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SCREENING AMONG SOME EASTERN AFRICA'S INDIGENOUS PLANTS FOR THEIR BIOTECHNOLOGICAL POTENTIAL

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Abstract

In Africa, as in many tropical countries, about 80% of the rural population still depends on traditional medicine and therefore to the use of plant extracts due to the accessibility to herbal medicines, the limited availability and affordability of pharmaceuticals. Traditional medicine, still massively used as an alternative medicine in some countries including developing countries, is mostly a non-conventional medicine due to the absence of the clinical study. People consume these plants randomly without knowing their origin, dosage and their action on the body which complicate state of their health and even being fatal. This references-based article it is a screening attempt on three indigenous medicinal plants, respectively Bidens pilosa, Ocimum suave, Tribulus terrestris from the Eastern African area which are described in terms of botanical, physiological and biochemical aspects. These three plants are annual plants used as laxatives, analgesics, antimalaria, antidiabetic, antihelmintics, aphrodisiacs, anticancer, anti-inflammatory, antirheumatic, haemostatic, and antimicrobials. These plants are not sufficiently characterized for the active biological compounds and it will be subject for furtherstudies to prove their biotechnological potential.

Key words*: Phototherapy, Bidens pilosa, Ocimum suave, Tribulus terrestris, Africa.*

INTRODUCTION

According to World Health Organization (2002), "refers to the knowledge, skills and practises based on the theories, beliefs and experiences indigenous to different cultures, used in the maintenance of health and in the prevention, diagnosis, improvement or treatment of physical and mental illness." Traditional medicine that has been adopted by other populations (outside its indigenous culture) is often termed complementary or alternative medicine, sometimes also non-conventional or parallel (WHO, 2002; Gurib, 2006). Herbal medicines include herbs, herbal materials, herbal preparations, and finished herbal products that contain parts of plants or other plant materials as active ingredients (Chintamunnee & Mahomoodally, 2012).

Traditional medicine represents an important component part of health care provision in many African countries. It has been estimated that around 80% of the population living in the African Region rely on traditional forms of medicine to meet their health care needs. The percentage of the population that uses traditional medicine ranges from 90% in Burundi and Ethiopia, to 80% in Burkina Faso, the Democratic Republic of Congo and South Africa; 70% in Benin, Cote d'Ivoire, Ghana, Mali, Rwanda and Sudan; and 60% in Tanzania and Uganda (WHO, 2002).

The sustained interest in traditional medicine in the African healthcare system can be justified by the limited availability and affordability of pharmaceuticals (WHO, 2002; Mueller & Mechler, 2005; Zirihi et al., 2005), the accessibility to herbal medicines at considerably reduced costs compared to imported medicines (Mueller & Mechler, 2005) and a considerable trust in traditional healers coupled to pride in local community knowledge (Mathur, 2003). Another reason why patients turn to tradition medicine for complementary care is the increasing cases of chronic and debilitating diseases for which there is no cure such as malaria and/or HIV/AIDS. According to a survey conducted by WHO Roll Back Malaria, in Ghana, Mali, Nigeria and Zambia, 60% of febrile cases among children, presumably due to malaria, were treated with herbal medicines at home in 1998 (Team, 1999; WHO, 2002). A study published by UNAIDS (The Joint United Nations Programme on

HIV/AIDS) suggests that about two thirds of AIDS patients in developing countries use traditional medicines to obtain symptomatic relief, manage opportunistic infections and boost their immune systems (UNAIDS, 2003).

Despite its existence and continued use over many countries, and its popularity and extensive use during the last decade, traditional medicine has not been officially recognized in most countries.

Consequently, education, training and research in this area have not been accorded the proper attention and support.

The quantity and quality as well as the safety and efficacy of data on traditional medicine are far from sufficient to meet the criteria needed to support its use worldwide.

However, there is a need for an increase in research to improve the evidence base as regards the efficacy of most tradition medicine therapies (WHO, 2002).

In this respect, the article proposes an overview on phytotherapy/traditional medicine in the African context, as well as a screening attempt on three indigenous medicinal plants *"Bidens pilosa, Ocimum suave, tribulus terrestris"* from the East African areathat are not sufficiently characterized for their active biological compounds and it will be the subject to further studies to prove their biotechnological potential.

TRIBULUS TERRESTRIS

Tribulus terrestris (Linn) belongs to family *Zygophyllaceae* and known as Puncture- vine, caltrop, yellow vine, goat head and devil's horn in English. *Tribulus terrestris L.* is widespread in Mediterranean, subtropical and desert climates worldwide, but now widely distributed in warm regions of Europe, Asia, America, Africa, and Australia (Ross, 2001).

Table 1: Taxonomical classification of *T. terrestris*

Kingdom	*Plantae*
Division	*Magnoliophyta*
Class	*Magnoliopsida*
Subclass	*Rosidae*
Order	*Sapindales*
Family	Zygophyllaceae
Genus	*Tribulus*
Species	*Tribulus terrestris Linn.*

Source: Plants Database Data Source and Documentation for *Tribulus terrestris* L.

1.1. Botanical description of *T.terrestris*

T. terrestris is an annual (sometimes perennial in warm climates) herb with a long, slender, branched tap-root. Stem is profusely branched, semi erect or prostrate reaching up to 2m long. The root is slender, cylindrical, somehow fibrous. Leaves are opposite, paripinnate, each consists of 4-8 pairs of linear or oblong leaflets with hairy margins. Stems are round and hairy. Flowers are yellow, solitary with 5 petals. The fruit is globose with 5-12 woody cocci with sharp spines of unequal length, giving it a star shape. The seeds are 1.5-3 mm long, yellowish, enclosed within 5-7 mm long carpels; up to 5 in each chamber (Ross, 2001).

1.2. Chemical composition of *T.terrestris*

It has been reported that each part of the plant has a different chemical composition as well regarding the quality of the products as the quantity. Occurrence of saponins, flavonoids, alkaloids, lignanamides and cinammic acid amides has been reported in *T. terrestris*(Saleh et al., 1982; Bourke et al., 1992; Ren et al., 1994; Wang et al., 1997; Li et al., 1998). Saponin such as glucopyranosyl, galactopyrans, ruscogenin, hecogenin, gitogenin, titogenin, protodioscin, diosgenin and yamogenin(Xu et al., 2001), sterols such as sitosterol, and campesterrol; flavanoids such as kaemferol, kaempferol-3-glucoside, tribuloside and quercetin (Zafar et al., 1987; Bhutani et al., 1969; Biary et al., 2000; Mahato et al., 1982) and other constituents like fatty acids, polysaccharides, tannins, amino acids and potassium salts have been isolated from this plant.

1.3. Traditional Uses of *Tribulus terrestris*

Tribulus terrestris L. is a famous herb traditionnally used by different cultures for a number of conditions. In Sudan, *Tribulus terrestris L* has been used as demulcent and in nephritis and the treatment of inflammatory disorders (Mohammed et al., 2014). In North Africa, it is used as an antidiarrheal, stimulant and aphrodisiac.In Tanzania, the leaves are used in the diet (Ross, 2001).

1.4. Pharmacological studies

Use in Diabetic Mellitus

Protective effects of *T. terrestris* was investigated the in diabetes mellitus (Amin et al.,

2006) and based on their investigation suggested that the protective effect of *T. terrestris* on streptozotocin-induced diabetes in rats may be mediated by inhibiting oxidative stress. It is reported that extract *T. terrestris* consisting of saponins appear to decrease blood sugar levels by acting on alphaglucosidase in small intestines of rats (Zhang et al., 2006).

Uses in cardiac disorders

Wang et al., 1997 conducted clinical trial in 406 patients with coronary heart disease. They were treated with saponins of *T. terrestris*. The results showed that the total efficacious rate of remission angina pectoris was 82.3% it is shown that saponin of *T. terrestris* has the action of dilating coronary artery and improving coronary circulation. Zhang et al. (2010a) evaluated the protective effect of tribulosin from *T. terrestris* against cardiac ischemia/reperfusion injury in rats. They observed that Tribulosin protected myocardium against ischemia/reperfusion injury through protein kinase C epsilon activation. *T. terrestris* also appears to protect the heart cells and may even improve the heart function following a heart attack(Zhang et al., 2010b).

Uses as anticancer agent

Inhibiting cell growth is a critical action of anticancer drug-induced cancer death. It is reported that *T. terrestris* extracts exhibits weak cytotoxic effects to normal cells compared to cancer cells (Kim et al, 2011). Zhong Yao Cai (2003) studied the effect of *T. terresteris* and opined that the saponins present in *T. terrestris* have inhibitory effect on breast cancer cell line. Aqueous extract of *T. terrestris* has reduced tumor incidence and number of papillomas in mice by decreased lipid peroxidation levels and increased glutathione levels in the liver. Wei et al. (2014) reported that terrestrosin D a steroidal saponin from *T. terrestris* inhibits growth and angiogenesis of human prostate cancer in vitro and in vivo. Etanolic extract of the fruits of *T. terrestris* revealed strongest anticancer activity against cervical cancer cell line (Dhanalakshmi et al., 2016).

Uses as anti-infertility agent

In indigenous medicine, *T. terrestris* has long been in use for different ailments, particularly, the fruits are extensively used since ancient times as aphrodisiac (Chopra et al., 2009). *T. terrestris* contains three groups of active phytochemicals: Dioscin, protodioscin, diosgenin and similar. These substances have effect on sexual performance and may treat various sexual disorders, they regulate sexual energy level and strength by increasing the percentage of free testosterone level for men and they affect pregnenolone, progesterone and estrogen (Akram et al., 2011).

OCIMUM GRATISSIMUM

Ocimum gratissimum commoly known as African basil, Clove basil, East Indian basil, Nchanwu leaf, Russian basil, Shrubby basil, Tree basil, Wild basil (Hawaii), is an aromatic, perennial and Forb/herb, Subshrub plant native to Africa, and southern Asia. The Recognized synonyms for African basil include *Ocimum suave* and *Ocimum viride Wild* (Plants Database and USDA, 2019).

Table 2: Taxonomical classification of *O.gratissimum*

Kingdom	*Plantae*
Division	*Magnoliophyta*
Class	*Magnoliopsida*
Subclass	*Asteridae*
Order	*Lamiales*
Family	*Lamiaceae*
Genus	*Ocimum*
Species	*Ocimum gratissimumL.*

Source: Plants Database, Data Source and Documentation for *Ocimum gratissimum L.*

2.1. Morphology of *Ocimum gratissimum*

O. gratissimum is a shrub up to 1.9m in height with stems that are branched. The leaves measure up to 10 x 5 cm, and have opposite phyllotaxy and petiole is 2-4.5 cm long, slender and pubescent. Stomata are rare or absent on the upper surface while they are present on the lower surface. Petioles are up to 6 cm long and racemes up to 18 cm long. The peduncles are densely pubescent. Calyx is up to 5mm long, campanulate and 5-7 mm long, greenish-white to greenish-yellow in colour.

Fruit consisting of 4, dry, 1-seeded nutlets enclosed in the persistent calyx. Basil produces small seeds which are reddish black in color. Stem becomes woody in older plants while it is green in newly born plant (Sembulingam et al., 1997).

2.2. Traditional uses of *Ocimum gratissimum*

Ocimum gratissimum has been used extensively in the traditional system of medicine in many countries of Africa.

The plant is commonly used in folk medicine in Nigeria to treat different diseases such as upper respiratory tract infections, diarrhoea, headache, diseases of the eye, skin diseases, pneumonia, cough, fever and conjunctivitis (Adebolu & Salau, 2005). In the coastal areas of Nigeria, the plant is used in the treatment of epilepsy, high fever and diarrhoea (Effraim et al., 2003).

People of Kenyan and sub Saharan African communities' use this plant for various purposes namely, the leaves are rubbed between the palms and sniffed as a treatment for blocked nostrils, they are also used for abdominal pains, sore eyes, ear infections, coughs, barrenness, fever, convulsions, and tooth gargle, regulation of menstruation and as a cure for prolapse of the rectum (Matasyoh et al., 2007).

The infusion of *O. gratissimum* leaves is used as pulmonary antisepticum, antitussivum and antispasmodicum in Cameroun (Ngassoum et al., 2003).

2.3. Chemical composition of *O.gratissimum*

Medicinal properties of this plant are all because of the secondary metabolite and essential oil present in the leaves, stem and roots.

The aqueous leaf extract assay shows the presence of steroids, tannins, flavonoids, saponins, terpenoids alkaloids, inulins, phenolic compounds, B-carotene, glycosides (Akinmoladun et al., 2007; Ajiboye et al., 2014; Chetia et al., 2014; Vilioglu et al., 2007), carotenoids, reducing sugars, phlobatannins, anthraquinones and cardiac glycosides (Chetia et al., 2014) with steroidal ring and deoxy–sugar (Akinmoladun et al., 2007).

Beside these, polyphenols, quinones, coumarins, and catechins (Vilioglu et al., 2007) were also detected in aqueous extract.

2.4. Pharmacological studies

Antifungal activity

An antifungal activity is found in the essential oil that can be obtained by steam-distillation (1.1% w/v) of the aerial parts of *O. gratissimum.* The results showed that the essential oil inhibit the growth of all fungi tested, including the phytopathogens, *Botryospaeria rhodina*, *Rhizoctonia* sp. and two strains of *Alternaria* sp. (Prabuseenivasan et al., 2006). Antifungal activities against *Microsporum canis, M. gypseum, Trichophyton rubrum and T. mentagrophytes*. *Trichophyton rubrum,* the most common dermatophytes in Brazil was carried out and found that hexane extract of *O. gratissimum* and eugenol is very effective against the dermatophyte (Silva et al., 2010).

Antibacterial activity

Different extracts from the leaves of *Ocimum gratissimum*, show antibacterial activity when tested against *Staphylococcus aureus, Salmonella typhi* and *Salmonella typhimurium*, pathogenic bacteria which causes diarrhea (Adebolu & Salau 2005). *Ocimum gratissimum,* ethanolic extract was tested for anti-microbial activity against *Actinobacillus actinomycetemcomitans* in human dental plaque and compared with 0.2% chlorhexidine as the positive control and dimethyl sulfoxide as the negative control. Maximum antimicrobial potential was at 0.6% concentration level (Eswar et al., 2016).

Ovicidal activity

The main component of ovicidal activity present in the essential oil of *Ocimum gratissimum* is eugenol. It was evaluated against *Haemonchus contortus*, a gastrointestinal parasite of small ruminants. The essential oil and eugenol showed maximum inhibition at 0.5% conc. These results suggest a possible utilization of essential oil of *O. gratissimum* as an aid to control *gastrointestinal helmintosis* of small ruminants (Pessoa et al., 2002).

Larvicidal, pupicidal and adulticidal potential

Larvicidal, pupicidal and adulticidal activities of acetone, hexane and chloroform extracts of *Ocimum gratissimum* investigated against filariasis mosquito vector *Culex quinquefasciatus*.

Results suggested that *O. gratissimum* chloroform extract is a best controlling agent for *Culex. quinquefasciatus* among all the extracts (Pratheeba et al., 2015). Pupicidal and

larvicidal mortality was recorded in the same extract exposure at 24 hrs is of 2.6916 mg/ml and 2.8916 mg/ml respectively.

Wound Healing activity

Wound healing effects of *Ocimum gratissimum* were investigated using incisional wound model in rats and found that *O. gratissimum* have wound healing potential (Eyo et al., 2014). The ability to increase the vascular permeability of *O. gratissimum* may be one of the factors that contribute to its wound healing property (Orafidiya et al., 2005).

Anti-Inflammatory activity

The study reported the inhibitory effect produced by chemical constituents of essential oils of *Ocimum gratissimum* used in traditional medicine as anti-inflammatory and analgesic drugs, in vitro, on soybean lipoxygenase L-1 and cyclooxygenase function of prostaglandin H synthase, the two enzymes, which are involved in the production of mediators of inflammation (Tanko et al., 2008)

BIDENS PILOSA

Bidens pilosa L. (Asteraceae) is an herbaceous plant widely distributed in Africa, America, China, and Japan. *Bidens pilosa* L. is originally native to South America which today is spread all over the world, particularly in tropical and subtropical regions (Oliveira et al., 2004)

Table3: Taxonomy of *Bidens Pilosa L.*

Kingdom	*Plantae*
Division	*Magnoliophyta*
Class	*Magnoliopsida*
Subclass	*Asteridae*
Order	*Asterales*
Family	*Asteraceae / Compositae*
Genus	*Bidens*
Species	*Bidens pilosa*

Source: Plants Database Data Source and Documentation for *Bidens pilosa L*,

3.1. Morphology of *Bidens pilosa L.*

Erect annual herbs 60-90 cm. high. Stem quadrangular, grooved, branches apposite. Leaves pinnately compound, usually 2.5-13.5 cm long including petiole, leaflets 3-5. Heads 21-42 in compound cymes terminating main stem and lateral branches, and 0.7-1 cm in diameter including ray florets, peduncles 1-9 cm long; outer involucral bracts spatulate-tipped, 2.5-5 mm long; ray florets absent or 4-7 per head, rays white or yellowish, 2-8 mm long; disk florets 35-75 per head, perfect, corollas yellow; pappus of 2-3 barbed awns 1-2 mm long. Achenes are dark brown or black, straight, wingless, 8-16 mm long, setose (Kirtikar, 1933).

3.2. Traditional uses of *Bidens pilosa*

B. pilosa is used as an herb and asan ingredient in teas or herbal medicines. Its shoots and leaves, dried or fresh, are utilized in sauces and teas (Rybalchenko et al., 2010). In the 1970s, the United Nations Food and Agriculture Organization (FAO) promoted the cultivation of *B. pilosa* in Africa because it is easy to grow, edible, palatable, and safe.

All parts of *B. pilosa* plant, the whole plant, the aerialparts (leaves, flowers, seeds, and stems), and/or the roots, fresh or dried, are used as ingredients in folk medicines. It is frequently prepared as a dry powder, decoction, maceration or tincture. Generally, this plant is applied as dry powder or tincture when used externally, and as a powder, maceration, or decoction when used as an internal remedy (Rybalchenko et al., 2010). *B.pilosa*, either as a whole plant or different parts, has been reported to be useful in the treatment of more than 40 disorders such as inflammation, immunological disorders, digestive disorders, infectious diseases, cancers, metabolic syndrome, wounds, and many others (Dimo et al., 2001; Pereira et al., 1999; Tan et al., 2000).

3.3. Phytochemistry and Pharmacological Action of *Bidens pilosa*

Interest in basic research and application of *B. pilosa* has increased. This is mainly due to its wide application in medicines, foods, and drinks. 201 compounds comprising 70 aliphatics, 60 flavonoids, 25 terpenoids, 19 phenylpropanoids, 13 aromatics, 8 porphyrins, and 6 other compounds, have been identified from this plant (Silva et al., 2011).*B. pilosa* is an extraordinary source of phytochemicals, particularly flavonoids and polyynes. In the present review, we explore possible associations (Table 5), describe the importance of the known compounds in relation to their biological activity.

Table 4: Chemical constituents of *B. pilosa* and their biological activities

Name	Classification	Biological activities
Centaureidin (Chang et al., 2007)	Flavonoid	Anti-listerial (Chang et al., 2007) Cytotoxic (FAO, 1997)
Centaurein (Chang et al., 2007)	Flavonoid	Anti-listerial (Chang et al., 2007) Cytotoxic (FAO, 1997) Anti-viral (Verma et al.,2001)
Luteolin (Corren et al.,2008)	Flavonoid	Anti-viral (Gachet et al., 2010) Cytotoxic (Kumari et al., 2009) Anti-inflammatory and Anti-allergic(Tewtrakul et al., 2003)
Butein (Tewtrakul et al., 2003)	Flavonoid	Anti-leishmanial (Li, 2002) Cytotoxic (Seelinger et al., 2008)
1,2-Dihydroxytrideca-5,7,9,11-tetrayne	Polyyne	Anti-angiogeneic (Wu et al., 1997)
1,2-Dihyroxy-5(E)-tridecene-7,9,11-triyne (Wright et al., 1992)	Polyyne	Anti-angiogeneic (Wright et al., 1992) Anti-proliferative (Wright et al., 1992)
1-Phenylhepta-1,3,5-triyne (Almiron and Brewer 1996)	Polyyne	Anti-microbial (Wang et al, 2007) Anti-malarial and Cytotoxic(Karis and Ryding 1994). Antifungal (Rybalchenko et al., 2010)
Linoleic acid (Seelinger et al., 2008)	Fatty acid	Anti-viral (Xia et al., 2013) Cytotoxic (Ayyanar and Ignacimuthu, 2005)
Ethyl caffeate (Chiang et al., 2005)	Phenylpropanoid	Anti-inflammatory (Chiang et al., 2005)
2-O-β-Glucosyltrideca-11(E)-en-3,5,7,9-tetrayn-1,2-diol (Tan et al., 2000)	Polyyne	Immunosuppressive and Anti-inflammatory (Tan et al., 2000)
2-β-D-Glucopyranosyloxy-1-hydroxytrideca-5,7,9,11-tetrayne (Chiang et al., 2007)	Polyyne	Anti-diabetic (Champagnat, 1951) Anti-inflammatory (Chiang et al., 2007)
3--D-Glucopyranosyl-1-hydroxy-6(E)-tetradecene-8,10,12-triyne (Dimo et al., 2001)	Polyyne	Anti-diabetic(Dimo et al., 2001) Anti-inflammatory (Nguelefack et al., 2005)
2--D-Glucopyranosyloxy-1-hydroxy-5(E)-tridecene-7,9,11-triyne (Dimo et al., 2001)	Polyyne	Anti-diabetic(Dimo et al., 2001) Anti-inflammatory (Nguelefack et al., 2005). Anti-malarial and antibacterial (Tobinaga et al., 2009)
Quercetin 3-O--D-galactopyranoside (Geissberger and Sequin, 1991)	Flavonoid	Anti-inflammatory (Nielsen et al., 1998)
3,5-Di-O-caffeoylquinic acid (Nguelefack et al., 2005).	Phenylpropanoid	Anti-viral (Lee, 2000) Antioxidant (Chiang et al., 2004)
4,5-Di-O-caffeoylquinic acid (Nguelefack et al., 2005).	Phenylpropanoid	Anti-viral (Lee, 2000) Antioxidant (Chiang et al., 2004)
3,4-Di-O-caffeoylquinic acid (Nguelefack et al., 2005).	Phenylpropanoid	Anti-viral (Lee, 2000) Antioxidant (Chiang et al., 2004).
Quercetin 3,3′-dimethyl ether 7-O--L-rhamnopyranosyl-(16)-β-D-glucopyranoside (Hwang et al., 2008).	Flavonoid	Anti-malarial (Andrade-Neto, et al., 2004)
Quercetin 3,3′-dimethyl ether-7-O-β-D-glucopyranoside (Hwang et al., 2008)	Flavonoid	Anti-malarial (Andrade-Neto, et al., 2004)
1-Phenyl-1,3-diyn-5-en-7-ol-acetate	Polyyne	Anti-malarial (Pereira et al., 1999)
Heptanyl 2-O-β-xylofuranosyl-(16)-β-glucopyranoside (Chiang et al., 2004)	Miscellaneous	Antioxidant (Chiang et al., 2004)
3-O-Rabinobioside (Chiang et al., 2004).	Saccharide	Antioxidant (Chiang et al., 2004)
Quercetin 3-O-rutinoside (Chiang et al., 2004).	Flavonoid	Antioxidant (Chiang et al., 2004)
Chlorogenic acid (Chiang et al., 2004).	Phenolic	Antioxidant (Chiang et al., 2004)
Jacein (Chiang et al., 2004)	Flavonoid	Antioxidant (Chiang et al., 2004)
(R)-1,2-dihydroxytrideca-3,5,7,9,11-pentayne (Tobinaga et al., 2009)	Polyyne	Anti-malarial and Antibacterial (Tobinaga et al., 2009)

CONCLUSIONS

Traditional medical knowledge is widely prevalent around the world and the larger public has integrated them for their various health needs. *Ocimum gratissimum*, *Bidens pilosa* and *Tribulus terrestris* are of significant value in the traditional systems of medicineand they are also the reputed herbs in the folk medicine of many countries for a number of diseases.

Ocimumgratissimum has been used in many countries because of its pharmacological l properties i.e. antimicrobial, antifungal, antibacterial, antimalarial, antiviral, anesthetic, antiprotozoal, anthelmintic antidiabetic, antifertility, anti-inflammatory and antistress agents. It can also be used to treat breast cancer very effectively. *O. gratissimum* have been recommended for the treatment of diarrhea, fever, ophthalmic skin diseases and upper respiratory tract infections and for insect bite.

B. pilosa is claimed to treat more than 40 disorders, and 201 compounds have been identified from this plant.Polyynes, flavonoids, phenylpropanoids, fatty acids, and phenolics are the primary bioactive compounds of *B. pilosa,* and they have been reported to be effective in the treatment of tumors, inflammation/immune modulation, diabetes, viruses, microbes, protozoans, gastrointestinal diseases, hypertension, and cardiovascular diseases.

The herb *T. terrestris* is used in many countries for a number of diseases. The whole plant has been explored exhaustively for its phytochemical and pharmacological activities such as diuretic, aphrodisiac, antiurolithic, immunomodulatory, antihypertensive, antihyperlipidemic, antidiabetic, hepatoprotective, anticancer, anthelmintic, antibacterial, analgesic, and anti-inflammatory.

RECOMMANDATION

Though *Ocimum gratissimum*, *Bidens pilosa* and *Tribulus terrestris* have been used extensively over the centuries and currently scientific evidence with respect to its pharmacological activities is also being generated, more studies at the molecular level are needed to further understand the mechanism by which it modifies the disease condition. The pharmacological experiments performed on these plants must also be extended to the next level of clinical trials to generate novel drugs.

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