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Review Article

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TO STUDY PHARMACOLOGICAL ACTIVITIES OF *LANTANA MONTEVIDENSIS*

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ABSTRACT

The pharmacological actions of Lantana montevidensis extracts were investigated across various domains, revealing promising therapeutic potential. Antifungal activity was observed in the essential oil extracted from L. montevidensis leaves, particularly when combined with fluconazole, enhancing its efficacy against Candida strains. Modulatory effects were demonstrated through the reduction of minimum inhibitory concentrations (MICs) of aminoglycoside antibiotics, suggesting a role in combating antibiotic resistance. Significant antioxidant activity was observed in both aqueous and ethanolic extracts, with the aqueous extract exhibiting stronger potency than ethanolic extract and ascorbic acid in scavenging DPPH free radicals. Cytotoxic effects on human leukocytes and erythrocyte membranes were noted, attributed to various compounds including gallic acid, catechin, chlorogenic acid, and quercetin. Furthermore, ethanolic extracts from L. montevidensis leaves and roots displayed notable antibacterial activity against multi-resistant bacterial strains, indicating potential therapeutic applications. Evaluation against L. donovani parasites and T. brucei brucei trypomastigote forms revealed promising antiproliferative activity, suggesting a role in combating parasitic infections. Overall, the findings highlight the diverse pharmacological potential of L. montevidensis extracts, warranting further investigation for therapeutic development.

KEYWORDS: Antifungal activity, Antibacterial, Antioxidant, Antiprotozoal, Modulatory, Cytotoxic

INTRODUCTION

Lantana montevidensis is a small strongly scented flowering shrub with oval-shaped green leaves. With support it has a climbing 'vine' form, when on edge a trailing form, and on the flat a groundcover form.

The inflorescence is a circular head of several purple to lavender to white funnel-shaped flowers with lobed corollas each nearly a centimeter wide. Yellow-flowered montevidensis are a case of misidentification and most often relate to the "New Gold" lantana Lantana × hybrida, a hybrid between camara and montevidensis. Occasionally these yellow-flowered plants are misidentified ***Lantana depressa var. depressa***, a Florida endemic taxon more closely related to ***Lantana camara*** with smaller, less robust flowers.

The fruit consists of a pair of nutlets surrounded by flesh somewhat like a berry.

Lantana camara and Lantana montevidensis, known as "camara" or "chumbinho," are commonly used in traditional medicine for reducing fever, aiding digestion, and treating respiratory infections. They're found in tropical areas worldwide.

Lantana is a genus of around 150 species of perennial flowering plants. They're not just pretty, but also have various uses like being antirheumatics, stimulants, antibacterials, and more. The phytochemical studies of Lantana have even led to the discovery of triterpenes, steroids, and flavonoids. The leaf extracts of Lantana have shown various biological activities**.**

Lantana montevidensis, also known as "chumbinho," is a shrub native to Brazil and Uruguay. It's interesting to know that it was introduced as an ornamental plant in many countries, but unfortunately, it's considered an invasive species in many parts of the world. People in folk medicine actually use leaf infusions of Lantana to treat various illnesses like fever, influenza, asthma, bronchitis, and many other diseases. It's fascinating how traditional remedies can have such a wide range of uses.

Distinguishing Features

- a low-growing, long-lived, shrubby plant forming dense mats of vegetation over the ground.
- its leaves are borne in pairs along the slender, unarmed, creeping stems.

- The flowers of Lantana camara and Lantana montevidensis are pretty small and grow in tight clusters, measuring around 1-4 cm across.
- these flowers (8-12 mm long and 4-8 mm across) are usually pink, mauve or purple with a white or yellowish coloured throat.

Scientific classification	
Kingdom:	Plantae
Clade:	Tracheophytes
Clade:	Angiosperms
Clade:	Eudicots
Clade:	Asterids
Order:	Lamiales
Family:	Verbenaceae
Genus:	*Lantana*
Species:	***L. montevidensis***
Binomial name	
Lantana montevidensis (Spreng.) Briq.	
Synonyms	
Lantana sellowiana *Lippia montevidensis* *Tantani*	

DESCRIPTION

PLANT

Lantana montevidensis is a small strongly scented flowering low shrub.It has oval-shaped green leaves. It is a climbing 'vine'. when on edge it forms a tail like structure, and on the flat surface it forms a ground cover.

Flowers and Fruit

The small tubular flowers (8-12 mm long and 4-8 mm across) are borne in dense clusters (1-4 cm across). The flowers on the outer edges of these clusters open first, with the others opening successively inwards. Individual flowers are borne on short stalks (i.e. pedicels) all originating from the same point at the top of a longer flowering stem (i.e. peduncle) 2-8 cm long. The flowers are initially pink, mauve or pale purple with a white or yellowish coloured throat. As they age they change colour slightly, generally become entirely purple. Flowering occurs throughout most of the year.

The fruit is a single-seeded fleshy 'berry' (i.e. drupe). These fruit (6-8 mm across) are green at first and turn pinkish, reddish-purple or purplish in colour as they mature.

CULTIVATION

Lantana montevidensis is also cultivated as an ornamental plant for its abundant colorful lavender to purple flowers and as a drought tolerant groundcover, woody vine, and trailing plant for containers and in the ground. In temperate climates there are flowers most of the year, with yellow blooming and variegated leaved cultivars also available.

INVASIVE SPECIES

The plant is present worldwide. It is introduced as a species of garden and landscape plant. In some areas, such as parts of Australia and Hawaii it is considered a noxious weed and invasive species. This plant is toxic to livestock.

Stems and Leaves

The slender stems (1-2 mm thick) are four-angled (i.e. quadrangular) at first, but become woody (about 5 mm thick) and more or less cylindrical as they mature. These stems grow to about 1 m long and form dense mats over the ground surface. They sometimes also produce roots at their joints (i.e. nodes) where they come into contact with the soil.

The leaves are oppositely arranged and are borne on short stalks (i.e. petioles) 2-4 mm long. These leaves (8-40 mm long and 5-25 mm wide) are egg-shaped in outline (i.e. ovate) with finely toothed (i.e. crenate or serrate) margins. Their upper surfaces are rough to the touch (i.e. scabrous), while their undersides are softly hairy (i.e. pubescent).

ETYMOLOGY

The name *Lantana* is derived from the Latin name of the shrub *Viburnum lantana*, the flowers of this plant closely resembles lantana.

Chemical constituents

Based on the analysis of their chemical and spectral properties (like UV, IR, EI-MS, 1H NMR, and 13C NMR), the compounds found in Lantana camara and Lantana montevidensis were identified as oleanonic acid, lantadene A, lantadene B, lantanilic acid, icterogenin, and 4', 5-dihydroxy-3,7-dimethoxyflavone-4'-O-beta-D-glucopyranoside.

Medicinal and Traditional Uses

Lantana montevidensis Briq. is shrub native to Brazil and Uruguay, and the infusion of the dried leaves have been used in folk medicine for the same purposes as ***L. camara***. Ethanolic extract and essential oil of leaves has antibacterial and modulation of antibiotic activity (Sousa et al., 2010a). The methanolic extract of leaf also has shown antiproliferative activity against tumor cells and the flavonoid-rich fraction was effective against human gastric adenocarcinoma, human uterine carcinoma and melanoma cell lines (Nagão et al., 2001). However, the antioxidant activity of ***L. montevidensis*** extracts and essential oil was not previously demonstrated.

Considering the importance of the oxidative stress in the pathogenesis of various diseases and importance of antioxidant properties in the plant, the aim of the present study was the phytochemical characterization and investigate the antioxidant capacity of ethanolic extracts and essential oils of ***L. camara*** and ***L. montevidensis***, in continuation of our earlier studies on biological properties of Cariri Cearense, Northeast Brazil Cariri species.

The essential oil (EO) of ***Lantana montevidensis*** (Spreng.) Briq. (***L. sellowiana*** Link & Otto) was investigated for its chemical composition and mosquito repellent activity.Lantana Oil treats skin itches, antiseptic for wounds, leprosy, and scabies. Lantana Repels Other Plants and Other Groups of Organisms Such As Insects. Lantana oil is a multipurpose oil. It can be used for skin problems treatment as well as for insect repellent, especially mosquito.

Studies conducted in India have found that Lantana leaves can display antimicrobial, fungicidal and insecticidal properties. ***L. camara*** has also been used in traditional herbal medicines for treating a variety of ailments, including cancer, skin itches, leprosy, chicken pox, measles, asthma and ulcers.

Many plant species are known for their antimicrobial properties and their wide use in traditional medicine, making them interesting for the development of alternative therapies with antifungal effect. Among these species are ***Lantana camara Linn***. as well as ***L. montevidensis*** (Spreng.) Briq., popularly known as “camara”, “cambara” or “chumbinho”, widely distributed in temperate, tropical and subtropical regions around the world. Substantial evidence from the literature indicate that ***L. montevidensis*** leaf essential oil exhibits a variety of pharmacological activities including antibacterial activity with the potential to modulate antibiotics drugs used in clinical infections.

Toxic and harmful effects

Species affected by lantana poisoning include cattle, sheep, goats, guinea pigs and rabbits. Further research is needed to determine the long term effects of lantana on goats and camels. Children can also be poisoned by eating berries, but symptoms differ to those of livestock.

The major clinical effect of acute Lantana camara is photosensitization, the onset of which often takes place 1–2 days after consumption of a toxic dose. Subacute poisoning is more common. In severely affected cattle, lesions may appear at the muzzle, mouth and nostrils.

Distribution

This plant has naturalized in eastern Australia, New Zealand, Hawaii, New Caledonia and southern USA (i.e. California, Texas, Louisiana, Alabama, Georgia, and Florida). Where naturalized, it is primarily a weed of pastures, open woodlands, hillsides, railways, roadsides, embankments, disturbed sites and waste areas.

Dimensions

Height: 1 ft. 0 in. - 1 ft. 6 in.
Width: 3 ft. 0 in. - 5 ft. 0 in.

Wildlife Value

Favorite among butterflies and other pollinators and a food source for birds.

Literature review

Lantana montevidensis, commonly known as trailing lantana, is a plant species of significant ecological and horticultural importance. This review paper provides a comprehensive analysis of the botanical, ecological, and horticultural aspects of *Lantana montevidensis*. With a global distribution, this species has attracted attention due to its versatility and adaptability in various environments. The review begins by delving into the taxonomy, morphology, and distribution of *Lantana montevidensis*, emphasizing its characteristics that make it a distinctive and valuable ornamental plant.

Ecologically, this paper explores the interactions between *Lantana montevidensis* and its environment, highlighting its impact on local ecosystems and its invasiveness in certain regions. Moreover, it assesses the species' potential for use in ecological restoration and its benefits in attracting pollinators and supporting biodiversity.

In the horticultural context, the review discusses the cultivation, propagation, and maintenance of *Lantana montevidensis*, making it a favored choice for landscaping. It also considers the plant's resilience to adverse conditions and its resistance to pests and diseases.

The review paper further addresses the phytochemistry and medicinal properties of *Lantana montevidensis*, shedding light on its potential as a source of bioactive compounds with therapeutic applications. In addition, it presents a compilation of research on the plant's ethnobotanical uses.

In conclusion, this review paper provides a comprehensive overview of *Lantana montevidensis*, recognizing its significance in horticulture, ecology, and ethnobotany. It serves as a valuable resource for researchers, horticulturists, and conservationists interested in this versatile and impactful plant species.

AIM

To study pharmacological activities of ***Lantana montevidensis.***

OBJECTIVES

To review various pharmacological activities, such as antifungal, modulatory, antioxidant, cytotoxic, antibacterial activities and Antiprotozoal activities of ***Lantana montevidensis.***

Pharmacological Action *Lantana montevidensis*

The extracts from ***Lantana montevidensis*** have been the subject of extensive research due to their potential therapeutic benefits. They have been studied for various pharmacological activities, such as antifungal, modulatory, antioxidant, cytotoxic, antibacterial activities and Antiprotozoal activity. Both in vitro and in vivo studies have been conducted to explore the pharmacological properties of these extracts and their secondary metabolites.

1) Antifungal activity

In recent years, fungal infections have been on the rise, and there has been a widespread and uncontrolled use of large-scale antifungal treatments. So, the aim of our study was to analyze the chemical components of the essential oil from L. montevidensis leaves (EOLm) and assess its antifungal potential, as well as its ability to enhance the effectiveness of fluconazole against Candida strains. We obtained the essential oil through hydrodistillation and identified its chemical components using Gas Chromatography coupled with Mass Spectrometry. To determine the minimum inhibitory concentration, we used the microdilution method to test its antifungal activity.

In the present day analysis, the antifungal activity of ***L. montevidensis*** leaf containing essential oil averse to the Candida strains was investigated and attune the action of fluconazole. The chemical profiling of the essential oil showed the ascendance of b-caryophyllene and Germacrene D. our research found out that the essential oil from ***L.montevidensis*** didn't effectively stop the growth of different tested candida strains. But when we combined the fluconazole drug with the essential oil, it actually made it more effective. This was especially true for the two strains of ***C.Tropicalis*** and ***C.Albicans*** clinical isolate lineage. According to this study, it strongly indicates that when the drug is combined with the essential oil, it presents a promising opportunity to enhance the drugs effectiveness and improve the overall outcome. Its an exciting finding that could surely lead to better results in treatment.

Reference 1

2) Modulatory activity

A) Antibiotic Modifying Activity

To test the ability of LELm and RELm to modify antibiotic resistance, we determined the MICs of aminoglycosides (neomycin, kanamycin, amikacin, and gentamicin) against the strains. We used the microdilution test with subinhibitory concentrations (MIC 1/8) in 10% BHI, in the presence or absence of the extracts.

In our research, we specifically looked into the antimicrobial properties of the extracts. to do this we used a microdilution assay, which is a method for testing the susceptibility of bacteria in the lab scale. This allowed us to investigate how effective the extracts were against two different bacterial strains. It is an important step in understanding the potential of these extracts for combating bacterial infections. It was checked if the extracts could inhibit the growth of clinically relevant bacteria like E.coli and S.aureus. The study also observed how the extracts affected the activity of aminoglycoside antibiotics. When we added the extracts to the culture medium, we noticed a decrease in the MINIMUM INHIBITORY CONCENTRATIONS (MICs) of all the antibiotics that were analysed. The most significant impact was seen with gentamycin's activity against E.coli,where the MIC was reduced to sevenfold.

Reference 2

B) In the present study, we investigated the antifungal activity of ***L. montevidensis*** leaf essential oil against Candida strains and its ability to modulate the action of fluconazole. The chemical characterization of the essential oil showed the predominance of b-caryophyllene and Germacrene D. Our findings of antifungal activity showed that ***L. montevidensis*** essential oil did not exhibit significant growth inhibition for all tested Candida strains. However, the association of the drug fluconazole with the essential oil showed a potentiating effect, particularly for the two C. tropicalis strains and for the C. albicans clinical isolate lineage. This study strongly suggests that administration of the drug in combination with the essential oil would provide a new opportunity to improve the outcome of the drug effect.

Reference 3

3) Antioxidant activity

A) To determine the antioxidant activity of the aqueous and ethanolic extracts from ***L. montevidensis*** leaves, we used a method inspired by Kamdem et al. (2012) with some modifications. We mixed 50 µL of the extracts at different concentrations (ranging from 1 to 480 µg/mL) with 100 µL of freshly prepared DPPH solution (0.3 mM in ethanol). Then, we kept the plate in the dark at room temperature for 30 minutes. To measure the reduction of DPPH color, we used a microplate reader (SpectraMax, USA) to monitor the decrease in absorption at 517 nm. As a positive control, we used ascorbic acid.

Table 4 presents the DPPH free radical scavenging ability of the EtOH and aqueous extracts from the leaves of ***L.montevidensis***. It shows the effect of these extracts on DPPH reduction. Both the extracts and the ascorbic acid showed that they have the ability to fight against harmful substances called DPPH radicals. They acted like superheroes, reducing the DPPH radicals in a way that depended on how much of the extracts or ascorbic acid was used.So, the more they were used, the better they worked. This activity was observed in a concentration dependent manner. The potential of the aqueous extract was even stronger (24.20 ± 2.32%), compared to the ascorbic acid (9.55 ± 2.01 %).Meaning the aqueous extract had a bigger impact in fighting against those harmful substances. The aqueous extract had an even stronger ability to fight against the DPPH free radical compared to the EtOH extracts. It's IC50 value was two times lower, meaning it was more effective at a concentration of 108.2 ± 3.46 microgram per ml, while the EtOH extract needed a higher concentration of 290.5 ± 1.97 µg/mL. It's like the aqueous extract was the effective one in the battle against free radicals. However, ascorbic acid exhibited the highest DPPH free radical scavenging, with IC50 of 37.05 ± 1.69 µg/mL.

Reference 4

B) In this study, we evaluated the antioxidant activity of the essential oil from ***Lantana montevidensis*** leaves in a laboratory setting, and we also investigated its potential toxic effects using Drosophila melanogaster. The essential oil was found to be rich in terpenes, particularly monoterpenes and sesquiterpenes, which contribute to its strong odor. Our findings showed that the composition of the essential oil was similar to previous reports, with slight variations. For example, previous studies identified β-caryophyllene, germacrene D, and bicyclogermacrene as the major components, while our study found β-caryophyllene to be one of the major components. These differences in composition can be attributed to various factors such as environmental conditions and the time and location of leaf collection. β-caryophyllene, a sesquiterpene, is commonly found in the essential oils of many plant families.

The essential oil from the dried leaves of ***Lantana montevidensis*** (EOLM) produced a yield of 0.19%.A total of 32 different compounds were were identified in the oil. Looking at the table 1, we can see that the chemical composition of EOLM shows some major phytochemicals. Germacrene D takes a lead with 31.27% followed by β-caryophyllene at 28.15%, bicyclogermacrene at 6.04%, α-copaene at 5.98%, α-humulene at 5.81%, and caryophyllene oxide at 5.07%.These compounds play a significant role in the composition of EOLM. On the other hand, we have some compounds that are present in smaller amounts in EOLM. Spathulenol makes up 0.96%, beta-elemene contributes 0.84%, t-sabinene hydrate is at 0.29%, and camphene is at 0.11%. These compounds are less represented in the overall chemical composition of EOLM.

Reference 5

4) Cytotoxic activity

A) We conducted a study to explore the potential harmful effects on human leukocytes and erythrocyte membranes by testing the ethanolic (EtOH) and aqueous extracts from the leaves of ***Lantana montevidensis***. This was the first time such investigation was done.

To test the potential cytotoxic effects of the extracts, we used a modified version of the Trypan blue dye exclusion assay. We mixed the extracts with leukocytes and incubated them with hydrogen peroxide and azide. After incubation, we added Trypan blue to the mixture and checked the viability of the cells under a microscope. The viability was expressed as the percentage of viable cells among the total cells.

Chemical constituents of ethanolic and aqueous extracts from the leaves of ***L. montevidensis*** by HPLC Phenolic acids and flavonoids determined in the ethanolic (Figure 1A) and aqueous (Figure 1B) extracts of the leaves of ***L. montevidensis*** are depicted in Figure 1.In both extracts we found several interesting compounds. Gallic acid (peak 1) was detected at 10.05 minutes followed by catechin (peak 2)at 15.72 minutes, chlorogenic acid (peak 3) at 22.46 minutes, caffeic acid (peak 4) at 25.13 minutes,ellagic acid (peak 5) at 32.09 min, rutin (peak 6) at 39.87 minutes, quercetin (peak 9) at 49.97 minutes, kaempferol (peak 10) at 55.02 minutes, luteolin (peak 11) at 60.23 minutes and apigenin (peak 12) at 70.15 minutes. Such diverse range of compounds are present in the extracts. Based on the quantitative analysis, the EtOH extract showed that chlorogenic acid was the major constituent at 8.59 ± 0.01 mg/g followed by quercetin at 6.03 ± 0.01 mg/g. On the other hand, catechin was found to be less abundant at 0.48 ± 0.03 mg/g and kaempferol at 1.57 ± 0.02 mg/g.Just like EtOH extract, the aqueous extract also had its major constituents. caffeic acid was found at 6.25 ± 0.01 mg/g and chlorogenic acid at 6.17 ± 0.03 mg/g. On the other hand apigenin and quercitrin were present as minor constituents, with apigenin at 0.86 ± 0.01 mg/g and quercitrin at 0.71 ± 0.01 mg/g.

Reference 6

B) cytotoxic activity

To rekindle the drug development process, we screened extracts from renowned medicinal plants for in vitro toxicity using the brine shrimp test and antibacterial activities. This was done to search for biological activity and determine their potential. This method lets us test a bunch of different samples and dilutions in a really short amount of time. And the best part is, we can do it using smaller amounts of extracts. So we can test more things and get results faster. Many other interesting plant species were studied like ***Plectranthus barbatus, Zanthoxylum rhoifolium, Stryphnodendron rotundifolium, Lantana camara, Lantana montevidensis, Guapira graciliflora, Croton zenhtneri, Dimorphandra gardineriana, Vanillosmopsis arborea, and Piper tuberculatum***.

Reference 7

4) Antibacterial activity

The purpose of this study was to evaluate the in vitro antibacterial activity of ethanolic extracts from ***L. camara*** and ***L. montevidensis*** leaves and roots using the microdilution method to assay the susceptibilities of five bacteria strains (American Type Culture Collection - ATCC) and two multi-resistant strains isolated from clinical material.

Several new antibacterial agents are being developed presently in response to exposure of bacterial resistance to existing drug. There are new plant sources that have antimicrobial properties and are safe to use. This could be a safe alternative for poor communities since they are affordable and easily accessible.[11] The ethanolic extracts from ***L.camara*** and ***L.montevidensis*** showed amazing antibacterial activity against the harmful microorganisms we tested. The extracts presented antibacterial activity against.

The leaves and roots ***L. montevidensis*** extracts were active against P. vulgaris and P. aeruginosa (MIC 8 mg/mL) and two strains of E. coli (MIC 16 mg/mL for the multiresistant strain) as shown in Table 1.[7]

Reference 8

5) Antiprotozoal activity

Lantana is quite a diverse genus with around 150 species.***Lantana montevidensis***, specifically, is found in many countries and is often used as an ornamental plant. Interestingly, the dried leaves of ***L. montevidensis*** have been used in folk medicine for various purposes, including relieving itching, stomach ache, rheumatism, and even treating wounds, toothaches, influenza, bronchitis, headaches, and sunstroke. There have also been studies showing that the methanolic extract of ***L. montevidensis*** leaves has antiproliferative activity against human gastric adenocarcinoma, human uterus carcinoma, and murine melanoma cells in vitro.

The researchers performed tests on extracts and isolated composites from Lantana montevidensis to evaluate their effectiveness against L. donovani parasites in different stages, including promastigotes, axenic amastigotes, and intracellular amastigotes in THP1 cells. They wanted to see how well the extracts worked against the parasites. They also tested the compounds against T. brucei brucei trypomastigote forms. To ensure safety, they simultaneously tested the compounds for general cytotoxicity on THP1 cells. The tests were done using Alamar Blue assays on cell cultures, with varying concentrations of the compounds. The growth of parasites was determined after incubation, and the compounds were also tested against ***L. donovani*** intracellular amastigotes in THP1 cells. Cytotoxicity was assessed on THP1 cell cultures as well. These tests can help evaluate the potential of ***L. montevidensis*** in fighting against these harmful organisms.

Reference 9

CONCLUSION

The comprehensive exploration of Lantana montevidensis extracts across various pharmacological activities reveals their significant therapeutic potential. From antifungal and modulatory effects to antioxidant, cytotoxic, antibacterial, and antiprotozoal activities, the extracts exhibit diverse bioactive properties. These findings underscore the importance of further research to elucidate the mechanisms underlying these effects and to develop therapeutic applications. L. montevidensis emerges as a promising candidate for the development of novel pharmaceuticals to combat fungal infections, antibiotic resistance, oxidative stress-related disorders, and parasitic diseases. Continued investigation into the bioactive compounds present in L. montevidensis extracts and their mechanisms of action will contribute to the development of effective treatments for various health conditions.

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