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Research Article

Formulation and Evaluation of Nabumetone Emulgel for Topical Drug Delivery

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ABSTRACT

Nabumetone is commonly used to relieve pain and inflammation, especially in conditions like arthritis. However, its use through oral administration poses certain difficulties. These include its poor solubility in water, which limits its absorption, and a tendency to irritate the gastrointestinal tract, which may lead to discomfort or other side effects in patients. To overcome these limitations, the present investigation focused on developing a topical emulgel formulation. Carbopol 934 and Hydroxypropyl Methylcellulose K15M (HPMC K15M) were employed as gelling agents, and their concentrations were systematically varied to assess their influence on the drug release profile. Emulsion systems were systematically developed using light liquid paraffin as the oil component, Tween 80 as the primary surfactant, and an appropriate co-surfactant. To identify the optimal emulsification zone, pseudoternary phase diagrams were constructed and analyzed. The final emulgel was prepared by incorporating the optimized emulsion into gel bases containing different concentrations of the gelling agents (1.5%, 2.0%, and 2.5%). Comprehensive evaluation of the formulations indicated that the optimized batch, F2, exhibited favorable physicochemical stability in terms of pH, viscosity, and cumulative drug release percentage under ambient and accelerated storage conditions.

INTRODUCTION

Nabumetone is a prodrug widely prescribed for managing conditions such as rheumatoid arthritis and osteoarthritis. After oral administration, it undergoes hepatic metabolism to produce its active form, 6-methoxy-2-naphthylacetic acid, which provides anti-inflammatory and analgesic effects by inhibiting the cyclooxygenase (COX-1 and COX-2) enzymes. Based on the Biopharmaceutical Classification System (BCS), Nabumetone is categorized as a Class II drug, characterized by low aqueous solubility and high permeability. Nabumetone is characterized by poor aqueous solubility and is associated with gastrointestinal adverse effects following oral administration [1].

Topical drug delivery involves the application of pharmacologically active formulations directly to the skin for localized therapeutic action. Among the commonly used semisolid dosage forms for topical drug delivery are creams, ointments, and gels. Gels, in particular, are semisolid formulations consisting of a continuous liquid phase embedded with either fine inorganic particles or high-molecular-weight organic polymers, forming a stable three-dimensional matrix. These systems are typically enriched with aqueous or hydroalcoholic components embedded within a colloidal matrix. Emulgels, which are essentially hydrogels embedded with oil droplets, represent a hybrid dosage form that combines the structural and functional attributes of both emulsions and gels. Emulsions are biphasic systems consisting of two immiscible liquids, one dispersed within the other, stabilized by surfactants. The integration of emulsions into a gel base results in the formation of emulgels, which serve as effective vehicles for controlled and localized drug delivery [2, 3].

Microemulsions are clear, thermodynamically stable mixtures of oil and water, stabilized by the presence of suitable surfactants and co-

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surfactants in appropriate ratios. Due to their nanometric droplet size, they are capable of solubilizing substantial amounts of lipophilic drug substances that are otherwise poorly soluble in aqueous media. The energy-efficient preparation and enhanced drug-loading capacity of microemulsions make them highly suitable for formulating hydrophobic drug candidates.

In light of the limitations associated with the oral administration of Nabumetone, the objective of the current study was to design a topical emulgel formulation for improved transdermal drug delivery. This approach involved the incorporation of a microemulsion containing Nabumetone into a gel matrix to facilitate improved solubility, enhanced stability, and localized drug delivery while minimizing systemic side effects.

MATERIALS AND METHODS

Materials

Nabumetone was kindly provided as a gift sample by Divi's Laboratories Pvt. Ltd., Hyderabad, India. Ingredients such as Carbopol 934, HPMCK 15M, oleic acid, Tween 20, and PEG 400 were procured from M/s Burgoyne Burbidges and Co., Mumbai. All additional chemicals and reagents used in the study were of analytical grade.

Methods

FTIR Spectroscopy:

Fourier Transform Infrared (FTIR) spectroscopy was employed to assess the compatibility between Nabumetone and the chosen pharmaceutical excipients. Infrared spectral analysis was conducted on pure Nabumetone and its physical mixtures with Carbopol 934 and Hydroxypropyl Methylcellulose K15M (HPMC K15M) using the potassium bromide (KBr) pellet method. This evaluation was carried out to identify any possible physicochemical interactions by examining the distinctive absorption bands of the drug and excipients in the spectra.

Differential Scanning Calorimetry (DSC):

Differential Scanning Calorimetry (DSC) analysis was carried out using a DSC-60 instrument (Shimadzu Corporation, Japan) to study the thermal properties and assess the compatibility of Nabumetone with the formulation excipients. Approximately 5 mg of pure Nabumetone and its physical mixtures with Carbopol 934 and Hydroxypropyl Methylcellulose K15M (HPMC K15M) were accurately weighed and placed in hermetically sealed aluminum pans. The thermal analysis was carried out over a temperature range of 30°C to 300°C at a controlled heating rate of 10°C per minute, under a constant nitrogen atmosphere to prevent oxidative degradation. An empty, sealed aluminum pan was used as the reference.

Saturation Solubility in Oils, Surfactants, and Co-Surfactants:

The solubility of Nabumetone was evaluated in several oils commonly used in pharmaceutical formulations, including coconut oil, light liquid paraffin, and oleic acid. An excess amount of the drug was added to vials containing 10 mL of each oil, followed by surfactants (Tween 20, Tween 40, and Tween 80) and co-surfactants (polyethylene glycol 400, polyethylene glycol 600, and propylene glycol). The mixtures were continuously shaken for 72 hours to ensure equilibrium solubilization. After this, the samples were centrifuged at 3000 rpm for 10 minutes to separate undissolved drug particles. The clear supernatant was collected, filtered, and appropriately diluted before quantifying the dissolved Nabumetone concentration using UV spectrophotometry at 261 nm [4, 5].

Construction of Pseudo-Ternary Phase Diagrams:

Ternary phase diagrams were developed with the help of Ternaryplot.com software to determine the area suitable for microemulsion formation. The study utilized the water titration technique. Mixtures of surfactant and co-surfactant (S_{mix}) were prepared at weight ratios of 1:1, 2:1, and 3:1 by maintaining a constant amount of co-surfactant while adjusting the surfactant concentration. These components were mixed thoroughly by vortexing for five minutes to achieve uniformity. Following this, the oil phase was combined with the Smix in varying proportions, ranging from 1:9 to 9:1 (oil to S_{mix} by weight). Water was gradually added dropwise using a burette with continuous stirring, and the clarity of each formulation was observed visually for any turbidity or gel formation. The titration endpoint was marked by the onset of cloudiness or phase separation. The resulting data were plotted using Ternaryplot.com software to map out the microemulsion region and determine optimal compositions for further formulation studies [6].

Preparation of Emulsion:
Nabumetone was dissolved within a blend of oil, surfactant, and co-surfactant, with varying proportions detailed in [Table 1]. Distilled water was slowly introduced drop by drop while continuously stirring the mixture at room temperature with a magnetic stirrer. This process was carried out until a clear and uniform phase formed, confirming the creation of a microemulsion system [7].

Table 1: Formulation Table of Nabumetone Microemulsion Emulsion Preparation

Sr. No.	Formulation Code	S:Cos ratio [S_{mix}]	Oil: S_{mix} Ratio	Amount of drug Added (mg)	Total volume of mixture (mL)	Amount of water (mL)
1	P1	1:1	1:9	200	10	0.6mL
2	P2	1:1	2:8	200	10	0.4mL
3	P3	1:1	3:7	200	10	0.1mL
4	Q1	2:1	1:9	200	10	0.6mL
5	Q2	2:1	2:8	200	10	0.5mL
6	Q3	2:1	3:7	200	10	0.3mL
7	R1	3:1	1:9	200	10	0.6mL
8	R2	3:1	2:8	200	10	0.5mL
9	R3	3:1	3:7	200	10	0.2mL

(P1, P2, P3 corresponds to Surfactant: Cosurfactant ratio 1:1, Q1, Q2, Q3 corresponds to Surfactant: Cosurfactant ratio 2:1, and R1 R2 R3 corresponds to Surfactant: Cosurfactant ratio 3:1)

Characterization of Emulsion:
The developed emulsion formulations were assessed for their drug concentration and droplet size.

Drug Content of the Emulsion:
A 1 mL sample of the drug-loaded emulsion was pipetted into a 10 mL volumetric flask and diluted to the mark using methanol. Additional serial dilutions were prepared as needed. The absorbance was recorded at 261 nm using a UV-visible spectrophotometer, with a drug-free microemulsion formulation serving as the blank. The absorbance readings were then utilized to calculate the Nabumetone concentration in the emulsion by referring to a pre-established calibration curve [8].

Globule Size Determination:
The particle size distribution of the emulsion formulations was measured using a Nanotrac dynamic light scattering (DLS) analyzer. Precisely 0.1 mL of the emulsion was taken and diluted with distilled water up to 250 mL to achieve the optimal scattering intensity for analysis. The diluted sample was then subjected to analysis, and the average globule size, along with the size distribution profile, was recorded.

Preparation of Emulgel:
Carbopol 934 and Hydroxypropyl Methylcellulose K15M (HPMC K15M) were separately dispersed in distilled water at concentrations of 1.5%, 2.0%, and 2.5% (w/v) to prepare gel bases. The optimized emulsion formulation containing Nabumetone, equivalent to 0.5% (w/w) drug content, was incorporated into the respective gel bases under continuous stirring to obtain the emulgel. Triethanolamine was used to adjust the pH of the prepared emulgel to the target range. Glycerin was added as a humectant to maintain moisture content, while methylparaben and propylparaben were included as preservatives to ensure microbial stability. The final emulgel formulation contained 1% (w/w) Nabumetone. Details of the compositions are summarized in [Table 2].

Characterization of Emulgel:
Physical Examination:
The emulgel formulations were visually examined to assess their color, uniformity, and texture.

Drug Content:
A precisely weighed 1 g portion of the emulgel was mixed with 100 mL of methanol and sonicated for two hours to facilitate complete extraction of the drug. The solution was then passed through filter paper to eliminate any residual excipients. The filtrate's absorbance was determined using a UV-visible spectrophotometer at 261 nm, employing a placebo emulgel as the reference. The amount of Nabumetone present was quantified using the linear equation obtained from the calibration

curve. All experiments were conducted in triplicate to ensure reliability and consistency of the results [9].

pH:
The pH of each emulgel formulation was evaluated using a calibrated digital pH meter. To perform this test, 1 gram of the emulgel was mixed with 100 mL of distilled water and kept undisturbed at ambient temperature for two hours to reach equilibrium. pH measurements were taken three times for each sample to confirm precision and reliability.

Table 2: Formulation table of Emulgel containing Nabumetone

INGREDIENTS	F1	F2	F3	F4	F5	F6
Nabumetone emulsion equivalent to 0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%
Carbopol934	1.5%	2%	2.5%	-	-	-
HPMCK15M	-	-	-	1.5%	2%	2.5%
Glycerine	1%	1%	1%	1%	1%	1%
Methylparaben	0.03%	0.03%	0.03%	0.03%	0.03%	0.03%
Propylparaben	0.03%	0.03%	0.03%	0.03%	0.03%	0.03%
Triethanolamine	0.02%	0.02%	0.02%	0.02%	0.02%	0.02%
Distilled water	q.s	q.s	q.s	q.s	q.s	q.s

Viscosity:
The flow behavior of the emulgel formulations was assessed using a CAP 2000+ cone and plate viscometer (Brookfield). Around 0.1 g of each sample was gently positioned at the center of the viscometer's plate below the spindle with the help of a spatula. The readings were taken at a speed of 50 rpm while maintaining a constant temperature of 25°C. The corresponding dial reading was recorded, and viscosity values were expressed in centipoise (cP). All measurements were performed in triplicate to ensure precision and reproducibility [10].

Spreadability:
To assess the spreadability of the emulgel formulations, the parallel plate technique was employed. A 1 g portion of the emulgel was positioned on a glass slide, confined to a circular area of 2 cm in diameter. Another glass slide was gently lowered over the formulation, and a 0.5 g weight was placed on top. After a resting period of 5 minutes without disturbance, the expansion in the diameter of the spread material was measured to evaluate its spreadability. Spreadability (S) was calculated using the following equation:

$$\mathbf{S=}B/A*100 \quad (1)$$

Where,
A= Diameter of the circle, B=Final area after spreading

Extrudability:
The ease of extrusion for the emulgel formulations was evaluated by determining the force needed to expel a 0.5 cm strip of the formulation from a lacquered collapsible aluminum tube within 10 seconds. The experiment was repeated three times, and the average values were calculated for accuracy [11]. The extrudability was calculated using the following expression:

Extrudability = Force required to expel the emulgel (g) / Orifice area (cm^2) (2)

***In-Vitro* Release Study:**
The *in vitro* release profile of the emulgel was investigated using a modified Franz diffusion apparatus equipped with a dialysis membrane. An emulgel sample weighing 1 gram was uniformly spread over the membrane surface, while 50 mL of phosphate buffer (pH 5.8) was added to the receptor chamber. The system was kept at 37±0.5°C with stirring. At regular intervals, 1 mL samples were taken and replaced with fresh buffer. Drug release was measured spectrophotometrically at 261 nm. Experiments were done in triplicate, and cumulative release was plotted over time [11].

Drug Release Kinetics:
The release data were analyzed using Zero-order, First-order, Higuchi, and Korsmeyer-

Peppas models to determine the release mechanism, with the best-fitting model chosen based on correlation values.

Stability Studies:
The optimized formulation's short-term stability was assessed by storing samples at 25°C/60% RH and 40°C/65% RH for two months. Evaluations for pH, viscosity, drug content, and cumulative drug release (% CDR) were performed at one-month intervals.

RESULT AND DISCUSSION

Saturation Solubility of Nabumetone in Oils, Surfactants, and Co-Surfactants:
The solubility of Nabumetone in different oils, surfactants, and co-surfactants was evaluated to choose suitable excipients for the emulsion formulation. Light liquid paraffin showed the highest solubility among the tested oils at 5.21 mg/mL, while coconut oil and oleic acid had solubilities of 3.0 mg/mL and 1.8 mg/mL, respectively. For surfactants, Tween 80 exhibited the highest solubility (1.0 mg/mL), followed by Tween 20 (0.7 mg/mL) and Tween 40 (0.6 mg/mL). Among co-surfactants, PEG 400 showed the greatest solubility (8 mg/mL), compared to PEG 200 (4 mg/mL) and PEG (3 mg/mL). Considering these findings, light liquid paraffin, Tween 80, and PEG 400 were chosen as the components for preparing the emulsion.

Construction of Pseudoternary Phase Diagram:
Using the water titration technique, pseudoternary phase diagrams were developed to identify the microemulsion region. Based on initial solubility assessments, light liquid paraffin was chosen as the oil phase, with Tween 80 and PEG 400 serving as the surfactant and co-surfactant, respectively. The surfactant-to-co-surfactant ratio (S_{mix}) was adjusted to 1:1, 2:1, and 3:1, while the oil-to-S_{mix} ratio varied between 1:9 and 9:1. Water was gradually added until the mixture became turbid. The microemulsion region, indicated by the formation of clear and transparent systems, was mapped in the phase diagrams (Fig. 1).

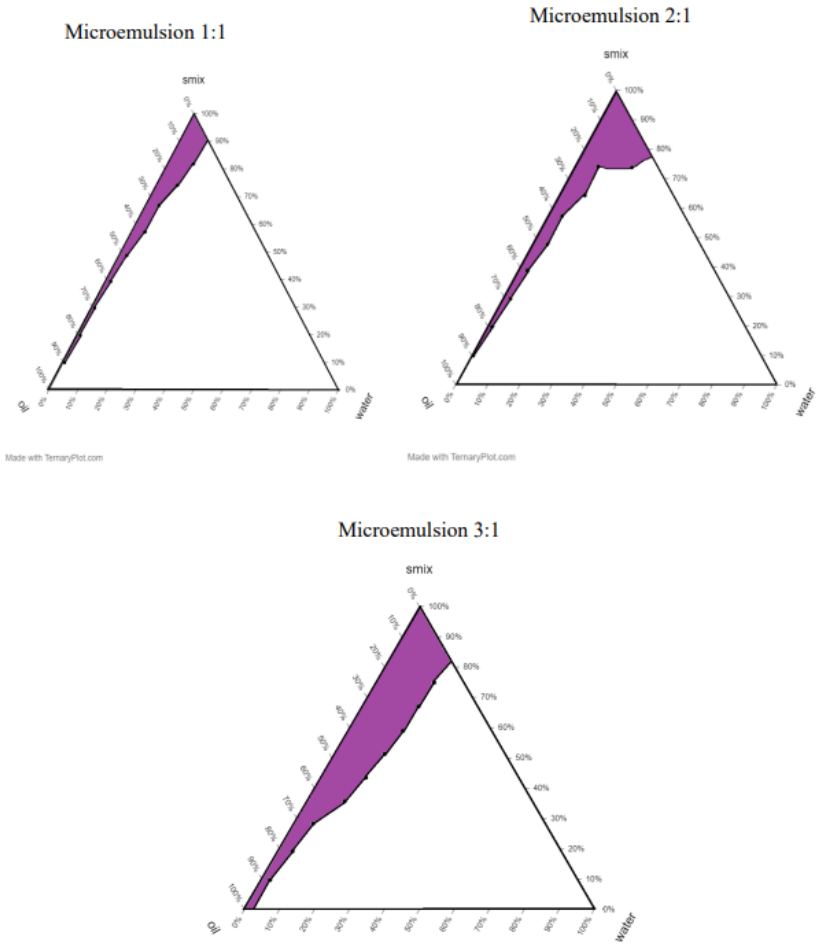

Figure 1: Pseudoternary Phase Diagrams of surfactant:co-surfactant ratios 1:1,2:1,3:1

The largest microemulsion area was obtained at a S_{mix} ratio of 3:1, suggesting improved microemulsification efficiency with increasing surfactant concentration. However, higher surfactant levels also required greater water content and were associated with reduced drug solubility. Additionally, formulations with oil: Smix ratios beyond 3:7 exhibited phase separation upon storage, indicating reduced physical stability. Therefore, the initial three oil: S_{mix} ratios from each S_{mix} level were selected for further formulation development.

Evaluation of Prepared Microemulsion:

Drug Content:

The drug content percentage was measured for all nine Nabumetone emulsion formulations. And the results are presented in Table 3. The drug content ranged from 79% to 94%, with formulation Q1 exhibiting the highest value at 94.05%, followed by R1 (92.70%) and P1 (92.18%). The higher drug content in formulation Q1 could be due to improved Nabumetone solubility in the chosen components and the reduced water volume needed to form the microemulsion. Q1 was formulated with a 2:1 surfactant to co-surfactant ratio and a 1:9 oil to S_{mix} ratio, which promoted effective drug loading and stability [12].

Globule Size Determination:

The size of globules in the prepared microemulsions was assessed using optical microscopy, and the data are shown in Table 3. A trend was observed wherein globule size decreased with increasing surfactant concentration. Among the formulations, Q1 exhibited the smallest globule size of 116 nm and was within the desirable microemulsion range (Fig. 2). In contrast, formulation R1 showed the largest globule size, which may negatively affect the diffusion rate, while P1 demonstrated an intermediate size. Based on its smaller globule size and higher drug content, formulation Q1 was selected as the optimized microemulsion for further evaluation [13].

Table 3: Drug Content and Globule Size Determination of the Prepared Microemulsions

Formulation Code	Globule Size	Drug Content*
P1	176.8 nm	92.18±1.850
P2	399 nm	89.07±1.126
P3	504 nm	83.29±2.219
Q1	116 nm	94.05±1.490
Q2	338 nm	89.69±1.290
Q3	454 nm	79.90±1.590
R1	199.5 nm	92.70±1.562
R2	202.4 nm	90.00±1.106
R3	347 nm	79.67±1.531

(P1, P2, P3 corresponds to Surfactant: Cosurfactant ratio 1:1, Q1, Q2, Q3corresponds to Surfactant: Cosurfactant ratio 2:1, and R1 R2 R3 corresponds to Surfactant: Cosurfactant ratio 3:1)

Characterisation of Nabumetone Emulgel:

Physical Appearance:

All formulations exhibited a uniform appearance ranging from cream to off-white. They demonstrated good homogeneity and consistency, with no evidence of phase separation observed during visual inspection, indicating satisfactory physical stability [12].

Drug Content:

The drug content in the prepared emulgels varied between 85.84% and 95.35%, as detailed in Table 4. Formulation F2, containing the optimized Q1 microemulsion and 2% Carbopol 934 as the gel base, exhibited the highest drug content at 95.35% [12].

pH:

The measured pH values for all formulations varied from 6.2 to 6.59, which is considered safe to prevent skin irritation. The data are shown in Table 4 [12].

Table 4: Appearance, Drug Content, pH of the prepared Emulgel Formulations

Formulation code	Colour	Drug content*	pH*
F1(Carbopol 1.5%)	Cream to off white	93.53±1.181	6.43±0.245
F2(Carbopol 2 %)	Cream to off white	95.35±0.812	6.54±0.410
F3(Carbopol 2.5%)	Cream to off white	90.70±1.440	6.38±0.306
F4(HPMCK15M 1.5%)	Cream to off white	91.48±1.039	6.59±0.394
F5(HPMCK15M 2%)	Cream to off white	85.84±2.579	6.35±0.145
F6(HPMCK15M 2.5%)	Cream to off white	86.52±2.314	6.51±0.109

EML

Microtrac Inc
10.6.2

Q1

Q1

02/06/2022 14:35
DB REC: 12355

Nanotrac
U2311l

Summary

Data	Value
MV(nm):	128.0
MN(nm):	102.4
MA(nm):	116.3
CS:	51.59
SD:	32.00
PDI:	0.1387
Mz:	121.5
σt:	36.82
Ski:	353.7
Kg:	1,378

Size %

Size(nm)	%Tile

%Tile

%Tile	Size(nm)
10.00	86.50
20.00	95.30
30.00	102.7
40.00	109.5
50.00	116.4
60.00	124.3
70.00	134.0
80.00	147.7
90.00	176.1
95.00	217.6

Peak Summary

Dia(nm)	Vol%	Width
116.4	100.0	63.90

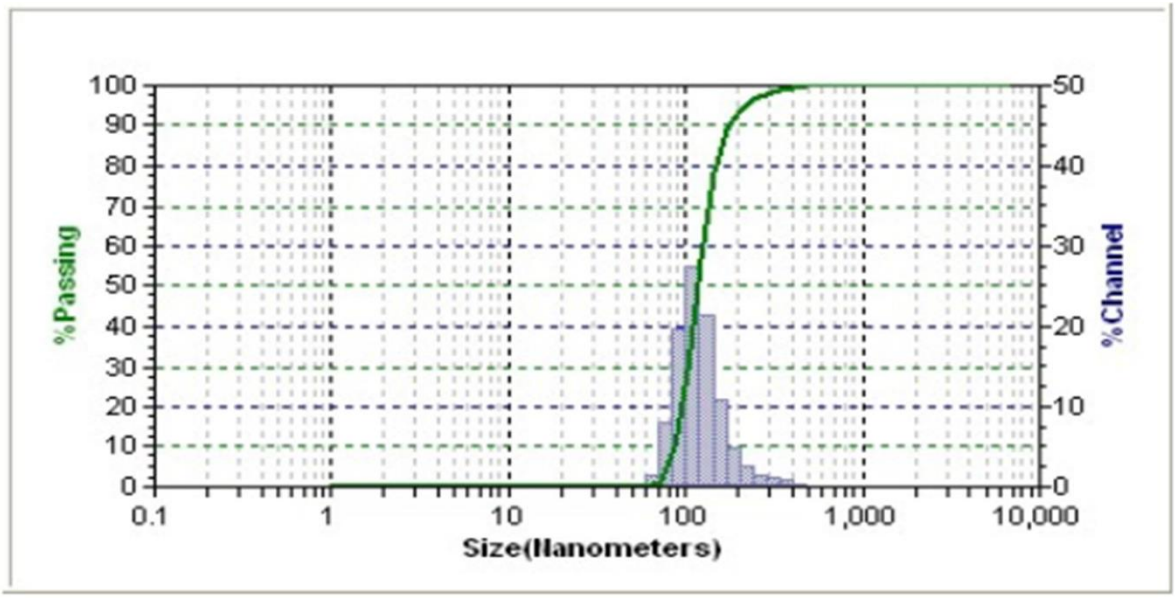

Figure 2: Globule size of Optimized Q1 formulation of emulsion

Viscosity:

Viscosity measurements of the Nabumetone emulgel formulations were carried out using a Brookfield viscometer, with results summarized in Table 5. The viscosities ranged from 11,800 to 44,474 cPs. Formulations containing Carbopol 934 exhibited higher viscosities compared to those prepared with HPMC K15M. Formulations F1 and F4 had the lowest viscosities, corresponding to their lower polymer concentrations (1.5% Carbopol 934 and 1.5% HPMC K15M, respectively). These findings indicate a direct correlation between polymer concentration and viscosity [14, 15].

Spreadability:

The spreadability of the emulgel formulations, indicating how easily they spread when applied,

varied between 2.0 and 3.9 g·cm/sec, as shown in Table 5. Spreadability was inversely related to viscosity; formulation F1, with a viscosity of 11,800 cPs, exhibited the highest spreadability value of 3.83 g·cm/sec. Increasing the concentration of the gelling agent led to higher viscosity and consequently reduced spreadability. Emulgels containing 1.5% Carbopol 934 demonstrated improved spreadability due to their lower polymer content [16, 17].

Extrudability:

Extrudability reflects the ease with which a semisolid formulation can be expelled from its container and is influenced by the formulation's viscosity and polymer concentration. As polymer concentration increased, extrudability decreased. The extrudability values of the formulations ranged from 2.1 to 14.32 g/cm^2, as shown in Table 5. Formulation F1 exhibited the highest extrudability (14.32 g/cm^2) corresponding to its lower viscosity (11,800 cPs), whereas formulation F6, with the highest viscosity (44,474 cPs), showed the lowest extrudability (5.03 g/cm^2) [18, 19].

***In-Vitro* Diffusion Studies:**

In vitro diffusion was performed using a Franz diffusion cell filled with 50 mL phosphate buffer (pH 5.8), maintained at 37±0.5°C, and continuously stirred with a magnetic stirrer. The cumulative percentage of drug released from the emulgel formulations after 8 hours ranged from 75.58% to 94.13%, as detailed in Tables 6. The drug release followed the order: F1 > F2 > F3 > F4 > F5 > F6, with respective release percentages of 95.22%, 94.13%, 91.95%, 89.77%, 87.01%, and 81.14%. An inverse relationship was observed between polymer concentration and drug release, where increased polymer content led to reduced drug diffusion. This decrease is attributed to the formation of a denser gel network at higher polymer concentrations, resulting in a longer diffusion path for the drug [20, 21].

Kinetic Study of *In Vitro* Release Data:

The drug release data were fitted to various kinetic models (Table 7). Formulation F1 best matched the Korsmeyer-Peppas model, indicating non-Fickian diffusion (n = 0.7801). Formulations F2 to F6 followed zero-order kinetics, showing a constant release rate [22, 23].

Table 5: Viscosity, Spreadability, and Extrudability of Emulgel Formulations

Formulation code	Viscosity*(cps)	Spreadability*(gm.cm/sec)	Extrudability*(gm/ cm^2)
F1(Carbopol 1.5%)	11800±159.21	3.83±0.11	14.32±0.687
F2(Carbopol 2 %)	15852.3±343.13	3.53±0.06	11.45±1.245
F3(Carbopol 2.5%)	37587±120.97	2.22±0.09	9.78±1.035
F4(HPMCK15M 1.5%)	15530±100.2	3.60±0.21	7.56±0.401
F5(HPMCK15M 2%)	26660±1945.1	3.54±0.10	6.37±0.730
F6(HPMCK15M 2.5%)	44474±131.3	2.75±0.13	5.03±0.450

Table 6: *In Vitro* Diffusion Profile of F1 – F6 Formulations

Time (Hrs.)	% Cumulative Drug Release for All the Formulations					
	F1	F2	F3	F4	F5	F6
0	0	0	0	0	0	0
1	9.09	16.27	15.00	15.54	15.36	11.23
2	20.54	25.23	23.11	22.40	23.30	26.03
3	36.04	36.73	33.76	34.75	32.67	32.00
4	41.75	46.63	52.14	42.61	41.49	38.54
5	61.92	63.62	60.70	58.43	53.84	50.10
6	74.66	74.39	71.96	69.65	61.60	61.70
7	84.00	84.80	81.78	80.88	71.04	72.51
8	95.22	94.13	91.95	89.77	87.01	81.14

Table 7: *In-Vitro* Drug Release Kinetics of F1 To F6 Formulations

FORMULATION	ZERO ORDER	FIRST ORDER	HIGUCHI	PEPPAS		HIX.CROW	BEST FIT MODEL
	(R^2)	(R^2)	(R^2)	(R^2)	(n)	(R^2)	
F1(Carbopol 1.5%)	0.9929	0.8751	0.9761	0.9946	0.7801	0.9497	Peppas
F2(Carbopol 2 %)	0.9954	0.8970	0.9735	0.9896	0.7384	0.9574	Zero order
F3(Carbopol 2.5%)	0.9933	0.9187	0.9786	0.9875	0.7347	0.9684	Zero order
F4(HPMCK15M 1.5%)	0.9946	0.9208	0.9660	0.9828	0.7264	0.9622	Zero order
F5(HPMCK15M 2%)	0.9929	0.8810	0.9590	0.9870	0.7675	0.9359	Zero order
F6(HPMCK15M 2.5%)	0.9923	0.9431	0.9701	0.9869	0.7710	0.9693	Zero order

Stability Studies:

Formulation F2 showed a consistent appearance throughout 60 days of storage. Minor pH changes were observed at 30 and 60 days, possibly due to drug-polymer interactions. Viscosity remained largely unchanged, and drug release showed a slight decline after 60 days under both normal and accelerated conditions. These results suggest that F2 is stable for two months at room temperature and one month under accelerated storage [23].

CONCLUSION

This study successfully formulated a topical Nabumetone emulgel. Compatibility assessments showed no interactions between the drug and polymers. Based on solubility results, light liquid paraffin, Tween 80, and PEG 400 were chosen as formulation components. The pseudoternary phase diagram revealed that a surfactant-to-cosurfactant ratio of 3:1 yielded the largest microemulsion region. The optimized microemulsion (Q1) exhibited favorable globule size and drug content and was incorporated into gels prepared with Carbopol 934 and HPMC K15M. Among the emulgel formulations, F2 exhibited the most desirable characteristics regarding viscosity, drug content, and release profile. Stability evaluations confirmed that F2 maintained its integrity over two months under both ambient and accelerated storage conditions. These findings support Nabumetone's potential as a topical emulgel with improved patient adherence, although further *in vivo* investigations are necessary to confirm clinical efficacy.

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