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Antimicrobial efficacy of *Tecoma stans* (L.) Juss ex Kunth: A review

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Abstract
Medicinal plants represent a rich source of antimicrobial agents. In recent years, in order to discover novel antioxidant and antimicrobial drugs, screening of medicinal plants has been accelerated**.** *Tecoma stans* of the Bignoniaceae family, is a potent medicinal plant with spectrum of therapeutic potential. *Tecoma stans* has been used for variety of purposes in herbal medicine for treating diabetes and gastro-intestinal disorders and various other non-communicable diseases**.** The increase in incidence of communicable diseases and emergence of multidrug resistant pathogens paved the way in search of new drugs for the treatment of various ailments. Traditionally plants have been used as curative agents for the treatment of numerous diseases. The main aim of this review was to collate the research work undertaken by various scientists regarding antimicrobial potential of *Tecoma stans* in order to provide a baseline for future works.

Keywords: *Tecoma stans*, medicinal plants, antimicrobial potential and diseases

1. Introduction
In recent years, in order to discover novel antioxidant and antimicrobial drugs, screening of medicinal plants has been accelerated**.** The rapid emergence of multiple drug resistance strains of pathogens to current antimicrobial agents has generated an urgent intensive for new antibiotics from medicinal plants. Various medicinal plants have been screened extensively for their antimicrobial potential worldwide, for the treatment of infectious diseases.
Tecoma stans (L.) Kunth belonging to the family Bignoniaceae, is an erect shrub commonly found in India. The shrub has some common names in different native Indian languages. *Tecoma stans* Linn is also known as yellow bells, yellow elder, trumpet flower in English and Piliya in hindi. *Tecoma stans* is an important medicinal plant. This plants' leaves, bark, flowers and roots contains biologically active components, and extracts from these tissues are being used as traditional folk medicines. Figure 1 depicts flower and leaves of *Tecoma stans* (L.) Kunth.
Various studies exhibited antidiabetic, antioxidant, hypoglycemic, antitumor, anti-inflammatory properties of *Tecoma stans* (Pulipati and Babu, 2017; Verma *et al.*, 2016 and Salem *et al.*, 2013) [21, 7, 20]. This review aims at describing the bioactive components and antimicrobial potential of *Tecoma stans*.

Fig 1: Flower (a) and Leaves (b) of *Tecoma stans* (L.) Juss ex Kunth

2. Bioactive Compounds
Various studies have revealed that leaves, flowers. roots and bark of *Tecoma stans* (L.) Juss ex Kunth contains spectrum of phytochemicals such as alkaloids (Tecomine, Tecostamine, γ- skythanthine, boshniakine, 5- dehydro-skythanthine, 4-noractenidine, N-normethyl-skythanthine), polyphenols, phenolic acids (Chlorogenic acid, caffeic acid, rutin, vanillic acid, o-couumaric acid, spinapcin acid), β-carotene, ascorbic acid 0-sitosterol, anthranilic acid, lutein, flavonoids, anthraquinones, tannins, sterols, terpenes, saponins, zeathanthine etc. (Khan *et al.*, 2018; Anand and Basavaraju, 2016; Dash *et al.*, 2011; Govindappa *et al.*, 2011) [5, 4, 1] and Singh *et al.*, (2011).
Chemical constituents of this botanical species are well known; numerous monoterpenic alkaloids have been identified and among them, tecomanine and tecostanine

possess hypoglycemic effects according to observations performed in animals. The biosynthesis of these monoterpene alkaloids in callus tissues of *Tecoma stans* has been studied, together with the identification of the presence of lapachol and other primary and secondary plant metabolites such as: sugars (glucose, fructose, sucrose and xylose), triterpenoids (ursolic and oleanolic acids and α-amyrine), p-sitosterol and phenolics (chlorogenic, caffeic, vanillic, o-cumaric and sinapicnacids). All of these compounds have already been identified in the whole plant at different concentrations (Anburaj *et al.*, 2016) [3].

Phytochemical bioactive compounds from a medicinal plants have shown many pharmacological activities.

Table 1: Phytochemical constituents reported in different parts of plant *Tecoma stans* by various authors.

S. No.	Plant Part	Chemical Constituents	References
1.	Crude Extracts of whole plant	Chrysoeriol, Apigenin and other polyphenols	Ramirez G. *et al*., 2016
2.	Fruits and Flowers	5-hydroxy skythanthine hydrochloride.	Verma S., 2016
3.	Leaves	Alkaloids	Analia *et al.*, 2015 [15]
4.	Crude Extracts of whole plant	Tecomine	Costantino L. *et al.*, 2003
5.	Fruits	Monoterpenic alkaloids	Lins A.P. and Joana D.A., 1993
6.	Leaves	Indolic compounds	Kunapuli S.P. and Vaidyanathan C.S.,1984
7.	Crude Extracts of whole plant	5- Deoxy stansioside and iridoid glycoside	Bianco. A *et al*., 1981

3. Antimicrobial Potential

Dewangan *et al.,* (2017) [6] conducted a study that revealed antimicrobial activity of water, ethanol and chloroform extract of *T. stans* shows significant higher inhibitory activity for both bacteria and fungi. The zone of inhibition for both bacteria and fungi was observed maximum in ethanol extract and minimum in water extract. For *A. niger* the zone of inhibition of water extract was found to be 11mm when compared with that of ethanol and chloroform extract of *T. stans*, which were found to be 16mm and 14mm respectively. For *P. aeruginosa* the zone of inhibition of water, ethanol and chloroform extract of *Tecoma stans* were found to be 13mm, 18mm and 15mm respectively.

A study conducted by Bhoopathi *et al.,* (2017) revealed the antimicrobial activity of leaves of *Tecoma stans.* The result of this study showed that the ethanolic extract of *Tecoma stans* have varied antibacterial activities against the tested gram-positive and gram-negative organisms. The growth inhibition zone measured ranged from 10-21mm for the bacterial strains, and 15- 18mm for fungal strains.

Another study conducted by Subalakshmi and Mohan (2017) [19] showed that the ethanol extract of *Tecoma stans showed* antibacterial potential against *Streptococcus* sp. bacterial strain with zone of inhibition in 16mm. The significant zone of inhibition of *Pseudomonas aeruginosa* against ethanol extract of *Tecoma stans* leaf was found to be 5mm. Another study revealed antimicrobial activities of flower of *Tecoma stans* (L.) ethanolic extract (TSEE) against selective Gram positive, Gram negative bacteria in-vitro. The diameters of zone of inhibition range from 20.33 ± 0.57 to 09.33 ± 1.52 mm (Pulipati and Babu, 2017) [21].

Antimicrobial activity of *Tecoma stans* was assessed by the agar disc diffusion method (Analia *et al.,* (2015) [15]. This study revealed that extracts from *Tecoma stans* were able to inhibit bacterial growth. The tested extracts were more effective against Gram-positive microorganisms. The Minimal Concentration Inhibitory (MIC) and Minimal Bactericidal Concentration (MBC) observed were between 125-1000 µg GAE/ ml and 500-1000 µg GAE/ml, respectively. Ethanolic extracts of *Tecoma stans* inhibited the growth of *Proteus* and *Morganella morganii*. Only the combination of *Tecoma stans* extract and ampicillin had a synergistic effect for both clinical isolates of *E. cloacae*. Another study conducted by Salem *et al.,* (2015) [20] showed significant antibacterial effect of the methanol, EtOAc and CHCl3 extracts of *Tecoma stans* against the tested bacteria (*Bacillus subtilis, Micrococcus luteus, Sarcina lutea, Staphylococcus aureus, Escherichia coli, Serratia marcescens, Salmonella typhi, Proteus vulgaris* and *Pseudomonas aeruginosa*).

Govindappa *et al.,* (2011) [1] studied the effect of three different extracts ethanol, methanol and water of *Tecoma stans leaf* on bacteria *(Pseudomonas fluorescens, Clavibacter michiganensis* sub sp. *michiganensis, Xanthomonas axanopodis* pv. *malvacearum, Staphylococcus aureus, E. coli, Pseudomonas aeruginosa* and *Klebsiella pneumonia*) and was found to have antimicrobial potential. In this study, the phytochemical analysis revealed the presence of alkaloids, flavonoids, phenols, steroids, tannins and anthraquinones. The three extract fractions have showed highest total Phenolic content (177-216 mg gallic acid equivalent/g), which could be attributed to its antimicrobial activity.

Another study conducted by Marzouk *et al.,* (2006) [2] revealed that *Tecoma stans* was effective against Helicobacter pylori, where methanolic extracts of the plants was found to be effective. In-vitro anti-bacterial study conducted by Senthilkumar *et al.,* (2011) [14] where the crude leaf extracts of *Tecoma stans* were tested against various bacterial starins like *Staphylococcus aureus, Staphylococcus epidermidis, Salmonella typhi, Klebsiella pneumoniae* and *Vibrio parahemolyticus* which were procured by disc diffusion method. Table 1. shows antimicrobial activity of *Tecoma stans* on bacterial and fungal strains

Subcutaneous mycoses are chronic, localized infections of skin and subcutaneous tissues, which are caused by direct penetration of fungus into dermis and subcutaneous tissues. Govindappa *et al.,* (2011) [1] and Marzouk *et al.,* (2006) [2] conducted a study using agar dilution method at a concentration of 100 µ/mL and revealed that the organic extract of *Tecoma stans* was found to be effective against *Fonsecaea pedrosoi* at MIC 12.5 µg/mL.

Methanolic extract of roots of *Tecoma stans* was analyzed for antibacterial activity by Ramesh *et al.,* (2009) [17] against four clinical isolates. Psuedomonas aeruginosa, showed moderately higher zone of inhibition (23 mm) when compared with other microorganisms i.e., *Staphylococcus aureus, Staphylococcus epidermidis and Klebsilla pneumonia.* The minimum zone of inhibition (16 mm) was observed in 75 g/mL concentration against *Staphylococcus epidermidis.*

Table 1: Antimicrobial activity of *Tecoma stans* for different bacterial and fungal strains

S. No.	Solvent/Concentration Sample: LEAF	Organism	Zone of Inhibition (mm)/Results						Reference
1.	Ethanol Sample: solvent- 100 g: Not mentioned Extract concentration: 400 µg/ml Standards:10µg/disc	Bacterial Strains	62.5 (µg/ml)	125 (µg/ml)	250 (µg/ml)	500 (µg/ml)	1000 (µg/ml)	Oxytetracycline (Std. drug)	Boopathi *et al.*, 2017
		Escherichia coli	00	26	89	1310	1714	2015	
		Klebsiella pneumonia	0	3	4	8	16	18	
		Proteus mirabilis	2	7	9	10	12	13	
		Shigella flexneri	0	0	5	8	14	15	
		Staphylococcus aureus	0	3	6	8	15	16	
		Streptomyces fulvissimus							
		Bacillus subtilis	0	0	4	14	21	22	
		Pseudomonas Aeruginosa	0	0	0	4	10	11	
		Fungal strains							
		Candida albicans	0	5	7	8	15	17	
		Aspergillus niger	4	6	7	9	18	20	
2.	Sample: solvent- 1:10, Extract concentration: 400 µg/ml		Water	Ethanol	Chloroform	-	-	-	Dewangan *et al.*, 2017 [6]
		P. aeruginosa	13	18	15				
		A. niger	11	16	14				
3.	Sample: solvent- 25g: not mentioned Plant extract volume: 20 µl		Acetone	Ethanol	Diethyl ether	Ethyl acetate	Chloroform	-	Subalakshmi and Mohan 2017
		Pseudomonas aeruginosa	0	3	4	5	5		
		Streptococcus sp.	12	16	0	14	4		
4.	Sample: solvent- 1:10 Plant extract volume: 20 µl	*Bacterial pathogens*	n-hexane	Chloroform	Ethyl acetate	Butanol	Levofloxacin (Std. drug)	-	Javid *et al.*, 2015
		Escherichia coli	16	19.66	15	19	23		
		Pseudomonas aeruginosa	15	0	0	16.33	21		
		Salmonella typhi	15.66	13.66	11.66	18.33	21		
		Staphylococcus aureus	17.33	0	13	17.33	22		
		Fungal pathogens	n-hexane	Chlor-oform	Ethyl acetate	Butanol	Clotrimazole (Std. drug)		
		Aspergillus flavus	+	+	+	+	+		
		Aspergillus niger	+	+	-	+	+		
		Aspergillus fumigatus	+	-	-	-	+		
		Fusarium solani	-	+	-	+	+		
5.	Fractionated extraction using 120 g of dry leaf powder Sample concentration: 2000 µg/ml – used 20 µl as extract volume (i.e., 40 µg concentration of each extract)		80 % Methanol	Ethyl acetate	Chloroform	Butanol	Aqueous	Gentamicin (Std. drug)	Salem *et al.*, 2013
		B. subtilis	15.66	19	20.33	13.66	0	25	
		S. aureus	15.66	18	22.33	7.66	0	23	
		E. Coli	22	18	18.66	17.33	12	22	
		S. marcescens	14.66	11.33	11.33	0	0	24	
		P. aeruginosa	11.33	0	13	0	0	25	
		P. vulgaris	13	12	11.33	0	0	30	
		S. typhi	12.33	14.33	15	11	0	35	
		M. luteus	17.3	15.6	12.3	0	6.3	23	
		S. lutea	0	13	12.3	0	16.6	25	
6.	Ethanol Sample: solvent: 1:10 Sample concentration: 500 and 1000 µg/ml Standard drug: Tetracycline (TET) – 30 µg/ml		500 µg/ml	1000 µg/ml	Std. drug	-	-	-	Pulipati and Babu, 2017 [21]
		S. aureus	15.66	18.33	28.33				
		E. faecalis	13.33	15.66	20				
		S. mutans	11	14.33	25.33				
		B. subtilis	16.66	20.33	26.66				
		B. megaterium	13.33	16.66	21.33				
		E. coli	10	14.33	27.66				
		K. pneumoniae	13.66	17	25.66				
		P. aeruginosa	9	12.66	21.33				
		P. vulgaris	10	13.66	15				

4. Conclusion

The various phytochemical studies resulted in isolation of different potent bioactive compounds from *Tecoma stans*, which are basis for its specific pharmacological activities. As this plant is widely spread across tropical and sub-tropical regions like America, Mexico, West-Indies and India, more research work is still continued. The rapid emergence of multiple drug resistance strains of pathogens to current antimicrobial agents has generated an urgent intensive for new antibiotics from medicinal plants. Various researchers have revealed antimicrobial potential of *Tecoma stans* against bacterial and fungal strains.

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