Antioxidant and Antibacterial formulation of *Tecoma stans* plant

Abhilash Kutlehria*[1], Rittika Choudhary[1], Dr. Kapil Kumar Verma[2]

*[1]Associate Professor, Minerva College of Pharmacy, Indora, Himachal Pradesh, India

[1]B. Pharma Scholars, Minerva College of Pharmacy, Indora, Himachal Pradesh, India

ABSTRACT

This study explores the formulation and evaluation of antioxidant and antibacterial properties of the *Tecoma stans* plant, known for its traditional medicinal uses. Leaf and flower extracts were prepared using methanol and water as solvents. Antioxidant activity was assessed using the DPPH radical scavenging method, while antibacterial efficacy was evaluated against selected bacterial strains including *Escherichia coli* and *Staphylococcus aureus* using the agar well diffusion technique. The extracts demonstrated significant antioxidant activity, with methanolic extracts showing higher free radical inhibition. Additionally, notable antibacterial activity was observed, particularly in methanolic leaf extracts, suggesting the presence of potent phytochemicals. These findings support the potential application of *Tecoma stans* in developing natural antioxidant and antimicrobial formulations for pharmaceutical or cosmetic use.

Keywords: Tecoma stans, Antioxidant activity, Polyphenols, Flavonoids, Free radical scavenging, Phenolic compounds.

INTRODUCTION

Tecoma stans, also referred to as yellow bell or yellow trumpet bush, is a member of the Bignoniaceae family. It's a decorative plant. It is an upright, branching shrub that ranges in height from two to four meters and is either sparsely hairy or almost smooth [1]. Medicinal plants generate a wide range of bioactive compounds and are a rich source of numerous medications. Herbal plant extracts are highly beneficial and one of the main sources of medication. They are essential for promoting growth and managing a variety of infections. There are fourteen species of tiny trees or shrubs in the genus *Tecoma* [2]. Twelve of the fourteen

species are native to America, while two are native to Africa. Trumpet bush is a common name for all plants in this genus. It is distinguished by its trumpet-shaped[3].

The plant is found in tropical and subtropical areas of Africa, Asia, Australia, Florida, the Bahamas, Trinidad, South America, and India. The roots of the plant are used as a tonic and diuretic, and the entire plant has therapeutic significance. Bark and flower decoctions are used to treat stomachaches. In addition to treating diabetes, the plant is utilized to treat a number of malignancies [4]. The bark exhibits modest cardiotonic and smooth muscle relaxant properties. The plant's root is said to have strong diuretic, vermifuge, and tonic properties. Promising properties of the entire plant include its potential to heal wounds and its antispasmodic effect [5].

In herbal medicine, *Tecoma stans* leaves, bark, and roots have been utilized for a variety of therapeutic applications. In Mexico, the most frequently cited traditional usage of the plant is for the treatment of diabetes. Hammouda, Rashid, and Amer (1964) found that the plant leaf extract lowers the blood sugar levels of rabbits that are fasting. Tecomine and Tecostanine, two of the monoterpene alkaloids found in the plant, are what give it its hypoglycemic properties (Hammouda & Amer 1966)[6].

In the alcoholic extract of pods and flowers, *Tecoma stans* were shown to have anti-inflammatory properties, whereas other species of *Tecoma sambucifolia* were found to have anti-nociceptive properties. According to reports, plant extract decreased the rabbit's area under the glucose tolerance curve. The leaves, bark, pods, and flowers of Ginger Thomas contain a variety of active constituents, including Tecostanine and Tecomine [7].

HISTORICAL REVIEW OF *TECOMA STANS* PLANT

Native to the high altitude regions of South America and the drier habitats of North America, *Tecoma stans* (L.) Juss. ex Kunth (Bignoniaceae) is also known as kusi urakame, koyawari, Palo Amarillo, Tronadora (Irigoten-Rascon and Paredes, 2015), yellow-elder, yellow trumpet bush, trumpet-flower, yellow-bells, trumpet bush, ginger-thomas, esperanza, and timboco [8]. Tropical and subtropical regions of Africa, Asia, and Oceania have seen its naturalization. It is cultivated as an ornamental plant with eye-catching clusters of bright yellow, cup-shaped blooms that have a subtle perfume, evergreen foliage, and a profusion of fruits and seeds (White, 2003)[9].

Fig.1 ***Tecoma stans*** **(flowers and leaves)**

- **The Native Range and Origins**

  Tecoma stans is a blooming plant that is indigenous to the tropical and subtropical parts of the Americas. It is sometimes referred to as Yellow Trumpetbush, Yellow Elder, or Esperanza. It is a member of the Bignoniaceae family and is renowned for its drought resilience and vivid yellow blooms. The plant thrives in arid, rocky, and disturbed environments and is native to the southern United States, Mexico, the Caribbean, and Central and South America [10].

- **Historical Uses and Spread**

  Tecoma stans have long been used medicinally by indigenous peoples in the Americas, especially to cure fevers, diabetes, and digestive disorders. Additionally, the plant was utilized to cure snake bites and as a diuretic [11]. Its introduction to parts of Africa and Asia during colonial periods, where it became naturalized, was probably facilitated by the Spanish and Portuguese [12].

  Tecoma stans gained popularity as an attractive plant because of its capacity to thrive in arid and disturbed conditions. It was commonly grown in parks, gardens, and roadside settings across the world in warm regions by the 19th and 20th centuries [13].

Scientific Classification of Tecoma stans Plant

Botanical Name	*Tecoma stans*
Family	Bignoniaceae
Sub Family	Asteriidae

Table. 1

Taxonomical Classification of Tecoma stans Plant

Kingdom	Plantae
Division	Tracheophyta
Subdivision	Spermatophytina
Class	Mangnoliopsida
Order	Lamiales
Family	Bignoniaceae
Genus	Tecoma
Species	Stans

Table. 2

Vernacular Names: The plant is known by different names in different areas by people. It is commonly called as Yellow bells because of the appearance of flower in bright yellow bell shaped[14].

Synonyms: Ginger-Thomas, Yellow Trumpet, Yellow-Elder.

Biological name*:* *Tecoma stans* (L.) Juss. Ex Kunth.

***Tecoma stans* Leaves**

- The simple leaves of Tecoma stans are arranged in an opposite pattern on the stem and are not divided into leaflets.
- The leaves typically have a pointed tip and are either ovate (egg-shaped) or lance-shaped (narrow and pointed)[15].

- There are no toothed or lobed leaf margins because the leaves have entire margins.
- The leaves are a bright green color on the upper surface and lighter green on the lower surface.

Materials and Methods

Materials

Tecoma stans flowers and leaves, n-hexane (for the extraction process), methyl paraben, cetyl alcohol, and stearic acid are the materials used[16].

Collection of plant material:

The plant leaves collected from our campus Minerva college of Pharmacy Indora, HP and wash it properly. Then dried it in the presence of sunlight for 5 to 6 days[17].

Extract Preparation:

The dried leaves and flowers of the plant *Tecoma stans* were crushed into powder with the help of mortar and pestle. The next stage was the extraction of the chemical constituents using the Soxhlet apparatus. 100 gm of powdered extract was assimilated with 350ml of n-hexane and extraction process were takes place. The extraction process of the plant was performed for about 5 to 6 hours by using the solvent of n-hexane[18].

Fig.2 Soxhlet apparatus

Fig.3 Dried powder of yellow elder leaves

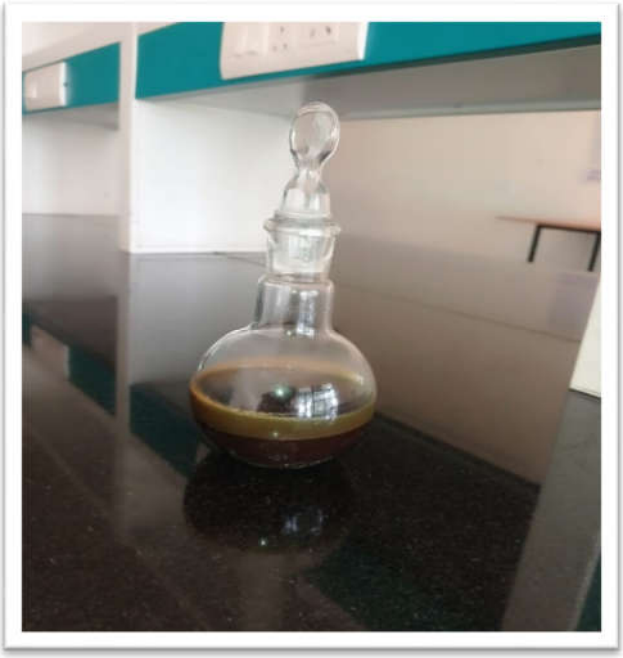

Fig.4 Extract of Yellow elder leaves

Formulation of the ointment:

Ointment base formulation.

Sr. no.	Name of the ingredient	Quantity taken
1.	Paraffin wax	20gm
2.	Cetyl alcohol	5gm
3.	Methyl paraben	0.2gm
4.	Stearic acid	10gm
5.	Petroleum jelly	60gm
6.	Propylene glycol	4.8gm

Table. 3

Fig.5 Herbal Ointment

Herbal ointment formulation.

Sr. no.	Name of the ingredient	Quantity taken
1.	**Prepared plant extract**	**5gm**
2.	**Ointment base**	**95gm**

Procedure for making the ointment:

Hard paraffin is weighed accurately to prepare ointment base which is placed in evaporating dish water bath. After the melting of hard paraffin remaining ingredients were added and stirred gently. Stirr the mixture homogeneously to mix and then cool the ointment base[19].

The *Tecoma stans* extract which is accurately weighed is added to the ointment base by levigation method for the preparation of smooth paste. This paste must be 2 to 3 times of its weight of base. Gradually added more base until to form homogenous ointment. Finally it is transferred in suitable container[20].

ROLE OF INGREDIENTS IN THE FORMULATION

Sr. No.	Name of the ingredient	Role of ingredient
1.	Herbal extract	Antioxidant, Antibacterial
2.	Methyl paraben	Preservatives
3.	Cetyl alcohol	Surfactant
4.	Stearic acid/Paraffin wax	Thickening agent
5.	Stearic acid	Emulsifier

Antibacterial Activity Determination:

Anti-microbial activity is a process of killing or inhibiting the growth of microbes. The microbes are either killed (bactericidal) or inhibited (bacteriostatic) by an antimicrobial agent. The standard bacterial test organisms were sub cultured on freshly prepared nutrient agar and the

extracted samples were inoculated into the culture using paper disc diffusion method[21].

PREPARATION OF NUTRIENT AGAR MEDIUM:

Nutrient agar was prepared by dissolving it in required quantity of distilled water by heating it on hot plate. Then the agar medium was sterilized in an autoclave at 121°c for 15min at 15lb pressure.

PAPER DISC DIFFUSION METHOD:

Two different leaf and flower extracts of Tecoma stans were tested for anti-microbial activity using PAPER DISC DIFFUSION METHOD. 15 milliliters of sterilized nutrient agar medium were poured into each petri plate, partially covered, and allowed to solidify before being used as bacterial culture growth medium[22]. Then the test microorganisms like Escherichia coli, Bacillus subtilis, and Staphylococcus aureus were inoculated into the petri plates using sterile cotton swabs. The sterilized paper discs were soaked in different solvent extracts like METHANOLIC LEAF, METHANOLIC FLOWER, AQUEOUS LEAF and AQUEOUS FLOWER (1µg/ml) and were dried at 50°c. Then the dried discs were placed on medium plated seeded with microorganisms & also prepared control and standard(Amoxicillin 1ug/ml). Then plates were incubated at 37°c. Then the zone of inhibition was measured after 24hrs. Three Petri plates with controlled and standard samples (1µg/ml) were taken and then discs were placed into the medium plates and incubated at 37°c. Then zone of inhibition was measured after 24hrs[23].

Antioxidant activity Determination:

In order to investigate the antioxidant properties of the examined extracts, ferric ion reducing antioxidant power (FRAP) and 2, 2- diphenyl-1-picrylhydrazyl (DPPH) assay.

DPPH (2, 2- diphenyl-1-picrylhydrazyl): The percentage of antioxidant assay was determined using the free radical scavenging activity (2, 2-diphenyl-1-picryl-hydrazyl-hydrate). About 1 mg of fresh and the dried plant extracts was dissolved in 1ml of methanol. About 10 mL of 0.1 mM of DPPH was prepared in methanol and stored in cool dark condition until use. Accurately, 1 mL of DPPH was added to different concentration (20, 40, 60, 80, 100 µg/mL) of T.stans extract[24]. The mixture of DPPH and extract was shaken and incubated at room temperature in

the dark for 30 minutes, then the absorbance was measured at 517 nm in the UV spectrophotometer. Ascorbic acid was used as a reference and DPPH without the extract served as negative control[25]. The IC50 value of the sample was calculated based on the absorbance. The percentage of inhibition was calculated using the formula:

Scavenging Activity = [(Abs control – Abs sample) / Abs control] x 100 [26]

Where:

Abs control = Absorbance of the negative control (DPPH + solvent)

Abs sample = Absorbance of the sample reaction mixture

EVALUATION PARAMETERS

1. **Color and odour:** Visual inspection was used to examine physical parameters like color and odor. examination.
2. **Consistency:** Formulation was smooth and greediness is observed.
3. **pH:** The digital pH meter is used to measure the pH of herbal preparation. Ointment solution was prepared by using 100ml of distilled water and set aside for 2 hrs. pH was determined three times for the solution and average value was determined[27].
4. **Spreadability:** For the determination of spreadability the amount of sample is placed in between two slides and which compressed to uniform thickness by placing definite weight for definite time. Time required for the separation of two slides was known as spreadability. Spreadability is better when time taken for the separation of two slides is less[28].

   Spreadability was calculated by the formula:

   S=MxL/T

   Where,

   S = Spreadability

   M = Tide weight on upper slide

   L = Length of glass slide

   T = Time taken for the separation of slides
5. **Extrudability:** Collapsible tube was used to fill the formulation. Extrudability was determined as weight of ointment required to extrude 0.5cm ribbon in 10 seconds.
6. **Diffusion Study:** Diffusion study agar nutrient medium was made. A whole board was placed in

the center of and ointment. After 60 minutes, it was noted how long the ointment took to diffuse.

7. **Loss on Drying:** For the determination of loss on drying the formulation was placed in petri-dish on water bath and dried at the temperature of 105*C.
8. **Solubility:** Miscible with chloroform and soluble in boiling water[29].
9. **Washability:** After the formulation was applied to the skin, its ease of washing with water was evaluated.
10. **Non irritancy:** testing Herbal ointment preparation was applied on human skin and the effect was observed.
11. **Stability Study:** Testing of physical stability of herbal ointment was carried out for four weeks at various temperature conditions like 2*C, 25*C, and 37*C. Herbal ointment was found to be physically stable at various temperatures 2*C, 25*C and 37*C within four weeks[30].

RESULT AND DISCUSSION

Results:

Antioxidant Activity: Antioxidant potential of *Tecoma stans* was analyzed using different assay and the findings proved a significant presence of antioxidant activity in the plant extracts. The following procedures were adopted:

DPPH Radical Scavenging Assay: Tecoma stans' ethanol and methanol extracts showed conside rable scavenging activity on DPPH radicals. Both extracts had their IC50 values calculated, with the methanol extract having a lower IC50, which means greater antioxidant activity compared to the ethanol extract.

Antibacterial Activity: The Antibacterial activity of Tecoma stans was evaluated by the disc diffusion method against different bacterial strains such as Escherichia coli, Staphylococcus aureus, and Pseudomonas aeruginosa. The findings were as follows:

Disc Diffusion Method: Both methanol and ethanol extracts of *Tecoma stans* indicated strong zo nes of inhibition towards the tested bacterial strains, reflecting extensive antibacterial activity. The inhibitory effect was more extensive and strong in the methanol extract compared to the ethanol extract, particularly in the case of S. aureus and E. coli.

Discussion:

Antioxidant Activity: The findings of the antioxidant assays (DPPH, and flavonoid content) sho w that *Tecoma stans* has high amounts of bioactive compounds capable of scavenging free radica ls and mitigating oxidative stress. These results correlate with established activities of flavonoid

compounds as strong antioxidants. The lower IC50 value of the methanol extract implies that it is more efficient in scavenging free radicals than the ethanol extract. This reinforces the potential of Tecoma stans as a natural antioxidant source, which can be utilized inpharmaceutical, and food preservation industries.

Antibacterial Activity: The broad-spectrum antibacterial property of Tecoma stans suggests that the plant could be a useful natural drug against a variety of bacterial pathogens. The methanol extract had better antibacterial activity, which can be related to the enhanced solubility of bioacti ve molecules in methanol over ethanol, facilitating better extraction of antimicrobial agents.

The notable inhibitory effect on Escherichia coli indicates that *Tecomastans* may be transformed into an antimicrobial formula for treating skin infections, gastrointestinal infections, or other bacterial illnesses.

CONCLUSION

The findings from this research illustrate that Tecoma stans has very high antioxidant and antibacterial activities, motivated by its very high content of phenolic and flavonoid compounds. The methanol extraction showed greater activity than the ethanol extraction, and thus is a candid ate for future development into natural health products.

The antioxidant activity combined with antibacterial action implies potential uses an antimicrobial agent in the treatment of infection and in maintaining overall health. Yet, more stu dies have to be conducted to identify the active constituents and assess their medicinal value in th e clinical environment.

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