Development and Evaluation of Fluocinolone Acetonide-Loaded Transferosomal Gel for Enhanced Topical Management of Psoriasis

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Abstract

Psoriasis is a persistent inflammatory skin disease characterized by abnormal keratinocyte proliferation, epidermal thickening, and immune system dysregulation. Although topical corticosteroids remain the cornerstone of treatment, their clinical effectiveness is frequently limited by inadequate skin penetration and poor drug retention at the target site. The present study aimed to develop and evaluate a transferosomal gel containing Fluocinolone Acetonide (FA) for improved topical delivery in psoriasis therapy**[4].**

Transferosomes were prepared using the thin-film hydration technique with phospholipids, cholesterol, and edge activators at different concentrations. The prepared vesicles were assessed for particle size, polydispersity index (PDI), zeta potential, drug entrapment efficiency, and morphological characteristics. The optimized transferosomal dispersion was subsequently incorporated into a Carbopol-based gel and subjected to physicochemical evaluation, including pH, viscosity, spreadability, drug content, and in vitro release studies**[37].**

Among all formulations, FAT6 demonstrated superior performance with a vesicle size of 134.1 ± 2.4 nm, PDI of 0.284 ± 0.04, zeta potential of −33.7 mV, and entrapment efficiency of 89.7 ± 1.1%. The transferosomal gel exhibited satisfactory rheological behavior, uniform drug distribution, and prolonged drug release reaching 93.01% over 12 hours. Release kinetics analysis indicated first-order drug release with a high correlation coefficient ($R^2 = 0.9837$).

The findings suggest that transferosome-mediated delivery significantly enhances the topical performance of Fluocinolone Acetonide and may represent a promising strategy for the effective management of psoriasis while minimizing systemic exposure and treatment-related adverse effects**[36].**

Keywords: Psoriasis, Fluocinolone Acetonide, Transferosomes, Nanovesicular Drug Delivery, Topical Gel, Controlled Drug Release.

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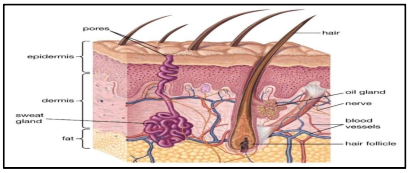
1. Introduction

1.1 Overview of Skin and Topical Drug Delivery

The skin is the largest organ of the human body and serves as a protective barrier against environmental insults, pathogens, chemical substances, and excessive water loss. Structurally, it consists of three primary layers: the epidermis, dermis, and hypodermis. Among these, the outermost layer of the epidermis, known as the stratum corneum, acts as the principal barrier limiting the penetration of therapeutic agents**[36].**

Topical drug delivery systems have gained considerable attention because they allow localized treatment while avoiding extensive systemic exposure. However, effective delivery through the skin remains challenging due to the highly organized lipid structure of the stratum corneum, which restricts drug permeation. Consequently, advanced carrier systems have been investigated to overcome these limitations and improve therapeutic outcomes**[38].**

Fig. 1.1: Structure of Skin.



2 Psoriasis: A Chronic Inflammatory Skin Disorder

Psoriasis is a long-term immune-mediated dermatological condition affecting approximately 2–3% of the global population. The disease is characterized by erythematous plaques covered with silvery scales, resulting from excessive proliferation and abnormal differentiation of keratinocytes. Genetic susceptibility, immune dysfunction, and environmental triggers contribute significantly to disease onset and progression**[4].**

Several clinical variants of psoriasis have been identified, including plaque psoriasis, guttate psoriasis, pustular psoriasis, inverse psoriasis, and erythrodermic psoriasis. Plaque psoriasis is the most prevalent form and is characterized by sharply demarcated inflamed lesions commonly occurring on the elbows, knees, scalp, and lower back**[25].**

The pathogenesis of psoriasis involves complex interactions between dendritic cells, T lymphocytes, cytokines, and keratinocytes. Cytokines such as tumor necrosis factor-alpha (TNF-α), interleukin-17 (IL-17), and interleukin-23 (IL-23) play crucial roles in sustaining chronic inflammation and epidermal hyperproliferation**[11].**

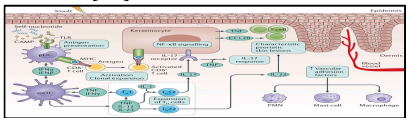


Fig. 1.2: Pathophysiology of psoriasis

1.3 Current Therapeutic Approaches

Management of psoriasis depends on disease severity and patient-specific factors. Available therapeutic options include topical agents, phototherapy, systemic medications, and biological therapies. Topical corticosteroids remain the first-line treatment for mild to moderate psoriasis because of their potent anti-inflammatory, antiproliferative, and immunosuppressive properties**[31].**

Despite their clinical effectiveness, conventional topical corticosteroid formulations often exhibit limited penetration through the skin barrier. Repeated administration is generally required to maintain therapeutic drug levels, which may increase the risk of local adverse effects such as skin atrophy, irritation, telangiectasia, and pigmentation changes**[33].**

These limitations highlight the need for innovative delivery systems capable of improving drug deposition within diseased skin while reducing systemic absorption and treatment-related toxicity[**36].**

1.4 Fluocinolone Acetonide

Fluocinolone Acetonide is a synthetic fluorinated corticosteroid widely used for the treatment of inflammatory skin disorders, including psoriasis, eczema, dermatitis, and allergic skin reactions. The drug exerts its pharmacological activity by inhibiting inflammatory mediators, suppressing cytokine production, and reducing leukocyte migration to affected tissues**[46].**

Although Fluocinolone Acetonide demonstrates excellent anti-inflammatory efficacy, its therapeutic performance following topical administration is often restricted by poor penetration across the stratum corneum. Therefore, formulation strategies aimed at enhancing dermal delivery are essential for maximizing clinical benefits**[47].**

1.5 Transferosomes as Advanced Drug Delivery Systems

Transferosomes are highly deformable lipid vesicles composed primarily of phospholipids and edge activators. Unlike conventional liposomes, transferosomes possess remarkable elasticity, enabling them to squeeze through intercellular pores that are significantly smaller than their own diameter**[37].**

The unique flexibility of transferosomes facilitates deeper skin penetration and improved localization of encapsulated drugs within target tissues. Additional advantages include enhanced drug entrapment, sustained release behavior, improved stability, and reduced systemic exposure**[36].**

Recent studies have demonstrated the effectiveness of transferosomal systems in delivering corticosteroids, antifungal agents, anti-inflammatory drugs, and other therapeutic compounds across the skin barrier. These findings support the application of transferosomal technology for improving psoriasis treatment**[48].**

1.6 Rationale of the Study

Conventional Fluocinolone Acetonide formulations face significant challenges related to inadequate skin permeation and insufficient drug retention. Transferosomal carriers offer an attractive solution by enhancing penetration through the stratum corneum while providing sustained release and improved drug localization.

Therefore, the present investigation was undertaken to formulate and evaluate a Fluocinolone Acetonide-loaded transferosomal gel with the objective of enhancing topical delivery, prolonging therapeutic action, and improving overall treatment effectiveness in psoriasis management**[52].**

2. Literature Review

2.1 Psoriasis and Challenges in Topical Therapy

Psoriasis is a chronic inflammatory skin disorder characterized by epidermal hyperproliferation, abnormal keratinocyte differentiation, and immune-mediated inflammation. The disease affects approximately 2–3% of the global population and significantly impairs patients' quality of life. Although the exact etiology remains complex, genetic predisposition, environmental triggers, and immune dysregulation are recognized as major contributing factors**[2].**

Topical corticosteroids continue to be the primary therapeutic option for mild-to-moderate psoriasis due to their anti-inflammatory and immunosuppressive properties. However, conventional topical formulations frequently suffer from poor skin penetration, inadequate drug retention, and the need for repeated application. Long-term use may also lead to adverse effects such as skin atrophy, irritation, telangiectasia, and hypothalamic-pituitary-adrenal axis suppression. These limitations have prompted researchers to explore advanced carrier systems capable of improving drug delivery and therapeutic efficacy**[33].**

Nanotechnology-based drug delivery systems have emerged as promising approaches to overcome the skin barrier and enhance the bioavailability of topical agents. Among these systems, transferosomes have attracted considerable attention because of their exceptional deformability and superior penetration capabilities**[12].**

2.2 Nanocarrier-Based Drug Delivery Systems

Recent advancements in pharmaceutical technology have led to the development of various nanocarrier systems designed to improve drug delivery through biological barriers. Nanocarriers offer several advantages, including enhanced drug solubility, prolonged drug release, improved stability, targeted delivery, and reduced systemic toxicity**[12].**

Commonly investigated nanocarrier systems include:

2.2.1 Liposomes

Liposomes are spherical vesicles composed of phospholipid bilayers enclosing an aqueous core. They can encapsulate both hydrophilic and lipophilic drugs and have been widely studied for topical and transdermal delivery applications. Despite their advantages, conventional liposomes often exhibit limited penetration through the stratum corneum due to their rigid bilayer structure**[61].**

2.2.2 Niosomes

Niosomes are vesicular systems prepared from nonionic surfactants and cholesterol. These carriers improve drug stability and skin retention while offering cost advantages over liposomes. Several studies have demonstrated enhanced topical delivery of corticosteroids using niosomal formulations**[36].**

2.2.3 Ethosomes

Ethosomes are lipid vesicles containing a high concentration of ethanol. The presence of ethanol disrupts the lipid organization of the skin, thereby improving drug permeation. Ethosomal formulations have shown promising results in enhancing the dermal delivery of anti-inflammatory and antifungal agents**[62].**

2.2.4 Nanostructured Lipid Carriers (NLCs)

Nanostructured lipid carriers consist of a blend of solid and liquid lipids. These systems exhibit high drug loading capacity, controlled release properties, and excellent biocompatibility. NLCs have been extensively explored for topical treatment of inflammatory skin disorders, including psoriasis**[50].**

Among all vesicular carriers, transferosomes have gained particular attention due to their ability to penetrate deep skin layers without compromising skin integrity**[37].**

2.3 Transferosomes: Concept and Mechanism

Transferosomes are highly deformable lipid vesicles composed of phospholipids and edge activators such as Tween 80, Span 80, or sodium cholate. The inclusion of edge activators destabilizes the lipid bilayer, increasing membrane flexibility and allowing the vesicles to deform significantly under stress**[37].**

The term "transferosome" was introduced by Civiand Blume, who described these carriers as self-optimizing and ultra-flexible vesicles capable of crossing narrow pores much smaller than their own diameter**[36].**

The mechanism of transferosomal penetration involves:

- Hydration gradient-driven transport.
- Vesicle deformation through intercellular skin channels.
- Enhanced interaction with epidermal lipids.
- Deep penetration into viable epidermis and dermis.

Unlike conventional liposomes, transferosomes maintain their structural integrity while passing through the stratum corneum, enabling efficient delivery of both hydrophilic and lipophilic therapeutic agents.

2.4 Advantages of Transferosomal Drug Delivery

Transferosomes offer numerous advantages over conventional topical formulations and other vesicular systems:

Enhanced Skin Penetration
The ultra-deformable nature of transferosomes allows efficient movement through the skin barrier, resulting in improved drug permeation and localization**[37].**

Improved Drug Entrapment
Transferosomes can encapsulate a substantial amount of active pharmaceutical ingredient, improving therapeutic efficiency and reducing dosing frequency**[48].**
Sustained Drug Release
The vesicular structure enables gradual drug release, maintaining therapeutic concentrations over extended periods**[52].**
Reduced Systemic Side Effects
By enhancing localized drug delivery, transferosomes minimize systemic absorption and associated adverse effects**[52].**
Better Patient Compliance
Reduced application frequency and improved efficacy contribute to increased patient adherence to therapy.
Because of these advantages, transferosomes have become an attractive platform for delivering corticosteroids in psoriasis treatment**[50].**

2.5 Fluocinolone Acetonide in Dermatological Therapy

Fluocinolone Acetonide (FA) is a synthetic fluorinated corticosteroid with potent anti-inflammatory, antipruritic, and vasoconstrictive properties**[46].** It is widely prescribed for various inflammatory skin disorders, including:

- Psoriasis
- Eczema
- Atopic dermatitis
- Seborrheic dermatitis
- Allergic skin reactions

The therapeutic action of FA is primarily mediated through inhibition of inflammatory mediators and suppression of cytokine release. The drug reduces capillary permeability, leukocyte infiltration, and epidermal hyperproliferation associated with psoriatic lesions**[47].**

Despite its effectiveness, topical administration of FA is often associated with limited penetration through the stratum corneum, resulting in reduced bioavailability at the target site. Consequently, advanced delivery systems are required to optimize its therapeutic potential**[54].**

Transferosomal encapsulation has emerged as an effective strategy for improving the penetration and retention of FA within deeper skin layers**[48].**

2.6 Previous Research on Transferosomal Corticosteroid Delivery
Several investigators have reported successful incorporation of corticosteroids into transferosomal systems.

Gupta and co-workers developed nanogel-based systems for topical psoriasis treatment and demonstrated improved drug penetration and prolonged retention compared with conventional formulations. Their findings suggested enhanced anti-psoriatic activity due to controlled drug release characteristics**[48].**

ELhabal and colleagues formulated polyethylene glycol-decorated hyalurosomes containing corticosteroids for transdermal delivery. Their study reported enhanced skin permeation, improved stability, and increased therapeutic efficiency**[49].**

Raza and co-workers prepared nanostructured lipid carriers loaded with anti-psoriatic agents. The developed formulations showed significant enhancement in drug deposition within the skin and sustained release behavior**[50].**

Pradhan et al. investigated nanocarrier-mediated corticosteroid delivery systems and reported improved topical bioavailability along with reduced systemic exposure**[52].**

Collectively, these studies support the concept that vesicular and nanocarrier systems can significantly improve the therapeutic effectiveness of corticosteroids used in psoriasis treatment.

2.7 Transferosomal Gels for Topical Application

Although transferosomal dispersions exhibit excellent penetration properties, their direct application may be inconvenient due to low viscosity and limited residence time on the skin surface**[39].**

To address these limitations, transferosomal dispersions are frequently incorporated into gel bases such as Carbopol, HPMC, or xanthan gum. Transferosomal gels combine the penetration-enhancing capability of transferosomes with the favourable application characteristics of gels**[41].** Benefits of transferosomal gels include:

- Increased contact time with skin
- Enhanced patient acceptability
- Improved spreadability
- Better formulation stability
- Sustained drug release
- Convenient topical administration

Carbopol-based gels are particularly popular because they provide suitable viscosity, transparency, and compatibility with vesicular system**[42].**

2.8 Research Gap and Need for the Present Study

Although several nanocarrier systems have been investigated for psoriasis management, limited studies have focused on the development of Fluocinolone Acetonide-loaded transferosomal gels with optimized physicochemical characteristics and sustained release properties**[52].**

Most conventional FA formulations continue to face challenges related to inadequate penetration and short duration of action. Furthermore, prolonged corticosteroid therapy may increase the likelihood of adverse effects and poor patient compliance.

The present study was therefore designed to develop and optimize a transferosomal gel containing Fluocinolone Acetonide to overcome these limitations. By utilizing ultra-deformable vesicular carriers and a suitable gel base, the formulation aims to improve drug penetration, enhance skin retention, provide controlled release, and ultimately improve therapeutic outcomes in psoriasis management**[37].**

Summary of Literature Review

The reviewed literature demonstrates that transferosomal technology represents a promising strategy for enhancing topical drug delivery. Previous studies have established the advantages of vesicular nanocarriers in improving skin penetration, drug retention, and therapeutic efficacy. Fluocinolone Acetonide remains a highly effective corticosteroid for psoriasis treatment, but its clinical performance can be further improved through advanced delivery systems. Based on the available evidence, the development of a Fluocinolone Acetonide-loaded transferosomal gel offers a scientifically justified and therapeutically relevant approach for effective psoriasis management**[48].**

3. Materials and Methods /

3.1 Materials

Fluocinolone Acetonide, soya lecithin, cholesterol, Span 80, Carbopol 934P, methanol, chloroform, phosphate buffer pH 7.4, and triethanolamine were used. All chemicals were of analytical grade.

3.2 Preformulation Studies

The drug was evaluated for:

- Physical appearance
- Melting point
- Solubility
- UV spectroscopic analysis
- Drug–excipient compatibility using FTIR

3.3 Preparation of Transferosomes

Fluocinolone Acetonide-loaded transferosomes were prepared by the thin-film hydration method. Lipids and drug were dissolved in chloroform:methanol, followed by solvent evaporation to form a thin lipid film. The film was hydrated with phosphate buffer and sonicated to obtain nanosized vesicles.

3.4 Characterization of Transferosomes

The prepared transferosomes were evaluated for:

- Vesicle size
- Polydispersity Index (PDI)
- Zeta potential
  - Entrapment efficiency
  - Transmission electron microscopy(TEM) **[61].**

3.5 Preparation of Transferosomal Gel

The optimized transferosomal dispersion was incorporated into a Carbopol 934P gel base and neutralized with triethanolamine to obtain a homogeneous gel**[64].**

3.6 Evaluation of Transferosomal Gel

The gel was evaluated for:

- Physical appearance
- pH
- Viscosity
- Spreadability
- Drug content
- Extrudability

3.7 In Vitro Drug Release Study

Drug release was studied using a Franz diffusion cell with phosphate buffer pH 7.4 as the receptor medium. Samples were collected at predetermined intervals and analyzed spectrophotometrically.

3.8 Release Kinetics

Release data were fitted to:

- Zero-order model
- First-order model
- Higuchi model
- Korsmeyer–Peppas model

3.9 Stability Studies

The optimized formulation was stored under accelerated conditions and evaluated periodically for physical appearance, pH, drug content, and drug release behavior.

4. Results and Discussion

4.1 Preformulation Studies

5.1.1 Organoleptic Properties

Observations:

- Fluocinolone acetonide was found to be a solid crystalline powder.
- The drug appeared white to off-white in colour.
- It was practically odorless. Fluocinolone acetonide as shown in **Fig. 5.1**

Table 5.1: Organoleptic Properties of Fluocinolone Acetonide

S.No.	Parameter	Result
1.	Physical form	Solid crystalline powder
2.	Colour	White to off-white
3.	Odor	Practically odorless
4.	Taste	Slightly bitter

5.1.2 Melting Point Analysis

Observations:

- **Melting point of Fluocinolone acetonide was determined using the capillary method.**
- **Triplicate readings were recorded for accuracy.**
- **The mean melting point was found to be 267°C.**
- **The observed value was in close agreement with the reported range (265–270°C).**

Table 5.2: Melting Point Analysis of Fluocinolone Acetonide

Observed Melting Point				Reported Melting Point
MP1 °C	MP2 °C	MP3 °C	Mean °C	
268	266	267	267	265-270 °C

5.1.3 Solubility Study

Observations:

- **Solubility study was performed in different aqueous and organic solvents.**
- **Fluocinolone acetonide showed poor aqueous solubility, confirming its hydrophobic nature.**
- **Very low solubility in water and phosphate buffer pH 7.4.**
- **High solubility observed in organic solvents, especially DMSO.**
- **Order of solubility: DMSO > Methanol > Ethanol > Propylene glycol > Phosphate buffer > Water. Table 5.3 and Fig. 5.2 represent the Solubility of Fluocinolone acetonide in different solvents.**

S. No.	Solvent	Solubility
1	Water	0.02 mg/mL
2	Ethanol	25 mg/mL
3	Methanol	32 mg/mL
4	DMSO	65 mg/mL
5	Propylene glycol	8 mg/mL
6	Phosphate	0.15 mg/mL

buffer pH 7.4	

Table 5.3: Solubility of Fluocinolone acetonide in different solvents.

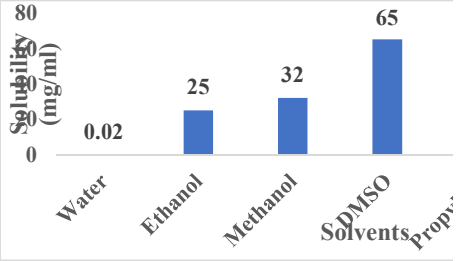


Figure. 5.2: Graph of Solubility of Fluocinolone acetonide in different solvents.

5.1.4 Preparation of Calibration Curve and Determination of λmax

- **The λmax of fluocinolone acetonide was found using a UV–Visible spectrophotometer.**
- **A stock solution (1 mg/mL) was prepared in phosphate buffer saline (PBS, pH 7.4). From this, different dilutions were made in the range of 2–10µg/mL.**
- **Each solution was scanned in the range of 200–400 nm, and the maximum absorbance was observed at: λmax = 238 nm**
    - **The absorbance of all solutions was measured at 238 nm**

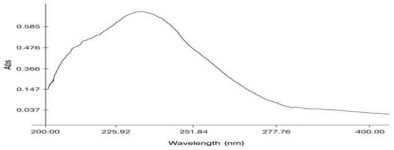


Figure 5.3: UV Absorption spectra of Fluocinolone acetonide in PBS (PH 7.4) with absorption maximum at 238 nm.

Concentration (µg/ml)	Absorbance
0	0
2	0.112
4	0.234
6	0.352
8	0.472
10	0.562

Table 5.4: Calibration curve data of Fluocinolone acetonide in PBS in PH 7.4 at 238 nm.

Figure. 5.4: Linearity curve of Fluocinolone acetonide in PBS in PH 7.4 at 238 nm.

5.1.5 FTIR Analysis

The FTIR spectrum of pure fluocinolone acetonide was recorded to confirm the presence of different functional groups and to verify the structural integrity of the drug.

Observation of FTIR Spectrum

- **The FTIR spectrum showed several characteristic absorption bands corresponding to functional groups present in fluocinolone acetonide.**
- **These peaks confirm that the drug structure remains unchanged and pure.**
- **The spectrum also helps in identifying key chemical bonds present in the compound.**

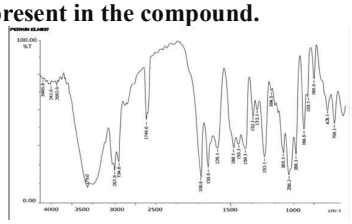


Figure. 5.5: FTIR Spectrum of Fluocinolone acetonide.

5.2 Evaluation of Fluocinolone acetonide loaded Transferosomes

5.2.1 Particle size analysis and polydispersity index

- **Particle Size Analysis**
- **Objective**

To determine the vesicle size of transferosomal formulations (FAT1–FAT8) and evaluate their suitability for drug delivery.

- **Results of Particle Size**

- **Particle Size distribution observed: 134.1 ± 2.4 nm to 205.1 ± 2.3 nm**

Formulation Batch	Vesicle Size (nm)
FAT1	155.8 ± 1.2
FAT2	159.4 ± 1.3
FAT3	162.7 ± 1.1
FAT4	192.3 ± 2.0
FAT5	157.6 ± 1.6
FAT6	134.1 ± 2.4
FAT7	163.8 ± 1.7
FAT8	205.1 ± 2.3

Table 5.5 Particle size analysis of Fluocinolone acetonide loaded Transferosomal (FAT1-FAT8)

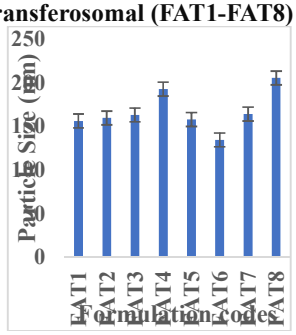


Figure. 5.6: Graph of Particle size analysis of Fluocinolone acetonide loaded Transferosomal (FAT1-FAT8)

- Polydispersity Index (PDI)
  - **Objective**

To evaluate the uniformity and homogeneity of vesicle size distribution.

- **Results of PDI**
- **PDI range observed: 0.284 ± 0.04 to 0.588 ± 0.01**
- **Lower PDI indicates better uniformity and stability.**

Formulation Batch	PDI Value
FAT1	0.554 ± 0.01
FAT2	0.449 ± 0.03
FAT3	0.316 ± 0.04
FAT4	0.586 ± 0.05
FAT5	0.399 ± 0.02
FAT6	0.284 ± 0.04
FAT7	0.588 ± 0.01
FAT8	0.374 ± 0.02

Table 5.6. PDI analysis of Fluocinolone acetonide loaded Transferosomal

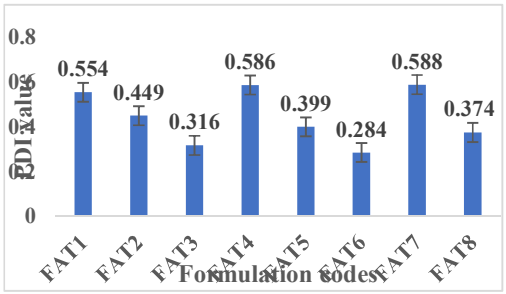


Figure. 5.7: Graph of PDI of Fluocinolone acetonide loaded Transferosomal (FAT1-FAT8)

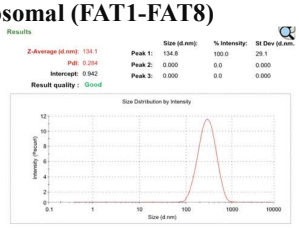


Fig. 5.8: Particle size and PDI value of Optimized Fluocinolone acetonide loaded Transferosomal (FAT6).

5.2.2 Zeta Potential

- **Objective**

To evaluate the surface charge and stability of fluocinolone

acetonide loaded transferosomal formulations (FAT1–FAT8).

- Results
- Zeta potential values ranged from: −15.5 ± 1.3 mV to −33.7 ± 1.7 mV
- All formulations showed negative charge

Formulation Batch	Zeta Potential (mV)
FAT1	−25.8 ± 1.1
FAT2	−15.8 ± 1.3
FAT3	−16.4 ± 1.4
FAT4	−19.9 ± 1.9
FAT5	−20.2 ± 1.8
FAT6	−33.7 ± 1.7
FAT7	−22.4 ± 1.4
FAT8	−15.5 ± 1.3

Table 5.7. Zeta potential analysis of Fluocinolone acetonide loaded Transferosomal (T1-T8)

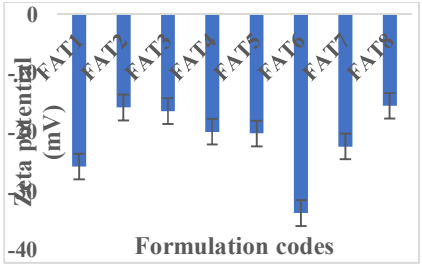


Figure. 5.9: Graph of PDI of Fluocinolone acetonide loaded Transferosomal (FAT1-FAT8)

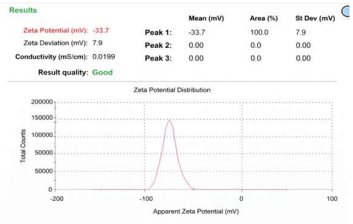


Figure. 5.10: Zeta Potential of Optimized Formulation FAT6.

- 5.2.3 Entrapment Efficiency (EE%)
  - Objective
  - To determine the drug loading capacity of fluocinolone acetonide in transferosomal formulations (FAT1–FAT8).
  - Results
  - Entrapment efficiency ranged from: 70.5 ± 1.1% to 89.7 ± 1.1%
  - Indicates good drug incorporation in vesicles

Formulation Batch	Entrapment Efficiency (%)
FAT1	70.5 ± 1.1
FAT2	75.6 ± 1.3
FAT3	88.4 ± 1.6
FAT4	80.9 ± 1.5
FAT5	85.2 ± 1.2
FAT6	89.7 ± 1.1
FAT7	79.1 ± 1.2
FAT8	76.8 ± 1.8

Table 5.8: EE (%) of Fluocinolone acetonide loaded Transferosomal

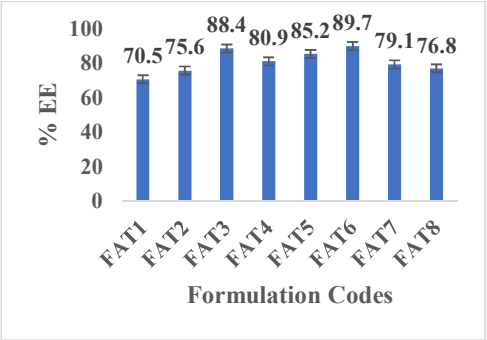


Figure. 5.11: EE (%) of Fluocinolone acetonide loaded Transferosomal (T1-T8).

- 5.2.4 Transmission Electron Microscopy (TEM)
  - Objective

To study the surface morphology of optimized transferosomal formulation (FAT6).

- Results
- TEM images showed uniform nanosized vesicles
- Vesicles had smooth and spherical structure
- No aggregation or irregular shapes observed

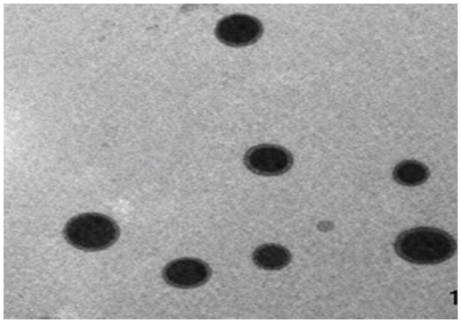


Figure. 5.12: Transmission Electron Microscopy of Fluocinolone acetonide loaded TransferosomalFAT6

5.3 Characterization of Fluocinolone acetonide loaded Transferosomal gel

Parameters	T1
Physical appearance	Turbid White
pH	6.5±0.123
Viscosity (cps)	6786
Drug content (%)	94
Extrudability	++
Spreadability	++
Washability	++ +

- **Where: Excellent: +++, Good: ++, Average: +, Poor: -**
- **Table 5.9: Results of Fluocinolone acetonide-loaded transferosomal gel.**

5.3.8 In Vitro Drug Release Study

- **Objective**

To evaluate the drug release behavior of fluocinolone acetonide from transferosomal suspension and gel.

Time (hours)	% Cumulative Drug Release – Fluocinolone acetonide -loaded Transferosomal Suspension	% Cumulative Drug Release – Fluocinolone acetonide -loaded Transferosomal Gel
0	0	0
0.5	8.45	4.08
1	15.72	8.10
1.5	22.68	12.34
2	30.14	17.65
3	45.32	32.80
4	58.67	48.78
6	72.85	62.30
8	88.94	84.30
10	94.65	90.12
12	98.12	93.01

Table 5.10: *In-vitro* drug delivery of Fluocinolone acetonide -loaded Transferosomal gel.

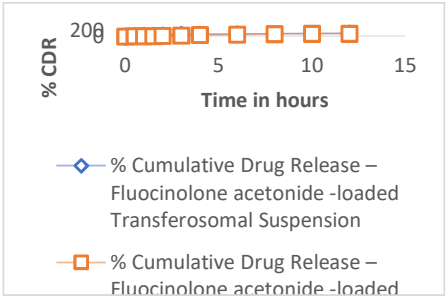


Figure. 5.12: In-vitro drug delivery outline of Fluocinolone acetonide -loaded Transferosomal gel and suspension.

5.4 *In-vitro* drug release kinetics studies

Formulation	Zero Order (R^2)	First Order (R^2)	Higuchi's (R^2)	Peppa's (R^2)	Best fitted model
Fluocinolone acetonide -loaded Transferosomal gel	0.9555	0.9837	0.9794	0.9827	First order model

Table 5.11: Model fitting to analyzed the kinetics of drug release and the mechanism of release from various formulations.

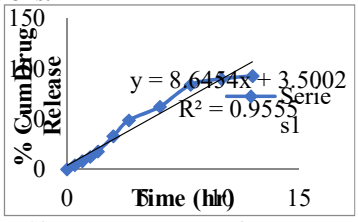


Figure. 5.13: Zero order plot for release kinetics of Fluocinolone acetonide -loaded Transferosomal gel.

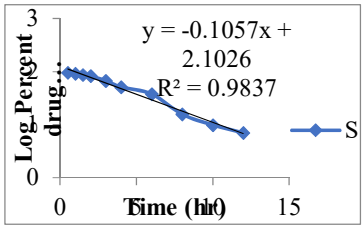


Figure. 5.14: First order plot for release kinetics of Fluocinolone acetonide -loaded Transferosomal gel.

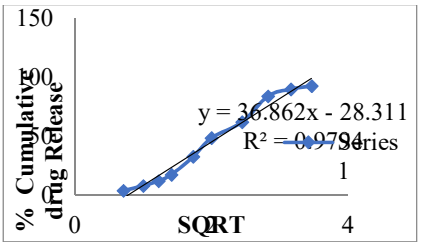


Figure. 5.15: Higuchi plot for release kinetics of Fluocinolone acetonide -loaded Transferosomal gel.

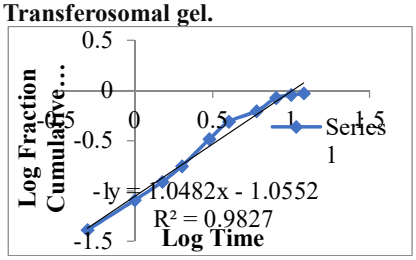


Figure. 5.16: Peppa's plot for release kinetics of Fluocinolone acetonide -loaded Transferosomal gel.

Conclusion

The present study successfully developed and evaluated a Fluocinolone Acetonide-loaded transferosomal gel for the topical treatment of psoriasis. Transferosomes were prepared using the thin-film hydration method and optimized based on vesicle size, polydispersity index, zeta potential, and drug entrapment efficiency. Among all formulations, FAT6 demonstrated superior performance with a vesicle size of 134.1 ± 2.4 nm, PDI of 0.284 ± 0.04, zeta potential of −33.7 mV, and entrapment efficiency of 89.7 ± 1.1%, indicating excellent stability and drug-loading capacity.

The optimized transferosomal dispersion was successfully incorporated into a Carbopol 934P gel and exhibited desirable physicochemical properties, including suitable pH, viscosity, spreadability, and uniform drug content. The formulation showed a sustained drug release profile with 93.01% cumulative release over 12 hours, following first-order release kinetics (R^2 = 0.9837). Stability studies further confirmed that the formulation remained physically and chemically stable under storage conditions.

Overall, the developed transferosomal gel enhanced the delivery potential of Fluocinolone Acetonide by improving drug encapsulation, stability, and controlled release characteristics.

The findings suggest that transferosomal technology represents a promising and effective approach for improving topical psoriasis therapy, offering the potential for enhanced therapeutic efficacy, prolonged drug action, reduced dosing frequency, and improved patient compliance. Future studies involving in vivo evaluation and clinical investigations may further establish its suitability for commercial pharmaceutical applications.

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