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A REVIEW: PHARMACOLOGY OF TRIDAX PROCUMBENS

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Abstract:

Tridax procumbens is a plant used majorly in Indian traditional medicine. This is rich in alkaloids, steroids, carotenoids, flavonoids (such as catechins, centaurein and bergenins), fatty acids, phytosterols, tannins and minerals. Concoctions of extracts from T. procumbens leaves, stem,flower, and roots are used to treat patients suffering from diabetes, arthritis, inflammatory reactions and even applied to open wounds. The medicinal value of extracts has been evident by in vitro/in vivo assay of antioxidant, anti-bacterial, antiinflammatory, anti-microbial, vasorelaxant, anti-leishmanial and mosquitocidal activities. Still, there is derth in the studies on isolation, characterization and evaluation of active principles from the extracts. This current review article gives comprehensive information about the T. procumbens taxonomy, morphology, geographical distribution, phytoconstituents and pharmacological activities.

KEYWORDS: *Tridax procumbens, Antioxidant, Anti-hepatic, Anti-inflammatory, Anti-arthritic, Anti-microbial, Antidiabetic, Anti-cancer, Antihypertensive, Immunomodulatory, Wound healing.*

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INTRODUCTION:

Tridax procumbens is a widely spread hispid, procumbent herb, usually found as a weed. T. procumbens is perennial in nature with flowering-fruiting throughout the year. [1-4] T. procumbens is commonly called as 'Jayanti-veda' in Sanskrit, Tikki-kasa/'Ghamra' in Hindi and 'Wild daisy', 'Mexican daisy' and 'Coat buttons'in English based on the appearance of the flower. The scientific name is 'Tridax procumbens' [3- 7]. The generic name is derived from the Greek, meaning 'summer eating', implying that it was a summer vegetable [8]. T. procumbens belongs to the kingdom: Plantae, sub-kingdom: Tracheobionta, division: Magnoliophyta Dicotyledons, class: Magnoliopsida, sub-class: Asteridae, order: Asterales, family: Asteraceae, genus: Tridax L. and species: procumbens [4]. T. procumbens is widely distributed in India up to 2400 m above sea level [6, 9]. The leaves of the plant are used as raw feed toncattle and food additive by humans as well [6]. The leaves have medicinal value and used to treat catarrh, dysentery and diarrhea.The different leaf extracts are used as antiseptic to treat fresh cuts, wounds, burns and in anemia [10]. It also contains hair growth enhancing ability [11, 12]. Aqueous leaves extract posses cardiovascular effect and signif icantly reduces heart rate and blood pressure. Lyophilized aqueous leaf extract showed antiinflammatory. Leaf juice is useful in dead space wound healing. Seeds are used to check all types of bleeding. Aqueous extract of whole arial part is used as immunomodulator. Dry extract showed antibiotic activity even when formulated in mineral base. Action comparable to ibuprofen and aspirin. Whole arial parts have hepatoprotective,antisecretory (antidiarrhoeal) activity. It is active against bacteria, protozoa and fungi.

Figure-1 Plant of Tridax Procumbens Linn.

CLASSIFICATION OF TRIDAX PROCUMBENS :

Table-1 Classification of Tridax Procumbens Linn

	Classification	Scientific Name	Biological Name
1	Kingdom	Plantae	Plant
2	Sub kingdom	Tracheobionta	Vascular Plants
3	Division	Spermatophyta	-
4	Subdivision	Magnoliophyta	Flowering plants
5	Class	Magnoliposida	Dicotyledons
6	Subclass	Asteridae	-
7	Order	Asterales	-
8	Family	Asteraceae	Aster family
9	Genus	Tridax L.	Tridax
10	Species	Tridax Procumbens L.	Cost buttons

PLANT MORPHOLOGY :

1.Habit: tridex procumbens is described as a prostrate plant indicating that it has a trailing or creeping a growth habit. It tends to grow close to the ground and spreads horizontally rather than growing upright.

2.Steam: stem are cylindrical,hispid, covered with multicellular hairs of millimetre tuberculation is strong transport system. The plant steam is ascending 30- 50 centimeter height branched, sparsely hairy, rooting at nodes. The stems of tridex procumbens are likely to be relatively thin and flexible. They may have a creeping or trailing nature allow the plant to form a mat-like appreance as it spreads along the ground.

3.Roots: As a prostrate plant, Tridex procumbens likely has a shallow root system, primarily focused near the soil surface.These roots would help anchor the plant and absorb water and nutrients from the surrounding soil.

4.Flowers: The plant Flowers are looking like daisy. The Flower having tubular shape, indicating that the petals are fused together to form a tube like structure.The centre of the flower is yellow. The petals of the flowers can be either white or yellow.the outermost petals known as florets, have three teeth or lobes. The Flowers are arranged in a compact cluster known as a capitulum or Flower head. The plant has two types of Flowers ray florets, and disc florets are the small tubular Flowers in the centre. The plant Flowers & produces Fruit throughout the year, indicating a perennial nature or continuous flowering behaviour.

5.Leaves: The leaf margins have irregular or uneven teeth.The leaves are generally arrow head or triangular in shape.the leaves are simple meaning they are not divided into leaflets. The leaves have an ovate (eggshaped) or lanceolate (lance-shaped) appreance.They are arranged opposite each other on the stem.The leaves are exstipulate,which means they do not have stipules (small,leaf-like appendages at the base of the petiole.The size of the leaves measure approximately 3-7cm in length.

PHYTOCONSTITUENTS :

The various research studies, it was showed that the plant has different phytochemical screening, it was observed that alkaloids, carotenoids,saponins, flavonoids and tannis are present in this medicinal plants.

1.Alkaloids: Alkaloids are a diverse group of organic compounds that often have pharmacological effect. Many alkaloids have been found to passes medicinal properties, such as analgesic, antimicrobial or antidiarrheal activities. Alkoloids are defined as any class of nitrogenous organic compounds of plant origin that have pronounced physiological effect on human.Tridex procumbens in the presence of some alkaloids has also been reported. Phytochemical screening analysis using aquious extraction of an leaves.thirty nine alkaloids were present, mainly: Akuamidine (73.91%) and Voacangine (22.33%) (Ikewuchi, 2012). Besides Alkaloids, the extract contained sterols and tannins. Alkaloids of the pedicle and buds of T. procumbens showed Antimicrobial activity against Proteus mirabilis and Candida albicans; alkaloids from buds showed activity Against E. coli and Trichophyton mentagrophytes. The total amount of alkaloids in the pedicle was 32.25mg/gdw in the pedicles and 92.66mg/gdw in the buds. The presence of these alkaloids point Once more to the great potential of this plant.

2.Carotenoids: Carotenoids are fat-soluble pigments found in the leaves that have threemain functions in a plant: light-harvesting, protection from photooxidative damage, and pigmentation to attract insects.Carotenoids have been postulated to prevent damage to DNA by oxidative stress.

Many Types of these secondary metabolites have been isolated from T. procumbent including betacarotene, which can be converted to vitamin A, which is important for maintenance of epithelial tissues. Vitamin A deficiency can result in impairment of immunity and hematopoiesis, night blindness, and

Xerophthalmia. Carotenoids such as beta-carotene and lutein have shown activity in the Reduction of UVinduced erythema. The photo protective properties have also been linked with the antioxidant properties of carotenoids.

3.Saponins: Saponins are steroidal glycosides that contain pharmacological and medicinal properties and have been detected in T. procumbens , specifically a steroidal saponin and pB-Sitosterol-3-OβDxylopyranoside in the flowers of the species . Another study determined thasaponins from an ethanolic extract of T. procumbens could potentially contain antidiabetic properties by inhibiting the sodium glucose cotransporter-1 in the intestines of male Wistar albino rats.

4.Flavonoids: A recent study has demonstrated the presence of twenty-three flavonoids in T.procumbens with total content around 65 g/kg. Kaempferol and catechin and its derivatives (-) -epicatechin, (+) catechin, (-)-eigallocatechin, (+)-gallocatechin, (-)-Epigallocatechin-3-Gallate (EGCG) and (-)

Epicatechin-3-Gallate) account for about 17.59% and 26.3% respectively. The remaining 56.11% represent sixteen flavonoids namely biochanin, apigenin, naringenin,daidzein, quercetin, butein,robinetinbaicalein, nobiletin, genistin, ellagic acid, l, myricetin, baicalin, isorhamnetin

and silymarin.

5.Tannis: Tannins are naturally occurring water-soluble polyphenols found in plants. Tannins have antimicrobial properties, as well as anti-carcinogenic and antimutagenic properties, potentially because of their antioxidant capabilities. Several researchers have described the presence of tannins in T. procumbens. Acetonewater Chloroform-water showed the .presence oftannins in leaf extracts of T.procumbens. Tannins are present in the pedicle and buds of T. Procumbens.

6.CHEMICAL CONSTITUENTS :

Tridax procumbens contains a variety of bioactive compounds including flavone glycosides, chromone glycosides, sterols, and polysaccharides with a β-1,6-D-galactan backbone. The unsaponifiable fraction of the petroleum ether extract was found to contain campesterol, stigmasterol, and β-sitosterol, as confirmed by GC– MS analysis (Gadre and Gabhe, 1992).

The ethyl acetate-soluble portion of the hexane extract yielded a novel bithiophene compound known as tri- bisbithiophene, along with four terpenoids: taraxasteryl acetate, β-amyranone, lupeol, and oleanolic acid (Ali and Jahangir, 2002). Additionally, a new flavonoid named Procumbenetin was isolated from the aerial parts of T. procumbens. It was characterized as 3,6-dimethoxy-5,7,2',3',4'-pentahydroxy flavone7O-β-D-glucopyranoside (Ali and Ramachandram, 2001).

Further chemical investigations revealed the presence of eight newly identified compounds, namely methyl 14- oxooctadecanoate, methyl 14-oxononacosanoate, 3-methylnonadecylbenzene, heptacosanyl cyclohexane caprylate, 1-(2,2-dimethyl-3-hydroxypropyl)-2-isobutyl phthalate, 12hydroxytetracosan15one, 32-methyl-30-oxotetratriacont-31-en-1-ol, and 30-methyl-28-oxodotriacont-29en-1-oic acid. These were identified through spectral analysis and chemical studies.

In addition to these, nine known compounds were isolated from the plant for the first time. These included dotriacontanol, amyrone, 12-dehydrolupen-3-one, amyrin, lupeol, fucosterol, 9-oxoheptadecane, 10oxononadecane, and sitosterol (Verma and Gupta, 2004).

Together, these findings demonstrate that Tridax procumbens is a rich source of diverse phytoconstituents, including sterols, terpenoids, flavonoids, and long-chain aliphatic compounds, all of which may contribute to its wide range of pharmacological activities.

MEDICINAL USES AND TRADITIONAL USES :

The aqueous leaf extract of Tridax procumbens possesses cardiovascular effects by significantly reducing heart rate and blood pressure. The lyophilized aqueous leaf extract exhibits anti-inflammatory action comparable to commonly used anti-inflammatory drugs such as ibuprofen and aspirin.The whole aerial parts of Tridax procumbens have hepatoprotective properties, meaning they can protect the liver from damage. Additionally, they exhibit antisecretory activity, which can help in reducing diarrhea.Tridax procumbens shows activity against bacteria, protozoa, and fungi, making it poten ially useful Icombating various infections. The leaf juice of Tridax procumbens is traditionally used for wound healing, particularly in dead space wounds. The seeds of Tridax procumbens are utilized to check all types of bleeding. The aqueous extract of the whole aerial parts of Tridax procumbens is used as an immunomodulator, meaning it helps modulate the immune system. Tridax procumbens has a long history of traditional use in different cultures. It has been used for treating anemia, colds, inflammation, hepatopathies, bacterial and fungal infections, vaginitis, stomach pain, diarrhea, mucosal inflammations, and skin infections. In Guatemala, it is used to treat protozoal infections, high blood pressure, diabetes, and various gastrointestinal and respiratory infections. Some of the traditional uses of Tridax procumbens are supported by scientific studies, such as its anti-plasmodial activity against. Chloroquine-resistant malaria parasites (Plasmodium falciparum) and its wound-healing and antibacterial properties.

TRADITIONAL USES :

In Nigeria, the entire plant is used to treat typhoid fever, cough,fever, stomachache, backache, diarrhea and epilepsy. Farmers in Africa use the plant for treatment of livestock for example, Tridax is used along Vigna parkeri toTreat chronic mastitis by grinding both plants, and adding salt and water and applying to the udder studied the antibacterial effect of Tridax against mastitis-causing bacteria and found that the ethanolic extract had significant activity against Staphylococcus aureus. However, there was little or no activity from the aqueous extracts against Streptococcus uberis and Klebsiella penumonia, in comparison with Spathodea campanulata extracts. In Benin, breeders complement the feed of rabbits or other livestock combining with other plants; although rabbits consume it in lower amounts than other fodder, probably due to low palatability. In Togo, the fresh, crushed leaves are used for dressing wounds. The decoction of the leaves is used against pain, to treat malaria, and against abdominal and gastrointestinal mycosis. In India it is known as an insect repellent, used to treat diarrhea, and to help check for Hemorrhages. In addition, some reports include the use as a cure for hair loss. A study in Tamilnadu, India, revealed that native inhabitants apply the juice from the leaves

for the healing of wounds. The same study also infers that T. Procumbens is one of the most useful traditional medicinal plants. It has also been shown to have many minerals like calcium, selenium, magnesium, potassium and sodium. The people in Udaipur, India, have traditionally ingested powdered T. procumbens leaves, along with other herbs, to treat diabetes. The species has shown to be a Great source of potassium, which isused for the treatment of cramps and a safe source ingredient for future medicinal uses. These traditional uses demonstrate the potential uses of this plant .Tridax procumbens has been extensively utilized in the Ayurvedic system of medication and is wellaccepted medicine for a liver disorder. It's been found to possess significant medicinal properties against malaria; dysentery, Diarrhoea, bronchial catarrh, blood pressure, hair fall, stomach ache, headache and hair fall. It also has wound healing properties and check hemorrhage from cuts and bruises. Antiseptic, insecticidal and parasiticidal properties were reported in flowers and leaves. The plant also possesses immunomodulatory, antidiabetic, antihepatotoxic and anti-oxidant, anti-inflammatory, analgesic activity.

Table-2 Traditional Uses and plant preparation:

Location	Preparation/extract	Plant ailment uses
Guatemala	Leaves: Juice Leaves: poultice, driedinfusions Stems: dried Whole plant: dried	Anemia, cold, inflammation, hepatopathies, vaginitis, stomach pain, diarrhea, mucosal inflammation, skin infections, bleeding. Reduce inflammation, gastrointestinal and Respiratory infections, high blood pressure, diabetes. Protozoal infections, treatment of chronic ulcers Caused by leishmaniasis, gastrointestinal disorders.
India	Leaves: dried and other herbs ingested orally,juice	Diabetes, insects repellent, used to treat diarrhea, and to help check for hemorrhages, as well as hair loss. Jaundice, healing of wounds, inflammation
Africa	Whole plant: blending with other herbs adding salt and water.	Treating mastitis in livestock

PHARMACOLOGICAL ACTIVITY:

Tridax procumbens has many possible health benefits, such as fighting infections, acting as an antioxidant, helping with wound healing, killing insects, reducing inflammation, and treating diarrhea and dysentery.

The leaf juice is used to heal fresh wounds, stop bleeding, and as a hair tonic. In India, it is commonly used for healing wounds, preventing blood clots, fighting fungal infections, and repelling insects. In traditional medicine, leaf extracts are used to treat skin infections. Tridax procumbens is also used as a material to remove harmful Cr (VI) from industrial wastewater. It is well-known for helping the liver and protecting it from damage, and it is also used for stomach issues like gastritis and heartburn. Tridax procumbens is used as a material to remove harmful Cr (VI) from industrial wastewater.

1. Antibacterial Activity

Tridax procumbens exhibits notable antibacterial activity, particularly against Pseudomonas aeruginosa. This bacterium, a common nosocomial strain, was isolated from patients with ventilator-associated pneumonia through tracheal secretions and bronchoalveolar lavage samples. The study revealed that the ethanolic extract of Tridax procumbens demonstrated strong antibacterial activity against P. aeruginosa, with the highest zone of inhibition observed at a concentration of 5 mg/ml.

When tested alongside standard antibiotics such as Augmentin, ciprofloxacin, cephotaxime, and ticarcillin, the ethanol extract showed resistance to all except imipenem, to which it was sensitive. This finding is statistically significant, as the ethanolic extract of Tridax procumbens produced a clear inhibition zone against major gram-negative bacteria responsible for hospital-acquired infections.

The antibacterial potential of the whole plant was evaluated against two gram-positive bacteria (Bacillus subtilis and Staphylococcus aureus) and two gram-negative bacteria (Escherichia coli and Pseudomonas aeruginosa) using the disc diffusion method. The results indicated that the extract was particularly effective against Pseudomonas aeruginosa.

Leaf extracts of Tridax procumbens prepared using various solvents hexane, chloroform, butanol, ethanol, and water were tested for antibacterial activity against several bacterial species, including Escherichia coli, Pseudomonas aeruginosa, Micrococcus sp., Staphylococcus aureus, Proteus vulgaris, Klebsiella pneumoniae, Bacillus subtilis, Citrobacter sp., and Serratia marcescens, using the disc diffusion method. The study observed that gram-negative bacteria exhibited a larger zone of

inhibition compared to grampositive ones.

In another investigation using the agar well diffusion method, leaf extracts prepared with five different solvents hexane, petroleum ether, chloroform, methanol, and one additional solvent were tested against Staphylococcus aureus, Escherichia coli, Proteus mirabilis, and Vibrio cholerae. The methanol extract showed a higher concentration of bioactive compounds and greater antibacterial efficacy than the hexane extract.

Furthermore, methanolic extracts of Tridax procumbens were tested against three enteropathogens using the disc diffusion method. The extract demonstrated the strongest antibacterial activity against Salmonella typhi and Shigella flexneri, with the least effect observed against Escherichia coli.

2. Anti-Arthritic Activity:

Arthritis is an inflammatory disorder that leads to damage in one or more joints. The ethanolic extract of Tridax procumbens has shown significant anti-arthritic activity in a rat model induced with Freund's
Complete Adjuvant (FCA), comparable to the standard anti-inflammatory drug indomethacin. The evaluation parameters included increased body weight, red blood cell (RBC) count, and hemoglobin levels, along with a reduction in erythrocyte sedimentation rate (ESR), white blood cell (WBC) count, pannus formation, and bone destruction. Rheumatoid arthritis is typically characterized by the loss of articular cartilage, narrowing of joint spaces, and severe soft tissue swelling, often resulting in bone resorption. Administration of the ethanolic extract of Tridax procumbens normalized these pathological changes, confirming its potential anti-arthritic properties.

3. Antifungal Activity:

The antifungal potential of Tridax procumbens has been demonstrated through several studies. The whole plant extract was found to be effective against the pathogenic fungus Aspergillus niger, while the leaf extract exhibited notable antifungal activity against Fusarium oxysporum. Essential oil derived from T. procumbens showed inhibitory effects against Candida albicans, Candida tropicalis, and Candida parapsilosis, producing inhibition zones ranging from 12–15 mm.

Flavonoids, identified as bioactive compounds within T. procumbens, were evaluated for their antifungal properties against Aspergillus niger, Aspergillus flavus, Candida albicans, and Trichophyton species.

Among these, Candida albicans exhibited the highest susceptibility, confirming the antifungal potential of the plant's flavonoid components.
Methanolic extracts obtained from different parts of the plant leaves, stems, flowers, and roots displayed significant inhibitory activity against Candida albicans (MTCC 227 and MTCC 3017), with inhibition zones ranging between 8 mm and 13 mm at a concentration of 100 mg/ml. The methanol extract from the roots also showed antifungal activity against Candida tropicalis and Candida glabrata, while the leaf extract was active against Candida albicans and Candida tropicalis.

These findings suggest that the root extract of Tridax procumbens contains potent bioactive compounds that may serve as promising candidates for developing natural antifungal agents, particularly for the treatment of Candida infections. The use of such natural fungicidal agents could help reduce reliance on synthetic and potentially harmful chemical fungicides in the future.

4. Hepatoprotective Property:

The liver plays a crucial role in detoxifying harmful substances in the body, aided by various enzymes responsible for metabolizing and eliminating toxins. When liver cells are damaged, these enzymes leak into the bloodstream, and their elevated levels indicate the extent of hepatic injury. Studies have shown that Tridax procumbens possesses hepatoprotective properties. In an experimental study on rats, liver injury was induced using lipopolysaccharide and D-galactosamine agents known to cause hepatic inflammation. Administration of a chloroform extract prepared from the aerial parts of T. procumbens significantly reduced liver damage. This protective effect was evidenced by decreased levels of serum enzymes such as aspartate transaminase (AST), alanine transaminase (ALT), lactate dehydrogenase (LDH), gamma-glutamyl transferase (GGT), and bilirubin. These results suggest that the extract supports liver cell regeneration and enhances hepatic recovery. Similar protective outcomes were observed when T. procumbens was administered alongside chloroquine, further confirming its hepatoprotective efficacy.

5. Hypotensive Effect:

The hypotensive effect of Tridax procumbens leaves was evaluated in anaesthetized Sprague-Dawley rats. The aqueous leaf extract demonstrated a dose-dependent cardiovascular effect, producing a significant reduction in mean arterial blood pressure. Higher doses of the extract led to a marked decrease in heart rate, whereas lower doses did not significantly affect it.

The findings indicate that the leaves of Tridax procumbens Linn. possess notable hypotensive properties, suggesting their potential use in

managing hypertension through natural plant-based interventions.

6. Anti-Inflammatory Activity:

The aqueous, ethyl acetate, alcoholic, and ethanolic extracts of Tridax procumbens have demonstrated strong anti-inflammatory activity by inhibiting the actions of inflammatory mediators such as histamine, serotonin, bradykinin, and prostaglandins. Several active constituents identified in these extracts namely bergenin, centaureidin, and centaurein were found to inhibit cyclooxygenase enzymes (COX-1 and COX2), which play a key role in inflammation.

In addition, the flavonoid quercetin, present in T. procumbens, has been reported to possess significant analgesic and anti-inflammatory properties. It can also alleviate inflammation-related pain and improve sensitivity in nerve damage models, such as chronic constriction injury (CCI).

The anti-inflammatory effect of T. procumbens extract was further confirmed through the carrageenaninduced paw edema model, where its efficacy was compared with the standard antiinflammatory drug ibuprofen. The inhibition of paw swelling was found to be similar between the T. procumbens extract and ibuprofen, and when administered together, the combination produced an even greater reduction in inflammation.

When a water-soluble powder derived from T. procumbens leaves was administered to rats in varying doses, it exhibited notable analgesic effects. Similarly, the alcoholic and hydroalcoholic extracts reduced inflammation in the rat paw edema test by 10.82%, 16.80%, and 11.39%, respectively, confirming the plant's potent anti-inflammatory potential.

7. Immunomodulatory Activity:

The ethanolic extract of Tridax procumbens has been shown to enhance immune system function by stimulating phagocytic activity. This means that immune cells such as phagocytes become more effective at engulfing and destroying pathogens. The extract also boosts cell-mediated immunity by increasing the number of white blood cells, plasma cells, and spleen cells, which together contribute to an elevated phagocytic index.

The primary active compound responsible for these effects is a sesquiterpene lactone, known to trigger delayed-type hypersensitivity reactions, an indicator of enhanced immune responsiveness. Furthermore, the extract was found to prevent anaphylactic reactions induced by bovine serum albumin (BSA). It achieves this by promoting the production of IgG antibodies, which block the interaction between BSA and IgE, thereby preventing mast cell degranulation and the release of inflammatory mediators. This immunoprotective effect has also been observed during Pseudomonas aeruginosa infections, highlighting the plant's potential as an immunomodulatory agent.

8. Antidiabetic Activity:

The alcoholic and aqueous leaf extracts of Tridax procumbens Linn. exhibit significant antidiabetic properties, effectively reducing blood glucose levels in diabetic models. In studies involving alloxaninduced diabetic rats, administration of the methanolic extract of T. procumbens both at acute and subchronic oral doses resulted in a marked decrease in fasting blood glucose levels.

Interestingly, the extract did not alter glucose levels in normal rats, suggesting that its hypoglycemic effect is specific to hyperglycemic conditions. These findings indicate that Tridax procumbens could serve as a promising natural therapeutic agent for managing diabetes mellitus.

9. Antioxidant Activity:

The total phenolic content of Tridax procumbens, expressed as Gallic Acid Equivalent (GAE), was found to be 12 mg/g GAE, indicating a high concentration of phenolic compounds. This suggests a strong correlation between phenolic content and antioxidant activity in the plant. Numerous studies have shown that secondary metabolites such as flavonoids, tannins, catechins, and other phenolic compounds exhibit potent antioxidant properties.

These bioactive molecules play an essential role in preventing chronic diseases such as cancer, cardiovascular disorders, and age-related degenerative conditions. They also function as chemopreventive agents by lowering cholesterol levels and facilitating cellular repair.

The antioxidant potential of T. procumbens extracts was assessed using the DPPH (1,1-diphenyl2picrylhydrazyl) free radical scavenging assay, a reliable method for evaluating in vitro antioxidant capacity. The DPPH radical readily accepts electrons or hydrogen atoms from antioxidants, leading to a decrease in absorbance, which indicates the scavenging efficiency.

Among the various extracts tested, the methanolic, ethyl acetate, and n-butanol fractions exhibited significant free radical scavenging activity. The antioxidant effect was determined based on the reduction in absorbance of the reaction mixture where lower absorbance values corresponded to higher antioxidant potential.

These findings confirm that Tridax procumbens possesses strong antioxidant properties, primarily due to its rich content of phenolic and flavonoid

compounds, making it a valuable natural source for therapeutic applications.

10. Anticancer Activity:

Tridax procumbens, which contains essential oils, has been shown to inhibit the spread of lung cancer in mice inoculated with the B16 F-10 melanoma cell line. This protective effect was evident through the stabilization of body weight, white blood cell count, and hemoglobin levels, which typically increase during tumor progression. The key active constituents identified in the extract include α-pinene, β-pinene, phellandrene, and sabinene compounds belonging to the monoterpene class. These bioactive compounds were found to activate caspase-3 and p53 enzymes, as confirmed by the TUNEL assay, indicating apoptosis (programmed cell death) induction.

Furthermore, the acetone extract from T. procumbens flowers triggered apoptosis within 24 hours of treatment. Another compound, lupeol a triterpenoid isolated from the dried leaves of T. procumbens exhibited over 90% cytotoxicity against human lung cancer A549 cells in colony formation inhibition assays. The anticancer mechanism of lupeol involves suppression of the COX enzyme and the activation of endonucleases, which promote DNA fragmentation and apoptosis. These results highlight the potential of T. procumbens as a promising natural source of anticancer agents.

11. Antihyperlipidemic Activity:

Leaf extracts of Tridax procumbens have demonstrated potent antihyperlipidemic activity by significantly reducing lipid accumulation. This effect is attributed to the presence of antioxidant compounds within the extract. When HepG2 liver cells were treated with 20 mg/ml of T. procumbens extract alongside 1 mM oleic acid, lipid accumulation was completely prevented.

Compared to the control group, the treated cells exhibited a notable reduction in lipid levels, suggesting that the extract effectively regulates lipid metabolism. Since excessive lipid accumulation and oxidative stress in the liver contribute to the development of Non-Alcoholic Fatty Liver Disease (NAFLD), T. procumbens may serve as a potential preventive agent against this condition.

Additionally, the hydroethanolic extract of T. procumbens shows potential for preventing and treating hyperlipidemia-related disorders, such as atherosclerosis, by maintaining lipid balance and reducing oxidative damage within hepatic tissues.

12. Wound Healing Activity:

Tridax procumbens exhibits remarkable wound healing properties, as demonstrated in animal studies. In a rat wound model, the plant extract enhanced the healing process by increasing levels of lysyl oxidase and hexosamine enzymes and compounds responsible for collagen stabilization through crosslinking. This action strengthens collagen fibers, promoting tissue regeneration and wound closure.

The extract also elevated mRNA expression and protein synthesis of glycosaminoglycans (GAGs), essential components of the extracellular matrix (ECM) in granulation tissue. Through its interaction with epidermal and dermal cells, ECM proteins, cytokines, and growth factors, T. procumbens facilitates angiogenesis and accelerates tissue repair.

The ethanolic extract, particularly in gel-based formulations, exhibited significant wound healing activity by enhancing epithelialization and collagen tensile strength. Furthermore, the leaf extract demonstrated hemostatic properties, effectively stopping bleeding when applied topically. These findings confirm that T. procumbens promotes wound healing through biochemical and cellular mechanisms that support tissue regeneration and repair.

13. Antimicrobial activity:

Antimicrobial tests have been carried out, but more research is needed to confirm some of the findings. Different types of bacteria and fungi have shown sensitivity to the antimicrobial qualities of T. procumbens.

Recently, the callus from the stem and leaves has been used to make silver nanoparticles, which had some antimicrobial effects against E. coli, V. cholerae, A. niger, and A. flavus. However, this effect was not as strong as that of silver nitrate, so the results are not certain. Extracts from the leaves of T. procumbens, like petroleum, ether, and ethanol, showed antibacterial effects against Bacillus faecalis. This effect is thought to be because of the presence of alkaloids. The chloroform extracts had antibacterial activity against B. faecalis, B. subtilis, E. coli, and Pseudomonas aeruginosa. There are conflicting results about the antimicrobial activity of this species. Some studies did not show much activity compared to standard antibiotics, but there is still some evidence that T. procumbens might have potential as an antimicrobial agent. Therefore, more studies are needed in this area.

14. Mosquitocidal:

From the linguistic competence that supports accurate and precise understanding of accounting concepts. Furthermore, in the field of higher education, this causes a reduction in glucose absorption and lowers the postprandial rise in blood glucose levels in Type-II diabetes mellitus [62]. Alpha-

Terpinene, α-Terpineol, and β-Pinene, being the

major chemical constituents in the essential oil extract from the T. procumbens plant, significantly demonstrated repellent activity against the malaria-causing mosquito Anopheles stephensi at a 6% concentration [25, 63].

15. Antiparasitic activity:

Steps of the Activity: 1.

The teacher prepares simple animal-shaped patterns (such as rabbit, bird, or fish) and conducts a bioassay guided fractionation using a methanol extract to isolate an active compound, (3,S)-16,17-Didehydrofalcarinol (an oxylipin). Tridax appears to have anti-leishmanial activity when using crude extracts from the whole plant. A study conducted in Ghana tested the antiplasmodial effect of aqueous, chloroform, ethyl acetate, and ethanolic extracts from the flowers, leaves, and stem of T. procumbens. There is evidence that the aqueous and ethanolic extracts from the species have anti-plasmodial properties; a study using the tetrazolium-based colorimetric assay showed that T. procumbens helped protect red blood cells from P. falciparum damage. Tridax shows great potential against a disease that kills millions of people around the world.

16. Waste water treatment:

The wastewater treatment system has several special features. One requirement is that the color of the water must remain the same. It should not disappear. The system must not use complicated or harmful methods. It should be simple and easy to manage. All the original parts of the process must stay the same. Nothing should be added or removed. The system should not depend on advanced or difficult technology. It must work naturally and look normal. The main goal is to keep trust and ensure the process is done correctly. The system must be reliable and clear without using complex structures or terms. Everything should remain as it is while keeping the process clean and effective.

17. Hemostatic activity:

Different extracts from Tridax procumbens leaves were tested for their ability to stop bleeding. The test was done by checking how long it took for blood to clot in 10 human volunteers using an in vitro method. The ethanol extract of the plant showed positive results. The ethanolic extract from the Tridax procumbens leaf consistently reduced clotting time in the blood samples. This study showed that the plant has hemostatic activity, which affects the body's natural process of stopping bleeding.

18. Anti-juvenile hormone activity:

Topical use of a part of the petroleum ether extract from T. procumbens had a strong effect on the transformation of Dysdercus and caused noticeable problems in adult development because of its effect on juvenile hormone. Out of fifteen plants tested, five plant extracts were found to have anti-juvenile hormone activity against late fourth instar larvae and adult female mosquitoes. The petroleum ether extract of Eichhornia crassipes and the acetone extracts of Ageratum conyzoides, Cleome icosandra, Tagetes erectes, and T. procumbens showed both growth inhibition and juvenile hormone-like effects on C. quinquefasciatus larvae. Some noticeable changes included larval pupal intermediates, pupae that didn't develop properly, eggs that didn't form correctly, and adults with weak flight muscles. Only the extracts from ageratum, cleome, and T. procumbens affected the biting behavior of the mosquitoes. The treated mosquitoes had reduced egg-laying ability, but they weren't completely sterile. Adults that came from larvae exposed to these plant extracts laid eggs that lasted significantly shorter than those from the control group.

19. Insecticidal activity:

The essential oils taken from T. procumbens showed insecticidal effects on house flies, mosquito larvae, Dysdercus similes, and cockroaches. These oils are very strong and work well as insect repellents when tested against three types of ants. During the collection of T. procumbens, it was noticed that the plant is not eaten or attacked by cattle, which suggests that it has insect repellent or insecticidal properties.

20. Anti-ulcer activity:

The anti-ulcer effects of the methanolic extracts from Tridax procumbens were tested by Aslam Pathan and others. In this study, albino rats were given a dose of 100 mg/kg of the methanolic extract of Tridax procumbens Linn. The researchers checked how well the extract protected against ulcers by measuring myeloperoxidase activity. The results showed that the myeloperoxidase activity in the extract-treated group was 2.74 U/g, which is less than the activity in the experimental control group, which was 4.74 U/g. Based on this study, it can be said that the methanolic extract from the whole plant of Tridax procumbens Linn at a dose of 100 mg/kg has the ability to prevent and protect against ulcers. This suggests that it may be helpful in preventing ulcerative colitis.

21. Anti-obesity activity:

In a study, animals that were given the plant decoctions had a noticeable decrease in total cholesterol, triglycerides, total protein, and free fatty acids, along with an increase in high-density lipoprotein cholesterol levels.

22. Antimalarial activity:

The water and alcohol-based preparations show anti-plasmodial effects against chloroquine-resistant Plasmodium falciparum. These preparations have low toxicity to human red blood cells, but additional animal toxicity tests should be done on the plant. Both the aqueous and ethanolic extracts from PA and TP also display antimalarial

activity against chloroquine-resistant P. falciparum parasites. These extracts have relatively low toxicity to human red blood cells. These findings support the traditional use by herbalists of TP or PA decoctions as effective treatments. However, further comprehensive animal studies on the plants are needed, particularly since they are currently being used by people to treat malaria and other illnesses.

23. Anti-lithic activity:

The ethanol extract of the plant was used to treat kidney stone problems. It showed effectiveness against kidney stone formation caused by 0.75% v/v ethylene glycol and 2% w/v ammonium chloride in animal models. It also helped reduce oxidative stress caused by high oxalate levels. Using the plant's decoctions lowered the amount of calcium oxalate excreted in urine and reduced its buildup in the kidneys. This also decreased lipid peroxidation, showing that the plant has both antiurolithiasis and antioxidant effects.

24. Repellency activity:

made by using steam distillation from the leaves of Tridax procumbens Linn.

The oil was tested against the malaria parasite, Anopheles stephensi, in mosquito cages to see how well it repels mosquitoes. All the essential oils were tested at three different strengths—2%, 4%, and 6%. Among these, the essential oils from Tridax showed a strong repellent effect, lasting more than 300 minutes at the 6% concentration. This suggests that Tridax essential oils could be a good option as a repellent against Anopheles stephensi at the 6% level.

25. Miscellaneous:

Miscellaneous: The effect of the water extract from the leaves of Tridax on the heart and blood pressure was studied in anaesthetized rats. The extract lowered the average blood pressure, and the more of it was given, the more the blood pressure dropped. Also, higher doses of the extract caused a big decrease in heart rate, but lower doses didn't change the heart rate much. This shows that Tridax leaves can lower blood pressure. In another study, essential oils from Tridax leaves were tested for their ability to repel the malariacarrying mosquito Anopheles stephensi. The oils were tested at three different strengths—2%, 4%, and 6%. The Tridax oils showed a strong ability to repel the mosquitoes.

CONCLUSION:

T. procumbens is a major medicinal plant that has been used for a long time in both organized systems like Ayurveda and Unani, as well as in unorganized systems like folk and tribal medicine.

With recent technology, it has become easier to find, separate, and prove the active parts of plants, which can be used to develop new medicines. Tridax procumbens, a weed originally from tropical America and now found in many places including India, Africa, Asia, and Australia, has several useful health benefits. Different parts of the plant, like leaves, stems, and roots, have been found to help in protecting the liver, boosting the immune system, healing wounds, controlling diabetes, lowering blood pressure, fighting microbes, repelling insects, reducing inflammation, acting as an antioxidant, and promoting hair growth.

It has also been used to clean up chromium (VI) from industrial waste.

In Ayurveda, it is known as "Bhringraj" and is used in traditional medicines.

However, there is not much scientific research linking its chemical components to its health benefits. Most studies focus on using plant extracts and checking what chemicals are present. To better understand and use this plant for medicine, researchers should use modern methods like guided chemical analysis, testing with cell cultures, and studying how the plant works in the body.

It is important to find out which chemicals are responsible for the plant's effects so that extracts can be made consistently.

Researchers can also look for enzymes that can be targeted for different diseases and test partially purified chemicals as possible treatments. Using tools like computer modeling, chemistry, and data analysis can help discover new chemicals that could be used as medicines. With modern technology, we can further study the health benefits of Tridax procumbens.

Overall, Tridax procumbens has a lot of potential in terms of its plant-based, chemical, nutritional, and health benefits.

Its long use in traditional medicine for various conditions, including mental health, shows that more research is needed to understand how it works. As a source of herbal medicines, Tridax procumbens has great promise for the pharmaceutical industry, and its wide range of chemicals could lead to the development of new treatment.

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