Review on Pharmacognostic, Physicochemical, Phytochemical and Pharmacological Studies of *Tridax Procumbens*

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Abstract

The weed Tridax procumbens Linn. (Compositae) is found throughout India. The plant originated in tropical America and has since migrated to Australia, Asia, and tropical Africa. It is referred to by the locals as "Ghamara," or "coat buttons" in English. It is prescribed by some Ayurvedic doctors as "Bhringraj." Tridax procumbens is a common medicinal herb used by ethnomedical practitioners. Numerous pharmacological properties, including hepatoprotective, anti-inflammatory, wound-healing, antidiabetic, hypotensive, immunomodulatory, bronchial catarrh, dysentery, and diarrhoea, have been associated with it.The distinctive characteristics of the leaves and stem of the plant Tridax Procumbens were established by the macroscopic, microscopic, and powder study. The presence or lack of many phytochemicals, including alkaloids, flavonoids, cardiac glycosides, tannins, saponins, triterpenes, etc., was assessed in the crude powder of the leaves and stem of both plants. Ash values (total ash, water soluble ash, acid insoluble ash, and sulphated ash) were the parameters assessed in the physicochemical analysis.Palisade tissue, parenchymatous tissue, xylem, phloem, pointed multicellular trichomes, and anomocytic stomata were all seen in the microscopic investigations.

Keywords: **Tridaxprocumbens, phytochemical analysis, physicochemical analysis, coat button, anomocytic**

Introduction

In India, people have been using the Ayurvedic medical system for almost 4,000 years. Different plant components were used in Siddha, Ayurvedic, and Unani medicine to cure human diseases, according to historical literature. It is acknowledged that the oldest kind of medicine is herbal medicine. (1)

A large number of human ailments can be effectively treated with medicinal plants or products derived from them. Although there are many plants, it is difficult to determine how many medicinal plants are now in use worldwide.(2)According to WHO statistics, between 35,000 and 70,000 plants were utilised to treat a variety of illnesses worldwide. Pharmaceutical companies have concentrated on the study and developmet of novel plant-derived medications during the past few decades. (3)

Maintaining the quality, repeatability, and effectiveness of herbal medications is crucial given the steadily rising demand for plant-based medications. Pharmacognostical standardization is a useful technique for defining plant quality control parameters. It assists in ensuring plant authenticity and preventing adulteration.(4)

Additionally necessary for the global acceptance of herbal products in the contemporary medical system are plant standardizations and quality control. As a result, every nation has enacted a set of regulations and quality standards for herbal medicine. (5)

The Compositae family includes Tridax procumbens Linn. It is commonly known as "Common button" or "Coat button" and is a common weed in India. Traditionally, it has been used to treat bronchial catarrh, diarrhoea, dysentery, malaria, and hypertension. It has also been used to stop hair loss and control bleeding from wounds, cuts, and bruises. It has been reported that Tridaxprocumbens has hepatoprotective qualities. It also has in vitro efficacy against promastigotes and anti-inflammatory, immunomodulatory, and anti-diabetic properties.(6) Additionally, it has antibacterial, antipyretic, anti-hepatotoxic, antioxidant, and haemostatic properties.(7)The leaves are thought to be helpful in treating bronchial catarrh since they have

been shown to have antidiarrheal and antidysenteric qualities. Bleeding wounds can be effectively controlled with the help of the leaf juice. Additionally, Tridax procumbens is used to treat fever, typhoid fever, cough, asthma, and epilepsy in addition to managing hypertension.[8]

Materials and Methods

Authentication of the plant material

In the month of January 2011, the plant material was gathered and verified from the Bansal College of Pharmacy campus in Bhopal, MP. Microscopic investigations were conducted using the plant's fresh components. For future research, the leaves were separated, dried, ground into a coarse powder, and kept in a tight container. (9)

Plant collection

T. procumbens (Voucher specimen number PSN 414) was placed in the Saurashtra University Department of Biosciences in Rajkot, Gujarat, India. After being separated, the leaf and stem were properly cleaned with tap water, shade-dried, and ground into a fine powder before being placed in a tight container for future research. Five grammes of dried leaf and stem powder were extracted using solvents with varying polarity for physicochemical investigations. After the solvent was completely evaporated, the dried crude extract was weighed in order to calculate the extractive values. In accordance with quality control procedures, both macroscopic and microscopical characteristics were examined.[10]

Pharmacognostic studies

Macroscopic studies

The organoleptic evaluation approach was used to conduct macroscopic investigations. We observed and recorded the plant's size, shape, colour, odour, taste, base, texture, margin, apex of leaves, and stem.(10)

Microscopic studies

Thin sections of the leaf and stem were prepared for microscopic examination. For inspection and confirmation of its magnifications (10x, 40x), the thin sections were further cleaned with water, dyed with congo red and malachite green, and then mounted in glycerine. Additionally, powder microscopic investigations were conducted, and the distinctive diagnostic features were noted.(11)

Organoleptic and macroscopic characteristics of Tridax procumbens

Organoleptic characteristics of T. procumbens leaf and stem are given in Table 1and fig. 1

Leaves

The leaf was symmetrical, lanceolate to ovate in shape, phyllotaxy opposite decussate, apex sharp, border irregularly toothed, rough and scabrous in appearance, reticulate venation, distinctive scent, and bitter in taste. The typical leaf was between 7 and 9.5 cm in length and between 3.5 and 4 cm in width.

Stem

Green, woody, erect, cylindrical, and up to 40 cm tall with many branches, the stem had a distinctive fragrance and a sharp flavour, and its outer surface was soft and rough.

Petiole

Fig. 2 displays the transverse section of T. procumbens. The petiole was crescent-shaped on the laminal side and kidney-shaped towards the distal end. Trichomes with two to three cells, both unicellular and multicellular, covered the single-layered top and lower epidermis (Fig. 2a). The hypodermis was composed of collenchymatous tissue and had 1-2 cells. There were three vascular bundles in the parenchymatous ground tissue, each with an arc-like structure. The size of the vascular bundles ranged from the centre to the leaf margin, ranging from large to small. They were arranged centripetally, with the phloem encircling the xylem. (Fig. 2b).

Leaf

Fig. 7 shows the transverse section of a leaf of T. procumbens. The nature of the leaf lamina was dorsiventral. There was only one layer to the upper and lower epidermis. The mesophyll was tiny, three to five layers thick, and the palisade tissue was single layered on both surfaces and coated in thick cuticle. Vascular bundles were visible towards the ventral surface of the T.S. as it passed through the midrib area. Simple, multicellular (2–3 cells), covering-type trichomes were more numerous on the dorsal side (Fig. 2c). Ground tissue included calcium oxalate prismatic crystals. Dark-contented parenchymatous cells encircled centrally situated conjoint collateral vascular bundles(Fig. 2d). The trichomes' basal cells were enlarged and pointed at the tips. The lower epidermis had anomocytic stomata (Fig. 2e). The stomata were encircled by tiny, wavy subsidiary cells, while the guard cells were noticeably bigger. Each stoma had four to five subsidiary cells, indicating that the stomata were either anomocytic or ranunculaceous(Fig. 2f).

Stem

Fig. 3 displays the transverse section of the stem of T. procumbens. Trichomes encircled the single-layered, narrow, tiny, thick-walled epidermis (Fig. 3a). Cork cells were composed of two to four layers, with polygonal lignified parenchymatous cells encircling vascular bundles. Numerous patches of tiny clusters of sieve tissue were embedded in parenchymatous cells above the cambium (Fig. 3b). The vascular bundles were close, collateral, conjoint, and ring-shaped. Protoxylem, xylem vessels, tracheids, and xylemfibre made up the xylem (Fig. 3c). Hexagonal parenchymatous cells were thick and uniform in size, and the pith was quite big (Fig. 3d). There were four to five layers of rectangular parenchymatous cells in the middle layer of the stem's longitudinal section(Fig. 3e).

Powder microscopy of leaf

The leaf of T. procumbens was ground into a fine, dark green, odourless, and somewhat bitter crude powder. Fig. 4 displays the properties of powder microscopy. Anomocytic stomata, unicellular trichomes, rosette crystal calcium oxalate, bordered pitted arteries, spongy parenchymatous cells, and other features were identified from the powder research under microscopic examination.

Physicochemical analysis

One crucial factor in identifying drug adulteration or inappropriate handling is the physical examination of the medications. Table 2 lists the physicochemical characteristics of the stem and leaves of T. procumbens. T. procumbens dry powder had a moisture content of 10.50% and 10.75%, respectively. The low and quiet moisture content would prevent the growth of yeast, fungus, or bacteria. T. procumbens had a total leaf ash content of 20.45%, although its water-soluble and acid-insoluble ash contents were 6.50% and 7.16%, respectively. In T. procumbens, the overall amount of ash in the stem was 14.75%, whereas the amounts of water-soluble and acid-insoluble ash were 7.50% and 6.00%, respectively. The amounts of sulphated ash in the leaf and stem were 13.78% and 16.83%, respectively. Table 2 lists the leaf and stem's extractive values.[(12)]

Extract Preparation

After being coarsely ground, the entire plant was placed in a Soxhlet apparatus and continuously extracted with ethanol at 60° to 80°C until all of the contents were removed. The success of the ethanol extraction was based on how much chlorophyll was removed into the solvent. After numerous extractions, it was believed that all of the low molecular weight compounds had been eliminated when the tissue was completely clear of green.[13]

Preliminary Phytochemical Investigation

To ascertain the existence of several chemical elements, including alkaloids, glycosides, flavonoids, essential oils, carbohydrates, proteins, tannins, and other substances responsible for biological activity, plant extracts were put through phytochemical testing. Consequently, a number of chemical components were found by chemical tests conducted in an ethanolic extract of Tridax procumbens. [14] Table 3 represents phytochemical screening of *tridaxprocumbens* leaf and stem.

Pharmacological Review:

Antifungal Activity:

Researchers have studied the antifungal properties of *Tridax procumbens*, exploring various extraction methods to determine the most effective way to inhibit fungal growth. Leaf extracts from the plant have been found to effectively combat dermatophytes, with inhibition zones ranging from 17 to 25 mm. However, the researchers do not identify the specific bioactive compounds responsible for the plant's antifungal activity. While they suggest that these compounds could be fatty acid derivatives or components, they do not provide evidence to support this claim.[15]

Antibacterial Activity:

The antibacterial properties of Tridax procumbens have been demonstrated. In rural areas, it is used to treat bacterial infections, with its extracts proving effective against various microorganisms. Hexane extracts are effective against E. coli, Klebsiella sp. Salmonella group C, and Salmonella paratyphi. Additionally, the ethyl acetate extract successfully eradicated Bacillus cereus and Mycobacterium smegmatis.[16] Staphylococcus aureus and Streptococcus pneumoniae are two Gram-positive bacteria that show strong sensitivity to the essential oil extract of Tridax procumbens. While there is significant evidence supporting the antibacterial activity of this species, further in-depth studies are needed due to inconsistencies in the testing methods used.[17]

Anti-inflammatory and Analgesic activity:

In this study, male C57 BL6/J mice and male Sprague-Dawley rats were used, and two analgesic and one inflammatory in vivo pain models were employed. The dorsal horn of the spinal cord was identified as the site of tissue and functional changes responsible for the late phase of moderate pain in the formalin test, which begins approximately 20 minutes after formalin injection and lasts for 40 to 60 minutes. Administration of the extract significantly inhibited this late-phase pain. Similarly, Tridax procumbens extract significantly and dose-dependently reduced abdominal writhing in the acetic acid-induced abdominal constriction test. In rats treated with CFA injections, oral administration of Tridax procumbens extract markedly decreased mechanical hyperalgesia. These results demonstrate that Tridax procumbens effectively reduces inflammatory pain in both central and peripheral models. The analgesic effect is attributed to the presence of flavonoids and sterols, suggesting that Tridax procumbens extract could serve as a potent painkiller.[18][19]

Wound Healing Activity:

Wound healing involves a complex interaction between epidermal and dermal cells, the extracellular matrix, regulated angiogenesis, and plasma-derived proteins. This process is controlled by various cytokines and growth factors. Tridax procumbens was found to counteract the anti-epithelialization and tensile strength-reducing effects of dexamethasone, a well-known wound healing suppressant drug.

This effect was achieved without interfering with the anti-contraction and anti-granulation properties of dexamethasone. An increase in lysyl oxidase activity was observed with the use of an aqueous extract, though to a lesser extent than with a whole plant extract.[20] Additionally, similar to normal rats, it has been shown that the leaf extract of Tridax procumbens accelerates wound healing in rats that have been immunocompromised by steroid treatment. In this case, the alive space wound healing model was used. The plant appears to upregulatelysyl oxidase activity, as well as protein and nucleic acid levels in the granulation tissue, likely in response to the increased glucosamine glycan content.[21,22]

Antimicrobial Activity:

Antimicrobial tests have been conducted on Tridax procumbens, but further research is needed to validate some of the findings. The plant has demonstrated antibacterial properties effective against a variety of bacterial and fungal species. More recently, it was discovered that the stem and leaf callus of Tridax procumbens played a role in the synthesis of silver nanoparticles, which exhibited antibacterial activity against E. coli, V. cholerae, A. niger, and A. flavus.[23] However, Since its activity was lower than that of silver nitrate, these findings cannot be considered conclusive. However, Tridax procumbens leaf extracts in petroleum ether and ethanol have demonstrated antibacterial activity against Bacillus faecalis.[24] Reports

suggest that alkaloids are likely responsible for the antibacterial activity of Tridax procumbens. The chloroform extract also exhibited antibacterial effects, although more rigorous controls and detailed method descriptions are needed in future studies. When used in moderation, alpha- and beta-pinenes, which are present in the essential oils of Tridax procumbens, may help treat bacterial and fungal infections.[25]While the antibacterial effectiveness of this species has yielded some inconsistent results, there is evidence supporting its potential as an antimicrobial agent. Further research is needed to fully explore its capabilities. However, several studies have shown that its biological activity is not as potent as that of the antibiotic control.[26]

Hepatoprotective Activity:

The effectiveness of Tridax procumbens in reducing oxidative stress in the liver, which can lead to liver damage, as well as its hepatoprotective properties, have been evaluated using various models and extracts.[27] The chloroform-insoluble fraction of the ethanol extract of Tridax procumbens may be beneficial in treating drug-induced disorders, such as viral hepatitis, drug overdose, and lipid peroxidation caused by reactive oxygen species. In a separate study, it was found that the ethanol extract of this chloroform-insoluble fraction reduced hepatotoxicity in rats treated with CCl_4 by lowering enzyme levels associated with liver damage.[28] When Tridaxprocumbensethanolic extract was administered orally at different concentrations, hepatoprotection was observed. Studies conducted on male albino rats with liver damage induced by paracetamol showed that treatment with the ethanolic extract led to a reduction in the levels of aspartate aminotransferase (AST), alanine aminotransferase (ALT), alkaline phosphatase (ALP), and bilirubin. These findings suggest that the ethanolic extract provides hepatoprotective effects.[29]Male Wistar albino rats were protected from hepatotoxicity by floral extracts of Tridax procumbens in petroleum ether, methanol, chloroform, and water, with the methanolic extract providing the most significant protection. Aqueous leaf extracts have also been shown to exhibit hepatoprotective effects in rats, likely due to their antioxidant properties and active free radical scavenging capabilities. In rats with hepatitis induced by d-galactosamine lipopolysaccharide, an ethanolic extract of Tridax procumbens leaves, separated with chloroform, demonstrated excellent hepatoprotective efficacy.[30] The research suggests that pretreatment with Tridax procumbens extract may have triggered regeneration of liver parenchymal cells. In rats treated with galactosamine lipopolysaccharide, those that were pretreated with the extract showed a return to normal lipid levels. Administering the extract alone resulted in little to no harmful effects, indicating that the plant is not particularly toxic to rats. It appears that the hepatoprotective effect is likely due to the flavonoids present in the plant. However, further studies are needed to fully understand the potential hepatoprotective properties of Tridaxprocumbens.[31][32]

Immunomodulatory Activity:

In albino rats given doses of Pseudomonas aeruginosa, ethanol extracts of *Tridax procumbens* leaves exhibited immunomodulatory effects, including the inhibition of bacterial growth. The ethanol-insoluble fraction of the Tridax aqueous extract was associated with an increase in leukocyte count and spleen antibody-secreting cells. Additionally, a rise in haemagglutination antibody titer and stimulation of the humoral immune response were observed. The study suggests that Tridax procumbens affects both cellular and humoral immune systems.[33]

Immuno-enhancement Activity:

To treat certain disorders, the immune system has been supported in normalizing through various biological chemicals. Research has shown that the adaptogen Tridax procumbens enhances the body's overall resistance to infections.[34]

Swiss Albino mice treated with immunomodulators derived from Tridax procumbens, known to stimulate the immune system, were used in several studies to assess the impact of Tridax procumbens on immune system activation. To evaluate cell-mediated immunity, the delayed-type hypersensitivity (DTH) response in the extract-treated mice was compared to that in the control group. Additionally, a study on neutrophil adhesion showed that both the DTH response and the number of neutrophils increased in a dose-dependent manner. The authors argue that the data supports the initiation of clinical trials with immunocompromised individuals. However, we believe more in-depth research is needed before starting clinical trials, as it remains unclear which constituents act as immunosuppressants and which function as immunostimulants.

To clarify this, various extraction and fractionation methods should be employed, and each fraction tested to identify its constituents and their specific activities.[35]

In an obesity model induced by an atherogenic diet, an extract of *Tridaxprocumbens* led to a significant reduction in total cholesterol, triglycerides, total protein, and free fatty acids, while also increasing high-density lipoprotein (HDL) cholesterol in the treated rats. Notably, Tridaxprocumbens demonstrated significant anti-obesity effects.[36]

Anticancer Activity:

Cancer is a complex
disease, and recent research has explored the anticancer properties of *Tridaxprocumbens*. The effects of unprocessed floral extracts in aqueous and acetone solvents were tested on PC3 prostate epithelial cancer cells. The aqueous extract showed minimal antitumor activity, while the acetone extract exhibited effectiveness against cancer cells after 24 hours of treatment. Cell viability was assessed using the MTT assay. The acetone extract was found to be effective, but the study does not provide details about the controls, as the authors did not include a toxicity study. As a result, the findings remain inconclusive. Furthermore, the study lacks information on the selectivity index and does not compare the results with those of conventional cancer treatments.[37]

When *Tridaxprocumbens* was used, there was a significant reduction in the development of tumor nodules in the lungs. This effect was likely due to the reduced ability of monoterpenes (such as alpha and beta pinenes) to promote the growth of new blood vessels. Additionally, the expression levels of P53 and caspase were increased, suggesting that the plant's oils may help trigger apoptosis. Several studies have shown promise for *Tridaxprocumbens* in cancer treatment, but more research is needed to fully understand the molecular mechanisms involved. Moreover, none of the studies on its anticancer activities followed the proper procedures for such research, which makes the results inconclusive.[38]

Antihyperuricemia and Antioxidant activity:

Tridax procumbens L., a medicinal plant traditionally used to treat liver disorders, diarrhea, dysentery, and bronchial catarrh, was investigated for its potential to treat hyperuricemia and oxidative stress. In this study, the ethyl acetate extract of Tridax procumbens was fractionated using column chromatography with methanol and chloroform as eluents. Each fraction was then tested for its ability to inhibit xanthine oxidase (XO), act as an antioxidant, and exhibit antibacterial properties. The highest antioxidant activity was measured using the ABTS (2,2'-azinobis(3-ethylbenzothiazoline-6-sulfonic acid)) and DPPH (2,2-diphenyl-2-picrylhydrazyl) assays, with IC50 values of 0.51 mg/mL and 1.04 mg/mL, respectively. The F45-47 fraction exhibited the strongest XO inhibitory activity (IC50 = 133). The F4-5 fraction was effective against Escherichia coli, Staphylococcus aureus, and Bacillus subtilis. Gas chromatography–mass spectrometry (GC-MS) and liquid chromatography–electrospray ionization–mass spectrometry (LC-ESI-MS) analyses identified fatty acids, glycerides, and flavonoids as the main constituents of the F45-47 fraction. The F48-50 fraction was dominated by glycerides, triose sugar alcohols, and fatty acids, while sterols were the primary components of the F4-5 fraction. This study suggests that Tridax procumbens has significant XO inhibitory, antioxidant, and bactericidal properties, and that its fatty acids, flavonoids, and sterols may be responsible for its various biological activities.[39][40]

Table 1: Organoleptic features of Tridax procumbens L.

	Observation	**Observation**
Part	**Leaves**	**Stem**

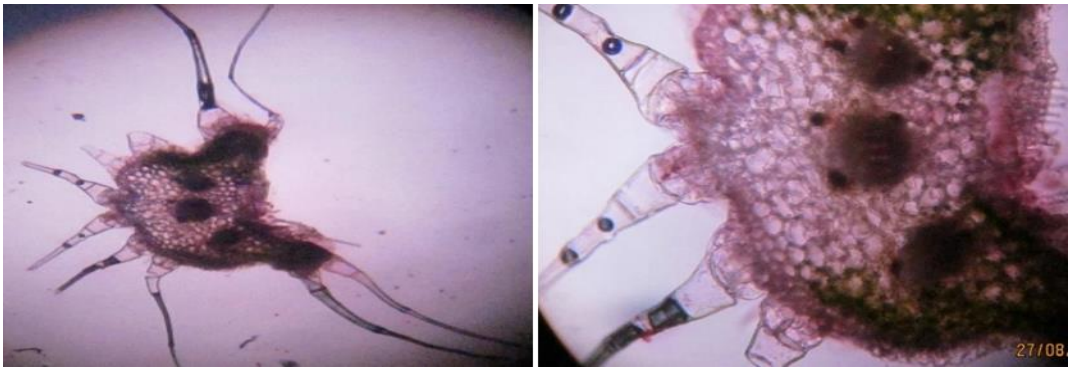
Arrangement	Opposite	-
Size	7-8cm long, 2-3cm wide	2to 4mmthickness,40 cm height
Shape	Lanceolatetoovate	Square orquadrangular
Colour	Green	Green
Odour	Characteristics	Characteristics
Taste	Bitter	Bitter
Appearance	Scabrous	Roughand hard
Margin	Entire	-
Apex	Acuminate	-
Base	Symmetrical	-
Petiole	Short	-
Texture	Short	-
Veination	Reticulateveination	-
Outer surface	_	Lightgreencolour. Rough surface

Table 2: Physiochemical parameter of T. procumbens leaf and stem

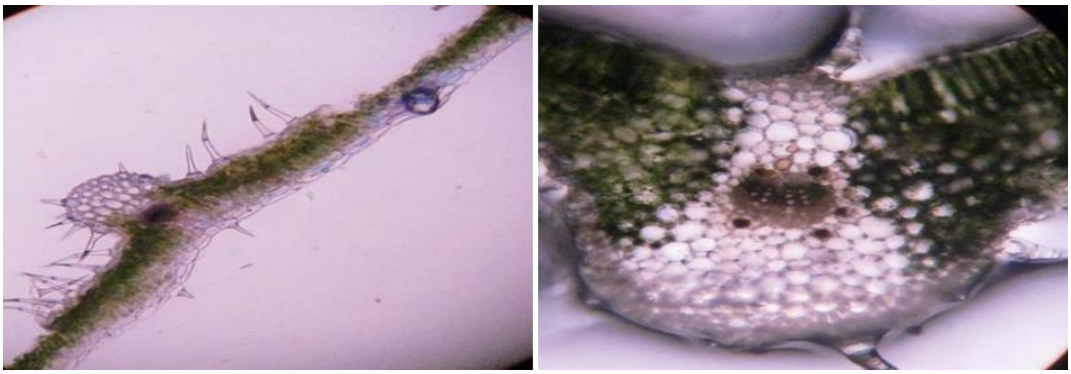
SrNo	**Parameters**	**%value(w/w)Leaf of *T.procumbens***	**%value(w/w)Stemof *T.procumbens***
1	Losson drying	10.50	10.75
2	Total ash	20.45	14.75
3	Watersolubleash	6.50	7.50
4	Acidinsoluble ash	7.16	6.00
5	Sulphatedash	13.78	16.83
6	Petroleum ether soluble extractive value	0.78	0.42
7	Toluenesoluble extractive value	0.41	0.66
8	Ethylacetate soluble extractive value	0.50	0.54
9	Methanol soluble extractive value	7.33	6.81
10	Watersolubleextractive value	17.20	10.48

Fig 1: Macroscopic characterstics of T. procumbens

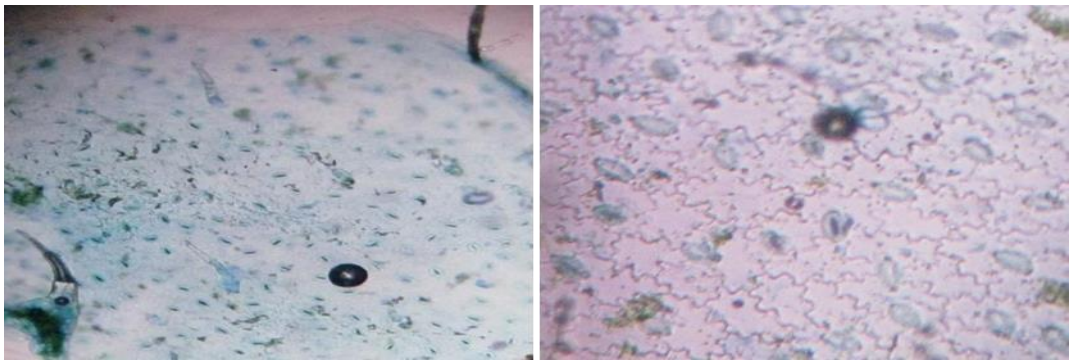
Fig 2: Microscopic characteristics of T. procumbens leaf



a) T.S of petiole with trichomes **b) T.S of petiole vascular bundles**

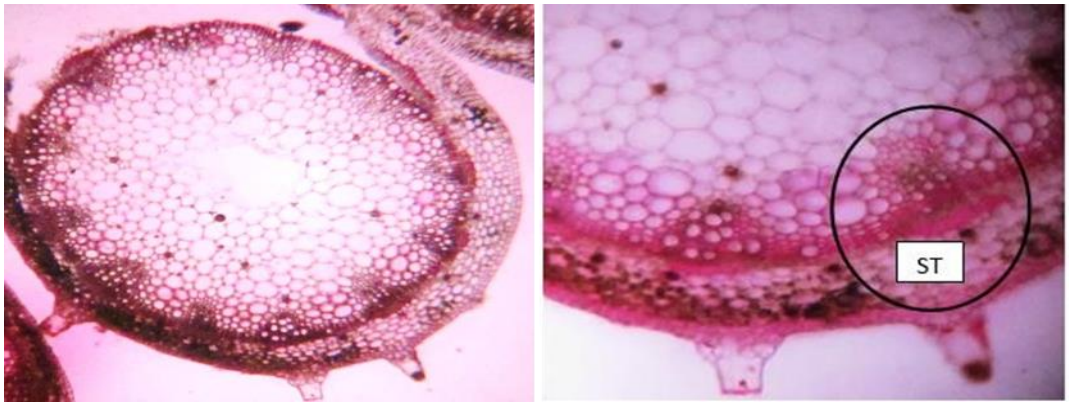


c) T.S of leaf passing through midrib **d) T.S of leaf passing vascular bundle**

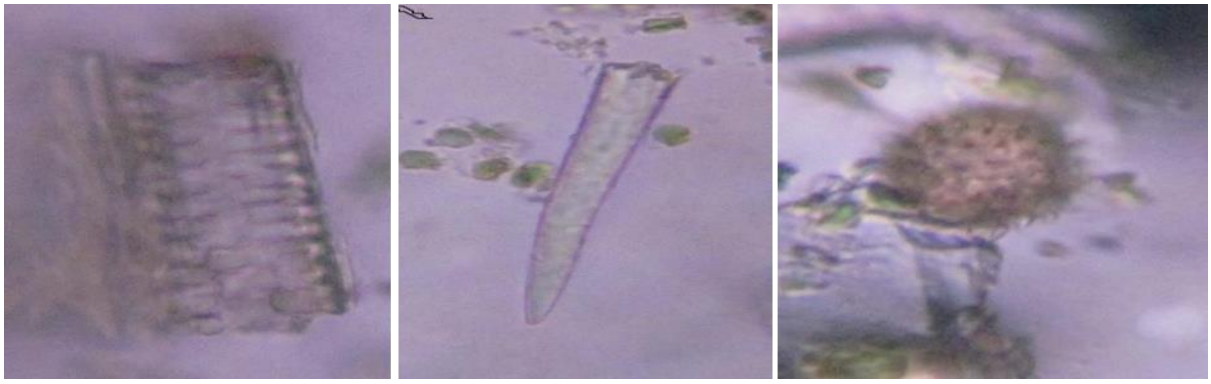


e) Multicellulartrichomesand stomata **f)Anomocyticstomata**

Fig 3: Microscopic characterstics of T. procumbens stem

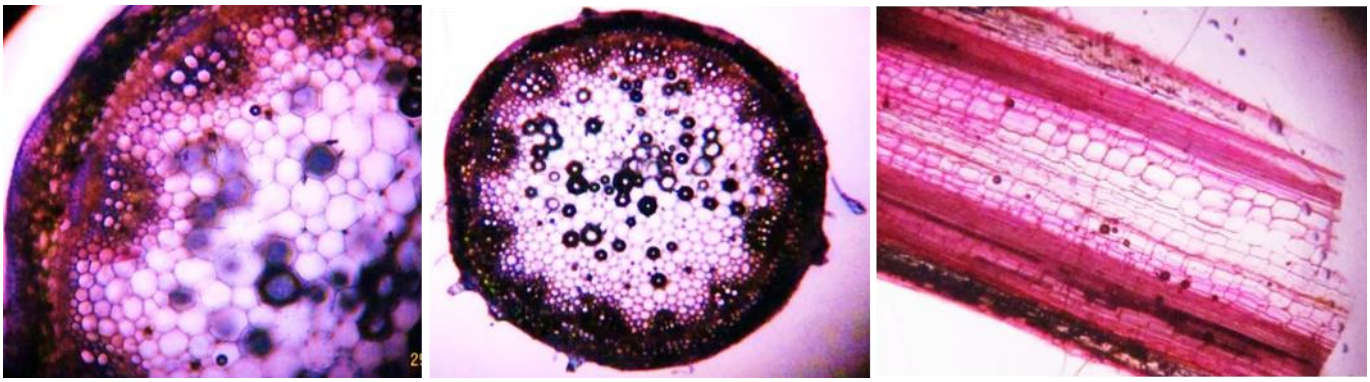


a) T.S of stem with epidermis and trichomes b) T.S of stem with cortex, cambium tissue

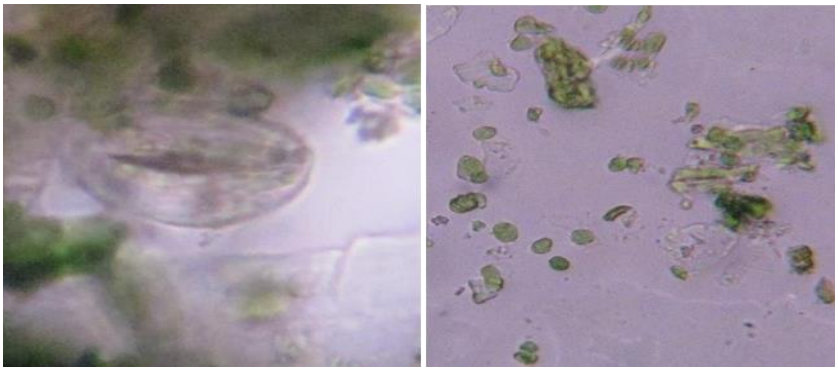


c) T.S.of stem with vascular bundles
d) T.S of stem with entire pith
e) L.S of stem with parenchymatous cells

Fig 4: Microscopic powder study of T. procumbens leaf



a) Bordered pitted vessels b) Unicellular trichome c) Rosette calcium crystal



d) Anomocytic stomata **e) Spongy parenchyma**

Table 3: Qualitative phytochemical analysis of T. procumbens leaf and stem

SrNo.	Phytochemicals	Leafof*T. procumbens*	Stemof*T. procumbens*
1	Alkaloids		
	(1)Mayer's reagent	++	++
	(2)Dragondroff's reagent	-	-
	(3)Wagner's reagent	++	++
2	Flavonoids	+++	+++
3	Tannins	+	+
4	Phlobatanins	+	+
5	Saponins	+	+
6	Steroids	+	+
7	Cardiacglycosides	+	+
8	Triterpenes	++	++
9	Anthocyanins	-	-

Conclusion:

Herbal medicines are a promising alternative to modern synthetic drugs because they typically have few or no side effects and are considered safe. These formulations usually involve the use of fresh or dried plant parts. A thorough understanding of these raw plant materials is crucial for ensuring the safety, effectiveness, and quality of herbal products. Pharmacognosy is a simple yet reliable method for obtaining comprehensive information about these crude drugs. One of the main challenges in integrating herbal medicine into modern medical practices is the lack of scientific and clinical data, as well as a limited understanding of the efficacy and safety of herbal products. To guarantee the quality and safety of herbal remedies, standardization is essential.The present study aimed to conduct pharmacognostic, physicochemical, phytochemical, and pharmacological analyses of the leaf and stem of T. procumbens.

References:

1) Rajaram s. Sawant and ashvin g. Godghate, Preliminary phytochemical analysis of leaves of Tridaxprocumbenslinn. International Journal of Science, Environment and Technology, Vol. 2, No 3, 2013, 388 –394.
2) Shah G, Baghel US. Pharmacognostic standardization of the leaf of Melaleucaalternifolia (Maiden &Betche) Cheel. African Journal of Traditional, Complementary and Alternative Medicines. 2017; 14(3):1-11.
3) Farnsworth NR, Soejarto DD. Global importance of medicinal plants. The Conservation of Medicinal Plants.1991; 26:25-51.

4) Chanda S. Importance of pharmacognostic study of medicinal plants: an overview. Journal of Pharmacognosy and Phytochemistry. 2014; 2(5):69-73.
5) Ahmad S. Introduction of Plant Constituents and their Tests. JamiaHamdard, Hamdard Nagar, New Delhi, 2007.
6) Durgacharan A. Bhagwat, Suresh G. Killedar, Rahul S. Adnaik: Antidiabetic activity of leaf extract of Tridaxprocumbens, International Journal of Green Pharmacy, 2(2): 126-128 (2008).
7) SnehaMundada and RuchiShivhare: Pharmacology of Tridaxprocumbens a weed: Review, International Journal of Pharma Tech Research 2(2):1391-1394 (2010).
8) PriyankaYadav and SatishNayak, microscopic studies of tridexprocumbenslinn, Bulletin of Pharmaceutical Research 2011;1(2):25-32.
9) Khandelwal KR. Practical Pharmacognosy. 19th edn. Pune, India: NiraliPrakashan. 2008, 49-70.
10) Tyler V, Brady L, Robber J. Pharmacognosy, Varghese Company, India. 1977, 103-141.
11) Pande J, Padalia H, Donga S and Chanda S, Pharmacognostic, physicochemical and phytochemical studies of AndrographisechioidesNees. and Tridaxprocumbens L. leaf and stem, The Pharma Innovation Journal 2018; 7(6): 303-315
12) Behera S, Babu SM, Ramani YR, Choudhury PK, Panigrahi R. J Drug Delivery and Therapeutics, 2012; 2(4):23-32.
13) Jayaprakasha G, Girennavar B, Patil BS. Bioresource Technology, 2008; 99(10):4484-4494.
14) Policegoudra RS, Chattopadhyay P, Aradhya SM, Shivaswamy R, Singh L, Veer V. Inhibitory effect of Tridaxprocumbens against human skin pathogens. J Herb Med. 2014;4(2):83-8.
15) Taddei A, Rosas-Romero AJ. Bioactivity studies of extracts from Tridaxprocumbens. Phytomedicine. 2000;7(3):235-8.
16) Manjamalai A, Valavil S, Grace V. Evaluation of essential oil of Tridaxprocumbens L. for Anti-Microbial and Anti-Inflammatory activity. Int J Pharm Sci. 2012;4(3):356-63.
17) Nia R, Essien EE, Oladimeji OH, Iyadi KC, Franz G. Investigation into in-vitro radical scavenging and in-vivo anti-inflammatory potential of Tridaxprocumbens. Nigerian Journal of Physiological Sciences. 2003;18(1):39-43.
18) Gubbiveeranna V, Nagaraju S. Ethnomedicinal, phytochemical constituents and pharmacological activities of Tridaxprocumbens: a review. Int J Pharm Pharm Sci. 2016;8(2):1-7.
19) Bhat RS, Shankrappa J, Shivakumar HG. A Review on Pharmacognosy, Pre-Phytochemistry and Pharmacological Analysis of Tridaxprocumbens. Asian J Pharm. 2007;2(1):11-7.
20) Nia R, Essien EE, Oladimeji OH, Iyadi KC, Franz G. Investigation into in-vitro radical scavenging and in-vivo anti-inflammatory potential of Tridaxprocumbens. Niger J Physiol Sci. 2003;18(1):39-43.
21) Shrivastav A, Mishra AK, Abid M, Ahmad A, Fabuzinadah M, Khan NA. Extracts of Tridaxprocumbenslinn leaves causes wound healing in diabetic and Non-diabetic laboratory animals. Wound Medicine. 2020;29:100185.
22) Panda SK, Luyten W. Antiparasitic activity in Asteraceae with special attention to ethnobotanical use by the tribes of Odisha, India. Parasite. 2018;25.
23) Christudas S, Kulathivel TM, Agastian P. Phytochemical and antibacterial studies of leaves of Tridaxprocumbens L. Asian Pac J Trop Biomed. 2012;2(1):S159-S61.
24) Mir AS, Mahmood D, Shabeer A. Analysis of Phytochemistry and Antimicrobial activity of Tridaxprocumbens Linn. ChemSci J. 2016;7(1000132.10):4172.
25) Jhample SB, Gajdhane SB, Kasabe PJ, Bhagwat PK, Dandge PB. Phytochemical screening and in vitro antimicrobial activity of Tridaxprocumbens L. Res J Pharm BiolChem Sci. 2015;1(1):42-51
26) Hemalatha R. Anti-hepatotoxic and anti-oxidant defense potential of Tridaxprocumbens. Int J Green Pharm. 2008;2(3):164.
27) Saraf S, Dixit VK, Tripathi SC, Patnaik GK. Hepatoprotective activity of Tridaxprocumbens. Part III. FITOTERAPIA-MILANO-. 1992;63:414.
28) Wagh S, Shinde GB. Antioxidant and hepatoprotective activity of TridaxProcumbens Linn, against paracetamol-induced hepatotoxicity in male albino rats. Adv Stu Biol. 2010;2:105-12.
29) Ahmed SS, Mani RK, Kiran S, Bharathi DR, Sunny A, Raveendran A. Tridaxprocumbens pharmacological activities-An updated review. UPI j pharm med health sci. 2021:06-12.

30) UgoNwanjo H. Aqueous extract of Tridaxprocumbens leaves: Effect on lipid peroxidative stress and antioxidant status in chloroquine- induced hepatotoxicity in rats. J Herbs Spices Med Plants. 2008;14(3-4):154-65.
31) Ravikumar V, Shivashangari KS, Devaki T. Hepatoprotective activity of Tridaxprocumbens against d-galactosamine/lipopolysaccharide- induced hepatitis in rats. J Ethnopharmacol. 2005;101(1-3):55-60.
32) Oladunmoye MK, NutanModi M, Dezzutti CS, Kulshreshtha S, Rawat A, Srivastava S. Immunomodulatory effects of ethanolic extract of Tridaxprocumbens on swiss Albino rats orogastrically dosed with Pseudomonas aeruginosa (NCIB 950). Int J Trop Med. 2006;1(4):152-5.
33) Dattaray D. Traditional Uses and Pharmacology of Plant Tridaxprocumbens: A Review. Sys Rev Pharm. 2022;13(5):511-7.
34) Tiwari U, Rastogi B, Singh P, Saraf DK, Vyas SP. Immunomodulatory effects of aqueous extract of Tridaxprocumbens in experimental animals. J Ethnopharmacol. 2004;92(1):113-9.
35) Bharathi V, Priya AS, Firdous SJ. Anti-obesity effect of Tridaxprocumbens in atherogenic diet- induced obese rats. Int J Pharm Technol. 2011;3(1):1565-9.
36) Vishnu Priya P, Radhika K, Siva Kumar R, Sri Ramchandra M, Prameela Devi Y, SrinivasRao A. Evaluation of anti-cancer activity of Tridaxprocumbens flower extracts on PC 3 Cell lines. Pharmanest. 2011;2(1):28-30.
37) Manjamalai A, Kumar MJM, Grace VMB. Essential oil of Tridaxprocumbens L induces apoptosis and suppresses angiogenesis and lung metastasis of the B16F-10 cell line in C57BL/6 mice. Asian Pac J Cancer Prev. 2012;13(11):5887-95.
38) Ahmed SS, Mani RK, Kiran S, Bharathi DR, Sunny A, Raveendran A. Tridaxprocumbens pharmacological activities-An updated review. UPI j pharm med health sci. 2021:06-12.
39) UgoNwanjo H. Aqueous extract of Tridaxprocumbens leaves: Effect on lipid peroxidative stress and antioxidant status in chloroquine- induced hepatotoxicity in rats. J Herbs Spices Med Plants. 2008;14(3-4):154-65.