ijlpr 2023; doi 10.22376/ijlpr.2023.13.4.P70-P80

International Journal of Life science and Pharma Research

ISSN 2250-0480

Review Article

Phytochemical and Pharmacological Potential of Lantana Camara Linn

Vaishali Naphade[*1], **Jayesh S. Bhamre**[2], **Manoj M. Avaghade**[2], **Mansi S. Kale**[2], **Atul R. Bendale**[2], **Sandhya L. Borse**[1] and **Laxmikant B. Borse**[2]

[1]*School of Pharmaceutical Sciences, Sandip University, Nashik, India*

[2]*Sandip Institute of Pharmaceutical Sciences, Nashik, (MH) 422213, India*

Abstract: Traditional medicine and medicinal plants, as well as their study of modern chemical principles, may lead to the creation of newer and less expensive medications. This overview incorporates all aspects of *Lantana camara Linn* that other papers have overlooked. *Lantana camara* Linn is also a widespread weed and a famous ornamental plant. It is noteworthy that plants have long been an excellent source of medicine. Lantana camara (L. camara) is well-known for its many ailments, such as cuts, inflammation, ulcers, cataract, itching, eczema, and arthritis. Various parts of the Lantana camara plant are used medicinally for colds, coughs, pox, bronchitis, and hypertension. *In addition, L. camara* scientifically studied various therapeutic activities such as antibacterial, antioxidant, antipyretic, larvicidal, antifungal etc. Over the past few decades, scientists and researchers worldwide have expanded their knowledge and studied the chemical composition of the entire L-plant and their medical activities. It is also known as a plant that produces essential oil, and essential oils are available in the market, known as Lantana oil. The phytoconstituents found in all portions of *L. camara* have been documented in various publications. Over the last few decades, scientists and researchers worldwide have thoroughly investigated the chemical content of the entire *L. camara* plant. The plant is widespread in Uttarakhand, Uttar Pradesh, Himachal Pradesh, and India's north-eastern provinces. This paper examined the phytochemicals found in L. camara. The review focuses on this plant's traditional usage, chemical constituents, pharmacological activity, and toxicology and other potential uses. This study aims to provide a comprehensive report on the literature on its phytochemistry and pharmacological action.

Keywords: *Lantana camara Linn*, Pharmacology, phytochemistry, oleanonic acid, Lantadene A and B, essential oil

***Corresponding Author**

Vaishali Naphade , School of Pharmaceutical Sciences, Sandip University, Nashik, India

Received On 8 August, 2022
Revised On 31 January, 2023
Accepted On 13 February, 2023
Published On 1 July, 2023

Funding This research did not receive any specific grant from any funding agencies in the public, commercial or not for profit sectors.

Citation Vaishali Naphade, Jayesh S. Bhamre, Manoj M. Avaghade, Mansi S. Kale, Atul R. Bendale, Sandhya L. Borse and Laxmikant B. Borse , Phytochemical and Pharmacological Potential of Lantana Camara Linn.(2023).Int. J. Life Sci. Pharma Res.13(4), P70-P80 http://dx.doi.org/10.22376/ijlpr.2023.13.4.P70-P80

1. INTRODUCTION

Medicinal plants have a significant source of medically important compounds. Since ancient times, medicinal plants have been used to cure several types of health problems and various kinds of diseases. *Lantana camara Linn*. is a flowering ornamental plant belonging to the family Verbenaceae. L. It is also known as red sage, Lantana, Wild Sage, Surinam Tea Plant, Spanish flag, and West Indian lantana. L. is used as a popular ornamental plant in gardens for decoration. *Lantana camara* originates from the Latin word 'lento', which means 'to bend'. Family with 600 other variations existing naturally, and plants are seen in different flower colours. It is seen in red, white, yellow and violet color[1].

1.1. Physical Appearance

It is a smelling shrub, and structurally this plant's leaves are opposite to others and have a shape with a size of 2-10 cm (length) and 2-6 cm (width). The leaves are green and have finer hair, simple with large petioles, and oval blades that are rugged and hairy with bluntly toothed margins. In the fruit part (figure 1), the plant's Berries are round and fleshy and have two-seeded bean shapes. Seeds of *Lantana camara L.* are green in colour, turning purple and turning to a blue-black colour. The leaves are green and are 3-8 cm long and 3-6 cm broad. Rough hairs cover the leaves and stem. Clusters of little flowers (called umbels). The colour is generally orange, although it can range from white to red in varied tints, and the flower's colour changes as it ages. Throughout the year, flowers with a yellow neck appear on the axillary head. The calyx is short, the corolla tube is slim, and the limb is 6 to 7 mm in diameter and split into uneven lobes. Stamens four in two pairs, ovary two-celled, two ovulated. In the axils of opposing leaves, inflorescences are formed in pairs. The inflorescences are dense, dome-shaped, and 2-3 cm wide, with 20-40 sessile flowers.[2]

1.2. Geographical Distribution

The plant grows significantly in favourable conditions, and flowering occurs from March to August. This plant is mainly found in tropical and subtropical regions. Mature plants give 2000 seeds throughout the year. *Lantana camara* is named differently in different languages of India, such as Raimuniya in Hindi, Kakke and Natahu in Kanada, Arippu and Unnichedi in Tamil, Aripoov, Poochedi, Thirei, Samballei, Chaturanga and Vanacehdi in Sanskrit, Nongballei in Manipuri, Tantani and Ghaneri in Marathi and Pulikampa in Telugu.

1.3. Uses

Lantana camara is commonly used as a herbal medicine and, in some regions, as firewood. The leaf oil is used as an antiseptic for scars or wounds; the roots are used for treating a toothache, and the flowers for chest pain issues in children. *Lantana camara* leaves extract exhibited anti-proliferative, antimicrobial, fungicidal, insecticidal and nematicidal activities, as antispasmodic, tonic, and antiemetic, to treat respiratory infections (Table 5).[4] Most previous reports have described the antifungal and antimicrobial activities of L. camara showed germicidal activity observed by Verma and Verma (2006)[5]. The present review aims to document the phytochemistry and pharmacological evaluation of Lantana camara Linn and the prospects for further scientific investigation of the therapeutic compounds. The taxonomic classification is given in Tables 1,[6,7]

Fig 1: Fruits and flowers of Lantana camara

Table 1: Taxonomic Classification of Lanata camara	
Kingdom	Plantae
Subkingdom	Tracheobionta
Super division	Spermatophyta
Division	Magnoliopsida
Subclass	Asteridae
Order	Lamiales
Family	Verbenaceae
Genus	Lantana
Species	Lantana camara

1.4. Synonyms of Lantana camara

Lantana aculeate, Camara vulgaris, Lantana indica Roxb., Lantana salvifolia Jacq., Lantana trifolia, Lantana orangemene, Lantana tiliaefolia Cham, Lantana achyrantifolia Desf., Lantana montevidensis Briq., Lantana viburnoides Vahl

1.5. Phytochemistry of Lantana camara

Primary and secondary metabolites like alkaloid, glycoside, tannin, resin, saponin, cardiac glycoside, carbohydrate, steroids, phenol, coumarin, terpenoids, flavonoid and anthraquinones are present, which are identified by the identification tests for them[8]. Because of the existence of natural agents, Lantana camara has therapeutic potential. Most of their activity is due to bioactive components such as saponins, alkaloids, tannin, anthocyanins, flavones, isoflavones, flavonoids, coumarins, lignans, catechins, iso-catechins, and triterpenoids (Table 4). Wollenweber et al. discovered and reported the presence of two triterpenoid esters, camarilic acid and camaricinic acid. [44] Silva et al. found the chemical makeup of essential oils gathered from several places in 1999. The main ingredients in Lantana camara oil were - phellandrene, germacrene-D, limonene, caryophyllene, sabinene, α-zingiberene, and humulene.[43]

1.6. Isolation of constituents from the leaves

Pan WD, in 1993 isolated six ingredients from the leaves of *Lantana Camara*. This chemical constituent was identified as oleanonic acid, lantadene A, lantadene B, Lantanilic acid, Icterogenin and 4',5-dihydroxy-3,7-dimethoxyflavone-4'-O-glucopyranoside (also known as Camaro side, Figure 2b). [9] This phytoconstituents content in plants is influenced by the various factors like geography, season, genetic factor and developmental stages of the plant[10].

1.7. Isolation of constituents from the Roots

From the ethanolic extract of lantana camara stachyose, verbascose, jugs, verbascotetracose, alpha-D-gala (1--6)-alpha-D-gala (-1(3)-6-D-gluc(also known as Lantanoside A), alpha-D-gala-(1-6)-alpha-D-gala (1)-(4)-6-D-gluc(also known as Lantanoside B), the side, 8-epiloganin,shanzhsid methyl ester, theviridoside, lamiridoside and genocide have isolated the help of different types of spectral analysis in which 6 are oligosaccharides, and 6 are iridoid glucosides[11].

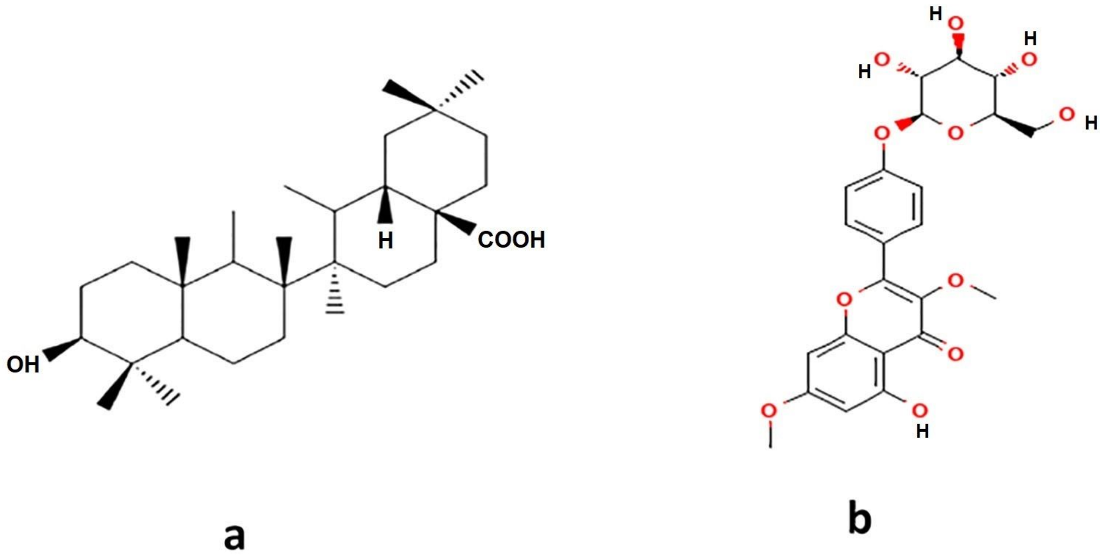


Fig 2: Chemical structure of (a) Oleanonic acid (OA) and (b) Camaroside

1.8. Isolation of constituents from the aerial parts of the plant

New pentacyclic triterpenoids 22β-acetoxy-3,25-epoxy-3α-hydroxyolean-12-en-28-oic acid (lancamarinic acid) and methyl 3,25-epoxy-3α-hydroxy-11-oxo-22β-senecioyloxyolean-12-en-28-oate (lancamarinin)[12,13]. Triterpenoids were also isolated from the Lantana camara, identified as lantanolic acid, 22 beta-O-angeloyl-lantanolic acid, and 22 beta-O-angeloyl-oleanolic acids, --bbeta-O-senecioyl-oleanolic acid, 22 beta-hydroxy–oleanolic acid, 19 alpha-hydroxy-ursolic acid and 3 beta-isovaleroyl-19 alpha-hydroxy-ursolic acid (lantaiursolic acid)[14]. The study by R.K. Singh, B. Tiwari, Uma Sharma and S.P. Singh in 2012 found the actual content percentage in the leaf and fruit oil of the Lantana camara as shown below in table 2[15].

Table 2: Phytoconstituents of Lantana camara

Sr. No.	Constituent	% Content of leaf oil from India	% Content of leaf oil from Bangladesh	% Content of leaf oil from South china	General % Content of fruit oil
1	β -caryophyllene	9.40%	13.57%	12.35%	21.42%
2	Germacrene	20.50%	10.88%	6.19%	2.19%
3	β -elemene	7.30%	-	-	0.94%
4	α humulene	-	11.76%	9.31%	9.97%
5	α -copaene	5.00%	-	-	-
6	Sabinene	-	-	-	1.13%

7	Eucalyptol	-	-	-	1.25%
8	Linalool	-	-	-	2.96%
9	Bicyclogermacrene	-	-	-	2.18%
10	Trans nerolidol	-	-	-	18.85%
11	Davanone	-	-		1.52%

1.9. Isolation of essential oil

β-caryophyllene (Figure 3), α humulene, germacrene, davanone and γ-curcumene were isolated from the essential oil of fresh leaves of lantana camara by gas chromatography (GC) and gas chromatography/mass spectroscopy (GC/MS)[16]. The content of essential oil from fresh leaves of Lantana camara is shown in table 3.

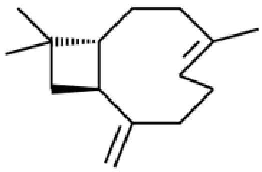
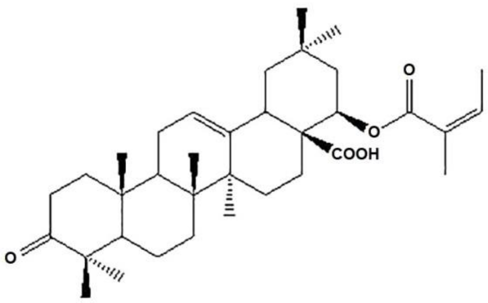
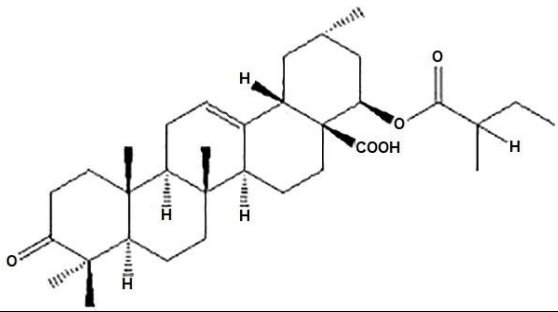
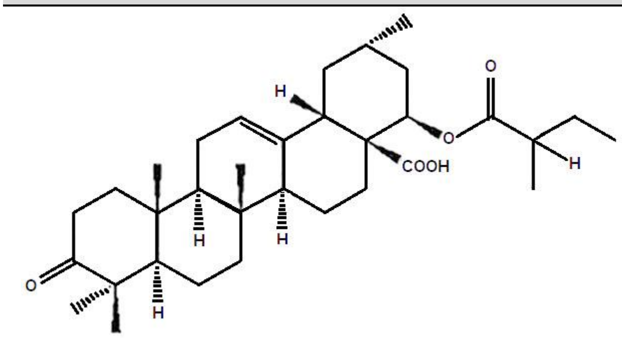
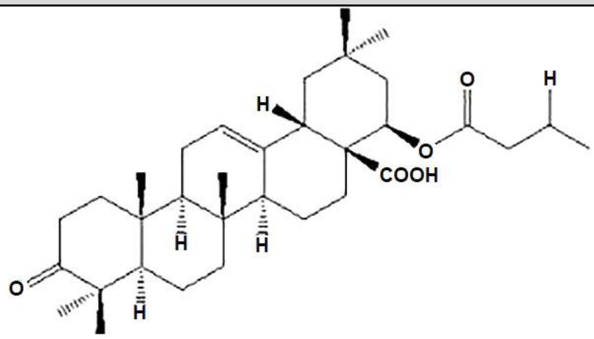


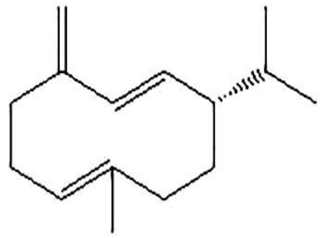
Fig 3: Chemical structure of beta-caryophyllene

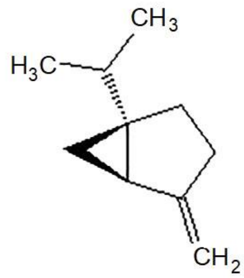
Table 3: Content of essential oil from fresh leaves of Lantana camara

Sr. No.	Components	% of content
1	β -caryophyllene	23.3%
2	α humulene	11.5%
3	Germacrene D	10.9%
4	Davanone	7.3%
5	γ -curcumene	6.3%

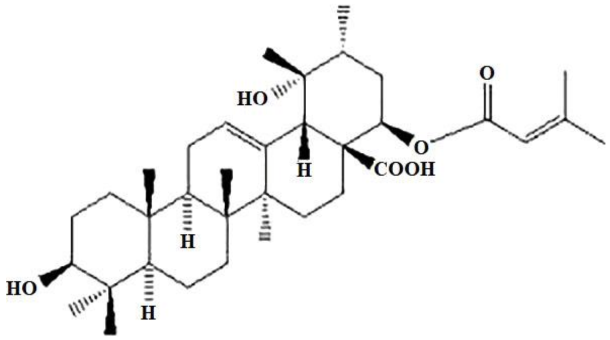
In 2015, S. begum and others isolated a new triterpene from the Lantana camara, lancamarolide[17]. In 2006, a pentacyclic triterpene, lantacin, camarinin and coumarin were isolated from the Lantana camara.[18.]

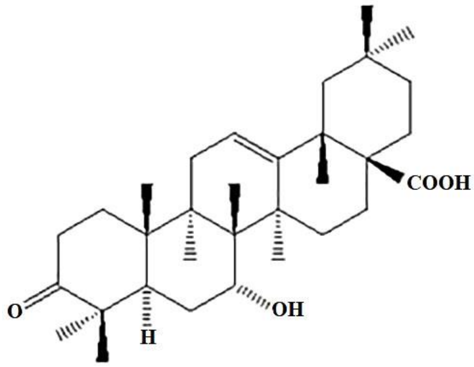
Table 4: Chemical constituents of Lantana camara	
	
LENTADENES A49	LENTADENES B49
	
LENTADENES C49	LENTADENES D49



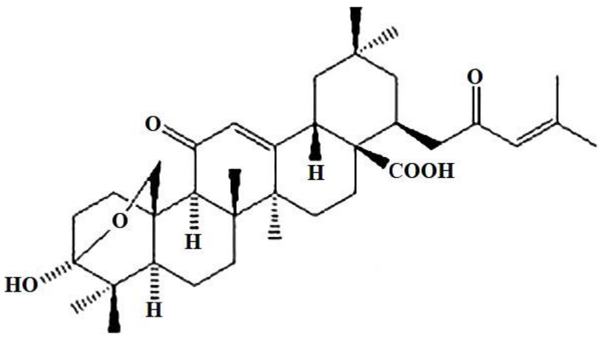


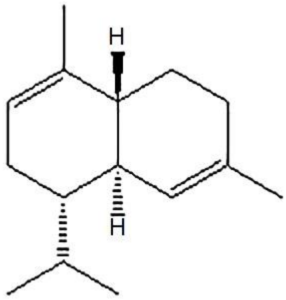
PHRLLA-NDRENE F49	SABINENE 50-52



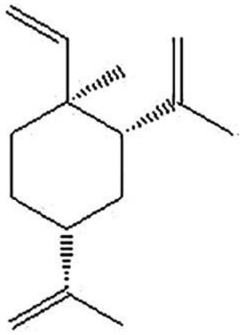


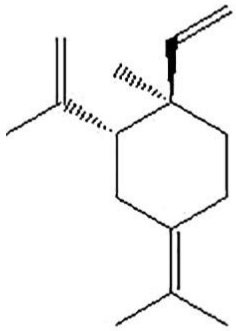
LANTACIN50-52	CAMARIN50-52



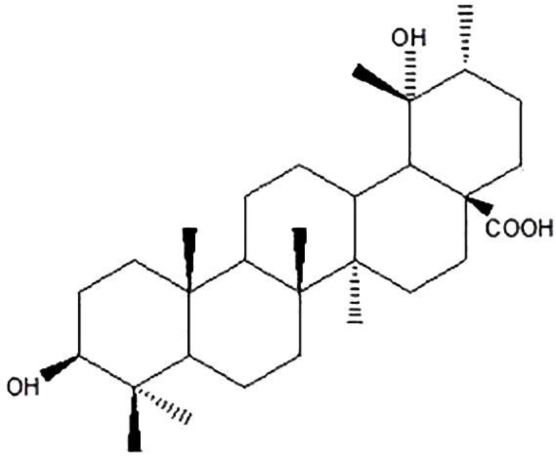


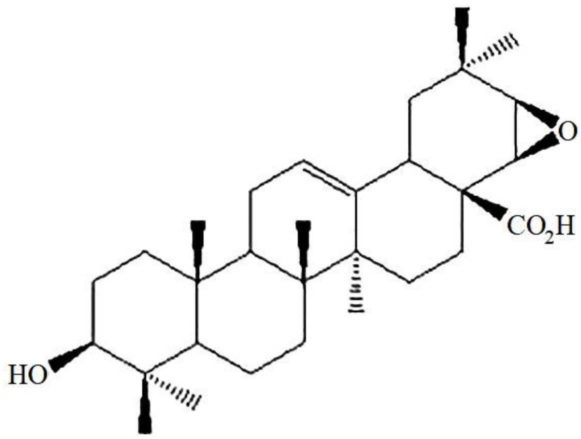
CAMARININ53	α -CADINENE54



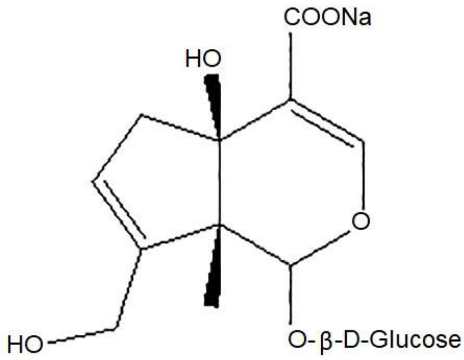


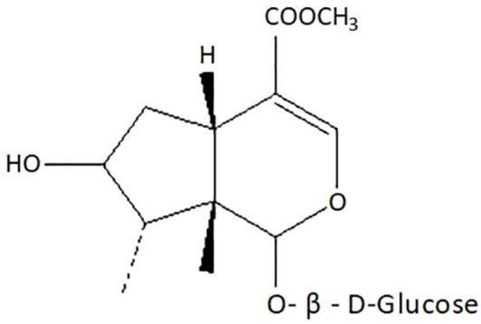
β - ELEMENE54	γ - ELEMENE54



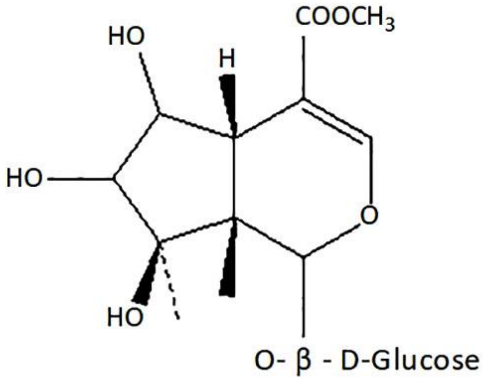


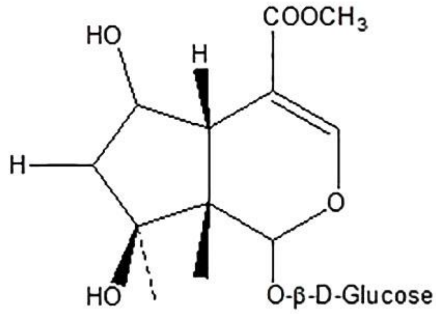
3β, 19α-DIHYDROXYURSAN-28-OIC ACID55 | 21, 22β-EPOXY-3β-HYDROXY OLEAN -12-EN-28-OIC ACID56



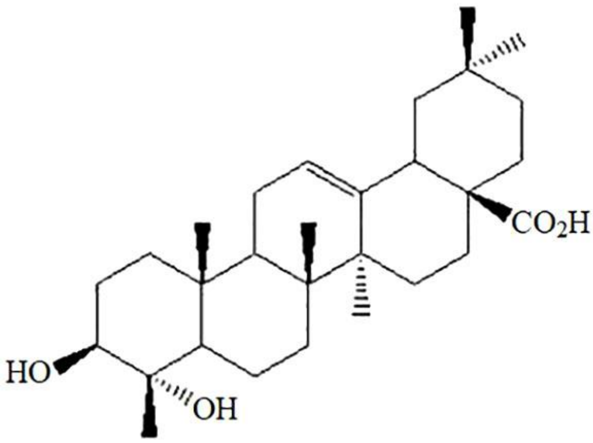


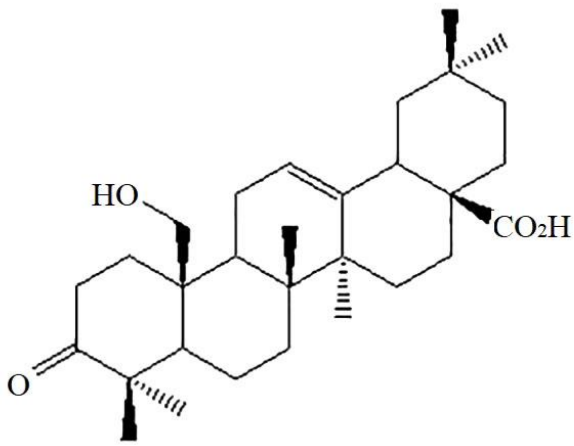
THEVESIDE 56 | 8-EPILOGANIN57, 58



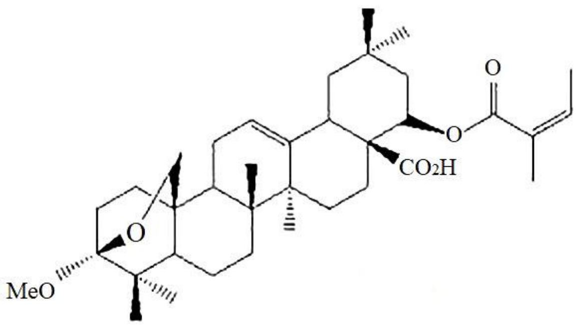


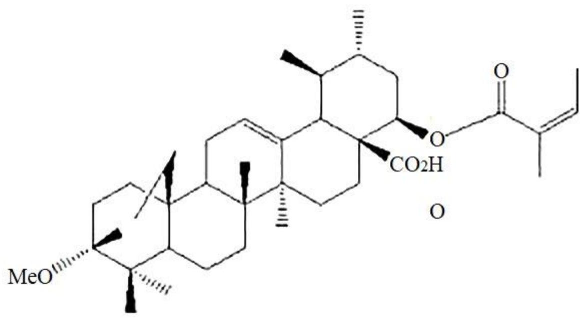
LAMIRIDOSIDE59 | SHANZHSIDE METHYL ESTER59





HEDERAGENIN59 | 25-HYDROXY-3-OXOOLEAN-12-EN-28-OIC ACID59





CAMARILIC ACID60 | CAMARACINIC ACID60

1.10. Pharmacology of Lantana camara

- ***Anti-bacterial activity***

Different types of leaves and flowers of L. camara plants reported antibacterial activity. Three other solvent extracts of four different leaves and flower varieties of L. camara exhibited an important antibacterial activity. These four different varieties are - *E. coli*, Bacillus subtilis and *P. aeruginosa*, while less antibacterial activity against Staphylococcus aureus.[19] Ethanolic extract of L. camara leaves and roots were reported for antibacterial activity.[20] In vitro antibacterial function is done in the form of microdilution. Extract showing antimicrobial activity against Staphylococcus aureus, Proteus vulgaris, Pseudomonas

Staphylococcus aureus, Proteus vulgaris, Pseudomonas aeruginosa, Víbrio cholareae, Escherichia coli, and two resistant against many species is E. coli and S. aureus[21].

- ***Anti-inflammatory Activity***

The aqueous extract of aerial parts of the plant Lantana camara was examined for analgesic (hot plate method), anti–inflammatory (carrageenan-induced paw oedema test) activities in albino rats by oral and topical routes, respectively. It exhibits the influence of Lantana camara aqueous extracts on the latency time for paw licking in response to heat stimulation. The rats demonstrated a substantial impact when treated with Lantana camara (500 mg/kg), with the leaking time increasing following treatment. Demonstrated anti-inflammatory action showing that oedema generated by carrageenan in rat's paw increased in the control group Treatment with Lantana camara aqueous extract (300 mg/kg) resulted in a slight drop in paw volume. In contrast, treatment with 500 mg/kg resulted in a considerable decrease.[22]

- ***Antipyretic Activity***

The antipyretic activity of L. Camara was determined using ethanolic and ethyl acetate extracts. The results showed a decrease in body temperature from 1.5 hours. However, the activity of both antipyretic agents was significant ($P < 0.01$) between the 2nd and 3rd hour compared to negative controls. The antipyretic activity of Lantana camara could be at least partly due to COX-1, and COX-2 enzyme inhibition and free radical-scavenging activities, which may be attributed to the presence of flavonoids and other polyphenols in the extracts. The results of this study provided scientific support for the use of Lantana camara in the treatment of Pyrexia[23].

- ***Anti-helminthic Activity***

Helminths, also known as parasitic worms, are essential germs worldwide [24]. These days, billions of people, especially in less developed lands, still survive infection with helminths transmitted to the ground. Infection of helminths is also a significant problem. Livestock production around the world has also caused substantial economic losses and the availability of threatening food. To find a solution to such a significant problem, L. camara was chosen for its anthelmintic work against Pheretima Posthuma. Ethanol emissions are made using the L.camara stem and are subject to anthelmintic force investigation[25]. The analysis showed a significant effect at a dose of 500 mg/ml compared to conventional medicine albendazole in 20 mg/ml concentration.

- ***Antifungal Activity***

Antifungal power of L. camara tested against them Alternaria sp. causing various plant diseases. The antifungal function was made by three food poison plate method extract concentrations: 10 mg/ml, 15 mg/ml and 20 mg/ml. The 20 mg/ml dose of *L. camara* has shown important antifungal activity against Alternaria sp.[26]. Antifungal activity of ethanol of L. camara was tested with destructive white wood and brown mould. Both episodes showed antifungal effect activity against white rotting red mould, yet ethanol. Therefore, the extract had great potential at low concentrations (0.01%)[27].

- ***Antiulcerogenic Activity***

To determine the antiulcerogenic potential of L.camara, a methanolic extract was prepared, and its experiments were performed with aspirin-induced gastric ulcerogenic in mice with pylorus ligated, ethanol-induced gastric ulcer, and duodenal ulcer models of cysteamine. Two oral doses were given at 250 mg/kg and 500 mg/kg. The results of L. camara extract showed a significant decrease ($P < 0.01$) in the ulcer index and total acidity as well substantial ($P < 0.01$) increase in gastric pH of aspirin + pylorus-ligation induced ulcerogenesis and ethanol-induced gastric ulcer models. Thus it concluded that the leaves of L.camara have the potential healing of stomach ulcers and can prevent intestinal ulcers in mice[28]. In another study, methanolic extract from leaf tissue was corrected, and the effect was read on aspirin, ethanol, and stress-induced gastric ulcers in rat models. The results reveal antiulcerogenic activity in a dose-dependent manner and reduce the dose of stomach juice, total acid, and free acid but showed significant improvement ($P < 0.001$) in pH stomach ulcer levels caused by aspirin. When the previous treatment was given in two doses (200 and 400 mg/kg), the wound protection effect was observed with a protective percentage (63.31%),71.02%) aspirin-induced, (85.79%, 93.09%) ethanol-induced and (46.86%, 63.90%) protection in stress-induced wound models. It was shown that the extract has in vivo antioxidant capacity as an increase was observed in superoxide dismutase (SOD) and catalase, which reduces glutathione (GR) activity in the treated group [29].

- ***Antihyperglycemic Activity***

Antihyperglycemic activity is also performed using prepared methanolic extract from L. camara leaf tissues under alloxan diabetic rats. The release was administered orally (400 mg/kg), and results show a decrease in glucose levels at (121.94) mg/dl) in the blood of diabetic rats with alloxan. [30] Take the treatment in 100 doses, and a body weight of 200 mg/kg led to a dose-dependent decrease in glucose levels in serum in synthetic streptozotocin mice with diabetes. Exhaust therapy also showed improved body weight, HbA1c profile and liver regeneration cell [31].

- ***Antifilarial Activity***

Antifilariall activity of L extract crude L. camara stem was to save. The extract and its component chloroform caused the death of an adult Brugia malayi and closed many germs and female worms surviving Mastomys mouse model house. The extract was also found effective against a subcutaneous rodent filariid Acanthocheilonema vitae maintained in Mastomys coucha, which exerted microfilaricidal solid (95.04%) and sterilization (60.66%) efficacy with mild macrofilaricidal action. Oleanonic acid (Fig. 2a) and oleanolic acid, isolated from hexane and chloroform fractions, showed LC100 at 31.25 and 62.5 mg/ml, respectively, on B. malayi in vitro. This is the first-ever report on the anti-filarial efficacy of *L. camara.*[32].

- ***Anti-cancer Activity***

The leaves of L. camara were reported to show a cytotoxicity effect on the Vero cell line. In vitro cytotoxicity testing was performed for MTT testing. Methanol extraction (500 µg / ml) inhibits cell growth 2.5 times less than Triton 100 × 1% . in 2 weeks, L. camara leaf extract showed no apparent acute toxicity. While female mice lost body weight after being treated with a single dose of leaf extract in an acute toxicity test, male ones lost organ mass, particularly in the heart and kidney. The biochemical liver function tests showed significantly elevated TBIL and ALT in the L. camara leaf extract-treated female mice group compared with the control group. The cytotoxicity effect of the leaf extract of L. camara was estimated through an MTT assay. Cytotoxicity tests on the Vero cell line disclosed that leaf extract at concentrations up to 500 μg/mL inhibited the growth of cells 2.5 times less than Triton 100 × 1%. More interestingly, the cytotoxicity declined at elevated concentrations of this extract. Conclusions: The results of both tests confirm that L. camara shows a pro-toxic effect[33].

- ***Larvicidal Activity***

The larvicidal activity of mosquito extracts prepared using the leaves and flowers of L flowers. Camara L. in methanol and ethanol is well processed. Larvicidal effects on 3 and 4 instar larvae of mosquito species Aedes aegypti and Culex quinque fasciatus have been investigated dose-dependent for 24 h. With a 1.0 mg/ml concentration of extracts of Lantana camara, maximum mortality was observed in Aedes aegypti exposed for 24 h. In the case of Culex quinquefasciatus, the mortality was seen as maximized when the concentration increased to 3.0 mg/ml. The presence of saponin, flavonoids, terpenoids and cardiac glycosides have also been observed, and GC/MS analysis was carried out on methanol flower and leaf extract to find the components[34].

- ***Effect of L. camara on GIT***

The antispasmodic effect of *L. camara* leaf constituents has been studied in the mouse ileum. Removal of methanolic leaves of *L. camara* showed promising antispasmodic action on cut mouse ileum. Where acetylcholine was given where methanolic leaves extracted from L. camara, discharge caused a significant decrease in the shrinkage of the ileum, which indicates that the methanolic leaves of *L. camara* have antispasmodic properties activity by blocking cholinergic receptors[35].It also has antimotility or antidiarrheal activity and antiulcerogenic activity[36].

- ***Hemolytic Activity***

The hemolytic activity of L. camara aqueous extract with the solvent components is made of modified spectroscopic methods in four different concentrations (125, 250, 500, and 1000 μg / ml). Aqueous extract and its solvent ingredients showed less hemolytic activity in many erythrocytes. Hemolytic activity of various extracts was obtained in the following order: part of chloroform>hexane and a portion of ethyl acetate (50:50) > aqueous extract > ethanol component > methanol component. In this study, they reported the hemolytic activity of L. camera to leave aqueous extract and its various solvent fractions. The results revealed that the leaves possess significantly less hemolytic activity and can further be used to isolate bioactive compounds. [37]

- ***Embryotoxicity or anti-fertility activity***

An effect of hydro-alcoholic extraction of L camara leaves was about reproduction, a normal reproductive function and teratology in female albino Wistar mice. Extraction disrupts the frequency of fetal skeleton anomalies from extract-treated dams, and embryotoxicity is created to indicate loss after implantation without any harmful symptoms to mothers. [38]

- ***Antioxidant Activity***

Antioxidant activity and hydrogen peroxide radicals are released, reducing energy, phenolic content, and flavonoid L content. In L. Camara, the total phenolic content was (40.859 ± 0.017) mg gallic acid / g in L leaves. Camara, while a total of flavonoids was (53.112 ± 0.199) mg/g dry weight. The leaf piece of L. camara demonstrated good hydroxyl drainage operations (45–73%) at a concentration of 0.2–0.8 mg/ml in the reaction mixture. Leaving quotes has shown a reduction-based ability to concentrate. It induces a reduction potential is 0.8 mg/ml [39]. Ethanolic extract of L. camara has shown important antioxidant activity in vivo studies. Released treatment reduces lipid peroxidation in the kidneys of urolithic mice. In vitro research is performed by DPPH radical scavenging assay and nitric oxide free radical respiratory tests. The extract is indicated for its high antioxidant properties in both experiments [40].

- ***Wound healing Activity***

The wound-healing function of L. camara was reported in mice. Topical use excessively improved wound penetration rate (98%), consolidation of collagen and reduced wound healing time[41]. A thin coating of placebo was placed topically on Group 1's wounds. Groups 2 and 3 animals had their wounds coated with a thin layer of placebo containing 5 and 10% L. camara extract, respectively. As a control, a slight coating of intrasite gel was given topically to the wounds of Group 4 animals. The effects of these topical applications on wound healing and histology were investigated. Wounds treated with a placebo containing plant extracts healed much faster than those treated with a blank placebo. Wounds treated with placebo extracts had much smaller scar breadth at the wound enclosure, significantly higher fibroblast proliferation and more mature and densely packed collagen with concomitant angiogenesis than wounds dressed alone with extracts.[42]

- ***Efficacy of wild sage (Lantana camara) extracts against almond moth (Cadra cautella):-***

One of the most economically important stored product pests is the almond moth [Cadra cautella (Walker) (Lepidoptera: Phycitidae). If not adequately handled, this bug causes significant harm directly by larval feeding on a range of dried fruits, preserved vegetables, and wheat seeds. Because they are natural substances, there should be no concerns with persistence in the environment. Thus, products based on plant extracts, phyto-oils, and purified plant components can be used as an alternative to traditional pesticides. Lantana camara is an evergreen hairy shrub grown as an ornamental hedge in Asia's tropics, subtropics, and coastal areas. It's also a major weed problem in tropical crops. The study aims to investigate the effect of L. camara leaf extracts on almond moth-infested 'HS 420' wheat seeds during storage. [45]

- ***Biological Control of Lantana camara***

The insect species brought into Australia and South Africa as prospective biological control agents of Lantana camara (lantana) were examined to identify characteristics that may have contributed to the large number of candidates that failed to establish on the plant. DNA investigations indicate that Lantana urticifolia and Lantana tiliifolia are more closely related to Lantana camara than other species of Lantana. Hence, a candidate's native host may impact its establishment on Lantana camara. Eight species showed some preference for distinct lantana morphologies, whereas three species showed no importance for phenotypes. Future studies into the biological management of L. camara should investigate tackling these areas, which might result in higher candidate establishment rates and improved control of the parasite. [46]

- ***Treatment of bovine dermatophilosis with Lantana camara***

It offers intriguing first findings on the therapeutic benefits of ointments created using medicinal plant extracts on bovine dermatophilosis. Our results suggest using ointments containing ethanolic extracts of Senna alata, Lantana camara, and Mitracarpus scaber leaves as topical therapies on chronic crusty or acute dermatophilosis lesions to heal the condition in the nine afflicted animals treated without recurrence. This is in contrast to what was found when oxytetracycline, terramycin long-acting (TLA), or procaine-penicillin, antibiotics routinely used parenterally for the treatment of dermatophytosis in the Republic of Benin, were administered, which did not prevent the condition from recurring. When administered once a day for 8-15 days, these ointments caused the crusts to break off after 3-4 days of therapy. Hair develops on the treated regions, which recover without scarring 3-4 weeks after the treatment. The cured animals were free of dermatophilosis for more than three years and in good condition. [47]

- ***Lantana camara for fuel ethanol production using thermotolerant yeast***

Lantana camara plant material was hydrolyzed with 1% sulfuric acid for 18 hours at room temperature, followed by a 20-minute heat treatment at 121 degrees Celsius. Hemicellulosic hydrolyzate was isolated and detoxified using ethyl acetate and overlining. The cellulosic fraction was hydrolysed for 18 hours at 55°C using Aspergillus niger crude cellulase enzyme. Acid and enzyme hydrolysate were combined and fermented using thermotolerant Saccharomyces cerevisiae (VS3). With a high fermentation efficiency, yeast fermented L. camara hydrolyzate to produce ethanol. Despite inhibitors in L. camara hydrolyzate, thermotolerant yeast consumed most of the sugars. [48]

Table 5: Different formulations of Lantana camara with their uses

Sr. no.	Extracts	Pharmaceutical formulations	Biological role	References
1	Leaves	Herbal gel	Anti-inflammatory activity	*Pawar DP et al.* (2013)
2	Leaves	Herbal Handwash	Washing and cleaning hands to remove soil, dirt and microorganism	*Bhor RJ et al.* (2018)
3	Leaves	Silver nanoparticles with extract	Wound healing activity, anti-inflammatory activity, antibacterial activity	*Muniraja Lakshmi K et al.* (2021)
4	Leaves	Herbal gel	Topical therapy on acne vulgaris	*Dange VN et al.* (2020)
5	Flower	Natural colourant	Natural colourant with preservatives for food, juices, etc.	*Annegowda HV et al.* (2020)
6	Oil extract from Flower	Ointment	The better alternative of Povidone-iodine, which has some delayed wound-healing action.	*Satyajit Samal et al.* (2017)
7	Leaves	Herbal Cream	Topical application on skin infection, antibacterial activity	*Pandit D et al.* (2017)

2. CONCLUSION

L. camara is a valuable medicinal herb with numerous applications in indigenous and traditional medicine. This report indicates that it has phytoconstituents that disclose its applicability for various therapeutic objectives. The herb or specific portions can be used to treat various human ailments, including antiulcer, analgesic, anti-inflammatory, anti-bacterial, anthelmintic, anti-cancer, anti-fungal, anti-microbial, and wound healing. Nonetheless, more research with the L. camara is necessary to examine the mechanism of action with other therapeutic activities. Therefore, this plant's study has a lot of potentials.

3. AUTHORS CONTRIBUTION STATEMENT

Jayesh S. Bhamre, Manoj M. Avaghade and Mansi S. Kale wrote the manuscript with support from Atul R. Bendale and Sandhya L. Borse. Vaishali Naphade conceived the original idea. Laxmikant B. Borse supervised the project.

4. CONFLICT OF INTEREST

Conflict of interest declared none.

5. REFERENCES

1. Ghisalberti EL. Lantana camara L. (Verbenaceae). Fitoterapia. 2000;71(5):467-86. doi: 10.1016/S0367-326X(00)00202-1.
2. Sankaran KV, Forest A-P, Invasive Species Network. The fact sheet is supported by the Food and Agriculture Organization of the United Nations (FAO) and the USDA Forest Service. USDA Forest Service; 2007.
3. Khare CP. Indian medicinal plants – an illustrated dictionary. Berlin: Springer; 2007.

4. Ganjewala D, . RL. Identification of Cymbopogon Species and C. flexuosus (Nees Ex. Steud) Wats Cultivars Based on Polymorphism in Esterase Isoenzymes. J Plant Sci. 2007;2(5):552-7. doi: 10.3923/jps.2007.552.557.
5. Barre JT, Bowden BF, Coll JC, Jesus D, La Fuente D, Janairo V, et al. A bioactive triterpenoid from Lantana camara. Phytochemistry. 1997;4:321-4.
6. Andersson S, Dobson HEM. Behavioural foraging responses by the butterfly Heliconius Melpomene to Lantana camara floral scent. J Chem Ecol. 2003;29(10):2303-18. doi: 10.1023/a:1026226514968, PMID 14682513.
7. Santos IEM. A taxonomic revision of Lantana sect. Lantana (Verbenaceae) in the Greater Antilles. Willdenowia. 2002;32(2):285-301. doi: 10.3372/wi.32.32210.
8. Oladoye SO. Lantana camara: phyto-constituents and antimicrobial Activity Study. PAJOLS. 2021;5(2):289-98. doi: 10.36108/pajols/1202.50.0270.
9. Pan WD, Mai LT, Li YJ, Xu XL, Yu DQ. Studies on the chemical constituents of the leaves of Lantana camara. Yao Xue Xue Bao. 1993;28(1):35-9. PMID 8328268.
10. Ganjewala D, Sam S, Hayat Khan K. Biochemical compositions and antibacterial activities of Lantana camara plants with yellow, lavender, red and white flowers. Eurasia J Biosci. 2009:69-77. doi: 10.5053/ejobios.2009.3.0.10.
11. Pan WD, Li YJ, Mai LT, Ohtani K, Kasai R, Tanaka O. Studies on chemical constituents of the roots of Lantana camara. Yao Xue Xue Bao. 1992;27(7):515-21. PMID 1442083.
12. Ayub A, Begum S, Ali SN, Ali ST, Siddiqui BS. Triterpenoids from the aerial parts of Lantana camara. J Asian Nat Prod Res. 2019;21(2):141-9. doi: 10.1080/10286020.2017.1408595, PMID 29188728.
13. Begum S, Zehra SQ, Hassan SI, Siddiqui BS. Noroleanane triterpenoids from the aerial parts of Lantana camara. Helv Chim Acta. 2008;91(3):460-7. doi: 10.1002/hlca.200890050.
14. Pan WD, Li YJ, Mai LT, Ohtani KH, Kasai RT, Tanaka O, et al. Studies on triterpenoid constituents of the roots of Lantana camara. Yao Xue Xue Bao. 1993;28(1):40-4. PMID 8328269.
15. Singh R, Tiwari B, Sharma U, Singh S. Chemical composition of Lantana camara fruit essential oil. Asian J Chem. 2012;24(12):5955-6.
16. Rana VS, Prasad D, Blazquez MA. Chemical Composition of the Leaf Oil of Lantana camara. J Essent Oil Res. 2005;17(2):198-200. doi: 10.1080/10412905.2005.9698874.
17. Begum S, Zehra SQ, Wahab A, Siddiqui BS. Triterpenoids secondary metabolites from Lantana CamaraLinn. Helv Chim Acta. 2006;89(9):1932-41. doi: 10.1002/hlca.200690184.
18. Begum S, Ayub A, Shaheen Siddiqui B, Fayyaz S, Kazi F. Nematicidal triterpenoids from Lantana camara. Chem Biodivers. 2015;12(9):1435-42. doi: 10.1002/cbdv.201400460, PMID 26363887.
19. Naz R, Bano A. Phytochemical screening, antioxidants and antimicrobial potential of Lantana camara in different solvents. Asian Pac J Trop Dis. 2013;3(6):480-6. doi: 10.1016/S2222-1808(13)60104-8.
20. Barreto F, Sousa E, Campos A, Costa J, Rodrigues F. Antibacterial activity of Lantana camara Linn and Lantana montevidensis Brig extracts from Cariri-Ceará, brazil. J Young Pharm. 2010;2(1):42-4. doi: 10.4103/0975-1483.62211, PMID 21331189.
21. Mansoori A, Singh N, Dubey SK, Thakur TK, Alkan N, Das SN, et al. Phytochemical characterization and assessment of crude extracts from Lantana camara L. for antioxidant and antimicrobial activity. Front Agron. 2020;2. doi: 10.3389/fagro.2020.582268.
22. Gidwani BK. The analgesic, anti-inflammatory and anti-hemorrhoidal activity of the aqueous extract of Lantana CamaraLinn. Res J Pharm Technol. 2009;2(2):378-81.
23. Shonu J, Priyank I, Amit J, Dubey BK. Pharmacognostic and phytochemical evaluation and antipyretic activity of leaves of Lantana camara Linn. Int J Biomed Adv Res. 2011;2:270-80.
24. Hotez PJ, Brindley PJ, Bethony JM, King CH, Pearce EJ, Jacobson J. Helminth infections: the neglected tropical diseases. J Clin Invest. 2008;118(4):1311-21. doi: 10.1172/JCI34261, PMID 18382743.
25. Patel J, Deepika S, Qureshi SA. Phytochemical and anthelmintic evaluation of Lantana camara (l.) var. aculeate leaves against Pheretima Posthuma. J Glob Trends Pharm Sci. 2011.
26. Srivastava D, Singh P. Antifungal potential of two common weeds against plant pathogenic fungi-Alternaria ssp. Asian J Exp Biol Sci;2(3):525-8.
27. Tripathi S. Weed against wood-destroying fungi. Indian Forest. 2009;135(3):403-11.
28. Sathish R, Vyawahare B, Natarajan K. Antiulcerogenic activity of Lantana camara leaves on gastric and duodenal ulcers in experimental rats. J Ethnopharmacol. 2011;134(1):195-7. doi: 10.1016/j.jep.2010.11.049, PMID 21129476.
29. Thamotharan G, Sekar G, Ganesh T, Sen S, Chakraborty R, Kumar SN. Antiulcerogenic effects of Lantana camara Linn. leaves on in vivo test models in rats. Asian J Pharm Clin Res. 2010;3:57-60.
30. Ganesh T, Sen S, Thilagam E, Thamotharan G, Loganathan T, Chakraborty R. Pharmacognostic and anti-hyperglycemic evaluation of Lantana camara (L.) var. aculeate leaves in alloxan-induced hyperglycemic rats. Int J Res Pharm Sci. 2010;1:247-52.
31. Venkatachalam T. Antidiabetic activity of Lantana camara Linn fruits in normal and streptozotocin-induced diabetic rats. J Pharm Res. 1550-2;4(5).
32. Misra N, Sharma M, Raj K, Dangi A, Srivastava S, Misra-Bhattacharya S. Chemical constituents and anti filarial activity of Lantana camara against human lymphatic filariid Brugia malayi, and rodent filariid Acanthocheilonema vitae maintained in rodent hosts. Parasitol Res. 2007;100(3):439-48. doi: 10.1007/s00436-006-0312-y, PMID 17061115.
33. Pour BM, Latha LY, Sasidharan S. Cytotoxicity and oral acute toxicity studies of Lantana camara leaf extract. Molecules. 2011;16(5):3663-74. doi: 10.3390/molecules16053663, PMID 21540795.
34. Kumar MS, Maneemegalai S. Evaluation of the larvicidal effect of Lantana camara Linn against mosquito species Aedes aegypti and Culex quinquefasciatus. Adv Biol Res. 2008;2:39-43.
35. Ghodake PP, Kulkarni AS, Aloorkar NH, Osmani RA, Bhosale RR, Harkare BR. In vitro, antispasmodic activity analysis of methanolic leaves extracts of Lantana camara on excised rat ileum. J Pharmacogn Phytochem. 2013;2:66-71.

36. Tadesse E, Engidawork E, Nedi T, Mengistu G. Evaluation of the anti-diarrheal activity of the aqueous stem extract of Lantana camara Linn (Verbenaceae) in mice. BMC Complement Altern Med. 2017;17(1):190. doi: 10.1186/s12906-017-1696-1, PMID 28376868.
37. Kalita S. Phytochemical composition and in vitro hemolytic activity of Lantana camara L. (Verbenaceae) leaves. Pharmacologyonline. 2011;1:59-67.
38. de Mello FB, Jacobus D, de Carvalho KC, de Mello JR. Effects of Lantana camara (Verbenaceae) on rat fertility. Vet Hum Toxicol. 2003;45(1):20-3. PMID 12583691.
39. Naz R, Bano A. Phytochemical screening, antioxidants and antimicrobial potential of Lantana camara in different solvents. Asian Pac J Trop Dis. 2013;3(6):480-6. doi: 10.1016/S2222-1808(13)60104-8.
40. Mayee R, Thosar A. Evaluation of Lantana camara Linn. (Verbenaceae) for antiurolithiatic and antioxidant activities in rats. Int J Pharm Clin Res;3(1):10-4.
41. Nayak BS, Raju SS, Eversley M, Ramsubhag A. Evaluation of wound healing activity of Lantana camara L. - a preclinical study. Phytother Res. 2009;23(2):241-5. doi: 10.1002/ptr.2599, PMID 18844241.
42. Abdulla MA. Acceleration of wound healing potential by Lantana camara Leaf extracts in experimental rats. Res J Med Sci. 2009;3(2):75-9.
43. Ved A, Arsi T, Prakash O, Gupta A. A review on phytochemistry and pharmacological activity of Lantana camara Linn. Int J Pharm Sci Res. 2018;9(1):37-43. doi: 10.13040/IJPSR.0975-8232.9(1).37-43.
44. Wollenweber E, Dörr M, Muniappan R, Siems K. Flavonoid aglycones and triterpenoids from the leaf exudate of Lantana camara and Lantana montevidensis. Biochem Syst Ecol. 1997;25(3):269-70. doi: 10.1016/S0305-1978(96)00115-9.
45. Gotyal BS C, Srivastava S, Walia. S, K Jain and DS. Efficacy of wild sage (Lantana camara) extracts against almond moth. (Cadra cautella) in stored wheat (Triticum aestivum) seeds. Indian J Agric Sci. 2010;80(5):433-6.
46. Day MD. Factors influencing the biological control of lantana camarain Australia and South Africa. Proceedings of the X international symposium on biological control of weeds. 1999;4:897-908.
47. Ali-Emmanuel N, Moudachirou M, Akakpo JA, Quetin-Leclercq J. Treatment of bovine dermatophilosis with Senna alata, Lantana camara and Mitracarpus sabre leaf extracts. J Ethnopharmacol. 2003;86(2-3):167-71. doi: 10.1016/s0378-8741(03)00054-0, PMID 12738081.
48. Pasha C, Nagavalli M, Rao LV. Lantana camara for fuel ethanol production using thermotolerant yeast. Lett Appl Microbiol. 2007;44(6):666-72. doi: 10.1111/j.1472-765X.2007.02116.x, PMID 17576231.
49. da Silva MHL, Andrade EHA, Zoghbi MdGB, Luz AIR, da Silva JD, Maia JGS. The essential oils of Lantana camara L. occur in North Brazil. Flavour Fragr J. 1999;14(4):208-10. doi: 10.1002/(SICI)1099-1026(199907/08)14:4<208::AID-FFJ811>3.0.CO;2-F.
50. Banik RM, Pandey DK. Optimizing conditions for oleanolic acid extraction from Lantana camara roots using response surface methodology. Ind Crops Prod. 2008;27(3):241-8. doi: 10.1016/j.indcrop.2007.09.004.
51. Kuhad RC, Gupta R, Khasa YP, Singh A. Bioethanol production from Lantana camara (red sage): pretreatment, saccharification and fermentation. Bioresour Technol. 2010;101(21):8348-54. doi: 10.1016/j.biortech.2010.06.043, PMID 20584600.
52. Zoubiri S, Baaliouamer A. Larvicidal activity of two Algerian Verbenaceae essential oils against Culex pipiens. Vet Parasitol. 2011;181(2-4):370-3. doi: 10.1016/j.vetpar.2011.04.033, PMID 21592668.
53. Begum S, Zehra SQ, Wahab A, Siddiqui BS. Triterpenoids Secondary Metabolites from Lantana CamaraLinn. Helv Chim Acta. 2006;89(9):1932-41. doi: 10.1002/hlca.200690184.
54. Khan M, Srivastava SK, Syamasundar KV, Singh M, Naqvi AA. Chemical composition of leaf and flower essential oil of Lantana camara from India. Flavour Fragr J. 2002;17(1):75-7. doi: 10.1002/ffj.1047.
55. Sharma OP, Singh A, Sharma S. Levels of lantadenes, bioactive pentacyclic triterpenoids, in young and mature Lantana camara var. aculeate leaves. Fitoterapia. 2000;71(5):487-91. doi: 10.1016/S0367-326X(00)00156-8.
56. Sharma OP. Review of the biochemical effects of Lantana camara toxicity. Vet Hum Toxicol. 1984;26(6):488-93. PMID 6393560.
57. El-Banna AA, Darwish RS, Ghareeb DA, Yassin AM, Abdulmalek SA, Dawood HM. Metabolic profiling of Lantana camara L. using UPLC-MS/MS and revealing its inflammation-related targets using network pharmacology-based and molecular docking analyses. Sci Rep. 2022;12(1):14828. doi: 10.1038/s41598-022-19137-0, PMID 36050423.
58. Ved A, Arsi T, Prakash O, Gupta A. A review on phytochemistry and pharmacological activity of Lantana camara Linn. Int J Pharm Sci Res. 2018;9(1):37-43. doi: 10.13040/IJPSR.0975-8232.9(1).37-43.
59. Singh SK, Singh A, Tripathi VJ, Finzi PV. ChemInform Abstract: minor constituents of Lantana camara. ChemInform. 2010;28(39):no. doi: 10.1002/chin.199739213.
60. Batt AM, Ahmed MS. CHEMICAL COMPONENTS OF LANTANA (LANTANA CAMARA L) AND LEMONGRASS (CYMBOPOGON CITRATUS "DC." STAPF.) PLANTS IN EGYPT. Menoufia J Agric Biotechnol. 2016;1(1):1-11. doi: 10.21608/mjab.2016.176600.