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Review Article

REMEDIAL AND PHYTOCHEMICAL REVIEW STUDY ON *TECOMA STANS*L.

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Abstract

Tecoma stans is a destructive invader that outcompetes natural florain its surroundings. This plant is considered as a modifier species which leads to a decrease in the biodiversity as well as natural resources. It has been planted as an ornamental garden and street plant, but possesses wide range of therapeutic and pharmaceutical applications. All parts (leaves, root, flower, seed, fruit, and bark) of the plant areusedas a remedy for different diseases. As anherbal remedythe plant parts are used for the treatment of diabetes, digestive problems, control of yeast infections, as powerful diuretic, vermifuge, anti-syphilitic, stomach pains and tonic. Preliminary phytochemical screening and isolation of compounds from this plant has revealed the presence of tannins, flavonoids, phenols, anthraquinones, glycosides, alkaloids, quinones and traces of saponins and amino acids. This article summarizesthe data on its medicinal applications and traditional uses.

Keywords: *Tecoma stans*, invasive shrub, medicinal uses, phytochemicals, allelochemicals

INTRODUCTION

*Tecoma stans*is a shrub or a small tree belonging to the family Bignoniaceae.It is commonly known as; English (ginger thomas,tecoma,trumpetflower,yellow bells,yellow bignonia,yellow cedar,yellow elder,yellow trumpet tree); French (Tecoma jaune,herbe de St. Nicholas,fleur de St. Pierre,chevalier); Arabic (tacoma); Creole (chevalye,flésenpié,zebsennikola); German (AufrechteTrompetenwinde); Italian (Tecomagiallo); Spanish (saúcoamarillo,roble amarillo); Tamil (sonapatti); Hindi (Piliya); Kannada (Koranekelar);Telugu (Pachagotla); Bengali(Chandaprabh); Marathi (Ghantiful); Nepali (Ghata Pushpa and Saawari).

The generic name is derived from the Mexican word for the plant "tecomnaxochitl" which means 'vessel-flower' and refers to the large, cup shaped or trumpet-shaped blooms. The species name means 'erect' in Latin.It attainsa height of up to of 8 m, and rarely goes upto10 m. The stem diameteris up to 25 cm. The plants in dense stands are normally smaller mostly 5-6m tall. The plant is evergreen in humid and warmer regions but changes to deciduous form in more temperate areas with a marked dry season (Pelton, 1964). The pinnate leaves are bright green above, paler below, smooth or hairy often around the veins, depending on the region it grows. The leaf size also varies and can be as large as 100-200 mm long, pinnate with 3-17 leaflets, which are 2.4-15 cm long, 0.8-6 cm wide, progressively larger distally (Gentry, 1992). Most leaves have 5-7 leaflets including the terminal one. Leaf margins can be sharply toothed or less toothed. Inflorescences are terminal or sub terminal with 20 bright yellow showy trumpet-shaped flowers, about 50 mm long. In some cases the corolla is slightly orange-yellow with pinkish lines in the tube part. The fruit is a linear shiny capsule, 12-22 cm long and about 1 cm thick, pointed at the end. The two-valve dehiscent capsule splits open to release up to 77 (mean 42) papery-winged seeds which are primarily wind dispersed, and to a lesser extent water dispersed.

Distribution: The plant is native to Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Ecuador, French Guiana, Guatemala, Guyana, Haiti, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Puerto Rico, Surinam, Uruguay, and Venezuela.It is recorded as an exoticin Benin, Burkina Faso, Cameroon, Chad, Cote d'Ivoire, Gambia, Ghana, India, Kenya, Liberia, Mali, Mauritania, Niger, Nigeria, Pakistan, Rwanda, Senegal, Sierra Leone, Sudan, Tanzania, Togo, Uganda, and United States of America.

Reproductive biology and seed dispersal

*T. stans*is probably pollinated by humming birds in its naturally distributed areas. This plant produces abundant light and papery

Fig.1: The native and exotic range of *Tecoma stans* in the world.

seeds that are primarily wind-dispersed. They may also be spread by flood waters and through dumped garden waste. This plant is auto compatible and requires external pollination (Kranz and Passini, 1997). It can flower throughout the year, or flowering can be seasonal, usually in summer and after good rains. Only a small proportion of the flowers set fruit in its native range which can be attributed to drought conditions, pollination failure and insect attack. In contrast, fruit set in countries of introduction is high, e.g. in South Africa. Vegetative reproduction from root and stem cuttings is less important for long distance dispersal but allows for rapid densification of populations after disturbances, including attempts to remove plants mechanically. The vigorous sucker shoots tend to be erect as the specific name 'stans' implies.

This pantresembles orange bells (*Tecomaalata*) and is also confused with the garden plants like golden trumpet vine (*Allamanda cathartica*) and shrubby allamanda (*Allamanda schottii*). Sometimesit is also confused with yellow oleander (*Cascabelathevetia*). These species can be distinguished by the following differences. However, *T. stans* differs from the Orange bells (*Tecomaalata*) in having compound (pinnate) leaves,oppositely arranged along the stems. These leaves have several toothed (serrated) leaflets and are borne on long slender stalks (petioles). Its moderately large (3-5 cm across) tubular flowers are reddish-orange from outside. Its fruit are usually long and with narrow capsules (10-30 cm long) that split open when mature to release numerous papery seeds. Similarly the Golden trumpet vine (*Allamanda cathartica*) has simple leaves that are clustered (whorled) along the stems. These leaves have entire margins and are borne on short stalks (petioles). Its flowers are very large (6-15 cm across) and its fruit are rounded and have prickly (4-6 cm long) capsules that split open when mature to release abundant winged seeds. In the case of Shrubby allamanda (*Allamanda schottii*) it has simple leaves that are clustered (whorled) along the stems. These leaves have entire margins and are borne on short stalks (i.e. petioles). Its flowers are moderately large (3-6 cm across) and its fruit are rounded and prickly (4-6 cm long) capsules that split open when mature to release numerous winged seeds.Yellow oleander (*Cascabelathevetia*) differs in having simple leaves that are spirally arranged (densely alternately arranged) along the stems. These leaves are long and narrow (i.e. linear) with entire margins and obscure stalks (petioles). Its flowers are moderately large (4-6 cm across) and its fruit are large fleshy drupes (25-55 mm across) that are somewhat rounded or slightly triangular in shape.

Phytochemical Studies

Its chemical constituents are phytosterols, alkaloids, quinines, amino acids, monoterpenes, triterpene, glycosides, phenols, flavonoids, saponins, and tannins. Studies have shown its effectiveness as a diuretic, tonic, anti-syphilitic, and vermifuge. In traditional folk uses mostly roots are reported to be diuretic, tonic, anti-syphilitic and vermifuge. In Veracruz, decoction of flowers and bark are used for stomach pains.

The callus induction studies byWani et.al (2014) have shown that this plant has active components and shows antioxidant activity.The phytochemical screening of the *T.stans*has revealed that depending on the solvents used for the extraction of the leaves; methanol and ethanol extracts of the leaves show the presence of all secondary metabolites such as; saponins, flavonoids, tannins, phenols, anthraquinones, alkaloids and glycosides which are the active principles of this plant. Ethyl acetate extract has shown the presence of saponins, tannins and phenols whereas aqueous extracts have shown saponins, flavonoids, phenols and alkaloids in the leaves of *T. stans*. Anburaj et.al (2016) ha undertakenphytochemical screening following GC-MS analysis of ethanolic extract of *T. stans*. His findings have revealed the presence of twentyfive compounds (phytochemical constituents) namely; Propane, 1,1,3-Triethoxy-, 5-Hydroxymethylfurfural, 1'-Hydroxy-4,3'-Dimethyl-bicycl,9-Oxabicyclo[3.3.1]Nonan-2-One,1,10-Decanediol,1,2,3,4,7,7a-Hexahydro-2,4,7 Trimethyl-6H,Tropane, 2-Acetyl-2,3-Methylene-,5-Undecanol, 2-Methyl,6-Dodecanol,Silacyclopentane, 1,1-Dimethyl,Cyclobutanecarboxylic Acid, Decyl ester,Propanamide, 3-(1-Piperazinyl)-,Tetradecanoic Acid,Tetradecanoic Acid, Ethyl Ester,2(4h)-Benzofuranone, 5,6,7,7atetr,L-(+)-Ascorbic Acid 2,6-Dihexadecanoate,Hexadecanoic Acid, Ethyl Ester,N-Nonadecanol-1,9,12-Octadecadienoic Acid (Z,Z),Ethyl (9z,12z)-9,12-Octadecadien,Octadecanoic Acid,N-Propyl 9,12-Octadecadienoate, 9,12,15-Octadecatrienoic Acid, Ethyl Ester, Octadecanoic Acid, Ethyl Ester and Hexatriacontane.

Table 1: Biological activities from Dr. Duke's phytochemical and ethnobotanical databasecreated by Dr. Jim Duke of the agricultural research service/USDA 2013.

S.no	Name of the compound	Biological activity
1	Tetradecanoic acid	Antioxidant, Lubricant, Hypercholesterolemic, Cancer-preventive, Cosmetic
2	Hexadecanoic Acid, Ethyl Ester	Antioxidant, hypocholesterolemic, Anti androgenic, hemolytic, Alpha reductase inhibitor.
3	l-(+)-Ascorbic acid 2,6- dihexadecanoate	Vitamin C, Antioxidant, Immunomodulator
4	N-Nonadecanol-1	Antiinflammatory, Hypocholesterolemic, Cancer preventive, Hepatoprotective, Nematicide, Insectifuge Antihistaminic, Antiarthritic, Anticoronary, Antieczemic Antiacne, 5-Alpha reductase inhibitor Antiandrogenic,
5	9,12-Octadecadienoic Acid (Z,Z)-	Hypocholesterolemic, 5-Alpha reductase inhibitor, Antihistaminic, Insectifuge, Antieczemic, Antiacne
6	9,12,15-Octadecatrienoic Acid, (Z,Z,Z)	Hypocholesterolemic, Nematicide Antiarthritic, Hepatoprotective, Anti androgenic, Nematicide 5- Alpha reductase inhibitor, Antihistaminic Anticoronary, Insectifuge, Antieczemic Anticancer
7	Octadecanoic acid	Cosmetic, Flavor, Hypocholesterolemic, Lubricant, Perfumery, Propecic, Suppository

Table 2: Detection of chemical constituents of*Tecoma stan* analyzed usingdifferent extracts.

		Extracts		
Componentes	Tests/Reagents	Aqueous	Ethanolic	n-Hexane
Alkaloides	Wagner	+	+	+
Coumarines	NaOH	+	+	+
Flavonoides	Salkowski	+	+	+
Sesquiterpenlactons	Baljet	+	+	+
Esteroles and metilesteroles	Liebermann-Burchard	_	+	+
Carbohydrates	Molisch	+	_	_
Saponines	Liebermann-Burchard	_	+	+
Quinones	Borntrager	_	+	_
Insaturaciones	KMnO4	+	+	_

The constituent was not found+ The constituent was present

Remedial uses

Almost all parts ofthis plant are used traditionally for the cure ofvarious diseases.The leaves,bark and roots have been used asherbal medicine.Bark shows smoothening of muscles as a relaxant, acts as mild cardiotonic and posseseschlorotic activity. Applications include treatment of diabetes, digestive problemsand control of yeast infections. It contains several compounds that are known for their catnip likeeffects on felines. The roots of this plant are reported to act as powerfuldiuretic, vermifuge and tonic. Grinded rootswith lemon juice arereportedly used for external application and also taken internally in small quantities as a remedy for snake and rat bites. In South America it is used traditionally for reducing blood glucose levels.

Pharmacological Actions

Antioxidant Activity: The phenolic compounds and total flavonoid contents have been determined in the callus tissue cultured under set photoperiod or in darkness(Alma et al., 2009).Thecalli of *T. stans*are a source of compounds with antioxidant activity that is favored by culture under a set photoperiod.

Anti-Inflammatory Activity: The anti-inflammatory activity of chloroform root extract of *T. stans* has been evaluated by Chaudhary (2009). The extract has been analyzed for anti-inflammatory activity against carrageenan-induced paw edema in Wistar albino rats. In control group simple distilled water was used, in standard group Aspirin (100 mg/kg) and in test groups chloroform extract (100mg/kg, 200mg/kg) have been administered orally, 1% w/v carrageenan solution injected intraperitoneally after 30 minutes. The paw volume of control, standards and test groups were noted at 1hr, 2hr, 3hr and 4hr time intervals. Anti-inflammatory effects of the extracthasshown significant anti-inflammatory activity at 200mg/kg (% of inhibition of paw edema 50.93 at 4 hrs.) as compared to control.

Cardio-protective effect: Myocardial infarction is the imbalance between oxygen supply to the myocardium followed by the development of myocardial necrosis. This causes increase in the toxic reactive oxygen species such as O_2-, H_2O_2, OH-etc. and exerts simple oxidative pressure on myocardium, prompting to CVD (cardiovascular diseases), like, ischemic heart disease, atherosclerosis, and congestive heart. *T.stans*shows cardio protective effect as screened by the animal model estimation of the antioxidant activities of the myocardium.

Cytotoxicity study: The cytotoxicity of *T.stans*has been determined in human hepatoblastoma by incubating the cells up to 72-hours, they changewithconcentrations of herbal extracts. Toxic effects are time-dependent in the presence and absence of fetal bovine serum.

Antidiabetic Activity:Leaf extracts of *T. stans* arewidely used as a traditional antidiabetic therapy in Mexico.Tecomine was shown to be one of the compounds responsible for the hypoglycemic action. Some investigatorsassessed in vivo and in vitro intestinal α-glycosidase inhibition as the potentialmethod of action of tecoma aqueous leaf extract on type 2 diabetes mellitus (DM2) animal models. The intravenous administration of itsinfusion in normal dogs has shown an early hyperglycemic response and arterial hypotension followed by a slow decline of the glucose blood values with a concomitant hypertriglyceridemia, but no important changes in immunoreactivity insulin have been detected. Heart frequency gradually increased after the first 60 min of drug administration and persisted for several hours. The effects observed on blood parameters seem to be related to hepatic glycogen metabolism, involving an activation of glycogenolysis. The late hypoglycemic effect of its infusion could be considered secondary to the observed hepatic glucose output.

Antimicrobial Activity: The methanol extracts of the leaves and stem bark of *T. stans*have been investigated for their antimicrobial activity using a wide range of gram-positive and gram-negative bacteria and fungi. Methanol extracts of leaves have been found to be effective against only *Candida albicans*. The extract of stem bark has generally shown better antimicrobial activity than leaves and some organisms were selectively more sensitive to the extracts than others.

Antispasmodic Activity: Naseri etal. (2007) haveexamined the effect of*T. stans* leaf extracts on rat ileum contractility and involved mechanism. Thehydro alcoholic leaf extract (TLE) has been prepared by maceration method using 70% alcohol. Distal segment of ileum (2 cm) from male Wistar rat have been mounted in an organ bath Containing Tyrode solution (10 ml, pH 7, 37 °C) and pre-contracted by carbachol (CCh, 10 μM) or by KCl (60 mm). The antispasmodic effects of TLE (0.125–2 mg/ml) have been studied prior and after 20-30 min incubation of ileum with propranolol (1μM), naloxone (1μM), LNAME(100μM), or 5 min incubation with glibenclamide (10 μM) and tetraethyl ammonium (TEA, 1mm). The effect of TLE on CaCl2-induced contraction in Ca2+- free with high K+ Tyrode solution has also been studied.The CChand KCl-induced ileal contractions have got reduced by TLE ($P<0.0001$). This effect was not attenuated by propranolol, naloxone, LNAME, glibenclamide and TEA. In Ca2+- free tyrode solution with high K+, cumulative concentrations of $CaCl_2$induced contractions which were inhibited by TLE dose dependently. Theleaf extracts of this plant induce antispasmodic effects without involvement of β-adrenoceptors, opioid receptors, potassium channels and NO production. It seems that, the calcium channels are involved in this spasmolytic effect.

Wound healing activity:Das et al. (2010) have studied the methanolic bark extract of *T. stan*for wound healing activity in albino rats. Wound healing practices are well controlledbiochemical and cellular events leading to the growth and regeneration of wound tissue in a special manner.Healing of wounds involves the activity of an intricate network of blood cells, cytokines, and growth factors which ultimately leads to the restoration to normal condition of the injured skin or tissue.Wound healing activity results of this plant suggest that local application and systemic administration of methanol extract of the bark has more significant wound healing activity in excision and incision wound models and support the popular use of plant for wounds in folk medicine. The presence of phytoconstituents like phytosterol, triterpene, glycosides, phenols, flavonoids, saponins, and tannins either individually or combined together may exhibit the synergistic effect towards healing of wounds.

Anti-Proliferative:Cancersicknesshasmore than 100 different types, categorized by uneven proliferation of cells which require multidimensional approach for treatment, control, and prevention. Breast cancer is one of the long-lasting ailments in females (32.1%). It effectsthe women all through their lifetime (Indra et.al ?????). The invitroantiproliferative activity of the various parts of the *T. stans*has been studied in the Breast cancer-MCF-7cell linesby MTT assay. The stem,root, bark and flower extracts have shown significant anti-proliferative action on the cell lines (MCF-7) but extreme action was found to be in extractstem bark.

Risk Factors of *T.stans*

The plant isinvasive in Mexico but hasproved invasive outside its native range as well. It is highly adaptable to different environments, tolerates or benefits from cultivation, browsing pressure, mutilation, fire etc,shows high reproductive potential, and propagules remain viable for more than 12 months. It damagesthe ecosystem services, changes the ecosystem, alters the habitat, negatively impacts agriculture, indirectly tourism, reduces amenity values as well as native biodiversity. This is achieved by competition and monopolizing of resources, competitionsmothering, pest and diseasetransmission.Easily transported internationally sometimes deliberately and is very difficult as well as costly to control.

Prevention and Control

Integrating various control methods is the most effective approach and includes the prevention of new introductions, dispersal and sales by the nursery trade as well as mechanical and chemical control.Maintaining a vigorous ground cover, preventing overgrazing and rehabilitation of disturbed areas remains one of the best methods to prevent establishment and invasion of the weedy intruder *T. stans*. Frequent inspections of pastures and forest margins are necessary to locate seedlings that can be hand-pulled. Larger plants can be uprooted by using a tractor, but resprouting from cut roots can cause rapid reinfestation unless the remaining roots are burnt after drying. Rehabilitation of such disturbed areas after uprooting and burning is essential. Follow-up control to remove the regrowth is necessary for at least a year after initial control (Kranz and Passini 1996, 1997).Conventional chemical control methods of shrubs and small trees as practised by manycounties are not effective against *T. stans.* Only repeated applications of foliar-applied herbicides are effective, but this method is usually not economic. More effective are cut-stump application methods using oil-based or oil/water emulsions of 2,4-D and picloram mixtures. These are generously applied to the freshly cut stumps by spraying or painting. Soil applied tebuthiuron also gives excellent control in 270 days after treatment (Kranz and Passini, 1997). Host specificity tests on two rust fungus species, namely, the microcyclic*Prospodiumtransformans* and the macrocyclic *P. appendiculatum*from Mexico are in progress in South Africa. *P. appendiculatum*is already present in Brazil and Argentina but is not contributing much to the suppression of populations. Further surveys for additional host-specific natural enemies are planned. A raceme-feeding membracid and the pyralid pod-feeding moth Clydenopteron sp. are to be introduced into quarantine in South Africa for possible biological control.

CONCLUSIONS

T. stans is rich in allelochemicals but is widely used as a traditionalmedicine as antidiabetic remedy in Mexico. It shows a wide spectrum ofpharmacological activitiesbut isalso allelopathic in nature. This planthas many active phyto constituents which leads to its great medicinal value. Various parts of the plantshow various pharmacological actions like anti-inflammatory, analgesic,anticancer cardio-protective, genotoxic, cytotoxicity, wound healing, anti-hyperglycemic, protection against CNS, gastric ulcer healing, antiproliferative, antioxidant, anti-microbial, hemolytic activity, anti-lipoxygenaseand acetyl-cholinesterase inhibitory activities. However, moreinvestigations are needed for the isolation ofconstituents and screening models for further confirmation in the case of woundhealing potential as well as the extraction of exact bioactive compounds present in this plant,which could be potentially used in weed management as well.

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