Formulation and Evaluation of Herbal Gel Containing *Fumariaindica* Extract and Isolated Compounds for Anti-Psoriatic Activity

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Abstract
Psoriasis is a chronic inflammatory skin disorder associated with oxidative stress, keratinocyte hyperproliferation, and immune dysregulation. The present study aimed to formulate and evaluate herbal gel formulations containing ethanolic extract and isolated compounds from Fumariaindica for anti-psoriatic activity. The aerial parts of *Fumariaindica* were collected, authenticated, and subjected to physicochemical, phytochemical, and chromatographic analysis. Two bioactive alkaloids, protopine (FI-1) and corydomine (FI-2), were isolated and characterized by spectral methods. Herbal gels (FG1–FG5) containing crude extract and isolated compounds were prepared and evaluated for physicochemical parameters, antioxidant activity, cytokine modulation, PASI score, Baker's score, and histopathological changes in imiquimod-induced psoriatic mice. Among all formulations, FG5 containing 2% FI-2 demonstrated superior spreadability, viscosity, antioxidant activity, cytokine suppression, and anti-psoriatic efficacy. The formulation significantly reduced erythema, scaling, epidermal hyperplasia, and pro-inflammatory cytokines (TNF-α, IL-6, IL-17). The study suggests that *Fumariaindica* isolated compounds possess promising anti-psoriatic potential and may serve as effective topical therapeutic agents.

Keywords: Psoriasis, *Fumariaindica*, Herbal gel, Protopine, Corydomine, Cytokines

Introduction

Psoriasis is a chronic autoimmune inflammatory skin disorder characterized by epidermal hyperproliferation, erythema, scaling, and infiltration of inflammatory mediators. Oxidative stress and inflammatory cytokines such as TNF-α, IL-6, and IL-17 play a major role in disease progression. Conventional therapies often produce adverse effects during long-term use, necessitating safer herbal alternatives.Psoriasis is a chronic inflammatory disease of the skin affecting about 2-3% of the population [1-3]. It sometimes affects the joints. The disease commonly presents as itchy, thick, dry, erythematous and scaly plaques that negatively affect the quality of life.Psoriasis in not curable and its treatment is individualised. In milder cases with limited skin involvement, topical therapy with corticosteroids, vitamin D3-derived drugs, dithranol (anthralin), retinoids (tazarotene) and tacrolimus, among others, are appropriate. Long-term adverse effects include local irritation, skin atrophy, telangiectasia and striae. However, in more extensive psoriasis, systemic treatments such as PUVA (psoralen plus ultraviolet-A radiation), cyclosporine, methotrexate and various biologics are often used [4-6]. Systemic treatments may be contraindicated in patients with premalignant (e.g., xerodermapigmentosum, albinism) and photosensitive dermatoses, patients with a history of melanoma or multiple skin cancers, in pregnant and lactating patients, in liver or kidney failure and in patients with immunodeficiency or blood dyscrasias. The dermatologic manifestations of psoriasis are varied; psoriasis vulgaris is also called plaque-type psoriasis, and is the most prevalent type. The terms psoriasis and psoriasis vulgaris are used interchangeably in the scientific literature; nonetheless, there are important distinctions among the different clinical subtypes [7-10].

Psoriasis is a common skin disorder that is associated with both a physical and psychological burden. As with other dermatoses, visible disfiguration can trigger a negative reaction in others, which can cause much of the readily measurable psychological burden of the disease. In a comparison with a selection of other chronic disorders including cancer, myocardial infarction, and congestive heart failure, only depression and chronic lung disease impaired psychological quality of life more than psoriasis. The high physical burden of disease is not so well understood by scientists, but might be related to symptoms such as itching or burning sensations [11-12]

Medicinal plants contain organic substances that have pharmacological actions (e.g., anti-inflammatory effects). This vast field needs further development and there is an urgent need for clinical studies. For any plant-derived products to be introduced for the treatment of disease, it is necessary to have extensive knowledge of the plant, its cultivation and

harvest characteristics, its composition (active substances), pharmacological effects, dose and forms of use. Safety and efficacy studies both in animals and humans also need to be performed [13-14].
Fumariaindica is traditionally used in Ayurvedic medicine for dermatological disorders, inflammation, and wound healing. The plant contains alkaloids, flavonoids, tannins, and terpenoids possessing antioxidant and anti-inflammatory properties. Fumariaindica is traditionally used for skin diseases and inflammatory disorders. Its alkaloids and phenolic compounds are reported to exhibit hepatoprotective, antioxidant, and antimicrobial activities. Fumariaofficinalis L. (common fumitory) is one of the most extensively studied species within the genus Fumaria (family Fumariaceae) and has long been used in traditional medicine across Europe and Asia. It was traditionally employed as a remedy for liver ailments, skin conditions, and inflammatory disorders due to its detoxifying, anti-inflammatory, and antiseptic properties. The plant's therapeutic effects are attributed to its diverse chemical constituents, including isoquinoline alkaloids, flavonoids, and phenolic compounds, making F. officinalis a promising candidate for the development of herbal medicines. Pharmacological studies indicate a broad spectrum of biological effects for F. officinalis. In addition to its anti-inflammatory properties, the plant also possesses antioxidant, antibacterial, antiviral, and hepatoprotective effects. Due to these properties, the mentioned herb is a promising candidate for the development of new pharmaceutical products that could improve the treatment of various chronic diseases [15-19]. The present investigation focused on isolation of bioactive compounds from *Fumariaindica* and development of topical herbal gel formulations for psoriasis management.

Materials and Methods

Collection and Authentication of Plant Material

The aerial parts of *Fumariaindica* were collected and authenticated by a qualified botanist. Plant material was shade-dried, powdered, and stored in airtight containers.

Extraction and Phytochemical Screening

Physicochemical parameters including total ash, acid insoluble ash, water soluble ash, loss on drying, alcohol soluble extractive, and water soluble extractive values were determined according to standard procedures.Powdered plant material was extracted using ethanol by maceration and Soxhlet extraction methods. Preliminary phytochemical screening was carried out for alkaloids, flavonoids, tannins, saponins, terpenoids, carbohydrates, and glycosides.

Isolation and Characterization of Compounds

Two compounds were isolated: FI-1: Protopine; FI-2: Corydomine.Structural characterization was performed using 1H NMR, 13C NMR and Mass spectroscopy.

Preparation of Herbal Gel

The herbal gel formulation of isolated plant extract was prepared with mixing of ethanol extract of Fumariaindica aerial part and isolated compound to gel base mixture. The gel based on synthetic gelling agents (Carbapol 940 (5 gm) was prepared in known amount of distilled water. After complete dispersion, the polymer solution was kept in dark for 24 hours for complete swelling. Accurately weighed amount of drugs were dissolved in a specified quantity of suitable solvent. The drug solution was added slowly to the aqueous dispersion of polymer with the help of high-speed stirrer (500 rpm) taking precaution that air did not entrap. Finally, the remaining ingredients were added to obtain a homogeneous dispersion of gel, finally transferred in a suitable container. The plant extract gel was finally transferred in aluminium collapsible tube and labelled.
FG1: Herbal gel containing 20% Fumariaindica aerial part ethanol extract
FG 2: Herbal gel containing 1% isolated compound (FI 1)
FG 3: Herbal gel containing 2% isolated compound(FI 1)
FG 4: Herbal gel containing 1% isolated compound (FI 2)
FG 5: Herbal gel containing 2% isolated compound(FI 2)

Evaluation of Gels:

Gels were evaluated for their clarity, pH, viscosity, spreadability, extrudability, drug content, *in vitro* diffusion studies by the standard procedure. All studies were carried out and average values were reported.

Anti-Psoriatic Activity

Imiquimod-induced psoriasis-like model in mice was used for evaluation. PASI score, Baker's score, cytokine estimation, and histopathological studies were performed.

Stability Studies

Optimized formulation FG5 was subjected to accelerated stability studies for 180 days under various temperature and humidity conditions.

Results and Discussion

Physicochemical and Phytochemical Evaluation

The plant exhibited acceptable physicochemical values indicating purity and quality. Ethanolic extract showed presence of alkaloids, flavonoids, tannins, terpenoids, and saponins.
Isolation of Compounds: FI-1 and FI-2 were identified as protopine and corydomine respectively based on spectral studies.

Evaluation of Gel Formulations

FG3 and FG5 showed excellent consistency, spreadability, viscosity, and extrudability. The pH values were within acceptable skin range.

The physical evaluation of topical formulations is essential to ensure patient acceptability, stability, uniform drug distribution, and therapeutic effectiveness. The developed herbal gels (FG1–FG5) were assessed for organoleptic characteristics, spreadability, consistency, pH, viscosity, and extrudability.

Anti-psoriatic activity

The anti-psoriatic potential of the developed herbal gel formulations containing Fumariaindica aerial part extract and its isolated compounds (FI-1 and FI-2) was evaluated using aImiquimod-induced psoriatic model, a well-established screening method that assesses epidermal differentiation, orthokeratosis formation and reduction in epidermal thickness. Gels were applied topically once daily on the tail for 14 consecutive days. After the treatment period, tails were excised and processed for histopathological examination.

Table 1: Physical parameters of herbal gel formulation

Parameters	FG1	FG2	FG3	FG4	FG5
Colours	Green colour	White colour	White colour	Pale yellow colour	Pale yellow colour
Appearance	Translucent	Transparent	Translucent	Translucent	Transparent
Odour	Pleasant odour	Define odour	Define odour	Define odour	Define odour
Feel of application	Smooth	Smooth	Smooth	Smooth	Smooth
Spreadability (g.cm/sec)	9.1	10.8	11.1	10.9	11.2
Consistency	Fairly good	Good	Excellent uniform	Good	Excellent uniform
pH	6.81	7.24	7.52	7.12	7.61
Viscosity (cps)	0.92	0.96	1.02	0.97	1.05
Extrudability	Poor	Good	Excellent	Good	Excellent

The anti-psoriatic potential of the developed herbal gel formulations (FG1–FG5) was evaluated using the imiquimod (IMQ)-induced psoriasis-like skin inflammation model in mice. This model closely mimics human plaque psoriasis with respect to erythema, scaling, epidermal thickening and inflammatory cytokine release. Disease control showed severe erythema, scaling, thickening, and high PASI score. Standard group showed marked improvement.

Baker's Score for Anti-psoriatic Activity

The anti-psoriatic activity of the formulated herbal gels was evaluated using Baker's scoring method, which assesses the degree of orthokeratosis and restoration of normal epidermal differentiation. In psoriasis, abnormal keratinocyte proliferation leads to parakeratosis and reduced granular layer formation; therefore, an increase in orthokeratosis and Baker's score indicates improvement in psoriatic lesions.

The results demonstrated that the negative control group showed very low orthokeratosis (19.10 ± 1.25%) and Baker's score (0.19 ± 0.02), confirming the persistence of psoriatic characteristics in untreated animals. In contrast, the standard-treated group exhibited a marked increase in orthokeratosis (72.45 ± 2.18%) with a Baker's score of 0.72 ± 0.02, representing complete therapeutic activity (100%), thereby validating the experimental model.

Among the formulated gels, FG5 exhibited the highest anti-psoriatic activity with 65.92 ± 2.26% orthokeratosis and a Baker's score of 0.66 ± 0.01, corresponding to 91% drug activity. This suggests that FG5 effectively restored epidermal differentiation and reduced psoriatic alterations. The enhanced activity of FG5 may be attributed to the optimized concentration of herbal extract and improved drug release characteristics of the gel base, leading to better penetration and prolonged retention at the affected site.

The study confirmed that the herbal gel formulations significantly improved orthokeratosis and Baker's score compared to the negative control group. Among all formulations, FG5 was found to be the most effective and showed activity comparable to the standard treatment, indicating its promising potential as a topical anti-psoriatic formulation for further pharmacological and clinical investigations.

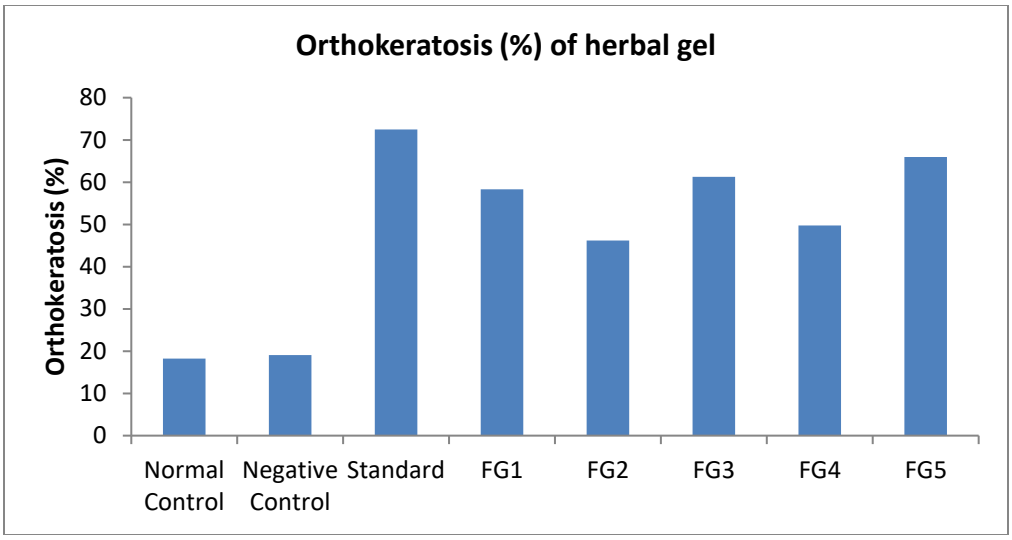

Figure 1: Orthokeratosis (%) for Anti-psoriatic Activity

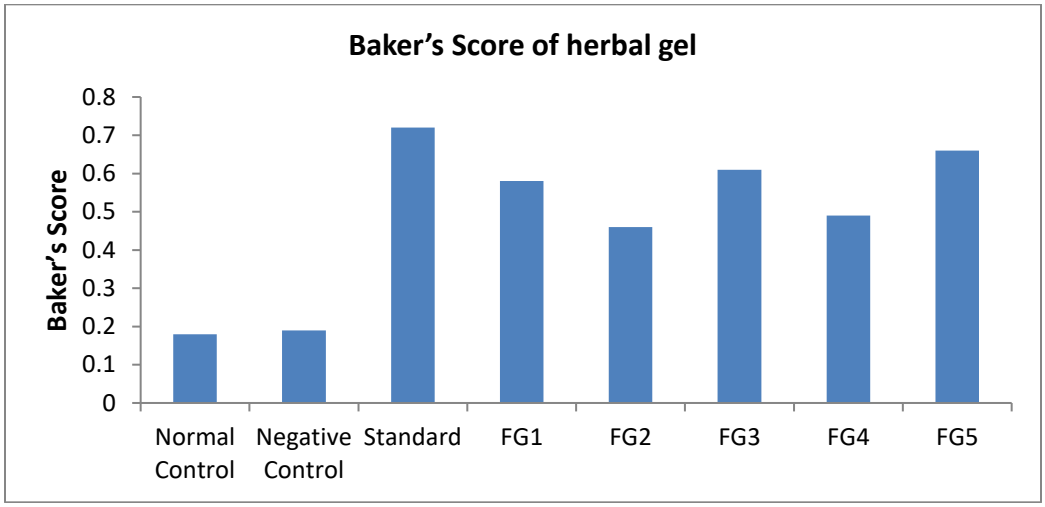

Figure 2: Baker's Score of herbal gel

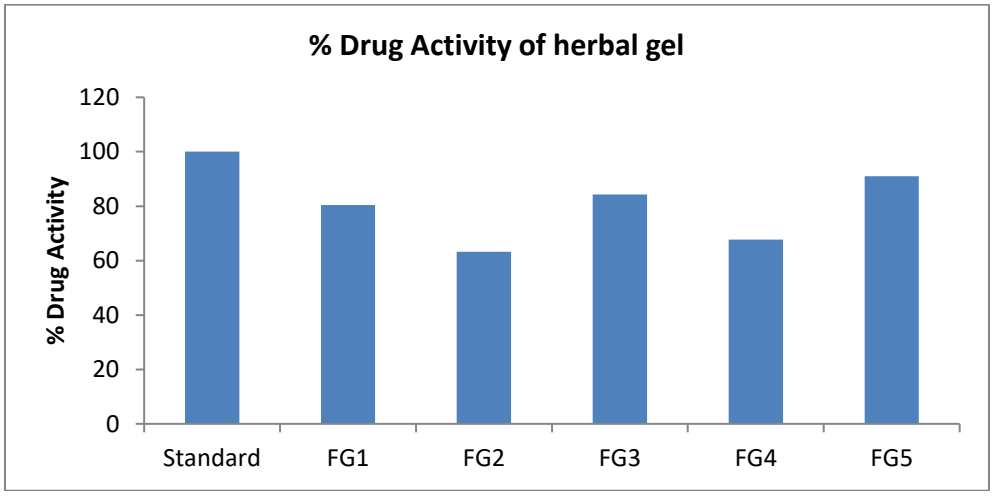

Figure 3:% Drug Activity of herbal gel

All developed formulations showed a significant increase in orthokeratosis compared with the negative control group, indicating promising anti-psoriatic potential. The standard drug tretinoin produced the highest orthokeratosis (72.45%), confirming the reliability of the model. Among the test formulations, FG5 (2% FI-2 gel) exhibited the strongest activity (65.92%), followed by FG3 (2% FI-1) and FG1 (20% extract). The higher activity of FI-2 suggests that this isolated compound may be a major bioactive constituent responsible for the anti-psoriatic effect of *Fumariaindica*.

Psoriasis Area and Severity Index (PASI).

The anti-psoriatic potential of herbal gel formulations containing *Fumariaindica* extract and isolated compounds (FI-1 and FI-2) was evaluated using the Imiquimod-induced psoriasis-like mouse model. The severity of psoriatic lesions was assessed by calculating the Psoriasis Area and Severity Index (PASI). PASI scoring evaluates three major symptoms of psoriasis erythema (Redness), scaling and skin thickening. Each parameter was scored daily on a scale of 0–4:

The Psoriasis Area and Severity Index (PASI) score is a widely accepted parameter for evaluating the progression and therapeutic response of psoriasis. In the present study, the PASI score was assessed for different herbal gel formulations (FG1–FG5) and compared with the standard treatment and disease control group over a period of 7 days.The disease control group exhibited a continuous increase in PASI score from 0.2 ± 0.1 on Day 0 to 11.2 ± 0.4 on Day 7, indicating successful induction and progression of psoriatic lesions in untreated animals. The progressive elevation in PASI score confirms severe erythema, scaling, and skin thickening associated with psoriasis.

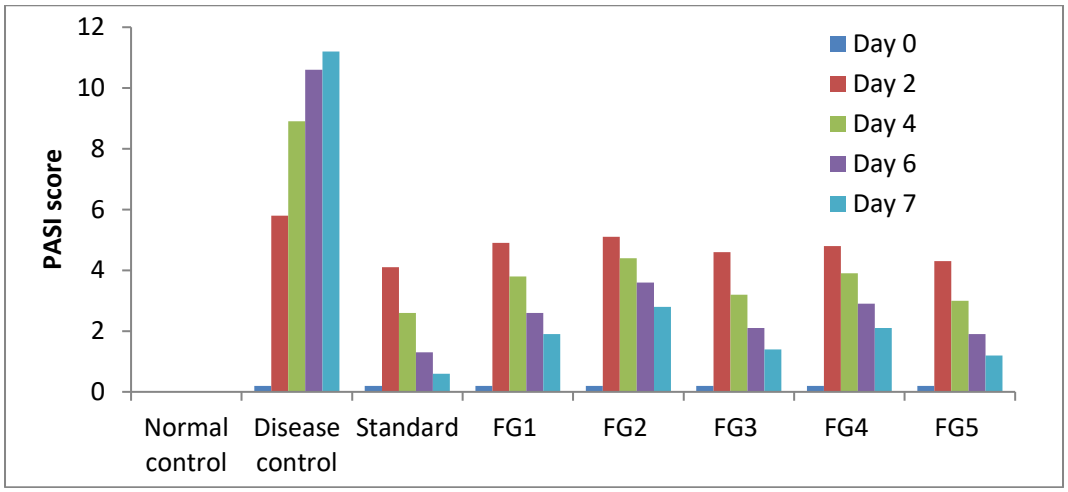

Figure 4: PASI score of formulations

In contrast, the standard-treated group showed a remarkable reduction in PASI score from 4.1 ± 0.2 on Day 2 to 0.6 ± 0.1 on Day 7, demonstrating significant anti-psoriatic activity and effective suppression of inflammatory symptoms. The marked decrease observed in the standard group validates the experimental model and therapeutic evaluation method.

Among the tested formulations, all herbal gel formulations demonstrated a considerable reduction in PASI score compared to the disease control group, indicating promising anti-psoriatic potential. Formulation FG5 exhibited the most significant improvement among all test formulations, with PASI scores decreasing from 4.3 ± 0.2 on Day 2 to 1.2 ± 0.1 on Day 7. The therapeutic response of FG5 was found to be closer to that of the standard treatment, suggesting enhanced efficacy in reducing psoriatic symptoms.Formulation FG3 also showed substantial anti-psoriatic activity, reducing the PASI score to 1.4 ± 0.1 on Day 7, followed by FG1 with a final score of 1.9 ± 0.2. These findings indicate that FG3 and FG1 possess moderate to strong therapeutic effectiveness against psoriasis progression.FG2 and FG4 showed comparatively lesser reductions in PASI scores, reaching 2.8 ± 0.2 and 2.1 ± 0.2 respectively by Day 7. Although these formulations exhibited noticeable improvement compared to the disease control group, their efficacy was lower than FG5 and FG3. The differences in activity among formulations may be attributed to variations in polymer concentration, drug release behavior, permeability, viscosity, and stability of the herbal constituents within the gel matrix.

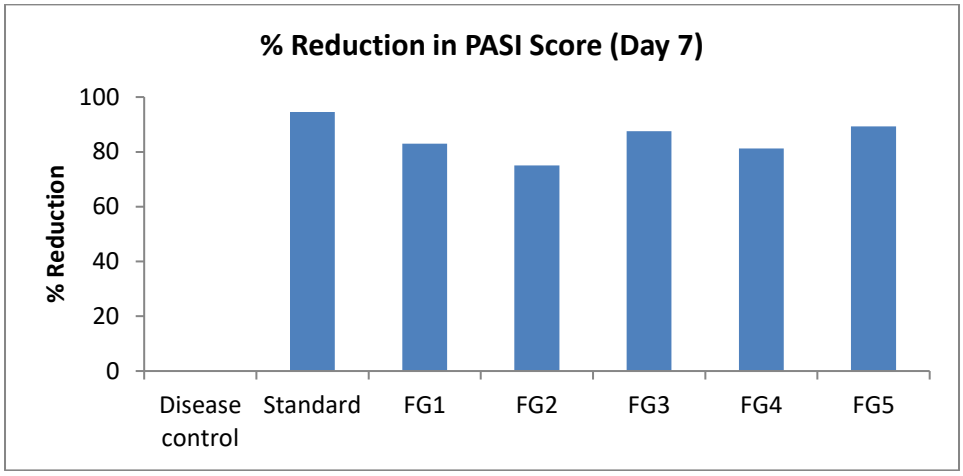

Figure 7: % Reduction in PASI Score (Day 7)

The gradual reduction in PASI scores observed with the herbal formulations may be associated with the anti-inflammatory, antioxidant, and immunomodulatory properties of the phytoconstituents present in the extract. These phytochemicals may inhibit keratinocyte hyperproliferation and inflammatory cytokine release, thereby reducing erythema, scaling, and plaque formation. The study demonstrated that the developed herbal gel formulations possess significant anti-psoriatic activity, with FG5 emerging as the optimized formulation due to its superior reduction in PASI score and better therapeutic performance comparable to the standard treatment.

Effect of Formulations on Pro-inflammatory Cytokines

Psoriasis is a chronic immune-mediated inflammatory skin disorder characterized by activation of dendritic cells and T-helper (Th1/Th17) immune pathways. Key pro-inflammatory cytokines involved in disease progression include TNF-α, IL-6, IL-17 and IL-23, which stimulate keratinocyte hyper-proliferation, epidermal thickening and inflammatory infiltration.In the present study, serum cytokine levels were estimated to understand the anti-inflammatory and immunomodulatory mechanism of the developed herbal gels. Imiquimod application produced a marked increase in pro-inflammatory cytokines in the disease control group, confirming successful induction of psoriasis-like inflammation. Topical treatment with *Fumariaindica* extract and isolated compound formulations significantly reduced cytokine levels compared to the disease control group.

Imiquimod application significantly elevated TNF-α, IL-6 and IL-17 levels, confirming induction of psoriasis-like inflammation. Treatment with Fumariaindica gels markedly suppressed cytokine production. All formulations significantly reduced cytokines vs disease control. FI-1 and FI-2 isolated compounds showed stronger inhibition than crude extract. 2% concentration produced greater suppression than 1%. FG5 showed maximum cytokine inhibition, suggesting potent immunomodulatory activity of FI-2. Reduction in TNF-α and IL-17 indicates inhibition of the IL-23/Th17 inflammatory axis, the key pathway in psoriasis pathogenesis. The findings confirm that Fumariaindica based gels possess significant anti-psoriatic activity by reducing psoriasis severity, suppressing inflammatory cytokines and improving skin histology. Among all formulations, FG5 (2% FI-2 gel) demonstrated the most promising therapeutic potential for topical psoriasis management.

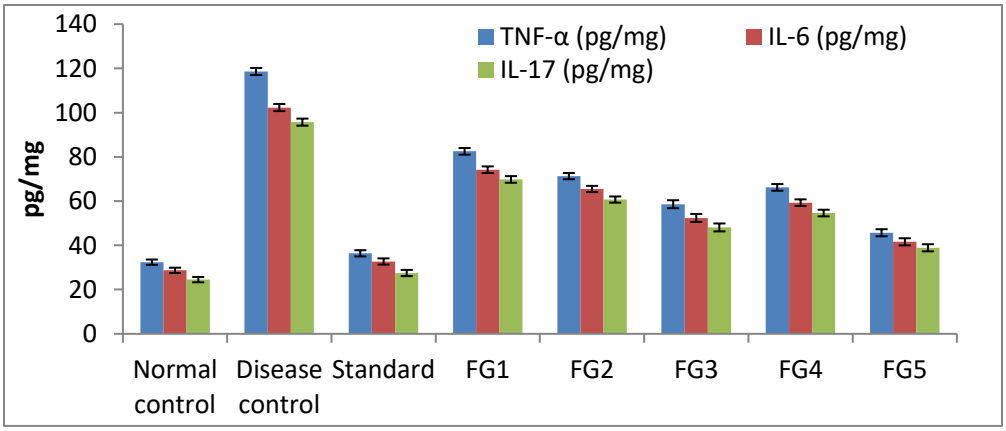

Figure 5: Effect of Formulations on Pro-inflammatory Cytokines

Disease control animals showed marked erythema, thick silvery scales and increased epidermal thickness, confirming successful induction of psoriasis. All herbal formulations produced significant improvement in psoriatic symptoms compared to disease control.

FG1 (crude extract) showed moderate reduction in erythema and scaling, confirming the anti-inflammatory potential of *Fumariaindica*. FG2 and FG4 (1% isolated compounds) showed better improvement than crude extract, indicating higher potency of purified phytoconstituents. FG3 and FG5 (2% isolated compounds) showed maximum reduction in PASI score, nearly comparable to the standard drug. This suggests a dose-dependent anti-psoriatic effect of isolated compounds FI-1 and FI-2.

Application of imiquimod produced classical psoriasis symptoms including erythema, scaling and thickening, leading to a progressive increase in PASI score in the disease control group. Topical treatment with the formulations significantly reduced PASI scores compared to the disease control group.

The standard drug showed maximum reduction in PASI score. The 20% extract gel (FG1) exhibited strong anti-psoriatic activity, confirming the therapeutic potential of the whole extract. FI-1 and FI-2 isolated compounds demonstrated dose-dependent activity. Among isolated compounds, 2% FI-2 (FG5) showed the highest efficacy, very close to the standard. Higher concentration (2%) formulations were more effective than 1% formulations.

The anti-psoriatic effect may be attributed to anti-inflammatory activity keratinocyte proliferation inhibition, antioxidant and immunomodulatory properties of Fumariaindica. The study confirms that Fumariaindica extract and its isolated compounds possess significant anti-psoriatic activity. Among the tested formulations, 2% FI-2 gel (FG5) showed the most promising therapeutic effect and could be considered a potential candidate for further clinical investigation. Psoriasis causes epidermal hyperplasia due to rapid keratinocyte proliferation. FG3 showed the greatest normalization of epidermal thickness, suggesting strong anti-proliferative activity.

Effect of Formulations on Pro-inflammatory Cytokines

Psoriasis is a chronic immune-mediated inflammatory skin disorder characterized by activation of dendritic cells and T-helper (Th1/Th17) immune pathways. Key pro-inflammatory cytokines involved in disease progression include TNF-α, IL-6, IL-17 and IL-23, which stimulate keratinocyte hyper-proliferation, epidermal thickening and inflammatory infiltration.

In the present study, serum cytokine levels were estimated to understand the anti-inflammatory and immunomodulatory mechanism of the developed herbal gels. Imiquimod application produced a marked increase in pro-inflammatory cytokines in the disease control group, confirming successful induction of psoriasis-like inflammation. Topical treatment with *Fumariaindica* extract and isolated compound formulations significantly reduced cytokine levels compared to the disease control group.

Tumor Necrosis Factor-α (TNF-α) plays a central role in psoriasis by activating NF-κB signaling and promoting inflammatory cell recruitment. Disease control group showed a sharp elevation of TNF-α levels. Standard treatment markedly reduced TNF-α.

All herbal formulations significantly lowered TNF-α levels. Maximum reduction among test groups was observed with FG5 (2% FI-2) followed by FG3 (2% FI-1) and FG1 (20% extract). 1% formulations (FG2, FG4) showed moderate reduction. This indicates strong inhibition of inflammatory signaling by isolated compounds, particularly FI-2.

Interleukin-6 (IL-6) is involved in keratinocyte proliferation and activation of the Th17 pathway. Disease control animals showed elevated IL-6 levels. Treatment with formulations significantly suppressed IL-6 production. The reduction was dose-dependent for both FI-1 and FI-2 formulations. FG5 exhibited near-normalization of IL-6, comparable to standard drug.

This suggests inhibition of keratinocyte hyper-proliferation and inflammatory signaling.Interleukin-17 (IL-17) is a hallmark cytokine of psoriasis responsible for neutrophil recruitment and epidermal thickening. Imiquimod markedly increased IL-17 levels. All formulations significantly decreased IL-17 levels. FG5 and FG3 showed strongest inhibition, indicating potent suppression of Th17 immune response. Whole extract (FG1) also showed significant activity, suggesting synergistic phytochemical effects.

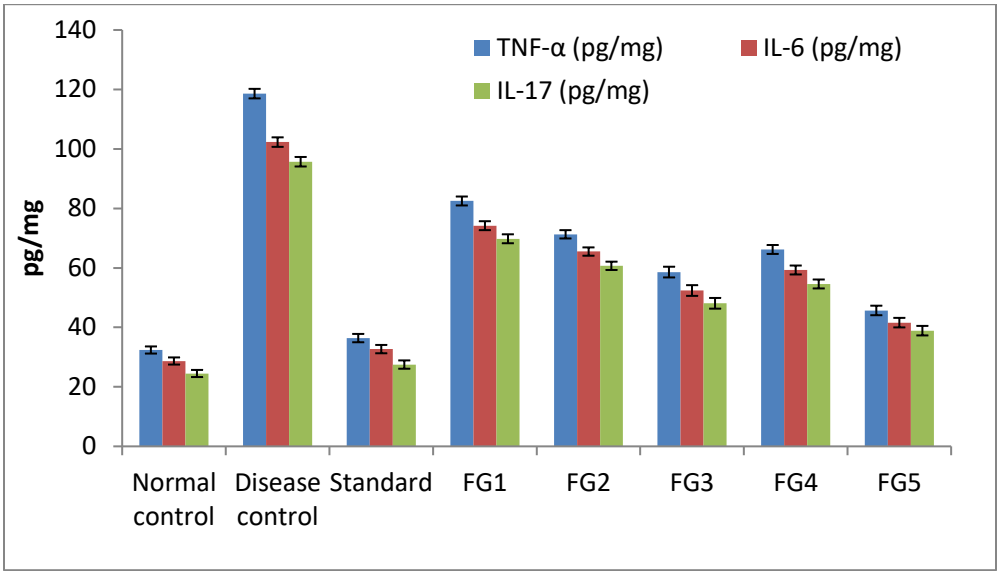

Figure 8: Effect of Formulations on Pro-inflammatory Cytokines

Interleukin-23 (IL-23) is essential for differentiation and maintenance of Th17 cells and is a major therapeutic target in psoriasis. Disease control group showed highest IL-23 levels. Standard treatment showed maximum suppression. Among test formulations, FG5 showed strongest IL-23 inhibition, followed by FG3 and FG1. Reduction in IL-23 confirms interruption of the IL-23/IL-17 axis, the key pathogenic pathway of psoriasis. The cytokine findings clearly indicate that the formulations exert anti-psoriatic effects by modulating immune responses. The observed therapeutic effect may be attributed to suppression of Th1/Th17 immune pathways, down-regulation of TNF-α mediated inflammation, inhibition of keratinocyte proliferation, antioxidant and immunomodulatoryphytoconstituents of *Fumariaindica.* The superior activity of FI-2 (2%) formulation (FG5) suggests that FI-2 may be the major bioactive anti-psoriatic compound in the plant. The cytokine analysis strongly supports the PASI score findings and confirms that *Fumariaindica* gel formulations significantly attenuate psoriasis-like inflammation.

Imiquimod application significantly elevated TNF-α, IL-6 and IL-17 levels, confirming induction of psoriasis-like inflammation. Treatment with Fumariaindica gels markedly suppressed cytokine production. All formulations significantly reduced cytokines vs disease control. FI-1 and FI-2 isolated compounds showed stronger inhibition than crude extract. 2% concentration produced greater suppression than 1%. FG5 showed maximum cytokine inhibition, suggesting potent immunomodulatory activity of FI-2. Reduction in TNF-α and IL-17 indicates inhibition of the IL-23/Th17 inflammatory axis, the key pathway in psoriasis pathogenesis. The findings confirm that Fumariaindica based gels possess significant anti-psoriatic activity by reducing psoriasis severity, suppressing inflammatory cytokines and improving skin histology. Among all formulations, FG5 (2% FI-2 gel) demonstrated the most promising therapeutic potential for topical psoriasis management.

Stability studies

The herbal gel FG5 was prepared with isolated compound into gel base and evaluated for the stability analysis at temperature 2±2°C, 25°C & 60% RH and 40°C & 75% RH, 50°C & 75% RH, 60°C & 75% RHfor a period of 180 days. The stability of a formulation is known as the power of the materials to stay on inside definite restrictions over a fixed phase of time and known as shelf life of the product. The data identified that the FG5were notchange their physical nature during to storageat temperature 25°C & 60% RH. It may indicate that the formulations could provide a minimum shelf life of 2 years.The stability of FG5 at room temperature and accelerated conditions demonstrates that the selected polymers, gelling agents, and excipients were compatible with the herbal extract and capable of maintaining formulation integrity. Furthermore, the formulation also showed stability at higher temperatures such as 50°C and 60°C, indicating resistance to thermal stress and environmental variations.These findings confirm that the optimized herbal gel FG5 possesses satisfactory storage stability and can maintain its physical characteristics for an extended period without significant deterioration. Therefore, the formulation may be considered suitable for pharmaceutical and topical applications with acceptable shelf-life stability.

Conclusion

The present investigation successfully demonstrated the formulation and evaluation of herbal gel formulations containing ethanolic extract and isolated bioactive compounds from Fumariaindica for anti-psoriatic activity. The

physicochemical and phytochemical studies confirmed the presence of important secondary metabolites such as alkaloids, flavonoids, tannins, terpenoids, and saponins, which are known for their antioxidant and anti-inflammatory properties. Two major alkaloidal compounds, protopine (FI-1) and corydomine (FI-2), were isolated and characterized through spectral analysis.The developed gel formulations (FG1–FG5) exhibited satisfactory physicochemical properties including appropriate pH, good spreadability, viscosity, homogeneity, consistency, and extrudability, indicating their suitability for topical application. Among the formulations, FG3 and FG5 showed superior pharmaceutical characteristics with excellent uniformity and patient acceptable properties.The anti-psoriatic evaluation using the imiquimod-induced psoriasis-like mouse model confirmed significant therapeutic efficacy of the formulations. All herbal gels reduced erythema, scaling, epidermal thickening, and PASI score when compared with the disease control group. The cytokine analysis revealed marked suppression of major pro-inflammatory mediators including TNF-α, IL-6, IL-17, and IL-23, indicating inhibition of the IL-23/Th17 inflammatory pathway involved in psoriasis pathogenesis. The isolated compounds exhibited stronger anti-inflammatory effects than the crude extract, and the 2% formulations produced better therapeutic responses than the 1% formulations.Among all formulations, FG5 containing 2% FI-2 (corydomine) demonstrated the highest anti-psoriatic activity with maximum reduction in PASI score, improved Baker's score, enhanced orthokeratosis, significant cytokine suppression, and better histopathological recovery. Stability studies further confirmed that the optimized formulation FG5 remained physically stable under different storage conditions for 180 days, suggesting satisfactory shelf-life stability.Overall, the study establishes that Fumariaindica and its isolated alkaloidal compounds possess significant anti-psoriatic potential through antioxidant, anti-inflammatory, and immunomodulatory mechanisms. The optimized formulation FG5 may serve as a promising and safer topical herbal therapeutic candidate for the management of psoriasis and warrants further clinical investigation.

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