Research Article

Isolation, Characterization And Pharmacological Evaluation Of Bioactive Compounds From Fumariaindica For Psoriasis Management

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Abstract

The present study investigated the phytochemical profile, isolation of bioactive compounds, antioxidant potential, and anti-psoriatic activity of Fumariaindica. Ethanolic extract of aerial parts was subjected to phytochemical screening and chromatographic separation. Two alkaloids, protopine (FI-1) and corydomine (FI-2), were isolated and characterized using spectroscopic techniques. The antioxidant activity was evaluated using DPPH and nitric oxide radical scavenging assays. Anti-psoriatic activity was assessed in imiquimod-induced psoriasis model. FI-2 demonstrated stronger antioxidant activity compared to FI-1 and crude extract. The findings indicate that isolated alkaloids from Fumariaindica possess potent anti-psoriatic activity and may serve as lead compounds for herbal dermatological formulations.

Keywords: Fumariaindica, Protopine, Corydomine, Psoriasis, Cytokines, Antioxidant activity

1. Introduction

Psoriasis is a chronic inflammatory disorder involving oxidative stress, immune dysfunction, and keratinocyte hyperproliferation. The IL-23/IL-17 axis plays a major role in disease progression. Psoriasis is an immune-mediated, genetic disease manifesting in the skin or joints or both. A diverse team of clinicians with a range of expertise is often needed to treat the disease. Psoriasis provides many challenges including high prevalence, chronicity, disfiguration, disability, and associated comorbidity. Understanding the role of immune function in psoriasis and the interplay between the innate and adaptive immune system has helped to manage this complex disease, which affects patients far beyond the skin [1-3].

Psoriasis is a chronic inflammatory skin disease with a strong genetic predisposition and autoimmune pathogenic traits. The worldwide prevalence is about 2%, but varies according to regions. It shows a lower prevalence in Asian and some African populations, and up to 11% in Caucasian and Scandinavian populations. Disease burden and epidemiology 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 [4-5].

Symptoms regularly reported by patients include pain, itch, and bleeding. Disease burden is further increased by several comorbid diseases, which include metabolic syndrome and cardiovascular diseases that result from the syndrome. In 2013, after consideration of a psoriasis burden of disease report, the Executive Board of WHO recommended to the 67th World Health Assembly a resolution that requests the Director-General to raise awareness of psoriasis as a major global health problem.3 Psoriasis prevalence is also an important consideration for WHO. In Europe and North America, psoriasis prevalence is about 2%.4 Prevalence increases are roughly linear over the life course, from 0·12% at age 1 year to 1·2% at age 18 years. About 70–80% of patients have mild psoriasis that can be controlled using topical therapies alone. Climate, sun exposure, and ethnicity are thought to affect psoriasis prevalence; however, results from a recent study showed weak correlation between latitude and psoriasis prevalence, which suggests that other factors, or combinations of factors, might be involved [7-10].

Medicinal plants containing antioxidant and anti-inflammatory compounds are increasingly explored as alternative therapies.Medicinal plants are an important and unique source of medicines. Psoriasis is a chronic skin condition where the skin develops areas that become thick and covered with silvery scales. For psoriasis treatment, topical

chemical agents are applied in spite of inefficient effects or less effectiveness but medicinal plants can be one of the alternative methods [11-12].

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 [13-19]. The present study aimed to isolate bioactive compounds from Fumariaindica and evaluate their anti-psoriatic potential.

2. Materials and Methods

Plant Collection and authentication

The aerial parts of Fumariaindica were collected from Bhopal, India. The collected aerial parts were carefully examined for too old, etiolated, infected parts and were removed accordingly. These aerial parts were dried in the shade till all its moisture gets evaporated. This dried aerial part then converted to the powder form for further analysis.

Macroscopical study

The macroscopical description of Fumariaindicainclude size, shape, nature of outer and inner surfaces, types of fracture, and organoleptic characters like color, odour, taste etc. were studied**.**

Physicochemical analysis

The physicochemical examination was examined for dried crude drugs. The dried aerial part powder of crude drugs were used to avoid batch-to-batch variation and also to evaluator with their quality. Their studies also provide the information on the nature of phytoconstituents present. The physicochemical analysis of were carried out using methods prescribed in the Ayurvedic pharmacopoeias of India with the prescribed following parameters total Ash value, acid insoluble ash value, water soluble ash value, alcohol soluble extractive value, water soluble extractive value, loss of moisture content and swelling index.

Phytochemical Analysis

Solvent extraction of selected plant i.e. Fumariaindicaaerial part was performed using soxhlet extractor. Air-dried powdered of Fumariaindicaaerial part was defatted with petroleum ether using maceration method. The marc was dried in an air every time prior to extracting with the ethanol; The marc was macerated with ethanol for 24 h (three times) to obtain the ethanol extract. The obtained extract concentrated using rotary vaccum evaporator. The consistency; color; appearance of the extracts and their percentage yield (% w/w) were noted**.**The extracts were then used for the various qualitative test to identified the presence of various phytoconstituents i.e. alkaloids; glycosides; flavonoids; carbohydrates; amino acids; saponins; sterols and terpenoids; cardiac glycosides; coumarins; carotenoids; tannins; phenolic compounds; fixed oils and fats etc**.**

Isolation of compounds from extract of Fumariaindicaaerial part

Powdered leaves (1 kg) was extracted with 80% ethanol (8 L) with occasional shaking for 24 h. The extract was filtered and the filtrate was concentrated to afforded the crude extract of the plant. The crude extract obtained was suspended in distilled water in a separating funnel and in turn partitioned with n-hexane, dichloromethane, ethyl acetate and n-butanol (BuOH). This yielded four solvent fractions. Column Chromatography using silica gel (60-120 mesh) as the stationary phase was used to fractionate ethyl acetate fraction. The column was eluted with gradient elution with chloroform and methanol starting with 10% up to 90% methanol . This was followed with an

increasing gradient of methanol from 10% in chloroform up to 90% methanol. Fractions (30 mL each) collected were analysed on TLC plates using chloroform/Methanol (5:5). This afforded ten fractions (fr1 to fr10).
Fraction 5 showed three spots on TLC plate which were fractionate on silica gel column using with n-hexane: ethyl acetate starting with 10% up to 100% ethyl acetate. This was followed with an increasing gradient of methanol from 10% in ethyl acetate up to 100% methanol. Fractions collected were analysed on TLC plate using Hexane/EtOAc (5:5) solvent system. One fraction showed single spot on TLC plate which were further purified using usingSephadex LH-20 column to obtain compound I. Isolated compounds I (FI 1) were characterized using spectroscopic techniques: mass spectrometry, 1H (400 MHz) and 13C NMR (100 MHz).
Fraction 7 showed two spots on TLC plate which were fractionate on silica gel column using chloroform: methanol gradient elution, chloroform (100%) was followed by an increased gradient of methanol up to 50%. Test tube fractions collected were analysed on TLC plate using chloroform: methanol (9:1) solvent system. Three fractions were obtained. Open column chromatography using Sephadex LH-20 as stationary phase was used to purify the isolated compound II showed single spot on TLC. Isolated compounds II (FI 2) were characterized using spectroscopic techniques: mass spectrometry, 1H NMR (400 MHz) and 13C NMR (100 MHz)

Preparation of herbal gel containing Fumariaindica aerial part extract and isolated compound: 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)

Antioxidant Activity of herbal gel
DPPH radical scavenging activity
4.3 mg of DPPH (1, 1-Diphenyl –2-picrylhydrazyl) was dissolved in 3.3 ml methanol; it was protected from light by covering the test tubes with aluminum foil. 150 µl DPPH solution was added to 3ml methanol and absorbance was taken immediately at 517nm for control reading. 50 to 250 µl of each of the concentrations of various herbal gel concentrations as well as standard compound (Ascorbic acid) were taken and the volume was made uniformly using methanol. Each of the samples was then further diluted with methanol up to 3ml and to each 150 µl DPPH was added. Absorbance was taken after 15 min. at 517nm using methanol as blank on UV-visible spectrometer Shimadzu, UV-1601, Japan. The IC50 values for each drug compounds as well as standard preparation were calculated. The DPPH free radical scavenging activity was calculated using the following formula:

% scavenging = [Absorbance of control - Absorbance of test sample/Absorbance of control] X 100

Nitric oxide free radical scavenging activity
Scavengers of nitric oxide compete with oxygen, leading to reduced production of nitrite ions. Large amounts of NO. may lead to tissue damage.50 to 250 µl of each of the concentrations of herbal gel previously dissolved in DMSO, as well as ascorbic acid (standard compound) were taken in separate tubes and the volume was uniformly made with methanol. To each tube 2.0 ml of sodium nitroprusside (10 mM) in phosphate buffer saline was added. The solutions were incubated at room temperature for 150 minutes. The similar procedure was repeated with methanol as blank which served as control. After the incubation, 5 ml of griess reagent was added to each tube including control. The absorbance of chromophore formed was measured at 546 nm on UV-visible spectrometer Shimadzu, UV-1601, Japan. Ascorbic acid was used as positive control. The IC50 values for each test compounds as well as standard preparation were calculated.

% scavenging/Reduction = [Absorbance of control - Absorbance of test sample/Absorbance of control] X 100

Anti-psoriatic activity

Animals: Albino mice (25-35g) of either sex were used for experimental study. The animals were housed in cages at 25 ± 2ºC, and relative humidity (50 ± 5%) with 12 h light, and 12 h dark cycle. All the animals were acclimatized to laboratory environment for a week before the experiment. They were provided with free access to food and water ad libitum. The animals were cared and used in accordance with the CPCSEA guidelines and experimental protocols approved by institutional animal ethics committee.

Acute Toxicity Study

Acute oral toxicity studies were carried out according to OECD guidelines at doses of 50, 300, and 2000 mg/kg.

Anti-psoriatic activity

The albino mice were divided into various groups, each group containing six animals, for excision and incision wound models. Formulated herbal gel (FG1-FG5) were applied topically to each animal once a day.

Group I: The animals of received gel base (control)
Group II: Treated group with standard
Group III: Herbal gel FG1
Group IV: Herbal gel FG2
Group V: Herbal gel FG3
Group VI: Herbal gel FG4
Group VII: Herbal gel FG5

Imiquimod-induced psoriatic model

The Imiquimod-induced psoriatic model was used to evaluate the wound-healing activity of Formulated gel (FG1-FG5). Psoriasis in mouse was induced using imiquimod-induced psoriasis, the animal's dorsal part was shaved and commercially available 5% (IMQ) cream (Aldara; 3M Pharmaceuticals) with dose of 62.5 mg of imiquimod was topically applied for 7 consecutive days and translating in a daily dose of 3.125 mg of the active compound. Control rat were treated similarly with a control vehicle gel. After 7 days skin biopsies were taken immediately, fixed in 10% formalin and embed in paraffin. The tissue section (4 µm thick) was taken and stained with haematoxylin and eosin. The number of keratinocytes layers including the basal layer was counted by direct microscopy.

Results and Discussion

Collection, verification of Plant material

Plants are being used for many ethnomedicinal and non-ethnomedicinal purposes of humans since ancient times. India is recognized the world over as a rich source of aromatic and medicinal plants. Pharmacognostic study helps in confirmation and determination of identity, purity and quality of a crude drug. The leaves of Fumariaindica aerial parts were collected and authenticated.

Morphology of Fumariaindica

Fumariaindica (commonly known as Indian Fumitory or Pitpapra) is a pale green, diffusely branched annual herb. It is characterized by finely dissected, glaucous leaves, small pale pink to white flowers arranged in racemes, and small, single-seeded subglobose fruits. Root features a slender, much-branched taproot system. Stem is highly branched, herbaceous, and diffuse or sub-erect, typically growing up to 15–50 cm tall. The stems are pale green, grooved or ridged, hollow, and glaucous. Leaves arrangement cauline and alternate, measuring roughly 3–10 cm in length. Irregularly 2-to-3 times pinnatisect. The leaf blade is compound and deeply divided into narrow, flat to obscurely channelled linear-lanceolate segments (lobules) having colourglaucous (having a waxy, pale bluish-green bloom).

Figure 1: Fumariaindica

Physicochemical analysis

Physicochemical parameter such as Ash values (Total ash, Acid insoluble ash and Water soluble ash), Extractive values, Loss on drying of both selected plant drugs neem and aloe vera were performed. Ash values of crude drug provide an idea about the inorganic composition or earthy matter and other impurities present in drug. The extractive values are mainly useful for the determination of adulterated or exhausted drug. All parameters of both drugs were found within the limit as per standard books.

Phytochemical test

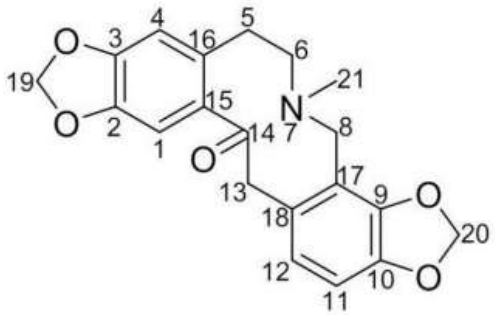
The preliminary phytochemical screening of leaves extracts reveals that alkaloids are Saponins glycosides, flavonoids, carbohydrates and proteins are present in ethanol extract. Ethanol Extracts of Fumariaindicawere obtained by maceration method were subjected to qualitative phytochemical tests to identify the presence of secondary metabolite (viz., alkaloids, glycosides, tannins, flavonoids, sterols, fats, oils, phenols and saponins) present in them. Phytochemical screening of Ethanol Extracts of Fumariaindicashowed the presence of carbohydrates, glycosides, alkaloids, tannins, flavanoids, protein and amino acids and saponins whereas Water extract showed the presence of carbohydrates, tannins, flavanoids, protein and amino acids and saponins. Preliminary phytochemical screening of the ethanolic extract of Fumariaindica revealed the presence of several bioactive secondary metabolites, including alkaloids, anthraquinones, carbohydrates, terpenoids, tannins, flavonoids, and saponins, while steroids, glycosides, proteins, xanthoproteins, and amino acids were absent. The qualitative presence of these phytoconstituents indicates that ethanol is an effective solvent for extracting moderately polar to polar compounds from F. indica.

Characterization of Isolated Compounds

Isolation of compounds from extract of Fumariaindica

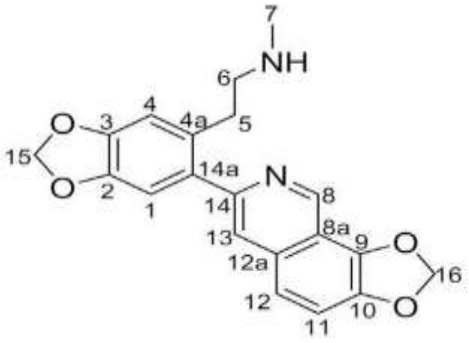
Compound I (FI) was obtained as white powder (protopine) H NMR spectral data of protopine showed characteristic proton signals corresponding to the benzylisoquinoline alkaloid skeleton.

Figure 2: Structure of isolated compound 1 Protropine (FI 1)



Compound II: Corydomine Compound II (FI 2) was obtained as white powder. Corydomine is a benzylisoquinoline alkaloid, so its proton NMR shows characteristic signals aromatic protons δ 6.5 – 7.2 ppm multiplets for aromatic ring protons (benzyl + isoquinoline rings),

Figure 3: Structure of isolated compound 2 Corydomine (FI 2)



Spectral analysis confirmed:

- FI-1 as Protopine
- FI-2 as Corydomine

Preparation of herbal gel containing Fumariaindica extract and isolated compound: The gel containing plant extract formulation was prepared with ethanol extract of Fumariaindica and isolated compoundmixedin gel base to get FG1 – FG5 and evaluated with various parameters.

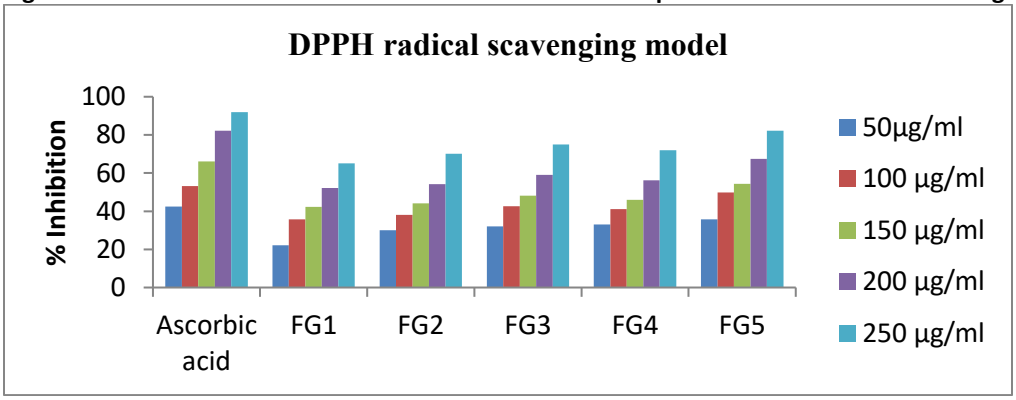
Antioxidant Activity

DPPH radical scavenging model:

The DPPH radical scavenging assay is a widely accepted in-vitro method for evaluating the hydrogen-donating ability and free-radical neutralizing capacity of herbal formulations. Oxidative stress is a key pathological factor in psoriasis, as excessive reactive oxygen species (ROS) trigger keratinocyte hyperproliferation, inflammation, and cytokine overexpression. Therefore, the antioxidant potential of the developed herbal gels containing Fumariaindica extract and isolated compounds provides an important mechanistic basis for their antipsoriatic activity.

All formulations (FG1–FG5) demonstrated a concentration-dependent increase in DPPH radical scavenging activity from 50–250 µg/ml, confirming the presence of bioactive phytoconstituents capable of donating hydrogen atoms to stabilize free radicals. Ascorbic acid, used as the standard antioxidant, showed the highest inhibition (42.36–91.92%), validating the assay.

Figure 4: Results of Fumariaindica extract and isolated compound on DPPH radical scavenging model



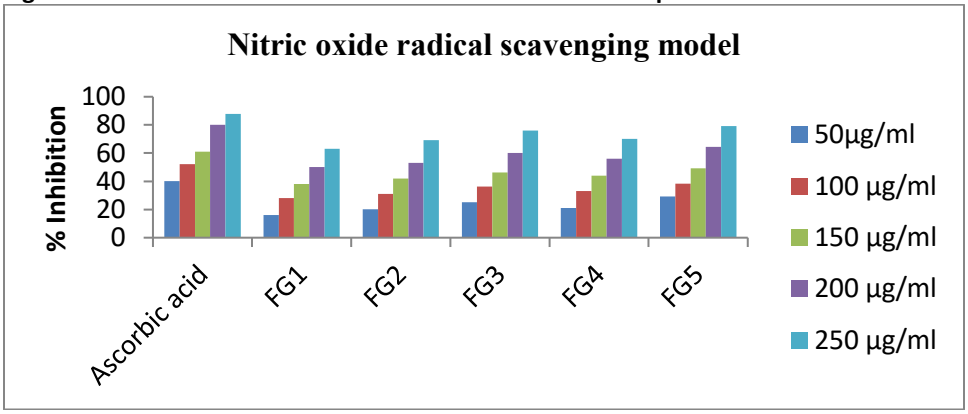
The order of antioxidant activity at 250 µg/ml can be summarized as Ascorbic acid > FG5 > FG3 > FG4 > FG2 > FG1

The higher activity of formulations containing isolated compounds compared to crude extract indicates that the purified bioactive molecules are major contributors to antioxidant activity. The concentration-dependent improvement from 1% to 2% (FG2 FG3 and FG4 FG5) further supports dose responsiveness of the isolated phytoconstituents.

Psoriasis is characterized by increased oxidative stress, lipid peroxidation, overproduction of inflammatory cytokines, Keratinocyte hyperproliferation. Excess ROS activate nuclear transcription factors such as NF-κB and MAPK pathways, which lead to the release of pro-inflammatory mediators and acceleration of epidermal turnover. Antioxidants can interrupt this pathological cascade by neutralizing free radicals, reducing lipid peroxidation in skin tissue, suppressing inflammatory signaling pathways and restoring redox balance in keratinocytes. The strong DPPH scavenging activity observed particularly in FG5 suggests enhanced ROS-neutralizing potential, which is directly relevant to controlling oxidative stress-mediated skin inflammation. The antioxidant ranking of formulations closely correlates with expected antipsoriatic efficacy. The highest scavenging activity of FG5 indicates better protection against ROS-induced skin damage, potential reduction of inflammatory cytokine cascade, possible improvement in epidermal barrier repair and enhanced therapeutic potential for psoriasis management. Thus, the antioxidant findings strongly support the hypothesis that the developed herbal gels exert antipsoriatic activity partly through mitigation of oxidative stress.

The study demonstrates that the herbal gels possess significant free radical scavenging capacity, with activity increasing alongside concentration and enrichment of isolated bioactive compounds. The pronounced antioxidant potential, particularly in FG5, provides a strong scientific rationale for the observed and anticipated antipsoriatic activity of the formulations. These findings highlight the importance of antioxidant-mediated mechanisms in herbal psoriasis therapy and justify further in-vivo and cytokine-level investigations.

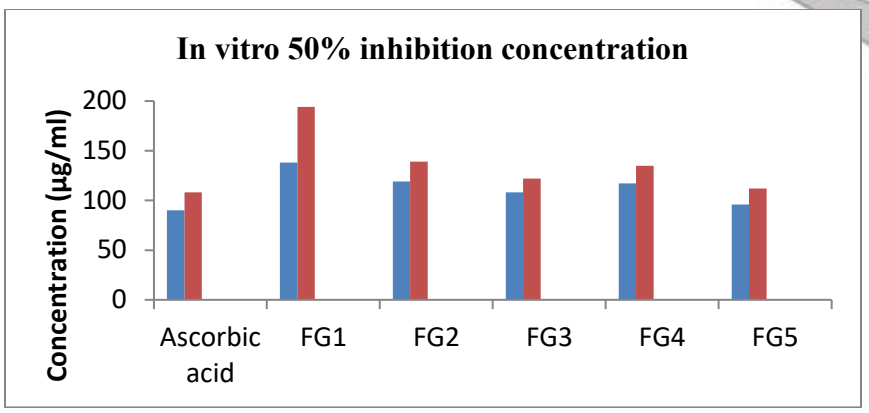
Figure 5: Results of Fumariaindica extract and isolated compound on Nitric oxide radical scavenging model



Nitric oxide scavenging activity

The present study evaluated the nitric oxide radical scavenging activity of herbal gels containing Fumariaindica extract and isolated compounds (FG1–FG5) at concentrations ranging from 50–250 µg/ml using ascorbic acid as the standard antioxidant. The results demonstrated a concentration-dependent increase in nitric oxide scavenging activity for all formulations, confirming the antioxidant potential of the developed herbal gels. The progressive increase in nitric oxide inhibition with concentration confirms that the antioxidant activity is dose dependent, which is characteristic of phytoconstituents rich in alkaloids, phenolics and flavonoids present in Fumariaindica. Psoriasis is strongly associated with overproduction of nitric oxide by inducible nitric oxide synthase (iNOS) , increased oxidative stress and inflammatory cytokines (TNF-α, IL-6, IL-17), hyperproliferation of keratinocytes. Excess nitric oxide reacts with superoxide to form peroxynitrite, which damages keratinocytes, triggers inflammatory cascades and enhances epidermal thickening and scaling. Therefore, the strong nitric oxide scavenging activity of the formulations directly supports their antipsoriatic potential.

Figure 6: IC_{50} of herbal gel containing Fumariaindica extract and isolated compound on DPPH radical scavenging model



The nitric oxide scavenging assay clearly demonstrates that the developed herbal gels possess significant antioxidant activity, which strongly correlates with their expected antipsoriatic effect. The activity ranking indicates that formulations containing isolated compounds, particularly FG5, provide enhanced therapeutic potential compared to crude extract formulation. Overall, the study suggests that FG5 and FG3 are the most promising candidates for further in-vivo antipsoriatic and anti-inflammatory investigations, owing to their strong nitric oxide radical scavenging and antioxidant capacity.

Both compounds exhibited concentration-dependent radical scavenging activity. FI-2 demonstrated stronger activity with lower IC50 values:

- DPPH IC50: 96 µg/ml
- NO IC50: 112 µg/ml

Acute Toxicity

No mortality or behavioral abnormalities were observed up to 2000 mg/kg, confirming safety of extracts and isolated compounds.

3.5 Anti-Psoriatic Activity

Imiquimod application induced erythema, scaling, and epidermal thickening. FI-2 treatment significantly reduced PASI score and inflammatory lesions.

Anti-psoriatic activity

Imiquimod-induced psoriatic model

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 a mouse tail model of psoriasis, a well-established screening method that assesses epidermal differentiation, orthokeratosis formation and reduction in epidermal thickness. Gels were applied topically once daily for 14 consecutive days. 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. Disease control showed severe erythema, scaling, thickening, and high PASI score. Standard group showed marked improvement.FG1 (20% extract) expected to show moderate anti-psoriatic effect due to synergistic phytoconstituents. FI-1 gels (FG2 & FG3) expected to show dose-dependent improvement. FI-2 gels (FG4 & FG5) expected to show stronger activity, especially FG5 (2%), indicating higher potency of isolated compound.

FG5 > FG3 > FG4 > FG2 > FG1

Phenotypical Observation of Herbal Gel Formulations

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 phenotypical observation in the imiquimod-induced psoriasis animal model. Phenotypical parameters such as erythema, scaling, skin thickening, dryness, and overall lesion severity were monitored throughout the treatment period and compared with the diseased control group.

Animals in the untreated psoriatic control group developed classical psoriasis-like symptoms within a few days of induction. These included:

a. Intense erythema and redness of the skin
b. Thick silvery-white scales
c. Severe skin thickening and rough texture
d. Visible dryness and cracking of the skin surface

The severity of lesions progressively increased during the study period, confirming successful induction of psoriasis.

Treatment with FG1 showed moderate improvement in visible psoriatic symptoms. Erythema and redness were noticeably reduced by the mid-treatment phase. Scaling decreased gradually and the skin surface appeared smoother. Moderate reduction in skin thickness and dryness was observed. The improvement suggests that the crude ethanolic extract possesses significant anti-inflammatory and keratolytic properties, contributing to partial recovery of the damaged skin.

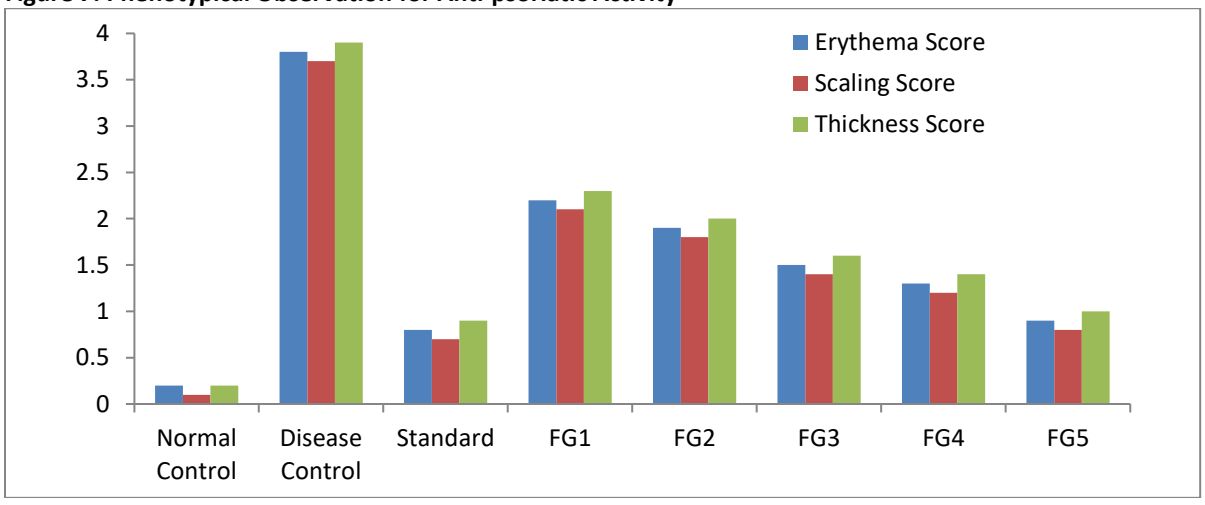
Animals treated with FG2 showed better improvement than FG1, showed marked reduction in redness and inflammation, noticeable decrease in scaling and dryness and skin texture began returning toward normal appearance. This indicates that FI-1 contributes strongly to the anti-psoriatic activity of the plant extract. FG3 demonstrated pronounced therapeutic activity showed rapid reduction in erythema and inflammation. significant disappearance of scales by the end of treatment and skin thickness reduced considerably and lesions nearly healed. The higher concentration of FI-1 enhanced the therapeutic response, suggesting dose-dependent anti-psoriatic activity.

FG4 exhibited comparable improvement to FG2 but slightly less pronounced than FG3 showed reduction in erythema and mild decrease in scaling and improvement in skin hydration and smoothness. This suggests that FI-2 also contributes to anti-psoriatic activity but is slightly less potent at this concentration.

Table 1: Phenotypical Observation for Anti-psoriatic Activity

Group	Phenotypical Observation
Normal Control	Normal skin
Disease Control	Severe erythema, scaling and thickening
Standard	Significant reduction of lesions
FG1	Moderate improvement
FG2	Visible reduction in redness and scaling
FG3	Good improvement; reduced plaques
FG4	Strong anti-psoriatic effect
FG5	Near-normal skin restoration

Figure 7: Phenotypical Observation for Anti-psoriatic Activity



FG5 showed the most prominent recovery among all formulations. FG5 showed almost complete disappearance of redness and scaling, restoration of normal skin texture and elasticity and significant reduction in lesion thickness and dryness. The results indicate that FI-2 at higher concentration exhibits strong anti-psoriatic potential and may be the most active compound among the tested formulations. The order of anti-psoriatic efficacy based on visual observation, FG5 > FG3 > FG2 ≈ FG4 > FG1 > Diseased Control. The improved activity of isolated compounds (FI-1 and FI-2) compared with crude extract suggests that the anti-psoriatic effect is strongly associated with specific bioactive alkaloids/flavonoids responsible for inhibition of keratinocyte hyperproliferation, reduction of inflammatory mediators, suppression of immune cell infiltration. Among all formulations, FG5 (2% FI-2) demonstrated maximum reduction in erythema, scaling and skin thickening, showing efficacy comparable to the standard drug.

Conclusion

The present investigation demonstrated that bioactive alkaloids isolated from Fumariaindica possess potent antioxidant and anti-psoriatic activities. The present study investigated the phytochemical profile, isolation of bioactive compounds, antioxidant potential, and anti-psoriatic activity of Fumariaindica. Ethanolic extract of aerial parts was subjected to phytochemical screening and chromatographic separation. Two alkaloids, protopine (FI-1) and corydomine (FI-2), were isolated and characterized using spectroscopic techniques. The antioxidant activity was evaluated using DPPH and nitric oxide radical scavenging assays. Anti-psoriatic activity was assessed in imiquimod-induced psoriasis model. FI-2 demonstrated stronger antioxidant and anti-inflammatory activity compared to FI-1 and crude extract. The study demonstrates that the herbal gels possess significant free radical scavenging capacity, with activity increasing alongside concentration and enrichment of isolated bioactive compounds. The pronounced antioxidant potential, particularly in FG5, provides a strong scientific rationale for the observed and anticipated antipsoriatic activity of the formulations. These findings highlight the importance of antioxidant-mediated mechanisms in herbal psoriasis therapy and justify further in-vivo and cytokine-level investigations. The imiquimod-induced psoriasis model demonstrated that herbal gels containing Fumariaindica extract and isolated compounds significantly reduced psoriasis-like symptoms by decreasing erythema, scaling and epidermal hyperplasia. The study confirms the anti-psoriatic potential of isolated compounds (FI-1 and FI-2), with 2% FI-2 formulation (FG5) showing the most promising therapeutic activity.The study supports the therapeutic potential of Fumariaindica isolated compounds as promising candidates for topical psoriasis management and future clinical development.

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