A Comprehensive Review On: Ageratum conyzoides Linn

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Abstract

The annual plant Ageratum conyzoides Linn has a lengthy history of being utilized as a traditional remedy in numerous countries globally, especially in tropical and subtropical regions. Commonly referred to as goat weed, Ageratum conyzoides Linn. belongs to the Asteraceae family. It is widely distributed across the globe, especially in tropical and subtropical areas. Ageratum conyzoides Linn. is an upright, annual herb that reaches a height of 30 to 80 cm. Its stems are covered with fine white hairs, and its leaves are opposite, hairy, and have long petioles with glandular trichomes. The achene fruit of this plant is easily dispersed by the wind and features an aristate pappus. In some countries, this species is considered a weed. This species has yielded a diverse array of chemical compounds, including alkaloids, flavonoids, chromenes, benzofurans, and terpenoids. Extracts and metabolites from this plant have been noted for their pharmacological and insecticidal properties. The primary pharmacological activities of the plant, such as anti-inflammatory effects, spasmolytic effects, gamma radiation effects, anti-cancer analgesic activity, antibacterial activity, radical scavenging activity, and antimalarial activity, have been well documented. An effort has been made in the current review to bring out the medicinal, agricultural and culinary uses of Ageratum conyzoides Linn.

Keywords: *Ageratum conyzoides, Agricultural uses, Medicinal uses, Phytochemistry, Traditional uses.*

1. Introduction

The name "*Ageratum*" comes from the Greek words "a geras," meaning "non-aging," which refers to the plant's overall longevity. *Ageratum conyzoides* Linn. (*A. conyzoides* L.) is part of the Asteraceae family, known for its distinct characteristics that set it apart from other plant families. Most plants in the Asteraceae family are herbaceous, with trees and shrubs being relatively uncommon (Okunade, 2002).

A. conyzoides L. is an aggressive allelopathic weed that leads to significant yield losses in various crops. Widely utilized in traditional medicine across several countries, it is resistant to common insects and diseases. Additionally, it exhibits bioherbicidal, analgesic, and anti-diarrheal properties. This plant serves as a source of nectar, a recyclable catalyst for treating environmental pollutants, and is also used in vermicompost production (Erida *et al*., 2023). *A. conyzoides* L. is polymorphic, aromatic, annual herb native to tropical America, and naturalized as a weed throughout India and is also found in the Middle Andaman. The plant is identifiable by its pale green color and pale blue or white, malodorous flowers, which appear in corymbs containing 50-80 flowers. It blooms from October to November. The genus *Ageratum* comprises approximately 30 species, but only a few have undergone phytochemical investigation (Thorat *et al*., 2018). This tropical plant is widespread in West Africa, Australia, parts of Asia, and South America. It is an erect, annual, branched, slender, hairy, and aromatic herb. The fruit is black and easily dispersed, while the seeds are photoblastic and often lost within 12 months (Kamboj and Saluja, 2008). The plant commonly grows near human habitation, thriving in any garden soil, and is frequently found in waste places and on ruined sites (Fig.1). It has a distinctive odor, similar to that of a male goat, which has led to its nickname "goat weed" or "billy goat weed" in Australia. *A. conyzoides* L. is not consumed by humans except for medicinal purposes. However, in some cultures, it is considered a delicacy for domestic guinea pigs, horses, and cattle (Thorat *et al*., 2018). The mature plant is valued for its haemostatic, anti-inflammatory, anti-spasmodic, and anti-asthmatic properties, making it useful for treating wounds and bacterial infections. Its essential oil can inhibit the growth and toxin production of the toxigenic strain *Aspergillus parasiticus*. The plant extract also exhibits cardiovascular depressant activity, anti-spasmodic effects, anti-oxidant properties, and insecticidal activities. *A. conyzoides* L. shows larvicidal and growth inhibitory effects on the 2nd and 4th instar larvae of *Anopheles stephensi*. The genus is well-known for its chromene and flavonoid content (Singh *et al*., 2013). These plants often display a wide range of biological and pharmacological activities. Extracts, syrups, infusions, and concoctions prepared from various parts of the plant are used to treat different ailments such as typhoid, anemia, malaria, and headaches. The secondary metabolites and other chemical constituents of these medicinal plants contribute to their therapeutic value (Abiodun *et al*., 2020). In India, Ayurvedic research has revealed that the plant's root is beneficial in treating fever and exhibits anti-parasitic and anti-dysentery properties. Nevertheless, investigations indicate that the plant harbors toxic characteristics and hinders the growth of indigenous flora in the invaded region, consequently diminishing productivity. The essential oil obtained via steam distillation is noted for its potent, nauseating scent (Singh *et al*., 2013). The plant is extensively utilized in traditional medicine across the mentioned geopolitical zones in Nigeria. Among the Igede people in Nigeria, it stands as the sole plant employed in treating HIV/AIDS (Amadi *et al*., 2012).

Fig.1 *Ageratum conyzoides* Linn. in its natural habitat

2. Taxonomical Classification (Erida *et al*., 2023)

Domain : Eukaryota
Kingdom : Plantae
Phylum : Spermatophyta
Subphylum : Angiospermae
Class : Dicotyledonae
Subclass : Asteridae
Order : Asterales
Family : Asteraceae
Genus : *Ageratum*
Species: *Ageratum conyzoides* Linn.

3. Botanical Characteristics

A. conyzoides L. is a seasonal plant, reaching heights of 30-90 cm. It's a branched, malodorous annual herb with a slender stem covered in fine white hairs. The young plant's stem is erect, round, often green, transitioning to brown, and adorned with trichomes (Fig.2A). Its leaves are single, opposite each other, ovate, pinnate, serrate, obtuse at the apex, rounded at the base, attached with petiole, and lamina without petals (Fig. 2B). The lamina measures about 10 cm long and 7 cm wide, while the petiole is straight with a concave-convex contour. The inflorescence forms corymbs, is self-incompatible, and contains 30 to 50 white purplish flowers located terminally (Fig. 2C). The fruit is black, easily dispersed, while the seeds are dark brown to black (Erida *et al*., 2023).

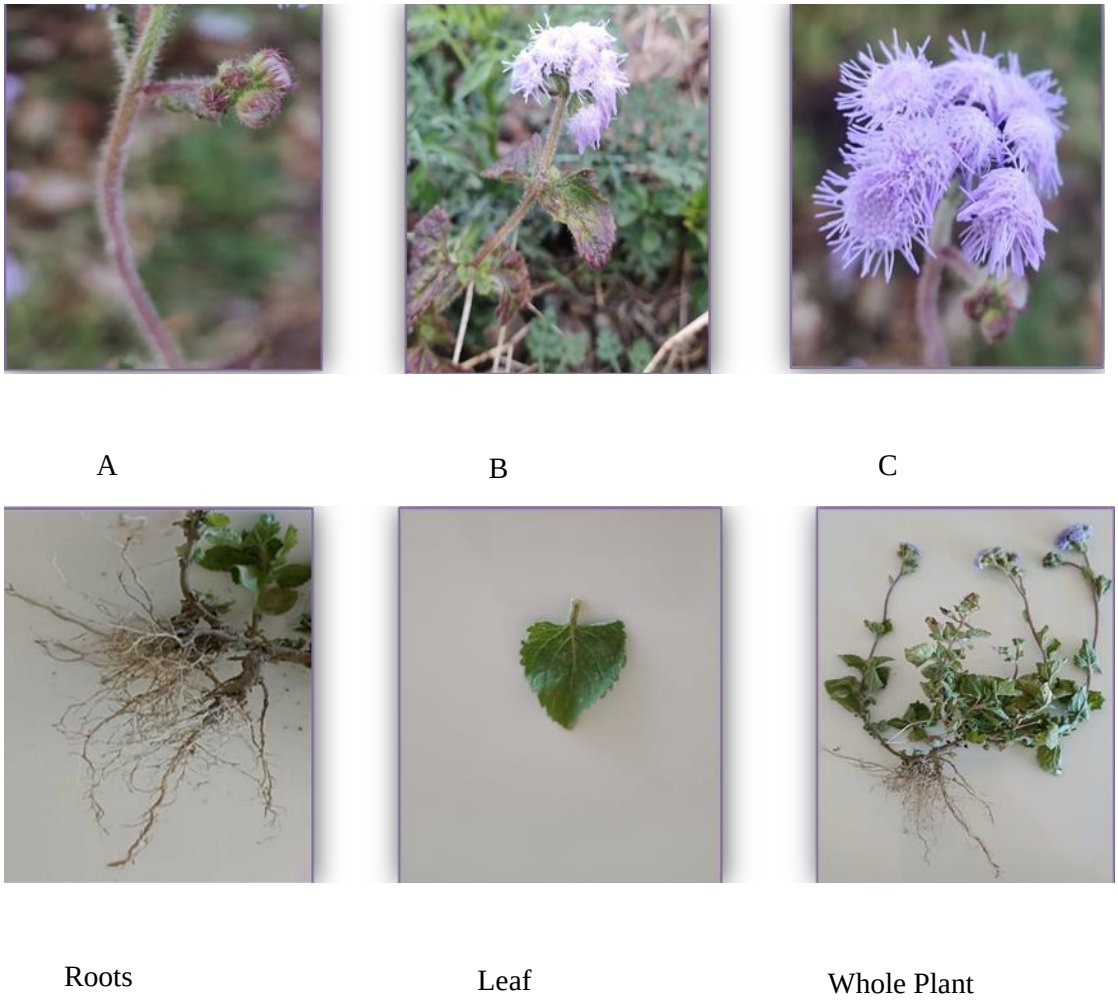


Fig.2 Botanical Characteristics of *Ageratum conyzoides* Linn.

4. Phytochemistry

A. conyzoides L. exhibits significant variability in its secondary metabolites, comprising flavonoids, alkaloids, coumarin, essential oils, and tannins, many of which possess biological activity. The yield of essential oil ranges from 0.02% to 0.16%. The species is rich in alkaloids, predominantly of the pyrrolizidinic group, indicating its potential suitability for pharmacological research (Ming, 1999).

Numerous phytochemicals have been discovered in the essential oil of the entire *A. conyzoides* L. plant including kaempferol, glycosides (rhamnoside), quercetin, chromene, stigma-7-en-3-ol, sitosterol, stigmasterol, fumaric acid, caffeic acid, saponin, pyrrolizidinic alkaloids, ageratochromene derivatives, and alkanes (Yadav *et al*., 2019). The presence of bioactive substances has been documented to provide plants with resistance against bacteria, which may account for the anti-bacterial activity exhibited by various fractions of the plant extracts. *A. conyzoides* L. contains numerous pharmacologically active compounds, potentially responsible for its anti-microbial effects. These compounds include alkaloids, almarins, essential oils, tannins, agertochromone, 2, 6-dimethylageratochromone, and eugenol. Additionally, flavonoids like conyzoigun and dotriaconthene have been identified. Phenol and phenolic esters, known for their disinfectant properties, along with other antimicrobials and insecticides, have also been observed (Ndip *et al*., 2009). In Manipur,

India, the entire plant is traditionally utilized as a hair lotion called "Cheng-hi," prepared by boiling the plant with rice water. Additionally, it has been discovered that the plant is toxic to rabbits because of the presence of coumarin and hydrogen cyanide (HCN) (Singh *et al*.,2013). Some of the phytoconstituents from *A. conyzoids* L. are:

I. Flavonoids

Several flavonoids within the *Ageratum* genus are polyoxygenated compounds, with some appearing to be distinctive to this plant. Nineteen polyoxygenated flavones have been identified in *A. conyzoides* L., Among them, two flavonoids have been isolated as glycosides: kaempferol 13,7-diglucoside and kaempferol 3-rhamnoglucoside (Sharma and Sharma, 1995).

Significantly, tricin derivatives, such as 3′4'5′-oxygenated flavones, which are uncommon in natural product chemistry, have been successfully extracted in substantial quantities from this plant. These derivatives encompass 5′-methoxynobilethin, linder flavone B, 5,6,7′3'4′5'-hexamethoxyflavone, eupalestin, and hexamethoxyflavone. Furthermore, isoflavones have been isolated from this plant as well (Yadav *et al*., 2019).

II. Chromene, Chromone, Benzofuran, and Coumarin

It has been documented that the predominant component of the essential oil extracted from *A. conyzoides* L. is 7-methoxy-2,2-dimethylchromene, commonly known as Precocene I (Solanki *et al*., 2010; Yadav *et al*., 2019).

A derivative of 6,7-dimethoxyageratochromene, known as ageratochromene, is present in the essential oil of *A. conyzoides* L., with concentrations ranging from 0.7% to 55%. Additionally, a dimeric form of ageratochromene has been isolated from this plant's essential oil. Related compounds such as encecalin, 6-vinyl-7-methoxy-2,2-dimethylchromene, dihydro encecalin, dihydro demethoxy encecalin, demethoxy encecalin, dimethyl encecalin, and 2-(1-oxo-2′-methylpropyl)-2-methyl-6,7-dimethoxychromene have also been identified in *A. conyzoides* L. (Yadav *et al*., 2019). The presence of these acetyl chromenes in *A. conyzoides* L. is believed to hold significant chemotaxonomic importance. Besides the chromenes obtained from the oil, seven other chromene derivatives have been isolated from the hexane extract of the plant's aerial parts. These include 2,2-dimethylchromene-7-O-β-glucopyranoside, 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-dimethyl chromene, and an inseparable mixture of encecanescins (Solanki *et al*., 2010).

Furthermore, derivatives of benzofuran, such as 2-(2′-methylethyl)-5,6-dimethoxybenzofuran and 14-hydroxy-2Hβ, 3 dihydro euparine, have been documented. Chromone derivatives, including 3-(2′-methylpropyl)-2-methyl-6,8-dimethoxy chroman-4-one, have also been isolated from the plant. It has been reported that *A. conyzoides* L. from Brazil yields 1.24% of coumarins and coumarin derivatives (Yadav *et al*., 2019).

III. Triterpene and Sterols

The triterpene friedelin and the typical sterols- β-sitosterol, stigmasterol—have been extracted from this plant. Although the two sterols are primary components, other secondary

sterols have also been identified. These include brassicasterol and dihydrobrassicasterol, spinasterol, and dihydrospinasterol (Solanki *et al*., 2010).

IV. Alkaloids and Miscellaneous Compounds

Two isomeric pyrrolizidine alkaloids, specifically lycopsamine and echinatine, have also been identified in this plant. Additionally, other compounds such as (+)-sesamin, fumaric acid, and caffeic acid have been reported (Nair *et al*., 1977), Phytol and hydrocarbons ranging from nC27-H56 to nC32-H66 have also been identified in *A. conyzoides* L. Additionally, 1,2-6 methyl-heptadecenoic acid has been extracted from the essential oil, which functions as an insecticide and influences the growth of the desert locust Schistocerca gregaria. The fatty acids extracted from the seed oil include oleic acid, palmitic acid, stearic acid, linoleic acid, linolenic acid, and hexadecenoic acid. The amino acids obtained from pollens include n-butyric acid, aspartic acid, proline, and glycine, while those extracted from leaves and flowers include cystine, leucine, histidine, arginine, serine, alanine, tyrosine, valine, phenylalanine, threonine, and trace amounts of glycine. It has also been reported that the flowers contain vitamin A and vitamin B (Yadav *et al*., 2019).

V. Monoterpenes and Sesquiterpenes

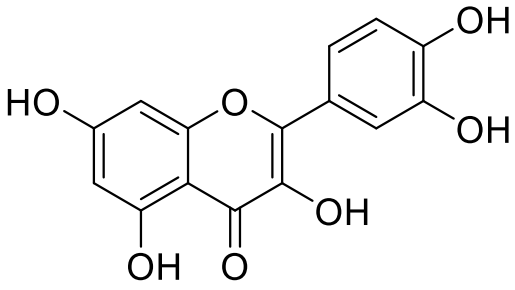
To date, a total of 51 constituents have been identified in the analysis of *Ageratum* oil. These include 20 monoterpenes (6.6%), with 1% consisting of sabinene, 1.6% of β-pinene and β-phellandrene, 2.9% of 1.8-cineole and limonene, 0.6% of terpinene-4-ol, and 0.5% of α-terpineol. Additionally, 20 sesquiterpenes (5.1%) have been found, with individual substances present in trace amounts of approximately 0.1%. Indian *Ageratum* oil contains 5.3% ocimene, which is only found in trace amounts in the Nigerian plant, along with 6.6% α-pinene, 4.4% eugenol, and 1.8% methyleugenol (Singh *et al*., 2013). The primary sesquiterpenes include β-caryophyllene at 1.9%, 10.5% in the extract from Cameroon, and 14-17% in the extract from Pakistan. The oxygenated sesquiterpene hydrocarbons, which constitute 69.29% of the oil, are primarily composed of ageratochromene (32.90%), 6-methoxyquinoline-1-oxide (20.77%), β-caryophyllene oxide (7.29%), and β-sinensal (5.82%). Ocimene is present in trace amounts in the Nigerian plant and makes up 5.3% of the oil from the Indian plant (Kamboj and Saluja, 2008).

VI. Essential Oils

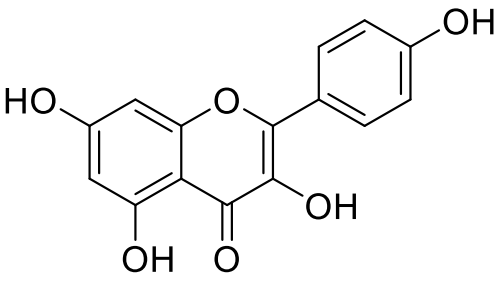
The oil content was determined to be 0.2% from water distillation of the fresh flowers, while the leaves and roots contained between 0.11% to 0.58% and 0.03% to 0.18%, respectively, depending on the season. The oil extracted using petroleum ether was reported to yield 26% (Chauhan and Rijhwani, 2015).

Structures of some major phytoconstituents reported from *Ageratum conyzoides* Linn. are as follow:

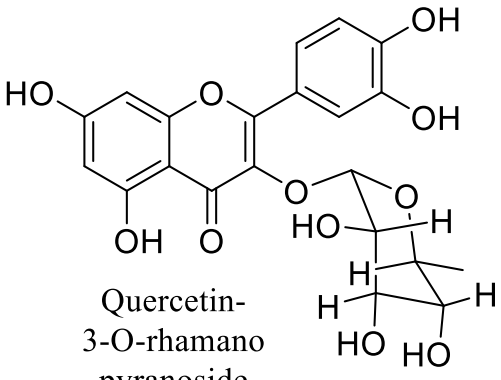
Flavonoids



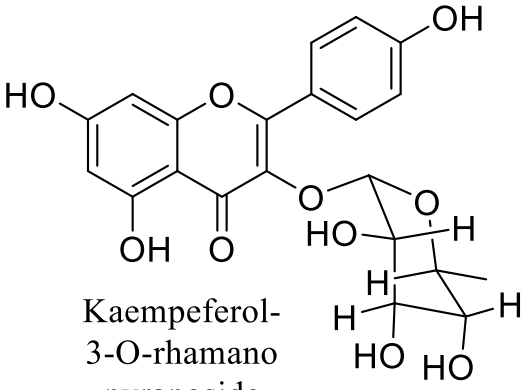
Quercetin



Kaempeferol

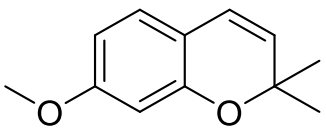


Quercetin-
3-O-rhamano
pyranoside

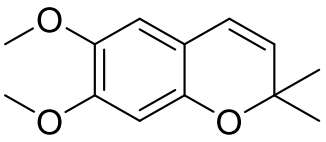


Kaempeferol-
3-O-rhamano
pyranoside

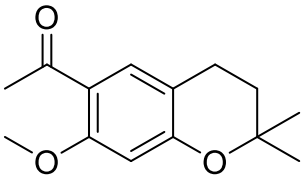
Chromene, Chromone, Benzofuran and Coumarins:



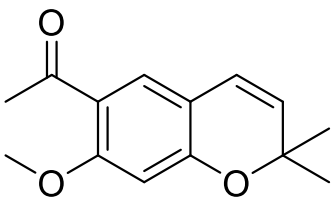
Precocene I



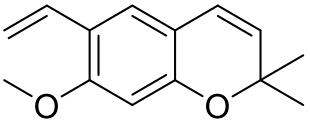
Precocene II



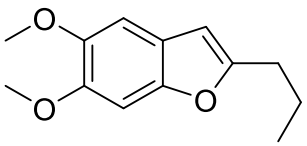
Dihydroencecalin



Encecalin

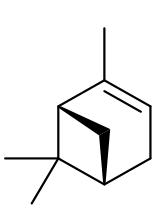


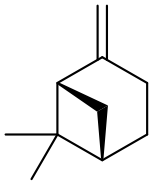
6-vinyl-7-methoxy-
2,2-dimethyl chromene

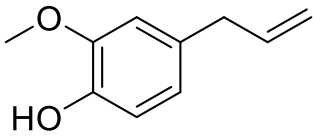


2-(2'-methylethyl)-
5,6-dimethoxybenzofuran

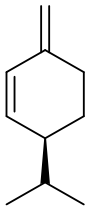
Monoterpene And Sesquiterpenes:

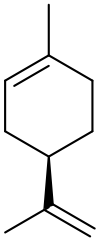

α-Pinene

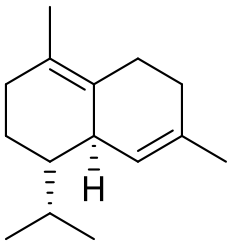

β-Pinene



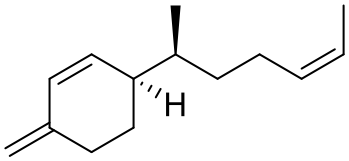
Eugenol


β-Phellandrene

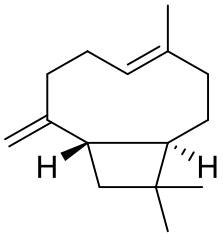

Limonene



δ-Cadinene

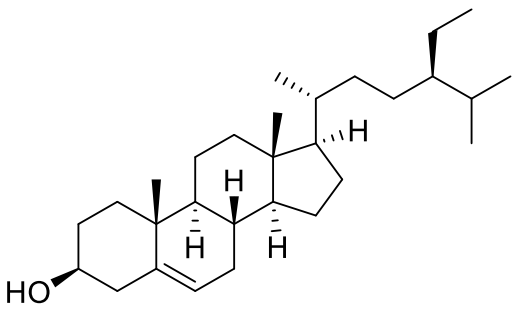


β-Sesquiphellandrene

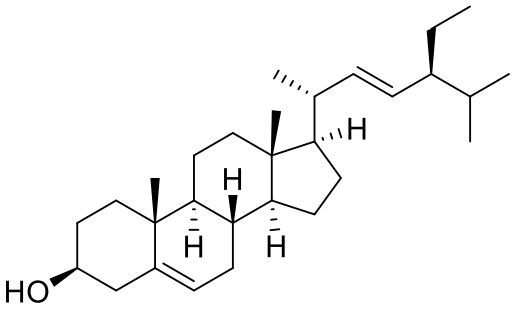


β-Caryophyllene

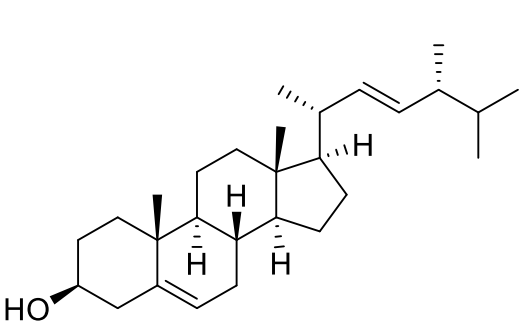
Sterols:



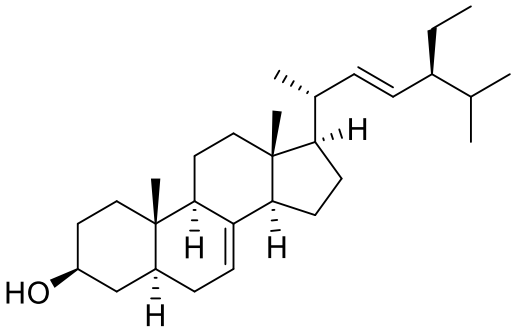
b-Sitosterol



Stigmasterol



Brassicasterol



Spinasterol

Table 1. Compounds Isolated from *Ageratum conyzoides* Linn.:

Sr. No.	Compound Name	Source	References
1	5,6,7,8,3′, 4′, 5′-heptamethoxyflavone, 5,6,7,8,3′-pentamethoxy-4′, 5′-methylenedioxyflavone	Leaves	Moreira *et al*., 2007; Adebayoa
2	2,2-Dimethylchromene-7-methoxy-6-O-β-D-glucopyranoside, precocene II, Precocene I, kaempferol	Whole plant	Adebayoa *et al*., 2011; Adebayoa *et al*., 2010; Warsinah and baroroh, 2019; Pari *et al*., 1997
3	5,6,7,5′ -tetramethoxy3 ′ ,4′ -methylenedioxy flavone, eupalestin, 5′ -methoxynobiletine, ageconyflavone C, encecalol methyl ether, 5,6,7,3′ ,4′ ,5′ -hexamethoxyflavone	Aerial part	Nour *et al*., 2010
4	7-methoxy-2,2-dimethyl-6-vinyl-2H-chromene, hexadecanoic acid (palmitic acid), 9,12-octadecanoic acid (linoleic acid), neopitadiene, methyl-5,11,14,17-eikosatetraenoic	Leaves	Warsinah and baroroh, 2019
5	(2s)- 7,3′ ,4′ -trimethoxyflavone, 7 -methoxy3 ′ ,4′ -methylene dioxyflavone	Whole plant	Munikishore *et al*., 2013
6	Stigmasterol	roots	Irmawan *et al*., 2018
7	lupeol	stem	Ahuchaogu and Echeme, 2019
8	Lycopsamine, Echinatine	Aerial part	Wiedenfeld and Röder, 1991
9	Stigmasterol, β-sitosterol.	Aerial part	Kamboj and Saluja, 2010, Ndacnou *et al*., 2020

10	2(2'-methylethyl)-5,6dimethoxybenzofuran	Aerial part	Pari *et al*., 1997; Shekhar and Anju, 2012
11	3-O-β-D-glucopyranosyl-β-sitosterol, undecan-1-ol, decan-1-ol,	Whole plant	Ndacnou *et al*., 2020

5. Phytochemical Analysis of Plant Extracts of *Ageratum conyzoides* Linn.

The qualitative analysis of phytochemicals in the crude methanolic extract and aqueous extract of *A. conyzoides* L. leaves indicated the presence of several phytoconstituents, as summarized (Table 2) below. The findings revealed the presence of alkaloids, carbohydrates, phenols, tannins, flavonoids, saponins, triterpenoids, glycosides, and steroids (Aernan *et al*., 2023; Ndacnou *et al*., 2020; Adeoye *et al*., 2020; puro *et al*., 2018; Brearley, 2020).

Table 2. Phytochemicals presents in methanolic and aqueous extract of *Ageratum conyzoides* Linn.

Sr. No.	Compound	Methanolic extract	Aqueous extract
1	Saponin	+	+
2	Alkaloid	+	+
3	Steroid	+	+
4	Flavonoid	+	+
5	Tannin	+	+
6	Phenol	+	+
7	Terpenoids	-	-
8	Quinones	+	+
9	coumarins	+	+

Present (+), Absent (-)

6. Bioactivity

A. conyzoides L. is a plant employed in traditional medicine to address mental and infectious diseases, dyspnea, enteralgia, and fever. It has been noted for its significant antifungal and insecticidal properties. The plant's biological activities are categorized under two headings:

I. Pharmacological properties

II. Insecticidal and other biological properties (Kamboj and Saluja, 2008).

To address various pathologies, the populace utilizes this species either alone or in combination, employing various forms such as decoction, trituration, maceration, infusion, or carbonization. Furthermore, depending on the pathology being treated and the method of preparation, the species can be administered orally, topically, vaginally, or rarely via the laryngeal route (Sikka *et al*., 2012).

I. Pharmacological Properties

a) Crude Extract

The raw extract derived from the entire plant has been noted to outperform Vaseline gauze as a wound dressing material. It exhibits calcium-blocking activity akin to that of verapamil.

Additionally, the aqueous extract obtained from the leaves has been shown to inhibit the coagulation of whole blood while inducing precipitation of certain blood components, consequently reducing bleeding time as well (Kamboj and Saluja, 2008). The leaf extract has been applied in treating chronic pain in patients with osteoarthritis. Moreover, its antimicrobial and anticonvulsant properties have been validated (Okunade, 2002). In the treatment of renal calculi, the hydroalcoholic extract derived from the entire plant was used (Agarwal, 2017).

b) Cardiovascular Activities

The haemostatic effect observed in the leaf aqueous extract of *A. conyzoides* L. primarily results from vasoconstriction and the creation of an artificial clot. This clot formation contributes to the development of a mechanical plug, effectively halting bleeding from small blood vessels (Yadav *et al*., 2019; Kamboj and Saluja, 2008).

c) Analgesic effects

Analgesic properties have been attributed to this herb through the use of an alcoholic extract derived from various parts of the plant. The crude ethanolic extract of its leaves demonstrated analgesic effects in mice induced by acetic acid. During inflammation, the increased levels of prostaglandins contribute to heightened pain perception by augmenting capillary permeability. At this juncture, the synthesis of prostaglandins is hindered through peripheral pain inhibition mechanisms, thereby producing analgesic effects. A clinical trial conducted on arthritis patients utilizing a water extract from the entire plant of *Ageratum* revealed promising results: 66% of the patients experienced pain relief, with a 24% improvement in joint mobility, all without any reported side effects (Kotta *et al*., 2020).

d) Anti-inflammatory effects

The anti-inflammatory effect of the hydroalcoholic leaf extract was investigated in rats using sub-acute (cotton pellet-induced granuloma) and chronic (formaldehyde-induced arthritis) models of inflammation. This was assessed through biochemical and hematological analyses of rat blood samples. The findings affirm the anti-inflammatory properties of the extract, without observable hepatotoxicity. Moreover, the ethanolic extract displayed considerable gastroprotective activity, potentially attributed to its anti-oxidant properties, calcium channel blocking, and anti-serotonergic properties. Additionally, the ethanolic extract derived from the roots exhibited anti-inflammatory and analgesic properties. (Kamboj and Saluja, 2008).

e) Anti-microbial and Anti-fungal effect

Both methanol and ether extracts of *A. conyzoides* L. have demonstrated anti-microbial activity. This herb contains anti-microbial constituents effective against oxidase enzymes found in bacteria, which are pathogens associated with systemic infections that can have lethal effects on animals and humans (Kotta *et al*., 2020). The acetone extracts of *A. conyzoides* L. displayed anti-fungal activity against the fungus causing wilt. Furthermore, the essential oil of *A. conyzoides* L. was found to impede the growth and production of a toxigenic strain of *Aspergillus parasiticus*. This essential oil could potentially serve as a natural fungicide for stored products, as it exhibited inhibition of aflatoxin production. Researchers observed that the essential oil, at a concentration of 0.75 mg mL−1, hindered the growth of *Aspergillus parasiticus* and inhibited over 84% of aflatoxin production by the test fungi at a concentration of 0.5 mg mL^{-1}. This biological efficacy was linked to its anti-oxidant properties, indicating *A. conyzoides* L. as a promising plant for safe guarding stored

products and managing aflatoxin contamination in food and feed, utilizing both its essential oil and macerated green leaf tissue as fumigants (Rioba and Stevenson, 2017).

f) Anti-diabetic

In Cameroon and Nigeria, *A. conyzoides* L. is utilized in the treatment of diabetes. Previous pharmacological investigations using crude leaf extract and butanol acetic acid fractions respectively have demonstrated the acute effect of *A. conyzoides* L. on diabetic rats (Nyunaı *et al*., 2015). Additionally, methanolic extracts of the leaf, stem, and roots of *A. conyzoides* L. were studied for their anti-diabetic effects. Researchers found that phytochemicals including alkaloids, carbohydrates, cardiac glycosides, flavonoids, saponins, tannins, steroids, and triterpenes were implicated in the anti-diabetic activity of these plant extracts. They further reported that the alkaloids of *A. conyzoides* L. suppress *α-glucosidase* activity, thereby reducing glucose transport by intestinal epithelial cells (Yadav *et al*., 2019).

g) Anti-oxidant

The main constituents of this plant were reported to be saponin, flavonoids, and tannins. These compounds are recognized for their anti-oxidant activities in numerous diseases, and their role in the treatment of diabetes and anti-oxidant activity is well documented. The presence of saponin, tannins, and flavonoids in the aqueous extract was confirmed. Studies have demonstrated that *A. conyzoides* L. leaves exhibit potent anti-oxidant activity, which may directly or indirectly contribute to its hypoglycemic properties. These potent anti-oxidant properties may play a role in preventing oxidative damage (Nyemb *et al*., 2009).

h) Anti-malarial

A study reveals that the water extract of *Ageratum conyzoides* L. has the potential to enhance the antimalarial efficacy of chloroquine and artesunate in Plasmodium-induced rats. The phytochemicals accountable for these antimalarial activities include alkaloids, glycosides, flavonoids, saponins, tannins, and resins. In this investigation, both the leaf extract and its fractions exhibited notable antimalarial activity against the Plasmodium parasite, as confirmed by either in vitro or in vivo models in mice (Kotta, 2020).

i) Radio protective Activity

The study investigated the impact of the alcoholic extract of the plant on the modification of radiation-induced mortality in mice exposed to 10 Gy of gamma radiation. Mice were administered with 75 mg/kg (optimal dose) of *A. conyzoides* L. extract prior to exposure to gamma radiation at doses ranging from 6 to 11 Gy. The treatment with *A. conyzoides* L. extracts effectively shielded mice from gastrointestinal as well as bone marrow-related fatalities (Kamboj and Saluja, 2008).

j) Anti-tumor activity

Isolated polymethoxy flavones from *A. conyzoides* L. have demonstrated significant activity in promoting the differentiation of human promyelocytic leukemia cells. The aqueous extract of *A. conyzoides* L. roots reduced glutathione levels in hepatocytic cells and lymphoma cells of tumor-bearing mice. The study concluded that leaf extracts exhibited anti-tumor activity by suppressing the growth and proliferation of lung carcinoma. Additionally, *A. conyzoides* L. has been utilized in the treatment of HIV/AIDS. Chemical constituents such as chromenes and kaempferol have been identified as playing crucial roles in inhibiting cell proliferation and serving as anti-cytotoxic agents (Yadav *et al*., 2019).

k) Wound Healing Properties

When applied on wounds, *A. conyzoides* L. exhibits styptic properties and facilitates rapid healing. The juice derived from the leaves and stems is employed for treating wounds and various skin ailments, particularly leprosy, and is recommended as a bath for individuals with ecchymoses. Moreover, the crude extract of *A. conyzoides* L. has been found to be notably more effective than Vaseline gauze as a wound dressing material (Sharma and Sharma, 1995).

l) Anthelmintic and Nematicidal Activity

The essential oil of the plant showed vermifuge activity against *Taenia solium* and *Pheretima posthuma*, whereas extracts from the stem and leaves displayed nematocidal effects against second-stage juveniles of *Meloidogyne incognita* (Kamboj and Saluja, 2008). In a study, *A. conyzoides* L. was evaluated for their nematicidal properties. Aqueous extracts of *A. conyzoides* L. demonstrated the most significant impact, causing extensive damage to eggs, reducing hatching rates, and inducing paralysis and mortality in second-stage juveniles (J2) of *Meloidogyne incognita* (Khan *et al*., 2017). Its efficacy against *Meloidogyne incognita* was further validated in another study involving black gram (Pavaraj *et al*., 2010; Baral *et al*., 2022; Khan *et al*., 2017).

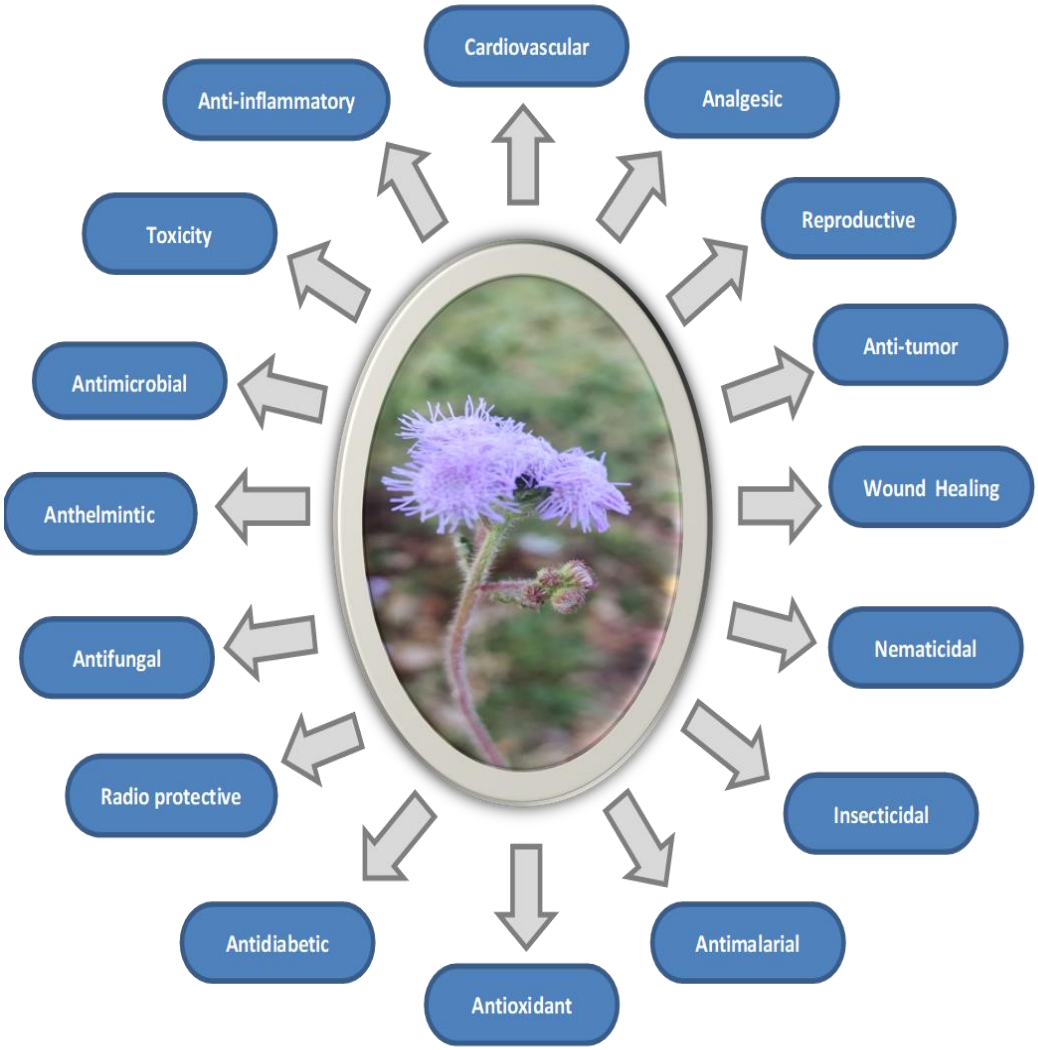


Fig 3. Bioactivities of *Ageratum conyzoides* Linn.

II. Other Biological Properties

a) Toxicity

Pyrrolizidine alkaloids in this plant, compounds known to be hepatotoxic and linked to lung cancer and various other ailments in rats. Such compounds pose potential hazards to human health. The cytotoxicity of the plant may be attributed to the oxidative dealkylation process (Singh *et al*., 2013).

b) Reproductive Problems

Many herbal remedies are traditionally employed as contraceptives, abortifacients, emmenagogues, or oxytocic. *A. conyzoides* L. is utilized to address prostate issues, unspecified female complaints, and venereal diseases. Extracts of the plant inhibited uterine contractions induced by 5-hydroxytryptamine, suggesting specific anti-serotonergic activity on isolated uterus, while having no effect on contractions induced by acetylcholine. These findings validate the traditional use of the plant as a spasmolytic (Kamboj and Saluja, 2008).

7. Ethnopharmacology (Traditional Uses)

In traditional systems of medicine, various parts of *Ageratum* are utilized to address a wide array of ailments. Different plant parts are employed in the treatment of diverse diseases including skin ailments, wound healing, ulcers, tetanus, asthma, stomach disorders, HIV/AIDS, rheumatism, ophthalmic conditions, and more (Chaudhary, 2022).

In several African countries, the plant is widely utilized for treating skin diseases, promoting wound healing, addressing mental and infectious diseases, alleviating headaches and dyspnea. It is employed in traditional medicine for its anti-asthmatic, anti-spasmodic, and haemostatic effects, as well as for managing uterine troubles and pneumonia by applying it to the patient's chest. In Cameroon, it serves as a local remedy for craw-craw. In India, it is employed in the treatment of leprosy and utilized as an oil lotion for purulent ophthalmia (Kamboj and Saluja, 2008).

Assays conducted in Kenya using aqueous extract from the entire plant demonstrated muscle-relaxing activities, validating its widespread use as an anti-spasmodic. Traditional communities in India utilize this species as a bactericide, anti-dysenteric, and anti-lithic agent. Additionally, in Asia, South America, and Africa, the aqueous extract of this plant is employed as a bactericide. Aqueous extracts of the leaves or whole plants are employed in treating colic, colds, fevers, diarrhea, rheumatism, spasms, or as a tonic. *A. conyzoides* L. exhibits rapid and effective action in burn wounds and is recommended by the Brazilian Drugs Central as an anti-rheumatic agent (Ming, 1999).

Additional folk remedies involving *A. conyzoides* L. encompass its use as an anti-itch remedy, for treating sleeping sickness, and as a mouthwash for alleviating toothache. It is also utilized as an anti-tussive (to relieve coughing), vermifuge (to expel worms), tonic, and for killing lice (Kapur, 1993).

The leaves of *A. conyzoides* L. are utilized for various purposes, including application on cuts and sores, as an anti-inflammatory agent, haemostatic agent, insecticide, and for treating skin diseases, ringworm infections, and snake bites. They are also used to malarial treat fever, tetanus, uterine problems, prolapse of the anus, swollen piles, throat infections, painful gums, abscesses for early suppuration, and leucorrhoea, as well as infant diarrhea. The plant has been reported to possess nematocidal activity and potential for controlling pests. Additionally, it is utilized for preparing local hair lotion in Manipur, India, for treating

dandruff. Crushed leaves, when mixed with water, are applied intra-vaginally for uterine troubles and can also be administered as an emetic. The leaves are reported to have hematopoietic potential, which may aid in treating anemia, and are further noted for their gastroprotective activity. *A. conyzoides* L. is considered one of the selective weeds suitable for substrate in oyster mushroom cultivation, as it enhances protein content and reduces production time (Sivakrishnan and Kavitha, 2017). *A. conyzoides* L. is employed both as a prophylactic measure and as a treatment for trachoma in cattle (Okunade, 2002).

Table 3. Traditional uses of plant parts of *Ageratum conyzoides* Linn.

Sr. No.	Plant part	Traditional use	Reference
1	Leaves	antilithic agent, pneumonia, antidote to snake venom, cuts and sores, anti-tetanus, headache, uterine problems, typhoid fever, malarial fever, throat infection, painful gums, and leucorrhoea, hematopoietic, gastroprotective, scavenging reactive radicals of oxygen, Prevent coagulation of whole blood.	(Agarwal, 2017; Jayasundera *et al*., 2021; Singh *et al*., 2013; Yadav *et al*., 2019)
2	Roots	Anti-helminthic and anti-dysenteric properties, treatment of renal calculi, Anti-tumor, lithiasis, and infant diarrhoea.	(Agarwal, 2017; Arya *et al*., 2011; Singh *et al*., 2013; Yadav *et al*., 2019)
3	Whole Plant	Treatment of renal calculi, Protection effects against gamma radiation, Active against certain selected micro-organisms, Dermatological remedy, Anti-coccidial effects, Antiprotozoal and cytotoxic, Wound healing, Spasmolytic medicine.	(Agarwal, 2017; Singh *et al*., 2013)
4	Flowers	Anti-itch, anti-tussive, sleeping sickness, vermifuge, tonic, and for killing lice.	(Chahal *et al*., 2021; Yadav *et al*., 2019)

8. Culinary uses of *Ageratum conyzoides* Linn.

The use of plants and their extracts for diverse purposes has been integral to human life since antiquity. In addition to providing sustenance, plants are often utilized for therapeutic purposes, with *A. conyzoides* L. being one such instance. This research was carried out to evaluate the nutritional value and antioxidant effectiveness of the whole *A. conyzoides* L.

plant. The analysis of the entire *A. conyzoides* L. plant revealed the following percentages: moisture (5.52±0.035), crude protein (24.53±0.104), crude lipid (3.78±0.069), ash (10.47±0.058), crude fiber (18.89±0.023), and carbohydrates (36.81±0.006). The mineral content (in mg/100g) included: sodium (88.50±0.346), potassium (139.10±0.006), calcium (220.60±0.173), magnesium (110.13±0.115), iron (22.73±0.289), zinc (43.50±0.173), and phosphorus (380.13±0.173). The findings of the proximate analysis showed that the entire *A. conyzoides* L. plant is a rich source of plant protein, minerals, crude fiber, and carbohydrates. When consumed in sufficient amounts, it may help meet the mineral needs necessary for human health (Abiodun *et al*., 2020). Due to its high caloric value and significant content of crude protein and essential minerals (particularly rich in potassium, phosphorus, calcium, iron, magnesium, and zinc, with moderate amounts of copper and manganese), it may also be recommended as a dietary supplement. In traditional medicine across various regions of Africa, Asia, and South America, including Nigeria, an infusion or decoction of the herb is administered to treat stomach ailments such as diarrhea, dysentery, and intestinal colic (Baral *et al*., 2022).

9. Agricultural uses of Ageratum conyzoides Linn.

As demonstrated by various research studies worldwide, the plant extract exhibits a range of effects, including insecticidal, anti-microbial, anti-fungal, herbicidal, and nematicidal activities, among others, as discussed below:

a) Insecticidal / Pesticidal effect

A. conyzoides L. exhibits bioactivity that could potentially be utilized in agriculture. The crude plant extract also demonstrates insecticidal and pesticidal activities against various types of insects and pests. The major components of the oil, specifically the precocenes, have been noted for their anti-juvenile hormonal activity. Furthermore, the petroleum ether extract derived from the leaves, flowers, and buds, when diluted in benzene and combined with green gram seeds, proved to be highly repellent, acting as a potent oviposition inhibitor and a safe protectant against infestations by the pulse beetle *C. chinensis*. Moreover, the crude extract of the plant displayed insecticidal activity against nymphs of the mustard aphid L. erysimi (Kamboj and Saluja, 2008). It has been observed to affect insects such as *Musca domestica, Sitophilus zeamais, Schistocerca gregaria*, mosquito larvae including *Anopheles stephensi, Aedes aegypti, Anopheles gambiae*, and *Culex quinquefasciatus*, as well as *Plutella xylostella, Spodoptera litura, Sitophilus oryzae, Thlaspida japonica, Leptocarsia chinesis, Dysdercus flavidus, Lucilia caesar, Tribolium confusum, Mythimna separata, Culex pipiens pallens*, and others (Okunade, 2002; Kong *et al*., 2004; Rioba and Stevenson, 2017). The insecticidal effects of *A. conyzoides* L. are likely attributed to its terpenic compounds, particularly precocenes, which exhibit anti-juvenile hormonal activity (Ming, 1999). Seeds treated with essential oils showed no adverse effects on seed germination or seedling growth, suggesting that the oils are non-phytotoxic (Jaya *et al*., 2014). Therefore, this essential oil could be recommended as a natural pesticide to safeguard stored food items from insect infestation, thereby prolonging their shelf life. In other research, crude extracts and essential oils were shown to be effective against adult female *Ae. aegypti* mosquitoes (Pintong *et al*., 2020). The volatile oil from air-dried leaves of *A. conyzoides* L., when used to fumigate artificially infested cowpea, exhibited acute toxicity on adult cowpea weevils (*Callosobruchus maculatus*), achieving a maximum mortality rate of 95-97% with 60 µL of

oil. Evidence suggests that *A. conyzoides* L. is as effective as synthetic pesticides and is also economically viable. Additionally, it has a significantly lower impact on beneficial insects such as ladybirds, hoverflies, and spiders compared to synthetic pesticides (Rioba and Stevenson, 2017; Baral *et al*., 2022; Jaya *et al*., 2014)

b) Allelopathic property

Both the volatile oil and the aqueous extract of *A. conyzoides* L. have been demonstrated to exhibit allelopathic effects on several cultivated crops, including radish, mungbean, and ryegrass. The allelopathic potential of the aqueous extract from various organs of *A. conyzoides* L. and from different stages of its development, particularly from diverse habitats, varied. The entire plant displays a high potential for allelopathic properties against intercropped crops in *citrus* orchards, where it quickly grows and covers the ground, outcompeting other weeds like *Cyperus difformis, Bidens pilosa,* and *Digitaria sanguinalis* (Singh *et al*., 2013). *A. conyzoides* L. emits a variety of allelochemicals into the environment through leaching, volatilization, and residue decomposition. Key constituents of the volatiles from plant include ageratochromene and its derivatives, monoterpenes, and sesquiterpenes, along with ten flavones from residues and aqueous extracts. These substances significantly hinder the germination and growth of numerous crops such as rice, wheat, sesame, soybean, mungbean, radish, tomato, peanut, corn, cucumber, and others. *A. conyzoides* L. infests cultivated fields and reduces agricultural yields. However, it is beneficial to certain crop plants in various agroecosystems. Additionally, it helps stabilize populations of *Amblyseius* species, an effective predatory natural enemy of the citrus red mite, *Panonychus citri*, by providing pollen as an alternative food source. Moreover, *A. conyzoides* L. reduces the spore germination of several fungal pathogens, such as *Phytophthora citrophthora*, *Pythium aphanidermatum*, and *Fusarium solani*, by releasing allelochemicals into the soil. Additionally, it is used as a source of plant nutrients. It contains 42.11% organic carbon, 3.78% total nitrogen, and 0.21% phosphorus, with a C/N ratio of 11.15, making it suitable for use as organic matter or compost. Traditionally, it is used as green manure in fields in South China to enhance crop yields and suppress weeds. 10% extract of *A. conyzoides* L. positively impacted pea seed germination. Lower concentrations of the extract stimulated growth and nodulation parameters, while higher concentrations reduced the pH and cation-exchange capacity (CEC) values of soil in the pea field. These findings support the use of *A. conyzoides* L. as green manure (Baral *et al*., 2022; Zohaib *et al*., 2017; Liang and Huang, 1994; Jianjun *et al*., 2002; Anhar *et al*., 2018). In another study, aqueous extracts of 50% and 100% concentrations were prepared from fresh and air-dried plant parts (leaves and roots) of plant, and their allelopathic effects were observed on the seed germination and seedling growth of two rice varieties, Sava and Geru. In the Sava variety, a significant reduction in seed germination, seedling length, and dry weight was recorded under dry leaf extract. However, fresh leaf extract at 50% concentration increased seed germination and seedling length compared to the control. In the Geru variety, both fresh and dry leaf extracts resulted in decreased seed germination and seedling growth with increasing concentration. Similar patterns were observed for fresh and dry root extracts. The inhibitory effect of leaf extracts was more pronounced than that of root extracts, and overall, dry aqueous extracts of leaves and roots were more inhibitory than fresh aqueous extracts. Among the varieties, Sava was less affected compared to Geru. This study indicates that *A. conyzoides* L. exerts an

allelopathic effect on rice crops by releasing water-soluble phytochemicals (Negi *et al*., 2020).

Table 4. Allelochemicals present in *A. conyzoides*

PLANT PART	ALLELOCHEMICALS	REFERENCE
Fresh leaves	precocene I, precocene II, 3,3-dimethyl-5-tert-butylindone, β-caryophyllene, G-bisabolene, and fenchyl acetate	Erida *et al*., 2023
Fresh leaves, stems, roots	Gallic acid, coumalic acid, and protocatechuic acid, and catechin was found only in the stem. *P*-hydroxybenzoic acid was detected in both *A. conyzoides* leaves and stem	Erida *et al*., 2023
Full mature plant	Precocene II, precocene I and caryophyllene, Precocene II, Precocene I, β-caryophyllene, α-bisabolene, Phenolics, Phenolic acid, Gallic acid, coumalic acid, protocatechuic acid, catechin and p-hydroxybenzoic acid	Erida *et al*., 2023
Flower	amino acids content, Vitamins A and B have also been reported	(Solanki *et al.*, 2010)

c) Anti-fungal effect

In a research study, water extracts of *Ageratum conyzoides* were tested for their anti-fungal properties. The extract from *A. conyzoides* L. inhibited the mycelial growth of *Rhizoctonia solani, Aspergillus niger,* and *Phomopsis theae* by at least 70%. (Iqbal *et al*., 2001). In another study, the essential oil of the plant demonstrated antifungal activity against *Helminthosporium turcicum, H. oryzae, Cercospora capsici, Pyricularia setariae,* and *Fusarium moniliforme* (Kamboj and Saluja, 2008). All parts of *A. conyzoides* L. contain fungitoxic chemicals effective against *Fusarium solani*, the pathogen causing wilt. Research has shown that exposing the target fungus to various concentrations (2%, 4%, and 6% w/v) of aqueous, methanolic, and n-hexane extracts from the inflorescence, leaf, stem, and root significantly suppressed the growth of the fungal pathogen (Sidra Javed, 2012; Baral *et al*., 2022).

Nguyen *et al*., 2021, isolate five anti-fungal compounds from the above-ground parts of *A. conyzoides* L. Among them, three polymethoxy flavones—5-methoxy nobiletin (compound 2), nobiletin (compound 3), and 5,6,7,3',4',5'-hexamethoxyflavone (compound 4)—inhibited the growth of *P. oryzae* and *R. solani* in laboratory settings. Eupalestin (compound 5) specifically targeted *P. oryzae*. Additionally, precocene II, which possesses a distinct structure, demonstrated strong antifungal activity against both fungi with an IC50 ten times lower. Furthermore, the ethanolic extract was shown to protect rice against blast disease in field trials conducted under shaded net-houses. Overall, the extract from *A. conyzoides* L. shows potential as an effective antifungal agent for combating fungal diseases in agricultural

contexts. This research lays the groundwork for developing natural fungicides as substitutes for synthetic agents (Nguyen *et al*., 2021).

d) Microbial effect

In a study, *A. conyzoides* L. biomass was vermi composted with cow dung in proportions of 25% (*Ageratum* + CD) (25:75 v/v), 50% (*Ageratum* + CD) (50:50 v/v), and 75% (*Ageratum* + CD) (25:75 v/v). The findings indicated that vermicomposting *Ageratum* with a 50-75% proportion in vermicompost beds yielded superior outcomes in waste mineralization, microbial enzymatic activities, and the buildup of microbial populations. Specifically, *Ageratum* at 50% and 70% proportions showed the highest fold increases in bacteria (2.09-2.51), fungi (1.48-2.41), and actinomycetes (1.52-1.79) populations. Additionally, vermicomposting led to a decrease in pH but increases in total nitrogen (59.6-69.9%), available phosphorus (53.8-148.7%), total potassium (32.2-92.43%), and total calcium (25.5-55.3%). These results suggest that *Ageratum* can be effectively transformed into non-toxic manure through vermicomposting technology (Baral *et al*., 2022; Gusain and Suthar, 2020).

e) Herbicidal effect

According to research conducted at Thai Nguyen University of Agroforestry, Vietnam, applying *A. conyzoides* L. leaves at a rate of 2 tons per hectare in a paddy field, two days after transplanting, resulted in approximately 75% reduction in paddy weeds and increased yield by 14% compared to using herbicides (Xuan *et al*., 2004). This research indicates it could serve as a natural herbicide for controlling weeds in paddy fields, potentially reducing reliance on synthetic herbicides. In another experiment conducted at the Laboratory of Crop Science, Faculty of Agriculture, Miyazaki University, Japan in 2002, applying *A. conyzoides* L. leaves at a rate of 2 tons per hectare significantly reduced the number of *Echinochloa crus-galli* weeds (inhibited by 78.4%) and completely prevented the emergence of *Monochoria vaginalis* and *Aeschynomene indica* under calcareous soil conditions (Xuan *et al*., 2004; Baral *et al*., 2022). In another study, various concentrations (0, 2, 4, 6, 8, and 10%) of aqueous extracts from different parts of plant were used in laboratory bioassays. Analysis of variance (ANOVA) indicated significant effects of both plant part and extract concentration on germination, as well as various root and shoot growth parameters. The leaf extract exhibited the highest herbicidal activity, completely inhibiting the germination and growth of *parthenium* at a 10% concentration. Extracts from the root and inflorescence also showed strong inhibitory effects, reducing germination by up to 89% and 95%, shoot length by up to 80% and 89%, root length by up to 86% and 91%, and overall plant biomass by up to 89% and 98%, respectively. In contrast, the stem extract demonstrated the least herbicidal activity, causing reductions of up to 46%, 59%, 73%, and 37% in germination, shoot length, root length, and plant biomass, respectively. This study concludes that leaf, root, and inflorescence extracts of *A. conyzoides* L. possess potent herbicidal properties against the germination and growth of *parthenium* (Javaid *et al*., 2020).

10. Conclusion

A. conyzoides L. is a multifaceted plant that, despite its reputation as an invasive weed, offers numerous benefits across various fields. Its rich phytochemical composition provides a valuable resource for medicinal research, with compounds demonstrating anti-inflammatory, analgesic, antimicrobial, and potential anti-cancer properties. These medicinal attributes

underscore the plant's potential in developing treatments for a range of ailments, from common infections to life-threatening diseases like cancer.

In agriculture, *A. conyzoides* L. contributes positively through its use as a green manure, enhancing soil fertility and promoting sustainable farming practices. Its insecticidal properties further highlight its utility as a natural, eco-friendly pesticide, offering a sustainable alternative to chemical pest control methods.

The plant's adaptability to diverse environmental conditions makes it an excellent candidate for soil stabilization and revegetation projects, aiding in the restoration of degraded ecosystems. This resilience, coupled with its various applications, positions *A. conyzoides* L. as a plant of significant ecological and economic importance.

Overall, while *A. conyzoides* L. poses challenges as an invasive species, its diverse applications in medicine, agriculture, and environmental management reveal a plant with considerable potential. Future research and careful management could harness its benefits while mitigating its invasive nature, turning a perceived weed into a valuable resource.

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