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Development and Evaluation of a Topical Herbal Formulation for the Treatment of Eczema

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Abstract: *The present study aimed to develop and evaluate a topical herbal gel incorporating the ethanolic extract of Karivepallai leaves for the treatment of eczema. The leaves were collected, authenticated, dried, powdered, and subjected to successive defatting and extraction using petroleum ether and ethanol. Physicochemical parameters such as moisture content, ash values, and extractive values were determined to ensure quality and purity. Preliminary phytochemical screening revealed the presence of proteins, carbohydrates, fats, alkaloids, steroids, diterpenes, and saponins, supporting the therapeutic potential of the extract. Herbal gels were formulated using Carbopol-934 as a gelling agent with varying concentrations of extract and excipients. The prepared gels were evaluated for organoleptic properties, pH, spreadability, consistency, homogeneity, extrudability, viscosity, and stability over 90 days, all of which indicated favorable characteristics suitable for topical use. Antimicrobial studies performed by agar diffusion demonstrated significant zones of inhibition against Escherichia coli, Staphylococcus aureus, Salmonella sp., and Candida albicans, highlighting the formulation's broad-spectrum activity. Among the formulations, F5 showed optimal pH, spreadability, extrudability, and viscosity along with strong antimicrobial efficacy. Stability studies confirmed that the gel maintained its physical, chemical, and microbiological integrity over 90 days. This research underscores the potential of Karivepallai-based herbal gel as a promising alternative therapy for managing eczema, combining traditional plant-based remedies with modern pharmaceutical technology.*

Keywords: *Karivepallai*, herbal gel, eczema, antimicrobial activity, phytochemical screening, topical formulation, stability studies

I. INTRODUCTION

Eczema, also known as atopic dermatitis, is a chronic, relapsing inflammatory skin disorder characterized by erythema, edema, vesiculation, oozing, crusting, scaling, and lichenification.[1,2] It significantly affects the quality of life due to persistent itching, discomfort, and visible lesions. The global prevalence of eczema is increasing, affecting up to 20% of children and 3% of adults worldwide, thereby posing a substantial healthcare burden. Current conventional treatments primarily involve topical corticosteroids and immunomodulators, which, despite their effectiveness, are often associated with adverse effects such as skin atrophy, irritation, and long-term systemic complications. This highlights the need for safer, effective, and patient-friendly alternatives.[3]

Medicinal plants and their phytoconstituents have long been explored for dermatological applications due to their multi-targeted mechanisms, safety profile, and cultural acceptability. Herbal formulations offer a promising complementary or alternative approach for managing eczema by leveraging natural bioactive compounds with anti-inflammatory, antimicrobial, antioxidant, and wound-healing properties. Among such medicinal plants, *Karivepallai*, belonging to the family Rutaceae, has gained attention for its rich phytochemical profile and diverse pharmacological activities.[4]

Karivepallai leaves are traditionally used in Ayurveda and folk medicine for treating various ailments including skin disorders, owing to their documented antibacterial, antifungal, anti-inflammatory, and antioxidant properties. Phytochemical studies have revealed the presence of alkaloids, flavonoids, steroids, saponins, and terpenoids, which contribute to its therapeutic potential. Despite these traditional claims and preliminary scientific evidences, there is

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limited systematic research focusing on the development of *Karivepallai*-based topical formulations specifically for eczema.[5]

The present study was designed to develop a topical herbal gel incorporating the ethanolic extract of *Karivepallai* leaves and to evaluate its physicochemical properties, stability, and antimicrobial activity against common skin pathogens. Gel formulations are particularly advantageous for topical delivery as they offer ease of application, good patient compliance, non-greasy texture, and enhanced drug release profiles. By integrating traditional herbal knowledge with modern formulation techniques, this research aims to provide a scientifically validated, safe, and effective natural alternative for the management of eczema.

This study not only investigates the qualitative phytochemical constituents of *Karivepallai* but also systematically assesses the quality parameters, spreadability, consistency, extrudability, and in vitro antimicrobial efficacy of the developed gel. The stability of the formulation under accelerated conditions further ensures its potential as a viable commercial product. Through this research, we seek to contribute to the growing field of herbal dermatology by offering a novel, evidence-based approach to eczema management, ultimately improving patient outcomes and expanding therapeutic options in skin care.

II. MATERIALS AND METHODS

Plant Selection, Extraction, and Physicochemical Evaluation

Karivepallai leaves were collected, authenticated under expert guidance, dried, and powdered. The powdered material (100 mg) was first defatted with petroleum ether (60–80 °C) using a Soxhlet apparatus, and then extracted with ethanol for 72 hours. The ethanolic extract was concentrated under reduced pressure using a rotary evaporator and stored in airtight containers protected from light. Physicochemical parameters of the powdered drug, including moisture content, total ash, acid-insoluble ash, water-soluble ash, alcohol-soluble extractive, and water-soluble extractive values, were determined to ensure quality, purity, and suitability for formulation development in the management of infectious eczema.[6]

Preliminary Phytochemical Screening

The ethanolic extract of *Karivepallai* leaves was subjected to qualitative phytochemical tests for the identification of primary and secondary metabolites. Standard procedures were employed to detect carbohydrates (Molisch's and Benedict's tests), proteins and amino acids (Biuret, precipitation, ninhydrin, and cysteine tests), fats (Sudan red, spot, and saponification tests), saponins (foam and haemolytic tests), alkaloids (Dragendorff's, Mayer's, Wagner's, and Hager's tests), flavonoids (Shinoda, alkaline reagent, and zinc-hydrochloride tests), phenols (ferric chloride test), triterpenoids (Libermann-Burchard and sulfur powder tests), lignins (phloroglucinol-HCl and thionine tests), and tannins (vanillin-HCl and gelatin tests). These analyses confirmed the presence of diverse phytoconstituents, supporting the potential therapeutic application of the extract.[7]

Preparation of Herbal Gel

The herbal gel was formulated using the ethanolic extract of *Karivepallai* and Carbopol-934 (1% w/w) as the gelling agent. Briefly, Carbopol-934 was gradually dispersed in distilled water with continuous stirring to avoid clumping and achieve a homogeneous base. The extract was then incorporated into the hydrated Carbopol matrix under constant stirring. The pH of the formulation was adjusted to neutral using sodium hydroxide solution. Preservatives (methyl paraben and propyl paraben) and menthol oil were added with thorough mixing to ensure uniform distribution. The gel was allowed to stand for complete hydration, re-stirred for uniformity, and then transferred to suitable containers for storage at cool temperatures away from light.[8,9]

Table 1: Composition of herbal Gel

Composition	F1	F2	F3	F4	F5	F6
Extract	1.5gm	2 gm	2.5 gm	3 gm	3.5 gm	4 gm
Carbopol 934	1 gm	1.5 gm	2 gm	1 gm	1.5 gm	2 gm
Propylene glycol	5 gm	10 gm	15 gm	5 gm	10 gm	15 gm
Methyl paraben	0.2 gm	0.2 gm	0.2 gm	0.2 gm	0.2 gm	0.2 gm

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Propyl paraben	0.5 gm	0.5 gm	0.5 gm	0.5 gm	0.5 gm	0.5 gm
Purified water	100 ml	100 ml	100 ml	100 ml	100 ml	100 ml
Menthol oil	0.1 ml	0.1 ml	0.1 ml	0.1 ml	0.1 ml	0.1 ml
Triethonal amine	q.s.	q.s.	q.s.	q.s.	q.s.	q.s.

Evaluation of Prepared Herbal Gel

The prepared *Karivepallai* herbal gel was evaluated through comprehensive parameters to ensure its quality, stability, and suitability for topical application. The organoleptic properties, including greenish color, pleasant odor, smooth texture, and uniform consistency, were favorable and contributed to an appealing user experience. pH was measured using a calibrated pH meter, ensuring compatibility with skin and formulation stability. Spreadability and consistency were assessed by the slide method, confirming ease of application and appropriate viscosity. Homogeneity was evaluated by sampling different portions of the gel, showing uniform distribution of ingredients without visible lumps or phase separation. Extrudability tests demonstrated that the gel extruded smoothly and uniformly with minimal force, indicating good dispensing properties. Stability studies conducted over 90 days under controlled conditions revealed no significant changes in physical appearance, pH, or microbial contamination, confirming the formulation's stability. These evaluations collectively assured that the herbal gel met essential quality standards for safe and effective topical use.[10,11]

Antimicrobial Studies

The in vitro antimicrobial activity of the prepared *Karivepallai* herbal gel was evaluated using the agar plate diffusion method against Escherichia coli, Staphylococcus aureus, and Salmonella species. Sterile filter paper discs (6 mm diameter) were impregnated with 10 µl of the herbal gel and allowed to dry to ensure complete absorption. These discs were then carefully placed on agar plates previously inoculated with the respective test microorganisms. The plates were incubated at 37 °C for 24 hours, after which the zones of inhibition were measured to assess the antimicrobial efficacy of the herbal gel. [12,13]

III. RESULT AND DISCUSSION

The present study focused on the development and evaluation of a topical herbal gel formulated using the ethanolic extract of Karivepallai leaves. The physicochemical evaluation of the powdered herb (Fig. 1) indicated acceptable quality parameters, establishing a reliable raw material foundation for formulation. Preliminary phytochemical screening (Table 2) confirmed the presence of proteins, carbohydrates, fats, alkaloids, steroids, diterpenes, and notably high levels of saponins (++ve), which are known for their anti-inflammatory, antimicrobial, and skin-protective activities. The absence of glycosides, tannins, resins, flavonoids, amino acids, and phenolic compounds suggested a specific phytochemical profile, potentially reducing the risk of irritancy often associated with certain phenolic or tannin-rich extracts. The evaluation of the prepared herbal gels (Table 3) demonstrated that all formulations possessed acceptable pH values ranging from 4.8 to 5.2, which are compatible with the natural pH of human skin, minimizing irritation risk upon application. Among these, F5 exhibited optimal physicochemical characteristics with a pH of 5.0 ± 0.63, highest spreadability (22.16 ± 1.06 cm), good extrudability (80 g), and a viscosity of 180 cps, indicating a balanced gel network that ensures ease of application and adequate retention on the skin. The rheological properties, supported by spreadability and extrudability data, affirmed that the formulation would provide uniform coverage without being too runny or overly stiff, thereby enhancing user compliance.

Antimicrobial studies (Table 4) revealed that all gel formulations exhibited appreciable zones of inhibition against the tested pathogens, including *Escherichia coli*, *Staphylococcus aureus*, *Salmonella* species, and *Candida albicans*, highlighting the broad-spectrum antimicrobial potential of the herbal gel. Particularly, F5 showed superior activity against *S. aureus* (35 ± 2.0 mm) and comparable efficacy against *E. coli* (34 ± 1.2 mm) and *Salmonella* (34 ± 1.7 mm). Notably, even the antifungal activity against *C. albicans* was moderate (29 ± 1.4 mm), indicating additional benefits in preventing secondary infections often associated with eczema.

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Stability studies over 90 days (Table 5) confirmed that the F5 formulation retained its physical appearance, spreadability, pH, and rheological properties without signs of phase separation, microbial growth, or degradation, underscoring the formulation's robustness and shelf-life potential. The sustained consistency and extrudability over the testing period suggest that the preservative system and gel matrix effectively maintained product integrity.

Overall, these results collectively support the successful formulation of a stable, user-friendly, and microbiologically effective herbal gel using Karivepallai extract. The findings validate the traditional claims and offer a scientifically substantiated alternative for managing eczema, combining desirable organoleptic, physicochemical, and antimicrobial properties tailored for topical dermatological use.

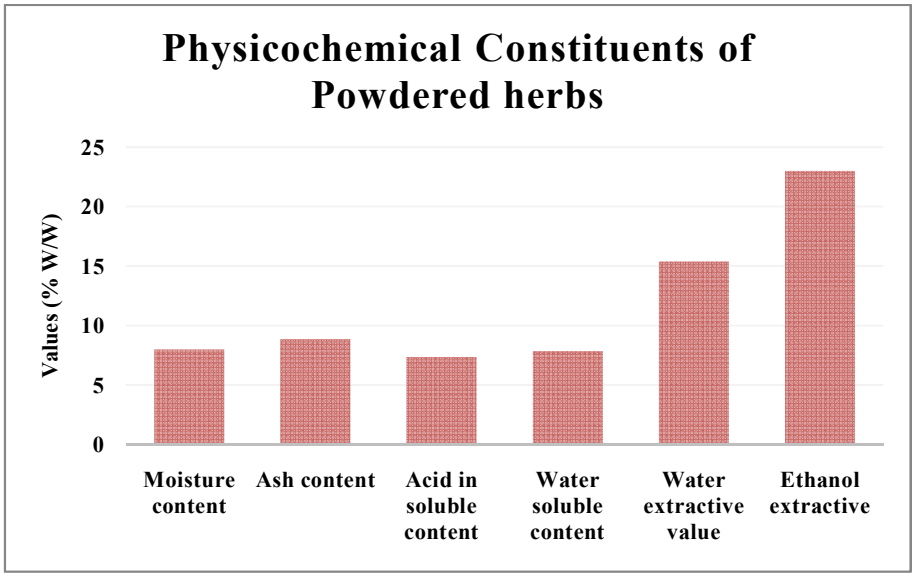

Fig 1: Physicochemical Constituents of Powdered herbs

Table 2: Phytochemical investigation

S. No	Phyto-constituents	*Karivepallai*
1	Proteins	+ve
2	Carbohydrates	+ve
3	Fats & Oil	+ve
4	Alkaloids	+ve
5	Glycosides	-ve
6	Tannins	-ve
7	Resins	-ve
8	Flavonoids	-ve
9	Steroids	+ve
10	Amino-acids	-ve
11	Phenol test	-ve
12	Diterpenes	+ve

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13	Saponins test	++ve

Table 3: Evaluation of prepared gel

Sample	pH Measurement	Spraedability	Extrudability (g)	Viscosity (cps)
F1	4.8±0.25	18.36±1.02	50	100
F2	5.1±0.23	20.06±2.01	70	150
F3	4.9±0.13	19.37±0.75	85	200
F4	5.2±0.92	21.38±1.03	60	120
F5	5.0±0.63	22.16±1.06	80	180
F6	5.1±0.29	19.45±1.27	75	160

Table 4: Antimicrobial study of herbal gel

Concn of Drug (µg/ml)/ *Organisms*	Zone of inhibition (diameter mm)					
	F1	F2	F3	F4	F5	F6
E. coli	36 ± 2.0	32 ± 1.2	34 ± 1.2	32 ± 1.2	34 ± 1.2	35 ± 1.2
S. aureus	32 ± 1.8	30 ± 2.0	33± 2.0	30 ± 2.0	35 ± 2.0	37 ± 2.0
Salmonella Sp.	37 ± 1.2	30 ± 1.7	35 ± 1.7	33 ± 1.7	34 ± 1.7	32 ± 1.7
C. albicans	31 ± 1.6	28 ± 1.4	29± 1.4	27 ± 1.4	29 ± 1.4	33± 1.4

Table 5: Stability studies

Property	Initial Value	Value after 90 days
Physical Appearance	Uniform gel	Uniform gel
Rheological Properties	Consistency: good Extrudability: good	Consistency: good Extrudability: good
Spreadability	Good	Good
pH	5-6	5-6

IV. CONCLUSION

The study successfully demonstrated the development of a stable and effective topical herbal gel using *Karivepallai* leaf extract. The formulation exhibited desirable physicochemical and rheological properties, maintained stability over 90 days, and showed significant antimicrobial activity against common pathogens associated with skin infections. These findings support its potential use as a natural, safe, and effective therapeutic option for the management of eczema and related skin conditions.

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