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Review Article: To Formulation and Evaluation of Natural Topical Gel for the Treatment of Acne Vulgaris

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Abstract: *Lantana cam ara is an im po rtant m edicinal plant widely used in traditional Indian m ed icine for treating various d iseases and skin disorders. Recent studies have highlighted its antibacterial, anti- inflam m atory, antioxid ant, and antim icrobial properties, m aking it a p rom ising herbal ingred ient for acne treatm ent. This review focuses on the form ulation and evaluation of herbal anti- acne gel containing hydroalcoholic extract of Lantana cam ara leaves. The plant extract showed significant antibacterial activity against acne-causing m icroorganism s such as Staphylococcus aureus and Prop ionibacterium acnes. Various gel form ulations p rep ared using Carbop ol 94 0 were evaluated for p hysicochem ical p aram eters including p H , viscosity, spread ability, stability, washability, d rug content, skin irritatio n , and antim icrobial activity. The studies rep orted good stability, effective antim icrobial action, and no skin irritation. H erbal form ulations containing Lantana cam ara m ay serve as a safe and effective alternative to synthetic anti-acne prod ucts with fewer side effects and r ed uced risk of antibiotic resistance...*

Keywords: Lantana cam ara, Herbal gel, A cne vulgaris, Hydroalcoholic extract, A ntim icrobial activity, Carbopol 940 , Herbal m ed icine, Anti- acne form ulation, S taphylococcus aureus, Propionibacterium acnes

I. INTRODUCTION

Lantana cam ara is a flowering m ed icinal shrub belonging to the Verbenaceae fam ily . It is com m only known as wild sage, red sage, or lantana weed . The p lant is believed to have been introduced to Ind ia from Sri Lanka d uring the early nineteenth century and is now widely distributed throughout the country. Lantana cam ara grows well in areas with m od erate to high rainfall and form s dense thickets in forests, grasslands, and wastelands. The p lant is recognized for its ornam ental value as well as its m edicinal im portance in trad itional system s of m ed icine such as Ayurveda and Siddha.

Lantana cam ara contains a wid e range of bioactive p hytochem icals includ ing flavonoid s, a lkaloids, tannins, saponins, steroids, phenols, proteins, and triterpenoids. The essential oils p resent in the p lant include sabinene, β - caryop hyllene, α - hum ulene, and 1 ,8 - cineole.

Due to these chem ical constituents, the p lant exhibits several pharm acological activities such as antim ic robial, antioxid ant, anti- inflam m atory, hepatop rotective, antifungal, antifilarial, and wound- healing p roperties. Different p arts of the p lant, includ ing leaves,

flowers, roots, and stem s, have been trad itionally used for the treatm ent of fever, wound s, cough, skin infections, asthm a , ulcers, and hyp ertension.

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Figure no. 1 .1 : Leaves and Flowers of lantana camara.

Table No .1 .1 : Taxonom ical classification.

Kingdom	Plantae
Subkingdom	Tracheobionta
Super division	Spermatophyta
Division	Magnoliopsida
Subclass	Asteridae
Order	Lamiales
Family	Verbenaceae
Genus	Lantana
Species	Lantana camara

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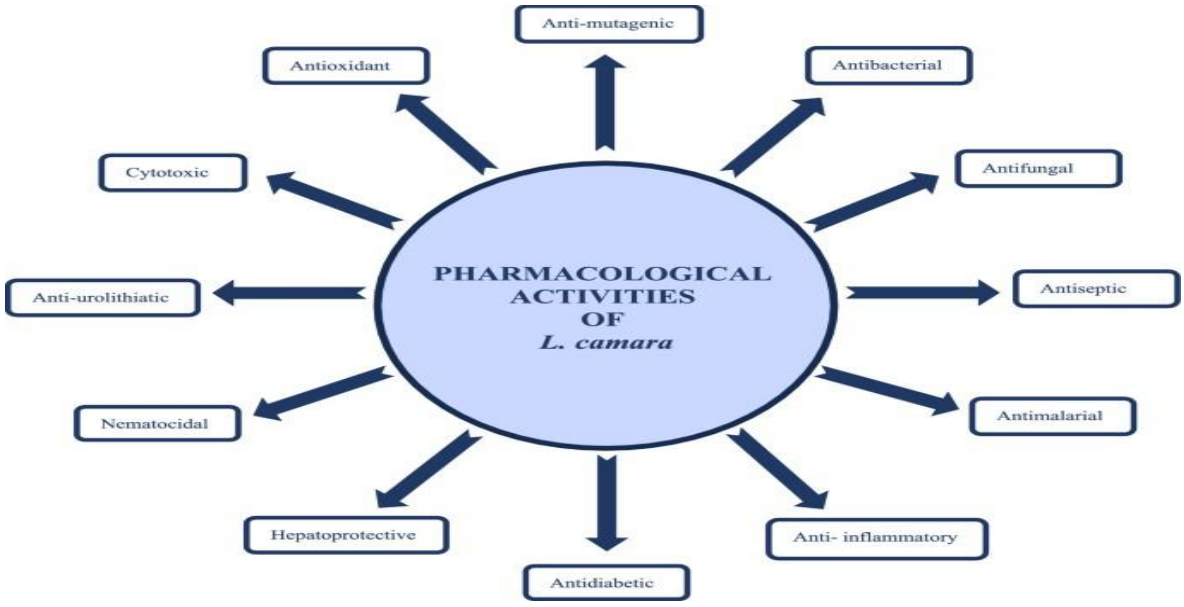

Figure no.1 .2 : Pharm acological activities of lantana cam ara.

A cne vulgaris is one of the m ost com m on inflam m atory skin disorders affecting adolescents and ad ults world wide. It occurs when hair follicles becom e blocked with excess sebum , dead skin cells, and bacteria. The m ajor m icroorganism s associated with acne are Propionibacterium acnes and S taphylococcus aureus, which cause inflam m ation, r ed ness, swelling, and form ation of pim p les. A lthough acne is no t a life-threatening disease, it can negatively affect p hysical ap pearance, self-confidence, and quality of life. The cond ition com m only ap pears on the face, chest, should ers, and back.

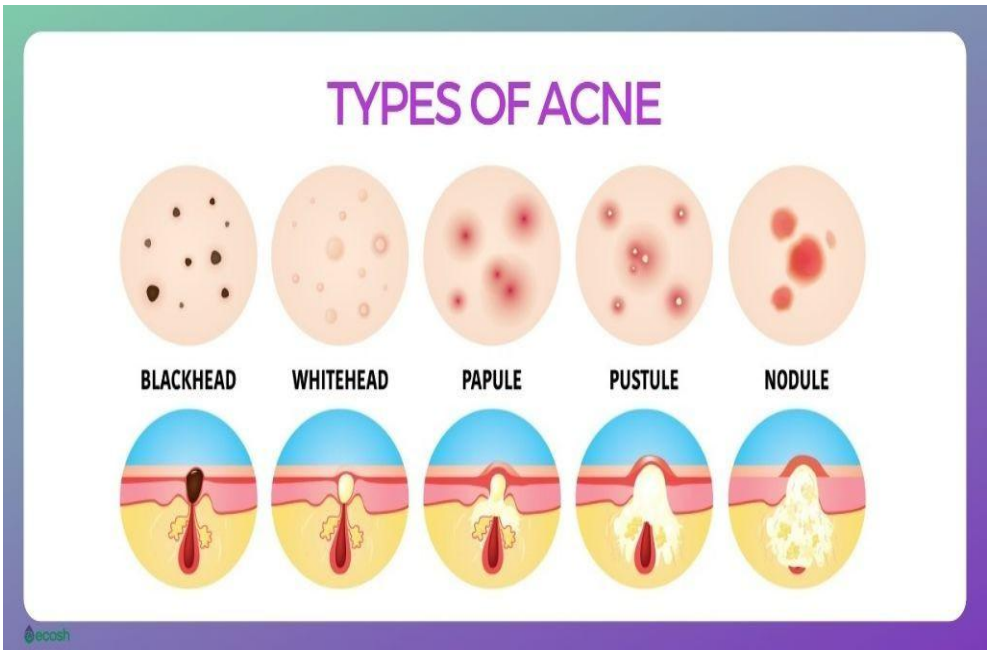

Figure no. 1 .3 : Type of acne

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Conventional treatm ent of acne m ainly includes antibiotics, r etinoid s, and synthetic antim icrobial agents. However, prolonged use of antibiotics m ay lead to antim icrobial resistance, skin irritation, d ryness, and other side effects. B ecause of these lim itations, there is increasing interest in herbal m ed icines as safer and m ore effective a lternatives for acne m anagem ent. Herbal form ulations are wid ely accep ted due to their natural origin, fewer ad verse effects, better patient com pliance, and therapeutic effectiveness. M ed icinal plants with antim icrobial and anti-inflam m atory p roperties are now being exp lored for topical anti-acne preparations.

R ecent stud ies have shown that Lantana cam ara p ossesses significant antibacterial activity against acne- causing m icroorganism s. H yd roalco holic extracts of the leaves have dem onstrated effective inhibition against S taphylococcus aureus and other pathogenic bacteria. Herbal gels p rep ared using Carbop ol 9 40 and Lantana cam ara leaf extract have shown good physicochem ical p roperties such as suitable p H, viscosity, spread ability, stability, and washability. In ad dition, these form ulations exhibited antim icrobial activity and did not p roduce skin ir ritation during experim ental studies, indicating their safety for top ical use.

The p resent review article focuses on the m edicinal im portance, p hytochem ical constituents, pharm acological activities, and anti- acne p otential of Lantana cam ara. It a lso highlights the form ulation and evaluation of herbal top ical gels co ntaining hydroalcoholic extract of the plant. The review em p hasizes the role of herbal m ed icines in overcom ing antibiotic resistance and p rom oting safer treatm ent op tions for acne vulgaris. Therefore, Lantana cam ara m ay serve as a p rom ising natural source for the develop m ent of effective herbal anti- acne form ulations.

Material and Methods

Selection, Collection, and Authentication of Lantana camara Leaves

Field Selection Criteria

To ensure high yields of bioactive second ary m etabolites (such as phenolics, flavonoids, and terpenoids) and m inim ize baseline contam ination, healthy, fully exp and ed , dark- green leaves of Lantana cam ara were selectively harvested . Sp ecim en collection prioritized areas free from visible agro nom ic pest infestations, fungal lesions, or anthrop ogenic environm ental p ollutants. 1 .2 B otanical Profile Lantana cam ara (Fam ily: Verbenaceae) is a p erennial, erect sp rawling or scandent shrub that typ ically averages 2 m eters (~ 6 .5 \ text { ft }) in height, form ing com p lex, dense thickets. Under optim al cond itio ns, it functions as a clim ber, scram bling up into tree canopies up to a ltitud es of 6 m eters (20 \ text{ ft }). Fo liage: The leaves are sim p le , opp osite, broad ly ovate, with serrate m argins, and exud e a characteristically pungent, arom atic o dour when m echanically crushed .

Inflorescence: The p lant bears sm all, tubular- shaped flowers with four petals, arranged in dense term inal clusters (um bellate corym bs). Flowers dem onstrate m ulti- chrom atic variations (red, yellow, white, pink, and orange) across a single inflorescence, dictated by age, m aturity, and pollination status.

Pollination Behaviour: Post- p ollination, flower colour transitions (typically yellow to orange, p ink, or r ed) as a visual cue to p ollinators signaling a reduction in floral rewards, thereby optim izing p ollination efficiency. The blossom s r elease a characteristic tutti- frutti scent with a distinct pepp ery und ertone. 1 .3 Geographic Source and A uthentication Fresh leaves of L. cam ara were gathered in M arch 202 4 from the senior staff quarters of Solankur, K olhap ur, M aharashtra, India (Latitude/ Lo ngitud e coordinates corresp onding to the r egion).

Taxonom ic A uthentication Note:

The p lant specim en was form ally evaluated and authenticated by the Departm ent of B otany, B hogawati Mahavid yalaya, Kurukali, M aharashtra, India. A voucher herbarium specim en was d ep osited for future reference. Correction of M orphological Record : The raw field log noted "co m p ound leaves with lance- shaped leaflets and long, slender fruit pod s" (which are traits indicative of the Fabaceae/ Mim osoid eae fam ilies). This official authentication corrects those anom alies, verifying that the sam p le exhibits the true m orphological traits of Lantana cam ara L. (Verbenaceae): sim ple, opp osite, broad ly ovate leaves and clustered, sm a ll fleshy d rupes (berries).

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UV- Visible Spectroscop ic Stand ard Calibration Curve

A standard stock solution was engineered by dissolving 10 0 \ text { m g } (0 .1 \ text { g }) of the d ried, p rocessed Lantana cam ara leaf extract into a 100 \ text{ m L } volum etric flask.

The volum e was brought to the m ark using warm distilled water to facilitate absolute dissolution, yield ing a prim ary stock co ncentration o f 10 00 \ text{ p pm } (\ m u\ text {g/ m L }).

From this p rim ary stock, accurate a liquots were transferred to establish a series of

working stand ard solutio ns at concentrations of 10 , 20 , 30 , 4 0 , 50 , and 6 0 \ text { pp m }.

The baseline absorbance was scanned and detected via a UV- Visible Sp ectrophotom eter at a designated wavelength (\ lam bd a_ {\ m ax }) of 201 .5 \ text{ nm }.

Table 2 .1 : Calibration Curve A bsorbance Profile

S erial No.	Standard Concentration(pp m)	Measured Absorbance
1	10	0 .11
2	20	0 .17
3	30	0 .23
4	40	0 .28
5	50	0 .33
6	60	0 .38

Preparation of Hydro-Alcoholic Crude Extract

The extraction p rotocol com bined classical m aceration with acoustic cavitation (sonication) p rocessing to m axim ize phytochem ical recovery from the cellular m atrix of the leaves.

Extraction Unit Op erations F lowchart [Glassware & Equipm ent S terilization]

▼

[Dehydration & M illing o f L. cam ara Leaves to Coarse Powd er]

▼

[Solvent A ssem bly: 75 % Ethanol + 25 % Distilled W ater]

▼

[Slurry Mixing: 75 g Powder + 75 0 m L Solvent M atrix]

▼

[7 - Day Closed M aceration with Interm ittent M agnetic S tirring]

▼

[Straining & M echanical Pressing of R esid ual Marc]

▼

[Filtration & Clarification of Com bined Liquors]

▼

[R otary Vacuum Evaporation & Concentration]

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▼

[A septically Sealed Storage o f Concentrated H yd ro-A lcoholic Extract]

Step -by-Step Procedure

Sanitisation: A ll glass app aratus, extraction cham bers, and processing vessels und erwent rigorous therm a l sterilization and chem ical sanitization to elim inate m icrobial carryover.

Size R eduction: Cleaned L. cam ara leaves were shad e- dried and m illed into a m oderately coarse p owder.

Solvent R atio: The extraction m enstruum was assem bled using an op tim ized
hydro- alcoho lic blend containing 75 % v/ v Ethanol and 2 5 % v/ v Distilled W ater.

M aceration Ratio: Exactly 75 \ text{ g } o f the coarse L. cam ara leaf po wd er was com bined with 75 0 \ text { m L } of the hyd ro- alcoholic m enstruum (1 :10 \ text { w/ v } ratio) inside an a irtight, light- resistant glass vessel.

Incubation: The system was allowed to m acerate over a p eriod of 7 days at room
tem perature. The m ixture was subjected to periodic agitation using a digital m agnetic stirrer to m axim ize solid - liquid m ass transfer.

Separation: A fter 7 d ays, the fluid extract was strained through m ulti- layered m uslin cloth. The spent solid residue (m arc) was m echanically pressed to express trap ped
interstitial solvent.

Concentration: The p ooled fluid extracts were clarified via W hatm an Filter Paper (No. 1) and concentrated using an evaporation system under reduced pressure to yield a dense,
viscous crud e hyd ro-alcoholic extract.

Storage: The final extract was p laced in sterile, am ber glass vials and stored in a
desiccator at 4 ^\ circ\ text {C} for subsequent phytochem ical and form ulation p roto cols. 3 .3 M athem atical Determ ination o f Extraction Yield

The p ercentage total yield calculations used the following form ula:

% Extraction Yield = W _ 2 - W _ 1 W _ 0 / × 100

W here: W _0 =The weight of initial dried sam ple W _ 1 =The weight of the container alone,
W _ 2 =The weight of the extract and the container.

Qualitative Phytochemical Screening

A sam ple solution was arranged by dissolving 100 \ text{ m g } of crud e hydro-alcoholic extract into 5 \ text { m L } of sterile distilled water, fo llowed by filtration. This filtrate was system atically analyzed using established colorim etric and p recipitation benchm arks:

Phytochem ical Screening Protocols

Alkaloids

M ayer' s Test: 1\ text{ m L } of filtrate was treated with a few drop s of M ayer' s reagent (Po tassium M ercuric Iodid e). Form ation of a cream / yellowish-white precip itate d enotes a lkaloids. A cid Confirm ation: 2 \ text { m L } of \ text {HCl} was add ed to 2 \text{ m L } of
sam ple p rior to reagent add ition to m o nitor for definitive white p recipitates o r green chrom ophores.

Dragend orff' s Test: 2 \ text { m L } of filtrate was treated with 1 \ text { m L } of Dragend orff' s reagent (Potassium B ism uth Iodid e). F orm ation of an orange- red precip itate indicates a positive reaction.

W agner' s Test: F ilam ent sam ples were m ixed with W agner' s r eagent (Iod ine in Potassium Iod ide). A redd ish-brown p recipitate confirm s p resence.

Hager' s Test: 2 \ text { m L } of extract was treated with H ager' s reagent (Saturated

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Picric A cid solution). F orm ation of a p rom inent yello w precip itate confirm s alkaloid s.

2. Flavonoid s

Sod ium H yd roxide Test: Treatm ent of 1 \ text { m L } of extract with dilute \ text {Na OH } ind uces an intense yellow coloration, which grows entirely clear/ colorless upon the step- wise add ition of dilute m ineral acid .

Zinc-\ text {HCl} R eduction Test: Crud e extract (1 \ text { m L }) was m ixed with a pinch of zinc dust followed by drop wise add ition of concentrated \ text{HCl }. A p pearance of a m agenta/ cr im son hue ind icates flavonoids.

Lead A cetate Test: 10 \ text{ m g } of crud e extract was treated with a 10 % Lead Acetate solutio n . A heavy yellow precip itate form s.

Shinoda's Test: 1\ text{ m L } of sam ple was treated with m agnesium turnings and 10 d rops of concentrated \ text {H Cl}. The develop m ent of a deep p ink to red color ind icates presence.

3. Tannins & Phenolics

M atchstick (Catechin) Test: A wooden m atchstick sp lint d ipp ed in the extract, m oistened with concentrated \ text {H Cl}, and warm ed near a flam e turns p ink/ red due to phloroglucinol cleavage.

Ferric Chlorid e Test: Direct r eaction of the extract with a dilute \ text {F eCl }_ 3 solution yield s a deep blue-black color (hyd rolyzable tannins) or a green-black hue (condensed/ catechol tannins).

Gelatin Test: The ad dition of a 1 % gelatin solution containing \ text{Na Cl} to the extract ind uces a white/ buff p recip itate, verifying tannin bonding.

Phenazone Test: 0 .5 \ text{ g } of sodium acid p hosp hate was ad ded to 5 \ text { m L } o f aqueous extract, warm ed , cooled, and filtered . Treatm ent of the filtrate with 2 % phenazone precip itates a bulky, colored m ass.

4. Saponins

Frothing Test: 3 \ text { m L } of aqueous extract was diluted with 10 \ text{ m L } of d istilled water in a test tube, shaken vigorously for 5 m inutes, and left und isturbed. A p ersistent " honeycom b" froth layer surviving > 30 \ text{ m inutes } indicates sap onins.

Fo am Test: 1 \ text { m L } of extract was diluted to 2 0 \ text { m L } with water in a grad uated cylinder and shaken for 15 m inutes. Persistence of stable foam confirm s presence.

5. Carbohydrates

M olisch' s Test: Filtrate treated with \ alpha-naphthol in ethanol, followed by the careful channeling of concentrated \ text{H }_ 2 \ text {S O }_4 d own the test-tube wall, p rod uces a violet/ purp le ring interface.

Fehling' s Test: Equal p ortions of Fehling' s A and B solutions were heated with the extract. Mod ification from clear blue to a brick- red cup rous o xide p recip itate indicates reducing sugars.

Benedict' s Test: Extract heated with B enedict' s qualitative reagent generates a green, yellow, or brick- red p recipitate depending on sugar concentration.

6. A nthraquinone Glycosides

Bro m ine Test: Equal volum es of extract and freshly p rep ared brom ine water were m ixed to observe color changes and precip itation pro files.

M odified B orntrager' s Test: Crude extract was heated with F erric Chlorid e (\ text{Fe Cl}_3) and \ text{HCl} to hydrolyze glycosid es, followed by extraction into an organic solvent (ether/ chloroform). The organic t ier was sep arated and shaken with d ilute A m m onia. A p ink- red hue in the am m oniacal layer confirm s C- glycosid es.

Prior to form ulation com pound ing, the chem ical structures of the prim ary gelling agents, stabilizers, and functional excipients were evaluated .

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Carbopol 934 : A high m olecular weight, synthetic allylsucrose cross-linked polym er of acrylic acid, p olym erized p rim arily in benzene. It features high carboxylic acid content (56 \% \ text{ to } 6 8 \% \ text { } -\ text {COOH } groups) which provid es cross- linked
thickening prop erties upon neutralization.
Triethanolam ine (TEA): A viscous, tertiary am ine and triol
(\ text{N(CH }_ 2 \ text {CH }_ 2 \ text {OH) }_ 3). It acts as a bifunctional neutralizing agent to expand the Carbop ol p olym er network by ionizing carboxyl units, ad justing the final p H to m atch norm a l skin p hysiology.
M ethylparaben: The m ethyl ester of p- hyd roxybenzoic acid
(\ text{CH }_ 3 (\text{C }_7 \ text{H }_5 \ text {O }_ 3)). Utilized as a broad- sp ectrum antim icrobial preservative.
Polyethylene Glycol (PEG 400) / Prop ylene Glycol: Low-viscosity, non- toxic hum ectants and hydrop hilic co-solvents that enhance consistency, prevent form ulation d esiccation, and act as skin p enetration enhancers.

II. CONCLUSION

The study successfully form ulated a stable, topical anti-acne hyd rogel using a bioactive-rich hyd ro- alcoholic extract of Lantana cam ara leaves incorporated into a Carbopol 934 m atrix. Phytochem ical screening confirm ed the presence of therap eutic second ary m etabolites, includ ing flavonoid s, a lkalo ids, and tannins.
Physicochem ical evaluations dem onstrated that the gel possesses op tim a l skin-com p liant p H, excellent spread ability, stable viscosity, and uniform d rug distribution. Furtherm ore, chem ical stability m etrics verified resistance to degrad ation, while in vitro assays confirm ed significant antibacterial activity against key
acne- causing p athogens (Cutibacterium acnes and Staphylococcus ep id erm id is).
Overall, this research establishes Lantana cam ara hyd rogel as a clinically p rom ising, stable, and effective p lant-based a lternative to synthetic anti- acne therap ies.

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