CODEN [USA]: IAJPBB ISSN : 2349-7750

INDO AMERICAN JOURNAL OF
PHARMACEUTICAL SCIENCES
SJIF Impact Factor: 7.187
https://doi.org/10.5281/zenodo.20513027

Available online at: http://www.iajps.com Research Article

FORMULATION AND EVALUATION OF HERBAL EMULGEL CONTAINING *RUBIA CORDIFOLIA* AND *MILLETTIA PINNATA* FOR TOPICAL DRUG DELIVERY

Shubham Suresh Gulhane[1*], Dr.Abhijeet V. Shrirao[1], Dr.Manisha D. Kitukale[1]
[1]Department of Pharmaceutical Science, SunRise University Alwar, Rajasthan, India.

Abstract:
Topical drug delivery systems have gained significant importance in modern pharmaceutical sciences due to their ability to provide localized therapeutic action with minimal systemic side effects. Emulgel, a combination of emulsion and gel, represents an advanced topical drug delivery system suitable for both hydrophilic and hydrophobic drugs. The present research work focuses on the formulation and evaluation of a herbal emulgel containing Rubia cordifolia and Millettia pinnata for enhanced topical drug delivery. Different formulations of emulgel were prepared using various concentrations of Carbopol 934, Carbopol 940, and Hydroxy Propyl Methyl Cellulose (HPMC) as gelling agents. The prepared formulations were evaluated for physicochemical parameters such as appearance, pH, homogeneity, spreadability, viscosity, drug content, in vitro drug release, stability studies, and skin irritation potential. FTIR studies confirmed compatibility between herbal extracts and excipients. In vitro drug release studies demonstrated controlled and sustained release behavior, particularly in formulation F5, which showed superior drug release and stability characteristics. Stability studies indicated no significant changes in physical appearance, pH, or drug content during storage. The study concluded that herbal emulgel formulations containing Rubia cordifolia and Millettia pinnata provide effective topical delivery with improved stability, patient compliance, and therapeutic potential for dermatological applications.

Keywords: *Herbal Emulgel, Topical Drug Delivery, Rubia cordifolia, Millettia pinnata, Carbopol 934, Carbopol 940, HPMC, Controlled Release, FTIR, Stability Study.*

Corresponding author:
Shubham Suresh Gulhane,
Department of Pharmaceutical Science,
SunRise University Alwar,
Rajasthan, India.

QR CODE

Please cite this article in press Shubham Suresh Gulhane et al., ***Formulation And Evaluation Of Herbal Emulgel Containing Rubia Cordifolia And Millettia Pinnata For Topical Drug Delivery****.., Indo Am. J. P. Sci, 2026; 13(05).*

1.INTRODUCTION:

Topical drug delivery systems are widely used in pharmaceutical sciences for the treatment of skin disorders, infections, inflammation, pain, and wound healing conditions. Conventional formulations such as ointments, creams, and lotions are commonly used because of their ease of application and patient convenience. However, these formulations possess disadvantages including greasiness, stickiness, poor spreadability, instability, microbial contamination, and reduced patient compliance.[1] To overcome these limitations, advanced topical systems such as emulgels have gained considerable importance because they provide better stability, enhanced drug penetration, improved cosmetic appearance, and greater patient acceptability. Herbal medicines are becoming increasingly popular due to their natural origin, safety, effectiveness, affordability, and minimal side effects. Medicinal plants contain phytoconstituents such as flavonoids, alkaloids, tannins, glycosides, and phenolic compounds that possess antimicrobial, antioxidant, anti-inflammatory, and wound healing activities. Rubia cordifolia and Millettia pinnata are important medicinal plants traditionally used for treating skin diseases, wounds, ulcers, infections, and inflammatory disorders. Rubia cordifolia contains anthraquinones, glycosides, tannins, and flavonoids, while Millettia pinnata contains karanjin, fixed oils, steroids, and flavonoids responsible for their therapeutic effects. The present study focused on the formulation and evaluation of a herbal emulgel containing Rubia cordifolia and Millettia pinnata using Carbopol 934, Carbopol 940, and HPMC as gelling agents. The prepared formulations were evaluated for pH, viscosity, spreadability, homogeneity, drug content, stability, skin irritation, and in vitro drug release to develop a stable and effective herbal topical drug delivery system.[2]

2. DRUG

2.1 Rubiya cordifoliya

Rubia cordifolia, commonly known as Manjistha, is an important medicinal herb belonging to the family Rubiaceae. It is widely used in Ayurveda and traditional medicine because of its significant therapeutic properties. The roots of the plant contain active phytoconstituents such as anthraquinones, glycosides, tannins, flavonoids, alkaloids, and phenolic compounds. The herb exhibits anti-inflammatory, antioxidant, antimicrobial, anti-allergic, blood purifying, and wound healing activities. Traditionally, it has been used for the treatment of skin diseases, ulcers, chronic wounds, itching, arthritis, and inflammatory disorders. Rubia cordifolia promotes healing by reducing redness, swelling, and microbial infection. Due to its natural therapeutic potential and lower adverse effects, it is increasingly used in modern herbal formulations such as creams, gels, ointments, and emulgels. Biologically, Manjistha consists of the dried roots of Rubia cordifolia. Its molecular formula is C33H28O9 with a molecular weight of 568.578 g/mol. The plant contains anthraquinone glycosides including rubiadin and related quinones responsible for its medicinal properties. Rubia cordifolia appears as a red crystalline powder and is soluble in water while slightly soluble.[3]

2.2 Millettia pinnata

Millettia pinnata, commonly known as Karanja or Indian Beech, is a medicinal plant belonging to the family Fabaceae. The plant is widely distributed in tropical and subtropical regions of India and has been extensively utilized in Ayurveda and traditional medicine because of its therapeutic importance. Different parts of the plant including seeds, bark, roots, leaves, and oil possess valuable medicinal properties. The plant contains various phytoconstituents such as flavonoids, alkaloids, tannins, fixed oils, saponins, karanjin, pongamol, and phenolic compounds which contribute to its pharmacological activities.[4]

Millettia pinnata exhibits significant anti-inflammatory, antimicrobial, antioxidant, analgesic, antipruritic, and wound healing properties. Karanja oil obtained from the seeds is frequently used in topical preparations for treating eczema, itching, wounds, rheumatic pain, and various skin disorders. Due to its natural origin and therapeutic effectiveness, the plant has gained considerable importance in herbal pharmaceutical formulations including creams, ointments, gels, and emulgels.[5]

Structure

Biological Source: Non-edible semi-drying fixed oil obtained from the seeds of Pongamia glabra Vent.
IUPAC Name: 2S-5-7-dimethoxy-8-formylflavanone
Molecular Formula: C18H12O4
Molecular Weight: 292.3 g/mol
Category: Ayurvedic Drug

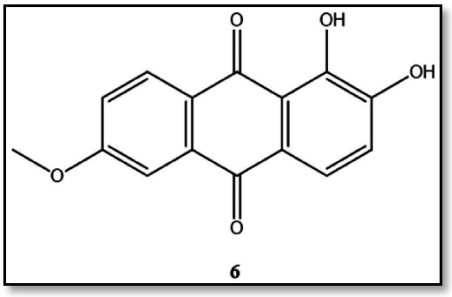

Fig. 1: *Rubiva cordifoliva*

Chemical Constituents

Millettia pinnata contains important phytoconstituents including flavonoids, fixed oils, glycosides, alkaloids, tannins, sterols, phenolic compounds, saponins, and fatty acids. The major bioactive constituents are karanjin and pongamol, which are mainly responsible for the antimicrobial, antioxidant, anti-inflammatory, and wound healing activities of the plant. The seeds contain fixed oils and fatty acids such as oleic acid, palmitic acid, linoleic acid, and stearic acid, whereas leaves and bark contain sterols like β-sitosterol and stigmasterol.

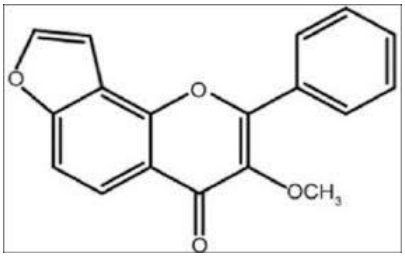

Fig.2 : Karanjin

EXCIPIENTS PROFILE

Carbopol 940 (Polyacrylic Acid)

Carbopol 940 is a cross-linked polyacrylic acid polymer widely used as a gelling and thickening agent in topical pharmaceutical preparations. It produces transparent gels with excellent viscosity and stability. The polymer is extensively utilized in emulgel formulations because of its ability to provide smooth texture, controlled viscosity, and improved spreadability.[6]

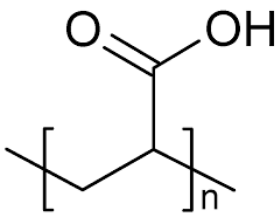

Fig.3: Carbapol

Span 80 (Sorbitan Monooleate)

Span 80 is a non-ionic surfactant used as an emulsifying agent in pharmaceutical formulations. It helps in stabilizing water-in-oil emulsions and improves the consistency of topical dosage forms.

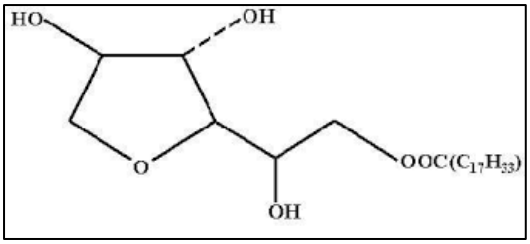

Fig.4: Span 80

Castor Oil

Castor oil acts as an emollient and penetration enhancer in topical formulations. It helps improve skin hydration and supports better drug penetration through the skin layers.[7]

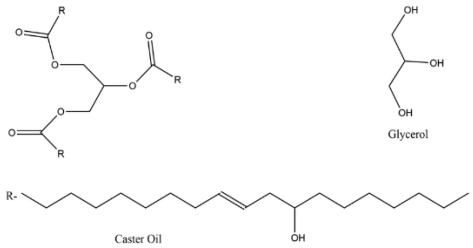

Fig.5: Castor Oil

Tween 20 and Tween 80

Tween 20 and Tween 80 are non-ionic surfactants commonly used as emulsifying agents. These surfactants assist in the formation of stable emulsions and enhance the uniform distribution of ingredients within the formulation.[8]

3. EXPERIMENTAL WORK

3.1 Material Used

Table 1. List of Drugs and Chemicals Used

Sr. No.	Materials	Supplied By
1	Span-80	Research Lab Fine Chem Industries
2	Tween-20	Research Lab Fine Chem Industries
3	Carbopol-940	Yarrow Chem Lab
4	Methyl Paraben	Thermosil Fine Chem Lab
5	Propylene Glycol	SDFC Ltd
6	Liquid Paraffin	K.R. Chemicals
7	Span-40	Research Lab Fine Chem Industries
8	Tween-80	Research Lab Fine Chem Industries
9	Propyl Paraben	Thermosil Fine Chem Lab
10	Purified Water	RO Processed Water

3.2 Instruments Used

Table 2. List of Instruments and Manufacturers

Sr. No.	Equipment	Manufacturer
1	Digital Weighing Balance	Hanna Instruments
2	High Shear Homogenizer	IKA
3	Diffusion Cell Apparatus	Magnified Glass Diffusion Cell
4	Stability Chamber	Remi
5	Digital pH Meter	HANNA Instruments, Italy
6	UV-Visible Spectrophotometer	Thermo Alpha Helios, Mumbai
7	Magnetic Stirrer	REMI, Mumbai
8	FTIR Spectrophotometer	FTIR-8001 Shimadzu, Japan

3.3 Preformulation Study of Drug

Preformulation studies are important investigations carried out before formulation development to understand the physicochemical characteristics of a drug substance. These studies assist in designing a stable, safe, and effective dosage form. The present investigation included evaluation of organoleptic properties, powder flow characteristics, solubility behavior, compressibility index, Hausner's ratio, and angle of repose.[9]

1. Organoleptic Evaluation

The powdered form of Rubia cordifolia was evaluated visually for colour, odour, taste, shape, texture, and appearance. These characteristics provide primary information regarding the purity and identity of the crude drug.

Observations

- Colour: Reddish brown
- Odour: Characteristic
- Taste: Slightly bitter
- Shape: Fine powder
- Texture: Smooth and slightly fibrous[10]

2. Bulk Density

Bulk density was determined by transferring accurately weighed powder into a graduated measuring cylinder and recording the initial volume occupied by the powder.

3. Tapped Density

Tapped density was measured by tapping the cylinder repeatedly until a constant volume was obtained. The final volume was used for calculation of tapped density.

Formula

Loose Bulk Density (LBD) = Weight of Powder / Initial Volume

Tapped Density (TBD) = Weight of Powder / Final Tapped Volume

4. Compressibility Index (Carr's Index)

Carr's Index was calculated to determine the compressibility and flow properties of the powder.

Table 3. Interpretation of Compressibility Index

Percent Compressibility	Type of Flow
5–15	Excellent
12–16	Good
18–21	Fair to Passable
23–25	Poor
33–38	Very Poor
>40	Extremely Poor

5. Hausner's Ratio

Hausner's ratio was determined to evaluate powder flowability.

Table 4. Interpretation of Hausner's Ratio

Hausner's Ratio	Flow Property
<1.25	Good Flow
1.25–1.50	Flow Improved with Glidant
>1.50	Poor Flow

6. Angle of Repose

Angle of repose was measured using the funnel method by allowing the powder to flow freely and form a conical heap.

Table 5. Interpretation of Angle of Repose

Angle of Repose	Powder Flow
<25°	Excellent
25–30°	Good
30–40°	Passable
>40°	Very Poor

The obtained results indicated satisfactory flow characteristics suitable for formulation development.

Physical Characterization of Drug Sample

The received sample of Rubia cordifolia and Millettia pinnata was evaluated for its physical characteristics. The powder was found to possess suitable organoleptic properties and acceptable physicochemical behavior.

Description

Nature of Drug: Powder form

Melting Range: 217–220°C

Solubility: Practically insoluble in water, soluble in acetone and methylene chloride, and slightly soluble in methanol.

3.4 Spectrum Measurement of Millettia pinnata

Selection of Solvent

Phosphate buffer pH 5.8 was selected as the dissolution medium because it closely resembles the pH of skin.

Determination of λmax

The absorption maximum of Millettia pinnata was determined using a double-beam UV-visible spectrophotometer. The drug solution was scanned around 256 nm according to pharmacopoeial specifications and literature references.

Preparation of Phosphate Buffer pH 5.8

For preparation of phosphate buffer, potassium dihydrogen phosphate and disodium hydrogen phosphate solutions were prepared separately. Appropriate quantities of both solutions were mixed to obtain phosphate buffer of pH 5.8. The prepared buffer solution was clear and suitable for spectrophotometric analysis.[12]

Preparation of Standard Stock Solution

A standard solution of Millettia pinnata was prepared by dissolving accurately weighed drug in phosphate buffer pH 5.8 to obtain the desired concentration.

Calibration Curve of Millettia pinnata

Different concentrations of the prepared stock solution were analyzed spectrophotometrically at 256 nm. The absorbance values obtained were used for plotting the calibration curve.

3.5 Spectrum Measurement of Rubia cordifolia

Determination of λmax

The absorption maximum of Rubia cordifolia was determined using UV-visible spectrophotometric analysis at 256 nm. Appropriate dilutions of the stock solution were prepared using phosphate buffer pH 5.8 and analyzed spectrophotometrically.

The absorbance values obtained at different concentrations were used to construct the calibration curve. The analytical method was found to be simple, accurate, and reproducible for quantitative estimation of the herbal extract.

3.6 Evaluation of Emulgel

3.6.1 Consistency

The consistency of the prepared emulgel formulations was evaluated visually. All formulations exhibited smooth texture and absence of excessive greasiness.

3.6.2 Spreadability

Spreadability was determined by placing the formulation between two glass slides and measuring the time required for separation of the slides under the influence of a specific weight. Better spreadability was indicated by shorter separation time.

3.6.3 Diffusion Studies of Emulgel

Diffusion studies were performed using a diffusion cell apparatus. Approximately 2 g of emulgel was placed in the donor compartment, while phosphate buffer pH 5.8 was used in the receptor compartment. The receptor medium was stirred continuously at controlled temperature conditions. Samples were withdrawn at predetermined intervals and analyzed spectrophotometrically.

3.6.4 pH Determination

The pH of prepared emulgel formulations was measured using a digital pH meter after dispersing the formulation in distilled water.

3.6.5 FTIR Spectra

FTIR studies were carried out in the wavelength range of 4000–500 cm−1 using the KBr pellet method. The spectra confirmed the absence of significant interaction between the herbal drugs and excipients.

3.6.6 Preparation of Emulgel

The herbal emulgel formulations containing Millettia pinnata and Rubia cordifolia were prepared by first dispersing Carbopol polymers in hot purified water to form a gel base. The oil phase was prepared using liquid paraffin and Span 80, whereas the aqueous phase contained Tween 80 and other water-soluble ingredients. Preservatives were dissolved in propylene glycol, and the drug solution was incorporated into the aqueous phase. Both phases were heated separately and mixed with continuous stirring to obtain an emulsion. Finally, the emulsion was mixed with gel base in a 1:1 ratio to obtain the emulgel formulation.[13]

Table 6. Composition of Emulgel Formulations

Ingredient	F1	F2	F3	F4	F5
Millettia pinnata	100 mg	100 mg	150 mg	150 mg	150 mg
Rubia cordifolia	100 mg	100 mg	150 mg	150 mg	150 mg
Liquid Paraffin	3.75 ml	4.75 ml	5.75 ml	6.5 ml	7.5 ml
Carbopol-934	0.5 g	0.7 g	1 g	1 g	1.5 g
Propylene Glycol	2.5 ml	2.5 ml	2.5 ml	2.5 ml	2.5 ml
Span-80	0.5 ml	0.5 ml	—	0.5 ml	0.5 ml
Tween-80	—	—	—	—	0.25 ml
Water	q.s.	q.s.	q.s.	q.s.	q.s.

3.7 Selected Batch of Emulgel Formulation

Batch F5 was selected as the optimized formulation based on physicochemical characteristics and in vitro drug release performance.[14]

Table 7. Composition of Optimized Batch F5

Sr. No.	Ingredient	Quantity
1	Millettia pinnata	150 mg
2	Rubia cordifolia	150 mg
3	Liquid Paraffin	7.5 ml
4	Water	12 ml
5	Methyl Paraben	0.03 mg
6	Propyl Paraben	0.03 mg
7	Propylene Glycol	2.5 ml
8	Carbopol-934	1.5 g
9	Span-80	0.5 ml
10	Tween-80	0.25 ml
11	Water	q.s.

4. RESULTS AND DISCUSSION:

Preformulation Study of Rubia cordifolia Powder Drug

Preformulation studies are an important stage in formulation development because they provide valuable information regarding the physicochemical characteristics of the drug substance. These studies assist in selecting suitable excipients and designing a stable, safe, and effective dosage form. In the present investigation, Rubia cordifolia powder was evaluated for organoleptic properties, solubility, powder flow characteristics, compressibility index, Hausner's ratio, and pH.

1. Organoleptic Properties

The organoleptic characteristics of Rubia cordifolia powder were evaluated visually to determine the appearance and purity of the herbal drug.

Table 8. Organoleptic Properties of Rubia cordifolia

Sr. No.	Parameter	Observation
1	Colour	Reddish-brown
2	Odour	Characteristic
3	Taste	Slightly bitter
4	Appearance	Fine powder

The drug powder exhibited acceptable organoleptic properties suitable for formulation development.

2. Solubility Studies

Solubility analysis was performed in different solvents to identify a suitable medium for formulation and analytical studies.

Table 9. Solubility Studies of Rubia cordifolia

Sr. No.	Solvent	Solubility
1	Distilled Water	Slightly Soluble
2	Ethanol	Soluble
3	Methanol	Soluble
4	Phosphate Buffer pH 5.8	Slightly Soluble

The results demonstrated that the drug possessed better solubility in organic solvents than aqueous media, supporting the selection of an emulsion-based topical formulation.

3. Loss on Drying

Loss on drying was determined to evaluate the moisture content present in the powdered drug. The moisture content was found to be within acceptable limits, indicating good stability and reduced chances of microbial contamination.

4. Bulk Density and Tapped Density

Bulk density and tapped density studies were carried out to assess the packing ability and flow properties of the powder.

Table 10. Bulk Density and Tapped Density of Rubia cordifolia

Sr. No.	Parameter	Value
1	Bulk Density	0.42 g/cm³
2	Tapped Density	0.51 g/cm³

The obtained values indicated satisfactory packing properties of the powder.

5. Angle of Repose

Angle of repose was determined by the fixed funnel method to evaluate powder flowability.

Observation

Angle of repose was found to be 29°, indicating good flow behavior of the powder material.

6. Compressibility Index (Carr's Index)

Carr's compressibility index was calculated using bulk density and tapped density values.

Formula

Carr's Index = (Tapped Density − Bulk Density / Tapped Density) × 100

Result

Carr's Index was found to be 17.64%, which indicated fair to good flowability of the drug powder.

7. Hausner's Ratio

Hausner's ratio was determined to further evaluate the flow characteristics of the powder.

Formula

Hausner's Ratio = Tapped Density / Bulk Density

Result

Hausner's ratio was calculated as 1.21, confirming acceptable powder flow properties.

8. pH Determination

The pH of 1% aqueous dispersion of Rubia cordifolia powder was determined using a digital pH meter.

Observation

The pH value was found to be 5.9, which is suitable and compatible for topical application on skin.

9. Drug–Excipient Compatibility Study

Drug–excipient compatibility studies were performed by physical observation and spectrophotometric analysis.

Observation

No significant changes in colour, odour, or appearance were observed after mixing the drug with excipients. This confirmed the compatibility of Rubia cordifolia with selected formulation ingredients.

7.1 Spectrum Measurement of Rubia cordifolia

The absorption maximum (λmax) of Rubia cordifolia was determined using a double-beam UV-visible spectrophotometer. The analysis was performed around the wavelength region of 256 nm according to pharmacopoeial standards and literature references.

A stock solution was prepared by transferring the required quantity of drug solution into a calibrated volumetric flask and diluting it with phosphate buffer pH 5.8. Further dilutions were prepared to obtain different concentrations suitable for spectrophotometric analysis.

The absorbance of each solution was recorded at 256 nm using phosphate buffer pH 5.8 as blank. The obtained absorbance values were used to prepare the calibration curve and determine the linearity of the method. The analytical method was found to be simple, precise, accurate, and reproducible for estimation of Rubia cordifolia.

Table 11. Calibration Curve of Rubia cordifolia in Phosphate Buffer pH 5.8 at λmax 256 nm

Sr. No.	Concentration (µg/mL)	Absorbance
1	1	0.033
2	2	0.064
3	3	0.108
4	4	0.137
5	5	0.166

7.2 Spectrum Measurement of Millettia pinnata

The absorption maxima of Millettia pinnata was determined using UV-visible spectrophotometric analysis. The sample solution was scanned around

256 nm using a double-beam UV-visible spectrophotometer.

A stock solution was prepared using phosphate buffer pH 5.8 and further diluted to obtain different concentrations. The absorbance values were recorded at 256 nm against phosphate buffer pH 5.8 as blank.

The obtained calibration data demonstrated good linearity and confirmed the suitability of the method for quantitative analysis of Millettia pinnata.

Table 12. Calibration Curve of Millettia pinnata in Phosphate Buffer pH 5.8 at λmax 256 nm

Sr. No.	Concentration (µg/mL)	Absorbance
1	10	0.013
2	20	0.027
3	30	0.038
4	40	0.046
5	50	0.055

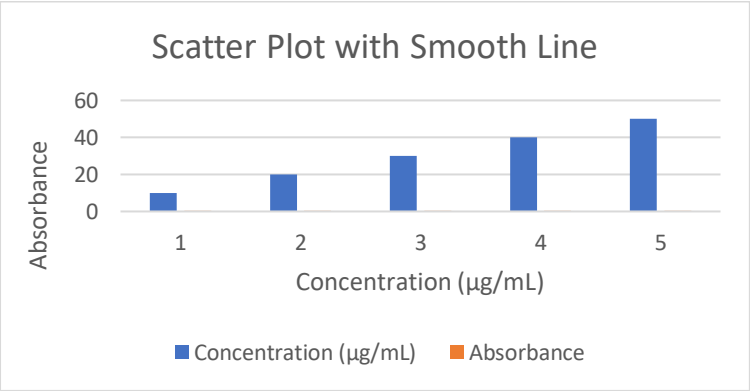

Fig no-6 Calibration curve of millettia pinnata in phosphate buffer pH 5.8

7.3 Fourier Transform Infrared Spectroscopy

FTIR analysis was carried out to evaluate the chemical integrity of the herbal drugs and to determine any possible interaction between the drugs and excipients. The spectra were recorded within the wavelength region of 500–4500 cm−1 using an FTIR spectrophotometer.

The observed peaks confirmed the presence of characteristic functional groups and demonstrated the absence of significant interaction between the herbal drugs and excipients.

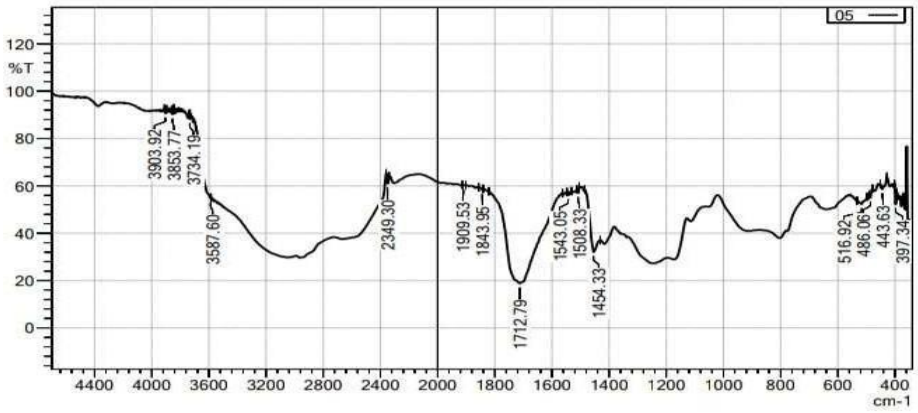

Fig no-7 FT-IR Spectrum of emulgel preparation

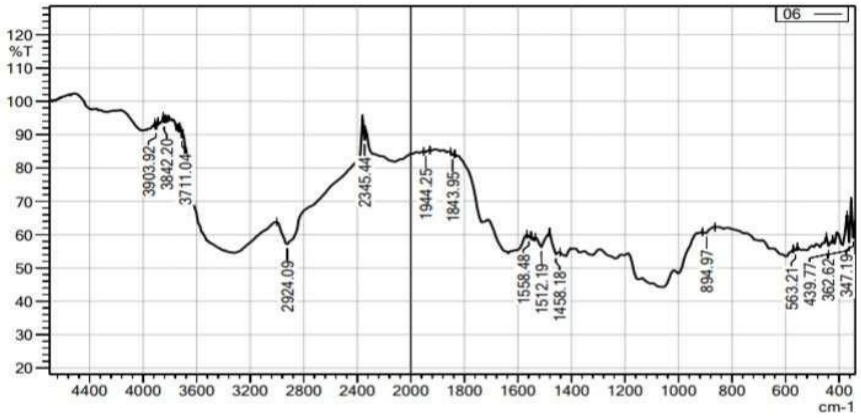

Fig no-8 FT-IR Spectrum of Millettia pinnata

Table 13. FTIR Spectrum of Millettia pinnata

Sr. No.	Functional Group	Wave Number (cm−1)
1	C=O	1944.25
2	C–C	1512.19
3	C–O	894.97
4	C–H	2924.09
5	N–O	1558.48

7.4 Evaluation of Emulgel

Consistency

The prepared emulgel formulations were evaluated visually and manually for consistency. All formulations showed smooth, homogeneous texture without lumps or phase separation. Slight greasiness was observed due to the oily phase, which contributes to improved emollient properties and skin hydration.

Spreadability

Spreadability is an important parameter for topical preparations because it determines the ease of application on skin. All formulations demonstrated satisfactory spreadability and could be applied uniformly with minimal friction.

Appearance

The formulations were visually evaluated for colour, texture, homogeneity, and appearance. All batches were found to be whitish-brown in colour with glossy appearance and smooth consistency. No grittiness or phase separation was observed.

Viscosity

Viscosity studies were carried out using a Brookfield viscometer. All formulations exhibited appropriate semisolid viscosity suitable for topical application. Adequate viscosity helps increase retention time and improves therapeutic efficacy.

pH

The pH of prepared emulgel formulations was measured using a digital pH meter.

Observation

The pH values of formulations ranged from 4.63 to 5.89, indicating compatibility with normal skin pH and suitability for dermal application.

In Vitro Drug Diffusion Study

Drug diffusion studies were carried out using a diffusion cell apparatus containing phosphate buffer pH 5.8 as receptor medium. The receptor compartment was continuously stirred at controlled temperature conditions.

Samples were withdrawn at predetermined time intervals and analyzed spectrophotometrically. The cumulative percentage drug release values of selected batches were calculated.

Table 14. Cumulative Percentage Drug Release of Batches F3, F5, F7, and F9

Sr. No.	Time (min)	F3 % CDR	F5 % CDR	F7 % CDR	F9 % CDR
1	0	0	0	0	0
2	30	15.05	25.92	22.25	27.95
3	60	23.34	34.71	29.74	33.28
4	90	29.55	38.26	38.57	40.89
5	120	39.61	48.88	44.77	48.89
6	150	48.39	55.00	52.81	55.10
7	180	82.48	90.04	85.03	85.56
8	210	90.47	100.07	97.77	98.12

Among all formulations, batch F5 exhibited the highest cumulative drug release of 100.07% at 210 minutes, indicating superior drug diffusion characteristics.

Table 15. Cumulative Percentage Drug Release of Optimized Batch F5

Sr. No.	Time (min)	% CDR
1	0	0
2	30	25.92
3	60	34.71
4	90	38.26
5	120	48.88
6	150	55.00
7	180	90.04
8	210	100.07

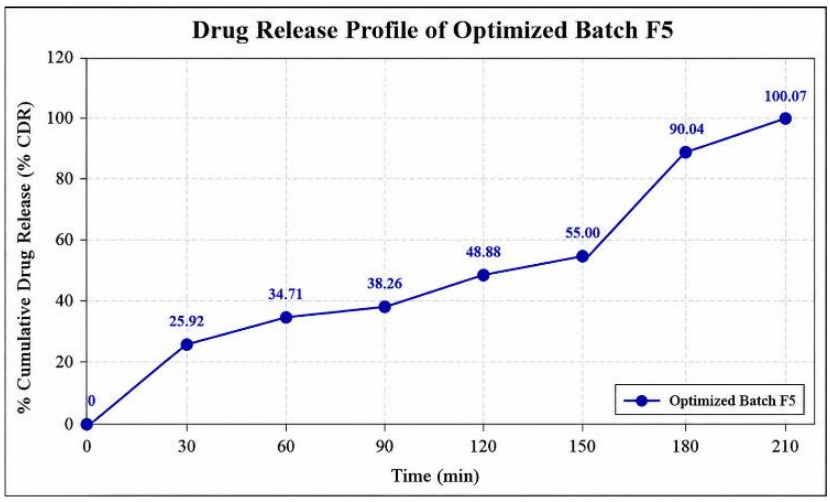

Fig no-9 : Drug release profile of Optimized batch F5

In Vivo Study

In vivo studies were conducted using experimental rats to evaluate the anti-inflammatory and wound healing activity of the herbal emulgel formulation. Before initiating the experiment, hair from the interscapular region was carefully removed using a razor blade.

Inflammation and wound conditions were induced through intradermal injection, resulting in symptoms such as edema, itching, erythema, inflammatory cell infiltration, and delayed wound healing. The prepared herbal emulgel formulations were applied topically once daily for seven days according to the treatment groups.

Group I served as the normal control, Group II served as disease control, and Group III received the test herbal emulgel formulation.

Table 16. In Vivo Study of Herbal Emulgel

Group	Treatment Group	Treatment	Duration	Observation
I	Normal Control	No treatment	7 Days	Normal skin without inflammation
II	Disease Control	Induced inflammation	7 Days	Severe edema and delayed wound healing
III	Test Emulgel	Herbal emulgel	7 Days	Significant reduction in inflammation and improved wound healing

The results confirmed that the herbal emulgel formulation effectively reduced inflammation, itching, edema, and tissue damage.

Histopathological Study

Histopathological analysis was performed to evaluate tissue architecture and inflammatory changes in treated skin samples.

Table 17. Histopathological Observations

Group	Histopathological Findings
Group I	Normal epidermal and dermal architecture
Group II	Severe inflammatory infiltration and tissue damage
Group III	Reduced inflammation and improved epithelial regeneration

Electron Microscopic Observation

Electron microscopic analysis was conducted to study cellular morphology and tissue organization.

Table 18. Electron Microscopic Observations

Group	Observation
Group I	Normal cellular morphology
Group II	Damaged tissue structure and inflammatory infiltration
Group III	Improved cellular organization and reduced inflammation

Stability Study

The optimized emulgel formulation (Batch F5) was packed in borosilicate glass containers and subjected to accelerated stability studies at 40°C/75% RH for two months.

The formulations were evaluated for pH, viscosity, spreadability, and drug release profile before and after stability testing.

Table 19. Evaluation Parameters Before and After Stability Study

Sr. No.	Parameter	Before Stability	After Stability
1	pH	5.80	5.81
2	Viscosity	3890 CPS	3922 CPS
3	Spreadability	Easily Spreadable	Easily Spreadable

Table 20. Two-Month Stability Study of Batch F5

Sr. No.	Time (min)	0 Day % CDR	1 Month % CDR	2 Month % CDR
1	0	0	0	0
2	30	25.92	22.20	23.17
3	60	34.71	36.20	35.89
4	90	38.26	44.20	42.88
5	120	48.88	49.20	47.88
6	150	55.00	58.26	57.29
7	180	90.04	92.04	86.22
8	210	100.07	99.85	99.03

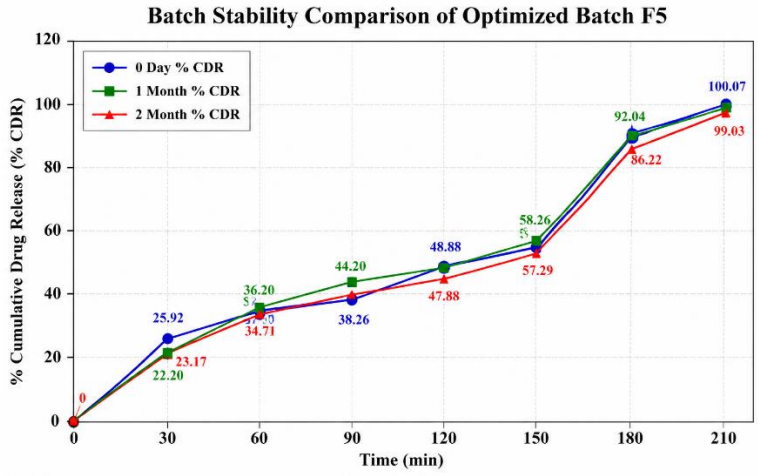

Fig no-10 : Batch Stability comparison

The stability study results indicated that the optimized herbal emulgel formulation remained stable throughout the study period without significant changes in physicochemical properties or drug release profile.

SUMMARY AND CONCLUSION:

The present study was carried out to formulate and evaluate a herbal emulgel containing Rubia cordifolia and Millettia pinnata for topical anti-inflammatory and wound healing activity. Analytical characterization using UV spectrophotometry and FTIR confirmed the identity, purity, and compatibility of the herbal drugs with formulation excipients. Different emulgel formulations were prepared using suitable gelling agents and evaluated for physicochemical parameters such as appearance, pH, spreadability, viscosity, homogeneity, and in vitro drug diffusion. All formulations showed satisfactory physical characteristics and skin-compatible pH. Among the prepared batches, formulation F5 exhibited the highest cumulative drug release and superior diffusion profile. In vivo studies demonstrated significant reduction in inflammation, edema, itching, and tissue damage, confirming effective wound healing activity. Histopathological studies also supported the therapeutic effectiveness of the formulation. Overall, the developed herbal emulgel proved to be a stable, safe, effective, and patient-friendly topical drug delivery system for managing inflammatory and wound healing conditions.

FUTURE PROSPECTUS

Future research may focus on improving the stability, spreadability, and therapeutic effectiveness of the herbal emulgel using advanced polymers and penetration enhancers. Development of sustained release systems, nanoemulgels, liposomal emulgels, and nanoparticle-based formulations may further enhance drug delivery and bioavailability. Additional preclinical and large-scale clinical studies are required to confirm safety, efficacy, and patient acceptability. Combination of Rubia cordifolia and Millettia pinnata with other medicinal herbs may provide synergistic therapeutic effects. Future industrial-scale manufacturing, quality control optimization, and comparative studies with

marketed formulations may support commercialization of the herbal emulgel as an economical and effective topical therapy.

REFERENCES:

1. Gupta G. D. Resent advancs in Topical Drug Delivary System, Indo American Journal of pharmaceutical research, 2016:6 page no. 6353-6369.
2. Joshi. B, Singh G, Rana AC, Saini S, Single V. emulgel: a compressive review on the resent advances in a topical drug delivary. International research journal of pharmacy 2011:2(11) p.n. 66-70
3. Dadwal M. Emulgel:A novel approach to topical drug delivery. IntJ Pharm Bio Sci. 2013; 4(1):847-56
4. Ajazuddin, Alexander A, Khichariya A, Gupta S, Patel RJ, Giri TK et al. Recent expansions in an emergent novel drug delivery technology: Emulgel. J Control Release, 2013; 171: 122-32.\
5. Vats S, Saxena C, Easwari T, Shukla V. Emulsion based gel technique: Novel approach for enhancing topical drug delivery of hydrophobic drugs. Int J Pharm Sci Res 2014;3:2277-7873.
6. Yadav S, Mishra M, Tiwari A, Shukla A. Emulgel: A novel approach for enhanced topical drug delivery. Int J Curr Pharm Res 2017;9:15-9.
7. More S, Nandgude T, Poddar S. Vesicles as a tool for enhanced topical drug delivery. Asian J Pharm 2016;10:S196-209.
8. Pant S, Badola A, Baluni S, Pant W. A review on emulgel novel approach for topical drug delivery system. World J Pharm Pharm Sci 2015;4:1728-43.
9. Sonaje S, Gondkar S, Saudagar R. Gellified emulsion: A new born formulation for topical delivery of hydrophobic drugs. World J Pharm Pharm Sci 2013:3:233-51.
10. Rieger M M, Lachman L, Liberman H A, Kanig J L .the theory and practice of industrial pharmacy. 3rd ed. Philadelphia P A:Lea and Febiger 1986 p. no. 502-533
11. Kuller R, Saini S, Seth N, Rana AC. Emulgel: A surrogate approach for topical used hydrophobic drugs. Int J Pharm Sci 2011;1:117-28.
12. Patil SS, Patil PA, Rane SS. Emulgel: a promising dual release system for topical drug delivery. Pharm Nanotechnol. 2023;11(3):191-200.
13. Prajapati A, Mehta M, Shah S. Indomethacin and Azadirachta indica emulgel: synergistic analgesic, anti-inflammatory effects. Indian J Pharm Sci. 2023;85(4):729-38.
14. George E, Thomas S, Mathew J. Formulation and evaluation of neem oil emulgel for anti-dandruff activity. Int J Pharm Investig. 2023;13(1):48-56.