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Research Article

Preparation And Evaluation of Polyherbal Emulgel for The Management of Psoriasis

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ABSTRACT

Psoriasis is a chronic autoimmune skin condition that causes rapid skin cell turnover, leading to the buildup of skin cells on the surface. This buildup results in thick, red patches covered with silvery scales, often appearing on the elbows, knees, scalp, and lower back. This study focuses on the formulation and evaluation of an herbal-based emulgel designed for psoriasis management, combining the stability and application ease of gels with the therapeutic benefits of emulsions. Utilizing Ayurvedic herbs, the formulation includes Curcuma longa, Emblica officinalis, and Aloe vera, chosen for their anti-inflammatory and antioxidant properties as a natural alternative to synthetic treatments for psoriasis. Curcuma longa and Aloe vera provide anti-inflammatory effects, while Emblica officinalis offers strong antioxidant activity. Extracts from these plants were obtained through Soxhlet extraction and maceration, yielding 34.76% for curcumin, 49.12% for Emblica officinalis, and 65% for Aloe vera. Five emulgel batches (F1-F5) were prepared using carbopol 934 as the gelling agent, oleic acid for the oil phase, and parabens as preservatives. Comprehensive characterization of each batch assessed key parameters such as pH, spreadability, viscosity, and drug release profile. Batch F5 exhibited the highest drug release rate, along with significant in vitro antioxidant and anti-inflammatory activities, marking it as the most promising formulation. F5's therapeutic properties suggest its potential to effectively reduce symptoms associated with psoriasis, including redness, scaling, and inflammation, offering a non-invasive and natural approach to treatment. This herbal emulgel formulation demonstrates significant promise for improving quality of life for psoriasis patients and warrants further research, particularly in vivo studies, to substantiate its clinical efficacy and safety.

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INTRODUCTION

Psoriasis is a chronic autoimmune condition characterized by accelerated skin cell turnover, resulting in the rapid accumulation of skin cells that form scaly, inflamed patches [1]. These lesions commonly appear on the scalp, elbows, and knees but can affect other areas of the body [1]. The exact cause of psoriasis involves a complex interplay of genetic predisposition and environmental triggers, although the precise mechanisms remain incompletely understood. Symptoms can fluctuate, with periods of exacerbation followed by remission, and severity ranges from mild, manageable cases treated with topical therapies to severe forms necessitating systemic medications or light therapy. Beyond its dermatological impact, psoriasis is associated with an increased risk of comorbidities including psoriatic arthritis, cardiovascular events, and mental health disorders. Understanding and managing these multifaceted aspects are crucial for comprehensive care of individuals affected by psoriasis [1]. Epidemiological studies show varied estimates regarding the prevalence of psoriasis, ranging from approximately 0.91% to 8.5% among adults and 0.0% to 2.1% in children. Globally, it is estimated that psoriasis affects approximately 2-3% of the world's population. These figures underscore the significant impact of psoriasis as a widespread dermatological condition [2].

Psoriasis is characterized by chronic inflammation that triggers excessive proliferation and abnormal differentiation of keratinocytes. Histologically, psoriatic plaques exhibit epidermal hyperplasia (acanthosis) atop inflammatory infiltrates comprising dendritic cells, macrophages, T cells, and neutrophils. Neovascularization is also prominently observed. While the inflammatory pathways are shared across plaque psoriasis and its clinical variants, distinct differences exist that contribute to variations in phenotype and treatment responses [1], [3]. Typically, treatment approaches for psoriasis include topical therapies and systemic treatments. For individuals with mild psoriasis affecting less than 10% of their body surface area (BSA), topical treatments are generally preferred. These include corticosteroids, calcineurin inhibitors, vitamin D3 analogues, and other topical agents like non-medicated moisturizers, coal tar, salicylic acid, and anthralin. Systemic treatments, on the other hand, are reserved for severe cases or when topical treatments prove inadequate. When choosing systemic therapies, considerations such as the presence of effective treatment for comorbid conditions and individual patient factors are crucial in tailoring the most appropriate treatment plan. The existing treatment for psoriasis is summarized as shown in figure. 1

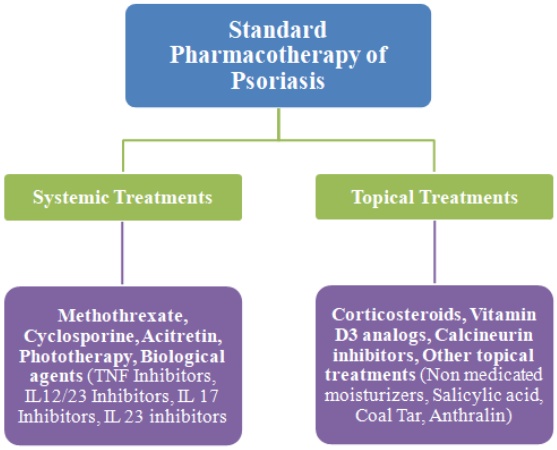


Figure 1. Standard Pharmacotherapy of Psoriasis

For topical treatment, corticosteroid creams are commonly used. However, prolonged use of these medications can lead to side effects, including skin damage such as thinning, pigmentation changes, easy bruising, stretch marks, redness, and dilated surface blood vessels. Long-term exposure to corticosteroids can also result in more severe consequences, such as osteoporosis, aseptic joint necrosis, adrenal insufficiency, gastrointestinal and hepatic issues, ophthalmologic effects, hyperlipidemia, growth suppression, and potential congenital malformations. As a result, many patients with chronic diseases or disorders prefer

herbal formulations over synthetic drugs, as herbal or Ayurvedic treatments are generally considered safer and have fewer side effects [4]. Topical drug delivery is a challenging endeavor due to the skin's natural barrier. Additionally, only a limited range of drugs are suitable for topical use, as most drugs are hydrophobic, which restricts their permeation and absorption through the skin. Herbal remedies, historically used to treat various conditions, including skin diseases, are gradually gaining acceptance as treatment options. However, these remedies are typically hydrophobic. In response to these challenges, formulators have developed drug delivery systems such as emulgels, which are effective carriers for hydrophobic drug molecules [5]. Emulgels have emerged as a popular drug delivery system, particularly for hydrophobic drugs. This innovative formulation combines the properties of both emulsions and gels. Emulgels are known for their easy removability, spreadability, thixotropic nature, non-greasiness, appealing appearance, emollient properties, long shelf life, and transparency. Currently, emulgels are utilized for delivering various drugs, including analgesics, anti-inflammatory agents, anti-acne treatments, and antifungal medications. They hold significant pharmacological importance and have minimal side effects. Due to their ease of use and ability to improve patient compliance, emulgels are expected to become increasingly common in the future [6].

Research indicates that one potential approach to modulate the cellular response involved in psoriasis is through the use of herbal drugs, which leverage their immunoregulatory and antioxidative properties in treatment.

In present study, we aimed to prepare emulgel using two popular herbal extracts, *Curcuma longa* and *Centella asiatica* for the topical application in psoriasis. *Curcuma longa* is well known anti-inflammatory agent whereas *Centella asiatica* is well known for collagen synthesis, antioxidant and anti-inflammatory properties. Emulgel was prepared and evaluated by physicochemical parameters, drug – excipient interaction and biological activities like antioxidant and anti-inflammatory effects as oxidative stress and chronic inflammation have been considered as triggering factors of psoriasis.

MATERIALS AND METHODS

Plant Materials

Ayurvedic herbs – *Curcuma longa*, *Emblica officinalis* and *Aloe vera* were selected for Emulgel formulation against psoriasis based on the extensive literature review for their therapeutic efficiency towards psoriasis.

Dried powders of *Curcuma longa*, *Emblica officinalis* and pure Aloe vera juice were procured from market. The procured plant materials were authenticated by the chemical tests for presence of the desired phytoconstituents before using for the emulgel formulation.

Chemicals

Carbopol 934, Cetostearyl alcohol, Methyl salicylate, Oleic acid, Tween 20, propylene glycol, methyl paraben, propyl parabens, distilled water were procured from CDH Chemicals, New Delhi.

Preliminary Phytochemical evaluation of plant material

Preliminary Phytochemical evaluation was performed to identify the presence of different phytochemicals [7]. Following chemical tests were performed:

Preparation of Extracts

Preparation of *Curcuma longa* Extract

Ethanolic extract of *curcuma longa* was prepared by the Soxhlet extraction technique. 100 gms of *curcuma longa* powder was transferred in the Soxhlet apparatus and extracted for 6 hours with 350 ml of 95% ethanol at 40 – 50 ºC temperature. After complete extraction, the extract was removed from the round bottom flask and concentrated at low temperature by evaporating excess of ethanol [8].

Preparation of *Emblica officinalis* extract

Extraction of *Emblica officinalis* was performed by maceration technique. In this method, 100 gm of *Emblica officinalis* powder was added to 350 ml of hydroalcoholic solvent (50% ethanol and 50% water) in a 500 ml beaker. The mixture was kept for maceration with occasional stirring for 24 hrs at room temperature. After 24 hours, the mixture was filtered and extract was collected in conical flask. Again 350 ml of hydroalcoholic solvent was added to the mark and kept for maceration for 24 hrs. The same process was repeated three times to ensure the complete extraction. All filtrates were collected together and concentrated to obtain percentage yield of extract [9].

Preparation of *Aloe vera* juice

The fresh leaves of aloe vera were cut vertically and the mucilage was scrapped and collected in a beaker. The mucilage was homogenized by using homogenizer to remove lumps and to make the juice uniform in texture. The Aloe vera juice was stored at 4ºC in refrigerator before use [10].

Qualitative analysis of extracts by TLC

Thin layer chromatography of all three extracts of *curcuma longa, Emblica officinalis* and *Aloe vera* was performed using Silica Gel GF 254 (Precoated) to ensure the presence of desired phytochemicals in the extracts. Following mobile phases were used for the TLC analysis of extracts:

Table 2. Mobile phases for TLC analysis

Sr. No	Name of Extract	Mobile Phase
1	*Curcuma longa* ethanolic extract	Chloroform: methanol (97:3V/V) [11]
2	*Emblica officinalis* hydroalcoholic extract	Toluene: Ethyl Acetate: Glacial Acetic Acid: Formic acid = (2:4.5:2:0.5) [12]
3	Aloe Vera Juice	Ethyl acetate : Methanol : Water (10 : 1.35 : 1.0) [13]

Preparation of Emulgel formulation

Five different batches of emulgel formulation were prepared by varying the ingredient quantities to get optimized emulgel formulation (As shown in table 1). For emulgel preparation, Carbopol 934 was soaked in distilled water for 4-5 hours at room temperature. Swelled carbopol was homogenized to make uniform mixture. The emulgel formulation involves three steps as follows [14],[15]:

a) Emulsion preparation:

For emulsion preparation, for oil phase, cetostearyl alcohol was melted in a china dish at temperature of 40 to 50ºC. Methyl salicylate was added to this oil phase and stirred well. Oleic acid and Tween 20 was added to this oil phase with continuous stirring. In aqueous phase, mixture of methyl paraben, propyl parabens dissolved in propylene alcohol was dissolved in quantity sufficient water. Amla extract and curcumin extract were dissolved in aqueous phase with constant stirring. Oil in water emulsion was prepared by adding oil phase to water phase with continuous stirring and kept aside to monitor any breakdown of emulsion [14],[15]

Preparation

Carbopol 934 and *Aloe vera* were mixed together uniformly by using magnetic stirrer at a moderate speed for 40 minutes.

c) Emulgel Preparation

To the above prepared gel, emulsion was added dropwise. This mixture was homogenized using magnetic stirrer for 20 -30 minutes until the required consistency of emulgel was obtained.

Table 3. Various batches for optimization of herbal emulsion formulation

Ingredient (% w/w)	F1	F2	F3	F4	F5

Carbopol 934	3	3.5	4	4.5	5
Cetostearyl alcohol	0.1	0.2	0.3	0.4	0.4
Methyl salicylate	0.1	0.3	0.5	0.7	1
Oleic acid	0.2	0.5	1	1.5	2
Tween 20	0.10	0.20	0.30	0.32	0.32
propylene glycol	0.2	0.3	0.4	0.5	0.5
methyl parabens	0.01	0.01	0.01	0.02	0.02
propyl parabens	0.01	0.01	0.01	0.02	0.02
Aloe vera juice (ml)	2	2.5	3	4	5
Curcuma longa extract	2	2.5	3	4	5
Emblica officinalis extract	2	2.5	3	4	5
distilled water	50 qs	50 qs	50 qs	50 qs	50 qs

Characterization of prepared Emulgel Formulation

Following parameters were evaluated to confirm the therapeutic efficacy of prepared formulation:

a) Organoleptic Evaluation

All the trial batches of emulgel formulations were tested for the color, odor, texture and appearance.

b) Determination of pH

Digital pH meter was used for the determination of the pH of prepared Emulgel formulation.

c) Determination of Viscosity

The viscosities of five freshly prepared formulations (F1-F5) were initially measured using a Brookfield viscometer with spindle no. 04. For each measurement, the spindle was carefully inserted vertically into the center of the emulgel formulation in a beaker, ensuring it did not come into contact with the beaker's base. The spindle was rotated at a speed of 2.5 rpm for duration of 5 minutes and viscosity was recorded [16]

d) Determination of spreadability

The procedure followed was as per the method suggested by Mutimer et al. 1956 [17]. Two glass slides with uniform dimensions were used, with one slide fixed in place on a flat surface. Approximately 2 g of the emulgel formulation was applied to this slide, and the second slide was carefully placed on top, creating a sandwich effect with the emulgel in between. A 1 kg weight was placed on the slides for 5 minutes to spread the emulgel evenly into a uniform film, free of trapped air, with any excess removed. Next, an 80 g weight was attached to the top slide, and the time (in seconds) required for the top slide to move a distance of 7.5 cm was recorded [14].

e) Study of drug excipient compatibility by FTIR

FTIR spectroscopy was conducted to examine the interactions between the extracts and excipients. The analysis utilized a Shimadzu FTIR Spectrophotometer, with the extracts serving as controls for comparative assessment of interactions.

f) Invitro drug release study

A Franz diffusion cell was utilized for conducting drug release studies from emulgel. A measured quantity of 500 mg of herbal emulgel was evenly spread on the surface of an egg membrane, which was then secured between the donor and receptor chambers of the diffusion cell. The receptor chamber was filled with freshly prepared PBS solution (pH 7.4) to enable drug solubility and was continuously stirred with a magnetic stirrer. At specific time intervals, 1.0 ml aliquots were collected and analyzed for drug content using a UV/VIS spectrophotometer, following suitable dilution. The cumulative drug release across the egg membrane was subsequently calculated over time [18].

g) Invitro drug efficacy studies

The therapeutic efficiency of prepared herbal emulgel formulation was analyzed by using *invitro* assays of free radical scavenging activity by DPPH and invitro anti-inflammatory assay since free radicals and chronic inflammation are one of the well identified causative factors of psoriasis development.

a) Antioxidant activity by DPPH assay

Anti-oxidant activity was performed as per the DPPH free radical scavenging method. Gallic acid was used as a standard drug. Stock solution of standard drug gallic acid was prepared by dissolving 10 mg in 10 ml ethanol to get 1 mg/ml concentration. Stock solution was used to make serial dilutions from 10-50 µg/ml concentration. Similar Serial dilutions of 10-50 µg/ml concentration of emulgel were prepared from stock solution of emulgel. DPPH working solution was prepared by dissolving 10.83 mg DPPH in small quantity of ethanol. Then volume was adjusted to 100 ml with ethanol. The absorbances were recorded at 520 nm. The solvent was used as blank and the DPPH solution without addition of emulgel. Following formula used to calculate % free radical scavenging potential of prepared herbal emulgel [19]:

% Inhibition of free radicals = Absorbance of blank – Absorbance of test/ Absorbance of Blank

b) Invitro anti-inflammatory assay

The anti-inflammatory effects of different batches of emulgel formulation were assessed through in vitro stabilization of sheep red blood cell membranes. An isotonic solution was prepared by combining 154 mM NaCl with a 10 mM sodium phosphate buffer at pH 7.4. A 50 µl suspension of sheep red blood cells was mixed with a hypotonic solution containing F1 – F5 emulgel formulation at concentrations of 12.5, 25, 50, and 100 ppm. A control solution without the drug was also included. After 10-minute incubation at room temperature, the mixture was centrifuged at 5000 rpm for 5 minutes, and the absorbance of the supernatant was measured at 540 nm using a UV spectrophotometer. Diclofenac sodium (200 µg/ml) served as the standard for comparison. The % inhibition of red blood cell lysis was calculated by following formula [20]:

% Red blood Cell membrane stability = 100 × [1 – OD2 – OD1/OD3 – OD1]

Here, OD1 represents the test sample in an isotonic solution, OD2 denotes the test sample in a hypotonic solution, and OD3 serves as the control sample in a hypotonic solution.

h) Stability Study

Stability testing was performed in alignment with the International Council for Harmonization (ICH) guidelines. The finalized emulgel formulation batch based on the above assessments underwent accelerated stability testing over a 3-month period under controlled conditions of 40 ± 2˚C temperature and 75 ± 5% relative humidity.

i) Statistical analysis

All values are expressed as Mean ± SD. All data was analysed statistically by Single factor ANOVA (Analysis of Variance) by using graph pad prism Ver 5.1.0. The p value less than 0.05 ($p < 0.05$) considered as statistically significant

RESULT AND DISCUSSION

Phytochemical evaluation of plant material

Preliminary phytochemical evaluation/identification of the powdered drugs *Curcuma longa, Emblica officinalis* and *Aloe vera* juice was performed to authenticate the plant materials for use in formulation. The outcomes of the specific chemical tests are as shown in table 4

Table 4. The outcomes of the drug specific chemical tests

Sr. No	Name of extract	Chemical test	Test inference
1	*Curcuma longa*	Treatment with sulphuric acid gives red color	Present

		Treatment with alkali solution gives red to violet color	
		.With acetic anhydride and concentrated sulphuric acid gives violet colour. Under UV light this colour is seen as an intense red fluorescence.	
		with borax solution gives .a green color	
		With boric acid gives reddish-brown color which, on addition of alkalies, changes to greenish-blue	
2	*Emblica officinalis*	Shinoda test: - To dry powder or extract, add 5 ml 95% ethanol/t-butyl alcohol, few drops conc.HCL and 0.5 g magnesium turnings Orange, Pick, Red to Purple colour appears (Flavanols, dihydro derivatives and xanthene's)	Present
		Sulphuric Acid test: - On addition of sulphuric acid (66% or 80%) flavones and flavonols dissolve into it and Chalcones and aurones gives red or red-bluish solutions. Flavones give orange to red colours. Give a Deep yellow solution.	
3	*Aloe Vera* juice	Borax test - 10 ml of aloe solution, add 0.5 gm of borax followed by heat gives a green colored fluorescence	presence of aloe-emodin anthranol confirmed

Extract preparation outcomes

Extracts of *Curcuma longa* was prepared by soxhlet extraction method by using 95% alcohol as a solvent. Ethanol selected as a solvent because curcuminoids are soluble in ethanol and insoluble in water. The percentage yield of the extract was found to be 34.76 %. *Emblica officinalis* is rich source of flavanoids and polyphenolic compounds which are highly soluble in polar solvents. Hence, the hydroalcoholic extract of Emblica was prepared by maceration technique. The % yield of the Emblica extract was found to be 49.12%. Aloe vera juice was obtained 65% from 100 gm weighed aloe vera leaf part.

Qualitative analysis of extracts by TLC

Qualitative analysis of plant extracts is crucial to ensure the presence of desired phytoconstituents to achieve desired therapeutic efficacy of the formulation. For TLC analysis of curcuma longa and *Emblica officinalis* extracts, curcumin and gallic acid were used as reference standards respectively. For aloe vera juice, aloin was used as reference standard. The outcomes of the TLC analysis are as follows (table 5):

Table 5. The outcomes of the TLC analysis

Sr. No	Name of Extract	Mobile Phase	Rf value observed
1	*Curcuma longa* ethanolic extract	Chloroform: methanol (97:3V/V) (Kushwaha P et al., 2021)	Rf value of extract = 0.36 Rf value of Curcumin = 0.37
2	*Emblica officinalis* hydroalcoholic extract	Toluene: Ethyl Acetate: Glacial Acetic Acid: Formic acid = (2:4.5:2:0.5) (Chaphalkar et al., 2017)	Rf value of extract = 0.85 Rf value of Gallic acid =0.87
3	Aloe Vera Juice	Ethyl acetate : Methanol : Water (10 : 1.35 : 1.0) (Shriwas et al., 2023)	Rf value of extract = 0.79 Rf value of Aloin = 0.80

The Rf values of curcumin, gallic acid and aloin extracts of *Curcuma longa*, *Emblica officinalis* and *Aloe vera* found to be 0.36, 0.85 and 0.79 respectively. These values found similar to the Rf values of respective reference standards. Hence the presence of phytoconstituents curcumin, gallic acid and aloin confirmed in the plant materials.

Characterization of prepared Emulgel Formulation

Characterization of emulgel formulations is essential to assess their physical, chemical, and functional properties, which influence their stability and efficacy. This process involves analyzing parameters such as viscosity, pH, spreadability, and drug release profile to ensure the formulation's suitability for topical application. Through characterization, the structural integrity and homogeneity of the emulgel are evaluated, aiding in the optimization of formulation components. Proper characterization is crucial to predict the emulgel's performance, patient acceptability, and therapeutic effectiveness.

The outcomes of the characterization of emulgel formulation are as follows:

a) **Organoleptic parameters evaluation**

All the trial batches of emulgel formulations were tested for the color, odor, texture and appearance. The outcomes of the test are discussed in the table as follows (Table 6):

Table 6. The outcomes of the organoleptic test

Emulgel formulations						
Sr. No	**Parameters**	**F1**	**F2**	**F3**	**F4**	**F5**
1	Color	Faint Yellowish	Faint Yellowish	Faint Yellowish	Faint Yellowish	Faint Yellowish
2	Odor	Pleasant	pleasant	pleasant	pleasant	pleasant
3	Texture	Smooth	smooth	Smooth	smooth	smooth
4	Appearance	Semi-solid	Semi-solid	Semi-solid	Semi-solid	Semi-solid

b) Determination of pH

For this test, the PH sensitive rod was immersed in 0.5 gm of emulgel formulation of each batch. The resultant PH recorded and summarized in following table.

Table 7. Outcomes of pH determination

Emulgel formulation					
Parameters	**F1**	**F2**	**F3**	**F4**	**F5**
pH	6 ± 0.12	6.1±0.23	6.6±0.03	6.6±0.12	6.8±0.24

Topical formulations pH should be compatible with human skin unless it causes skin irritation and reduces patient acceptability. Ideal pH of human skin is 6.5 – 6.8. Hence, the pH of the formulation batches F3, F4 and F5 found to be in the range of 6.6 – 6.8 compatible with the human skin.

c) Determination of Viscosity

Viscosity of all batches of emulgel formulations was performed by using Brookfield viscometer at 25°C temperature. The outcomes of the test are discussed in table 8.

Table 8. Outcomes of determination of viscosity

Emulgel Formations						
Sr. No	**Parameters**	**F1**	**F2**	**F3**	**F4**	**F5**
1	Viscosity in centipoises	21031± 1.02	20899± 1.14	18435± 0.23	22103± 1.34	24034± 2.02

The viscosity of an emulgel is a key parameter that determines its consistency, spreadability, and ease of application. It is typically measured using a viscometer or rheometer, assessing the emulgel's flow behavior under varying shear rates. Optimal viscosity is essential to maintain the stability of the emulsion within the gel matrix, ensuring uniform drug distribution and effective topical delivery. In this study, F5 emulgel formulation was found to be more viscous as compared to remaining four formulations. This may be due to high content of gelling agent.

d) Determination of Spreadability

The outcomes of the spreadability test are discussed in the following Table (9)

Table 9. The outcomes of the spreadability test

Emulgel formulations					
Parameters	**F1**	**F2**	**F3**	**F4**	**F5**
Spreadability (g. cm/sec)	21.02±0.04	20.9±1.03	13.45±1.14	23.43±0.23	25.76±0.42

The spreadability of an emulgel measures how easily it can be applied over the skin, reflecting its usability and patient comfort. It is assessed by applying a set weight over the emulgel and measuring the extent to which it spreads. Good spreadability indicates that the emulgel can be evenly distributed without excessive effort, which is important for achieving consistent therapeutic effects and enhancing user experience. In this study, F5 formulation shown highest spreadability as compared to the remaining four batches.

e) Study of drug excipient compatibility by FTIR

FTIR (Fourier Transform Infrared) analysis of the formulation is used to identify functional groups and assess the chemical compatibility between the drug and excipients. This technique helps detect any potential interactions or changes in molecular structure within the formulation. By analyzing the specific IR peaks, FTIR ensures the stability and integrity of the formulation's components. In this study, the FTIR chromatogram of formulation is compared with the FTIR chromatograms of individual extract.

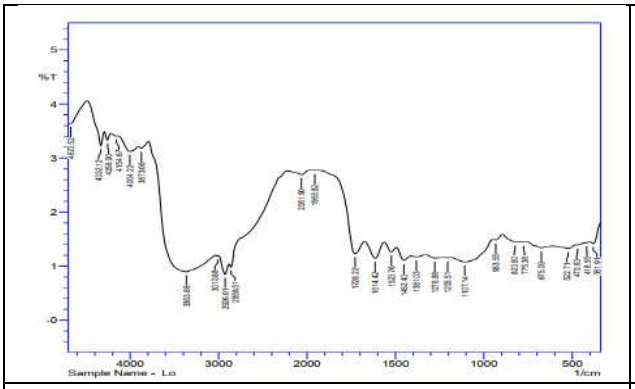


Figure 2 FTIR chromatogram of Curcumin extract

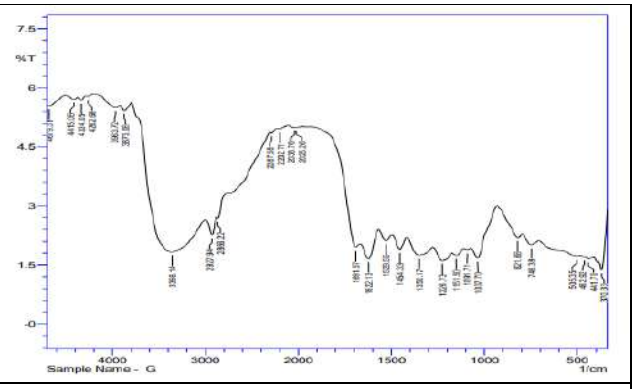


Figure 3 FTIR chromatogram of Emblica officinalis extract

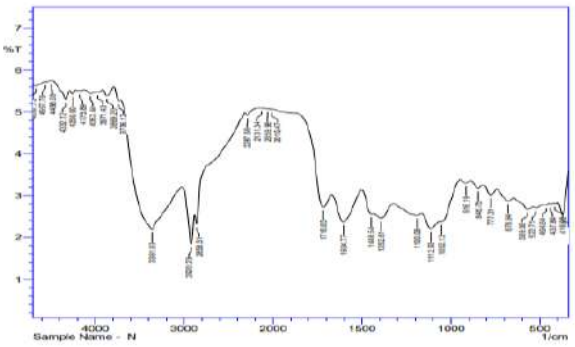


Figure 4. FTIR chromatogram of Aoe vera extract

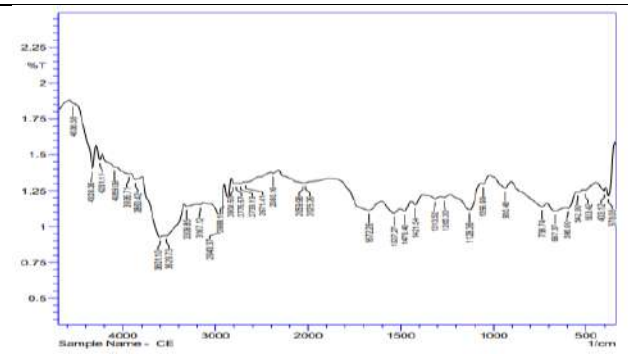


Figure 5. FTIR chromatogram of Emulgel formulation

Table 10. FTIR analysis chart

Extract	Peaks (cm^{-1})	Characteristic Functional Group
C. Longa extract	3010.88	C-H Stretching
	2926.01	C-H Stretching
	2061.90	C-H bending
	1955.82	C=C=C or C=C=N stretching
	1728.22	C=O stretching
	1614.42	C = C Stretching
E. officinalis	2926.01	C-H stretching
	2862.36	O –H Stretching
	2351.23	O=C=O Stretching
	2285.65	O=C=O Stretching
	2131.34	O=C=O Stretching
	2079.26	O=C=O Stretching
	2023.33	O=C=O Stretching
	1950.03	O=C=O Stretching
	1616.35	C=C Stretching
Aloe vera	3361.93	O-H stretching
	2920.23	C-H stretching
	2287.58	N =C=O stretching
	2131.34	CΞC stretching
	2059.98	CΞC stretching
	2019.47	CΞC stretching
	1716.65	C=O stretching
	1604.47	C=C stretching
Emulgel Formulation	3356.14	O-H Stretching
	2927.94	C-H stretching
	2866.22	C-H stretching
	2287.58	O=C=O stretching
	2202.71	CΞC stretching
	2038.76	C=C=C stretching
	2025.26	C=C=C stretching
	1691.57	C-H bending

In IR study of emulgel, as shown in the above table, the C-H stretching, C-H bending, O-H bending in the range of 3300 to 2500 cm ⁻1 found similar to that of the extracts IR spectrum. Thus, no significant drug interaction induced structural changes observed in cream formulation. Hence,

the excipients used for emulgel formulation found compatible with extracts.

f) *Invitro* drug release study

This study helps to predict the drug release profile, ensuring effective delivery and therapeutic action of the emulgel. In this study, the drug release from prepared emulgel for 0, 50, 100, 150, 200, 250 min was determined using UV spectrophotometer. The samples collected at certain time intervals were analyzed by UV. The UV wavelength of curcumin, gallic acid and aloin was found to be 430, 270 and 350 nm [21], [22], [23]. The percent drug release from emulgel was determined based on these UV absorbances. The % drug release for extracts is as shown in table 11.

Table 11. Invitro drug release study outcomes

Formulation		% drug release at 0 min	% drug release at 50 min	% drug release at 100 min	% drug release at 150 min	% drug release at 200 min	% drug release at 200 min
F1	Curcumin	0	5.2± 0.12	13.8± 0.22	31.5± 1.24	36.23± 0.67	40.55± 0.33
	Gallic acid	0	11.34± 0.11	31.23± 1.03	45.20± 1.07	69.65± 1.23	85.30± 0.32
	Aloin	0	14.20± 0.23	24.77± 1.45	36.20± 0.22	42.14± 0.10	52.90± 1.11
F2	Curcumin	0	6.0± 0.42	14.1± 0.10	34.2± 0.56	42.2± 0.66	47.18± 0.43
	Gallic acid	0	15.6± 0.24	37.2± 0.11	51.40± 1.32	70.23± 0.76	89.10± 1.04
	Aloin	0	20.20	31.76	42.43	51.22	61.90
F3	Curcumin	0	15.89± 0.10	33.8± 0.43	41.5± 0.29	46.23± 0.22	50.55± 0.76
	Gallic acid	0	22.24± 0.12	38.10± 0.04	52.10± 0.45	74.09± 0.11	90.13± 0.23
	Aloin	0	24.11± 0.24	35.02± 0.01	46.05± 0.12	57.98 ± 0.67	60.11± 0.13
F4	Curcumin	0	21.09± 0.16	39.21± 0.32	49.76± 0.18	51.44± 0.35	60.45± 1.05
	Gallic acid	0	27.10± 0.34	42.19± 0.38	58.19± 1.03	80.22± 0.12	92.10± 0.23
	Aloin	0	29.14± 0.10	41.20± 1.33	51.11± 0.12	62.13± 0.43	68.29 ± 0.25
F5	Curcumin	0	32.10± 0.12	42.22± 0.22	58.45± 1.24	60.23± 0.67	68.21± 0.33
	Gallic acid	0	33.45± 0.02	49.20± 0.34	65.45± 0.11	85.78± 0.12	95.12± 0.34
	Aloin	0	32.23± 0.22	44.19± 0.03	64.21± 0.14	71.90± 0.24	75.11± 0.54

Among all five batches of formulation, the better drug release was observed in F5 emulgel formulation. Gallic acid from *Emblica officinalis* extract shown more amount of drug release as compared to aloin from *Aloe vera* juice and curcumin from *Curcuma longa* extract. In this way, emulgel found to release drug effectively within 250 minutes time period from the moment of consumption.

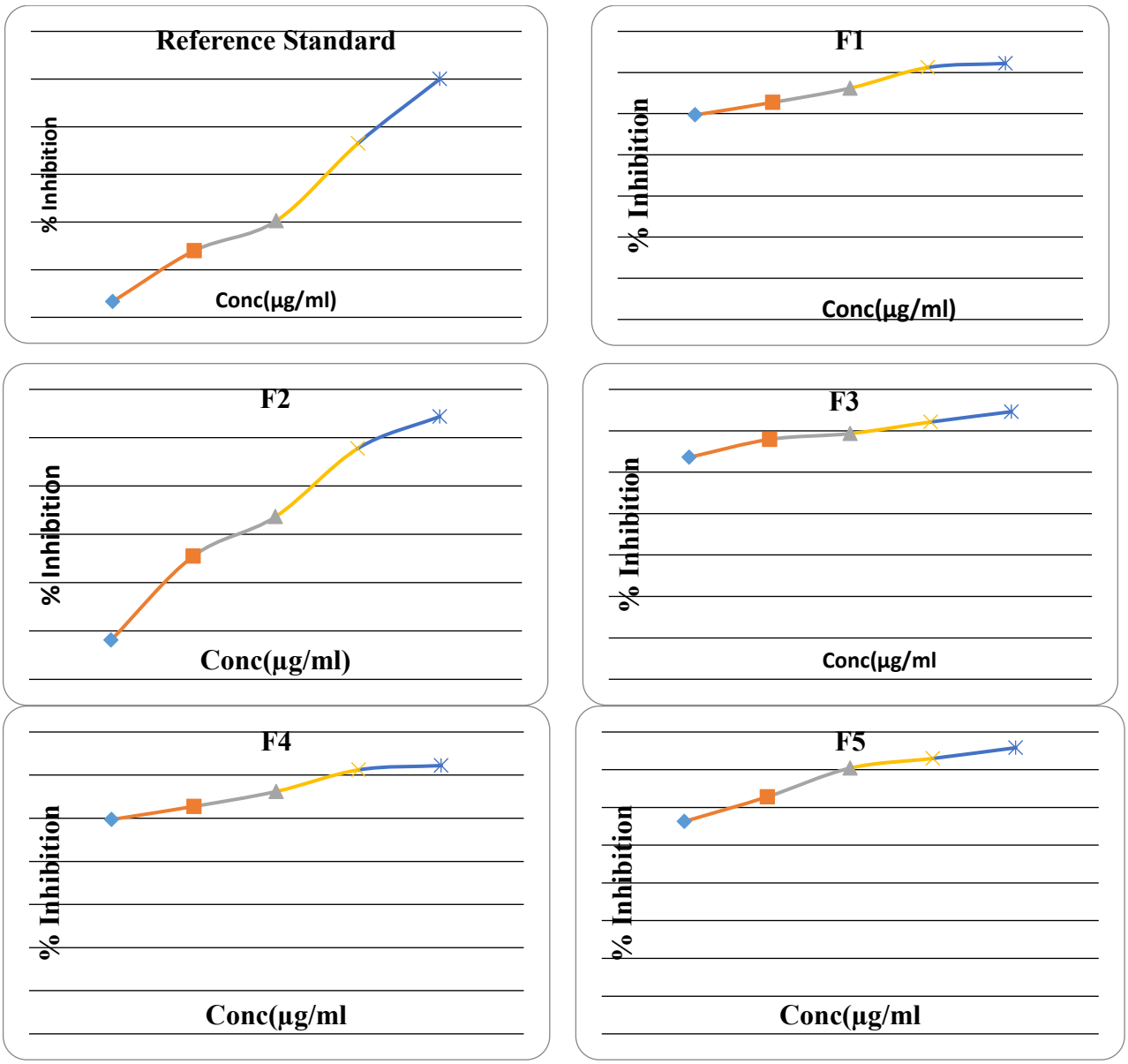
4.5 Invitro drug efficacy studies

In vitro drug efficacy studies assess the therapeutic effectiveness of a drug by evaluating its activity in a controlled laboratory setting, typically using cell cultures or isolated tissues. These studies measure parameters like cell viability, inhibition of specific enzymes, antimicrobial or anti-inflammatory effects, and drug-induced cellular responses. By simulating target conditions, in vitro efficacy testing provides insights into the drug's potency, mechanism of action, and optimal dosage, laying the groundwork for further preclinical and clinical testing. According to the previous studies, Reactive oxygen species or free radicals and chronic inflammation plays crucial role in development of psoriasis [24],[25]. Hence it was necessary to analyze the antioxidant and anti-inflammatory activity of prepared emulgel formulation to ensure its therapeutic efficacy. The outcomes of the invitro drug efficacy studies are as follows (Table 12):

a) Antioxidant activity by DPPH assay

Table 12. Invitro antioxidant study outcomes

Sr. No	Name of Sample	Conc. (µg/ml)	% Inhibition
1	Ascorbic acid (Reference standard)	10	84.66±0.11
		20	86.80±0.02
		30	88.05±0.14
		40	91.30±023
		50	94.00±0.43
2.	Emulgel Formulation batch F1	10	49.70±0.18
		20	52.74±0.04
		30	56.21±0.10
		40	61.23±0.23
		50	62.21±0.45
	Emulgel Formulation batch F2	10	51.63±0.08
		20	55.10±0.23
		30	56.73±0.24
		40	59.55±0.33
		50	60.88±0.13
	Emulgel Formulation batch F3	10	53.60±0.29
		20	57.93±0.09
		30	59.34±0.11
		40	62.13±0.29
		50	64.61±0.66
	Emulgel Formulation batch F4	10	49.70±0.28
		20	52.74±0.13
		30	56.21±0.34
		40	61.23±0.13
		50	62.21±0.05
	Emulgel Formulation batch F5	10	56.29±1.03
		20	62.82±0.45
		30	70.43±0.63
		40	73.00±0.22
		50	75.83±0.42



In this study, it is observed that, emulgel formulation have significant free radicals scavanging activity. However, when compared to the reference standard, it is found lower than the antioxidant activity of standard ascorbic acid. Hence from this study, it can be conclued that prepared emulgel formulation have significant antioxidant effect and can be effective against psoriasis lessions.

b) Invitro anti-inflammatory assay

The anti-inflammatory activity of an emulgel for psoriasis is assessed to evaluate its effectiveness in reducing inflammation associated with psoriatic lesions. This is typically done through in vitro and in vivo studies. In vitro, anti-inflammatory effects can be tested using assays like the red blood cell membrane stabilization method, which measures the emulgel's ability to prevent cell lysis under stress. By effectively targeting inflammation, an emulgel formulation can aid in alleviating symptoms of psoriasis, potentially enhancing patient comfort and skin condition.

The outcomes of anti-inflammatory activity are as follows (Table 13):

Table 13. The outcomes of anti-inflammatory activity of F1, F2, F3, F4, F5 formulations

Sr. No	Name of Sample	Conc. (µg/ml)	% Inhibition
1	F1	12.5	36.80±0.02
		25	38.08±0.04
		50	37.88±0.23
		100	39.78±0.11
2	F2	12.5	34.03±0.23
		25	32.98±0.44
		50	39.26±0.20
		100	40.49±0.75
3	F3	12.5	28.21±0.34
		25	33.74±0.55
		50	36.87±0.32
		100	42.78±0.16
4	F4	12.5	31.06±0.04
		25	33.35±0.06
		50	40.76±0.45
		100	46.14±0.29
5	F5	12.5	36.10±0.36
		25	41.49±0.08
		50	45.64±0.46
		100	55.74±0.56

In this way, from this study it is observed that, percentage inhibition of red blood cells membrane lysis was found to be directly proportional to the quantity of the extracts. In batch F5, the percentage inhibition found to be higher than remaining F1, F2, F3 and F4. This observation clearly indicates the significant anti-inflammatory efficacy of the prepared emulgel formulation

STABILITY STUDY

Stability studies were conducted in Environmental test chamber to assess stability of emulgel formulation with respect to their physical appearance, drug content and drug release characteristics after storing them at 45^0c/75% RH for 3 months. The formulation found to be stable after 3 months period.

CONCLUSION

In conclusion, the emulgel formulation developed in this study, particularly batch F5, demonstrates significant potential as a therapeutic agent for psoriasis management. By harnessing the anti-inflammatory and antioxidant properties of natural herbal extracts from *Curcuma longa*, *Emblica officinalis*, and *Aloe vera*, this formulation offers a safe, effective, and non-invasive approach to reduce psoriatic symptoms such as redness, scaling, and inflammation. The thorough pharmaceutical characterization and in vitro efficacy tests confirm that batch F5 not only exhibits optimal stability and spreadability but also achieves an enhanced drug release profile, which is essential for sustained therapeutic action. This emulgel provides a promising alternative to synthetic drugs, with additional potential for in vivo validation, making it a valuable addition to topical psoriasis treatments aimed at improving patient outcomes and quality of life.

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CONFLICT OF INTEREST

There is no conflict of interest.

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