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REVIEW ARTICLE

Medicinal importance of *Ajuga bracteosa* Wall ex Benth. – A Review

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Abstract

The genus *Ajuga* has great medicinal and economic importance. *Ajuga bracteosa* has anti-microbial, anti-tumor, anti-inflammatory, anti-plasmodial, antipyretic, anti helmenthic, anti-malarial, hepatoprotective, immunomodulatory, cytotoxic, and insect-antifeedant properties. A large variety of compounds have so far been isolated from *Ajuga bracteosa*.

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Introduction

Plant resources not only provide materials for survival, medicinal and forage values, but also possess and preserve cultural heritages, biological information and indigenous knowledge (Morgan, 1981; Hameed *et al.*, 2011). Medicinal plants constitute the basis of primary health care for the majority of the population in Asia and are a critical source of income for rural populations. Bioactive compounds currently extracted from plants are used as pharmaceuticals, agrochemicals, flavour and fragrance ingredients, food additives, and pesticides. Studies have suggested that the antimicrobial activity of plants is particularly related to the chemical composition of their essential oils (Angeline *et al.*, 2006; Mothana *et al.*, 2010, 2011; Polatoglu *et al.*, 2010).

Ajuga bracteosa is an important medicinal plant which belongs to the family Lamiaceae and tribe Ajugeae. *Ajuga bracteosa* is commonly known as “bungle” in English and “Jan-i-adam” in Kashmiri. It is a perennial erect or ascending hairy herb, often prostrate with oblanceolate or sub-spathulate leaves and grows up to 5-50cm tall. It is distributed in subtropical and temperate regions from Kashmir to Bhutan, Pakistan, Afghanistan, China, Malaysia, western Himalayas, plains of Punjab and upper gangetic plains of India (Khare, 2007) at an altitude of 1300m. In India, it abounds in western Himalaya at an altitude of 1300m (Chandel and Bagai, 2010). It is found along roadsides, open slopes, and rock cervices up to 1500m above mean sea level (Chauhan, 1999; Upadhyay *et al.*, 2011).

A large variety of compounds have so far been isolated from *Ajuga bracteosa*. *Ajuga bracteosa* afforded five compounds including one new clerodane diterpenoid designated as Bracteonin-A 6 f -acetoxy, 15 -methoxy, 18-(4'-hydroxy, 3'- g -methyl, 3'- f -acetoxy, butyryloxy) neoclerodane. The other compounds identified were 14, 15-dihydroajugapitin, 14-hydro-15-hydroxy ajugapitin, g -sitosterol, and stigmasterol. (Verma *et al.*, 2002; Riaz *et al.*, 2007; Upadhyay *et al.*, 2011).

Riaz *et al.*, 2004; Upadhyay *et al.*, 2011 carried out Phytochemical studies on *Ajuga bracteosa* which results in the isolation and structure elucidation of withanolides .Withanolides posses both immunosuppressive and immunomodulatory properties. 8 -o acetylharpagide was isolated and characterized from *Ajuga bracteosa* .pharmacological screening of this compound for antibacterial, antifungal, antispasmodic activities was carried out (Shafi *et al.*, 2004; Chandel and Bagai, 2010).The compound was found effective against a number of human pathogenic bacteria and fungi.

1, 2-benzenedicarboxylic acid bis (2s-methyl heptyl) ester was isolated from hexane extract of the whole plant of *Ajuga bracteosa* (Singh *et al.*, 2006).

Riaz *et al.*, 2007; Israili and Lyoussi, 2009 isolated Bractin A, bractin B and bractic acid from *Ajuga bracteosa*. These compounds showed their inhibitory potential against enzyme lipoxygenase. Effect of *Ajuga bracteosa* on blood sugar level and its possible use as a substitute for oral hypoglycemic drugs was carried out (Gupta *et al.*, 2008). *Ajuga bracteosa* contains fiber and antioxidants which play a very important role in controlling diabetes and hypertension (Ziyyat *et al.*, 1997; Jouad *et al.*, 2001; El-Hilaly *et al.*, 2003; Eddouks *et al.*, 2007; Pawar *et al.*, 2011).

Ethanol leaf extract of medicinal plant *Ajuga bracteosa* shows antiplasmodial activity (Chandel and Bagai, 2010). This extract was found to exert significant *in-vitro* antiplasmodial activity against *plasmodium berghei* infected BALB/C mice. Investigators report that the herb possesses anti-malarial activities (Njoroge and Bussmann 2006; Kuria *et al.*, 2001, 2002). It could be an alternative to Artemisia (Srivastav *et al.*, 2013). *In vitro* evaluation of antihelminthic efficacy of *Ajuga bracteosa* on *Ascaridia galli* (a poultry worm) has been studied by Agarwal *et al.*, 2010.

Pawar *et al.*, 2011 carried out Phytochemical investigations of *Ajuga bracteosa* which led to the isolation of a large number of compounds from *Ajuga bracteosa* including glycoside, tannins, ceryl alcohol and cerotic acid. Clerdone diterpenoid is the compound isolated from the bark of the plant. Roots of the *Ajuga bracteosa* contains steroids, palmitic acid and hepatacos -3-ene-5 one. Extract from the plant *Ajuga bracteosa* inhibited the development of CCl₄-induced liver fibrosis in rat (Hsich *et al.*, 2011).

Studies were carried out to investigate the analgesic activity of *Ajuga bracteosa* (Pawar *et al.*, 2011). Aerial part of *Ajuga bracteosa* was extracted with petroleum ether, chloroform, methanol and water. Analgesic activity of these extracts was assessed in Swiss albino mice with acetic acid induced withering test and tail immersion test. Among these extracts chloroform and water extract showed significant analgesic activity.

Vohra *et al.*, 2011 carried out the analysis of chemical composition of essential oil from the leaves of *Ajuga bracteosa*. Main components present in essential oil of leaves are limonene, α -humulene, β -myrcene, elemol, camphene, β -caryophellene, α -phellendrene the various constituents of essential oil and their percentage were examined by gas chromatography and gas chromatography mass spectrometry (gc/ms). Different neo-clerodane diterpenoids were isolated from different species of *Ajuga* (Arfan *et al.*, 1996; Coll *et al.*, 2007; Coll and Tandron, 2008; Castor *et al.*, 2011).

The root of *Ajuga bracteosa* is used in conjunctivitis of newborns in malaria (Upadhyay *et al.*, 2011), as antidote to snake bites (Vohra and Kaur, 2011), for purification of blood, as an anthelmintic (Agarwal *et al.*, 2010) and purgative. *Ajuga bracteosa* is used in the treatment of fever, bronchitis, pneumonia, agues, diarrhea, jaundice, rheumatism, gout, palsy and amenorrhoea (Kartikar and Basu, 1918; Manjunath, 1948; Chopra *et al.*, 1986; Manandhar, 2002; Sharma *et al.*, 2004, Islam *et al.*, 2006.) It is also used for the treatment of burns boils and syphilis (Johnson, 1999; Sharma *et al.*, 2004)

A. bracteosa contains compounds of the class diterpenoids and withasteroids, which are a group of naturally occurring C₂₈ steroidal lactones, built on an intact or rearranged ergostane framework (Vohra and Kaur, 2011; Upadhyay *et al.*, 2011). Withasteroids exhibit a number of biological activities such as anti-microbial, anti-tumor, anti-inflammatory, hepatoprotective, immunomodulatory, cytotoxic, and insect-antifeedant properties.

Hussain *et al.*, 2012 discovered a new phenolic compound from *Ajuga bracteosa* termed as ajuganane. Ajuganane was extracted from the crude methanol extract of *Ajuga bracteosa*. Antiarthritic activity of 70% ethanolic extract of *Ajuga bracteosa* was evaluated (Kaithwas *et al.*, 2012) against turpentine oil and formaldehyde induced acute non-immunological and complete Freund's adjuvant induced chronic immunological arthritis in albino rats. The acute inflammatory response in the knee joint of rat induced by turpentine oil was checked by ethanolic extract of *Ajuga bracteosa* in a dose dependent manner.

Inflammation is a response of living tissue to injury that leads to accumulation of plasma and blood cells. Recently, it has been investigated that *Ajuga bracteosa* contains withanolides which are responsible for anti-inflammatory activity by inhibiting Cyclooxygenase (COX) enzyme which is essential for prostaglandin synthesis and further inflammation (Singh *et al.*, 2012, Upadhyay *et al.*, 2011). Methanolic extract of *Ajuga bracteosa* has significant anti-inflammatory property at various concentrations.

Flowers of *Ajuga bracteosa* contain higher amounts of phenolic compounds, flavonoids and tannins. Phenolic compounds are of considerable importance in areas of food and medicine owing to their anti-oxidant capacity. It has been investigated that phenolic compounds of *Ajuga bracteosa* are powerful free radical scavengers of DPPH (1,1-diphenyl-2-picrylhydrazyl) radical (Chao *et al.*, 2012). Flavonoids-a major class of natural products are having a wide spread distribution in fruits, vegetables, spices and food stuffs for their antiproliferative activity. It has been investigated that antiproliferative activity of *Ajuga bracteosa* is due to its flavonoid content (Chao *et al.*, 2012).

Essential oils from the aerial part of *Ajuga bracteosa* were obtained by hydrodistillation and analysed by gas chromatography and gas chromatography mass spectrometry (Mothana *et al.*, 2012). Oil from *Ajuga bracteosa*

contain a high content of aliphatic acids (30.3%) Borncol (20.8%) and hexadecanoic acid (16.0%). The essential oil possesses antimicrobial activity.

A study on *in vivo* antinoceptive activity of *Ajuga bracteosa* was carried out (khatri *et al.*, 2013). Methanolic extract of the plant was investigated for its antinoceptive activity.

Discussion

The aim of the present review is to present comprehensive information about the medicinal importance of *Ajuga bracteosa*. Studies have shown that the essential oil, as well as their active principles possess several pharmacological properties like anti-microbial, anti-tumor, anti-inflammatory, anti-plasmodial, anti-helmenthic, antipyretic, hepatoprotective, immunomodulatory, cytotoxic, and insect-antifeedant ones. A large variety of compounds have so far been isolated from *Ajuga bracteosa* including essential oils, phenolic compounds, flavonoids and tannins. Main components present in essential oil of leaves are limonene, α -humulene, β -myrcene, elemol, camphene, β -caryophellene, α -phellendrene (Vohra *et al.*, 2011). *Ajuga bracteosa* has important biological activities and acts against different types of diseases. The present literature study further reveals that the biological properties of the *Ajuga bracteosa* are not only due to their essential oils and their main compounds such as limonene, α -humulene, β -myrcene, elemol, but also to the other polar constituents acting synergistically or possessing different biological activities.

Conclusion

The synthesis of medicinally important biochemical compounds by *Ajuga bracteosa* has been established beyond doubt. The plant species is used both in allopathic and traditional system of medicine as a remedial measure for number of ailments. Mechanisms of action of a few bioactive compounds have been identified so far. Hence, extensive research is required to find out the mechanisms of action as well as bioactivity of other compounds in crude extracts and to exploit their therapeutic potential to combat various diseases.

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