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Formulation Development and Characterization of Transdermal Gel Containing Fenoprofen-Loaded Solid Lipid Nanoparticle

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ABSTRACT

The topical administration of anti-inflammatory drugs by Solid Lipid Nanoparticles (SLNs) has enormous potential. This study aimed to develop a topical Fenoprofen-loaded SLNs gel to improve the efficacy of the well-known antifungal drug in the treatment of wound healing. Materials and Methods: In order to create Fenoprofen SLNs, concentrations of surfactants were chosen as independent factors, and particle size and %Entrapment Efficiency were chosen as dependent variables. The produced Fenoprofen -SLNs were examined using zeta potential, polydispersity index, and particle size measurements. Additionally, Carbopol 934 was used to incorporate the improved Fenoprofen-SLN formula into gel. The outcomes demonstrated that Fenoprofen -SLNs had colloidal sizes. Fenoprofen -SLNs were discovered to have a particle size and an Entrapment Efficiency. The in vitro release, among other assessment criteria, was evaluated for the improved SLN gels. The study's conclusions imply that the topical gels made with Fenoprofen -loaded SLNs must be effective in the management of wound healing..

Keywords: *Fenoprofen, Solid lipid nanoparticle, Central-composite design, Topical delivery, Optimization*

1. INTRODUCTION

The diverse applications of Nanoparticles (NPs) across a range of biological, pharmacological, and medical fields have led to a high level of value in recent years. When seen structurally, they scarcely even approach 100 nm in size. Several drugs, including vaccines, tiny hydrophobic and hydrophilic chemicals, and biological molecules, can be controlled by these NPs.[1] NPs can be utilized as scaffolds for tissue engineering, for targeted medication delivery, and for disease diagnosis, among other things.[2] Nanoparticles (NPs) are frequently used as drug delivery systems, cellular scaffolds, carbon nanotubes, nanofibers, and nanocapsules. In order to successfully deliver a given drug at a precise time and place for maximal efficacy, it is imperative to manage particle size, surface characteristics, and other aspects of NP production as a drug delivery system.[3] In addition to being biocompatible and biodegradable, the NPs used for drug delivery should also have the following characteristics: prompt release, optimal mechanical properties, and ease of production. Surface modification enables the tracking of NPs that are ingested through phagocytosis or the circulatory system and then preserved in the circulatory system.[4] SLNs are advantageous in many ways, including their low toxicity, ease of incorporation, ability to improve the bioavailability of lipophilic compounds, ability to stop the degradation of molecules sensitive to chemicals, light, moisture, and oxidation, ability to provide sustained drug release, and minimal negative effects of drug molecules that have been encapsulated. High pressure homogenization, solvent evaporation, and precipitation from both microemulsions and emulsions including organic solvents are the main manufacturing techniques utilized for the fabrication of lipid nano dispersions based on solid lipids. Triglycerides, stearic acid, waxes, and emulsifiers make up the majority of the structure of SLNs. Several approaches were taken into consideration while making SLNs, with the solvent emulsification/evaporation process described as being the most pertinent. As a result, an organic solvent that is water-miscible (like acetone) is used to dissolve the lipophilic substance. After the organic solvent has evaporated and the temperature of the medium has dropped

to room temperature, the lipid-containing phase is then emulsified in a phase of water. The lipid hardens in the aqueous medium due to the solvent's evaporation, creating the nanoparticle dispersion.[5] Fungal skin infections are one of the most prevalent dermatological issues nowadays. According to research, roughly 40 million people in developing and underdeveloped nations have fungal diseases. Onychomycosis and tinea have dermatophytes as one of their common causes. For the treatment of a fungus infection, both physicians and patients have a variety of options at their disposal, including liquid preparations as well as solid, semisolid, and liquid forms. Both the cosmetics and pharmaceutical industries have embraced the creams and transparent clear gels. Candida species is one of the fungus in charge of the most prevalent superficial cutaneous fungal infection. Systemic candidiasis can result from candida overgrowth in deeper tissues and blood when the immune system is compromised. Greek in origin, dermatophyte is also known as a plant's epidermis. Three types of fungi called dermatophytes cause cutaneous illnesses in both humans and animals. Three types of asexual dermatophytes are recognized: Trichophyton, Microsporum, and Epidermophyton. These can result in a variety of illnesses, including Tinea corpora (ringworm of the body), Tinea faciei (facial ringworm), Tinea pedis (athlete's foot), and Tinea cruris (jock itch). The most prevalent and common group of mycoses are fungal infections of the skin and nails. Skin mycoses are currently one of the most prevalent types of infections, affecting more than 20–25% of the global population due to the high incidence of superficial mycotic infections that has increased in recent decades.[6]Topical therapy modalities offer a number of advantages over alternative delivery methods, including non-invasiveness, usability, targeting infection areas, less side effects and interactions between drugs, increased patient compliance, and more cost treatment.[7] In comparison to oral pharmaceutical therapy, these properties make topical therapy an appropriate therapeutic option for superficial cutaneous fungal infections. Targeted skin areas can simply receive appropriate concentrations of antifungal medicines with topical therapy if drug release and penetration are sufficiently managed.[8,9] Moreover, topical antifungal delivery reduces drug-related side effects since significantly lower amounts of the medicines are produced in the blood. Higher oral doses are necessary to produce equivalent local drug concentrations in comparison to other treatment modalities, which may have negative implications. Oral administration is also connected to dangerous adverse effects, including serious liver damage, and medication interactions.[9-11]

2. MATERIALS AND METHOD

Materials

Fenoprofen (Glenmark, Pharmaceuticals Ltd. India), Carbopol (934), Carbopol (940), Propylene Glycol, Tween–20, Span–20, Light Liquid Paraffin, Disodium Hydrogen Phosphate (SD – Fine Chemicals), Propyl Paraben (Himedia), Oleic Acid, Potassium Dihydrogen Phosphate (Central Drug House Pvt. Ltd Mumbai).

Equipments

FTIR spectroscopy (Buck Scientific Inc.), Viscometer (Brookfield technology), pH meter (Meteller toledo), Magnetic stirrer (Madeline), Hot plate (Thermo.lab), Thermometer (Amber India), Electronic weighing machine (Sartorius), Oven and autoclave (Unilabs), UV-VIS spectroscopy (Shimadzu).

Preparation of gel

The gel phase of Transdermal gel was prepared by dispersing Carbopol 934 and 940 in purified water. The ratio of Carbopol 934 and 940 was varied from 1:1 to 1:9. Formulation of Transdermal gel was carried out by incorporating emulsion into gel with continuous stirring at room temperature.

Table No. 1: Formulation Table for Fenoprofen Transdermal gel batches

Ingredients	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10
Fenoprofen (SLNs) (%w/w)	1	1	1	1	1	1	1	1	1	1
Carbopol 934 (%w/w)	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	0.10
Carbopol 940(%) w/w	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.0
Tween 20 (%w/w)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Span 20	1	1	1	1	1	1	1	1	1	1

(%w/w)										
Propylene glycol (%w/w)	5	5	5	5	5	5	5	5	5	5
Methyl paraben (%w/w)	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Propyl paraben (%w/w)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Distilled water (%w/w)	q.s	q.s	q.s	q.s	q.s	q.s	q.s	q.s	q.s	q.s

Note – Out of the 10 batches of Transdermal gel formulations only 5 batches were further evaluated on the basis of physical parameters like appearance, consistency and grittiness. The formulation table for selected 5 batches is given below.

Table no. 2. Formulation Table for selected 5 batches of Transdermal gel

S. No	Ingredients	F2	F4	F6	F8	F9
1.	Fenoprofen (SLNs) (%w/w)	1	1	1	1	1
2.	Carbopol 934 (%w/w)	0.1	0.4	0.6	0.8	0.9
3.	Carbopol 940 (%w/w)	0.9	0.6	0.4	0.2	0.1
4.	Tween-20 (%w/w)	0.5	0.5	0.5	0.5	0.5
5.	Span-20 (%w/w)	1	1	1	1	1
6.	Methyl paraben (%w/w)	0.03	0.03	0.03	0.03	0.03
7.	Propylene glycol (%w/w)	5	5	5	5	5
8.	Propyl paraben (%w/w)	0.01	0.01	0.01	0.01	0.01
9	L. liquid paraffin (%w/w)	7.5	7.5	7.5	7.5	7.5
10.	Water q.s (%w/w)	-	-	-	-	-

Note – From the above mentioned 5 batches 3 batches were selected for further study on the basis of Texture analysis (Hardness and Adhesiveness). The 3 selected batches (F2, F6, and F8) were also prepared using penetration enhancer (Oleic acid).

Table no. 3. Formulation table for selected 3 batches of Transdermal gel along with 3 same batches with penetration enhancer.

S. No	Ingredients	SD F2	F6	F8	F2A	F6A	F8A
1.	Fenoprofen (SLNs) (%w/w)	1	1	1	1	1	1
2.	Carbopol 934 (%w/w)	0.2	0.6	0.8	0.2	0.6	0.8
3.	Carbopol 940 (%w/w)	0.8	0.4	0.2	0.8	0.4	0.2
4.	Tween-20 (%w/w)	0.5	0.5	0.5	0.5	0.5	0.5
5.	Span-20 (%w/w)	1	1	1	1	1	1
6.	Methyl paraben (%w/w)	0.03	0.03	0.03	0.03	0.03	0.03
7.	Propylene glycol (%w/w)	5	5	5	5	5	5
8.	Propyl paraben (%w/w)	0.01	0.01	0.01	0.01	0.01	0.01
9	L. liquid paraffin (%w/w)	7.5	7.5	7.5	7.5	7.5	7.5
10.	Oleic acid (%w/w)	-	-	-	1	1	1
11.	Water q.s (%w/w)	q.s	q.s	q.s	q.s	q.s	q.s

EVALUATION PARAMETERS FOR TRANSDERMAL GEL FORMULATION

There are various parameters for the evaluation of Transdermal gel, which are discussed below.

Appearance of formulations

The appearance of the Transdermal gel formulation was judged by its color, homogeneity, physical touch, consistency and phase separation. [12]

pH of the formulations:

The electronic pH meter was calibrated by buffer pH 7 to dissolve in distilled water. After that about 1 gram of the Transdermal gel formulation was weighed and dissolved in 100 ml of distilled water and its pH was measured. [13]

Swelling index:

To determine the swelling index of the formulation of Transdermal gel, firstly 1 gram of Transdermal gel formulation was weighed and taken on the aluminum foil. Then it was placed separately in a 50 ml beaker containing 10 ml of 0.1 N NaOH, after that samples were removed from beaker at different time intervals and put it in a dry place for some time and it was reweighed. [14]

Rheological studies:

The viscosity of the formulated batches was determined by using Brookfield Viscometer with spindle 07. The formulation was added to the beaker and was allowed to settle down for 30 min at the 25^0C before the measurement was taken. Spindle was lowered into the centre of Transdermal gel taking care that that spindle does not touch to the bottom of the jar and rotated at a speed of 50 rpm for 10 min. The viscosity reading was noted. [15]

Hardness/Firmness:

The hardness/firmness of the Transdermal gel formulation was determined using Brookfield Pro CT3 Texture analyzer using probe TA-10. The result were obtained as Load Vs Distance and Load Vs Time graphs by keeping target 30.0 mm, Trigger load of 2g at 0.5mm/s test speed.

Adhesiveness:

The Adhesiveness of the Transdermal gel formulation was determined by Brookfield Pro CT3 Texture analyzer using Probe TA10. The results were obtained as Load Vs Distance and Load Vs Time graphs by keeping target 10mm, Trigger Load 5g

at 0.5mm/s test speed.

Spreadability:

The spreadability of the Transdermal gel was determined by Brookfield pro CT Texture analyzer using Probe TA 15/100. The result were obtained as Load Vs Distance and Load Vs Time graphs by keeping target 10 mm, Trigger Load of 2g at 2mm/s speed.[16]

Extrudability:

The Extrudability of Transdermal gel formulation was determined by Brookfield Pro CT3 Texture analyzer using Probe TA4/100. The results were obtained as Load Vs Distance and Load Vs Time graphs by keeping target 30mm, Trigger Load 2g at 0.5mm/s test speed.[17]

Drug content determination:

Weight accurately 1 gm of Transdermal gel formulation and it was dissolved in 100 ml of 0.1 N NaOH. The volumetric flask was kept for 2 hr and shaken well in mechanical shaker to mix it properly. The solution was passed through the filter paper for filtration. The sample were diluted and absorbance was measured by UV Spectroscopy at 273 nm. The drug content was determined using following formula.[18]

Drug content = (Concentration * Dilution factor * Volume taken) * Conversion factor

In-vitro drug release studies:

In vitro drug release study was carried out by using modified Franz diffusion cell. Modified Franz diffusion assembly was set by using egg membrane as dialysis membrane containing 2.5 gram of Transdermal gel formulation which was placed between donor and accepter compartment of the Franz diffusion cell. Phosphate buffer pH 6.8 was used as dissolution media. The temperature of the cell was maintained at 37^{o}C. The whole assembly was kept on a magnetic stirrer and the solution was stirred continuously using a magnetic bead. Withdrawn 5 ml of sample at the interval of 1 hr and replaced with the equal amount of fresh buffer media. The samples were analyzed by UV spectrophotometer at 273 nm and the % drug release was calculated. [19]

Stability studies

The prepared Transdermal gel were packed in test tubes (5g) and subjected to stability studies at room temperature and at 40^{0}C/ for a period of 20 days. Samples were analyzed at 10 days of intervals and checked the appearance, consistency and grittiness of the formulations.[20]

3. RESULTS OF PREFORMULATION STUDIES

Organoleptic characterization of Fenoprofen

The drug was characterized for its organoleptic features including the physical state, colour and odour.

Table no. 4: Organoleptic properties of the drug

S. No	Characteristics	Specification
1	Physical state	Solid, Powder
2	Colour	Crystelline White
3	Odour	Characteristic

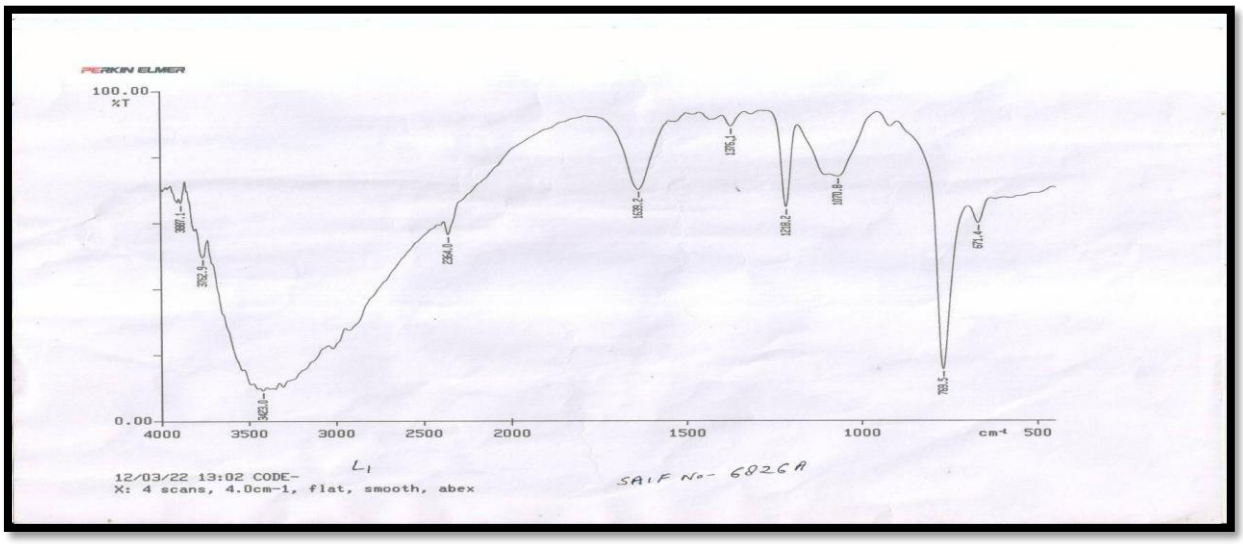


Fig. no; 1. IR studies of the pure drug

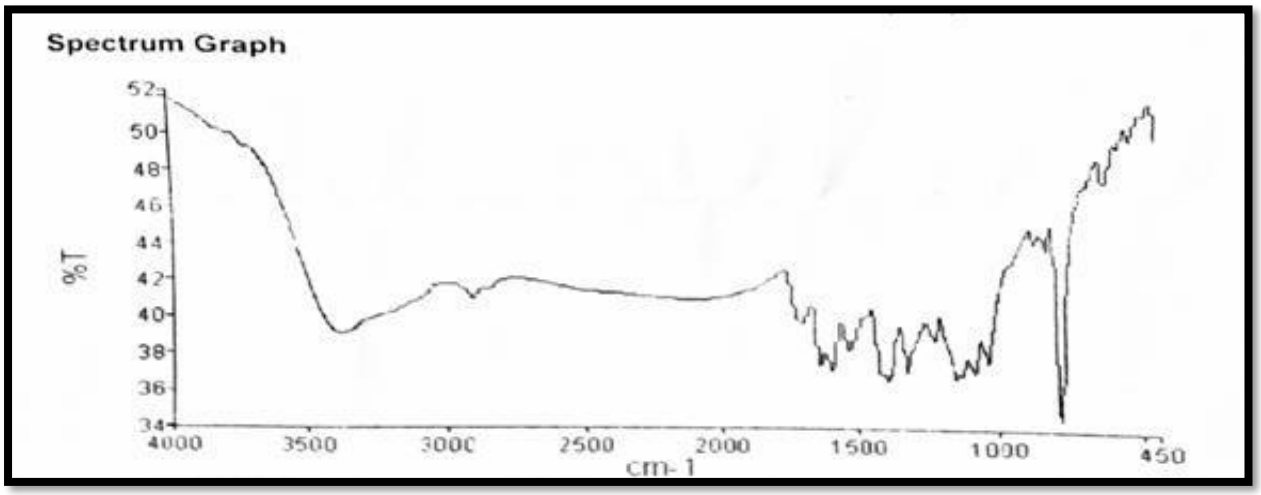


Fig. no . 2. FTIR presentation of the Drug + Carbopol 934

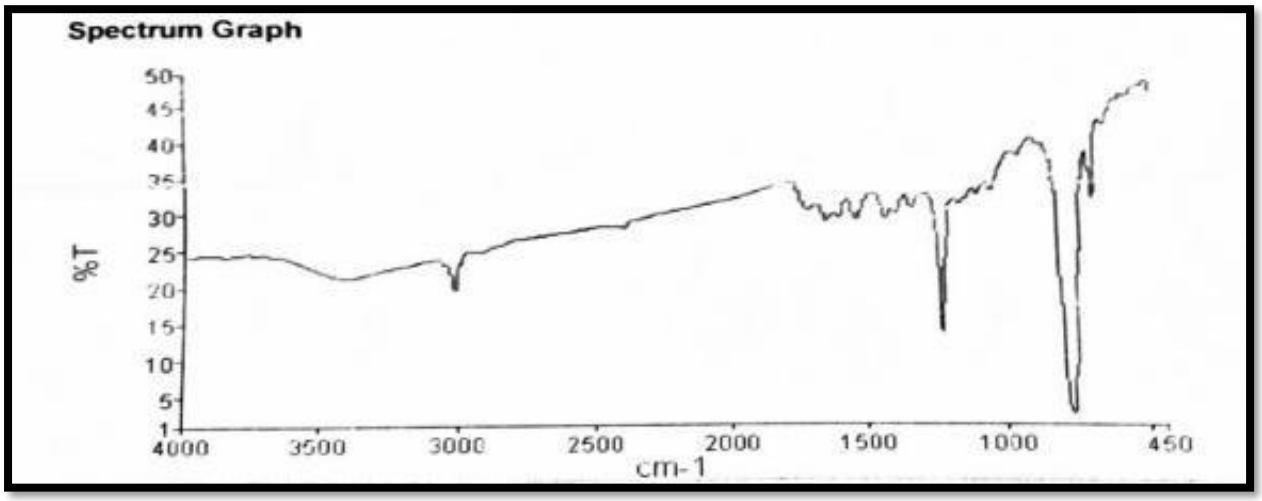


Fig. no. 3 FTIR presentation of Drug + Carbopol 940

Solubility Study

Common solvents used various polar and nonpolar solvent. The API and solvent were added in a ratio of 1:1.

Table no. 5. Solubility studies of Fenoprofen drug

S. No.	Solvent	Solubility
1.	Distilled water	Insoluble
2.	PBS (6.8 PH)	Freely soluble
3.	DMSO	Freely soluble
4.	Methanol	Slightly soluble
5.	Ethanol	Slightly soluble

Calibration curve of API (Fenoprofen)

The calibration curve of the Fenoprofen was done by using phosphate buffer pH 6.8 at max 273 nm using UV spectrophotometer.

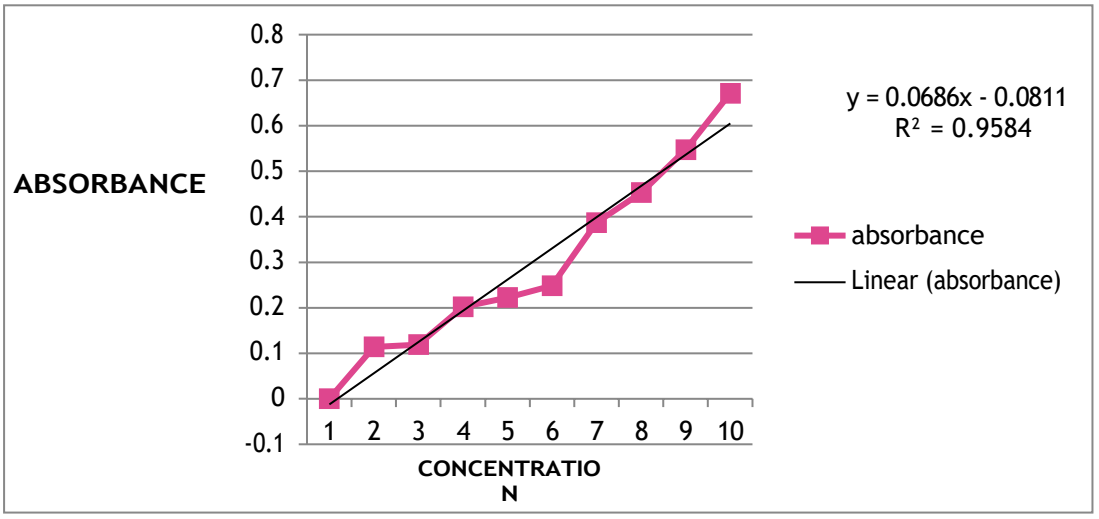


Fig. no. 4. Calibration curve of Fenoprofen in phosphate buffer pH 6.8

4. RESULTS OF EVALUATION PARAMETERS OF FORMULATION

Physical appearance

The Transdermal gel of Fenoprofen were White viscous creamy preparation with a smooth homogeneous texture and glossy appearance and result have been discussed in table.

Table no. 6. Evaluation result for physical parameter of the formulation

S. N.	Formulations	Color	Homogeneity	Consistency	Phase separation
1	F1	White	Good	Good	None
2	F2	White	Excellent	Excellent	None
3	F3	White	Good	Fair	None
4	F4	White	Excellent	Excellent	None
5	F5	White	Good	Good	None

6	F6	White	Excellent	Excellent	None
7	F7	White	Good	Fair	None
8	F8	White	Excellent	Excellent	None
9	F9	White	Excellent	Excellent	None
10	F10	White	Good	Fair	None

pH of formulations:

The pH of the Transdermal gel formulation was found to be in range of 5-7 which is compatible range for topical preparation. The selected topical formulations were shown nearer to skin required. The values were found to be in the range of skin pH of 5.5- 7 as shown in table 6.2.2.

Table no. 7. pH of the formulation batches

S. No	Formulation batches	pH value
1	F2	6.72
2	F6	6.21
3	F8	5.11
4	F2A	7.30
5	F6A	6.02
6	F8A	6.08

Swelling index

Swelling index was calculated as follows

Swelling index (SW) % = [Wt-Wo]*100

Where, (SW) % = Equilibrium percent swelling

WO = Original weight of Transdermal gel at zero time after time t

Wt = Weight of swollen Transdermal gel.

The results were shown in the table.

Table no. 8. Swelling index values of formulation

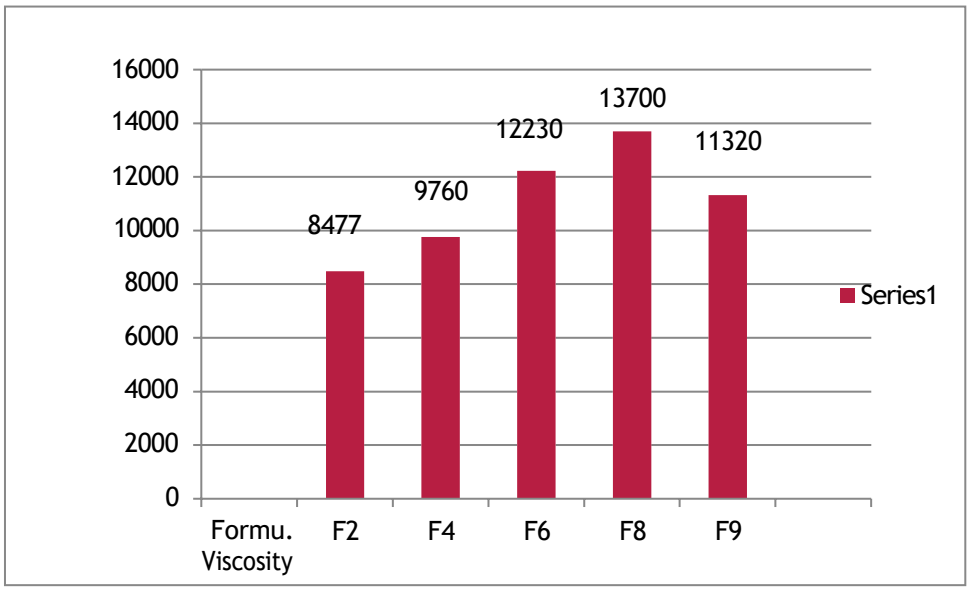
S. No	Parameter	F2	F6
1	Swelling index	97%	98%

Rheological studies

The result of the viscosity is given below

Table no. 9. Viscosity of the prepared formulations

S. No	Parameter	F2	F4	F6	F8	F9
1	Rheology studies (Centipoise)	8477	9660	12230	13700	11320



Viscosity (Cps)rpm

Fig. no. 5 Viscosity of different batches of Transdermal gel formulations

Hardness/Firmness

Hardness is the amount of forced required to resist the change in the shape of a object. It is measured by the resistance which a smooth surface offers to abrasion. The values obtained are depicted in table

Table no. 10. Hardness value of formulation batches

S. No	Parameter	F2	F4	F6	F8	F9
1	Hardness	20g	8g	14g	13g	8g

An increasment was found in the hardness of the formulations till formulation no. 8 after that the hardness value of the formulation little decreased.

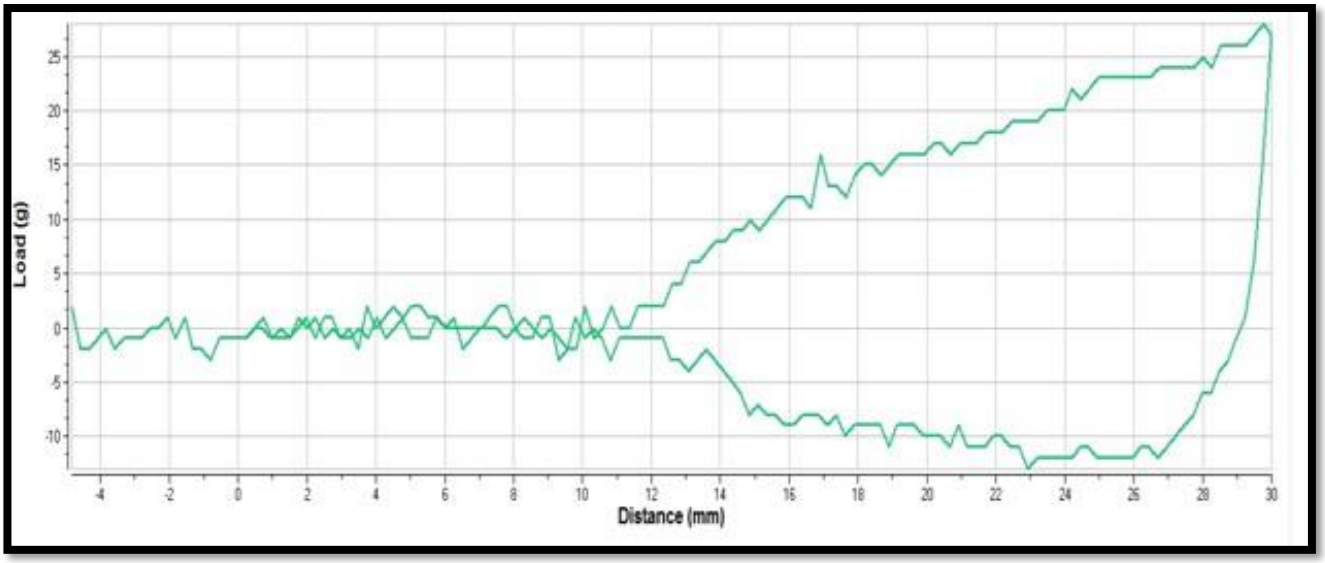


Fig. no. 6. Depicting the hardness value of Transdermal gel (Load vs. Distance) F2

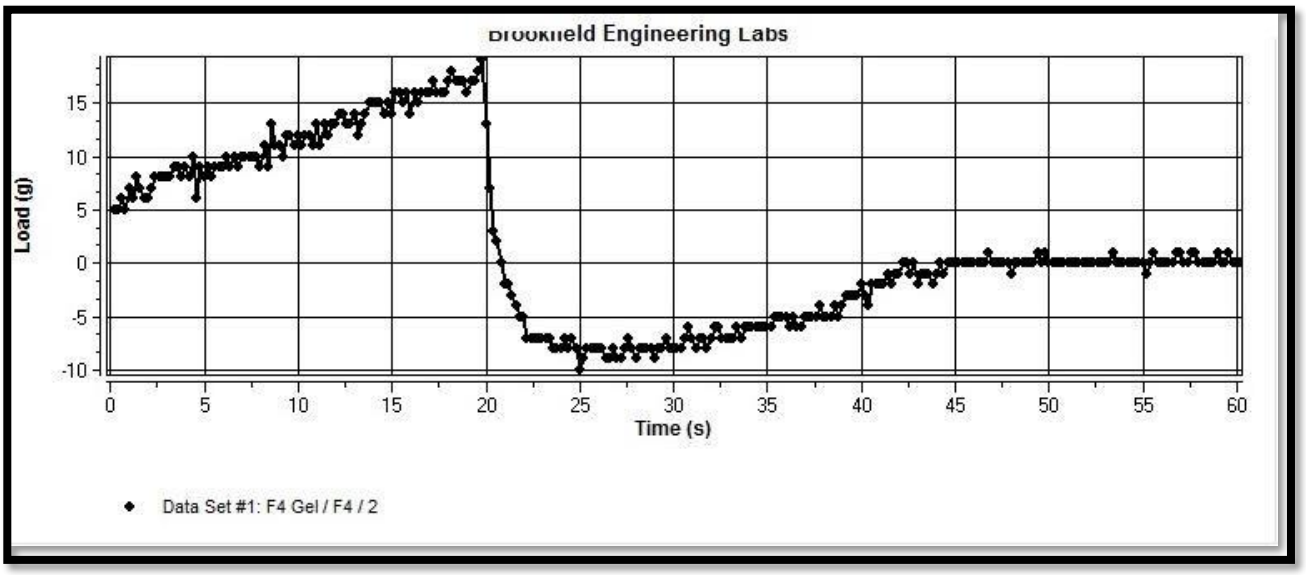


Fig. no. 7 Depicting the hardness value of Transdermal gel (Load vs. Time) F4

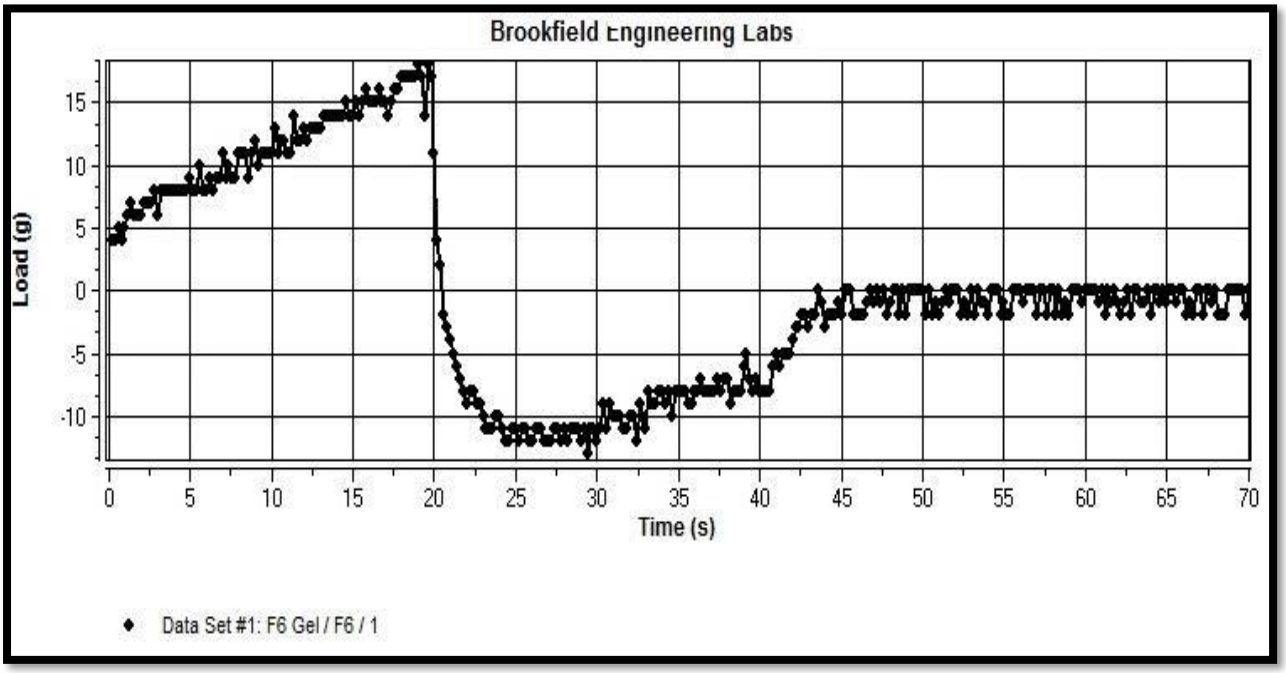


Fig no. 8 Depicting the hardness value of Transdermal gel (Time vs. Load) F6

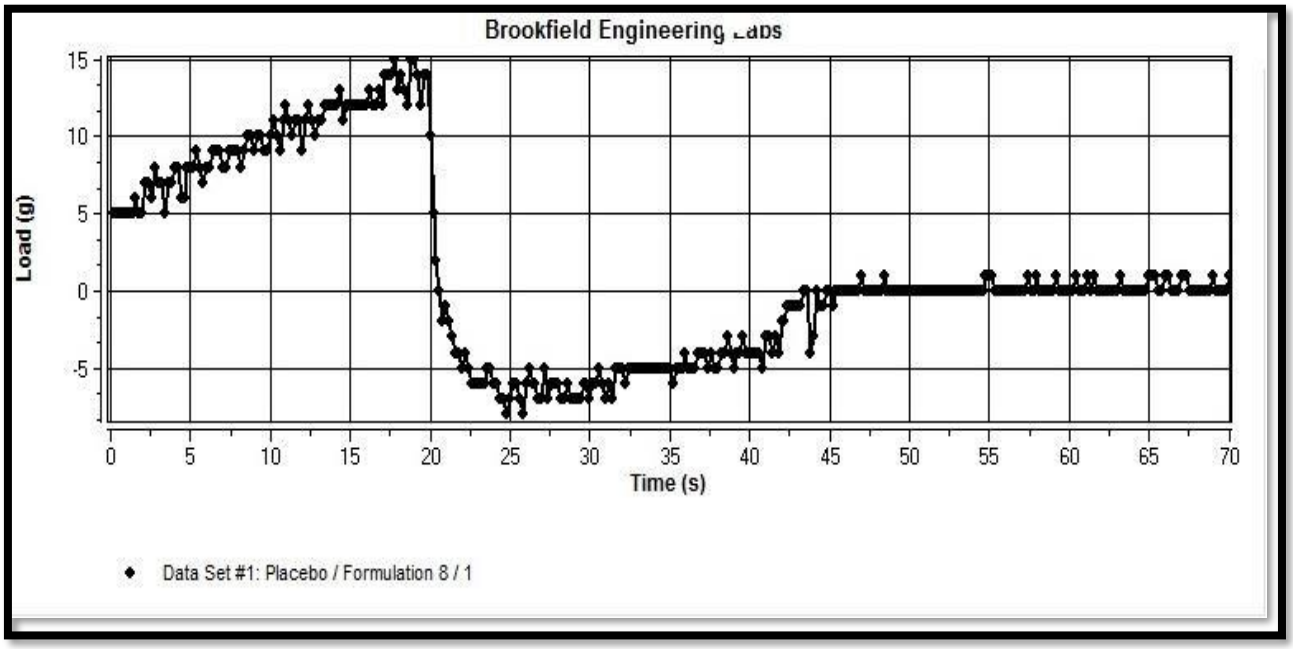


Fig. no. 9 Depicting the hardness value of Transdermal gel (Time vs. Load) F8

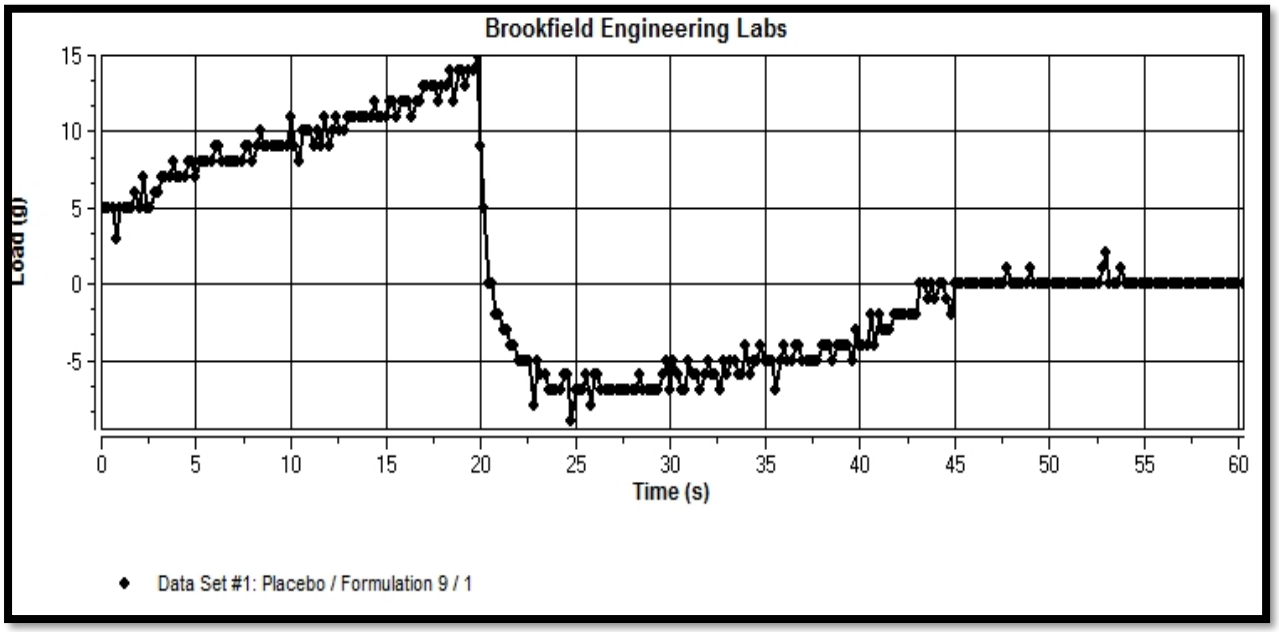


Fig. no. 10 Depicting the hardness value of Transdermal gel (Load vs. Time) F9

Adhesiveness studies

Adhesiveness can be defined as the maximum forced required for the overcoming the attractive force between surface and sample, was characterized as measure of the stickness of the sample. The values are shown in the table.

Table no. 11. Adhesiveness values of formulation

S. No	Parameter	F2	F4	F6	F8	F9
1	Adhesiveness	14g	8g	14g	13g	8g

An increasment was found in the Adhesiveness of the formulation from F2 to F8 and F9 formulation value was decrease.

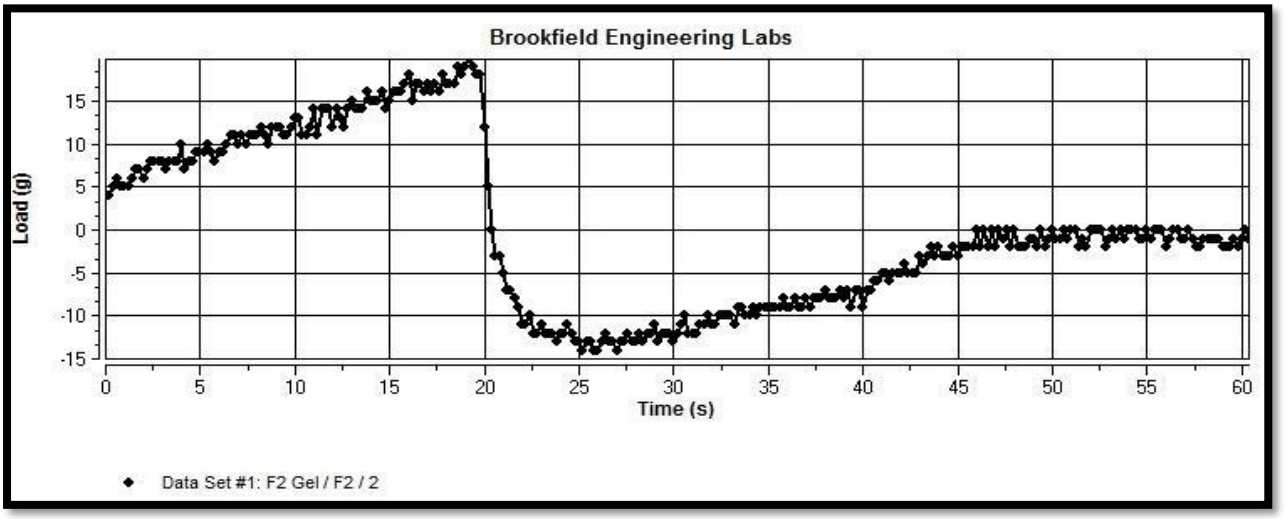


Fig. no. 11 Depicting the Adhesiveness value of Transdermal gel (Time vs. Load) F2

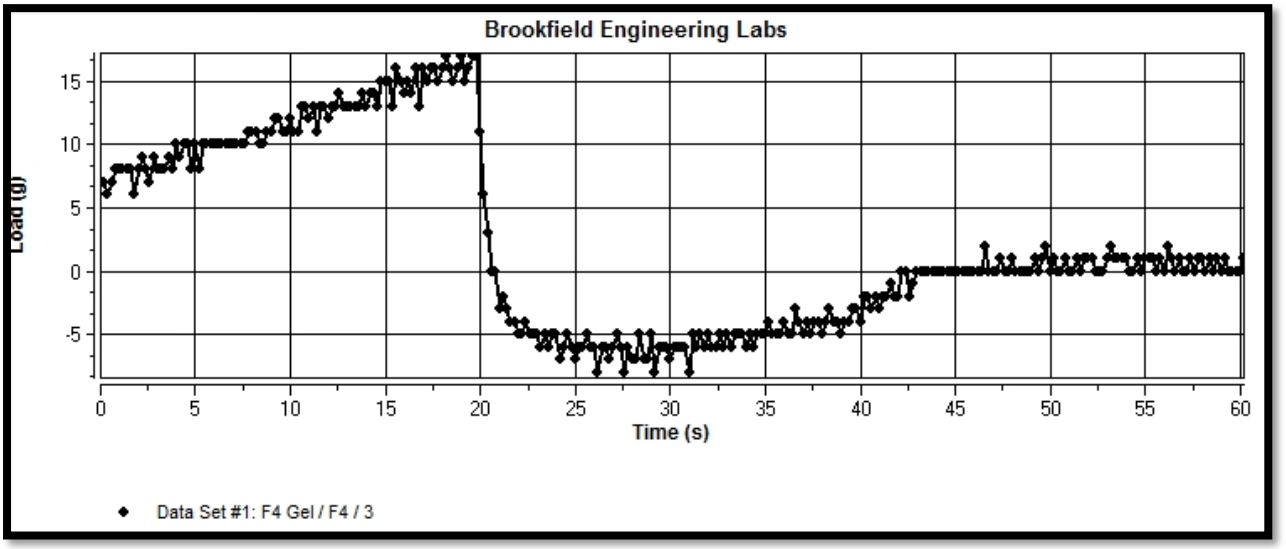


Fig. no. 12 Depicting the Adhesiveness value of Transdermal gel (Time vs. Load) F4

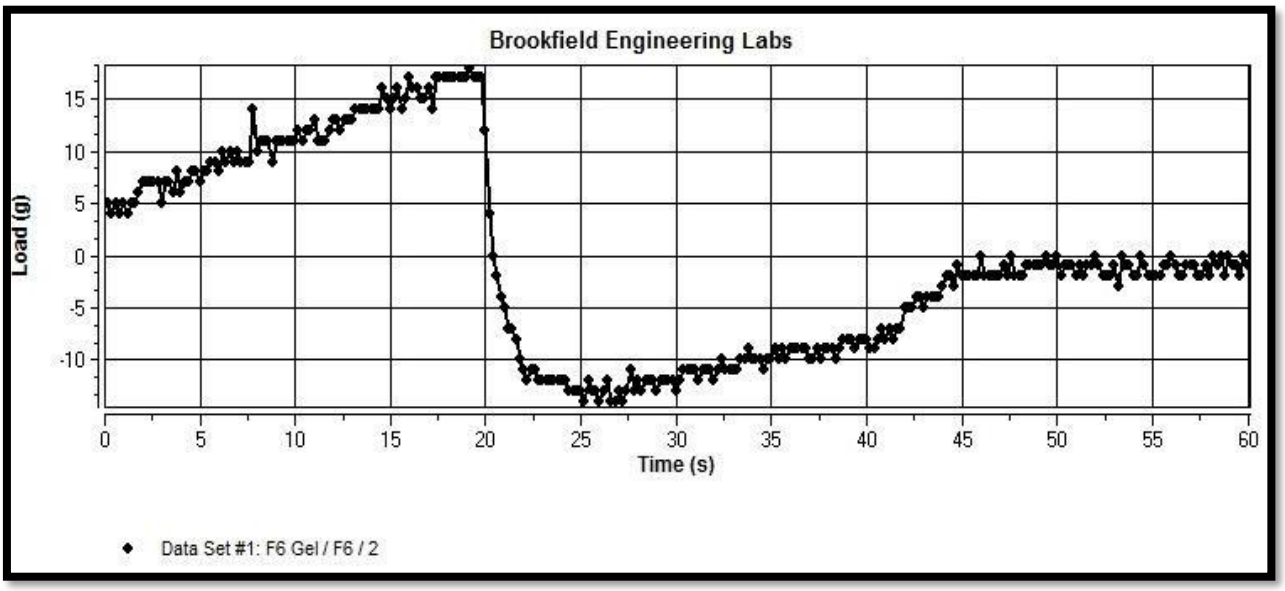


Fig no. 13 Depicting the Adhesiveness value of Transdermal gel (Time vs. Load) F6

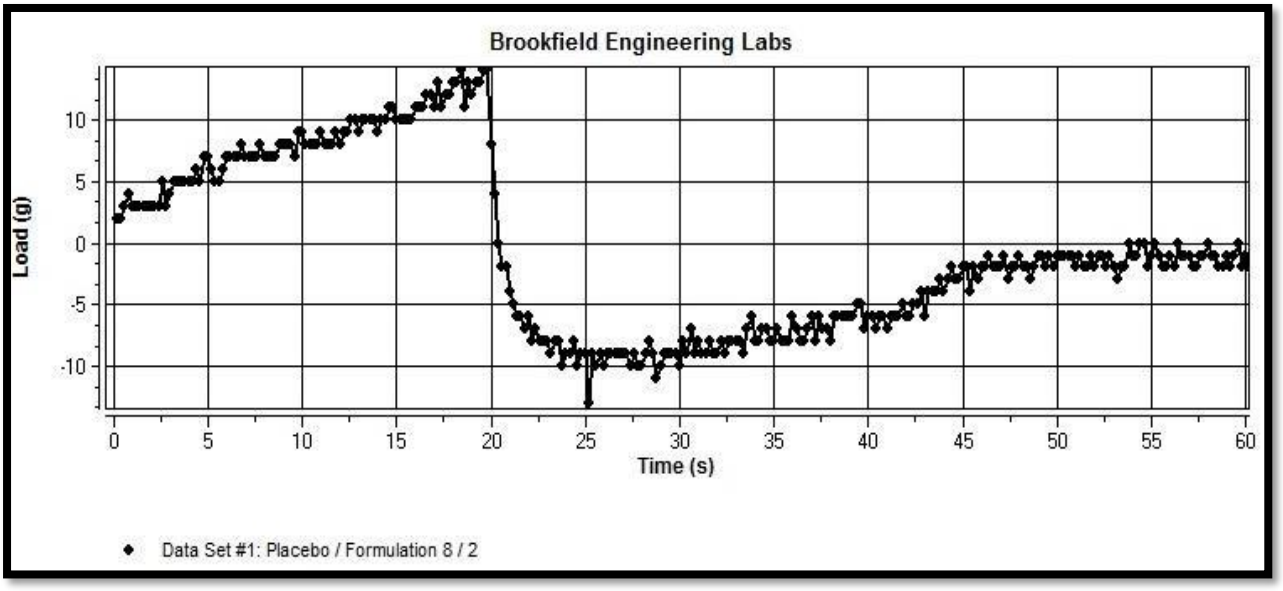


Fig. no. 14 Depicting the Adhesiveness value of Transdermal gel (Time vs. Load) F8

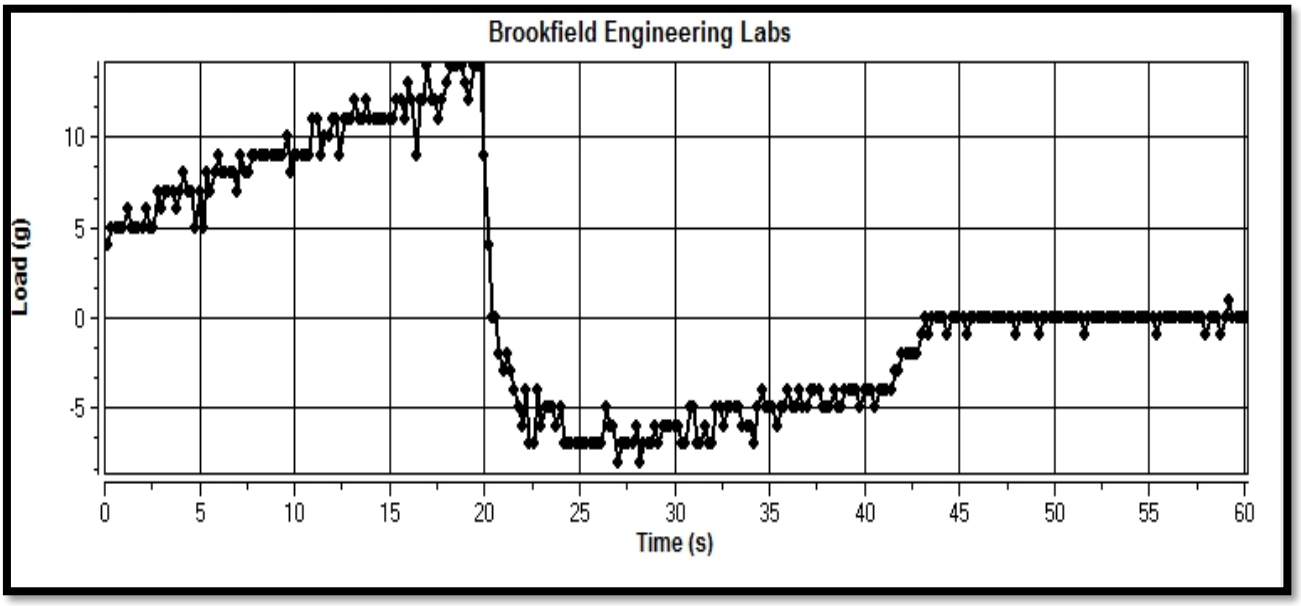


Fig. no. 15 Depicting the Adhesiveness value of Transdermal gel (Time vs. Load) F9

Spreadability studies

The amount of force required to spread the formulation is given by spreadability parameter. A high value shows that the formulation required a high force to spread and does not comply with the elegant marketed preparation of same.

Table no. 12. Spreadability values of formulation

S. No	Parameter	F2
1	Spreadability	91g

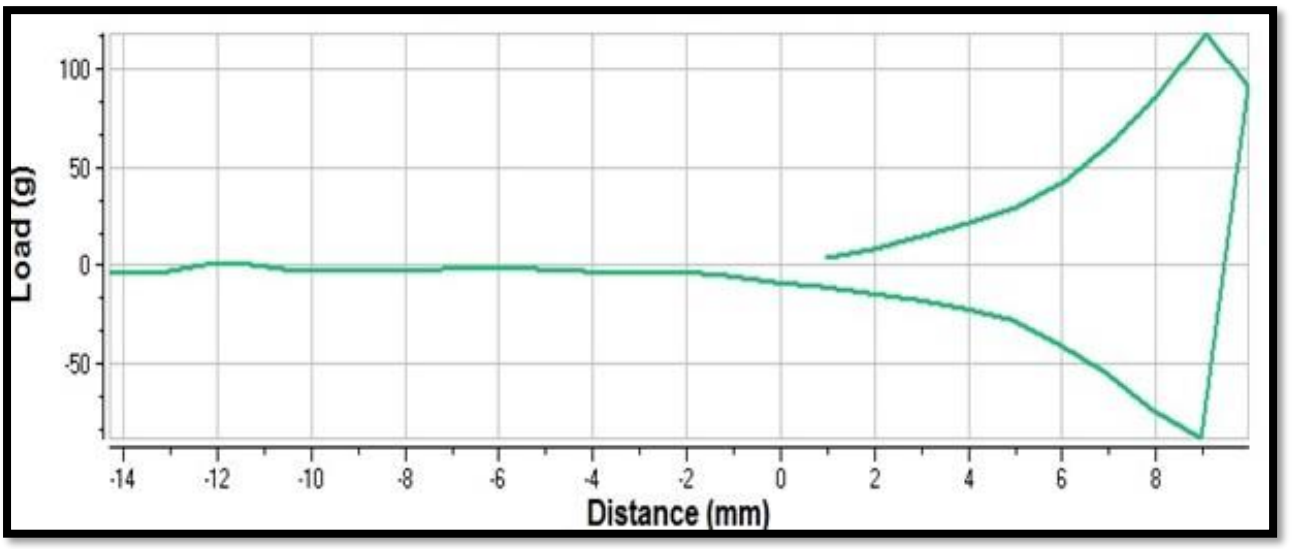


Fig. no. 16 Depicting the Spreadability value of Transdermal gel (Distance vs. Load) F2

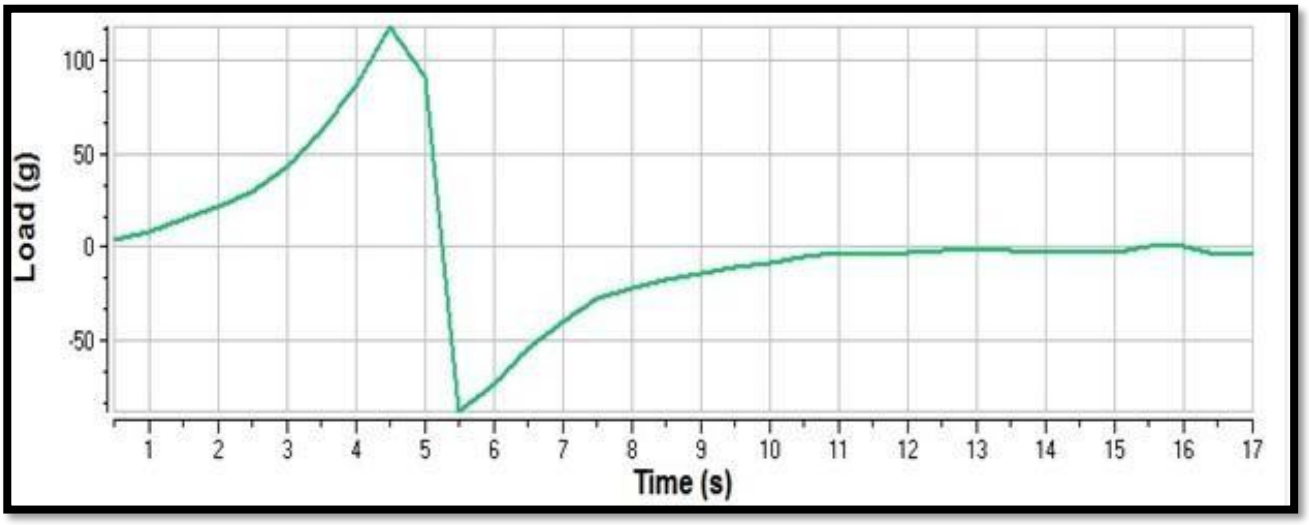


Fig. no. 17 Depicting the Spreadability value of Transdermal gel (Time vs. Load) F2

Extrudability studies

The amount of force required to extrude the formulation from the fixed orifice is given by the parameter of Extrudability. The values are shown in the table.

Table no. 13. Extrudability values of formulation

S. No	Parameter	F2
1	Extrudability	143g

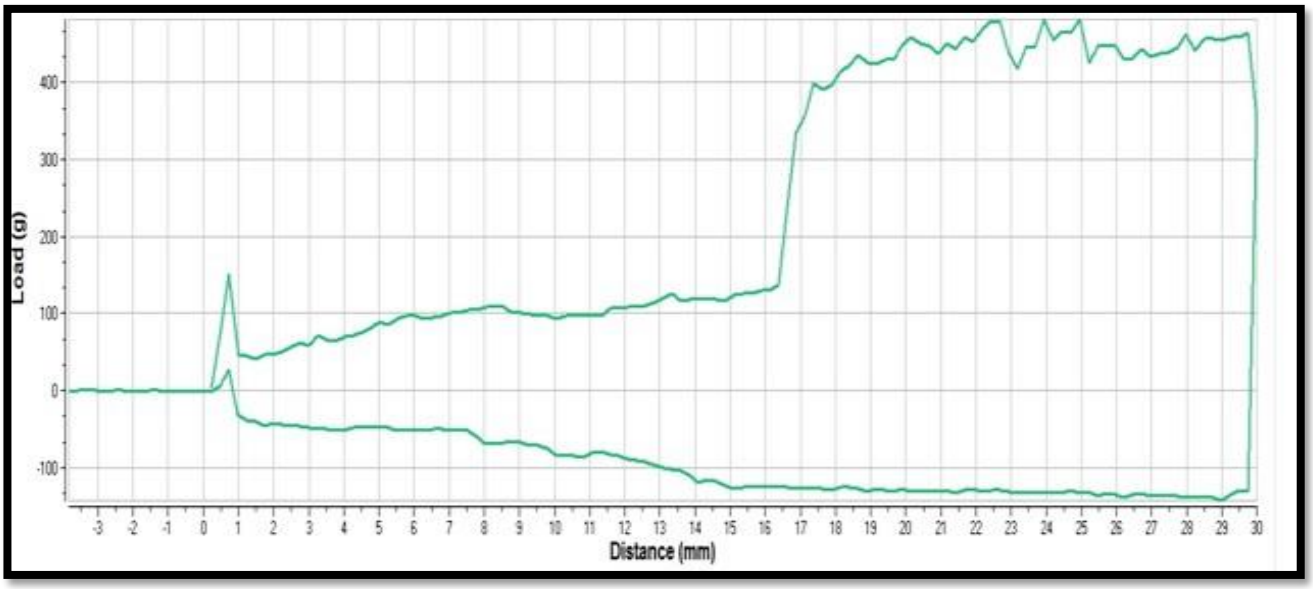


Fig. no. 18 Depicting the Extrudability value of Transdermal gel (Distance vs. Load) F2

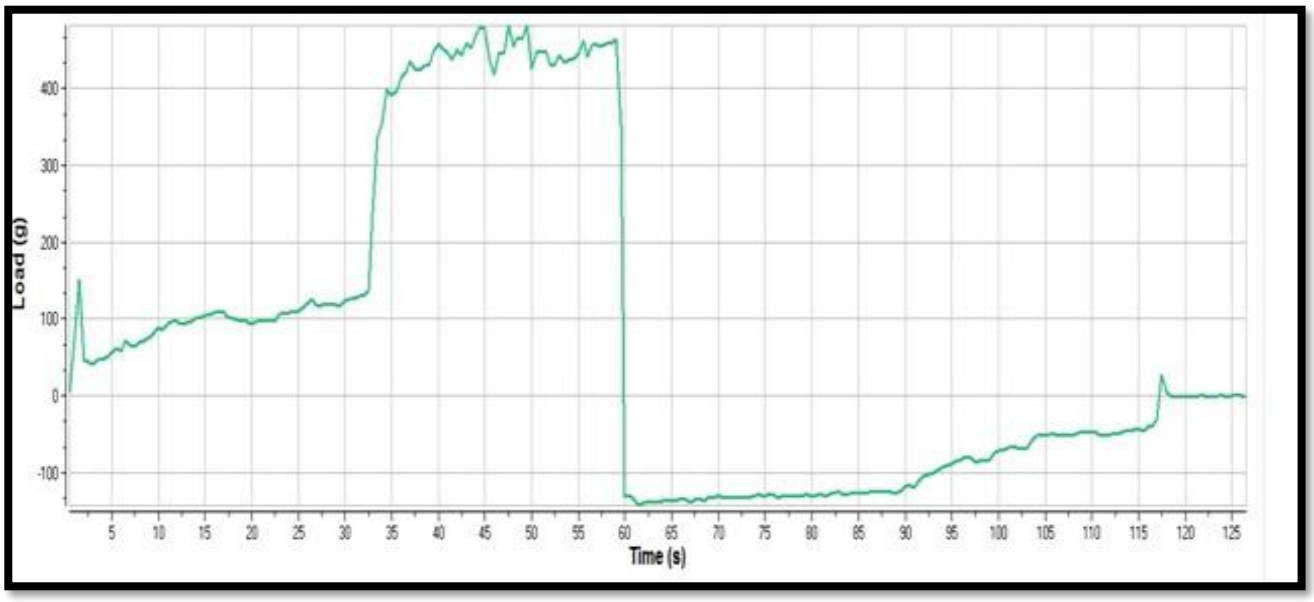


Fig. no. 19 Depicting the Extrudability value of Transdermal gel (Time vs. Load) F2

Stability study

Ability of a substance to remain unchanged over time under stated or reasonably expected condition of storage and use.

Table no. 14. Stability studies value of formulation

S. No	Formulations	Grittiness	Homogeneity	Consistency	Phase separation
1	F2	None	Excellent	Good	None
2	F6	None	Excellent	Excellent	None
3	F8	None	Excellent	Excellent	None
4	F2A	None	Excellent	Excellent	None
5	F6A	None	Good	Good	None
6	F8A	None	Excellent	Excellent	None

Table no. 15. Resulting values of evaluation parameters for formulation no. F2, F4, F6, F8 and F9

S. No	Physical parameters	F2	F4	F6	F8	F9
1	Physical appearance	Soft, Smooth, Consistent	Soft, Smooth, Viscous	Soft, Smooth, Consistent	Soft, Smooth, Consistent	Soft, Smooth, Consistent
2	pH	6.72	6.21	5.11	7.30	6.02
3	Hardness	20g	15g	18g	15g	15g
4	Adhesiveness	14g	8g	14g	13g	8g
5	Rheological studies (cps)	8477	9760	12230	13700	11320
6	Swelling index	97%	98%	---		

Table no. 16. Resulting values of evaluation parameters for formulation no. f6

S. No	Physical parameters	F6
1	Spreadability	91g
2	Extrudability	143g

Drug contents determination

The drug content of the formulated Transdermal gel was determined by UV Spectrophotometer at 273 nm. The results were given in the table

Table no. 17. Drug content determination of the formulations

S. No	Parameter	F2	F4	F6	F8	F9
1	Drug content (%)	94.8	95.2	97.2	96.1	91.7

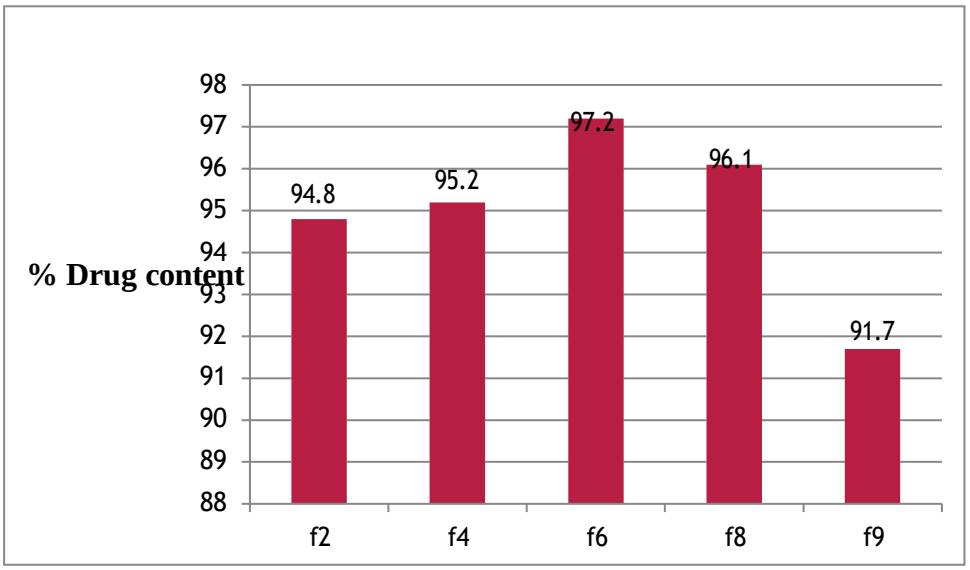


Fig. no. 20 Drug content of the formulations

In-Vitro drug release study

In vitro release successfully performed with the help of modified Franz diffusion cell.

The diffusion media was phosphate buffer pH 6.8 and the results of release study were given below.

Table no. 18. % Drug release of the formulation F2

S. No	Time (Hrs)	Absorbance	% Drug release
1	1	0.208	6.80
2	2	0.276	12.8
3	3	0.444	24.8
4	4	0.620	38.0
5	5	0.657	41.0

6	6	0.698	48.0
7	7	0.741	56.7

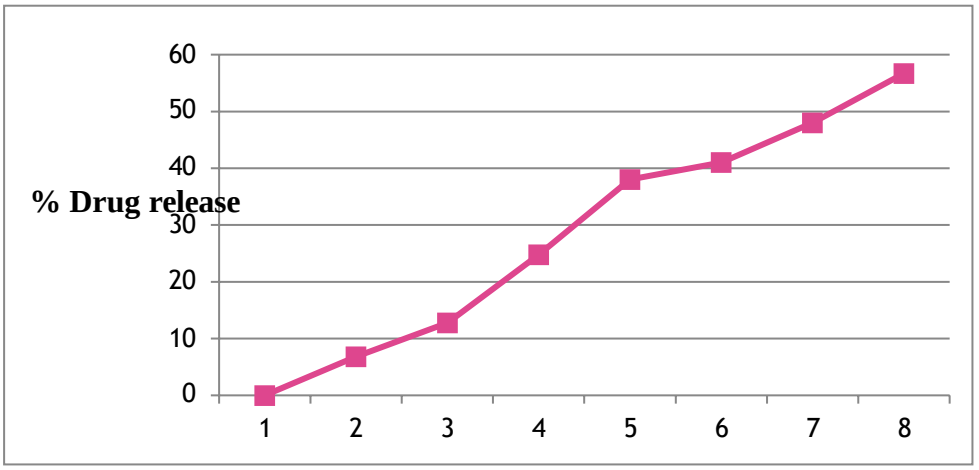


Fig. no. 21 Depicting the % drug release value of Transdermal gel (F2)

Table no. 19. % Drug release of the formulation F6

S. No	Time (Hrs)	Absorbance	% Drug release
1	1	0.261	14.0
2	2	0.321	18.8
3	3	0.441	28.0
4	4	0.542	36.0
5	5	0.689	46.0
6	6	0.812	56.0
7	7	0.987	70.4

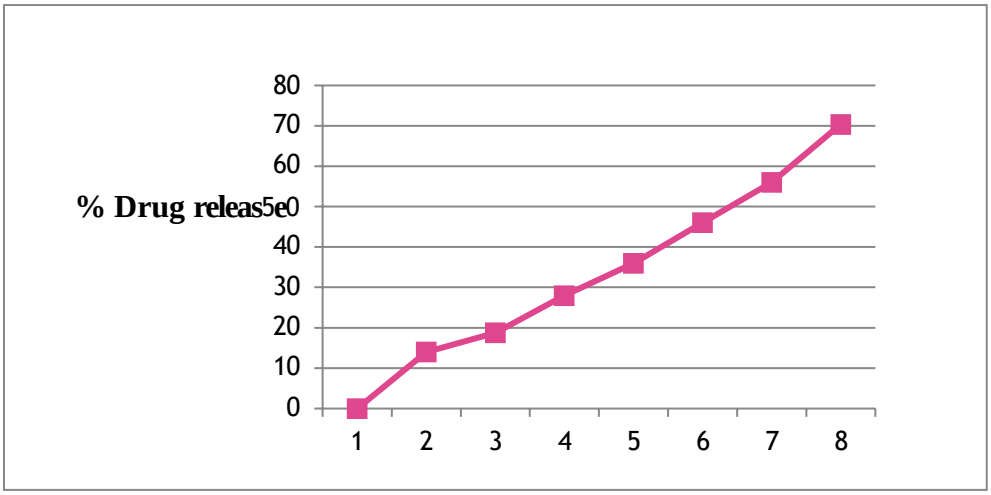


Fig. no. 22 Depicting the % drug release value of Transdermal gel (F6)

Table no. 20. % Drug release of the formulation F8

S. No	Time (Min)	Absorbance	% Drug release
1	60	0.250	14.0
2	60	0.332	20.0
3	60	0.510	34.0
4	60	0.678	46.0
5	60	0.761	52.0
6	60	0.876	60.0
7	60	0.941	66.0

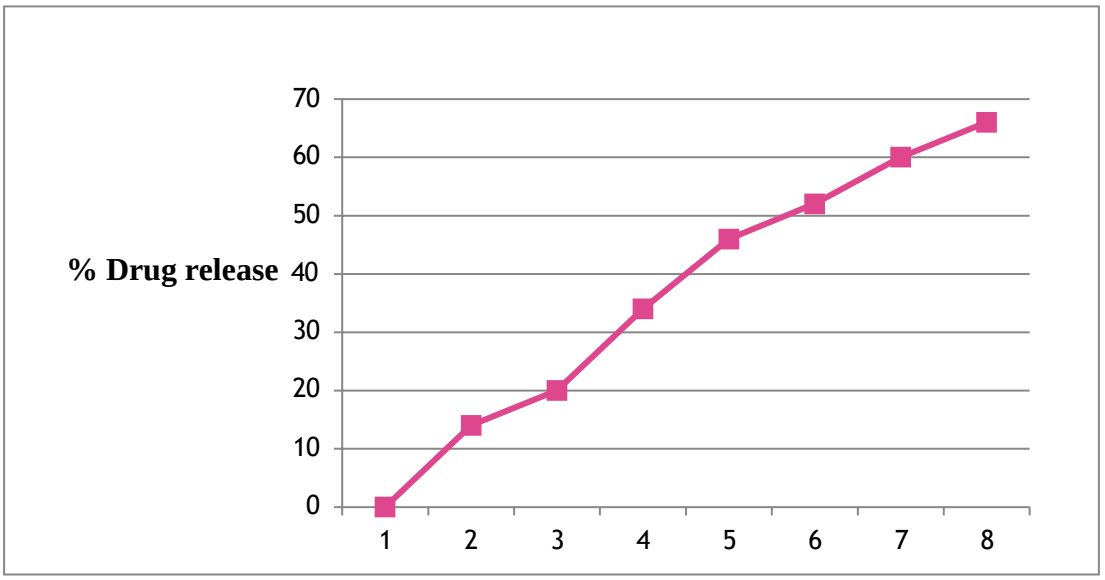


Fig. no. 23 Depicting the % drug release value of Transdermal gel (F8)

Table no. 21. % Drug release of the formulation F2 with penetration enhancer

S. No	Time (Hrs)	Absorbance	% Drug release
1	1	0.230	12.0
2	2	0.322	16.8
3	3	0.457	26.8
4	4	0.612	38.0
5	5	0.712	46.0
6	6	0.843	56.0
7	7	0.844	56.1

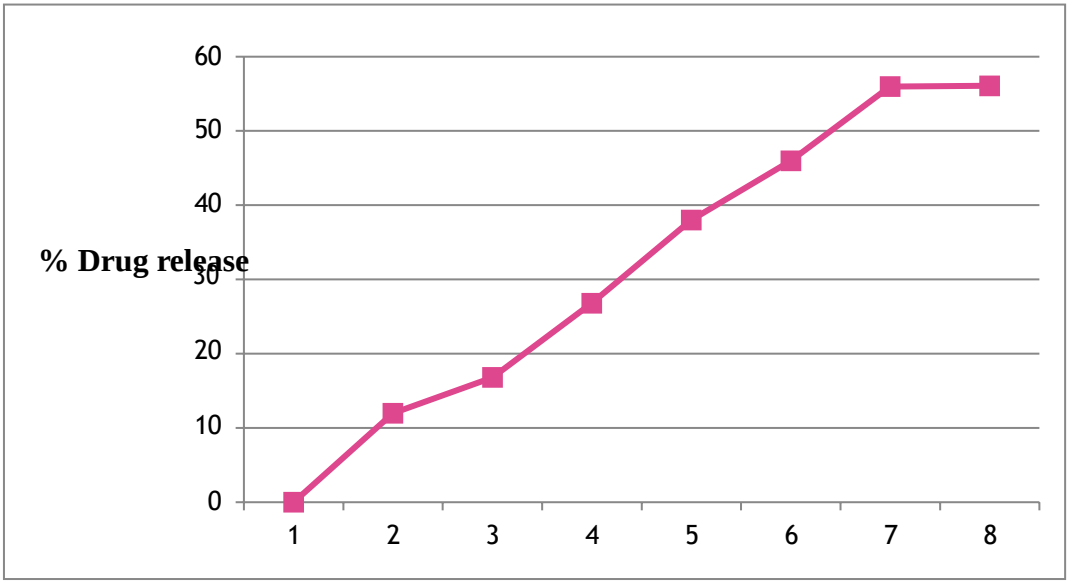


Fig. no. 24 Depicting the % drug release value of Transdermal gel with penetration enhancer (Oleic acid) (F2)

Table no. 22. % Drug release of the formulation F6 with penetration enhancer

S. No	Time (Hrs)	Absorbance	% Drug release
1	1	0.114	20.0
2	2	0.253	40.0
3	3	0.391	48.0
4	4	0.498	60.0
5	5	0.673	50.0
6	6	0.795	58.0
7	7	0.761	56.1

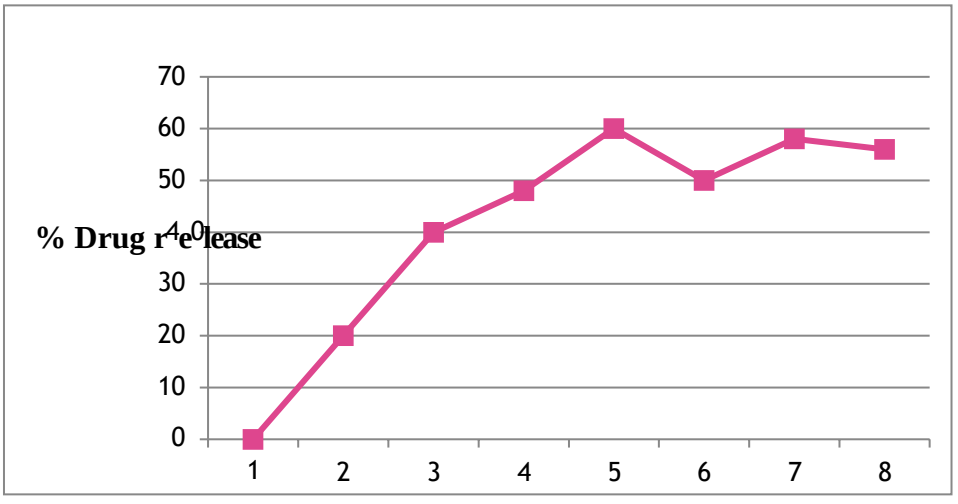


Fig. no. 25 Depicting the % drug release value of Transdermal gel with penetration enhancer (Oleic acid) (F6)

Table no.23. Result of In vitro drug release study for different batches of Transdermal gel

S. No	Formulation No.	Time (Min)	Maximum absorbance	Maximum amt. of drug	% drug release
1	F2	60	0.657	1.02	40.8
2	F6	60	0.987	1.76	70.4
3	F8	60	0.941	1.65	66
4	F2A	60	0.843	1.40	56
5	F6A	60	0.195	0.150	58

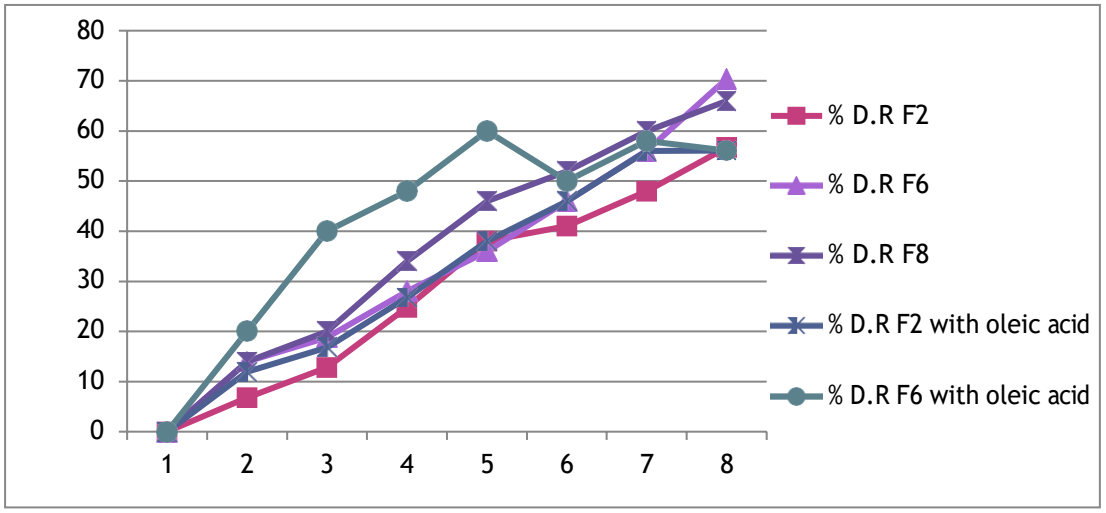


Fig. no.26 Depicting the % drug release of all the formulations

Note - Thus the 5 selected batches were examined for the drug release study and the maximum drug release was found to be 70.4% by f6 formulation batch.

Although in Literature oleic acid is reported as a penetration enhancer, however in the Transdermal gel of Fenoprofen, the oleic acid did not produce good effect. In all three batches f2, f6 and f8 oleic acid did not produced good effect.

5. SUMMARY AND CONCLUSION

This study sought to harness the promising advantages of Solid Lipid Nanoparticles (SLNs) for the topical delivery of anti-inflammatory drugs, specifically Fenoprofen. The objective was to create a gel formulation loaded with Fenoprofen-loaded SLNs to enhance the effectiveness of this widely recognized anti-inflammatory medication in the context of wound healing. The resulting gel formulations underwent a comprehensive assessment of various attributes to demonstrate their efficacy. Transdermal gel formulation of Fenoprofen was successfully developed using carbopol 934 and carbopol 940 at different ratio. Transdermal gel have proven as most convenient, better and effective delivery system than other topical formulation. Due to its non-greasy, gel like property it provides better release of drugs as compare to other topical drug delivery system. Incorporation of emulsion into gel makes it a dual control release system Further problem such as phase separation, creaming associated with emulsion gets revolved and its stability improves. Stable Transdermal gel represents an effective approach for the resolution of problem in drug and cosmetic agent delivery. Transdermal gel loaded with specific drugs has been found effective in some topical disorders and it is emerging as potential drug delivery system in area of dermatology. The carbopol 934 and carbopol 940 were used as gelling agent at various concentrations and it provide good appearance and consistency to the formulation. The combination of carbopol 934 and carbopol 940 were used in the formulation of Transdermal gel in ratio of 1:1 to 1:9. All the formulations were examined for its hardness, adhesiveness, Extrudability, spreadability, In vitro release study and other physical parameters. The best batches of the formulations are given as F6 > F2 > F8 > F9 > F4 > F7 and F1. Stable topical Transdermal gel formulations were developed, evaluated and all the formulations were stable,

consistent, smooth and viscous. All the developed formulation was found to be good in the action. However, the formulations of Transdermal gel were good in appearance and produced good release rate. The best batch of Transdermal gel was formulation no F6 which produce maximum drug release rate, hardness, adhesiveness, Extrudability, and good spreadability as compare to other formulation batches

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