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***Review Article***

# Ethano-botanical, Agronomical, Phytochemical, and Pharmacological Aspects of *Mikania micrantha Kunth*, its medicinal properties and uses - A Review

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**Abstract**

This review paper focuses on the plant *Mikania micrantha* Kunth, which has many phytochemical compounds, medicinal properties, and agricultural uses. Previous studies have found various substances in this plant, including alkaloids, flavonoids, reducing sugars, saponins, phenolics, tannins, amino acids, terpenoids, glycosides, steroids, proteins, and essential oils in its leaves. Different parts of the plant contain several pharmacologically active compounds such as sesquiterpenes, diterpenes, coumarins, sesquiterpene lactones, kaurenic acid, stigmasterol, germacranolide, resin, and phytosterols. *M. micrantha* is an invasive plant known for its various beneficial effects, including antioxidant, antihelmintic, antidermatophytic, anti-stress, anti-diabetic, antispasmodic, antimicrobial, antiprotozoal, antitumour, anti-proliferative, anti-inflammatory, and anti-viral properties. The plant also contains important phenolic compounds like ethyl caffeate, ethyl ferulate, 3, 5-di-O-caffeoylquinic acid, and mikanin. Therefore, this review aims to highlight the ethano-botanical, agronomical, phytochemical, and pharmacological aspects of *M. micrantha* Kunth, along with its medicinal properties and useful applications.

## 1.INTRODUCTION

These days, studying medicinal plants is very important because of the growing need for natural solutions to environmental and health problems. For this reason, a review has been done on *Mikania micrantha* Kunth, focusing on its ethnobotanical, agronomical, phytochemical, pharmacological, and biotechnological aspects, as well as its medicinal uses. Many researchers have already studied this plant, and a lot of work has been done on different aspects of it. *Mikania micrantha* Kunth, known as a "plant killer," is one of the ten most invasive weeds worldwide (Wu et al., 2013; Clements et al., 2019; Wang et al., 2019). It is an invasive alien weed and is referred to as a plant killer in many parts of the world (Xi et al., 2020). This plant is used in traditional medicine and has been widely studied in chemical and biological research because of its various biological activities, such as antibacterial, antitumor, analgesic, antimicrobial, cytotoxic, and phytotoxic properties, as reported by several researchers (Laurella et al., 2012; Dou et al., 2014; Zhang et al., 2009; Rios et al., 2014; Zhuang et al.,

2010; Ghosh et al., 2008; Ahmed et al., 2001; Facey et al., 1999; Yan et al., 2011; Li et al., 2013). Jali et al. (2021) studied the secondary metabolites or allelochemicals of this plant, which have various agricultural applications and help protect crops from harmful plants.

*Mikania micrantha* is a plant that originated from the tropical regions of Southeast Asia, such as Indonesia and Malaysia. It has spread to other tropical areas like Central America, Sri Lanka, Madagascar, the Caribbean, Hawaii, and northern Australia. Currently, much of the drug discovery research is based on natural plant resources and their compounds. Most of the drugs used today are developed based on knowledge from traditional medicine. People now prefer natural lifestyles and prevention over cure, which has increased the use of herbal products. Ayurveda uses methanolic or hot aqueous extracts of *Mikania micrantha* for its antibacterial properties. This plant has been used in traditional Indian medicine to treat five harmful bacteria: *Staphylococcus aureus*, *Bacillus subtilis*, *Escherichia coli*, *Proteus vulgaris*, and *Enterobacter aerogenes*.

*Mikania micrantha* has a wide range of chemical compounds. Amador et al. (2010) identified some chemicals in the leaves of this plant using gas chromatography, including Linalool (15.86%), alpha-Pinene (10.14%), beta-Pinene (8.72%), beta-Ocimene (7.12%), Teripeniol (6.31%), Geraniol (2.89%), Geranyl acetate (0.83%), Thymol (0.46%), alpha-felandrene (0.39%), and Champene (0.187%). According to Taylor, the main components are caffeolylquinic acid, cinnamic acid, glycosides, coumarin, kaurenic acid, stigmasterol, tannins, germacranolide, and resin. Ma et al. (2020) also reported the presence of germacrane-sesquiterpenoids in the leaves of this plant. This plant is used to treat various conditions like upper respiratory tract disorders, bacterial, protozoal, fungal, and yeast infections, snake bites, insect stings, and for its anti-inflammatory and pain-relieving properties. In Southern India, the juice of its leaves is used to treat abdominal pain. In Indonesia, it is used for stomach upsets, skin itching, lameness, wound infections, rheumatism, menstrual pain, bloating, diarrhea, influenza, diabetes, and malaria.

## 2. Botanical Aspects of *Mikania micrantha*

### 2.1. Taxonomy

***Mikania micrantha***

**Systematic position**

Kingdom: Plantae
Division: Magnoliophyta
Class: Magnoliopsida
Order: Asterales
Family: Asteraceae
Genus: *Mikania*
Species: *micrantha Kunth*

SYNONYM: These are also called as bitter vine, climbing hemp vine, Chinese creeper or American rope. Vernacular names of *Mikania micrantha*, in the Manipuri language it is called as Oori hingchabi, in Nepali –Laharebanamaaraa, in Malayalam- Vayara, in Bengali – Ravanlata.

### 2.2. Origin and distribution

*Mikania micrantha* is native to Central and South America and is a fast-growing, perennial creeping weed (Kong et al., 2000). In India, it is known as "Japani lota" in Assam. It is a fast-growing plant that prefers humid areas and can grow even in less fertile soils. Its seeds are light and spread through the wind, with a single plant producing around 20,000 to 40,000 seeds per season (Bora et al., 2023). This plant was introduced to India during World War II for use in camouflaging airfields or as ground cover for tea plantations (Choudhury, 1972). *Mikania* is found in tropical forests like the Western Ghats and the North Eastern Himalayas (Rameshprabu and Swamy, 2015). Banerjee and Dewanji (2012) reported that in Kerala, Assam, and the Western Ghats, this plant was documented about 12 years later. They also noted that it is present in five Indian states: Tamil Nadu, Uttar Pradesh, Andhra Pradesh, Orissa, and Meghalaya. The weed *Mikania micrantha* H.B.K (Asteraceae) is an invasive plant that causes significant economic and ecological damage in the forestry and plantation sectors in Asia-Pacific countries (Sankaran et al., 2008). Banerjee et al. (2017) detailed the potential distribution of *Mikania micrantha* Kunth in India. Although *Mikania*

*micrantha* has some economic benefits, the losses from its infestation outweigh these gains. It is used as livestock fodder in several countries, including Malaysia, where sheep and cattle prefer to eat it. In some parts of Kerala, India, it is used as a food source during the summer when other grasses are scarce. However, it can cause liver toxicity and damage in dairy cattle. The antibacterial properties and wound-healing effects of *Mikania* have been studied. In Assam, the Kabi tribes use the leaf juice of this plant as an antidote for insect bites and scorpion stings. The leaves are also used to treat stomach aches. In Malaysia, it is used for treating itching. However, there is limited scientific evidence supporting these uses. In Africa, *Mikania* leaves are used as a vegetable in soups. The weed is used as a cover crop in rubber plantations in Malaysia and planted on slopes to prevent soil erosion. In Mizoram, India, green manure made from *Mikania* has been shown to increase rice yields. Recent studies suggest that *Mikania* may not be suitable for mulching and composting due to its high content of certain compounds due to its high water content.

### 2.3. Morphology

**Fig.1.** *Mikania macrantha kunth*

It is a fast-growing plant that comes back every year. It grows best in places with lots of moisture, light, and rich soil, but it can still grow in less fertile soil. Its seeds are very light and can be carried by the wind. A single plant can make between 20,000 and 40,000 seeds in one season. The stems of *Mikania micrantha* are thick and have ridges. They can grow up to 6 meters long, with leaves that are 4 to 13 centimeters long. These leaves have a heart-shaped base and a sharp tip. The flowers are white and are grouped together. They are about 4.5 to 6 millimeters in size.

## 3. Agronomical aspects of *Mikania micrantha*

### 3.1. Climate, Soil and Environmental Requirements

*Mikania micrantha* can grow in a wide range of altitudes. It can be found at elevations up to 3000 meters in Bolivia and from sea level up to 1100 meters in Malaysia and Papua New Guinea. In Fiji, Vanuatu, and Taiwan, it grows up to 1000 meters. In southern China, this plant can grow in different types of soil, from acidic to alkaline, with a pH range of 4.1 to 8.3. It can also grow in soils that are not very fertile to very fertile. In China, it grows best where the average temperature is above 21 degrees Celsius and where the soil has more than 15% moisture. It can grow in various soil types, including sandy loam and gravelly soils, and can survive in areas with good drainage, waterlogged soil, and wet ground.

### 3.2 Propagation Technique

*Mikania micrantha* can be controlled in several ways. Mechanical methods like weeding with a sickle, uprooting, and digging are commonly used. Weeding before the plant flowers or produces seeds gives temporary control, but the plant can quickly regrow from the cut roots. Uprooting early in the growth cycle, before the plant flowers or produces fruit, is the most effective mechanical method. The slash and burn technique is also used. However, even after burning, the plant can survive and grow new shoots within a few months. Mechanical control requires a lot of labor and is not very cost-effective. One advantage of this method is that it limits the plant's ability to spread through its stems. In Indonesia, the cost of mechanical control of *Mikania* is said to be 125 to 175% higher than using herbicides.

## 4. Phytochemistry

Some studies suggest that *Mikania micrantha* contains various compounds. A study on the leaf extract showed the presence of alkaloids, flavonoids, reducing sugars, saponins, phenolics, tannins, amino acids, and proteins. Another study

found that the aerial parts of the plant contain glycosides, terpenoids, phenolics, alkaloids, steroids, and flavonoids. A qualitative analysis of the whole plant showed tannins, phenols, flavonoids, glycosides, cardiac glycosides, carotenoids, and saponins. More than 27 terpenoids have been found in the plant, with sesquiterpenoids and linalool being the main components. Other studies have found terpenoids like linalool and alpha-pinene from seeds and flowers. The concentration of linalool in these parts is similar to that found in the whole plant. Different parts of the plant and extraction methods produce different chemical compounds. Saponins were found in the leaves using petroleum ether, while the aerial parts mainly contain terpenoids and steroids. Ethyl acetate extraction of the aerial parts showed the presence of terpenoids, steroids, alkaloids, and glycosides, with terpenoids being the main component. However, these findings were based on qualitative tests, so exact amounts of these chemicals are not known. The dominant components in the leaf essential oils are beta-cubebene, germacrene D, and alpha-zingiberene, making up 11.34%, 10.96%, and 10.76% respectively. The main components in stem essential oils are d-limonene (16.99%), beta-pinene (7.91%), and alpha-zingiberene (7.26%). These findings give more understanding about the chemical makeup of *Mikania micrantha* essential oils and show their possible future uses.

**Phenolics**

*M. micrantha* contains the phenolic derivatives namely - 8,10-dihydroxy-9-benzoyloxythymol, 9-isobutyryloxy-10-hydroxythymol, 10-isobutyryloxy-6-methoxy-8,9-epoxy-thymol, 7,8,9,10- tetrahydroxythymol, 7,8,10-trihydroxy-9-Eferuloyloxythymol, 8,9,10-trihydroxythymol, 8,10-dihydroxy-9-acetoxythymol, 8,10- dihydroxy-9-isobutyryloxythymol, 8,10- dihydroxy-9-(2-methylbutyryloxy)thymol, 8,9-dehydro-10-hydroxythymol, 8-methoxy9-hydroxythymol, ethyl caffeate, ethyl ferulate, 3,5-di-O-caffeoylquinic acid, and mikanin.

## 5. Pharmacological Properties of *Mikania micranta*

Recent studies on the biological activities of *M. micrantha* have been increasing. Many researchers have tested different parts of this plant and used various solvents to extract compounds, looking for their effects on things like fighting free radicals, killing certain parasites, stopping fungal infections, reducing stress, helping with diabetes, easing muscle spasms, fighting bacteria, protozoa, cancer, inflammation, and viruses. Earlier research showed that compared to other plant remains, *M. micrantha* has more helpful chemical groups in different parts, like flavonoids, sesquiterpenes, diterpenes, coumarins, sesquiterpene lactones, and phytosterols or terpenoids (Sheam et al., 2020, Saikia et al., 2020). To make *M. micrantha* useful, these chemicals have been collected from the plant and tested against harmful fungi and bacteria (Huang et al., 2008, Saikia et al., 2020). Also, these chemicals might be released into the air or broken down as the plant residue decays (Ni et al., 2007). It's important to note that the rise in antibiotic resistance and antibiotic resistance genes (ARGs) has led scientists to focus more on the importance of medicinal plants and their chemical components (Dassanayake et al., 2021). Besides helping against bacterial infections, some of these chemicals can work along with existing antibiotics, which might be a good way to fight drug resistance (Dassanayake et al., 2021, Saikia et al., 2020). So far, very few studies have used *M. micrantha* in the composting process. For example, Kauser et al., 2020, and Kauser and Khwairakpam, 2022, used *M. micrantha* to study plant growth before and after composting to check for harmful effects. However, it is still unknown whether the chemicals from *M. micrantha* can help reduce the amount of pathogen-holding substances (PHI - Pathogen-host interactions) and speed up the removal of ARGs in compost. Also, there's a lack of deeper understanding about how these chemicals reduce ARGs, virulence factors (VFGs) and harmful microbes. Therefore, research is being done to find out if adding *M. micrantha* to compost could be a good way to manage the spread of antibiotics, ARGs, VFGs, and harmful microbes in compost products. The findings of this study can offer useful

info about how *M. micrantha* can be used to lower the amount of ARGs and harmful microbes in raw compost material. Using compost mixed with *M. micrantha* can create economic benefits by using organic waste again and also help the environment by reducing the harmful effects of antibiotics and the spread of *M. micrantha* itself.

**6. Biotechnological Aspects of *Mikania* micranta**

Recently, the complete genome of the chloroplast (cp genome) of *M. micrantha* was studied by Huang et al., 2016. Su et al., 2018, studied the chloroplast genomes of the invasive weed *M. micrantha* and its native relative *M. cordata*, and also did a phylogenetic analysis.

**Table1.** Lists of the summary of existing studies on the pharmacological properties of *M. micrantha*

| Pharmacological properties | Findings / uses |
|---|---|
| Antimicrobial (antibacterial and antifungal) | (1) Antibacterial activity against *Klebsiella* pneumonia and Staphylococcus aureus at 100 µg/100 µL of extract.<br>(2)Antifungal activity against *Candida albicans*. |
| Anti-diabetic | Reduction of blood glucose level in diabetic rats treated with aqueous and ethanolic extract of *M. micrantha* |
| Antidermatophytic | (1) Ethyl acetate extract of *M. micrantha* showed the highest antidermatophytic activity, followed by petroleum ether and methanolic extracts.<br>(2) Ethyl acetate extract completely inhibited the growth of dermatophytes at the tested concentration of 2 mg/mL. |
| Antioxidant | (1)Total phenolic contents (3.34±0.02 mg catechol/g dry material) and total flavonoid contents (2.07±0.03 mg quercetin/g dry material).<br>(2)Percentage of inhibition were 63.57% and 75.20%using 2,2-Diphenyl-1-picrylhydrazyl (DPPH) and 2,2'-azinobis-3 -ethylbenzothiazoline-6-sulphonic acid (ABTS) radical scavenging activity, respectively. |
| Anti-cancer | 1) In vitro: Treatment with 50, 100, 200 and 400µg/mL of *M. micrantha* aqueous extract inhibited the proliferation of both cells.<br>(2) In vivo: *M. micrantha* aqueous extract led to damages of organelles, induced apoptosis,and necrosis. The tumour nhibitory rate of S180 (sarcoma cell)-bearing mice was 12.1% to 46.9%. |
| Anti-inflammatory | (1) Treatment of 1 mg hexane and ethyl acetate extracts of the ear of 12-O-tetradecanoylphorbol-13-acetate (TPA) - induced mouse ear edema showed a significant anti-inflammatory activity. Ethyl acetate extracts has the highest anti-inflammatory activity.<br>(2)The methanolic extract did not show anti-inflammatory activity. |
| Anti-stress | (1) Wistar albino rats (either sex) given oral doses of methanolic extract at 500 mg/kg body weight showed an increase in duration of anoxia stress tolerance and swimming endurance time.<br>(2) Treatment of 500 mg/kg methanolic extract of *M. micrantha* to stress-induced immobilized rats significantly reduced glucose, cholesterol, and blood urea nitrogen level. |

**7. Current Demand**

In India, Malaysia, and Taiwan, *M. micrantha* has been introduced or used as a cover crop to improve the soil or prevent soil erosion. It's also used as feed for sheep and cattle in India, Malaysia, and Fiji. However, it can cause liver damage when eaten. In India, *M. micrantha* is known to help increase the growth and yield of rice when used as green manure. But it's not good for mulching or composting because it has a lot of water and decomposes quickly. It's also used as a medicinal plant in various countries because it has antibacterial and antimicrobial properties. In India, some tribal people use the gum from the leaves to treat snake, insect, and scorpion bites. In Fiji, Samoa, and to a smaller extent in Papua New Guinea, *M. micrantha* is used to treat cuts and nausea. The leaves can be used as a topical ointment to ease the pain of hornet, bee, and ant

stings. In Ecuador, it's reportedly used as rat poison.

### 8. Adulteration and Authentication of *Mikania* micranta

*Mikania* is a group of climbing plants, with the majority of its 430 species coming from tropical America. The three most common species are *M. cordata*, *M. scandens*, and *M. micrantha*, and these are often mistaken for each other. These species can be generally told apart by the following features (Holm et al., 1991). *M. micrantha*: have 32–38 white bristles (pappus), white corolla, head length 4.5–6 mm, and nodal appendages that are thin and membrane-like. It is found in tropical and central America. *M. cordata*: have 40–45 reddish bristles, white corolla, head length 7–7.5 mm, and nodal appendages that form fuzzy ridges, not membrane-like. It is found in Southeast Asia and Africa. *M. scandens*: has 30–35 white or pale bristles, pale purple corolla, and head length 5–7 mm. It is found in eastern North America. In Taiwan, *M. micrantha* is hard to tell apart from the native *M. cordata*, so a molecular technique has been developed to tell them apart. *M. micrantha* has unique semi-transparent structures between the petioles on young shoots, similar to small leaf-like structures (stipules). These are very unusual in the Compositae family. They disappear on older shoots and aren't seen on flowering branches. Differences in these structures can help tell *M. micrantha* apart from *M. cordata*.

### 9. Conclusions and Future Scope

Based on earlier research, *M. micrantha* has shown promise in treating several health issues like diabetes, infections, and cancers. Different parts of this plant contain many useful chemicals, which help give it its medicinal qualities. Among these, terpenoids are the main compounds found. The plant also has value as a resource for agriculture, such as being used with chicken manure. *M. micrantha* has been found to have many helpful effects, including antioxidant, antihelmintic, antidermatophytic, anti-stress, anti-diabetic, antispasmodic, antimicrobial, antiprotozoal, antitumour, anti-proliferative, anti-inflammatory, and anti-viral properties. However, more studies are needed to back up the traditional use of this plant and the limited scientific support for its health benefits. Also, because of concerns about quality and safety, it's important to do research on the toxic effects of different parts of *M. micrantha*. More studies on animals and humans should be carried out to better understand how effective and safe this plant can be for treating and preventing diseases.

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