A Comprehensive Review on Phytochemistry of *Ageratum conyzoides* linn. (Goat weed)

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**ABSTRACT**

In the present review, an attempt has been made to congregate the phytochemical studies done on an important medicinal plant, *Ageratum conyzoides* Linn. (Family Asteraceae) which is widely spread all over the world, especially in the tropical and subtropical region. Phytochemical investigations have revealed that many components are bioactive due to the presence of broad range of secondary active metabolites such as terpenoids, flavonoids, alkaloids, steroids, and chromene. The plant has been examined on the basis of the scientific in vitro, in vivo or clinical evaluations possessing the major pharmacological activities that includes analgesic activity, antimicrobial activity, anti-inflammatory activity, spasmolytic effects, gamma radiation effects, anti cancer and radical scavenging activity, antimalarial activity and others activities. The information summarized here is intended to serve as a reference tool to practitioners in the fields of ethnopharmacology, natural product chemistry and drug discovery related research.

**KEYWORDS** - Alkaloids, Terpenes, Flavonoids, Phytochemistry, Steroids

**1. INTRODUCTION:**

Since ancient times plants are used as rich source of medicine. Scientific exploration of traditional knowledge of use of herbs in treatment of various ailments is one of the thrust areas of research. Herbal medicines are in great demand in the developed as well as developing countries for primary healthcare because of their wide biological and medicinal activities, higher safety margins and lesser costs. The genus *Ageratum* is derived from the Greek words ‘a geras’ meaning non-aging which refers to long life-time of plant and the species epithet ‘konyz’ is the Greek name of *Inula helenium* which resembles the plant. *Ageratum conyzoides* Linn. (Family Asteraceae, Tribe Eupatoriae) is an annual herb with a long history of traditional medicinal use in the tropical and subtropical regions of the world, commonly known as Billy goat weeds. The stems and leaves of the plant are covered fully with fine white hairs.

It is an annual branching herb which grows to approximately 1 m in height. The stems and leaves are covered with fine white hairs, the leaves are ovate and up to 7.5 cm long. The flowers are purple to white, less than 6 mm across and arranged in close terminal inflorescences. The fruits are achene and are easily dispersed. The plant grows commonly in the proximity of habitation, thrives in...
any garden soil and is very common in waste places and on ruined sites. It has a peculiar odor likened in Australia to that of a male goat and hence its name ‘goat weed’ or ‘billy goat weed’.

2. PHARMACOGNOSY OF AGERATUM CONYZOIDES

SYNONYMS

TAXONOMICAL CLASSIFICATION
- Kingdom: Plantae
- Subkingdom: Angiosperm
- Class: Eudicots
- Order: Asterales
- Family: Asteraceae
- Genus: Ageratum
- Species: conyzoides
- Binomial name: Ageratum conyzoides Linn.

3. PHYTOCHEMISTRY OF AGERATUM CONYZOIDES

3.1 Monoterpenes and sesquiterpenes
So far, a total of 51 constituents have been reported from the analysis of the Ageratum oil sample from Nigeria as the highest which include 20 monoterpenes (6.6%) of which 1% of it contains sabinene, 1.6% contains β-pinene and β-phellandrene, 2.9% contains 1.8-cineole and limonene, 0.6% contains terpenen-4-ol and 0.5% contains α-terpineol and further found 20 sesquiterpenes (5.1%) and that of single substance were found to be in traces approximately 0.1%. Indian Ageratum oil is found to contain 5.3% ocimene which was found in traces from Nigerian plant, 6.6% α-pinene, 4.4% eugenol and 1.8% methyleugenol (Rao and Nigam, 1973). The major sesquiterpenes are beta-caryophyllene, 1.9 to 10.5% from an oil sample obtained from Cameroon and 14 to 17% in a Pakistani oil sample. Another sesquiterpene, δ- cadinene occurred in approximately 4.3% in the oil received from Indian plants (Rao and Nigam, 1973). Sesquiphellandrene and caryophyllene epoxide have been obtained in 1.2 and 0.5%, respectively from leaves (Ekundayo et al., 1988). The summary is as shown in Table 1.

3.2 Benzofuran, chromene, chromone and coumarin
Precocene I (Figure 1a) or 7-methoxy-2,2- dimethylchromene ranging from 30 (Vietnamese oil) to 93% (Congo oil) (Pham et al.,1976; Sharma et al., 1980; Wandji et al., 1996) while Precocene II (Figure 1b) ranging from 0.7% (Quijano et al., 1982) to 55% (Pham et al.,1976) while cumarine
(5.01%) and transcaryophyllene (3.02%) are the most common components of essential oil of A. conyzoides. They are found to have Aspergillus flavus suppressing activity and also completely inhibit the growth of Rhizoctonia solani and Sclerotium rolfsii. Ageratochromene dimer is also reported from the essential oil (Burkill, 1985) which believes the genus is chemically closer to the Ageritanae subtribe and possesses chemotaxonomic activity to the Piqueriiae group (Burkill, 1985).

Seven other chromene derivatives are isolated from oil in the aerial part of the plant. They are 2,2-dimethylchromene-7-β-glucopyranoside (Figure 1c) (Nair et al., 1977); 6-(1-methoxyethyl)-7-methoxy-2,2-dimethylchromene; 6-(1-hydroxyethyl)-7-methoxy–2,2-dimethylchromene; 6-(1-ethoxyethyl)-7-methoxy-2,2-dimethylchromene; 6-angeloyloxy-7-methoxy-2,2-dimethylchromene, 3-(2-methylpropyl)-2-methyl-6,8-dimethoxychrom-4-one, 2-(2-methylethyl)-5,6-dimethylbenzofuran and a mixture of ageratochromene dimer (Figure 2a) and encecanescin (Figure 2b) (Nair et al., 1977). 1.219% of coumarin and a minor amount of benzofuran and its derivatives are yielded from its essential oil.

3.3 Flavonoids and alkaloids

A total of 21 polyoxygenated flavonoids have been reported from the species which includes 119 polymethoxylated flavones, namely scutellarein-5,6,7,1-tetrahydroxyflavone, quercetin, quercetin-3-rhamnopiranoside, kaempferol, 14 polymethoxy flavones (Figure 3a), Eupalestin (Figure 3b), quercetin-3-rhamnopiraninoside (Figure 3c) and kaempferol 3,7-diglucopiranoside (Nair et al., 1977). A novel isoflavone glycoside, 5,7,2,19-tetrahydroxy-6,3-di-(3,3-dimethylallyl)-isoflavone 5-O-α-L-rhamnopyranosyl–(1→19)–α-Lrhamnopyranoside was isolated from the stems (Gill et al., 1978).

Some alkaloids found in Ageratum species are lycopsamine (Figure 4a), echinatine (Figure 4b), caffeic acid (Figure 4c), phytol (Figure 4d), 2-(2′-methylthyl) 5,6-dimethoxybenzofuran (Figure 4e), 2-(2-methylprop-2-enyl)-2-methyl-6,7-dimethoxychromene-4-one, 2-oxo-2′methylpropyl)-2-methyl-6,7-dimethoxychromene (Figure 4f) and 3-(2′-methylpropyl)-2-methyl-6,8-dimethoxychrom-4-one (Figure 4g) (Adewole, 2002).

Pyrrolizidine alkaloids (PAS) are widely distributed in Asteraceae family (particularly in tribes Senecioneae and Eupatorieae), but only lycopsamine and echinatine (isomeric) are isolated from this plant (Nair et al., 1977). Other common compounds isolated are sesamin, aurantiamide acetate, fumaric acid, caffeic acid, phytol and hydrocarbons nC27 H56 to nC32 H66 (Nair et al., 1977; Pari et al., 1998). The flowers were reported to contain vitamins A and B (Nair et al., 1977; Tyagi et al., 1995).

3.4 Triterpenes and steroids

The oil from leaves and stems of this plant is reported to contain sterols like friedelene (Figure 5a), beta-sitosterol (Figure 5b) and stigmasterol as major constituents and minor sterols include brassicasterol (Figure 5c) (Okunade, 2002). The presence of beta-sitosterol and stigmasterol in various tissue samples and plants parts of A. conyzoides were confirmed by thin layer chromatography (TLC) for beta-sitosterol (Rf 0.95, Melting point 139 to 140) and stigmasterol (Rf 0.89, Melting point 142 to 144). Sterols content were found to be higher in 6 weeks old tissue of A.
conyzoides. In case of in-vivo plant parts, *A. conyzoides* was observed slightly higher in stem (0.0868%) followed by leaves (0.0656%) and roots (0.0533%) (Sarin and Bansal, 2011).

**Yield of essential oils**

The oil content was found to be 0.2% from water distillation of the fresh flowers (Sood, 1973) and that of leaves and root were found to be 0.11 to 0.58% and 0.03 to 0.18%, respectively, depending on the seasons. The oil yielded from petroleum ether extract was reported to be 26% (Devdhar and Rao, 1970).

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**Figure 1.** Structures of (a) Procene I; (b) Procene II; (c) 2,2-dimethylchromene-7-Obetaucopyranoside; (d) 3-(2’ methylpropyl)-2-methyl-6,8demethoxychrom-4-one; (e) 2-(2’ methyllethyl)-5,6-dimethoxybenzofuran; (f) 14-Hydroxy-2H beta3-dihydroeuparine

**Figure 2.** Organic structures of (a) Ageratochromene dimer; (b) Encecanescin

**Figure 3.** Organic structures of (a) 14 Polymethoxy flavones; (b) Eupalestin; (c) Quercetin-3-rhamnopiranoside

**Figure 4.** Organic structures of (a) Friedeline; (b) Beta-Sitosterol; (c) Brassicasterol; (d) Spinasterol.
Figure 5. Organic structures of (a) Lycopsamine; (b) Echinatine; (c) Caffeic acid; (d) Phytol; (e) 2-(2′-Methylethyl)5,6-dimethoxybenzofuran; (f) 2-(1′-oxo-2′-methylpropyl)-2-methyl-6,7-dimeyloxychromone; (g) 3-(2′-Methypropyl)-2-methyl-6,8-dimethoxychrom-4-one; (h) 2-(2′-Methylpropyl)-2-methyl-6,7-dimethoxychroman-4-one
<table>
<thead>
<tr>
<th>S.No</th>
<th>Compound</th>
<th>Class</th>
<th>Source</th>
<th>Reference</th>
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</thead>
<tbody>
<tr>
<td>1.</td>
<td>Ageratocromene dimer</td>
<td>Chromene</td>
<td>Oil</td>
<td>Katsuri et al. (1973)</td>
</tr>
<tr>
<td>2.</td>
<td>B-caryophyllene</td>
<td>Sesquiterpene</td>
<td>Oil</td>
<td>Ekundayo et al. (1988)</td>
</tr>
<tr>
<td>3.</td>
<td>Brassicasterol</td>
<td>Sterol</td>
<td>Oil</td>
<td>Dubey et al. (1989)</td>
</tr>
<tr>
<td>4.</td>
<td>Caffeic acid</td>
<td>Secondary metabolites</td>
<td>Oil</td>
<td>Nair et al. (1977)</td>
</tr>
<tr>
<td>5.</td>
<td>Caryophyllene epoxide</td>
<td>Sesquiterpene</td>
<td>Oil</td>
<td>Ekundayo et al. (1988)</td>
</tr>
<tr>
<td>6.</td>
<td>Dihydrobrassica sterol</td>
<td>Sterol</td>
<td>Oil</td>
<td>Dubey et al. (1989)</td>
</tr>
<tr>
<td>8.</td>
<td>Eugenol</td>
<td>Terpenes</td>
<td>Oil</td>
<td>Ekundayo et al. (1988)</td>
</tr>
<tr>
<td>9.</td>
<td>Fumaric acid</td>
<td>Secondary metabolites</td>
<td>Oil</td>
<td>Nair et al. (1977)</td>
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<tr>
<td>10.</td>
<td>Kaempferol-3,7-diglucopiranoside</td>
<td>Flavonoid</td>
<td>Oil</td>
<td>Nair et al. (1977); Gill et al. (1978)</td>
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<td>11.</td>
<td>Lycopamine</td>
<td>Alkaloid</td>
<td>Oil</td>
<td>Wiedenfeld and Roder (1991)</td>
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<td>Oil</td>
<td>Ekundayo et al. (1988)</td>
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<td>13.</td>
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<td>Terpenes</td>
<td>Oil</td>
<td>Rao et al. (1973)</td>
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<td>14.</td>
<td>Precocene I(7-methoxy-2,2’-dimethylchromene)</td>
<td>Chromene</td>
<td>Oil</td>
<td>Wandji et al. (1996)</td>
</tr>
<tr>
<td>15.</td>
<td>Spinasterol</td>
<td>Sterol</td>
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<td>Dubey et al. (1989)</td>
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<td>17.</td>
<td>5,7,2’,19’-tetrahydroxy-6,3’-di-(3,3-dimethylallyl)-iso flavone</td>
<td>Isoflavone</td>
<td>Stem</td>
<td>Yadava et al. (1999)</td>
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<td>18.</td>
<td>α-pinene</td>
<td>Terpenes</td>
<td>Oil</td>
<td>Rao et al. (1973)</td>
</tr>
<tr>
<td>19.</td>
<td>β-pinene</td>
<td>Terpenes</td>
<td>Oil</td>
<td>Ekundayo et al. (1988)</td>
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4. PHARMACOLOGICAL ACTIVITIES of AGERATUM CONYZOIDES

- **Crude extract**
  It has been found to have neuromuscular blocking activity. The leaf extract has been used in the treatment of chronic pain in osteoarthrotic patients. Its antimicrobial and anticonvulsant activities have also been demonstrated. The methanolic extract of the whole plant also has antimicrobial activity. The analgesic activity of the leaf extract was detected by hot plate method. (Oladejo, OW, et al, 2003)

- **Essential oil**
  Essential oil of A. conyzoides has been tested for antiinflammatory, analgesic and antipyretic activities in mice and rats. At doses of 3 and 4 ml kg per os, the oil was found to have a significant anti-inflammatory (cotton pellet granuloma) activity. (Silva MJ, et al, 2000)

- **Metabolites** (Okunade, A.L, 2002)
  Pharmacological activities of the most significant metabolites, besides the essential oil from this plant, responsible for the medicinal properties have not been identified. There are, however, a wide spectrum of pharmacological activities of the classes of compounds obtained from this plant. For example, simple chromenes and chromans especially the 6-amino and 6-acetamido derivatives have been reported to have anti-depressant, analgesic and antipyretic properties. Other simple 2,2-dimethyl chromene derivatives like 6(1-hydroxyethyl)-7,8-dimethoxy-2,2-dimethylchromene and 6-hydroxy-7,8-dimethoxy-2,2 dimthyl chromene have been shown to have antimicrobial activities. The sterols, especially stigmasterol, have been shown to exert significant anti-inflammatory activity. The flavonoids possess a wide range of biological activities. The free radical scavenging and anticancer activities of the flavonoids are of public knowledge. Even though the biological activities of the flavonoids isolated from Ageratum conyzoides have not been investigated.

Some of the important pharmacological properties exhibited by Ageratum conyzoides Linn include: (Achola, KJ, et al, 1993)
A) Antibacterial effects B) Anti-inflammatory effects C) Wound healing effects D) Spasmolytic effects and gastro protection and E) Antitumour activity

- **INSECTICIDAL ACTIVITIES**
  Ageratum conyzoides has bioactivity that may have agricultural use. The insecticidal activity may in fact be the most important biological activity of this species. Both the essential oil as well as the major components of the oil, namely the precocenes, have been reported to have antijuvenile hormonal activity. (Shirwaikar A et al, 2003)

5. CONCLUSION

Ageratum conyzoides has been widely studied. Among the weeds, members of Ageratum seem to be the most commonly spreading in agricultural areas throughout the world. The species is believed to possess various biological activities starting from its various phytochemical contents. It
offers many opportunities to investigate the various functions and prospects in pharmaceutical studies. It is believed that a detailed information as presented in this review on its phytochemistry and various biological properties of the extracts and the constituents might provide incentive for proper evaluation of the use of the plant in medicine and in agriculture. Further work, however, still needs to be carried to reveal the structure activity relationship of these active constituents. Outcome of the future research in the aforementioned areas will provide a convincing support for the future clinical uses of A. conyzoides in modern medicine.

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