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PHARMACEUTICAL DEVELOPMENT OF LODHRADI HYDROGEL FROM CLASSICAL LODHRADI LEPA AND ITS COMPARATIVE IN-VITRO ANTIBACTERIAL EVALUATION AGAINST ACNE-ASSOCIATED BACTERIA.

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ABSTRACT

Background: *Lodhradi Lepa* is a classical Ayurvedic external formulation indicated for the management of *Mukhadushika* (acne vulgaris). Although its clinical efficacy is well established, the conventional paste form is associated with limitations related to stability, portability, and patient compliance. To overcome these drawbacks, the present study focused on the development of a hydrogel dosage form while retaining the therapeutic potential of the classical formulation. **Objectives:** To prepare *Lodhradi Lepa* and a novel *Lodhradi* Hydrogel, undertake pharmaceutical and analytical study, and comparatively evaluate their in-vitro antibacterial activity against acne-associated microorganisms. **Materials and Methods:** This pharmaceutical, analytical, and experimental in-vitro study involved the preparation of *Lodhradi Lepa* as per classical Ayurvedic references and formulation of *Lodhradi* Hydrogel by incorporating the hydroalcoholic extract into a Carbopol-based gel. Both formulations were assessed for organoleptic and physicochemical parameters. In-vitro antibacterial activity was evaluated using the agar well diffusion method against *Propionibacterium acnes* and *Staphylococcus epidermidis*. Zones of inhibition were measured, and statistical analysis was performed using Student's *t*-test. **Results:** Both formulations demonstrated acceptable pharmaceutical and analytical characteristics. *Lodhradi* Hydrogel showed better spreadability, skin-friendly pH, and enhanced stability. Significant antibacterial activity was observed with both formulations. The hydrogel exhibited comparable activity against *Staphylococcus epidermidis* ($p > 0.05$) and significantly higher activity against *Propionibacterium acnes* at higher concentrations ($p < 0.05$). **Conclusion:** Conversion of *Lodhradi Lepa* into a hydrogel is pharmaceutically feasible and therapeutically effective, offering a stable, patient-friendly, and cosmetically acceptable alternative without compromising antimicrobial efficacy.

KEYWORDS: Acne vulgaris, Ayurveda, Topical Drug Delivery Systems, Hydrogels, Propionibacterium acnes, Staphylococcus epidermidis.

1. INTRODUCTION

Skin disorders affect psychosocial well-being and quality of life, making them a major worldwide health concern. One of the most common chronic inflammatory conditions of the pilosebaceous unit, acne vulgaris typically affects teenagers and young adults. I t mainly affects the face, neck, chest, and upper back and is clinically represented by comedones, papules, pustules, nodules, and, in extreme cases, cysts.[1] A number of factors contribute to the pathophysiology of acne, including excess sebum production that is influenced by androgenic hormones, follicular hyperkeratinization that causes obstruction, colonization by bacteria linked to acne, such as Propionibacterium acnes and Staphylococcus epidermidis, and ensuing inflammatory reactions. The requirement for efficient and patient-acceptable treatment methods is highlighted by the fact that persistent or poorly treated lesions frequently cause scarring and post-inflammatory hyperpigmentation.[2]

Topical treatment serves as the primary means of dealing with acne because it acts directly and has fewer systemic side effects. However, most of the usual topical drugs show some disadvantages that irritate the skin, cause dryness, if antibiotics are used then resistance may arise. Due to these problems, people have become more and more interested in herbal and traditional medical systems, especially the ones that give a combination of several effects with a better safety record.

Ayurveda, the Indian traditional medical system, takes a comprehensive view of health by harmonizing physical, mental, and environmental aspects. In this context, pharmaceutical sciences are under the direction of *Rasa Shastra* and *Bhaishajya Kalpana*, which aim at the elaborate conversion of natural substances into dosage forms that are safe and therapeutically beneficial. According to the Namaste Portal Acne vulgaris is correlated with *Mukhadushika*, which were mentioned by *Acharya Sushruta* in the section of *Ksudra Roga*.[3] The main sign of *Mukhadushika* is that the face gets covered with thorn like eruptions, which are the results of aggravation of *Vata*, *Kapha*, and *Rakta Doshas*, the core etiological factors are *Srotorodha* (blockage of channels) and *Medodushti* (change in the nature of fat tissue), resulting in inflammation and abscess formation. It is said to be present with features such as *Ruja* (pain), *Ghana* (hard), *Pidaka* (boil), and *Daha* (itching) at the affected area. *Mukhadushika* is also known as *Yuvanapidika*.[4] *Acharya Vagbhaṭṭa* has also stated the role of *Meda* along with *Kapha* and *Rakta* in the causation of *Yuvanapidika*. In *Yuvanapidika*, the involvement of *Meda* can be compared to sebum described in modern medicine.[5]

In Ayurveda, mainly two types of treatments have been described in the texts to treat *Mukhadushika*, i.e., *Samshodhana* (biopurification of the body at the cellular level) and *Samshamana* (conservative treatment by oral and topical medicines). *Lepa Kalpana* is one of the important external therapeutic measures explained in Ayurveda. *Lepa* preparations are indicated to reduce the *Kleda* (excess moisture), for balancing of *Kapha* and *Rakta Doshas* and for improvement of skin texture and complexion. One of the classical formulations is *Lodhradi Lepa*, which is first indicated in *Chakradatta*-[6] under *Tarunyapidika Chikitsa* and also mentioned in *Sharangdhara Samhita*[7] and *Bhaishajya Ratnavali*.[8] It contains *Lodhra* (Symplocos racemosa), *Dhanyaka* (Coriandrum sativum), and *Vacha* (Acorus calamus), which are herbal products with astringent, anti-inflammatory and antimicrobial properties.

Traditional *Lepa* formulations, even though effective and therapeutic, have several practical limitations when used in contemporary times such as poor shelf life, difficulty in preparation and application, lack of portability, staining, and low cosmetic acceptability. All these factors make patient compliance difficult especially in the case of skin diseases which require the treatment to be prolonged. Hydrogel-based topical delivery systems have introduced as an advancement in pharmaceutical technology. Hydrogels are three- dimensional polymeric networks capable of absorbing large amounts of water while remaining insoluble due to chemical or physical cross-linking of polymer chains. These hydrophilic systems show excellent physicochemical properties, making them suitable for biomedical and drug delivery applications.[9] Incorporating classical Ayurvedic formulations into modern dosage forms like hydrogels provides an opportunity to retain traditional therapeutic efficacy while improving stability, usability, and acceptability.

Converting *Lodhradi Lepa* into a hydrogel is a new approach that combines traditional Ayurvedic skin therapy with modern pharmaceutical formulation techniques. However, it is essential to evaluate whether such modification alters the biological activity of the formulation. Therefore, a comparative assessment of the in-vitro antimicrobial activity of *Lodhradi Lepa* and *Lodhradi* Hydrogel against common acne-causing microorganisms such as *Propionibacterium acnes* and *Staphylococcus epidermidis* is done. Parameters such as zone of inhibition and antimicrobial potency provide insight into the retention or enhancement of therapeutic efficacy following formulation modification. The present study aims to bridge traditional Ayurvedic knowledge with contemporary pharmaceutical science by preparing and analyzing *Lodhradi Lepa* and *Lodhradi* Hydrogel, and comparatively evaluating their antimicrobial activity. The study aims to scientifically confirm the effectiveness of the classical formulation, create a stable and easy-to-use topical product, and support the use of Ayurveda in evidence-based skin care.

OBJECTIVES

1. Preparation of *Lodhradi lepa* as mentioned in *Chakradutta (kshudrarogadhikar)*
2. Preparation of the *Lodhradi* Hydrogel from the extracts of ingredients present in *Lodhradi lepa.*
3. To study Analytical evaluation of *Lodhradi lepa* and *Lodhradi* Hydrogel.
4. Comparative assessment of In-vitro antibacterial activity of the *Lodhradi lepa* and *Lodhradi* Hydrogel.

2. MATERIALS AND METHODS

2.1 Pharmaceutical Study

The pharmaceutical component of the study focused on the preparation of *Lodhradi Lepa* as per classical Ayurvedic references and the development of a modified topical dosage form, *Lodhradi* Hydrogel, using modern pharmaceutical principles. The aim was to ensure reproducibility, quality, and suitability for experimental evaluation.

2.1.1. Raw Drug Procurement and Authentication

Lodhra (*Symplocos racemosa* bark), *Dhanyaka* (*Coriandrum sativum* fruit), and *Vacha* (*Acorus calamus* rhizome) were purchased from Panna Lal Brij Lal, Govindpuri, Haridwar, Uttarakhand, India and

botanically identified under expert supervision in the Department of Dravyaguna, Institute for Ayurved Studies and Research, Kurukshetra, Haryana. Excipients used for hydrogel preparation were purchased from A to Z Chemicals Khari Baoli, New Delhi, India.

2.1.2. Preparation of Lodhradi Lepa

Lodhradi Lepa was prepared using equal proportions of finely powdered *Lodhra*, *Dhanyaka*, and *Vacha*. The raw drugs were cleaned, shade-dried, pulverized, and sieved (mesh no. 80) to obtain a uniform, fine powder, which was thoroughly homogenized and stored in airtight containers. Finished product LL, 140 g, was packed in wide mouth white coloured High-Density Polyethylene (HDPE) jar (GC100, V-PLA Products, Pune, India).

2.1.3. Preparation of *Lodhradi* Hydrogel Extraction of Herbal Drugs

Lodhra, *Dhanyaka* and *Vacha* were separately extracted using a Soxhlet apparatus with a hydroalcoholic solvent (Ethanol:Water, 70:30). This solvent system was selected to ensure optimal extraction of both polar and moderately non-polar phytoconstituents.[10]

Formulation of Hydrogel

Table 1: Formulation of *Lodhradi* Hydrogel.

Sr. No.	Name of the Ingredient	Purpose in Formulation	Quantity (%)	Quantity (gm)
1	*Lodhra* extract	Active herbal drug	2.5	2.5
2	*Dhanyaka* extract	Active herbal drug	2.5	2.5
3	*Vacha* extract	Active herbal drug	2.5	2.5
4	Carbopol 940	Gelling agent	1.0	1.0
5	Glycerine	Humectant	4.0	4.0
6	EDTA	Preservative	0.02	0.02
7	Phenoxyethanol	Preservative	0.5	0.5
9	Triethanolamine (TEA)	Neutralizer	2.0	2.0
10	Distilled Water	Vehicle	84.98	84.98
	Total		100	100

The hydrogel base was prepared by dispersing Carbopol (1 g) in 70 g distilled water under gentle stirring and allowing complete hydration. The dispersion was neutralized with triethanolamine (TEA) to obtain a pH of 5.5–6.8, followed by the addition of glycerine (4 g) with gentle mixing. In a separate vessel, disodium EDTA (0.02 g) and phenoxyethanol (0.5 g) were dissolved in 14.98 g distilled water at 35–40 °C and cooled. This preservative phase was slowly incorporated into the gel base with gentle stirring to obtain a homogeneous mixture.

Hydroalcoholic extracts of Lodhra, Dhanyaka, and Vacha (2.5 g each) were then added sequentially with continuous low-shear mixing. Final pH was adjusted to 5.5–6.8, and the formulation was allowed to stand for de-aeration. The prepared hydrogel was filled into amber containers, labelled, and stored under cool, dry conditions.

Optimization and Physical Characteristics

Three batches (F1–F3) were prepared to optimize formulation parameters. Batch F3, containing 7.5% total extract, 1.0% Carbopol, and 2% triethanolamine, showed optimal consistency, stability, spreadability, and pH and was selected as the final formulation. The optimized hydrogel was smooth, homogeneous, semi-solid, brown in colour, and stable, with no phase separation observed.

Table 2: Batches of *Lodhradi* Hydrogel.

Sr. No.	Name of the Ingredient	F1 (%)	F2(%)	F3(%)
1	*Lodhra* extract	5	2	2.5
2	*Dhanyaka* extract	5	2	2.5
3	*Vacha* extract	5	2	2.5
4	Carbopol 940	0.8	1.2	1.0
5	Glycerine	4.0	4.0	4.0
6	EDTA	0.02	0.02	0.02
7	Phenoxyethanol	0.5	0.5	0.5
9	Triethanolamine (TEA)	4.0	3.0	2.0
10	Distilled Water	75.68	85.28	84.98

Pharmaceutical yield

Lodhradi Hydrogel had optimal yield with minimal loss and the details are given in.

Table 3: Result *of Lodhradi* Hydrogel preparation.

Initial weight	Final weight	Loss in weight	Loss in %
100 gm	95.6 gm	4.4 gm	4.4%

2.2 Analytical Study

The analytical study was conducted to assess the quality and purity of raw drugs and final formulations, evaluate physicochemical and phytochemical parameters, and ensure microbial safety and in-vitro antimicrobial efficacy. All analyses were performed as per the Ayurvedic Pharmacopeia of India (API) and CCRAS guidelines.[11]

2.2.1. Basic physicochemical analysis

Organoleptic characters such as colour odour, taste and appearance and were observed Physicochemical parameters like loss on drying (LOD), specific gravity, refractive index, water soluble extractive, alcohol soluble extractive, pH, Particle size, Viscosity, Spreadability, ash value and acid insoluble value, was determined as per guidelines.

2.2.1. Chromatographic analysis

Ethanolic extract of raw drug were run on pre-coated Silica Gel G60F254 plate in mobile phase, under standard Thin Layer Chromatography (TLC) conditions and chromatograms were recorded under Ultra-Violet (UV) radiation at short UV (254 nm) and long UV (366 nm) wavelengths as well as after spraying anisaldehyde sulphuric acid reagent.

2.2.1. Safety parameters

The total aerobic bacterial count and total fungal count of *Lodhradi Lepa* and *Lodhradi* Hydrogel were determined using the plate count method in accordance with Ayurvedic Pharmacopoeia of India (API), Part I, Vol. VI (2009).

2.2.1. Stability testing

The study was conducted as per the International Council for Harmonisation (ICH) of Technical Requirements for Pharmaceuticals for Human Use guidelines Q1A (R2) for evaluation of the shelf life of *Lodhradi* Hydrogel samples were stored and maintained at 40 ± 2 C, RH 75 ± 5% for an accelerated study (AS) of 6 months. The variables were tested on Day 0 and after every 3 months. specific gravity, refractive index, pH, Viscosity and Spreadability, were studied for calculation of shelf life.

2.2.1. Patch test

The skin irritation potential of the test formulation was assessed using a single-application occlusive patch test on healthy human volunteers. 1% (w/w) sodium lauryl sulfate and 0.9% isotonic saline served as positive and negative controls, respectively. Patches were applied to intact skin on the upper back (scapular region) and removed after 24 h. Cutaneous reactions were evaluated by a dermatologist at 0 h and 24 h post-removal, with follow-up at 7 days for positive responses. Erythema and oedema were scored on a 0–4 Draize scale in accordance with IS 4011:2018 guidelines. The irritation index was calculated as the mean combined score of erythema and oedema. The study was conducted in accordance with ethical standards and approved by the Institutional Ethics Committee, and written informed consent was obtained from all participants.

2.3 In vitro antimicrobial testing

The in-vitro antimicrobial activity of *Lodhradi Lepa* and *Lodhradi* Hydrogel was assessed using the agar well diffusion method (Kirby–Bauer technique). Mueller–Hinton agar plates were inoculated with freshly prepared microbial suspension cultures. Wells of 8 mm diameter were aseptically punched into the agar, and 100 µL of each test sample was introduced into the wells. The formulations were tested in undiluted form (100%) and at 50%, 10 mg/mL, and 5 mg/mL, prepared using dimethyl sulfoxide (DMSO) as the solvent. Gentamicin served as the standard antibacterial agent and DMSO was used as the negative control.

Plates inoculated with bacterial strains were incubated at 37 °C for 18–24 h. Antimicrobial activity was determined by measuring the zone of inhibition (ZOI) in millimeters, including the well diameter. The sensitivity of the microorganisms to the test formulations was evaluated by comparing the inhibition zones with those produced by the standard drugs.

2.3.1. Statistical analysis

Obtained data in In-vitro antimicrobial activity were analysed using an independent Student's *t*-test.

3. RESULT AND DISCUSSION

3.1. Raw material analysis

3.1.1. Organoleptic Evaluation

Organoleptic (macroscopic) evaluation of the powdered raw drugs was carried out to assess colour, odour, and taste as described in classical texts. *Lodhra* and *Vacha* exhibited greyish-brown colour with characteristic odour, while *Dhanyaka* showed brownish-yellow colour and aromatic odour. Taste was astringent for *Lodhra*, spicy for *Dhanyaka*, and characteristic for *Vacha*.

3.1.2. Physicochemical Analysis

Foreign matter analysis revealed no detectable contamination in *Lodhra* and *Vacha*, while *Dhanyaka* showed 0.24% foreign matter, within permissible limits. Moisture content (loss on drying at 105 °C) ranged from 5.07% to 6.52%, indicating acceptable moisture levels. Total ash values ranged between 5.07% and 5.78%, suggesting minimal inorganic impurities. Acid-insoluble ash values (0.63–1.0%) indicated low silica contamination. Water-soluble extractive values were highest for *Dhanyaka* (23.70%), followed by *Lodhra* (20.57%), whereas *Vacha* showed comparatively lower

extractive values (9.58%). Alcohol-soluble extractive values ranged from 7.45% to 12.40%, reflecting the presence of alcohol-soluble phytoconstituents. Overall all raw drugs complied with API quality standards, confirming their suitability for pharmaceutical processing.

TLC fingerprinting is vital for identification as, *Lodhra* showed three Rf values (0.52, 0.67, 0.71), *Dhanyaka* displayed two significant bands (0.09, 0.19). *Vacha* exhibited one prominent spot (0.73) These chromatographic profiles match the API standards, confirming the presence of characteristic phytoconstituents.

Table 4: Report of raw drug testing.

Sr. No.	Parameters	Lodhra[12]	Dhanyaka[13]	Vacha[14]
1.	Colour	Greyish brown	Brownish yellow	Greyish brown
2.	Foreign matter	Nil	0.24%	Nil
3.	Loss on drying at 105°C	5.07%	5.48%	6.52%
4.	Total Ash	5.07%	5.78%	5.75%
5.	Acid Insoluble Ash	1.0%	0.86%	0.63%
6.	Alcohol Soluble Extractive	10.43%	12.40%	7.45%
7.	Water Soluble Extractive	20.57%	23.70%	9.58%
8.	TLC	0.52, 0.67, 0.71	0.09, 0.19	0.73

3.2. Phytochemical Analysis of Extracts

Qualitative screening showed that hydroalcoholic extracts of *Lodhra*, *Dhanyaka*, and *Vacha* contained alkaloids, flavonoids, phenolics, tannins, and terpenoids, while aqueous extracts showed fewer phytoconstituents, indicating better extraction efficiency of the hydroalcoholic solvent.

Quantitative analysis revealed the highest alkaloid (22.89µg/mL) and flavonoid content (58.76µg/mL) in *Lodhra* extract, followed by Vacha. These findings support the use of hydroalcoholic extracts for formulation due to their higher phytochemical content and potential therapeutic relevance.

Report of Phytochemical Analysis of Extracts

Table 5: Qualitative Phytochemical Testing of Extracts.

Extracts	Alkaloids	Flavonoids	Phenolic Compounds	Tannins	Terpenoids
***Lodhra* (Symplocos racemosa) bark extracts**					
Ethanolic extract	+	+	+	+	+
Aqueous extract	-	+	+	-	-
Hydroalcoholic extract	+	+	+	+	+
***Dhanyaka* (Coriandrum sativum) fruit extracts**					
Ethanolic extract	+	+	+	+	+
Aqueous extract	-	-	+	+	+
Hydroalcoholic extract	+	+	+	+	+
***Vacha* (Acorus calamus) rhizome extracts**					
Ethanolic extract	+	+	+	+	+
Queous extract	-	-	+	+	+
Hydroalcoholic extract	+	+	+	+	+

Table 6: Quantitative Phytochemical Testing.

Sl. no.	Hydroalcoholic Extracts	Alkaloids (µg/ml)	Flavonoids (µg/ml)
1.	*Lodhra*	22.89	58.76
2.	*Dhanyaka*	12.07	9.82
3.	*Vacha*	10.39	31.13

3.3. Analysis of finished products

3.3.1. Physiscochemical analysis

Lodhradi Lepa was a fine, light reddish-brown powder with acceptable moisture content (2.99%), low ash values, and high water-soluble extractive (48.24% w/w), indicating good extractability of active constituents. Particle size analysis of *Lodhradi Lepa* showed a mean particle size of 440.1 nm, indicating uniformity and potential for enhanced topical performance.

The *Lodhradi* Hydrogel exhibited acceptable physicochemical properties indicative of good quality and dermal compatibility. The formulation showed a skin-compatible pH of 6.35, suggesting suitability for topical application with minimal irritation potential. The viscosity (2500 cps) indicated an optimal rheological profile, ensuring ease of application and adequate retention on the skin. Good spreadability (6.0 g·cm/s) reflected satisfactory extensibility, supporting uniform

application and patient compliance. The specific gravity (1.0686) suggested formulation homogeneity, while the refractive index (1.355) indicated clarity and uniformity of the gel system. Collectively, these findings confirm that the *Lodhradi* Hydrogel possesses desirable physicochemical attributes for a stable, skin- friendly, and cosmetically acceptable topical herbal formulation.

Table 7: Result of Analytical study of *Lodhradi Lepa.*

Sr No	Protocol	Observation
1.	Description	Fine Powder Lepa
2.	Uniformity of weight	50 gm
3.	Colour	Light Reddish Brown
4.	Odour	Characteristic
5.	Taste	Characteristic
6.	pH	4.76
7.	Water soluble extractive	48.24%
8.	Loss on drying at 105^0 C	2.99%
9.	Particle size	440.1
10.	Acid insoluble Ash	0.59%
11.	Microbial Staining Test/Physical Microscopy	No, Viable organism, animal body tissue or any insect body part is detected into the sample.

Table 8: Result of Analytical study of *Lodhradi* Hydrogel.

Sr. No.	Protocol	Observations
1.	Appearance	Thick viscous gel
2.	Colour	Brown
3.	Odour	Characteristic
4.	pH	6.35
5.	Viscosity	2500 cP
6.	Specific gravity	1.0686
7.	Refractive index	1.355
8.	Spreadability	6.0
9.	Thermal stability	Stable
10.	Total Bacterial count	220 cfu/ml
11.	Total fungal count	<10 cfu/ml
12.	Patch test	Non irritant

3.3.2. Chromatographic Fingerprinting (HPTLC)

The HPTLC fingerprint analysis provided a distinct chromatographic profile for both formulations, confirming the presence of multiple phytoconstituents corresponding to the marker compounds of *Lodhra*, *Dhanyaka*, and *Vacha*. This analytical fingerprint serves as a reproducible identification tool.

In the presented study, HPTLC of *Lodhradi Lepa* at 510 nm with three tracks was done. In the first track, it showed a total of 2 peaks, with the highest peak at 56.00% with an R.F. value of 0.04 and another peak at 44.00% with an R.F. value of 0.02. In the second track, 1 peak was obtained and highest peak at 100.00% with an R.F. value of 0.04. In the third track a total of one peak was obtained, with the highest peak at 100.00% with an R.F. value of 0.04.

HPTLC of *Lodhradi* Hydrogel at 510 nm three tracks were done. In the first track, it showed a total of 3 peaks, with the highest peak at 50.21% with an RF value of 0.06. In second track 1 peak was obtained, with the highest peak at 100.00% with an RF value of 0.05. In the third track a total of one peak was obtained and highest peak at 100.00% with an RF value of 0.05.

3.3.3. Microbial Quality and Safety Evaluation

Both formulations complied with API microbial limits. Total bacterial and fungal counts were significantly below permissible limits, confirming microbiological safety. The microbial load of the formulation indicates that the preparation, storage, and handling of intermediates and finished products were carried out under hygienic and aseptic conditions.

3.3.4. Stability

Stability studies provide a systematic approach to evaluate the consistency of a formulation in terms of its physicochemical characteristics, phytochemical content, and contaminant profile over time when exposed to environmental factors such as temperature, humidity, and light. Such studies also aid in determining the shelf life of a product under recommended storage conditions. A formulation is regarded as stable when no significant alterations are observed during testing under either accelerated or real-time storage conditions.

Based on the findings of the present study, for accelerated stability testing of LH revealed no significant variations in specific gravity, refractive index, pH, Viscosity and Spreadability.

3.3.5. Patch Test

Patch testing revealed no erythema or oedema in the test product, with a mean irritation score of 0.7, categorizing *Lodhradi* Hydrogel as non-irritant and safe for topical application.

Table 9: Result of Antimicrobial activity of *Lodhradi Lepa.*

Antimicrobial Activity (Values are mean of triplicate)	As per standard antimicrobial sensitivity protocol of pharmacopoeia	**Zone of Inhibition (mm)**			
		Standard	**Test Sample (in DMSO)**		
		Positive control	**50mg/ml**	**100mg/ml**	**DMSO Negative control**
Staphylococcus epidermis		24	14	18	8
Propionibacterium acne		24	18	20	8

Table 10: Result of Antimicrobial activity of *Lodhradi* Hydrogel.

Antimicrobial Activity (Values are mean of triplicate)	**As per standard antimicrobial sensitivity protocol of pharmacopoeia**	**Zone of Inhibition (mm)**			
		Standard	**Test Sample (in DMSO)**		
		Positive control	**50mg/ml**	**100mg/ml**	**DMSO Negative control**
Staphylococcus epidermis		24	16	18	8
Propionibacterium acne		24	18	22	8

Both *Lodhradi Lepa* and *Lodhradi* Hydrogel exhibited antibacterial activity against *Staphylococcus epidermidis* and *Propionibacterium acnes* at tested concentrations. Antimicrobial activity against *Staphylococcus epidermidis.*

At concentrations of 50 mg/ml and 100 mg/ml, both formulations produced clear zones of inhibition. Statistical analysis using an independent Student's *t*-test showed no significant difference between *Lodhradi Lepa* and *Lodhradi* Hydrogel at either concentration ($p > 0.05$), indicating comparable antibacterial activity against *S. epidermidis*.

Antimicrobial activity against *Propionibacterium acnes.*
At 50 mg/ml, both formulations demonstrated similar zones of inhibition, with no statistically significant difference ($p > 0.05$). However, at 100 mg/ml, *Lodhradi* Hydrogel produced a significantly larger zone of inhibition compared to *Lodhradi Lepa* ($p < 0.05$), indicating superior antibacterial activity of the hydrogel at higher concentration.

Comparative in-vitro antimicrobial evaluation revealed that both formulations possess significant antibacterial activity against Staphylococcus epidermidis and Propionibacterium acnes. While the antimicrobial efficacy against S. epidermidis was comparable between the two formulations ($p > 0.05$), *Lodhradi* Hydrogel demonstrated significantly higher activity against *P. acnes* at higher concentrations ($p < 0.05$). This enhanced performance may be attributed to improved dispersion, diffusion, and bioavailability of phytoconstituents in the hydrogel base.

Overall, the findings validate that *Lodhradi* Hydrogel is a stable, non-irritant, patient- friendly topical formulation with antimicrobial efficacy equal to or superior to the classical *Lodhradi Lepa.* The study supports the feasibility of integrating classical Ayurvedic formulations with contemporary pharmaceutical approaches to enhance usability, acceptability, and therapeutic performance, thereby providing a rational basis for further in-vivo and clinical evaluation in the management of acne vulgaris.

5. CONCLUSION

The present study demonstrates that *Lodhradi Lepa*, a classical Ayurvedic external formulation indicated in *Mukhaduṣika* (*Yuvan Piḍika),* can be successfully transformed into a modern hydrogel dosage form without compromising its traditional composition or therapeutic intent. Standardized pharmaceutical processing and analytical evaluation confirmed the quality, purity, stability, and safety of both *Lodhradi Lepa* and the developed *Lodhradi* Hydrogel in accordance with Ayurvedic Pharmacopoeia of India guidelines.

PREPERATION OF *LODHRADI* HYDROGEL

Fig 1: Weighing of *Lodhra.*

Fig 2: Weighing of *Dhanyaka.*

Fig 3: Weighing of *Vacha.*

Fig 4: Pulverization of raw drugs.

Fig 5: Filteration of fine powder through Muslin cloth

Fig 6: Weighing of *Lodhra* powder.

Fig.7 Weighing of *Dhanyaka* powder

Fig.8 Weighing of *Vacha* powder

Fig. 9 Final mixing of powder of raw drugs

Fig 10 Weighing of *Lodhradi Lepa*

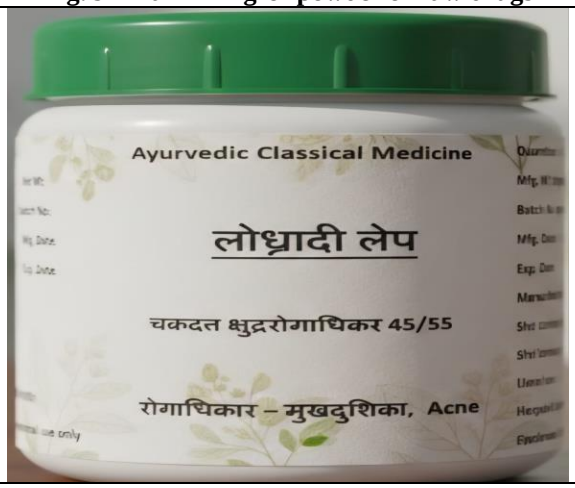

Fig.11 *Lodhradi Lepa* Packing and labelling

REPERATION OF *LODHRADI* HYDROGEL

1. Extraction procedure

Fig. 12: Drug powder placed in Thimble

Fig. 13: Extraction in Universal Extractor

Fig.14: Extracts obtained

Fig.15: Solvent evaporation through Rotary Evaporator

Fig.16: Weighing of Extracts

Fig.17: Extracts stored in airtight containers

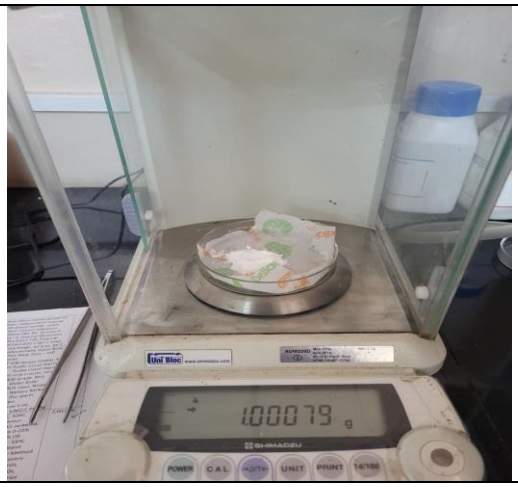

Fig. 18: Weighing Carbopol 940

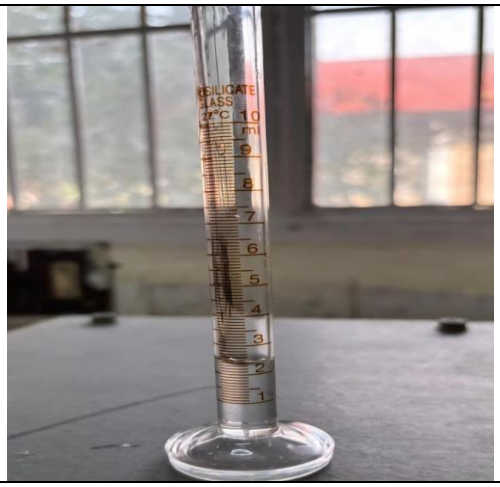

Fig.19: TEA (Triethanolamine)

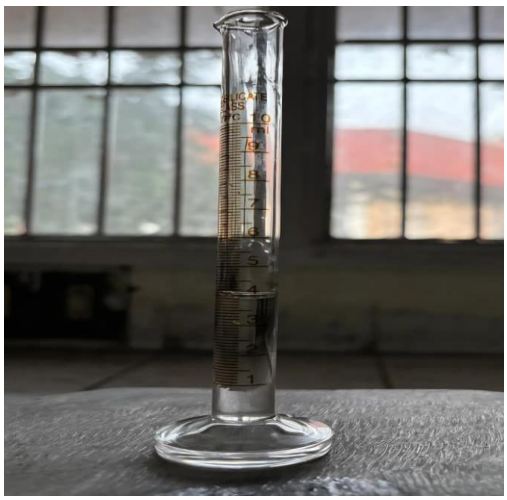

Fig.20: Glycerin.

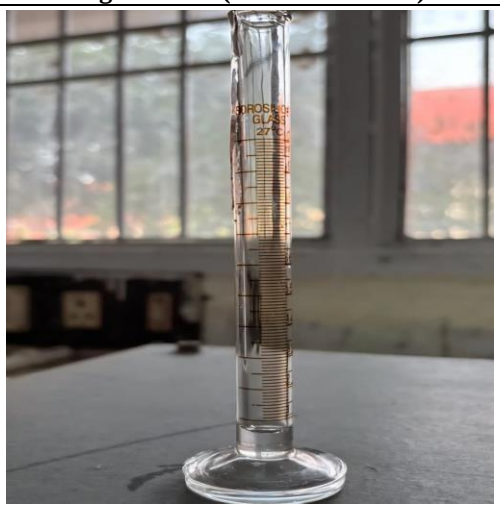

Fig.21: Phenoxyethanol.

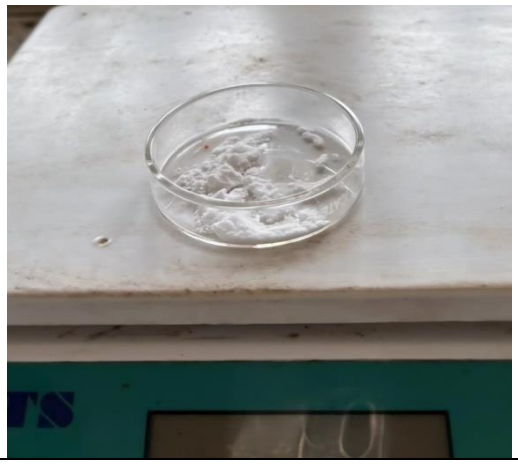

Fig.22 EDTA.

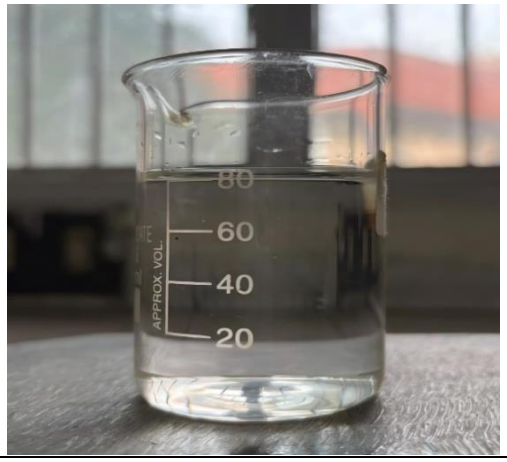

Fig.23 Distilled Water.

Fig. 24: Beaker A -Carbopol 940 added in Distilled Water.

Fig.25: Stirring of Carbopol.

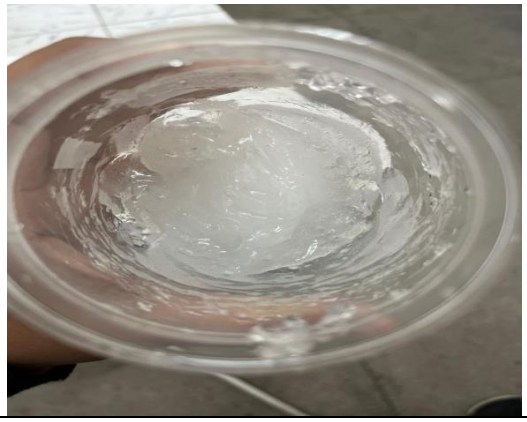

Fig.26: After mixing TEA, Glycerin to Carbopol solution

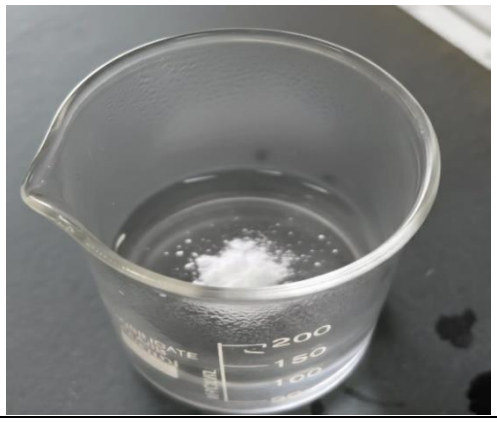

Fig.27: Adding Preservatives to beaker B

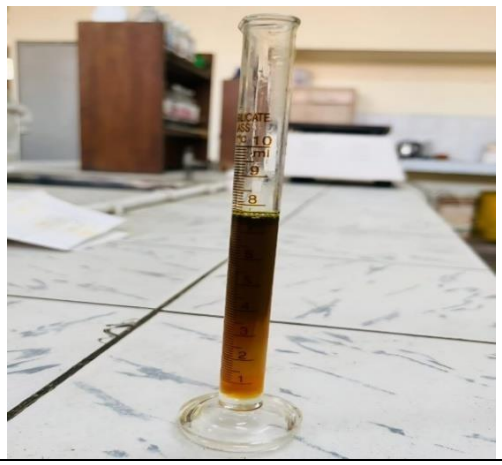

Fig.28: Extracts

Fig.29: Adding extracts to solution

Fig.30: Prepared *Lodhradi* Hydrogel with air bubbles.

Fig 31: After De aeration.

Fig 32. *Lodhradi* Hydrogel packing and Labeling.

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