



Nutritional, Phytochemical and Pharmacological Properties of *Mikania micrantha* Kunth

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Abstract – *Mikania micrantha* Kunth (Asteraceae) is a perennial creeping vine that can be found in South and North America, Africa, Pacific Islands and Southeast Asia, including Southern China and Malaysia. Previous studies have reported that this plant possesses several pharmacological properties which can be used to prevent and cure several diseases. Phytochemicals found from various parts of *M. micrantha* have been linked to beneficial medicinal properties such as antioxidant, antimicrobial, antitumour, anti-inflammatory, anti-stress, and also anti-diabetic activities. The primary aim of this paper is to review available scientific information on the nutritional, phytochemical and pharmacological properties of *M. micrantha* to provide baseline information for future studies.

Keywords: Antioxidant, medicinal properties, *Mikania micrantha*, pharmacological, phytochemical

Introduction

Asteraceae (or Compositae) is one of the largest family of flowering plants which contains the genus *Mikania* (Pérez-Amador, Muñoz Ocotero, Ibarra Balcazar, & García Jiménez, 2010). This genus has more than 430 species distributed mainly in the tropical regions (Rufatto, Gower, Schwambach, & Moura, 2012). Traditionally known for its medicinal properties, several species of this genus are edible and have been used as folk medicine (Chetan, Sampath Kumara, Sekhar, & Prakash, 2012). *Mikania micrantha* Kunth or commonly known as “*selaput tunggul*” in Malaysia is a type of weed originated from tropical Central and South America. It is also known as American rope, Chinese creeper, or mile-a-minute (Wang, Peng, Zeng, Ding, & Xu, 2009) and recognized as “*sembungrambat*” in Indonesia (Haisya, Latifah, Suratno, Sa’diah, & Afiff, 2013).

Since the early 20th century, this perennial creeping vine has been widespread to the Pacific Islands and Southeast Asia, including Southern China (Xu, Xie, Xiao, & Wei, 2013). They have been found in India, Malaysia, Thailand, Indonesia, Nepal, Papua New Guinea, Philippines, and also Australia. *M. micrantha* can be found growing along the roadside, swampy woods, bushes of moist places, forest borders, and also along streams and rivers (Saha, Mandal, & Chowdhury, 2015). They grow and spread easily by wind dispersion of the seed and stem fragments that root easily at the nodes (Shao, Peng, Wei, Zhang, & Zhang,). The flowering season for *M. micrantha* is from August to February (Saha et al., 2015). *M. micrantha* can be divided into several anatomical parts, namely seeds, inflorescences, leaves, stems, and roots. The leaves are simple, heart-shaped, opposite, petiolate, cordate or hastate, acuminate, having the size of 11.5 - 6.6 cm × 1.8 - 0.7 cm. Meanwhile, the stems are nearly rounded, hairy, and sometimes inconspicuously five ribbed (Saha et al., 2015).

M. micrantha has distinctive characteristics that differentiate it from other species in the genus *Mikania* such as *M. scandens* and *M. cordifolia*. Identification of *M. micrantha* within the other genus

depends either on flowers or inflorescences, or the specific phytochemical components. Another vegetative character that differentiates *M. micrantha* from other genus includes leaf colour and shape, stem colour, growth habit, and the pseudostipules between the petiole bases of the leaves. However, the most reliable diagnostic character is the pseudostipule structure (Anderson, Weaver, Neubig, Frank, & Dixon, 2012). According to Nicollier and Thompson (1981), the major difference between *M. micrantha* and other previously investigated species of the genus is the absence therein of aromatic terpenes or coumarin derivatives. Meanwhile, Anderson et al. (2012) had characterized *M. micrantha* for the leaves (pale or yellow-green), flowers (white, 2.5-3 mm long), phyllaries (glabrous or nearly so), inflorescence (glabrous or nearly so), and the pseudostipules (membranous flap with incised lobes). Figure 1 shows the aerial parts of *M. micrantha*.



Figure 1: Aerial parts (leaves and stems) of *M. micrantha*

M. micrantha can be found easily in plenty from its natural habitat, which makes the plant readily available for traditional treatment. Moreover, this plant could provide an adequate supply of raw material for the pharmaceutical industry to develop modern medicines (Jyothilakshmi, Jyothis, & Latha, 2015). However, *M. micrantha* is considered as a weed which reduces the growth and productivity of several crops such as rubber, oil palm and cocoa plantation in Malaysia where around 8-10 million dollars have been invested per annum to control its growth (Sankaran, 2008). Scientific studies on the medicinal properties of *M. micrantha* could increase the value of the plant from weed to medicinal plant. Despite that, there is still limited study on the nutritional and pharmacological properties of *M. micrantha* from other geographical variation as a scientific evidence to prove its traditional uses. This paper will provide information on the nutritional, phytochemical, and pharmacological properties of *M. micrantha* which can provide baseline knowledge for future research.

Traditional medicinal uses of *M. micrantha*

In South America and Southeast Asia, *M. micrantha* is commonly used as a folk medicine to treat several diseases. The aerial parts of *M. micrantha*, mainly leaves, are commonly used in traditional medicine preparation. They are consumed as juice, or as a poultice to treat insect bites or scorpion stings. *M. micrantha* is also used to treat skin diseases such as rashes and skin itches (Li, Li, Li, Wang, & Cao, 2013).

In Malaysia, *M. micrantha* is consumed as a juice (prepared by decoction method) to treat diabetes, stroke, hypercholesterolemia and hypertension. In addition, the leaves are used for treating stomach

ache, jaundice, and placed in lukewarm water bath for women after confinement. It has also been reported that *M. micrantha* is used to treat fever, rheumatism, cold and respiratory diseases (Chetia et al., 2014). In Fiji, it is used to heal cuts and stop minor external bleeding whereas, in Bangladesh, *M. micrantha* has been used as an antiseptic medicine (Dev, Hossain, & Islam, 2015). According to Facey, Peart, & Porter, (2010), people in Jamaica used *M. micrantha* for wound dressing and healing of sores.

Traditional uses of *M. micrantha* in medicinal preparation, especially for the treatment of external wounds, have been proven since they are reported to possess antimicrobial activity. In fact, the wound healing properties of *M. micrantha* have been proven through the application of the extract as an ointment on excision wound of diabetic rats (Nurdiana, Nur Ajeerah, Nur Farhana, Siti Khairiyah, & Norashirene, 2013). Tannins and flavonoids are compounds that can activate collagen synthesis and increase the number of granulation tissue, thus increase the wound healing rate (Nurdiana et al., 2013).

Apart from that, *M. micrantha* is also used in the decoctions for skin infections and ulcers (Zhang et al., 2004) because it is a rich source of terpenoids (Nicollier & Thompson, 1981). It was found that *M. micrantha* possess antibacterial activity (Facey et al., 2010) that it has potential as wound healing. In 2010, Facey and his colleagues proved that the sesquiterpene lactones, i.e. mikanolide are the compounds responsible for the antibacterial activity. The Gram positive bacteria (*Staphylococcus aureus* and *Streptococcus* group A) were found susceptible to 100 µg ethyl acetate: acetone extract of *M. micrantha* from the presence of $\alpha\beta$ -unsaturated lactones in the examined sesquiterpenoids which contribute to the antibacterial activity (Facey et al., 2010).

Nutritional compositions of *M. micrantha*

Different parts of *M. micrantha* have different valuable compounds. Proximate compositions of different parts of *M. micrantha* such as moisture and ash content have been reported. Dev et al. (2015) have reported the moisture and ash content for the air-dried leaves of *M. micrantha*. Five grams of powdered leaves of *M. micrantha* contains 9.71% moisture content and total ash content of 5.23%. Meanwhile, the acid insoluble and water soluble ash content of the dried leaves were 4.77% and 4.15%, respectively. Another study by Saha et al. (2015) reported the moisture and ash content of the fresh aerial parts of *M. micrantha* which includes the leaves and stems. The moisture content of the fresh aerial parts was high, which is 87.63% whereas the total ash, acid insoluble ash, and water soluble ash contents were 10.55%, 0.59%, and 3.13%, respectively.

Proximate analysis is important for the quality assessment of the sample. Ash content indicates the mineral composition of the plants, either major minerals (e.g. calcium, phosphorus, magnesium, sulphur, potassium, chloride, and sodium) or trace minerals such as zinc, iron, silicon, manganese, copper, fluoride, iodine and chromium (Thomas & Krishnakumari, 2015). In fact, the information on the acid insoluble and water soluble ash is important in the elucidation of the quality, purity, and standardization of a crude drug (Kunle, Egharevba, & Ahmadu, 2012). Further studies are needed on the basis of other macronutrients (protein, fat, fibre, and carbohydrate) and micronutrients (vitamins and minerals) content from various parts of *M. micrantha*.

Chemical constituents of *M. micrantha*

M. micrantha has been tested for its phytochemical contents in several studies. Phytochemicals are biological, non-nutritive plant chemicals that have protective or disease preventive properties. Terpenes (essential oil) are the major constituents isolated from *M. micrantha* (Jyothilakshmi et al., 2015; Nicollier & Thompson, 1981). Table 1 lists the identified phytochemicals from various parts of *M. micrantha*.

Table 1: Phytochemicals identified from M. micrantha extracts.

Chemical classification	Phytochemical compounds	Plant parts	Author/year
Flavonoids	Eupalitin, eupafolin, 3,4',5,7-tetrahydroxy-6-methoxyflavone 3-O-β-D-glucopyranoside, luteolin, 3,5-di-O-caffeoylquinic acid <i>n</i> -butyl ester and 3,4-di-O-caffeoylquinic acid <i>n</i> -butyl ester	Whole plant	Wei, Huang, Wu, Cao, & (2004)
Sesquiterpene dilactones	Mikamicranolide, 11β,13-dihydromikamicranolide, 3α-hydroxy-11β,13-dihydrodeoxymikanolide, 2β,3β-dihydroxy-11β,13-dihydrodeoxymikanolide, dihydromikanolide, deoxymikanolide, 11β,13-dihydrodeoxymikanolide, and dihydroscadenolide	Whole plant	Huang, Ye, Wu, Lin, & Wei, (2004)
Terpenoids (essential oil)	2-butanamine, limonene, β-copaene, β-terpinene, α-terpinene, α-longipinene, α-bergamotene, α-zingiberene, carveol, linalool, α-humulene, p-cymene-2-ol, β-caryophyllene, menthol, curcumene, β-himachalene, β-cubebene, verbenone, terpinene-4-ol, geraniol, cadinene, β-germacrene	Leaves and stems	Zhang et al. (2004)
Sesquiterpene lactones	3β-acetoxy-1,10-epoxy-4-germacrene-12,8;15,6-diolide, 1,10-epoxy-4-germacrene-12,8;15,6-diolide, dihydromikanolide, potassium mikanin 3-sulfate, mikanin, alpinetin, and ergosta-7,22-dien-3β-ol	Aerial parts	But et al. (2009)
Terpenoids (essential oil)	Camphene, β-pinene, α-felandrene, β-ocimene, geranyl acetate, terpineol, geraniol, thymol, linalool and α-pinene	Seeds and inflorescence	Pérez-Amador et al. (2010)
	Deoxymikanolide, scandenolide, dihydroscandenolide, mikanolide, dihydromikanolide, m-methoxy benzoic acid	Leaves	Li et al. (2013)
Phenolics	8,10-dihydroxy-9-benzoyloxythymol, 9-isobutyryloxy-10-hydroxythymol, 7,8,9,10-tetrahydroxythymol, 7,8,10-trihydroxy-9-E-feruloyloxythymol, 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-methoxy-9-hydroxythymol, ethyl caffeate, ethyl ferulate, 3,5-di-O-caffeoylquinic acid, and mikanin	Roots	Xu et al. (2013)
Sesquiterpene lactones	Acetyl β-amyrin, lupeol, stigmaterol, 8-epi-mikanokryptin	Aerial parts	Ríos et al. (2014)

A preliminary phytochemical study from the methanolic extract of the leaves revealed the presence of alkaloids, flavonoids, reducing sugars, saponins, phenolics, tannins, amino acids and proteins (Dev et al., 2015). Meanwhile, the methanolic extract of the aerial parts of *M. micrantha* contains glycosides, terpenoids, phenolics, alkaloids, steroids, flavonoids, and tannins (Jyothilakshmi, Jyothis, & Latha, 2015). In addition, there were the presences of tannin, phenol, flavonoid, glycoside, cardiac glycoside, carotenoid, and saponin from the qualitative phytochemical analysis performed using the methanolic extract of whole plant parts of *M. micrantha* (Chetia et al., 2014).

There were 27 terpenoids have been reported from the whole plant part of *M. micrantha* where sesquiterpenoids (21.64%) and linalool (15.86%) are the major components isolated (Nicollier & Thompson, 1981). In addition, Pérez-Amador et al. (2010) reported the presence of terpenoids obtained by steam distillation of the seed and inflorescence of *M. micrantha* where linalool and α -pinene are the major components isolated (Pérez-Amador et al., 2010). The trend of linalool concentration in seed and inflorescence of *M. micrantha* were similar to the whole plant parts as reported by Nicollier and Thompson (1981).

The geographical region, extraction media and plant parts revealed the presence of different phytochemical compounds. Petroleum ether extract of the leaves revealed saponins (Dev et al., 2015) while the aerial parts contained mainly terpenoids and steroids (Jyothilakshmi et al., 2015). Besides, ethyl acetate of aerial parts revealed the presence of terpenoids, steroids, alkaloids, and glycosides; with terpenoids the major component present (Jyothilakshmi et al., 2015). However, the presence of all these metabolites was determined using qualitative phytochemical screening; therefore, the exact amount of metabolites was unknown.

Pharmacological properties of *M. micrantha*

The studies on biological activities of *M. micrantha* have increased recently. Several studies using different solvent extracts and different parts of *M. micrantha* have been performed to determine antioxidant, antihelmintic, antidermatophytic, anti-stress, anti-diabetic, antispasmodic, antimicrobial, antiprotozoal, antitumour, anti-proliferative, anti-inflammatory, and anti-viral activities. Table 2 lists the summary of existing studies on the pharmacological properties of *M. micrantha*.

Table 2: Pharmacological properties of *M. micrantha*

Pharmacological properties	Findings	Parts/ Types of extraction	Author/year
Antimicrobial (antibacterial and antifungal)	(1) Antibacterial activity against <i>Klebsiella pneumonia</i> and <i>Staphylococcus aureus</i> at 100 µg/100 µL of extract. (2) Antifungal activity against <i>Candida albicans</i> .	Whole plant; methanol	Chetan et al. (2012) Chetia et al. (2014)
Anti-diabetic	Reduction of blood glucose level in diabetic rats treated with aqueous and ethanolic extract of <i>M. micrantha</i> .	Leaves; aqueous	Wan Nurhayati, Norli Arlizan, & Nurdiana, (2013), Nurdiana et al. (2013)
Antidermatophytic	(1) Ethyl acetate extract of <i>M. micrantha</i> showed the highest antidermatophytic activity, followed by petroleum ether and methanolic extracts. (2) Ethyl acetate extract completely inhibited the growth of dermatophytes at the tested concentration of 2 mg/mL.	Aerial parts; petroleum ether, ethyl acetate, methanol	Jyothilakshmi et al. (2015)
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). (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,	Whole plant; methanol	Chetia et al. (2014)

Anti-stress	<p>respectively.</p> <p>(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.</p> <p>(2) Treatment of 500 mg/kg methanolic extract of <i>M. micrantha</i> to stress-induced immobilized rats significantly reduced glucose, cholesterol, and blood urea nitrogen level.</p>	Roots; methanol & aqueous	Sibi & Sajid (2014)
Anti-viral	<p>(1) Compound 1,10-epoxy-4-germacrene-12,8;15,6-diolide showed moderate activity against respiratory syncytial virus (IC₅₀ = 37.4 µM) and parainfluenza virus type 3 (IC₅₀ = 37.4 µM).</p> <p>(2) Potassium mikanin 3-sulfate, the main component of <i>M. micrantha</i> showed inhibitory activity against parainfluenza virus type 3 with IC₅₀ of 19.7 µM.</p>	Aerial parts; hot methanol	But et al. (2009)
Anti-inflammatory	<p>(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 extract has the highest anti-inflammatory activity.</p> <p>(2) The methanolic extract did not show anti-inflammatory activity.</p>	Leaves and stems, seeds and inflorescences; hexane, ethyl acetate, methanol	Pérez-Amador et al. (2010)
Anti-proliferative	<p>Almost all sesquiterpene lactones exhibit moderate activity for antiproliferative activity in human cancer cell lines: HCT-15 (colon), K562 (leukemia), U251 (glioblastoma), MCF-7 (breast), PC-3 (prostate) and SKLU-1 (lung) where glioblastoma, breast, and lung cancer cell lines showed major anti-proliferative activity.</p>	Aerial parts; dichloromethane /methanol	Ríos et al. (2014)
Anti-spasmodic	<p>The aqueous extract of <i>M. micrantha</i> showed a non-competitive inhibition (IC₅₀ = 0.54 mg/mL) of the acetylcholine employed to the isolated duodenum and ileum of Sprague-Dawley rats due to the blockade of calcium L-channels.</p>	Leaves and stems; aqueous	Colares, Muguerza, Rosella, & Consolini, (2013)
Antiprotozoal	<p>Positive antiprotozoal activity against <i>Trypanosoma cruzi</i> and <i>Leishmania braziliensis</i> at concentration of 100, 10 and 1 µg/mL.</p>	Aerial parts; dichloromethane /methanol	Laurella et al. (2012)
Anti-cancer	<p>(1) <i>In vitro</i>: Treatment with 50, 100, 200 and 400 µg/mL of <i>M. micrantha</i> aqueous extract inhibited the proliferation of both cells.</p> <p>(2) <i>In vivo</i>: <i>M. micrantha</i> aqueous extract led to damages of organelles, induced apoptosis, and necrosis. The tumour</p>	Leaves; aqueous	Dou, Zhang, Sun, Wu, & Li, (2014)

Antihelmintic	<p>inhibitory rate of S180 (sarcoma cell)-bearing mice was 12.1% to 46.9%.</p> <p>(1) <i>M. micrantha</i> extract at 50 mg/mL paralyzed and killed <i>Pheretima posthuma</i> (earthworm) at 83 min and 101 min post-exposure, respectively.</p> <p>(2) Methanolic leaves extract of <i>M. micrantha</i> showed mild antihelmintic activity as compared to the standard drug (albendazole).</p>	Leaves; methanol	Dev et al. (2015)
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Antioxidant

Different extraction method resulted in different levels of antioxidant activities. Methanolic extract from the whole plant part of *M. micrantha* has shown good antioxidant activity through the test performed by DPPH and ABTS radical scavenging activity (Chetia et al., 2014; Chetan et al., 2012). The latest study by Dev et al. (2015) demonstrated the moderate to high antioxidant activity through DPPH radical scavenging assay, reducing power assay and phosphomolybdenum assay from the methanolic leaves extract of *M. micrantha* which is comparable to the standard drugs, i.e. butylated hydroxytoluene (BHT), ascorbic acid, and gallic acid. The scavenging activity of the extracts on DPPH radical was highest with methanolic extract (IC₅₀ = 41.8 µg/mL) followed by chloroform (420.0 µg/mL), petroleum ether (482.9 µg/mL), and water (575.7 µg/mL). Lowest number of IC₅₀ indicates highest antioxidant activity. Methanolic extract showed prominent antioxidant activity due to the presence of phenolic compounds found in the extract (Dev et al., 2015). The use of methanol as an extracting solvent may result in greater isolation of active constituents since methanol has stronger extraction capacity. In addition, the nature of biologically active components such as alkaloids, flavonoids and terpenoids may be enhanced in the presence of methanol (Ghosh, Das, Roy, Mandal, & Chandra, 2008).

Antibacterial

Ethyl acetate extract of *M. micrantha* has shown significant antibacterial activities against *Bacillus subtilis* and *Escherichia coli* (Pérez-Amador et al., 2010). This relates to the presence of linalool and α-pinene in the volatile oil of *M. micrantha* which have been demonstrated as antibacterial agents (Pérez-Amador et al., 2010). Meanwhile, hot aqueous extract of the leaves of *M. micrantha* (2000 µg/mL) showed a higher antibacterial activity against pathogenic bacteria i.e. *Escherichia coli*, *Bacillus subtilis*, *Staphylococcus aureus*, and *Proteus vulgaris* compared to the methanolic extract (Ghosh et al., 2008). In contrast, Chetan et al. (2012) reported the antibacterial activity of methanolic extract from the whole plant part of *M. micrantha* against *Klebsiella pneumonia* and *Staphylococcus aureus* at 100 µg/100µL of extract.

Antidermatophytic

A recent study by Jyothilakshmi et al. (2015) reported the antidermatophytic activity from the aerial parts of *M. micrantha* extracted with petroleum ether, ethyl acetate, and methanol. Ethyl acetate extract (2 mg/mL) was found to be the best solvent which completely inhibited the growth of *Epidermophyton floccosum* var. *nigricans*, *Microsporum canis*, *Microsporum gypseum* and *Trichophyton rubrum* (Jyothilakshmi et al., 2015). The pharmacological properties of different parts of *M. micrantha* extracted with ethyl acetate are believed due to the presence of secondary metabolites such as coumarins, terpenoids, and phenolic compounds, which have a wide range of biological activities (Jyothilakshmi et al., 2015; Pérez-Amador et al., 2010).

Anti-hyperglycaemic

Wan Nurhayati et al. (2013) studied the anti-hyperglycaemic effect of aqueous extract of the leaves of *M. micrantha* by performing oral glucose tolerance tests (OGTT) on normal and alloxan-induced diabetic rats. The aqueous extract at 150 mg/kg body weight significantly reduced blood glucose level of diabetic rats by 5.6% after 20 days of treatment. In addition, oral administration of ethanolic extract of *M. micrantha* leaves at a concentration of 200 mg/kg body weight of alloxan-induced diabetic rats

for a period of 30 days significantly reduced the fasting blood glucose level by 72% as compared to metformin which caused only 15% reduction (Nurdiana et al., 2013). The reduction of blood glucose activity takes effect because of the existence of antioxidant properties such as terpenes, flavonoids, and alkaloids in *M. micrantha* (Wan Nurhayati et al., 2013).

Anti-cancer

The aqueous leaves extract of *M. micrantha* showed anti-cancer activity against leukaemia (K562) and cervix cells (Hela) *in vitro*, while the tumour inhibitory rate of S180-bearing mice was 12.1 to 46.9% *in vivo* (Dou et al., 2014). Previous research also found that both aqueous and methanol extract of *M. micrantha* could stimulate the expression of CD⁴⁺ and CD⁸⁺, increasing the ratio of CD⁴⁺/CD⁸⁺ in the mouse where aqueous extract made notable effects to T lymphocyte. This result indicated that *M. micrantha* could enhance the immune protection and improve the anti-tumour activity (Wu et al., 2005). Flavonoids are the compounds that contribute to the anti-cancer activity of *M. micrantha* (Dou et al., 2014). The beneficial effects of flavonoids are related to the inhibition of the enzymes involved in signal transduction and their antioxidant properties (Plazonic, Males, Mornar, Nigovic, & Kujundzic, 2011). In fact, flavonoids have a remarkable spectrum of biological activities that affect the basic cell functions, such as growth, differentiation and apoptosis (Batra & Sharma, 2013).

Conclusion

On the basis of previous studies, *M. micrantha* has demonstrated the potential therapeutic effects on several diseases including diabetes, infections, and cancers. Many phytochemicals have been detected from different parts of *M. micrantha* which contribute to the medicinal properties of this plant, especially terpenoids, the major compounds isolated. However, further research works are needed to support the traditional claims and the limited scientific evidence on the health benefit of *M. micrantha*. In fact, due to quality and safety concerns, studies on the toxicological effects of various parts of *M. micrantha* should be conducted. Research on animal and human subjects should be done to have a better understanding of therapeutic and preventive effects of *M. micrantha*.

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