf sap	Burns
Nigeria	Powder from seeds	Anesthetic
Kenya (Giriama)	Leaf extract	Swollen spleens
	Ground leaves	Insecticides
		Colds/flu
		Urinary tract infections
		Infected wounds of skin
		Upper respiratory tract infections

Valdés and Rego, 2001). The boiling water extract of the aerial parts of *B. pilosa* in Japan has anti-inflammatory and anti-allergic properties (Horiuchi and Seyama, 2006). Aqueous extract of the leaves is used by the Zulu tribe in South Africa for treating dysentery, diarrhea and colic (Rabe and van Staden, 1997).

Various compounds with biological activity, mainly, polyacetylenes and flavonoids have been isolated and identified in all parts of the plant (Brandão et al., 1997; Isakova et al., 1986; Geissberger and Séquin, 1991; Sarg et al., 1991; Alvarez et al., 1999). The flavonoids from various species of the genus *Bidens*, including *B. pilosa*, are mainly aurones and chalcones (Sashida et al., 1991). For the polyacetylenes, 1-phenylhepta-1,3,5-tryine has been the principal representative of this group of compounds. It is claimed that antimicrobial, antihelmintic and protozoocidal activities shown by different extracts of *B. pilosa* is due to its content of polyacetylene *(*Bondarenko et al., 1985; Geissberger and Séquin, 1991). The ethylacetate extract of the fungal isolate exhibits significant antifungal activity as well as potent cytotoxic and antiproliferative effects against several cancer cell lines (Abdou et al., 2010). Four complex depsidones, botryorhodines A–D and the auxin indole carboxylic acid were isolated. Botryorhodine A and B showed moderate to weak cytotoxic activities against HeLa cell lines with a CC50 of 96.97 lM and 36.41 lM, respectively.

B pilosa var. *radiate* Schult.Bip. is used to treat stomach disorders including peptic ulcers. The ethanolic extract (0.5 to 2 g/kg) decreased the gastric juice volume, acid secretion, as well as pepsin secretion in pylorus ligated rats. *B. pilosa* extract showed antiulcer activity against indomethacin-induced gastric lesions. The extract effectively inhibited gastric haemorragic lesions induced by ethanol, and with an effective dose of 2 g/kg being more potent than sucralfate (400 mg/kg). In contrast, ranitidine (50 mg/kg) failed to reduce these lesions.

These results indicated that *B. pilosa* ethanolic extract exerts a cytoprotective effect in addition to its gastric antisecretory activity that could be due, partly to the presence of flavonoids, of which quercetin, was identified by HPLC (Alvarez et al., 1999). A new compound, heptanyl 2-*O*-β-xylofuranosyl-(1→6)-β-glucopyranoside (1), and eight phenolic compounds, namely quercetin 3-*O*-rabinobioside (2), quercetin 3-*O*-rutinoside (3), chlorogenic acid (4), 3,4-di-*O*-caffeoylquinic acid (5), 3,5-di-*O*-caffeoylquinic acid (6), 4,5-di-*O*-caffeoylquinic acid (7), jacein (8), centaurein (9) were for the first time isolated from *B. pilosa*. Compounds 2 to 7 are the major antioxidative constituents in the *B. pilosa* extract (Yi-Ming et al., 2004). Using a modified agar well diffusion method, water extracts of *B. pilosa* L. showed a higher activity against *Bacillus cereus* and *Escherichia coli* than gentamycin sulfate and the ethanol extract was active against *Staphylococcus aureus* (Rojas et al., 2006). The ethanol extract of the leaves of *Bixa orellana* possesses antimicrobial activity against Gram (+) microorganisms and *C. albicans* (Fleischer et al., 2003). Pharmacognostic studies and phytochemical screenings of *B. pilosa* had shown the presences of other compounds with biological activities which include terpenes (Geissberger and Séquin, 1991; Zuluetac et al., 1995) essential oils (Deba et al., 2008) tannins, polysaccharides, phenols, amino acids, ascorbic acid, organic acids and polyacetylenes (Pozharitskaya et al., 2010).

The increasing prevalence and distribution of malaria has been attributed to a number of factors, one of them being the emergence and spread of drug resistant parasites. It is estimated that there are at least 300 million clinical cases of malaria per annum, making it one of the top three killers among communicable diseases (WHO, 2003). Despite intensive efforts to control malaria, the disease continues to be one of the greatest health problems facing Africa (Ridley, 2002). Although a number of advances have been made towards the understanding of the disease, relatively few antimalarial drugs have been developed in the last 30 years. Efforts are now being directed towards the discovery and development of new chemically diverse antimalarial agents (Ridley, 2002). Since the treatment and control of malaria depends largely on a limited number of chemo-prophylactic and chemotherapeutic agents, there is an urgent need to develop novel, affordable antimalarial treatments. This urgency has been further highlighted by the increasing prevalence of drug resistant strains of the malaria parasite *Plasmodium falciparum*, which have contributed to the escalating disease load (Clarkson et al., 2004). The leaves have also been used to treat malaria and leishmaniasis (Irobi et al., 1996). The ethanolic crude extract from the roots of *B. pilosa* contain polyacetylenes and flavonoids that exert *in vitro* anti-malarial activity against *Plasmodium falciparum* (Oliveira et al., 2004). Therefore, it is possible that with further developments, future anti-malarial drugs containing extracts from *B. pilosa* may become available to treat communities in Africa.

The widespread use of *B. pilosa* both in Africa and the rest of the world indicate that this plant may yield valuable drugs to treat a variety of different ailments including malaria. Although considered an invader in many countries, the potential benefit may outweigh the risks that the weed poses to the environment. Ethanolic extracts have demonstrated both antibacterial and antifungal activity as well as potent cytotoxic and anti-proliferative effects. Various polyacetylenes and flavonoids that have been isolated have shown to possess antimicrobial, antihelmintic and protozoocidal activities. The wide spread use of the plant by indigenous communities for treating a variety of ailments implied that medicinal knowledge regarding Bidens has been passed down from generation to generation. However, further studies, especially cytotoxicity testing may be needed to determine the full potential of this valuable medicinal plant.

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