



Trichodesma indicum – an Overview

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ABSTRACT

The aim of the present study was to survey the current research status of the valuable medicinal plant *Trichodesma indicum* and update the knowledge about it. *Trichodesma indicum* commonly known as Adhapushpi and belongs to the family Boraginaceae. Traditionally it was a useful medicinal plant to cure various ailments like Arthritis, fever, skin disease, arthralgia and dysentery. Each part of the plant is useful and was reported for its antioxidant, antiinflammatory, analgesic, antipyretic, antimicrobial and antidiabetic activity. The current review highlights the pharmacognosy, phytochemistry, ethanopharmacology, and pharmacological properties of the *Trichodesma indicum*.

Keywords: Antioxidant, antipyretic, Arthritis, antiinflammatory, antimicrobial.

INTRODUCTION

Medicinal plants have always been part of human culture and have the potential to cure different diseases caused by various factors. Since the ancient times, many herbal medicines have been used in people for the treatment of various diseases and disorders. *Trichodesma indicum* is used in Indian system of medicine to cure for fever and diseases of eye and ear. The plant is used to treat inflammation and joint disorders as an emollient, anodyne, febrifuge, carminative, depurative and pectoral. The leaves of the plant are used to treat cancer.

Trichodesma indicum is found throughout India on roadside and stony dry wastelands up to 1500m. The plant is acrid and bitter in taste. It is an erect, spreading, branched and annual herb, about 50 centimeters in height with hairs springing from tubercles. The leaves are stalkless opposite, lance shaped, 2-8cm long, pointed at the tip and heartshaped at the tip. The flowers occurs singly in the axils of the leaves and usually violet, light blue or purple in color. The calyx is green, hairy and 1-1.3 cm long with pointed sepals. The corolla is pale blue with limb about 1.5cm in diameter and the petals are pointed. The fruit is ellipsoid and is enclosed by the calyx. The nutlets are about 5mm long and rough on the inner surface.¹⁻⁷

Vernacular names

Hindi – Chhotakalpa
Gujarati – Undhanphuli
Kannada – Kattetumesoppu
Tamil – Kalluthaithumbi
Telugu – Guvvagutti
Marati – ChotaKalpa
Sanskrit - Adhapushpi

English – Indian borage

Scientific Classification⁷

Kingdom - Plantae
Phylum - Tracheophyta
Class - Magnoliopsida
Order - Boraginales
Family - Boraginaceae
Genus - *Trichodesma*
Species - *Trichodesma indicum*



Trichodesma indicum Plant

Ethanopharmacology

Ethanobotanical study was conducted on medicinal plants with 44 species of plants covering 43 genera and 33 families used for curing Rheumatoid Arthritis used by the tribble people of Adilabad district Andhra Pradesh. Among



those species *Trichodesma indicum* was considered as one of the important medicinal plant and its warmed root poultice was effective when massaged on painful parts. It has been successfully proved the ethanobotanical use of *Trichodesma indicum* and useful for further autoimmune related disorders study.⁸

An ethanobotanical survey was carried out among the Paliyar tribal villages of theni district, Tamil Nadu. Ethanobotanical plants were identified and 101 species belongs to 90 genera and 48 families. Externally the Leaf juice *Trichodesma indicum* was found to be useful in the treatment of ear pains and wound healing. The study showed a high degree of ethanobotanical novelty and usefulness among the tribal people.⁹

Ethanobotanically the plants from Thari desert was studied and 51 species were distributed among 28 families with 48 genera have been identified to have medicinal uses by local peoples of Thari. Among those 21 species were proposed to have new uses from Boraginaceae and Amaranthaceae and not mentioned in the Indo – Pak folk herbal medicinal literature. Various parts of the 51 medicinal plant species were found to be useful for 44 types of ailments. 53% of whole plant, 18% of leaves, 14% of roots and 10% of fruits were useful for the ailments. Decoction of whole plant *Trichodesma indicum* was found to be useful in the treatment of influenza and cough.¹⁰

Pharmacognosy and Phytochemistry

Pharmacognostical and phytochemical characters were studied on aerial parts and stems of *Trichodesma indicum*. Trichomes, Anisocytic stomata, Anamocytic stomata, wavy epidermal cells were observed from surface preparation. It was observed from transverse section of leaf collenchyma, vascular bundles, palisade cells, prisms of calcium oxalate, covering trichomes with bulbous base upper and lower epidermis. The powder microscopy of aerial parts of the plant exhibited epidermal cells, parenchyma, fibres, xylem vessels, trichomes, calcium oxalate crystals. Phenolic compounds were identified by fluorescence analysis of the plant powder. Phytochemical screening of the aerial parts showed triterpenoids, phenolic compounds, tannins, phytosterols, carbohydrates, fatty acids, fixed oil and mucilage.¹¹

The root, stem and leaf of *Trichodesma indicum* was studied for morphological and anatomical characters to upgrade the knowledge for standardisation. Transverse section of leaf showed trichomes of both glandular and covering type (unicerate), anamocytic stomata and anisocytic stomata, phloem, radiating arc of xylem and pericyclic fiber. Root exhibited starch grains, phloem, xylem and oil globules. Stem showed cortex with collenchymatous cells. Anatomical study of roots showed the presence of xylem phloem and oil globules. Unicerate covering trichomes and anisocytic stomata were present.¹²

Macroscopical, quantitative and cytomorphological studies were carried out. Microscopical study of the young stem showed the presence of vascular bundles and thin layer of epidermal cells, primary and secondary xylems with phloem. The microscopical study of the young root showed thin layer of secondary phloem, secondary xylem and xylem fibres. Powder microscopy of the plant showed non glandular, unbranched unicellular trichomes, tracheids, vessel elements and starch grains. Phytochemical investigation revealed the presence of phytosterols, tannins, sugars, flavonoids, protein, saponins and free amino acids.¹³

It has been evaluated for biosystematics of three species of *Heliotropium indicum*, *Trichodesma indicum* and *Trichodesma zeylanicum* from boraginaceae family. The difference was found in leaf and inflorescence morphology, epidermal trichome, stomatal behaviour, stem anatomy and pollen grain characteristics, hypodromous and brochidodromous venation of their leaves for all the three species. The leaves were found to be lanceolate to ovate and the inflorescence was pale blue to white. The length of the inflorescence was 4.0 to 6.5. All the three species contains varied types of stomatal index. *Trichodesma zeylanicum* and *Trichodesma indicum* exhibited anomocytic stomata with 16mm in length and 12mm width and stomatal index was found to be 34.88 and 44.68. Anisocytic stomata were found in *Heliotropium indicum* with 12mm long and 10mm wide and the stomatal index was 32.65. Unicellular glandular trichomes were found in all the three species and showed tricolpate pollen grains with varied size. All the three species exhibited similar anatomical structures and differ in hypodermal layers. Similarity of morphological and anatomical characters between *Heliotropium indicum* and *Trichodesma indicum* were compared with *Trichodesma zeylanica* and found to be similar in some characters specifically stomata, pollen grains, trichomes, stem anatomy and stomatal index etc. *Trichodesma indicum* and *Trichodesma zeylanicum* showed exhibited similarities in twenty two characters. The matching coefficient was observed that *Heliotropium indicum* showed only 25.80% resemblance with *Trichodesma indicum*, and 29.03% with *Trichodesma zeylanicum*. *Trichodesma indicum* and *Trichodesma zeylanicum* showed 70.96% resemblances, and it is evident that the species are considered as same species of the genus *Trichodesma*.¹⁴

Trichodesma indicum was found to be a useful medicinal herb and genetic variations were assessed among different populations using DNA (RAPD) markers. Different populations of *Trichodesma indicum* were collected from different locations and in vitro regenerated plants were also collected for the study. Micropropagated plants from zygotic embryos and all the populations were assessed and detected the genetic variations. 20 primers generated a total of 121 polymorphic bands out of 125 total bands (96.8% polymorphism), with an average of 6.05 amplified bands



per primer. The exhibited results showed the elevated level of genetic diversity among the species.¹⁵

The phytochemical and anatomical structure of *Trichodesma indicum* was studied to establish the botanical identity of the herbal drug. The preliminary phytochemical screening of the methanolic extracts showed the presence of secondary metabolites like alkaloids, saponins, flavonoids, steroidal compounds, tannins and phenolic compounds and aqueous extract showed the presence of alkaloids, flavonoids, tannins, saponins and steroids.¹⁶

23 compounds were identified and reported from *Trichodesma indicum* which were from different chemical categories. It was traditionally used for dysentery, arthritis, arthralgia, dysentery, skin disease, as an antidote and diminished Vata and Kapha in Ayurvedic system of medicine. The identified compounds from extracts of different plant parts were reported and had antioxidant, antitussive, antidiabetic, antiinflammatory, diuretic, antimicrobial, antifungal, dermal toxicity and metal chelating efficacy.¹⁷

Biological activities

Antipyretic and analgesic activity

The effect of ethanolic extract was studied for antipyretic and analgesic activity. Thermal and pain models were used to assess the analgesic activity in mice. Aspirin was used as a standard drug. The doses of 100, 200 and 400mg/kg of ethanolic extract inhibited acetic acid induced abnormal constrictions in mice. At 400mg/kg ethanolic extract showed significant elevation in pain threshold to the heat stimulus. The ethanolic extract of 400mg/kg significantly inhibited both phase of hyperalgesic mode of formalin test and produced less effect in first and more in second phase. A rectal temperature was reduced up to 3 hours after administration in rats. The extract also reduced the rectal temperature in rats in yeast induced pyrexia for up to 4 hours after the administration and the efficacy produced was similar to that of standard drug. Tannins, steroids, flavonoids, triterpenoids and saponins were obtained by chemical analysis of the extract. The results suggested that the extracts of different dose levels showed analgesic and antipyretic activity.¹⁸

Antidiabetic activity

The leaves have been extracted using four solvents Hexane, acetone, methanol and aqueous and investigated for antidiabetic activity in both in vitro amylase assay and in vivo streptozotocin – nicotinamide induced type 2 diabetic rats. In vitro α -amylase activity and glucose uptake was tested for extract using yeast cells. The effect was studied for four extracts at the dose of 200 mg/kg and 400mg/kg in rats by inducing type 2 diabetes with streptozotocin – nicotinamide. All the four extracts exhibited significant glucose uptake activity. The methanolic extract of leaf showed moderate α -amylase

inhibitory activity as it was compared with acarbose. Methanolic extract exhibited effective inhibition of glucose uptake with standard. All the four extracts marked decrease in the blood glucose levels in streptozotocin – nicotinamide induced type 2 diabetic rats. The methanolic extract exhibited decreased level of blood glucose along with glibenclamide. It has been reported that the *Trichodesma indicum* exhibited anti-diabetic activity in type 2 diabetes mellitus.¹⁹

In vitro antioxidant and antidiabetic activity was evaluated for hydroalcohol extract of *Trichodesma indicum* whole plant. 2, 2-Diphenyl 1-picryl hydrazyl assay (DPPH), Superoxide radical methods and Scavenging of Nitric oxide were used to evaluate total antioxidant capacity and reducing power of the extract. Cytotoxic effect of the extract was screened by MTT assay and in-vitro antidiabetic effect was evaluated using the glucose uptake model in rodent skeletal muscle cells (L-6 cells) involved in glucose utilization. *Trichodesma indicum* extract exhibited effective antioxidant activity against DPPH radical with IC50 value of > 1000mg/ml. Total antioxidant activity was found to be 225.28 mg/gram of dried extract which was expressed equivalent to Ascorbic acid. The increased reducing power of samples were due to increase in absorbance at 700nm. The drug extract exhibited percentage growth inhibition value of 500 μ g/ml and showed average glucose uptake ($P < 0.05$) with percentage of glucose uptake of 91.03 ± 10.12 over the control. The extract of *Trichodesma indicum* exhibited significant antioxidant activity and moderate antidiabetic activity.²⁰

Antiinflammatory activity

It has been demonstrated that the chloroform extract of *Trichodesma indicum* root exhibited antiinflammatory activity against edema produced by carrageenan, dextran, histamine and serotonin and against formation of granulation tissues by cotton pellet in rats. Different types of inflammation was evaluated for the extract and compared with dexamethasone, cyproheptadine and indomethacin. The significant antiinflammatory activity was observed for chloroform extract at the doses of 50, 100 and 200mg/kg using acute and chronic inflammatory models. The chloroform extract at 200mg/kg showed maximum inhibition carrageenan induced rat paw edema which was compared with standard values. The chloroform extract of all three doses inhibited dose dependently and significantly against dextran, histamine and serotonin-induced rat paw oedema which was comparable with control group. The chloroform extract at 100 and 200mg/kg restrained the granuloma weight by 15.42 and 21.12% whereas the indomethacin and dexamethasone restrained it by 29.29 and 34.13%. The results suggested anti-inflammatory activity of the extract at different dose levels.²¹

Trichodesma indicum leaves were extracted with Hexane, Acetone, Methanol and Water and evaluated for in vitro enzyme assay and in vivo anti-inflammatory activity in



rats. *In vitro* and *in vivo* anti-inflammatory activity was evaluated by 5 – Lipoxigenase enzyme assay and carrageenan induced rat paw oedema in rats respectively. Methanolic extract of *Trichodesma indicum* produced less IC₅₀ (133.55µg/ml) when compared to other three extracts. *In vivo* evaluation of methanolic extract of 200 and 400mg/kg body weight exhibited significant inhibition of paw oedema 55.61% and 71.43% (P<0.01), which was compared with standard drug. The obtained results proved the effect of extracts for *in vitro* and *in vivo* anti-inflammatory activity.²²

The study was performed to screen the phytochemicals and *in vitro* antiinflammatory activity for aqueous and alcoholic extracts of flowers of *Trichodesma indicum*. The phytochemical screening showed the presence of flavonoids, terpenoids and steroids. The prevention of hypotonicity induced HRBC membrane lysis was taken as a measure of antiinflammatory activity. The effect of ethanolic extract of flower was compared with standard drug indomethacin for antiinflammatory activity. The effect ethanolic extract was also compared with aqueous extract and it showed antiinflammatory activity.²³

Phytochemical screening and antiinflammatory activity was evaluated for ethanolic extract of flowers of *Trichodesma indicum*. Phytochemical screening of the extract showed the presence of terpenoids, steroids and flavonoids which attributed the membrane lysis activity. Ethanolic extract and aqueous extract was compared for membrane stabilization property and ethanolic extract was found to have higher antiinflammatory activity than the aqueous extract of *Trichodesma indicum* it has been proved as antiinflammatory agent for further studies.²⁴

Biosafety and anti-inflammatory activity was evaluated for methanolic extract of *Trichodesma indicum*. The membrane stabilization capacity was analysed on newly hatched Brine shrimp larvae and Human HRBCs suspension. It has been proved that the extract was safe (LD₅₀ 891.25mcg/mL) and it has exhibited strong antiinflammatory activity (71.21 ± 2.06% at 88.89mcg/mL).²⁵

Antimicrobial activity

The ethanolic extract of root of *Trichodesma indicum* was evaluated for antimicrobial activity. To isolate the phytochemical compounds from *Trichodesma indicum* root, it was extracted with ethanol and separated by chromatographic techniques and structures were elucidated for isolated compounds by spectroscopic methods. Disc diffusion method was selected to screen the antimicrobial activity for ethanolic extracts and isolated compounds of roots of *Trichodesma indicum*. The isolated compounds and ethanolic extract were assessed for antimicrobial activity by determining minimal inhibition concentration and minimal bactericidal or fungicidal concentration. n-tetradecanoyllaurate, n-Decanoyllaurate, stigmast-5-en- 3b-ol-21(24)-olide, n-pentacos-9-one, n-nonacosanoylpalmitate, n-dotriacont-9-

one-13-ene, lanast-5-en-3b-D-glucopyranosyl-21(24)-olide and stigmast-5-en-3b-ol-23- one were the isolated compounds from ethanol extract of *Trichodesma indicum*. The ethanolic extract and isolated compounds exhibited varying degrees of antimicrobial activities. The ethanol extract exhibited potent growth inhibitory activity against *S. aureus*, *B. subtilis* and *C. albicans* with an MIC value of 19.2 mg/ml. It has been proved that among all the isolated compounds, lanast-5-en-3b-D-glucopyranosyl-21(24)-olide exhibited strongest antibacterial activity against *S. aureus* with Minimum Inhibitory Concentration value of 2.4 mg/ml. The results were proved that the ethanolic extract of *Trichodesma indicum* root and its isolated compounds effective against infections and microorganisms.²⁶

Extracts of *Trichodesma indicum* leaves were evaluated to identify the phytochemical constituents using petroleum ether, ethyl acetate, ethanol and also leaves were subjected to cold maceration method using distilled water. Alkaloids, glycosides, proteins, flavonoids, steroids, terpenoids and carbohydrates. All the extracts were tested for antimicrobial activity against *Escherichia coli*, *Staphylococcus aureus*, *Coagulase-negative staphylococci*, *Pseudomonas aeruginosa*, and *Klebsiella pneumonia*. The petroleum ether and ethanolic extract exhibited significant antimicrobial activity as it was compared with ethylacetate and aqueous extract. It was vice versa for Minimum inhibitory concentration of antifungal activity.²⁷

Phytochemical screening and selected pharmacological activities were carried out on methanolic extracts of leaves of *Trichodesma indicum*. The leaf extract was tested for antibacterial activity against *Escherichia coli*, *Pseudomonas aeruginosa*, *Klebsiella pneumonia*, *Bacillus subtilis* and *Streptococcus pyrogenes* by agar well diffusion method. At 100µg/ml concentration of the extract was effective against *Bacillus subtilis* and the zone of inhibition was found to be higher (15mm). Preliminary phytochemical screening showed alkaloids, flavonoids, tannins and reducing sugars. 20 different compounds were identified from methanolic extract and confirmed by GC-MS analysis. The results proved the traditional use of the plant.²⁸

Antimicrobial activity was evaluated for petroleum ether, chloroform, ethanol and water extracts of aerial parts of *Trichodesma indicum* and *Trichodesma sedgwickianum* against five gram positive and gram negative bacteria and fungi. The zone of inhibition of the extracts was found to be in the range of 12 to 29mm. The minimum inhibition concentration was found in the range of 5 to 0.625 mg/ml. The ethanolic extract of both the species were found to have more active against gram positive bacteria, *S. aureus* and *B. subtilis* and aqueous extract had strong inhibitory effect against gram negative bacteria like *E. coli* and other organism. Phytochemical screening of the extract showed the presence of steroids, β-sitosterol and phenolics, catechin and gallic acid. Both the plants have



proved to be antimicrobial and chemotherapeutic agents and had broad spectrum of activity.²⁹

Insecticidal and herbicidal activity

Phytotoxic and insecticidal activities were assessed for ethanolic extracts of whole plant of *Trichodesma Indicum*, corns, leaves and berries of *Sauromatumguttatum* and roots of *Aconitum leave*. Herbicidal activity was found in all the extracts except *Aconitum leave* against *Lemna minor*. The extracts completely inhibited the plant growth at 500µg/ml and also exhibited effective insecticidal activity and the highest mortality has been found in of *Sauromatum guttatum* berries against *Bruchu spisorum* and *Trichodesma Indicum* against *Rhizoper thadominica*. The obtained results suggested the insecticidal and herbicidal activity of the extracts.³⁰

Antioxidant activity

The antioxidant activity was studied for *Trichodesma indicum* leaves using solvents such as hexane, ethyl acetate and methanol of increasing polarity. The obtained extracts were screened for antioxidant activity using phosphomolybdenum assay, DPPH assay, metal chelating assay and Hydroxyl Radical Scavenging assay. The ethyl acetate fraction exhibited the presence of tannins, flavonoids and terpenoids. It has been reported that the ethyl acetate fraction of leaves exhibited antioxidant activity and yet to discover antiproliferative and anticancer activity.³¹

The leaves, fruits and root extracts of *Cleome viscosa* and *Trichodesma indicum* were evaluated for flavonoids, alkaloids and total phenols. The plants exhibited all the chemical constituents. The enzymatic and nonenzymatic antioxidant components were determined using standard protocols. Alkaloids are absent in *Cleome viscosa* leaves and flavonoids are absent in *Trichodesma indicum* leaves. The *Trichodesma indicum* leaves and fruits of *Cleome viscosa* showed higher catalase activity. The fruits and roots of *Trichodesma indicum* and *Cleome viscosa* showed maximum activity of peroxidase and glutathione-S-transferase. The results of the study confirmed the antioxidant activity from the root, leaf and fruit of both the plants and possess significant non-enzymatic activity.³²

Antitussive activity

It has been evaluated for Sulphur oxide induced cough reflex in swiss albino mice on methanolic extract of whole plant of *Trichodesma indicum*. The methanolic extract of *Trichodesma indicum* showed significant inhibition in frequency of cough for all test doses which was compared with control groups and standard drug codeine phosphate. The effect produced was persisted for 90 minutes of its oral administration. The exhibited results confirmed the traditional use of the plant in the treatment of cough.³³

Corrosion inhibition effect

Corrosion inhibition effect was evaluated from alkaloid extract of *Trichodesma indicum* and compared with imidazole compounds on C38 steel in 1MHCl solution by weight loss method at various temperatures. The alkaloid extract of the plant showed better inhibition as it was compared with organic inhibitors. The inhibition efficiency was found to be 94.5% at a concentration of 75 mg/L at 30°C. It has been confirmed the potentiality of alkaloidal extract against corrosion inhibition.³⁴

Metal chelating activity

Metal chelator complex was formed by binding of ions which were used to iron excretion and synthetic chelators have strong capability to bind metal ions. Metals play an important role on body at normal doses and at higher doses produces toxic sever effects. To reduce the metal toxicity in organisms use of chelating agent is an optimal treatment. To estimate the chelating efficiency of ferrous ions from *Trichodesma indicum* extracts using Dinis et al at various concentration of the extract by the addition of 0.05ml of 2mM FeCl and initiated Ferrozine (5mM). Absorbance was measured using spectrophotometer at 560nm. The generation of hydroxyl radical was reduced by binding of ferrous ions from *Trichodesma indicum* extracts. It is evident that the ethyl acetate extract of *Trichodesma indicum* has significant metal chelating activity. The redox potential was reduced by chelating agents which are effective as secondary antioxidants and stabilizes the oxidized form of metal ion. It has been proved the metal chelating efficiency of the extract and was helpful to screen the toxicology study.³⁵

Diuretic activity

Diuretic activity was evaluated for methanolic and aqueous extract of aerial parts of *Trichodesma indicum* using Lipschitz model. The diuretic effect was evaluated for the extract by measuring the urine volume. The extract at the dose of 300mg/kg exhibited effective diuretic activity with lipschitz value 1.25 which was compared with standard. The urinary potassium concentration was more in aqueous extract whereas sodium concentration was found to be more in methanolic extract. The exhibited results proved that the methanolic extract had effect like K⁺ sparing diuretics. It is evident that the phytoconstituents present in *Trichodesma Indicum* were responsible for the diuretic activity.³⁶

Hepatotoxicity study

A study was carried out to evaluate the acute and subacute hepatotoxicity of *Trichodesma indicum* aqueous methanolic extract of whole plant in mice. Acute and subacute toxicity was screened for aqueous methanolic extract during one day and after fifteen days. The LD50 for the extract was found to be more than 4000mg/kg and sub acute treatment exhibited no change in weight of liver and Aspartate amino transferase (AST), Alkaline



phosphatase (ALP), Alanine amino transferase (ALT), no marked effect on bilirubin, Albumin, protein decreased and globulin values were increased significantly. Necrosis and excessive vacuolation was observed for the maximum dose under histopathological study. It has been demonstrated that the aqueous methanolic extract had dose related hepatotoxicity and mild injury in liver function.³⁷

Antimitotic and antiproliferative activity

To evaluate the antimitotic and antiproliferative activity of the aerial parts were successively extracted with petroleum ether, chloroform, ethanol and water. The *in vitro* antioxidant activity was screened for all the four extracts using 2, 2'-diphenyl-1-picrylhydrazyl, 2, 2'-azino-bis (3-ethylbenzothiazoline-6-sulphonic acid) radical inhibition systems. The extracts were also screened for *in vitro* antimitotic activity in *Allium cepa* root and antiproliferative activity using the yeast model and five human cell lines (MCF-7, HOP-62, MOLT-4, HCT-15 and PRO). The mitotic index for SCH and SEE was found to be 12.01 ± 1.34 and 12.99 ± 0.25 mg/mL, respectively. The IC50 value in the antiproliferative assay was found to be 30.14–35.36 mg/mL for SCH and SEE respectively. Both SCH and SEE extracts exhibited significant antimitotic and antiproliferative activity and it was compared to the standard methothrexate, vincristine and adriamycin. Among the extracts, SEE showed strong inhibition against MCF-7 and MOLT-4 cell lines at concentration <30 g/mL. Phytochemical screening of extracts indicated the presence of β -sitosterol, gallic acid and catechin. The results have been concluded that *Trichodesma indicum* might be a valuable drug for the treatment of a variety of cancer and it is validated the traditional use.³⁸

Micropropagation

Shoot tip explants were used to develop *in vitro* flowering and micropropagation protocol and the physiological role of cytokinin and its combination of auxins were evaluated for micropropagation and *in vitro* flowering of *Trichodesma indicum*. The highest number of shoot and shoot length was found to be more in Murashige and Skoog (MS) medium which was supplemented with benzylaminopurine (BAP) (4.44mM) and Naphthalene acetic acid (2.69mM). The *in vitro* floral development was observed for the effect of sucrose concentration and studied for plantlets cultured in MS medium supplemented with gibberlic acid and BAP. The gibberlic acid, BAP and sucrose supplemented MS medium was more effective towards highest percentage of floral development. MS medium containing indole-3- butyric acid was responsible for the formation of root and adventitious shoots. The survival rates of regenerated plantlets were found to be 86% and are phenotypically normal. The study successfully explained the *in vitro* flowering and micropropagation of *Trichodesma indicum*.³⁹

In vitro techniques were employed to get a cross pollinated species of *Trichodesma indicum* for regeneration. The zygotic embryos placed on MS (Murashige and Skoog) medium fortified either with kinetin, BA (N6-benzyl Aminopurine) or NAA (α -naphthalene acetic acid) produced callus and adventitious shoots; whereas those placed on MS medium supplemented with 2,4-D (2,4-dichlorophenoxyacetic acid) formed callus. On subculture, the nodal pieces produced axillary shoots that were suitable for further propagule proliferation. Rhizogenesis occurred in 60% micro shoots treated with IBA (indole-3-butyric acid) pulse. The regenerated plants successfully acclimatized and started flowering in green house maintained at 30 \pm 2°C temperature and 70% RH.⁴⁰

CONCLUSION

The present review represents pharmacognostical study, diagnostic characters and microscopical characters and it could be useful for further studies. The quantitative parameters performed for the specific parts might be useful for the identification of the plant material. The phytochemical screening, physicochemical analysis and histological studies described the presence of possible phytochemicals and it will be useful for further studies. The pharmacological activity of the plant gives an idea about current status of the plant research. Hence the plant can be further explored to be used as a potent therapeutic agent for various diseases and disorders. Since this knowledge is the basis for development of new therapeutic approaches for diseases.

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