A COMPREHENSIVE REVIEW ON TRIDAX PROCUMBENS LIN.

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(Received 07th May 2025; revised 09th August 2025; accepted 16th August 2025)

Abstract. The highly promising species Tridax procumbens produces secondary metabolites that are said to have a number of medical applications, such as anesthetic, anti-inflammatory, anti-diabetic, and anti-anemic effects etc. Many communities have traditionally used this species in traditional ways. Tridax procumbens is a unique member of the Asteraceae family. Naturally occurring in tropical Africa, Asia, and Australia, the plant is native to tropical America. The locals name it "Ghamara," which is also known as "coat buttons" in English. Some Ayurvedic practitioners prescribe it as "Bhringraj." Alkaloids, carotenoids, flavonoids (catechin and flavones), fumeric acid, fl-sitosterol, saponins, and tannins were all found throughout the phytochemical screening. Pharmacologically, Tridax procumbens is well known for its antioxidant, hepatoprotective, antiviral, wound-healing, insecticidal, antidiabetic, hypotensive, immunomodulating, bronchial catarrh, dysentery, diarrhea, and prevention of hair loss by promoting hair growth. It also has antimicrobial activity against both gram-positive and gram-negative bacteria, anti-cancer, anti-inflammatory, and antitubercular properties. This review is attempts to present phytochemical & pharmacologically use, significance of Tridax procumbens to treat, prevent the acute & chronic diseases, and also present Pharmacognostic and phytochemical investigation of Tridax procumbence plant.
Keywords: *tridax procumbens, anti-inflammatory, anti-cancer, immunomodulating, anesthetic*

Introduction

T. procumbens is a common but often ignored weed in the Asteraceae family which is full of medicinal properties (Chauhan and Johnson, 2008). Tridax species was first introduced by Linnaeus in 1753 as the publication of T. procumbens. The genus Tridax contains 30 species, and this one is among the most powerful of them all (Powell, 1965). Tridax is a week-straggling herb that is 12 to 24 cm long, with a few leaves that are 6 to 8 cm long and very long, slender, solitary peduncles that are at least a foot long. It is mainly found in Tropical America, Africa, and Asia (Rogers, 1969). It is used for wound healing in the form of herbal remedy, T. procumbens is often utilized in Ayurveda (Udupa et al., 1991a). The plant T. procumbens is a dominating one in Maharashtra, Madhya Pradesh, Gujarat, Odisha, and other Indian states. It grows mostly in roadsides, open areas, lawns, meadows and croplands (Mir et al., 2017). It is also known as "Mexican daisy" in Mexico, "Coat button" and "Tridax daisy" in English, "Jayanti Veda" in Sanskrit, "Gharma" in Hindi, "Dagadipala" in Marathi, "Vettukkaayathalai" in Tamil/Siddha, and "Akala kohadi" in folk (Christudas et al., 2012; Agrawal et al., 2010; Pathak et al., 1991). T. procumbens is very important plant that possess hygienic as well as sanitary properties. Since ancient times, Tridax Procumbens has been used to treat a wide range of diseases and disorders and is found all over the world. This plant is also used as food or medication in India and other countries (Beck et al., 2018). T. procumbens have been the subject of numerous phytochemical and pharmacological investigations. This plant contains a wide range of phytoconstituents that which are isolated and identified, including flavonoids, essential

oils, carotenoids, steroids, alkaloids, carbohydrates, saponins, tannins and terpenoids. T. procumbens possess numerous pharmacological activities include antiviral, antifungal, and antibacterial effect (Sathya Bama et al., 2012), anticancer, antioxidant (Andriana et al., 2019), antileishmanial (Martín-Quintal et al., 2009), anti-inflammatory (Berlin Grace et al., 2020; Jachak et al., 2007) wound healing (Berlin Grace et al., 2020; Shrivastav et al., 2020), larvicidal (Kamaraj et al., 2011).

In Ayurvedic literature, T. Procumbens is considered as one of the key components for many ayurvedic preparations, it is a highly valuable plant with the greatest number of pharmacological properties (Kethamakka and Deogade, 2014). In ancient times, it was used to treat bronchial catarrh, bruises, dysentery, malaria, high blood pressure, check for hemorrhage from cuts and wounds, stop bleeding backaches, and cure diarrhea (Udupa et al., 1991b). This weed's extracts are also used to stop hair loss. It has anti-diabetic properties (Bhagwat et al., 2008), anti-bacterial (Pai et al., 2011), anti-plasmodial (Pai et al., 2011), anti-hepatotoxic, anti-oxidant (Hemalatha, 2008) and antimicrobial (Mundada and Shivhare, 2010) properties. Reviews that had already been published were not consistently reported. Morphology, traditional applications, phytochemistry, and pharmaceutical/pharmacological activities including structures, yield, in vitro and in vivo models, controls MIC/MFC, and effects were covered in the first part of the current review. All things considered, this evaluation lays the groundwork for the plant's future growth and commercialization.

Table 1. *Taxonomic classification.*

Category	Description
Subkingdom	Tracheobionta
Division	Magnoliophyta
Class	Magnoliopsida
Subclass	Asteridae
Order	Asterales
Family	Asteraceae
Tribe	Heliantheae
Genus	Tridax
Species	T. procumbens
Binomial Name	Tridax procumbens

Table 2. *Vernacular names of T. procumbens found throughout the world.*

Country	Vernacular name	Source
India	Bisalyakarmi, Mukkuthipoo, Phanafuli, Tunki, Ghamara, Javanti Veda, Dhaman grass, Vettukkayapoondu, Vettu kaaya	Silambarasan and Ayyanar (2015) Kethamakka and Deogade (2014) Yabesh et al. (2014) Jindal and Kumar (2012) Pareek et al. (2009) Bhagwat et al. (2008) Ravikumar et al. (2005b) Holm et al. (1997)
Japan	Kotobukigiku	Holm et al. (1997)
United States	Tridax daisy	Holm et al. (1997)
Tamil	Thata poodu	Jain Ankita and Amita Jain (2012)
Telugu	Gaddi Chemanthi	Jain Ankita and Amita Jain (2012)
Spanish	Cadillo, Chisaca	Jain Ankita and Amita Jain (2012)
French	Herbe Caille	Jain Ankita and Amita Jain (2012)
English	Coat buttons, Tridax daisy	Jain Ankita and Amita Jain (2012) Jindal and Kumar (2012) Bhagwat et al. (2008) Chauhan and Johnson (2008) Ravikumar et al. (2005a)
Chinese	Kotobukigiku	Jain Ankita and Amita Jain (2012)

		Holm et al. (1997)
Brazil	Erva de Touro	Holm et al. (1997)
Australia	Australia	Holm et al. (1997)
Mexico	Flor Amarilla, Panquica, Rosilla, t'ulum	Gamboa-Leon et al. (2014) Holm et al. (1997)
Trinidad	Railway Weed	Holm et al. (1997)
Taiwan	Kotobuki-giku	Holm et al. (1997)
Latin	Tridax procumbens (Linn.)	Jain Ankita and Amita Jain (2012)

Morphology

T. procumbens is a small, green perennial plant that grows 15–40 cm tall, with hairy, oblong to lanceolate leaves and a petiole that is 4–30 mm long. The roots grow at the nodes of the stems. Ray and disk florets are its two flower forms; the disk of the corollas is yellow, and the base is tubular with light yellow or cream-white ligules. The basal placentation is 3–6cm (Powell, 1965). A plume, feathery, white pappus is attached to one end of the fruit, which is a rigid achene coated in stiff hairs. Scales or pappus are used to symbolize the calyx. Pendulous endosperm and no embryo are present in the seed (Chauhan and Johnson, 2008; Rahman et al., 2008) (*Figure 1* and *Figure 2*).

Figure 1. *Leaves of Tridax procumbence (left side); Unit plant of Tridax (right side).*

Figure 2. *Bunch of Tridax procumbence L.*

Traditional uses

T. procumbens is an herb found in wild throughout India, Nepal, and Nigeria and used to treat bronchial catarrh, dysentery, diarrhoea, and inflammation (Singh and Maheshwari, 1994; Bhat et al., 1990). In Ayurveda, this herb was used either alone or in various formulations to treat wounds. It is well known and dispensed as 'Bhringraj' for liver disorders, (Saxena and Albert, 2005) and preventing hair loss, and hair growth. The fresh leaves juice is used to stop bleeding from wounds, cuts, and bruises and has insecticidal parasite qualities (Verma and Gupta, 1988). In India, some tribal and rural populations use this plant as a nutritious vegetable and as a traditional remedy. This plant is not only a healthy food but has also been used as a traditional remedy for wounds and as a medication. In African, many traditional medicines contain the fresh leaf juice of T. procumbens to heal wounds, skin conditions, typhoid fever, fever, cough, and to prevent blood clotting (Adetutu and Olorunnisola, 2013; Soladoye et al., 2005). In many regions of Guatemala T. procumbens is used in the treatment of gastrointestinal disorders, stomach pain diarrhea (Logan, 1973). In Cuba, this herb is used to cure tonsils, tonsillitis, and mouth ulcers. In America, this herb is widely used to cure and treat hepatopathies, inflammations, anemia and colds (Taddei and Rosas-Romero, 2000). Anticoagulant, antileishmanial, anthelmintic cardiovascular, antioxidant, immunomodulatory, anticancer, insecticidal, antiseptic, and antibacterial qualities are among its many attributes (Syed et al., 2020). Considering its many pharmacological properties, motivated us to write a review report on T. procumbens which highlights the pharmaceutical and pharmacological values of this plan.

T. procumbens also is used as an antibacterial, antifungal, and antiviral agent in Guatemala (Cáceres et al., 1998) as well as for vaginitis, stomach pain, diarrhea, mucosal inflammations, and skin infections (Taddei and Rosas-Romero, 2000). The leaf juice is used to cure wounds and halt bleeding (Cáceres et al., 1998). According to research conducted in Chiquimula, Guatemala, Tridax can help pregnant women with anemia by reducing their symptoms. This species is also used to treat gastrointestinal

diseases, diabetes, high blood pressure and respiratory diseases. Malaria, leishmaniasis and dysentery are the examples of protozoal infections that can be treated with the whole plant and its parts. The aqueous extracts of T. procumbens have potent anti-plasmodial action against P. falciparum parasites which are resistant to chloroquine (Appiah-Opong et al., 2011), they also exhibit wound-healing, antibacterial, and Trypanosoma brucei activity (Koram and Ahorlu, 2014). In Nigeria, whole plant is used for the treatment of Cough, fever, Typhoid, backache, Diarrhea, and epilepsy (Mann et al., 2003). In African, farmers utilize the plant to treat and cure animals (Mann et al., 2003). For the treatment of chronic mastitis, Tridax and Vigna Parkeri are ground then mixed with water and salt, and applied to the udder. Das et al. (2009) investigated Tridax's antibacterial efficacy against microorganisms that cause mastitis and discovered that the ethanolic extract significantly inhibited Staphylococcus aureus (Das et al., 2009). However, as compared to extracts from Spathodea campanulata, the aqueous extracts showed little to no efficacy against Streptococcus uberis and Klebsiella pneumonia. Although rabbits eat less of it than other fodder most likely because it is not as palatable, breeders in Benin supplement the diet of rabbits (Aboh et al., 2002) or other animals by mixing it with other plants (Edeoga et al., 2005).

Review literature

Phytochemicals/Phytoconstituents

These are some phytochemicals which are found in the plant of T. procumbens, which can be extracted out through various extraction process.

Essential oil

Though few are major and common constituents, plants synthesize a wide range of essential oils. In plants, these basic substances serve a variety of vital functions. One of the main components of this plant is said to be essential oils. Using methods such as hydro-distillation, Soxhlet extraction, and supercritical CO_2 extraction, essential oils: fragrant, aromatic compounds; are extracted from this plant. Long-chain fatty acids, terpenoids, and volatile oils make up the majority of essential oils. Numerous biological actions, such as antibacterial, antifungal, anticancer, antiparasitic, and antioxidant properties, are linked to essential oils. Their components were examined independently using various techniques. Falcarinol, (3S)-16,17-dihydro falcarinol (Larqué-García et al., 2020) extracted using a supercritical process with a yield greater than that of a traditional column chromatography method at 200 bar of pressure, 40 °C temperature, and 4.5 hours. It was previously reported to have antileishmanial activity (Martín-Quintal et al., 2009). T. procumbens contains three primary essential oil constituents: zerumbone, α-selinene, and (Z)-falcarinol. Some other essential oils are as follows: 32-methyl-30 oxotetratriacon-31-en-1-ol, 30-methyl-28-oxodotriacont-29-en-1-oic acid, hexadecanoic acid ethyl ester, 3-octene-1-ol, 9,12-Octadecadionic acid, ethyl ester, 9-Octadecanoic acid, ethyl ester, Octadecanoic acid, 2-methyl, methyl ester, and Dotriacontanol (Verma and Gupta, 1988) (*Figure 3*).

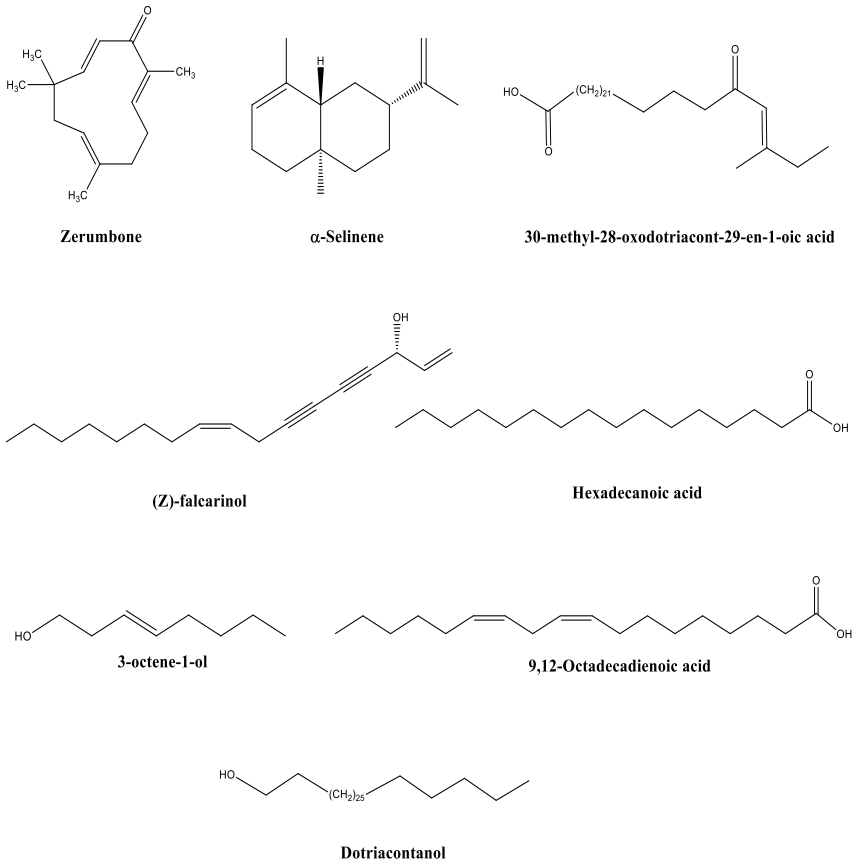


Figure 3. *Representative chemical structures of phytochemical constituents identified by GC–MS analysis.*

Polyphenols (Flavonoids)

According to phytochemical analyses, T. procumbens is a rich source of flavonoids, with the Asteraceae family having the highest percentage of flavones and flavanones. They are in charge of the antibacterial, anticancer, hepatoprotective, antioxidant, and wound-healing qualities. Furthermore, flavonoids are crucial for regulating the development of bacteria that produce toxins in plants (Mecina et al., 2019). The first reports of luteolin, Gluco luteolin, quercetin, and iso-quercetin from T. procumbens flowers were made by Subramanian et al. (1968). From the ethanolic extract of flowers, R=Gu 8,3′-dihydroxy-3,7,4′-tri methoxy-6-O-β-D-glucopyranosyl flavone (Xu et al., 2010), 6 methoxy-7,8-dihydroxyflavone, 7 methoxy-6,8-dihydroxyflavone, Wogonin, and oroxylin were extracted out and found that they possess antioxidant properties. Methoxy-7,8-dihydroxyflavone was the most potent one among these six, having an EC50 value of 21.75 µg/ml. 3,6-Dimethoxy-5,7,2′,3′,4′-pentahydroxy-7-O-β-D-glucopyranoside (Ali et al., 2001). Luteolin-7-O-β-D-glucoside, 5,7,3′ -trimethyl-4′-methoxyl 3-O-β-D-flavonoid glycoside, 8,3′ dihydroxyl-3,7,4′-trimethoxy-6-O-β-D-flavonoid glycoside, and 4,2,4′-tri hydroxyl-6′-methoxyl-3′ isopentenyl chalcone were isolated from the ethanolic extract of entire plant of Tridax Procumbens. According to research, T. procumbens growing in a light-intense environment possess a higher amount of flavonoid and phenolic component recovery than the shaded area (Idris et al., 2018) (*Figure 4*).

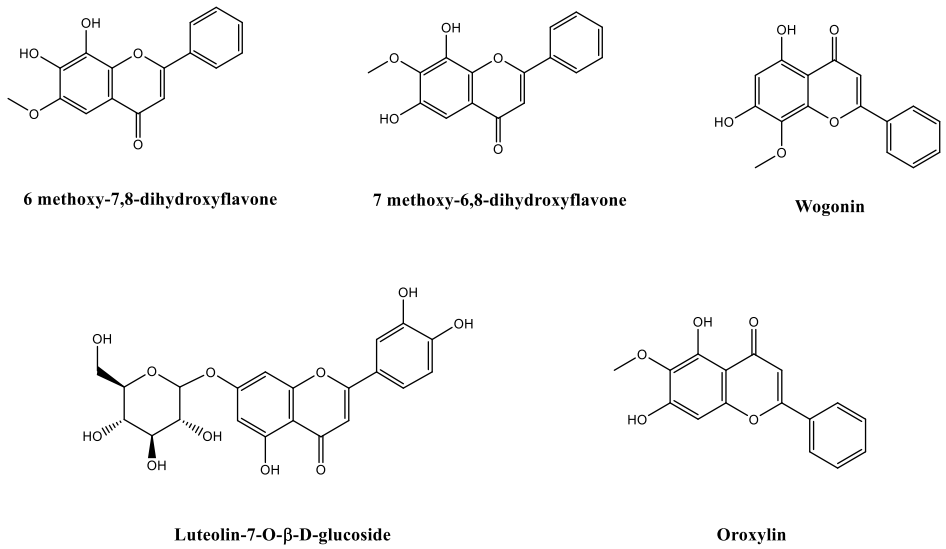


Figure 4. *Molecular structures of flavonoids identified by phytochemical analysis.*

Nor isoprenoids

The ethanolic extract of the aerial part of T. procumbens generally contains nine nor isoprenoids. These include (3S, 5R, 6S, 7E) -5,6 epoxy3hydroxy-7-megastigmene-9-one, S-(+)-dehydrovomifoliol, Icariside B1, and Loliolide (Chen et al., 2008) (*Figure 5*).

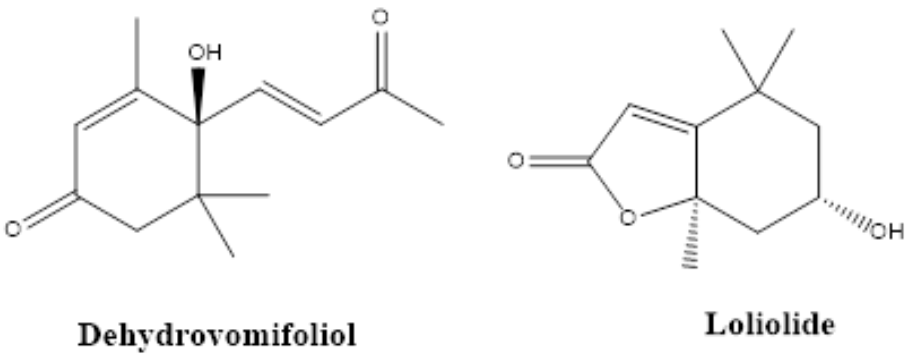


Figure 5. *Chemical structures of identified sesquiterpenoid compounds.*

Benzoic acid derivatives, tannins, lignans

The fresh juice of T. procumbens leaves contains derivatives of benzoic acid, including 4-hydroxybenzoic acid, ferulic acid, and vanillic acid (Ikese et al., 2015; Chen et al., 2008). Among the polyphenolic substances (tannins) include amino acids, alkaloids, Lignans, Epieudesmin, Apigenin-4′,7-dimethyl ether, Dehydroabietic acid, and Retusin. They possess antibacterial and antioxidant properties. Tannins were isolated and identified from a methanol extract of the aerial portion of T. procumbens, as reported by Verma and Gupta (1988) (*Figure 6*).

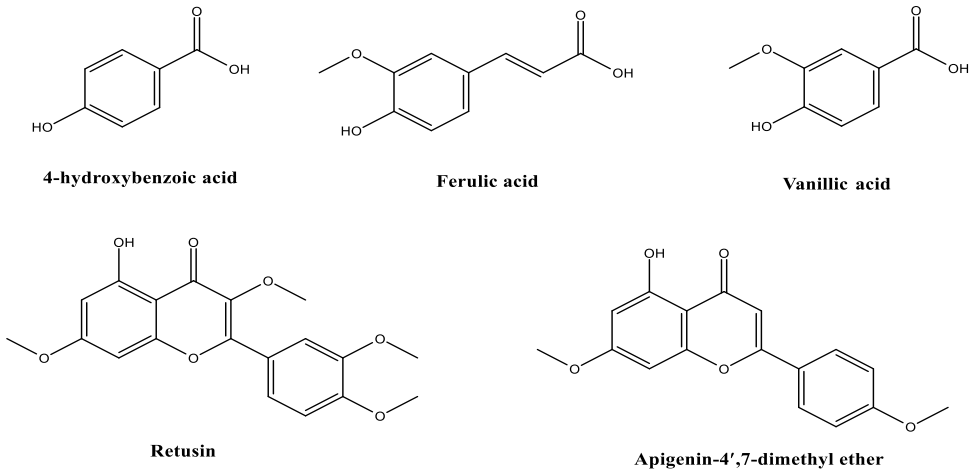


Figure 6. *Chemical structures of identified phenolic acids and flavonoid derivatives.*

Terpenoids

The greatest and largest class of natural products is terpenoids, which are followed by carotenoids, saponins, and Phyto steroids. According to Salminen et al. (2008), they have immune-boosting, blood-cholesterol-lowering, antiparasitic, anti-inflammatory, anticancer, antifungal, antiviral, antimutagenic, antioxidant, and anti-HBV qualities. The aerial parts, leaves, and flowers of T. procumbens were used to isolate and identify the following steroids. Beta-amyrone, beta-amyrin, β-sitosterol 3-O-b-D-xylopyranoside (Saxena and Albert, 2005), lupeol, and gabriel (Verma and Gupta, 1988). It also contains butilinic acid and oleanolic acid (Xu et al., 2010). The methanol leaf extract of this plant contains carotenoids, primarily Lutein, Neoxanthin, Antheraxanthin, and Carotene (Ikewuchi et al., 2009) (*Figure 7*).

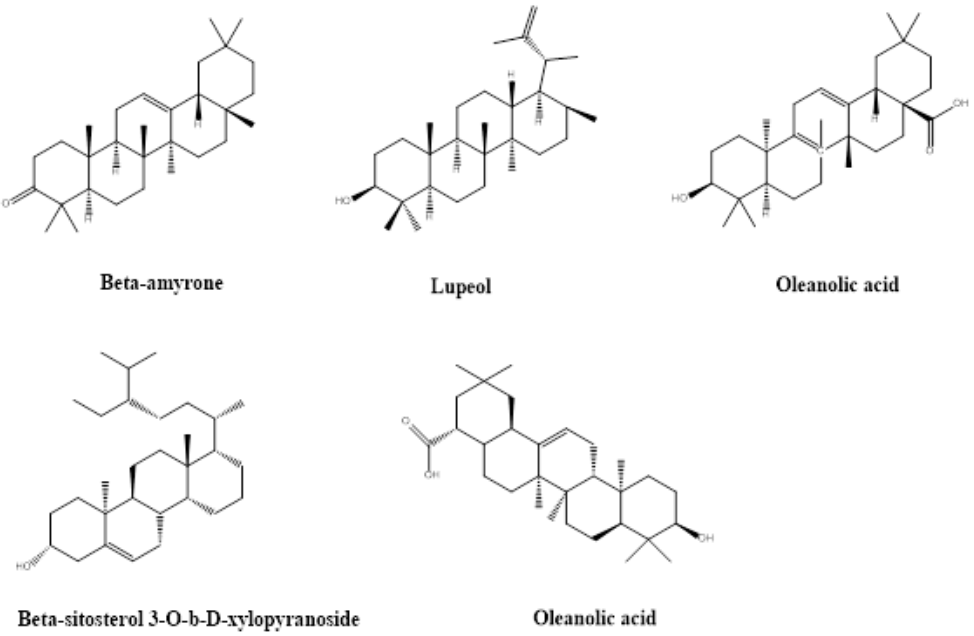


Figure 7. *Chemical structures identified triterpenoid and sterol compounds.*

Tannins

Most of the plants naturally contain water-soluble polyphenols called tannins. Due to their antioxidant qualities, tannins exhibit anti-carcinogenic, antimicrobial, and anti-mutagenic qualities and they are considered as valuable secondary metabolites (Chung et al., 1998). The presence of tannins in T. procumbens has been reported by a number of researchers (Jindal and Kumar, 2012). The presence of tannins in T. procumbens leaf extracts was observed by acetone-water or chloroform-water (Sawant and Godghate, 2013). Tannins are also present in flower buds and pedicle of T. procumbens. The most commonly found tannin in this plant is Tannic acid.

Carotenoids

Carotenoids are fat- soluble pigments present in leaves that mainly have three major functions: They enable light absorption, offer protection from photooxidative damage, and act as pigments that attract insects (Ikewuchi et al., 2009). Carotenoids are assumed to protect DNA from oxidative damage (Wagener and Gupta, 2005). Many secondary metabolites, including beta-carotene, which is necessary for the maintenance of epithelial cells and may be converted into vitamin A, have been produced by T. procumbens (Ikewuchi et al., 2009). Night blindness, xerophthalmia, and issues with immunology and hematopoiesis can all result from a vitamin A deficiency (Sommer, 1995). Carotenoids, such as lutein and beta-carotene, have been shown to be effective in lowering UV-induced erythema (Sommer, 1995). The photoprotective properties are also said to be linked with the antioxidant properties of carotenoids (Wagener and Gupta, 2005).

Alkaloids

This is the family of nitrogenous organic chemicals derived from plants that have observable physiological effects on body are known as Alkaloid. After some research, it is found that T. procumbens also contain some alkaloids (Jindal and Kumar, 2012). Total thirty-nine alkaloids were found in a phytochemical screening examination by using aqueous extraction of the leaves, which are primarily Voacangine (22.33%) and Akuammidine (73.91%) (Ikewuchi et al., 2015). The extract had tannins and sterols in addition to alkaloids. T. procumbens pedicle and bud alkaloids demonstrated antibacterial action against Candida albicans and Proteus mirabilis, while bud alkaloids demonstrated antimicrobial activity against Trichophyton mentagrophytes and E. coli. According to Jindal and Kumar (2012), the total alkaloids in the pedicles were 32.25 mg/gdw, whereas the total alkaloids in the buds were 92.66 mg/gdw. The presence of these alkaloids points once more to the great potential of this plant (*Figure 8*).

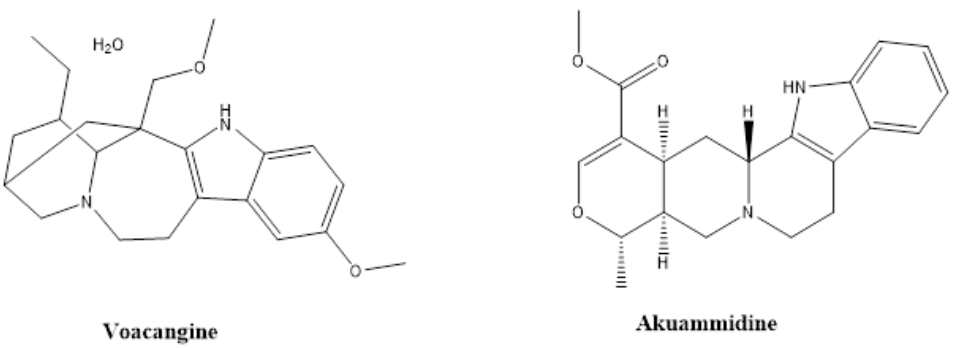
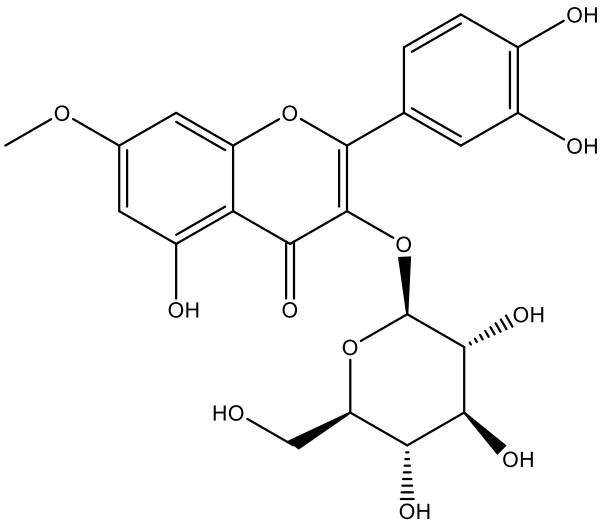


Figure 8. *Chemical structures of identified indole alkaloid compounds.*

Saponins

T. procumbens has been found to contain a steroidal saponin and Beta-Sitosterol-3-O-β-D-xylopyranoside in its flowers (Jindal and Kumar, 2012). Saponins are steroidal glycosides with pharmacological and medicinal properties (Attele et al., 1999). Another study found that by blocking the sodium glucose co-transporter-1 (S-GLUT-1) in the intestines of male Wistar albino rats, saponins from an ethanolic extract of T. procumbens may have antidiabetic effects (Petchi et al., 2013) (*Figure 9*).



Beta-Sitosterol-3-O-β-D-xylopyranoside

Figure 9. *Chemical structure of a sterol glycoside (β-Sitosterol-3-O-β-D-xylopyranoside).*

Pharmacological activities

Antimicrobial activity

Although antimicrobial tests have been conducted, more research is required to validate some of the findings. Numerous bacterial and fungal species have demonstrated susceptibility to T. procumbens' antibacterial qualities. Silver nanoparticles with some antibacterial action against E. coli, V. cholerae, A. niger, and A. flavus have been synthesized using stem and leaf callus in more recent times (Bhati-Kushwaha and Malik, 2014). These results are not certain, though, because the activity was lower than that of silver nitrate. T. procumbens leaf extracts in ethanol, petroleum, and ether demonstrated antibacterial efficacy against Bacillus faecalis. It was stated that the presence of alkaloids was most likely the cause of this behavior. According to Christudas et al. (2012), the chloroform extracts shown antibacterial activity against B. faecalis, B. subtilis, E. coli, and Pseudomonas aeruginosa; nevertheless, the tests require improved controls and protocol descriptions. When taken in tiny amounts, the alpha and beta pinenes found in T. procumbens essences can aid in the treatment of bacterial and fungal illnesses (Manjamalai et al., 2012). The antibacterial activity of this species has been the subject of conflicting findings (Taddei and Rosas-Romero, 2000). There is evidence that this species has antimicrobial potential, thus additional research is needed in this field. However, other investigations (Jhample et al., 2015) did not include substantial biological activity compared to the antibiotic control.

Antifungal activity

T. procumbens's antifungal properties have been studied. To determine the ideal zone of inhibition from various fungal strains, such as Microsporum fulvum, Microsporum gypseum, Trichophyton mentagrophytes, Trichophyton rubrum, Candida albicans, and Trichosporon beigelii, several extraction techniques have been employed. With the dichloromethane (DCM) fraction producing the best response, extracts of this plant's aerial parts have demonstrated efficacy against dermatophytes with zones of inhibition ranging from 17 to 25 mm (Policegoudra et al., 2014). Nevertheless, the authors do not specify which bioactive substances are in charge of the antifungal effects. The authors speculate that these substances might be components and derivatives of fatty acids, however they provide no supporting data.

Wound healing activity

In experimental male Wistar rats, aqueous extract of T. procumbens (leaves) not only accelerated healing but also defeated steroid-depressed healing. It has been proposed that the preparation's elevated lysyl oxidase activity is what causes the wound-healing action. The activity at the cellular level is shown by the elevated nucleic acid level (Udupa et al., 1991b). Tridax procumbens leaf juice has been demonstrated to reduce wound contraction in test animals. A variety of cytokines and growth factors orchestrate the intricate interactions between plasma-derived proteins, the extracellular matrix, epidermal and dermal cells, and controlled angiogenesis (Bhat et al., 2007). Without influencing the ant contraction or granulation action of dexamethasone, Tridax counteracted the anti-epithelization and tensile strength lowering effects of the well-known healing suppressant. The plant raises the amount of protein and nucleic acids in the granulation tissue in addition to lysyl oxidase, most likely due to an increase in glycosaminoglycan content (Nia et al., 2003).

Antidiabetic activity

The hypoglycemic properties of the ethanolic extract (TP-1) and its fraction were evaluated. The search was perused in normoglycemic and alloxan-diabetic rats. The blood sugar level of diabetic rats was reduced by 10-17%, however this extract has no effect on fasted blood sugar level of the normal rats. oral administration of TP-2-1 could improve both oral and intraperitoneal glucose tolerance of normoglycemic rats. Dried aqueous, alcoholic, and petroleum ether (60- 80°C) extracts of leaves of Tridax procumbens were subjected for hypoglycemic activity in Wistar rats (150-200 g). Experimental studies revels that the aqueous and alcoholic extracts from Tridax procumbens leaves (200 mg/kg) orally administered for 7 days produced a significant decrease in the blood glucose level in the model of alloxan-induced diabetes in rats (Bhagwat et al., 2008). Oral administration of acute and sub-chronic doses (250 and 500 mg/kg body weight) of Tridax procumbens' ethanolic extract demonstrated a significant reduction in fasting blood glucose levels in diabetic rats when compared to the standard medication Glibenclamide (10 mg/kg body weight) (Pareek et al., 2009). This evaluation also assessed Tridax procumbens' anti-hyperglycemic potential. Male Wistar rats with diabetes were given injections of streptozotocin (50 mg/kg, i.p.) and nicotinamide (120 mg/kg, i.p.) in 95% ethanol-extracted T. procumbens. Glibenclamide (0.25 mg/kg, p.o.) was administered as a standard treatment to diabetic rats for 21 days

in a row, along with procumbens extract (250 and 500 mg/k, p.o.). Serum lipid profiles and liver enzyme levels were assessed for each experimental animal and compared to the diabetic control group. At 250 and 500 mg/kg, the ethanolic extract of the entire T. procumbens plant has strong antihyperlipidemic and antidiabetic effects. The body weight of the diabetic control animals was much lower than that of the control animals. T. procumbens dramatically changed the lipid levels and prevented weight loss brought on by streptozotocin (Petchi et al., 2013).

Malarial vector repellency

In mosquito cages, the topical repellency effects of the essential oils isolated by steam distillation from Tridax procumbens L. leaves against the malarial vector Anopheles stephensi were assessed. Three distinct concentrations of oils (2, 4, and 6%) were examined. T. procumbens demonstrated a comparatively significant repellency effect (>300 minutes at 6% concentration). All essential oils showed distinct dose-response correlations, with 6% being the highest concentration (Sawant and Godghate, 2013).

Antihypertensive activity

Any measurement where the systolic number is greater than 140 mmHg and the diastolic reading is greater than 90 mm Hg is considered hypertension, or high blood pressure, in persons over 20. People who were using drugs to decrease their blood pressure were also classified as having hypertension by the CDC. According to the National Center for Health Statistics, 30% of Americans over 20 had high blood pressure between 2009 and 2012. In Benin and other nations, Tridax procumbens is used to treat hypertension since ancient times (Salami et al., 2017; Adjagba et al., 2015). Its traditional background motivated research investigating its antihypertensive properties. Cyclohexane, micellar, dichloromethane, and ethyl acetate fractions were made from a crude aqueous extract of the plant's aerial parts. To develop hypertensive dug products, rats were given 20 mg/kg of N (G)-Nitro-L-Arginine-Methyl Ester (L-NAME) for seven days. They were then administered with various extracts for seven additional days. The ethyl acetate and dichloromethane fractions were the most efficient in reducing the mean arterial pressure of the rats. The outcomes replicated the effects of the common drug captopril on the rats. Both the dichloromethane and ethyl acetate fractions included alkaloids and flavonoids, which may indicate that these phytochemicals are responsible lowering the blood pressure. Flavonoids may be the cause of vasorelaxation, which lowers blood pressure, according to one theory about the mechanism of action. It is also said that flavonoids may have a diuretic effect that may also explain about the plant’s antihypertensive activity (Adjagba et al., 2015).

Anti-cancerous activity

The anti-cancer activity of crude aqueous and acetone extracts from the traditional herb Tridax procumbens flowers were studied using prostate epithelial malignant cells PC3. The MTT assay was used to evaluate the viability of cells. The soluble yellow tetrazolium salt MTT [3-(4, 5-dimethyl –thiazole-2- yl)-2, 5-diphenyl tetrazolium bromide] is broken down by the mitochondrial succinate dehydrogenase to produce a blue formazan in the experiment. The test depended on the mitochondrial enzymes of living cells' capacity to change the yellow soluble salt MTT into a purple-blue insoluble

formazan precipitate, which is subsequently detected by spectrophotometry at 570 nm. The results of the analysis showed that floral crude extract had anti-cancer potential (Vishnu Priya et al., 2011). The cytotoxicity of T. procumbens compounds against human lung cancer has been evaluated by the MTT assay. Cell viability was reduced by 90%, which was indicated by the Rf value of 0.66 by aqueous extract components. NMR, MS, and IR spectra showed the chemical to be lupeol. 320 µg/ml of the Lupeol molecule displayed possible anticancer effects. Clonogenic survival, cell cycle control, cell-based assay for COX-2 activity suppression, and DNA fragmentation analysis have all been used to evaluate Lupeol's anticancer potential against human lung cancer (Sankaranarayanan et al., 2013). The in-vitro anticancer activity of T. procumbens leaf extracts in ethanol, acetone, and aqueous solution was evaluated on a subset of malignant cell lines using the MTT assay and the tryphan blue dye exclusion experiment. T. procumbens leaf extracts in ethanol, acetone, and aqueous form were evaluated for their in vitro anticancer activity on a subset of malignant cell lines using the MTT assay and the tryphan blue dye exclusion experiment. T. procumbens leaf extracts in acetone and ethanol shown potent anticancer activities on the human liver carcinoma cell line Hep G2 and the human lung cancer cell line A549 (Vishnu and Srinivasa, 2015). The hydro distilled essential oil of T. procumbens contains eighteen components, on the basis of GC-MS analysis. Biformeme (3.95%), p-cymen-7-ol (2.52%), 1,8-cineole (2.44%), dibutyl phthalate (19.29%), and trans-(α)-caryophyllene (9.55%). Trans-α- Bergamotol (1.78%), 2-αpinene (1.62%), α-Selinine (1.49%), Caryophyllene oxide (1.39%), and α-humulene (0.95%) are the minor components. The MTT test was used to determine the obtained essential oil's anticancer potential against the human breast cancer cell line (MCF-7) at different essential oil dosages (18.5–300 µg/ml). 96.6 µg/ml was the IC50 value for the MCF-7 cell line. The terpene content of the oil may be the cause for this (Poonkodi et al., 2017).

Anti-inflammatory activity

Tridax procumbens extracts showed good anti-inflammatory action by considerably reducing parameters such as exudate volume, leukocyte migration, edema fluid, granuloma tissue, and γ-glutamyl transpeptidase. Tridax procumbens inhibits SRs and PGs to produce anti-inflammatory effects while having very little ulcerogenic potential. T. procumbens leaf aqueous extract was lyophilized and tested on rat skin fibroblasts, rat paw oedema, and an excision wound model. When compared to ibuprofen, T. procumbens did not considerably raise the fibroblast count. While ibuprofen and aspirin treatment significantly impacted the aforementioned metrics, the control and T. procumbens treatments showed negligible changes in the fibroblast cell count, hydroxyproline/DNA ratio, and collagen production. In the Carrageenan-induced Oedema model, the specific activity of the enzyme gamma glutamyl transpeptidase was similar in the Tridax procumbens, ibuprofen, and aspirin at 200 mg/kg, and the suppression of Oedema was similar in the 200 mg/kg Tridax procumbens and 50 mg/kg ibuprofen therapy (Margaret et al., 1998). In conjunction with the common medication Ibuprofen, the anti-inflammatory properties of Tridax procumbens were tested on carrageenin-induced paw edema. Ibuprofen reduced paw edema considerably. An equieffective dose of Tridax procumbens administered orally had roughly 20–35% more activity than that of ibuprofen. In comparison to Ibuprofen alone, Tridax procumbens combined with different dosing regimens of Ibuprofen demonstrated stronger anti-inflammatory effects (Awasthi et al., 2009). The presence of flavonoids and other

polyphenols in the extract may be responsible for the free radical scavenging properties, while the restriction of COX-1 and COX-2 enzymes may be at least partially responsible for the anti-inflammatory effect of Tridax procumbens aerial parts (Jachak et al., 2007).

Hepatoprotective activity

It was examined whether the aerial portions of Tridax procumbens may protect rats from hepatitis caused by d-galactosamine/lipopolysaccharide (d-GalN/LPS). Because it can destroy liver cells, DGalN/LPS has been suggested to be hepatotoxic. There are similarities between the lesion of viral hepatitis in humans and the multifocal necrosis caused by DGalN. Within eight hours of dosing, this amino sugar produces fulminate hepatitis due to endotoxin toxicity, which is known to specifically inhibit transcription and indirectly hepatic protein synthesis (Ravikumar et al., 2005b). Morphology, metabolic, histological, and biochemical parameters were recorded in both acute and chronic models of liver injury. The use of T. procumbens in liver illness is justified by its antihepatotoxic activity. Hepatoprotective efficacy was only shown by the ethanolic extract and the chloroform insoluble fraction (Pathak et al., 1991).

Immunomodulatory activity

Researchers were looking at the immunomodulatory qualities of the ethanol-insoluble fraction of the T. procumbens aqueous extract. The phagocytic index, leucocyte count, and splenic antibody-secreting cells all significantly increased after IP injection of TPEIF at doses of 0.25 and 0.5 g/kg body weight (BW). A rise in the titer of hemagglutination antibodies substantially increased the humoral immune response. Strong evidence that the cellular immune system was triggered was provided by an increased delayed type hypersensitivity reaction. TPEIF influences the humoral and cell-mediated immune systems and helps in producing a stronger antibody response to a specific clinical antigen (Tiwari et al., 2004). The immune-modulatory effects of an ethanolic leaf extract of Tridax procumbens were investigated when Pseudomonas aeruginosa was administered orally to Swiss albino rats in 2006. Both in vitro (phagocytosis) and in vivo (hemagglutination and delayed hypersensitivity) studies were conducted to examine the effects of extract and fraction on cellular and hormonal immunity. The results show how Tridax procumbens' flavonoidal and saponin component can impact the hormonal and cell-mediated components of the immune system. Also, they examined at the phytoconstituents that provide Tridax procumbens its immunomodulatory qualities (Agrawal et al., 2010).

Antioxidant activity

In rats, the chloroform insoluble portions of Tridax procumbens ethanolic extract prevents hepatitis caused due to D-galactosamine/lipopolysaccharide (D-galn/LPS). Thiobarbituric acid, a reactive molecule in the liver, indicates a substantial increase in lipid peroxidation in rats administered with D-galn/LPS (300 mg/kg body weight). Tridax procumbens strongly reduces the oxidative stress brought on by D-galn/LPS, indicating that it possesses antioxidant properties (Ravikumar et al., 2005a). Antioxidant activity was determined by methanolic extract portions from the aerial section using the DPPH technique. Significant activity that is comparable to that of the common antioxidant ascorbic acid was demonstrated by the n-butanol and ethyl acetate fractions

(Agrawal et al., 2009). The reducing power capacity was examined for total phenolics using the Follian-Cocalteu method and for antioxidant activity using the 1, 1-diphenyl-2-picrylhydrazyl (DPPH) assay. Tridax procumbens was shown to have a greater percentage antioxidant activity (96.70) in the ethanolic extract than the standards gallic acid (92.92) and ascorbic acid (94.81). Tridax procumbens has a phenolic concentration of 12 mg/g GAE (gallic acid equivalent), according to the total phenolic measurement. Natural antioxidants are abundant in plants (Habila et al., 2010).

Antiprotozoal activity

Plant extract is employed both in vivo against tripomastigotes and in vitro against epimastigote and tripomastigote. Five of the examined exhibited in vitro action against Trypanosoma cruzei, three against yeasts, six against bacteria, and five against Microsporum gypsum. Varolaena lobata and Solanum americanum showed both in vitro and in vivo action; Acalypha guatemalensis, Petiveria alliacea, and T. procumbens showed both in vitro and in vivo activity, while S. americanum was found to be poisonous to Artemia salina (Aqueous, 160 ppm). None of them exhibited oral or acute toxicity to mice. IP mild toxicity was seen in S. Americanum (Cáceres et al., 1998).

Anti-ulcer

Anti-ulcer drugs are used to prevent ulcers. Tridax procumbens methanolic extracts have antiulcer properties. In this investigation, myeloperoxidase activity in albino rats was used for evaluating the ulcer-prevention effect of 100 mg/kg of Tridax procumbens Linn methanol extract. According to the study's results, the whole methanolic extract of the Tridax procumbens Linn plant contains protection and ulcer prevention properties that could help ward toward ulcerative colitis (Jhample et al., 2015).

Haemostatic/Blood clotting activity

Several extracts from Tridax procumbens leaves were tested for their hemostatic properties. An in vitro method was used to analyze the clotting times of ten human volunteers. Results from plant ethanol extract were encouraging. The ethanolic extract of Tridax procumbens leaves reliably reduces the clotting time in blood samples. This study illustrated the relationship between hemostatic activity and hemostasis (Ikese et al., 2015).

Anti arthritic activity

Arthritis is an inflammatory illness that can affect one or more joints. It is rising as a result of people's hectic schedules and dehydration. The effects of 500 and 250 mg/kg dosages of Tridax procumbens ethanol extract on arthritis have been documented in a number of research. 10 mg/kg of indomethacin was the suggested dosage. The entire plant extract of Tridax procumbens showed strong anti-arthritic properties. The results paralleled the effects of indomethacin (Nazeruddin et al., 2011).

Anti-obesity activity

In an atherogenic diet-induced obesity paradigm, the plant extract significantly decreased free fatty acids, total protein, triglycerides, total cholesterol, and elevated high-density lipoprotein cholesterol in the treated rats. It was discovered that Tridax

Procumbens has a significant anti-obesity effect. These are the some pharmacological activities shown by the Tridax Procumbens (Bharathi et al., 2011).

Analgesic activity

The analgesic activity of the tridax procumbens is evaluated by therse in vivo methods: Formalin induced persistent pain (Biphasic pain), Acetic acid induced writhing test, CFA induced hyper analgesia in rat (Inflammatory pain). Lyophilized extract of tridax procumbens was found to be potent analgesic. In accordance to the present study, it has been observed that tridax procumbens has marked beneficial effect against centrally, peripherally, and inflammatory pain models. This protective action maybe attributed towards the presence of flavonoid and sterols (Prabhu et al., 2011).

Hair regrowth activity

The crude extract or herbal oil of Tridax procumbens can be used for hair regrowth and treatment of dandruff. However further research on this matter yet has to be done (Sulthana et al., 2022).

Conclusion

Tridax procumbens is a highly valuable plant possessing a wide range of medicinal, ecological, and agricultural applications. It contains a wide range of phytochemical, including compounds which possess antimicrobial, anti-inflammatory, and antioxidant properties, which defines its potential for the development of traditional as well as modern pharmaceutical substances. Furthermore, this plant has the ability to adapt to various environmental conditions which makes it a resilient species, offering easy production, handing and management. However, due to its invasive nature it has to be managed carefully to prevent negative impacts on local biodiversity. Also, continued research for the plant's bioactive compounds and its pharmacological activity is essential to fully utilize the plant’s benefits while avoiding any risks. Overall, Tridax procumbens is a valuable plant with extreme potential for diverse applications, due to its numerous pharmacological activities it can be valuable resource for the development of Pharmaceutical products for, which can play an important role the treatment prevention and cure of many diseases.

Acknowledgement

This research is self-funded.

Conflict of interest

The authors confirm that there is no conflict of interest involve with any parties in this research study.

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