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Research Article

Formulation and Evaluation of Transferosomal Gel of Delgocitinib for Enhanced Transdermal Delivery

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ABSTRACT

The present study aimed to formulate and evaluate a transferosomal gel of Delgocitinib for enhanced transdermal delivery, improved drug entrapment, sustained drug release, and better physicochemical stability. Delgocitinib transferosomes were prepared by the thin-film hydration method using soya lecithin, cholesterol, and Span 80. Eight formulations (F1–F8) were developed by varying the lipid concentration and subsequently incorporated into Carbopol 934 gel. The prepared transferosomes were characterized for particle size, zeta potential, surface morphology (SEM), percentage yield, drug entrapment efficiency, pH, viscosity, spread ability, in vitro drug release, release kinetics, and stability according to ICH guidelines. The prepared transferosomes exhibited particle sizes ranging from 253 to 352 nm and zeta potential values between −24 and −36 mV, indicating nanosized, physically stable vesicles. SEM analysis confirmed the formation of spherical and uniformly distributed transferosomes. The percentage yield ranged from 78.57% to 91.25%, while drug entrapment efficiency varied from 72.59% to 90.25%. Among all formulations, F8 demonstrated the best performance with a particle size of 253 nm, 90.25% drug entrapment efficiency, 91.25% production yield, pH 5.9, viscosity 176 cps, and spread ability of 6.50 g·cm/sec. In vitro diffusion studies revealed sustained drug release over 12 hours, with formulation F8 exhibiting the highest cumulative drug release of 98.37%. Drug release kinetic analysis indicated that the optimized formulation followed the Higuchi diffusion model (R^2 = 0.989), suggesting diffusion-controlled release.

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Stability studies conducted for three months under accelerated conditions showed no significant changes in physicochemical properties or drug release, confirming good formulation stability. The developed Delgocitinib transferosomal gel successfully enhanced drug encapsulation, maintained nanosized stable vesicles, and provided sustained transdermal drug release. The optimized formulation (F8) demonstrated excellent physicochemical characteristics, high entrapment efficiency, superior drug release, and satisfactory stability.

INTRODUCTION

Transferosomal delivery offers several potential advantages over conventional vesicular systems. The flexible vesicles can improve drug deposition and permeation through the stratum corneum, while the lipidic structure can facilitate interaction with skin lipids and enhance drug transport.[1] In addition, transferosomes can protect the incorporated drug from environmental degradation and provide controlled or sustained release. These characteristics make transferosomes attractive carriers for topical and transdermal delivery of drugs intended for localized treatment of inflammatory and dermatological conditions.[2] Incorporation of transferosomes into a gel base can further improve their pharmaceutical and patient-related properties. A transferosomal gel combines the enhanced permeation characteristics of flexible vesicles with the ease of application, non-greasy nature, spreadability, and prolonged residence time associated with topical gels.[3] The gel matrix can also help maintain the formulation at the site of administration and facilitate uniform distribution of the vesicles over the skin surface. Thus, a transferosomal gel may provide improved drug release, skin permeation, and localized drug deposition compared with conventional topical formulations.[4] Delgocitinib is a pan-Janus kinase (JAK) inhibitor that inhibits multiple JAK-mediated signaling pathways involved in inflammatory and immune responses. By interfering with the JAK–STAT signaling pathway, delgocitinib can suppress the activity of several cytokines implicated in inflammatory skin diseases. The present research therefore focuses on the formulation and evaluation of a delgocitinib-loaded transferosomal gel as an advanced approach for enhanced transdermal delivery.[5] The optimized transferosomal formulation is subsequently incorporated into a suitable gel base and evaluated for physical appearance, pH, viscosity, spreadability, extrudability, drug content, in-vitro drug release, release kinetics, and skin permeation.[6] Stability studies are also performed to assess the physical and chemical stability of the optimized formulation. The developed system is expected to improve the delivery of delgocitinib across the skin and enhance its potential as an effective topical/transdermal formulation for the management of inflammatory skin disorders.[7]

MATERIALS

Delgocitinib was procured from Hetero Labs, Hyderabad. Soya lecithin and Cholesterol were obtained from Synpharma Research Labs, Hyderabad. Other chemicals and the reagents used were of analytical grade.

METHODOLOGY

Formulation development

Table None: 1: Formulation Table

Ingredients	F1	F2	F3	F4	F5	F6	F7	F8
Delgocitinib(mg)	50	50	50	50	50	50	50	50
Soya lecithin(mg)	100	200	300	400	500	600	700	800
Cholesterol(mg)	20	20	20	20	20	20	20	20
Span 80(mg)	10	10	10	10	10	10	10	10
Chloroform(ml)	10	10	10	10	10	10	10	10
Methanol(ml)	5	5	5	5	5	5	5	5

Preparation of Delgocitinib Transferosomes by Thin Film Hydration Method[8]

1. Preparation of Organic Phase

- Accurately weigh Delgocitinib (50 mg), soya lecithin, cholesterol, and Span 80 according to the formulation composition shown in Table-3.
- Transfer all the weighed ingredients into a clean, dry round-bottom flask.
- Add 10 mL of chloroform and 5 mL of methanol to dissolve the lipid components and the drug completely, producing a clear homogeneous solution.

2. **Formation of Thin Lipid Film**

- Attach the flask to a rotary vacuum evaporator.
- Evaporate the organic solvents at 40–45**°C** under reduced pressure at 80–100 rpm until a thin, uniform lipid film is deposited on the inner wall of the flask.
- Continue evaporation for an additional 15–20 minutes to ensure complete removal of residual solvents.

3. Hydration of Lipid Film

- Hydrate the dried lipid film with 10 mL of phosphate buffer (pH 7.4) preheated to approximately 40°C**.**
- Rotate the flask gently for 30–45 minutes to detach the lipid film and form multilamellar transferosomal vesicles.

4. Size Reduction

- Subject the resulting vesicular suspension to probe sonication or bath sonication for 10–15 minutes to reduce the vesicle size and obtain nanosized transferosomes.
- Alternatively, extrusion through polycarbonate membranes may be employed to achieve uniform vesicle size.

5. Maturation of Vesicles

- Store the prepared transferosomal dispersion at 4°C overnight (approximately 12–24 hours) to allow complete hydration and stabilization of the vesicles.

6. Collection and Storage

- The prepared Delgocitinib transferosomes are collected and stored in airtight amber-colored glass containers at 4°C until further characterization.

Incorporation into gel base (Carbopol gel)

Table None: 2: Formulation Development of Transferosomal Gel

Ingredients	F1	F2	F3	F4	F5	F6	F7	F8
Transferosomes (ml)	5	5	5	5	5	5	5	5
Carbopol 934 (mg)	100	200	300	400	500	600	700	800
Methyl paraben (ml)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Glycerine (ml)	1	1	1	1	1	1	1	1
Water	q. s	q. s	q. s	q. s	q. s	q. s	q. s	q. s

Preparation of Delgocitinib Transferosomal Gel[9]

The transferosomal gel containing Delgocitinib was prepared by incorporating the optimized transferosomal dispersion into a Carbopol 934 gel base. The required quantity of Carbopol 934 (100–800 mg, according to the formulation shown in Table 4) was slowly dispersed in an adequate quantity of distilled water with continuous stirring to prevent lump formation. The dispersion was allowed to hydrate and swell for 4–6 hours (preferably overnight) at room temperature until a clear, homogeneous gel base was obtained. Methyl paraben (0.01 mL) was dissolved in a small quantity of warm distilled water and added to the hydrated Carbopol gel as a preservative. Glycerine (1 mL) was then incorporated into the gel with continuous stirring to act as a humectant and improve the spreadability of the formulation. The required quantity of

optimized Delgocitinib transferosomal suspension (5 mL) was added slowly to the gel base with gentle stirring to ensure uniform distribution of the vesicles without causing their rupture. The pH of the gel was adjusted to 6.5–7.0 using a few drops of triethanolamine (TEA), which neutralized the Carbopol and converted the dispersion into a smooth gel. The final volume was made up with distilled water (q.s.), and the gel was stirred gently until a homogeneous, bubble-free preparation was obtained. The prepared transferosomal gels (F1–F8) were transferred into clean, airtight, light-resistant containers and stored at room temperature (25 ± 2°C) until further evaluation for physicochemical properties, drug content, viscosity, spreadability, pH, in vitro drug release, and stability studies.

CHARACTERIZATION

Particle Size Analysis

The mean particle size and polydispersity index (PDI) of the prepared Delgocitinib transferosomes were determined using Dynamic Light Scattering (DLS) with a Malvern Zetasizer (Nano ZS90 or equivalent). Before analysis, the transferosomal dispersion was diluted appropriately (about 1:100) with filtered distilled water to prevent multiple scattering effects. Approximately 1 mL of the diluted sample was transferred into a disposable polystyrene cuvette and analyzed at 25 ± 1°C with a scattering angle of 90°. [10]

Zeta Potential Analysis

The zeta potential of the transferosomes was measured using a Malvern Zetasizer based on electrophoretic light scattering to determine the surface charge and predict the physical stability of the vesicles. The transferosomal suspension was diluted with deionized water and transferred into a folded capillary zeta cell. Measurements were carried out at 25 ± 1°C, and each sample was analyzed in triplicate. The average zeta potential was expressed in millivolts (mV). Higher positive or negative zeta potential values (generally greater than ±30 mV) indicated better electrostatic stability of the transferosomal formulation.[11]

Scanning Electron Microscopy (SEM) Analysis

The surface morphology and shape of the optimized Delgocitinib transferosomes were examined using Scanning Electron Microscopy (SEM). A drop of the transferosomal dispersion was placed on a clean aluminum stub and allowed to dry under vacuum or at room temperature. The dried sample was then coated with a thin layer of gold or gold–palladium using a sputter coater to improve electrical conductivity. The coated sample was examined under the SEM at an appropriate accelerating voltage (typically 10–20 kV). Micrographs were captured at different magnifications to evaluate the morphology, surface characteristics, and vesicle integrity. The transferosomes were expected to appear spherical or nearly spherical with smooth surfaces, confirming successful vesicle formation.[12]

Drug Entrapment Efficiency (%EE)

The drug entrapment efficiency of the prepared Delgocitinib transferosomes was determined by the ultracentrifugation method. A known volume (1 mL) of the transferosomal suspension was transferred into centrifuge tubes and centrifuged at 15,000–20,000 rpm for 30–60 minutes at 4°C using a refrigerated ultracentrifuge. After centrifugation, the supernatant containing the unentrapped (free) drug was carefully separated. The concentration of free Delgocitinib in the supernatant was determined by UV–Visible spectrophotometry at the drug's λmax after suitable dilution with phosphate buffer (pH 7.4). The amount of drug entrapped within the transferosomes was calculated by subtracting the amount of free drug from the total amount of drug initially added.[13]

The percentage entrapment efficiency was calculated using the following equation:

%EE=Total drug/Total drug−Free drug×100

EVALUATION PARAMETERS OF TRANSFEROSOMAL GEL

Measurement of pH

The pH of the prepared transferosomal gel formulations was determined using a digital pH meter. Before measurement, the pH meter was calibrated using standard buffer solutions of pH 4.0, 7.0, and 9.2. Approximately 1 g of the gel was dispersed in 10 mL of distilled

water and allowed to stand for 30 minutes to obtain a uniform dispersion. The electrode of the pH meter was immersed into the gel dispersion, and the pH was recorded after the reading became stable. The measurements were performed in triplicate, and the average value was reported. The pH of the gel was maintained close to the physiological skin pH (5.5–7.0) to minimize the risk of skin irritation.[14]

Determination of Viscosity

The viscosity of the prepared transferosomal gel formulations was measured using a Brookfield Digital Viscometer equipped with a suitable spindle (e.g., Spindle No. 64). Approximately 50 g of the gel was transferred into the sample container, ensuring that no air bubbles were present. The spindle was immersed vertically into the gel, and the viscosity was measured at 25 ± 1°C using an appropriate rotational speed (generally 10 rpm). The reading was recorded after attaining equilibrium, and the viscosity was expressed in centipoise (cP). Each formulation was evaluated in triplicate, and the mean value was reported.[15]

Spreadability

The spreadability of the transferosomal gel was determined using the glass slide method. Approximately 0.5 g of gel was placed between two clean glass slides of equal dimensions. A weight of 500 g was placed on the upper slide for 5 minutes to obtain a uniform film of gel and remove entrapped air. Subsequently, a weight of 20 g was attached to the upper slide through a pulley, and the time required for the upper slide to move a distance of 7.5 cm was recorded.[16]

The spreadability was calculated using the following equation:

$S = m \times l/t$

where,

S= spread ability, m-weight tied to upper slides (1 g),

l- Length of the glass slide (7.5 cm), t- time taken in sec.

In Vitro Diffusion Profile

The in vitro diffusion study of the optimized Delgocitinib transferosomal gel was carried out using a Franz diffusion cell. dialysis membrane (previously soaked in phosphate buffer pH 7.4) was mounted between the donor and receptor compartments of the diffusion cell. The receptor compartment was filled with phosphate buffer (pH 7.4) and maintained at 37 ± 0.5°C with continuous magnetic stirring at approximately 100 rpm to simulate physiological conditions. A measured quantity of the transferosomal gel (equivalent to the required dose of Delgocitinib) was placed uniformly in the donor compartment. At predetermined time intervals (1, 2, 3, 4, 6, 8, 10, and 12 hours), 1 mL of the receptor medium was withdrawn and immediately replaced with an equal volume of fresh phosphate buffer maintained at the same temperature to maintain sink conditions. The collected samples were filtered, suitably diluted, and analyzed using a UV–Visible spectrophotometer at the λmax of Delgocitinib. The cumulative percentage drug diffused was calculated and plotted against time to obtain the in vitro diffusion profile. [17]

Drug release kinetics[18]

The models used were zero order (equation 1) First order (equation 2) and Higuchi model (equation 3) and Korsmeyer Peppas model (equation 4).

i) Zero order kinetics:

$R = Ko\ t$ -- (1)

R=cumulative percent drug

Ko=zero order rate constant

ii) First order kinetics

$\log C = \log Co - K_1\ t / 2.303$ -- (2)

where C = cumulative percent drug

K_1 = first order rate constant

iii) Higuchi model

$R = K_H\ t^{0.5}$ -- (3)

Where R = cumulative percent drug

K_H = higuchi model rate constant

iv) Korsmeyer peppas model:

$M\ t / M\ \alpha = K_k\ t^n$

$\log M\ t / M\ \alpha = \log K_k + n \log t$ -- (4)

where K_k = korsermeyer peppas rate constant

'M t / M α' is the fractional drug , n = diffusional exponent, which characterizes the mechanism of drug.

The obtained regression co-efficient (which neared 0.999) was used to understand the pattern of the drug from the Transferosomal gel.

Stability studies[19]

The stability study of the optimized Delgocitinib transferosomal gel formulation was carried out according to ICH Q1A (R2) guidelines to evaluate its physical and chemical stability during storage. The optimized formulation was packed in airtight, light-resistant containers and stored under the following conditions:

25 ± 2°C / 60 ± 5% RH (Room temperature)

40 ± 2°C / 75 ± 5% RH (Accelerated stability condition)

Any changes in colour, phase separation, consistency, or odor were visually observed. The results obtained at each interval were compared with the initial values to determine the stability of the formulation. The formulation was considered stable if no significant changes were observed in its physicochemical properties, drug content, vesicle characteristics, or drug release profile throughout the storage period. The stability data were expressed as the mean ± standard deviation of three determinations.

RESULTS AND DISCUSSION

Determination of Vesicle morphology and Size

Particle size Analysis

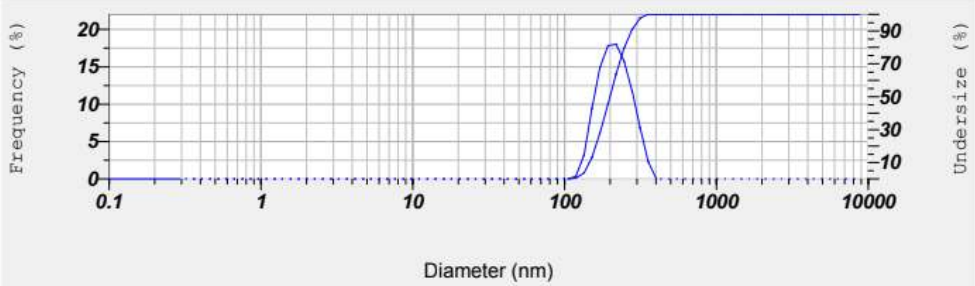

Figure None: 1: Particle Size Analysis of Transferosomes

SEM Analysis

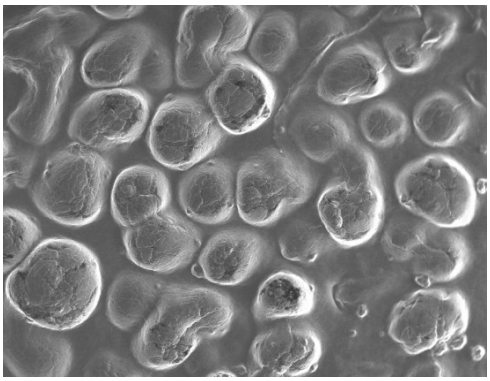

Figure None: 2: SEM Analysis of Transferosomes

Zeta potential

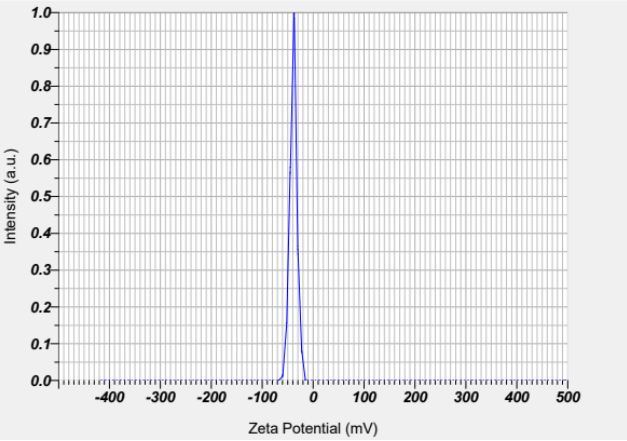

Figure None: 3: Zeta Potential of Transferosomes

Table None: 3: Evaluation Studies of Particle Size and Zeta Potential Transferosomes

F. No	Particle size (nm)	Zeta potential(mV)
F1	352	-25
F2	349	-32
F3	289	-31
F4	315	-29
F5	325	-28
F6	346	-32
F7	278	-36
F8	253	-24

DISCUSSION:

Vesicle Morphology and Particle Size

The particle size of transferosomes plays a significant role in determining vesicular stability, skin penetration, and drug delivery efficiency. The prepared Delgocitinib transferosomes exhibited particle sizes ranging from 253 to 352 nm, indicating successful preparation of nanosized vesicles. Formulation F8 showed the smallest particle size (253 nm), suggesting the formation of uniformly dispersed vesicles with improved flexibility. The reduction in particle size observed in F8 may be attributed to the optimized phospholipid-to-edge activator ratio, which promoted the formation of stable and compact vesicles. Smaller vesicles are advantageous for transdermal drug delivery because they can penetrate the stratum corneum more effectively, thereby enhancing drug permeation.

SEM Analysis

Scanning Electron Microscopy (SEM) demonstrated that the prepared transferosomes were predominantly spherical, smooth, and well-defined, with no evidence of aggregation or structural deformation. The vesicles exhibited uniform morphology, confirming successful formation by the thin-film hydration technique. The optimized formulation (F8) displayed intact vesicles with narrow size distribution, indicating good physical stability. The SEM findings were in agreement with the particle size analysis and confirmed the nanoscale characteristics of the transferosomal system.

Zeta Potential

The zeta potential values of the prepared formulations ranged from −24 to −36 mV. These negative values indicate good electrostatic repulsion between vesicles, thereby minimizing aggregation and improving dispersion stability. Formulation F7 exhibited the highest negative zeta potential (−36 mV), while F8 showed −24 mV, which still falls within the acceptable range for stable colloidal systems. The observed zeta potential values suggest that all formulations possessed adequate physical stability during storage and handling.

Yield of Transferosomes

Table None: 4: Yield of Transferosomes

F. No	Yield (%)
F1	82.49
F2	78.57
F3	83.56
F4	79.81
F5	81.25
F6	85.59
F7	86.90
F8	91.25

DISCUSSION:

Yield of Transferosomes

The percentage yield of the prepared transferosomes ranged from 78.57% to 91.25%. Among all formulations, F8 exhibited the highest yield (91.25%), indicating efficient utilization of formulation components and minimal processing loss during preparation. The high yield obtained for F8 reflects the suitability of the optimized formulation variables and confirms the reproducibility of the thin-film hydration method. Overall, all formulations demonstrated satisfactory production efficiency.

EVALUATION PARAMETERS:

P^H and Viscosity

Table None: 5: PH And Viscosity Values of All Formulations

F. code	pH	Viscosity (cps)
F1	6.1	163
F2	5.8	172
F3	6.3	169
F4	6.8	175
F5	6.4	165
F6	6.7	170
F7	6.5	168
F8	5.9	176

DISCUSSION:

The pH values of all transferosomal gel formulations ranged from 5.8 to 6.8, which are within the normal physiological pH of the skin. This indicates that the developed gels are unlikely to cause skin irritation and are suitable for topical application. Formulation F8 exhibited a pH of 5.9, closely matching the natural skin pH. The viscosity values ranged between 163 and 176 cps, indicating that all formulations possessed suitable consistency for topical administration. Formulation F8 showed the highest viscosity (176 cps), providing better residence time on the skin while maintaining acceptable spreadability. The optimized viscosity contributes to prolonged contact with the skin surface and sustained drug release.

Spread ability

Table None: 6: Spread Ability Values of All Formulations

F. code	Spread ability (g.cm/sec)
F1	5.63
F2	5.48
F3	5.67
F4	6.21
F5	6.32
F6	5.78
F7	5.55
F8	6.50

DISCUSSION

Spreadability is an important characteristic of topical gels, as it determines the ease of application and uniform distribution over the skin. The spreadability values ranged from 5.48 to 6.50 g·cm/sec. Formulation F8

exhibited the highest spreadability (6.50 g·cm/sec), indicating excellent ease of application. The optimized polymer concentration provided an ideal balance between viscosity and spreadability, allowing the gel to spread uniformly without excessive flow.

Entrapment Efficiency:

Table None: 7: Drug Entrapment Efficiency

F. code	Drug entrapment efficiency
F1	72.59
F2	81.59
F3	76.38
F4	75.52
F5	82.47
F6	86.36
F7	84.27
F8	90.25

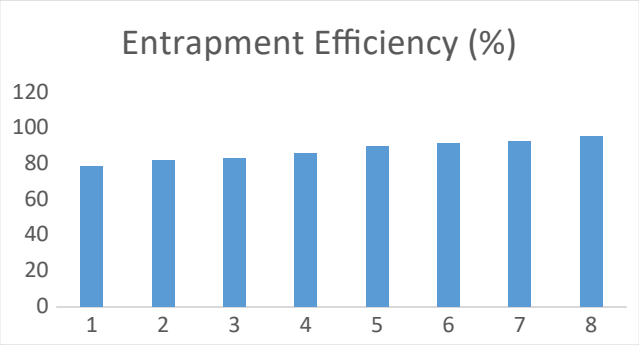

Figure None: 4: Drug Entrapment Efficiency of All Formulation

DISCUSSION:

Drug entrapment efficiency is an important parameter that reflects the capability of transferosomes to encapsulate Delgocitinib. The entrapment efficiency of all formulations ranged from 72.59% to 90.25%. Formulation F8 exhibited the highest entrapment efficiency (90.25%), indicating maximum incorporation of the drug within the phospholipid bilayer. The higher encapsulation efficiency may be attributed to the optimized lipid composition, which increased vesicle integrity and reduced drug leakage. High entrapment efficiency is beneficial for achieving sustained drug release and improved therapeutic efficacy.

***In vitro* release study:**

Table None: 8: *In vitro* Drug Release Profiles of Transferosomal Gel (F1-F8)

Time (hr)	F_1	F_2	F_3	F_4	F_5	F_6	F_7	F_8
0	0	0	0	0	0	0	0	0
1	17.59	18.20	18.45	17.68	18.20	16.87	19.58	20.19
2	26.35	22.59	25.79	24.76	25.67	27.85	28.47	32.58
3	45.59	41.57	43.36	46.98	48.80	49.81	47.83	48.91
4	55.36	53.36	54.79	56.87	58.76	57.84	59.87	58.87
6	61.55	60.28	62.38	63.59	65.35	66.83	68.43	69.82
8	72.30	73.59	75.81	76.98	77.85	78.19	76.80	79.83

Time (hr)	F_1	F_2	F_3	F_4	F_5	F_6	F_7	F_8
10	82.35	83.64	84.57	85.51	86.91	87.53	84.37	88.85
12	91.28	92.58	93.65	94.58	95.58	96.38	97.83	98.37

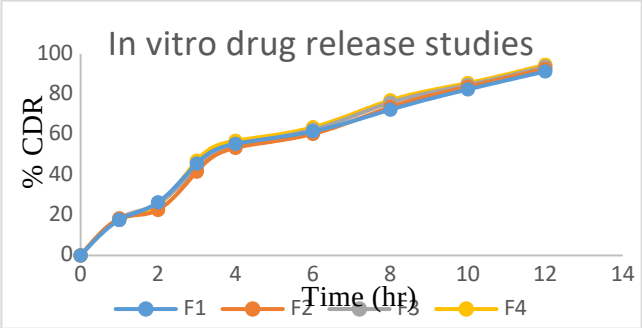

Figure None: 5: In Vitro Drug Release Studies of F1-F4 Formulations

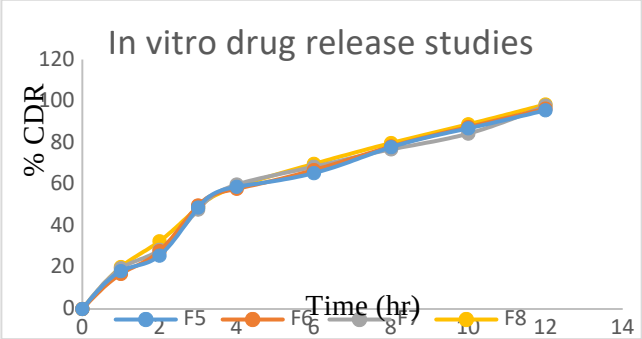

Figure None: 6: In Vitro Drug Release Studies of F5-F8 Formulations

DISCUSSION:

The in vitro drug release studies demonstrated sustained release of Delgocitinib from all transferosomal gel formulations over 12 hours. The cumulative drug release ranged from 91.28% (F1) to 98.37% (F8) at the end of the study. Formulation F8 showed the highest cumulative drug release (98.37%), indicating superior drug diffusion and enhanced release characteristics. The nanosized vesicles and optimized formulation composition facilitated efficient diffusion of Delgocitinib through the dialysis membrane. The results suggest that transferosomal encapsulation effectively enhanced the release profile and may improve transdermal delivery compared with conventional formulations.

Kinetic modelling of drug release

All the 8 formulation of prepared transferosomal gel of Delgocitinib were subjected to in vitro release studies these studies were carried out using diffusion apparatus.

Zero order kinetics

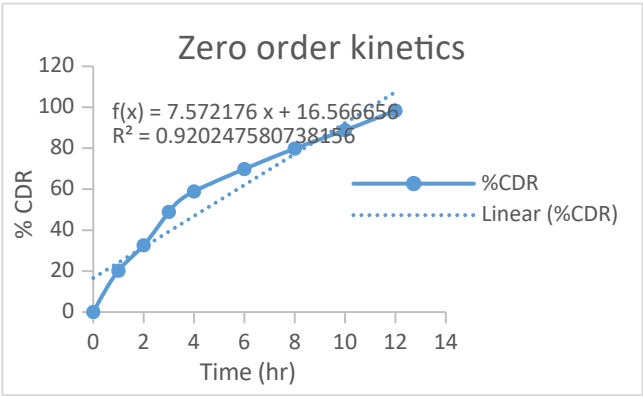

Figure None: 7: Zero Order Kinetics of Optimized Formulation

First order kinetics

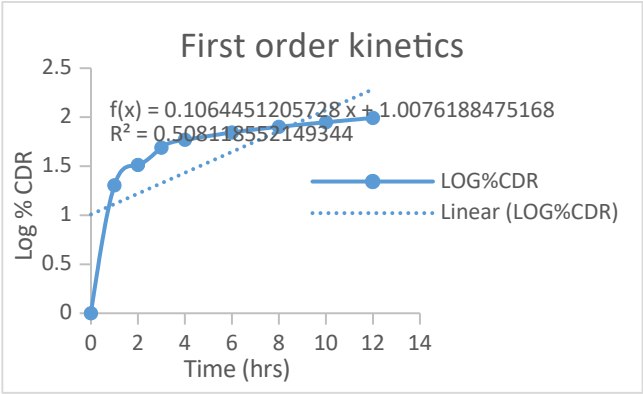

Figure None: 8: First Order Kinetics of Optimized Formulation

Higuchi model

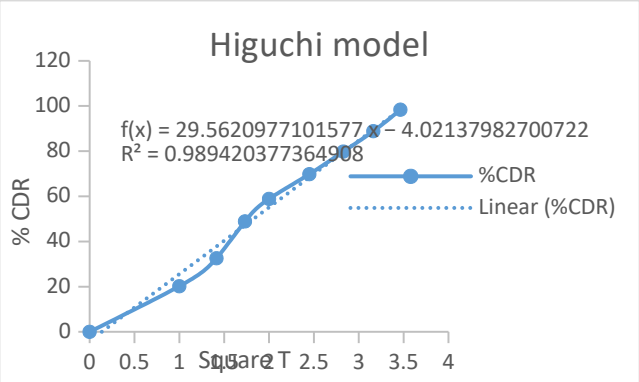

Figure None: 9: Higuchi Model of Optimized Formulation

Korsmeyer peppas

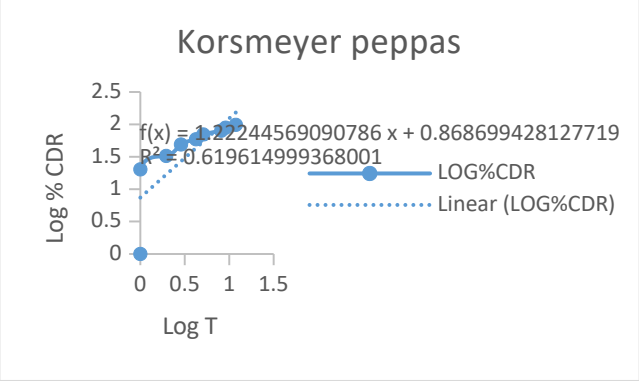

Figure None: 10: Korsmeyer Peppas of Optimized Formulation

The kinetic values obtained for formulation F8 were shown. The values of in vitro release were attempted to fit into various mathematical models. Regression values are higher with First order release kinetics. Therefore, Delgocitinib optimized formulation follows Higuchi model release mechanism.

DISCUSSION:

The optimized formulation F8 was subjected to kinetic modelling using Zero-order, First-order, Higuchi, and Korsmeyer–Peppas models. Among these, the Higuchi model exhibited the highest regression coefficient (R^2 = 0.989), indicating that drug release predominantly occurred through a diffusion-controlled mechanism. Although the first-order regression value was comparatively lower, the highest correlation with the Higuchi model confirms that Delgocitinib release from the transferosomal gel followed matrix diffusion. Therefore, the optimized formulation exhibited a sustained diffusion-controlled release pattern suitable for prolonged topical drug delivery.

Stability studies

Table None: 12: Stability Studies of Optimized Formulations at 40 ± 2 ^{0}C and 75 ± 5% RH for 3 Months

Table None: 9: Stability Studies of All Formulations

	Parameters	Initial	1st Month	2nd Month	3rd Month	Limits as per Specifications
F-8	**25^{0}C/60%RH % Release**	98.37	97.81	96.35	95.58	**Not less than 85 %**
F-8	**30^{0}C/75% RH % Release**	98.37	97.38	96.28	95.42	**Not less than 85 %**
F-8	**40^{0}C/75% RH % Release**	98.37	97.52	96.25	95.20	**Not less than 85 %**

DISCUSSION:

The stability studies conducted under 25°C/60% RH, 30°C/75% RH, and 40°C/75% RH for three months demonstrated that the optimized formulation (F8) remained physically and chemically stable throughout the study period. The cumulative drug release showed only a slight reduction from 98.37% initially to 95.20–95.58% after three months under different storage conditions. The drug release remained well above the acceptable limit of 85%, indicating excellent formulation stability. No significant changes in physical appearance or performance were observed, confirming that the optimized transferosomal gel retained its quality during storage and possesses good shelf-life characteristics suitable for pharmaceutical application.

CONCLUSION

The present investigation successfully developed and evaluated a Delgocitinib transferosomal gel for enhanced transdermal drug delivery. The transferosomal system effectively improved vesicle characteristics, drug encapsulation, and sustained drug release compared with conventional topical formulations. Among the developed formulations, F8 emerged as the optimized formulation, exhibiting the smallest particle size (253 nm), high entrapment efficiency (90.25%), maximum production yield (91.25%), suitable pH (5.9), optimum viscosity (176 cps), excellent spreadability (6.50 g·cm/sec), and the highest cumulative drug release (98.37%) over 12 hours. The optimized formulation also demonstrated good physical stability and followed a diffusion-controlled release mechanism consistent with the Higuchi model. Overall, the results indicate that the developed transferosomal gel is a promising carrier for the transdermal delivery of Delgocitinib, offering improved skin permeation, prolonged drug release, enhanced formulation stability, and potential improvement in therapeutic effectiveness and patient compliance.

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