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PHYTOCHEMICAL AND MEDICINAL STUDY OF *LANTANA CAMARA* LINN. (VERBENACEAE) - A REVIEW

L. D. Battase* and D. L. Attarde

Department of Pharmacognosy, MGV's Pharmacy College, Nashik - 422003, Maharashtra, India.

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Lantana camara, Verbenaceae, antioxidant, antibacterial, anti-inflammatory, etc.

Correspondence to Author:

L. D. Battase

Department of Pharmacognosy,
MGV's Pharmacy College, Nashik -
422003, Maharashtra, India.

E-mail: battaselalita@gmail.com

ABSTRACT: *Lantana camara* is a plant from the family- Verbenaceae. It is found in many states of India, mostly in Jammu-Kashmir, Himachal Pradesh, Tamil Nadu, South India, Uttar Pradesh and various parts of Maharashtra and other countries also. Mainly in disturbed areas, which include roadside, railway tracks, and canals. It is an ornamental plant but, in ancient times, it was used traditionally. The plant has various traditional uses. Parts of plant extracts are used traditionally like the healing of wounds, cuts, skin itches, eczema. The plant containing many more phytoconstituents like alkaloids, glycosides, saponins, steroids, terpenoids, carbohydrates, flavonoids, coumarins, etc. It has various pharmacological activities antioxidant, anti-microbial, antibacterial, antifungal, antiulcerogenic, anthelmintic, anti-hyperglycemic, anti-inflammatory, analgesic, anti-cancer, antitubercular, etc. It also has mosquito larvicidal activity. This review article was written by the study of many research and review articles from 1956 to March 2021 in which 72 articles were cited. This article reviewed various phytochemicals present in *L. camara*. The review draws attention to the traditional uses, analytical work, pharmacological activities and toxicology of this plant and also the potential uses of this plant.

INTRODUCTION: *Lantana camara* is a flowering ornamental plant. It is used in several traditional medicinal preparations and is well known to cure several diseases. It is a major source of various classes of bioactive natural metabolites. From ancient times, flowers were used as pectoral for children, leaves and fruits of that plant can be used externally in various skin diseases, cuts and wounds. Stems and roots are used for gargles and toothaches as a toothbrush. The present article is reviewed that the phytochemical, analytical,

pharmacological activities and toxicology of *Lantana camara* Linn.¹⁻³

Synonyms: The plant having different names in different countries, in Marathi-Ghaneri, Tantani; Hindi-Raimuniya; English-Spanish flag, Wild sage; Tamil-Unnichedi; Kannada-Kakke, Natahu; Telugu-Pulikampa; Manipuri-Samballei, Nongballei; German-Wandelroschen; Arabic-Multawiat Em Kalthoom, Mina Shajary; Brazil-Cambara de espinto; Spanish-Cinco negritos; French-Lantanier, Verbene; Malaysia-Ayam, Big sage, Black sage^{4, 5}.

Biological source: It is a flowering ornamental plant of *Lantana camara* Linn. belonging to the family- Verbenaceae⁶.

Taxonomy: Classification of *L. camara* Linn. as follows, Kingdom: Plantae; Subkingdom: Tracheo-

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bionta; Superdivision: Spermatophyta; Division: Magnoliophyta; Class: Magnoliopsida; Subclass: Asteridae; Order: Lamiales; Family: Verbenaceae; Genus: *Lantana*; Species: *L. camara*.⁷

Geographical Distribution: The *Wild sage* plant is found in many states in India like Jammu-Kashmir, South India, Tamil Nadu, in various parts of Maharashtra and also in Himachal Pradesh and Uttar-Pradesh. It is found in the Caribbean and central and northern South America also now dispersed in about 60 tropical and subtropical countries and also temp. parts of the world. It extends from the innate range of the Greater Antilles, the Bahamas and Bermuda also on the lesser Antilles, through Trinidad and Aruba.

It is usually found in beach areas of the United States from South America to northern Mexico and from Georgia through Texas as well as Peru and Brazil and possibly Northern Argentina and Bolivia. It has adapted to the most suitable habitats in tropical and subtropical Africa, Australia, and Asia. It is also found in many African countries including South Africa, Uganda, Kenya, and Tanzania⁸⁻¹¹.

Plant Description:¹²⁻¹⁴ *L. camara* is a low erect or subscandent vigorous shrub with a tetragonal stem, a strong odour of black currants and stout recurved pickles. The plant is found up to height 1 to 3 m and its width is 2.5 m. Images of plants, flowers, fruits, front and dorsal view leaf as shown in **Fig. 1**.



FIG. 1: IMAGES OF LANTANA CAMARA LINN. A) WHOLE PLANT, B) LEAF (DORSAL & FRONTAL VIEW), C) FLOWER, D) FRUITS

Leaves: Leaves are ovate or ovate-oblong, crenate serrate, acute or subacute, rugose above, scabrid on both sides. The leaves are averagely 3-8 cm long and 3-6 cm wide and have a green colour. Leaves and stems are covered with rough hairs. Leaves are the main source of phosphorous and potassium when used as green mulch.

Inflorescence: Pairs in the axils of opposite leaves inflorescences are produced, which are compact, dome-shaped 2-3 cm across and contain 20-40 sessile flowers.

Flowers: Flowers of *L. camara* are small usually yellow or orange changing to red or scarlet, in dense axillary heads. The calyx is small, corolla tube slender, the limb spreading 6 to 7 mm wide and divided into unequal lobes. Stamen is four in two pairs, which included ovary two ovules, two-celled. Flowering arises between August and March, or all-around year if suitable moisture and light are available and small flowers are held in clusters. Colour usually orange, sometimes varying from white to red in various shades and the flowers usually change colours as they age.

In the axillary head, flowers have a yellow throat almost throughout the year.

Fruits: The ripe fruits are heavily consumed by birds and frequently eaten by humans in some countries.

Roots: The root system of this plant is very strong and even after repeated cuttings, it gives out new fresh shoots.

Ecology: *Ghaneri* is collected from an area that about 250 mm to 2900 mm of rainfall. It grows on all types of well-drained soil. It tolerates salt spray and keeps out in a dry period very well. Aerial portions of the plant are killed by temperatures of -2°C but quickly grow back.

It is colonizing disturbed areas because they are an intolerant pioneer³. The species of that plant occur in varied habitats at open unshaded regions which include forests, rainforest edges, wastelands, beach fronts and spread by activities like logging or fire. The species also grow well in disturbed areas which include beach areas, roadside, railway tracks and canals.

At early of the second growing (summer) season Lantana can flower. In most places, during the wet, summer months if adequate moisture, light and temperature are available with flowering peaking plants can be a flower.

Flowering occurs only in the warmer or wetter months, in drier or cooler regions. Seeds are widely spread, usually by birds but also pets such as cattle, goats, sheep and also by jackets and foxes¹⁵⁻¹⁸.

Traditional uses: *L. camara* was used as a garden decorative plant while in some countries it is implanted as a border to keep out animals.

It has many more therapeutic uses, mostly as herbal medicine. On this natural element of plant extract, there has been abundant work conducted in India¹⁹.

Leaves of Lantana show biocidal activity, fungicidal, anti-microbial, nematicidal, insecticidal. Powdered leaves are used for swellings, wounds, cuts, and ulcers and an infusion of the leaves is used for eruptions, eczema and bilious fever²⁰.

Lantana oil is used to treat wounds as an antiseptic, skin itches, and also reported in the treatment externally for scabies and leprosy²¹. This plant is used as carminative, diaphoretic, tonic, antispasmodic, antiemetic, respiratory disorders (bronchitis, asthma, cold and cough) and to treat respiratory infections also in the treatment of gastropathy, epilepsy, tetanus and dysentery. The compound isolated from *tantani* extract can be reported that is verbascoside, which has been established to pass antitumor activities, immune suppressive and anti-microbial. The fruits are used in rheumatism, fistula, tumors, and pustules. The roots are used in rheumatism, malarial, dermatitis, skin rashes, eczema, respiratory tract infections including tuberculosis and influenza, and mycotic infections²²⁻²⁴.

An infusion of the entire plant is boiled for tea and the decoction is therapy against cough and it is used as a lotion for wounds and crushed leaves are useful to swellings, cuts and ulcers²⁵.

Potential Uses: Sulphate process is on the stems of *L. camara* carried out to produce printing and writing paper, temporary shelters, and making baskets also used as a fuel for heating and cooking. For many native birds, it may provide vital winter food and shelter. When natural habitat is unavailable a no. of endangered bird species uses its tickets and it is a major liquid source for various species of moths and butterflies. It can also be used for the prevention of erosion and soil compaction. Organic substances of this plant are used for grassland renovation. In Australia, the nursery sector is a brilliant source of income as an ornamental plant. The roots containing substances of the plant are sometimes used in the rubber industry. The plant has been used for biogas production mixed with cow dung and the seeds have additional nutritive value when feeding with wheat straw to sheep. It is used in some household furniture like chairs and tables are made from the stems, or the small branches are bundled together to make brooms and sometimes used as mulch and firewood²⁶⁻²⁸.

Phytochemical Constituents: The literature proposes the plant of *Lantana camara* possesses important bioactive compounds, as shown in **Fig. 2**.

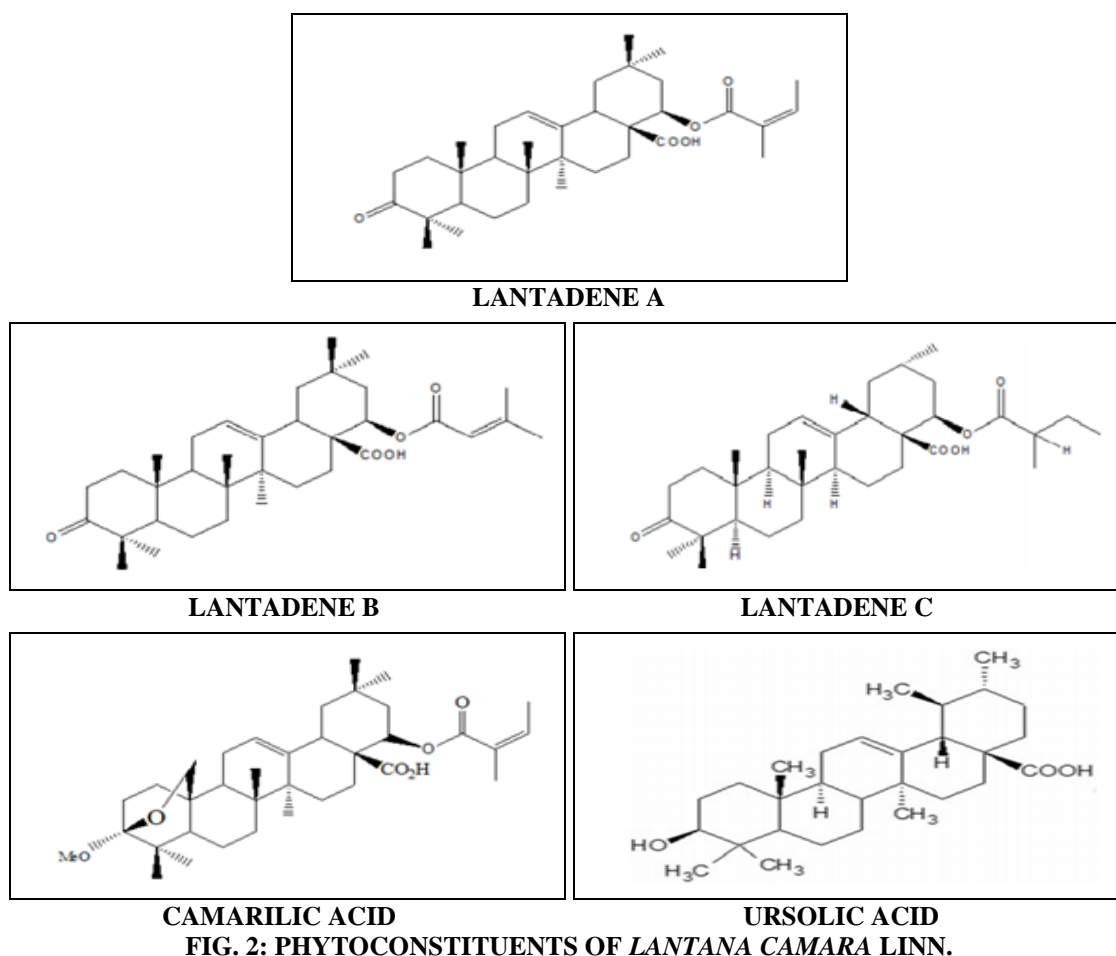


FIG. 2: PHYTOCONSTITUENTS OF *LANTANA CAMARA* LINN.

Parts of *L. camara* like leaf, stem and roots contained flavonoids, alkaloids, tannin, protein, catechin, phenol, saponin, steroids, anthraquinone, reducing sugar and several tri-terpenoids which contain various important phytochemicals such as verbascoside, linarioside, lantanoside, umuhengerin, ursolic acid, carmarinic acid, camarilic acid, and phytol. These are mostly responsible for using various biological activities²⁹⁻³².

The elements of essential oil of *Lantana* are sabinene, β -caryophyllene, α -humulene, 1,8-cineole and 8-hydroxy bicycle germacrene, caryophyllene, 1,8-cineol, two rare sesqui-terpenoid humulene epoxide-III, sabinene³³.

Chemical investigation of the flower and leaves extract to give knowledge of similar lipid and carbohydrate compositions.

The flowers carried carbohydrates more than leaves; although the lipids were more in the leaf extract³⁴.

Pentacyclic triterpenoids (camangeloyl acid, methyl camaralate and camaryolic acid), octadecanoic acid, palmitic acid, camaric acid, β -sitosterol 3-o-beta-D- glycopyranoside, docosanoic acid, lantanolic acid, oleanolic acid, icterogenin, lantadene A, lantadene B, and lantadene C were isolated from the aerial parts of it³⁵.

TABLE 1: ESSENTIAL OILS PRESENT IN FLOWER, FRUIT AND LEAVES OIL EXTRACT OF *L. CAMARA*³⁶

S. no.	Oil extract	Essential oils	References
1	Flower oil	Thymol (32.3%), (E)- β -caryophyllene (13.5%), α -humulene (6.4%), sabinene (15.6%), β -phellandrene (7.1%), germacrene D (6.6%)	<i>Fatimata Nea et al.</i> (2017)
2	Fruit oil	(E)- β -caryophyllene (25.5-32.6%), α -humulene (12.4-13.3%), limonene (16.0%), (E)- β -farnesene (5.5%), bicyclogermacrene (6.2%), τ -cadinol (5.0%)	
3	Leaf oil	(E)- β -caryophyllene (40.8%), α -humulene (21.2%), sabinene (9.0%), bicyclogermacrene (7.9%), germacrene D (6.9%), α -pinene (4.4%), β -elemene (3.5%), linalool (0.4-1.9%), sesquithuriferol (0.3-1.7%), spathulenol (0.2-1.5%), (E)-nerolidol and τ -cadinol (0.0-1.0%)	

TABLE 2: PHARMACEUTICAL FORMULATIONS WITH THEIR BIOLOGICAL ROLE USING L. CAMARA

S. 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 removing 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)

Qualitative Analysis:

Preliminary Phytochemical Analysis: Ganatra SH et al., (2016) studied that preliminary phytochemical analysis of aerial parts of plant extracts of *L. camara* using various solvents was done qualitative analysis and identification test. In that article for Alkaloids-Hager's test, for Glycosides-Liebermann's test, for Saponins-Foam test, for Carbohydrates-Molisch's test, for Steroids-Liebermann Burchard test, for Flavonoids-Lead acetate test was done. As per the researcher's work, the aerial part of plant extract contains various metabolites like alkaloids, glycosides, saponins, carbohydrates, steroids, terpenoids, flavonoids, coumarins, etc. Phytochemical analysis using n-Hexane extract alkaloids, saponin, steroids, and terpenoids tests are positive. In ethyl acetate extract saponin, steroids, terpenoids, flavonoids, coumarins tests are positive. In methanol extract, glycosides, saponins, terpenoids, carbohydrates, flavonoids and coumarins tests are positive in ethanol extract saponin, steroids, terpenoids, carbohydrates and flavonoids tests are positive⁴⁴.

Sushama Raj RV (2017) studied that preliminary phytochemical analysis of leaves and root extract of *L. camara* using maceration method with solvents separately in acetone, petroleum ether, chloroform, ethyl alcohol, benzene and water. As per the researcher's phytochemical screening of leaves and roots, solvents extract containing metabolites are proteins, amino acids, carbo-

hydrates, alkaloids, saponins, phytosterols, phenols, tannins, flavonoids, steroids, and vitamin C.⁴⁵

Kedar KA et al. (2012) studied the phytochemical screening of successive leaf extract of *L. camara* with solvents petroleum ether, ethyl acetate, methanol and water. As per the researcher's work, all solvent extract contains metabolites are saponins, flavonoids, tannins, alkaloids, fats and oil. In that article Saponins-Foam test, for Flavonoids-Shinoda test, Sulphuric acid test, for Tannins-5% FeCl₃ test, Lead acetate test, Bromine water test, for Alkaloids-Dragendrop's test, Mayer test, for Fats and oil- solubility test was done. In petroleum ether extract, fats and oils test is positive. In ethyl acetate extract, tannins and fats and oils, tests are positive. In methanol extract saponins, flavonoids, tannins, fats, and oil tests are positive. In aqueous extract, saponins, flavonoids, tannins, alkaloids, fats, and oil tests are positive⁴⁶.

TLC Analysis: Ganatra SH et al., (2016) studied the TLC of aerial parts of *L. camara* with various solvents extracts like n-Hexane, ethyl acetate, methanol using different mobile phases for each extract⁴⁴. Jain S et al., (2011) studied that TLC of ethanolic leaf extract of it can be performed with mobile phase Ethyl Acetate: Methanol (80:20). As per the researcher, the results are shown in **Table 3**. For spot visualization, the Iodine chamber can be used⁴⁷.

TABLE 3: TLC ANALYSIS OF L. CAMARA LINN. WITH DIFFERENT EXTRACTS^{44, 47}

S. no.	Extracts	Mobile Phase	Spots	R _f Value
1	n-Hexane Extract	Ethyl acetate: Chloroform (9:1)	5	0.33, 0.42, 0.46, 0.52, 0.56
2	Ethyl acetate Extract	n-Hexane: Chloroform (9:1)	3	0.45, 0.53, 0.65
3	Methanol Extract	n-Hexane: Chloroform (9:1)	4	0.48, 0.68, 0.85, 0.91
4	Ethanol Extract	Ethyl acetate: Methanol (8:2)	3	0.36, 0.42, 0.46

Vyas N *et al.*, (2014) studied that TLC of oleanolic acid which is isolated from roots of *L. camara* can be performed on a pre-coated plate of Silica G 60 by using mobile phase Chloroform: Methanol (95:5) as shown in **Table 4**. Anisaldehyde-sulphuric acid is used as a spraying reagent⁴⁸.

TABLE 4: TLC ANALYSIS OF *L. CAMARA* LINN. COMPARED WITH STD. OLEANOLIC ACID⁴⁸

S. no.	Track	Mobile Phase	Spots	R _f value
1	Standard Oleanolic acid	Chloroform: Methanol (95:5)	1	0.51
2	Extracted test sample		1	0.50

HPLC Analysis: Vyas N. *et al.*, (2014) and Liang Z. *et al.*, (2009) studied that HPLC analysis of oleanolic acid which is isolated from roots of *L. camara* was analyzed by Shimadzu LC 20 ATVP HPLC system. Column- Exsil ODS Column (250 cm x 4 mm, particle size-5 μ) in isocratic mode. Mobile phase - acetonitrile: water (85:15 v/v), Column temperature - 30°C (const.), the flow rate of mobile phase - 1ml/min, Detector – photodiode array detector (This detector monitored elution at 215 nm.). HPLC spectra of standard oleanolic acid showed two peaks at 2.43 min. and 7.01 min and extracted test sample of oleanolic acid showed at 1.73 min., 2.44 min. and 6.94 min. By observation, we say that with some minor impurities isolated test sample of oleanolic acid shows resembling HPLC spectra as compared to HPLC spectra of standard oleanolic acid^{48, 49}.

Hitesh SH *et al.* (2012) studied that HPLC analysis of pentacyclic triterpenoids isolated from aerial parts of *L. camara* was analyzed using column-phenomenex, C18, 5 μ m, 250 x 4.6 mm, mobile phase-pump A (Acetic acid 0.5%) and pump B (water: acetonitrile (90:10 v/v)), flow rate- 1ml/min with gradient elution. The volume of injection- 20 μ l, detector- SPD-M20A prominence diode array detector at 242 nm. As per research work, two peaks with similar retention times were observed at 18.496 min and 18.246 min. From that observation, it is showed that an isolated compound of pentacyclic terpenoids is present in the aerial part of plant extract⁵⁰.

HPTLC Analysis: Mahvish Jamal *et al.* (2018) studied the isolation and validation of ursolic acid from leaves of *Lantana camara* by HPTLC.

Extraction was carried out with different methods maceration, reflux, Soxhlet and UAE by using different solvents ethanol, methanol, acetone and chloroform. The methanolic extract gives a high % of yield, on that basis for HPTLC analysis methanolic extract was used. Instrument-Camag Linomat V (Switzerland), Stationary phase-Precoated silica gel aluminium plates 60F 254 (20 x 10 cm), mobile phase-Toluene: Acetone: Formic acid (7.8: 2.2: 0.15). Scan at 540 nm and R_f of ursolic acid was observed 0.49⁵¹.

Jaafar N S *et al.* (2018) studied the detection of phenolic acids in leaves extract of *L. camara* by HPTLC. Extraction was done with method maceration using petroleum ether and ethanol as a solvent followed by acid hydrolysis was done with crude ethanolic extract in reflux, then fractionation was done with solvents petroleum ether, chloroform, ethyl acetate and n-butanol. HPTLC analyzed the chloroform and ethyl acetate fractions compared with standards. For this instrument was used is CAMAG-Laboratory, Switzerland, plates were used silica gel 60 F 254 (20 x 10 cm), mobile phase- chloroform: ethyl acetate: formic acid (25: 20: 5), at 254 and 366 nm wavelength and spray-5% alcoholic KOH. Phenolic acids detected in chloroform and ethyl acetate fractions are Gallic acid, caffeic acid, and p-coumaric acid. Gallic acid detected only ethyl acetate fractions⁵².

T. Venkatachalam *et al.* (2010) studied the detection of flavonoids from dried fruits of *L. camara* by HPTLC compared with Rutin as a standard. The successive extraction method was used with solvents petroleum ether, chloroform, methanol, and water. The methanolic extract was used for detection of flavonoids by HPTLC, Mobile phase used was ethyl acetate: methanol: water (10: 1.65: 1.35). At 366 nm, 5 spots of active constituents were confirmed⁵³.

Quantitative Analysis:

Total Phenolic Content: Farooq Anwar *et al.*, (2013) studied that the determination of total phenolic content (TPC) from leaves and flowers of *L. camara* with different concentrations of ethanol and methanol extracts was done by Folin-Ciocalteu Method. The amount of TPC present in leaves and flowers extracts of it was compared with gallic acid standard. The result was analyzed by Gallic Acid

Equivalent (GAE) g/100g of dry weight (DW). 80% methanol and 80% ethanol contained higher TPC as compared to absolute ethanol. 80% methanol flowers extract of TPC is higher (21.45 g GAE/100g DW) than leaves extract (18.37 g GAE/100g DW)⁵⁴.

Mortada M. El-Sayed *et al.* (2017) studied that total phenolic content of leaves, stem and flower of *L. camara* was determined. Leaves, stems and flowers are extracted separately with 85% methanol. Methanolic extract further defatted with petroleum ether and fractionated with solvents like dichloromethane, ethyl acetate, n-butanol and water. The TP content was determined by the Folin-Ciocalteu method, gallic acid is used as a standard. In that methanolic flowers, the extract contains higher (180.3 g GAE/g of extract) TPC than stems (57.28 g GAE/g of extract) and leaves (148.97 g GAE/g of extract) extract and ethyl acetate fractions also gives higher (301.5 g GAE/g of extract) TPC than other solvent fractions⁵⁵.

Total Flavonoid Content: Farooq Anwar *et al.*, (2013) studied that the determination of total flavonoid content (TFC) from leaves and flowers of *L. camara* with different concentrations of ethanol

and methanol extracts was done by AlCl₃ Method. The amount of TFC present in leaves and flowers extracts of it was compared with the standard. The result was analyzed by catechin equivalent (CE) g/100g of DW. As per the researcher, 80% methanol and 80% ethanol contained higher TFC as compared to absolute ethanol. 80% methanol flowers extract of TFC is higher (13.76 g CE/100g DW) than leaves extract (13.41 g CE/100g DW)⁵⁴.

Mortada M. El-Sayed *et al.* (2017) studied the total flavonoid content of leaves, stems, and flowers of *L. camara* was determined. Leaves, stems, and flowers are extracted separately with 85% methanol. The methanolic extract was further defatted with petroleum ether and fractionated with solvents like dichloromethane, ethyl acetate, n-butanol, and water.

The TF content was determined AlCl₃ method; Rutin is used as a standard. In that methanolic flowers extract contains higher (99.7 mg RE eq./g of extract) TFC than stems (42.63 mg RE eq./g of extract) and leaves (63.76 mg RE eq./g of extract) extract and ethyl acetate fractions also gives higher (126.17 mg RE eq./g of extract) TFC than other solvents fractions⁵⁵.

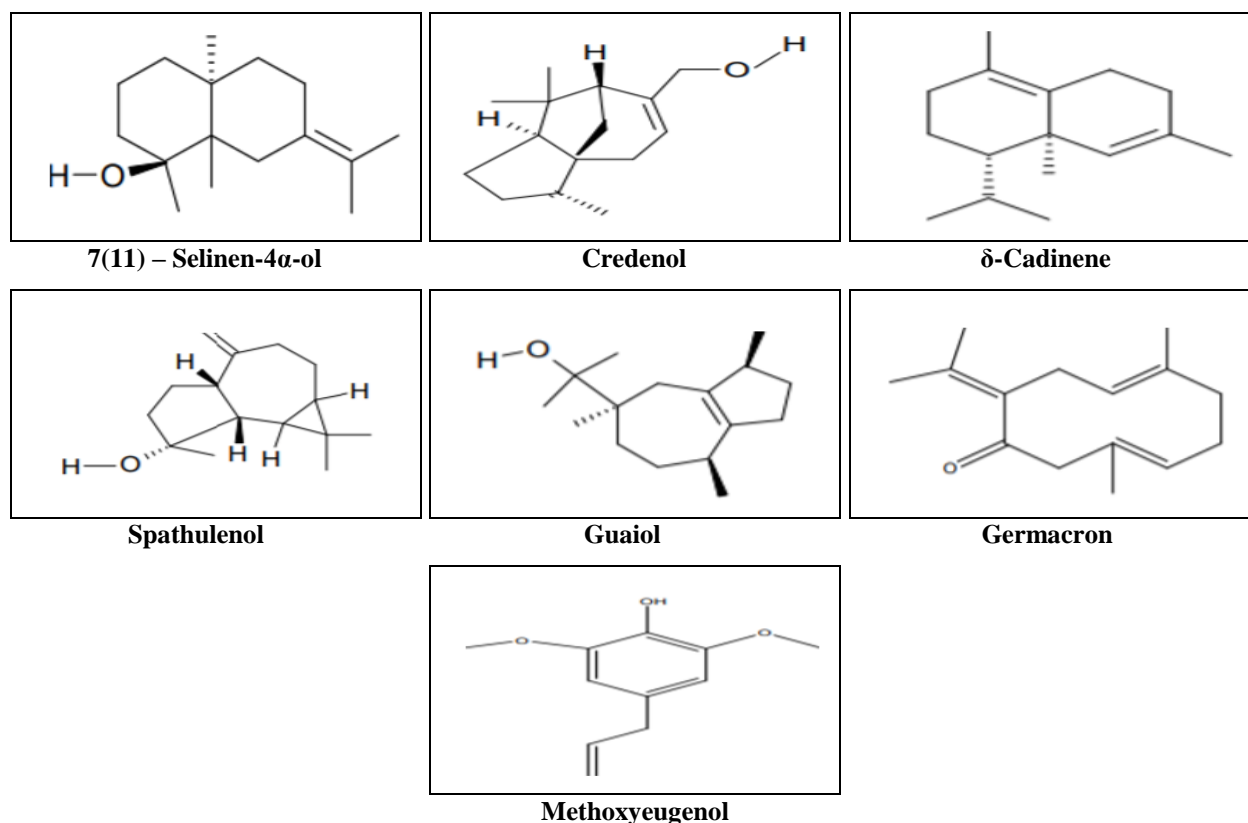


FIG. 3: THE STRUCTURE OF MAJOR COMPOUND FOUND IN THE ESSENTIAL OIL OF LEAVES AND FLOWERS OF *L. CAMARA*

GC-MS Analysis: Mortada ME *et al.*, (2017) studied that Essential oil extracted from leaves and flowers of *L. camara* by Clevenger-type apparatus were injected to GC-MS technique. The identification of the components of each essential oil was done by their molecular formula (MF), retention time (RT), molecular weight (MW), mass fragmentation pattern, and concentration (%). The researcher found 47 essential oil components from leaves and 40 components from flowers. Those compounds are majorly classified as monoterpenes, sesquiterpenes, and fatty acids. The major compound detected in essential oil of leaves extract were 7(11)-selinen-4 α -ol (14.5%), 4a,7-methano-4a H-naphth [1,8a-b] oxirene, octahydro-4,4,8,8-tetramethyl (6.5%), cedrenol (6.5%), δ -cadinene (5.8%), linoleic acid (6.3%), guaiol (5%), spathulenol (5%) and the compounds in the essential oil of plant flowers were found farnesyl acetone (7.15%), cedrenol (10.71%), clovane (5.08%), germacron (5.21%), and methoxyeugenol (5.06 %). The structure of majorly identified compounds of essential oil of leaves and flowers of it. As shown in **Fig. 3**⁵⁵.

Pharmacology Activities:

Antioxidant Activity: Bhakata D *et al.*, (2009) studied that *in vivo* and *in-vitro* methanolic and ethanolic extract of *L. camara* shows significant antioxidant activity. In that leaves extract exhibited strong antioxidant activity. The methanolic extract from the stem of *Wild sage* showed weak antioxidant activity. *In vitro*, Antioxidant activity was measured by nitric oxide free radical scavenging method and DPPH radical scavenging activity. The antioxidant activity of icterogenin, lantadene A, lantadene B and lantadene C was examined using DPPH. Lantadene A and B had the highest scavenging activity, while lantadene C and icterogenin showed a lesser antioxidant effect. The extract shown high antioxidant properties in both assays. *In-vivo* studies, ethanolic leaves extract of that plant shows significant antioxidant activity on urolithic rats. On the treatment, ethanolic extract decreased the range of lipid peroxidation in the kidneys of urolithic rats⁵⁶.

Anti-microbial Activity: Kedar KA *et al.*, (2012) studied the *in-vitro* Anti-microbial activity of dried leaves extract of *L. camara* on species of *E. coli*, *Bacillus subtilis* and *Staphylococcus aureus* by the

Agar Plate Method. Four types of solvent extracts can be used for maximum zone inhibition. On Ethyl acetate extract showed resistance by *Staphylococcus aureus* and *E. coli*. Aqueous extract showed resistance by *Bacillus subtilis*. Methanolic extract showed moderate, Aqueous extract showed minimum, and ether extract showed the highest anti-microbial activity⁵⁷.

Antibacterial Activity: Ganjewala D *et al.*, (2009) studied that *in-vitro* antibacterial activity of aqueous and organic extract of *L. camara* leaves were investigated against various clinical pathogens. The ethyl acetate and ethanol extract of leaf effectively inhibited the growth of both gram-positive and negative bacteria. By researcher work, we say that the disc diffusion method showed significant zones of inhibition against test bacteria. The ethanolic leaf extracts exhibited greater inhibition in the test bacteria. The zone of inhibition was higher in *Staphylococcus aureus*, *Klebsiella pneumonia*, and *Proteus Vulgaris*, and moderate inhibition was associated with *Vibrio cholerae*, *Salmonella typhi*, *E. coli*, *Enterobacter aerogenes*, and very poor inhibition was observed against *Staphylococcus epidermitis*. The essential oil of *L. camara* exhibited prominent antibacterial activity against all the bacterial strains tested.⁵⁸

Antifungal Activity: Mudasir F *et al.*, (2017) studied the *in vitro* Antifungal activity of *L. camara* leaf extract with successive extraction using different solvents, acetone, chloroform, ethanol and methanol. For this antifungal activity research used the poisoned food technique. In that mycelial growth zone of fungus in Petri plates and percentage inhibition of fungal growth was measured. Antifungal activity of leaf extract was tested on *Aspergillus flavus* and *Aspergillus Niger* fungal strains. Methanol and Chloroform extract shows maximum zone inhibition⁵⁹.

Antiulcerogenic Activity: Thamotharan G *et al.*, (2010) studied that *in-vivo* antiulcerogenic activity, Pre-treatment with methanol extract of *L. camara* leaves produced a significant antiulcer effect which can be compared with an aspirin-induced ulcer on rats. The methanolic extract of leaves was administered orally in pyloric ligated rats, ethanol-induced gastric ulcer and cysteamine-induced duodenal ulcer.

The plant extract shows healing of gastric ulcers and also prevents the development of duodenal ulcers in rats. The extract shows dose-dependent antiulcerogenic activity in all models⁶⁰.

Mosquito Larvicidal Activity: M. Sathish Kumar *et al.*, (2008) studied that *in vitro* Mosquito larvicidal activity of methanol and ethanol leaves and flower extract of *L. camara* was found to have a higher rate of Larvicidal rate against *Aedes aegypti*. Whereas, in the *Culex quinquefasciatus* variety, the conc. of extracts has to be increased for a better larvicidal effect. An essential oil obtained from the leaves shows larvicidal activity against important vectors of dengue, malaria, yellow fever, hemorrhagic fever, and chikungunya⁶¹.

Anthelmintic Activity: Girme A.S. *et al.*, (2006) studied that *in-vitro* Helminth infection is among the most common infection in men. On selected worms, successive leaf extracts of *L. camara* show significant anthelmintic activity. Anthelmintic activity by methanol extract from the stems, leaves and roots of the plant was investigated against *Pheritima Posthuma*. The methanolic extract of the stem was found to be more effective. The anthelmintic activity on ethanolic extract was also found to be more active⁶².

Anti-Hyperglycemic Activity: Ganesh T. *et al.*, (2010) studied that *in-vivo* Anti-Hyperglycemic activity. Oral administration of a methanol extract of *L. camara* leaves in alloxan-induced diabetic rats showed significant dose-dependent reduction of blood glucose concentration and also promising anti-hyperglycemic activity against alloxan-induced diabetic rats. Aqueous extract of the leaves of it was evaluated using both alloxan-induced hyperglycemic rats and normoglycemic rats also show Anti-Hyperglycemic activity⁶³.

Wound-Healing Activity: Abdulla MA *et al.*, (2009) studied ethanolic leaf extract's *in vivo* wound healing activity on adult male Wistar rats. Topical application of ethanolic leaf extract on wounds showed increasing wound healing activity. Using the excision wound model, aqueous extract of leaf showed significant wound healing activity in rats. Topical application of the extract on the wound significantly increased the rate of wound contraction, synthesis of collagen, and decreased wound healing time⁶⁴.

Anti-inflammatory and Analgesic Effect: Millycent SA *et al.*, (2017) studied the *in-vivo* anti-inflammatory and analgesic activities of aqueous extract of *L. camara* were studied using animal models. As per the researcher's work, the anti-inflammatory activity was studied using carrageenan-induced lung edema and pleurisy mice, while the analgesic effect was studied using a formalin pain test in rats. The administered doses exhibited significant ($p < 0.05$) minimal toxic effects, anti-inflammatory and analgesic activity and. Methanolic extracts of the leaves and bark were screened for analgesic activity by carrageenan and histamine-induced paw edema models. Concerning the Antipyretic activity, the plant of ethyl acetate and ethanolic extract start dropping the body temperature from 1.5th hour.⁶⁵

Anti-cancer Activity: Badakhsan MP *et al.*, (2011) studied the *in-vitro* anti-cancer activity. Different solvent extracts like pet. Ether, chloroform, ethanol and aqueous extract for *L. camara* are screened for anti-cancer activity, in that ethanolic extract shows better effect. By MTT assay, root and leaf extract were investigated against *Jurkat leukemia cells*. The root and leaves extract of it might be studied for further identification and fractionation of new anti-cancer agents⁶⁶.

Antitubercular Activity: Misra N. *et al.*, (2006) studied that *In vitro* antitubercular activity *L. camara* showed on multiple-drug-resistant. Mycobacterium activity was investigated on HIV-infected persons. The well-in-agar-diffusion method used to estimate Minimal inhibitory concentration (MIC) and potency of extracts was compared with standard drug⁶⁷.

Antimutagenic Activity: Barre JT *et al.*, (1997) studied that *in-vivo* *L. camara* showed Antimutagenic activity with the compounds 22 β -acetoxy lantic acid and 22 β -dimethylacrylacroxy lantanolic acid. On swiss mice, the anti-mutagenicity test was done by micronucleus test. 22 β -acetoxy lantic acid and 22 β -dimethylacrylacroxy lantanolic acid both compounds showed high antimutagenic activity in Mytomyacin C induced Mutagenesis in mice⁶⁸.

Hemolytic Activity: Kalita S *et al.*, (2011) studied that *in-vitro* Hemolytic activity. Aqueous extract

and its solvent fractions were performed hemolytic activity using the modified spectroscopic method at various concentrations (125, 250, 500, 1000 µg/ml). It exhibited very low hemolytic activity on human erythrocytes. Another solvent extracts and its fractions showed hemolytic activity in the following order: chloroform > hexane and ethyl acetate (50:50) > water > ethanol > methanol⁶⁹.

Hepatoprotective Activity: Asija R *et al.*, (2015) studied that In vivo Hepatoprotective activity. Dried rind extract of *L. camara* has studied carbon tetrachloride (CCl₄)- induced liver damage of male Wistar rats. On the treatment of 28 days, that plant extracts reduced the toxicity of CCl₄ on serum markers of liver damage, alkaline phosphatase, alanine aminotransferase, aspartate aminotransferase. The plant extract also increases the levels of superoxide dismutase and catalase enzymes in rats⁷⁰.

TOXICOLOGY: Due to the high consumption toxicity of *L. camara* occurs only on animals like sheep, goats, cattle, pigs, horses. In humans, poisoning was not shown. In some countries, the ripe fruit of the plant is eaten by humans. Sometimes due to unripe fruit, acute toxicity in humans may occur.

A high amount of consumption of *Lantana camara* showed toxicity on animals like sheep, cattle, goats, horses, and rats. Active constituents present in this plant, Lantadene A, B, D, and icterogenic acid, showed toxicity. Signs of poisoning are photosensitization, jaundice, loss of appetite and sometimes death, liver enlargement, swollen kidney, *etc.*

The case study, poisoning of *Lantana camara* in a kid of Sirohi goat, showed consumption of plants causes phototoxicity and some side effects like anorexia, depression, swelling of eyelids, sloughing of the superficial layer of skin, itching of skin. Treatment was given on that toxicity is purgative, and liver tonic electrolyte and parental administration of vitamin B complex and antihistaminic with extract, oral administration of activated charcoal were given^{71, 72}.

CONCLUSION: The present review article covered several phytoconstituents present in *Lantana camara* are alkaloids, glycosides,

saponins, steroids, terpenoids, flavonoids, carbohydrates, coumarins. Some essential oils are also present in this plant. The plant has many traditional as well as potential uses. The plant has many pharmacological activities, majorly antioxidant, antibacterial, anti-inflammatory, analgesic, anti-cancer, *etc.* and also has some medicinal properties to cure various diseases. This review article highlights the potential of that plant can be working in new therapeutic drugs and will offer the base for future research like herbal medicines. It is a very cost-effective and easily available plant; by using this plant extract, we can formulate many formulations and medicines like anti-inflammatory or antibacterial cream, analgesic tablets, anti-cancer medicine, *etc.*

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