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(RESEARCH ARTICLE)

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# Development and *In vitro* characterization of submicron emulsion gel of Tenoxicam

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## Abstract

The study was conducted to prepare the submicron emulsion gel of tenoxicam to improve the drug loading and permeation of the drug through the skin. The emulsion was prepared using hot homogenization and ultrasonification method. Further sonification was done to obtain the desired size of emulsion. Then by adjusting the concentration of carbopol 947 as 1%, 1.5%, and 2%, the gel was produced from prepared emulsion. The prepared emulgel was evaluated for its pH, viscosity, drug loading, and *In vitro* drug release studies. The appearance, phase separation, drug entrapment, and globule size of each produced formulation was also evaluated. All submicron emulsion made were consistent, homogenous, and free from phase separation and drug precipitation.

**Keywords:** Submicron emulgel; Tenoxicam; Novel drug delivery system; Hydrophobic drugs

## 1. Introduction

Submicron emulsions are tiny granular systems in the atomic size range which act as a carrier for drug molecules for enhancing the bioavailability of therapeutics. The size of submicron emulsion range within 10-1000nm. They are thermodynamically unstable isotropic systems in which emulsifying agents (surfactant and cosurfactant) are mixed along with two immiscible liquids to form a single phase. Submicron emulsions consist of oil, water, surfactant and cosurfactant. They are spherical in shape. They are classified as: o/w emulsion, w/o emulsion and bi-continuous emulsion.

Tenoxicam, sold under the brand name Mobiflex among others, is a nonsteroidal anti-inflammatory drug (NSAID). It is used to relieve inflammation, swelling, stiffness, and pain associated with rheumatoid arthritis, osteoarthritis, ankylosing spondylitis (a type of arthritis involving the spine), tendinitis (inflammation of a tendon), bursitis (inflammation of a bursa, a fluid-filled sac located around joints and near the bones), and periarthritis of the shoulders or hips (inflammation of tissues surrounding these joints).

Lecithin is a generic term to designate any group of yellow-brownish fatty substances occurring in animal and plant tissues which are amphiphilic – they attract both water and fatty substances (and so are both hydrophilic and lipophilic), and are used for smoothing food textures, emulsifying, homogenizing liquid mixtures, and repelling sticking materials. Lecithins are mixtures of glycerophospholipids including phosphatidylcholine, phosphatidylethanolamine, phosphatidylinositol, phosphatidylserine, and phosphatidic.

Carbopol polymers are high molecular weight, cross linked, acrylic acid-based polymer. These are polymers of acrylic acid cross-linked with polyalkenyl ethers or divinyl glycol. They are produced from primary polymer particles of about 0.2-to-6.0-micron average diameter. Today, Carbopol polymers are widely accepted ingredients in pharmaceutical dosage systems of almost every form, from controlled release tablets to oral suspensions to other Novel Delivery Systems, as well as a variety of topical products. Although these polymers are very mild acids - weaker than acetic acid

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- they readily react with alkali to form salts. Aqueous dispersions of Carbopol polymers have an approximate pH range of 2.8 to 3.2 depending on polymer concentration. Greater the concentration, the higher the carboxyl concentration and, therefore, lower the pH. Carbomer readily absorb water, get hydrated and swell. In addition to its hydrophilic nature, its cross-linked structure and its essentially insolubility in water makes Carbopol a potential candidate for use in controlled release drug delivery system.

## 2. Material and methods

### 2.1. Materials

Tenoxicam was obtained from Anant pharmaceutical Pvt Ltd, Maharashtra and Ex**c**ipients - Tween 80, Sodium chloride, Methanol and Disodium hydrogen phosphate were obtained from Finar Pvt. Ltd., Ahmedabad, Cholesterol from Thomas baker (chemical), Mumbai., Ethanol from Changshu Yangquan Chemical, China, Coconut Oil and Potassium dihydrogen phosphate, Molychem, Mumbai, Soyabean oil and Mustard oil from Avarice laboratories Pvt. Ltd., G.B Nagar, India and Span 40 from LobaCheim Pvt. Ltd., Mumbai.

### 2.2. Preformulation studies

#### *2.2.1. Organoleptic properties*

Visual observations were used to conduct organoleptic investigations on things like general look, nature, colour, and odour.

#### *2.2.2. Melting point*

To understand drug purity, understanding the melting point is crucial. To establish the melting range, the sample was first dried. This determination was made using the capillary fusion method and a digital capillary melting point device from Cambell Electronics in Mumbai. One end of a capillary was sealed after being brought close to the burner flame. The capillary tube's open end was inserted into a small pile of drug, causing a small plug of powder to gather there. The tube was then gently tapped, causing the drug lump to settle. This procedure was carried out numerous times. The melting point measurement device was then used to position the capillary tube, and the temperature at which the sample transforms from a solid to a liquid was monitored. The experiment was performed in triplicate. The temperature at which starts to melt was noted with the help of thermometer compared with earlier reported value.

#### *2.2.3. Solubility*

Tenoxicam's solubility in a variety of solvents, including 0.1NNaoH, acetone, 0.1NHcl, DCM, Methanol, and distilled water, was assessed. Studies on drug solubility are conducted in triplicate at 25 °C by agitating extra drug in a stoppered volumetric flask containing 5 ml of solvent. The flasks were vortex combined for five minutes after sealing and then sonicated for thirty minutes. Then, using a water bath shaker, the mixtures were allowed to shake for 24 hours at 100 rpm. Samples were looked at with a UV spectrophotometer after 24 hours.

#### *2.2.4. Drug- Excipients compatibility study*

The behavior of the tenoxicam in the optimized formulation was ascertained using FTIR spectroscopy of the pure medicine and the optimized formulation. For the proposed investigation, samples were suitably diluted with dried KBR, and Shimadzu 8400S FT-IR was used to obtain IR spectra with a resolution of 4 $cm^{-1}$ in the 400–4000 $cm^{-1}$ range.

#### *2.2.5. Partition coefficient studies*

Prior to conducting the experiments, the two solvents were mutually saturated at a 1:1 ratio. Unknown drug concentration saturated solutions were made in aqueous solutions. Then, in glass flasks, 5.0 mL of the aqueous chemical solution was mixed with 5.0 mL of octanol. After then, the mixes were shaken mechanically for an hour. At room temperature, samples were let to stand in a separating funnel for 24 hours. Following this, the aqueous phases were separated, and the drug concentrations were calculated using the same method described earlier by measuring the UV absorbances. The partition coefficients were determined using the provided equation. At least three times each of the partitioning experiments were repeated.

$$\text{Log p} = \frac{concentration\ of\ drug\ in\ non-aqueous\ phase}{concentration\ of\ drug\ in\ aqueous\ phase}$$

## 2.3. Preparation of standard plot of tenoxicam in methanol

### *2.3.1. Standard Solution*

10 mg precisely weighed. The drug was dissolved in 100 ml of methanol solution to produce a 1 mg/ml solution.

### *2.3.2. Dilutions*

Aliquots of the reference solution were pipette-out into 10-milliliter volumetric flasks for dilution. Methanol solution was added to the volume as needed to create a concentration range of 2-20µg/ml. With a UV spectrophotometer, the absorbance of each produced solution was measured at 360 nm in comparison to a suitable blank (Methanol solution). Every absorbance test was done in triplicate (n = 3).

## 2.4. Preparation of Submicron emulsion

Hot homogenization and ultra sonification were used to create a tenoxicam-loaded submicron emulsion. To obtain a transparent solution, the oil phase, which contains oil-soluble components (lipid, oil, and drug), and the aqueous phase, which contains water-soluble components (tween 80), were each heated to a temperature of 70 °C. The oily phase was then mixed with the aqueous phase for 5 minutes to create a coarse emulsion. To obtain submicron lipid emulation, the coarse emulsion was further sonicated using a probe at 50% amplitude for around 20 minutes. Zeta potential, polydispersity index, and globule size were used to describe the prepared TSE.

**Table 1** Composition of different tenoxicam loaded submicron lipid emulsion

| S. No. | Formulation code | Tenoxicam (% w/w) | Lipid (Soya lecithin) (%w/w) | MCT Oil (%w/w) | Coconut Oil (%w/w) | Mustard (%w/w) | Soybean oil (%w/w) | Tween 80 (%w/w) |
|---|---|---|---|---|---|---|---|---|
| 1 | TSE1 | 1 | 2 | 10 | - | - | - | 1 |
| 2 | TSE2 | 1 | 2 | - | 10 | - | - | 1 |
| 3 | TSE3 | 1 | 2 | - | - | 10 | - | 1 |
| 4 | TSE4 | 1 | 2 | - | - | - | 10 | 1 |
| 5 | TSE5 | 1 | 1 | - | - | - | 10 | 1 |
| 6 | TSE6 | 1 | 3 | - | - | - | 10 | 1 |
| 7 | TSE7 | 1 | 3 | - | - | - | 5 | 1 |
| 8 | TSE8 | 1 | 3 | - | - | - | 15 | 1 |

## 2.5. Evaluation of Tenoxicam loaded Submicron lipid emulsion

### *2.5.1. Visual Appearance*

The physical stability of the generated drug-loaded submicron emulsion, such as phase separation and drug precipitation after 24 hours, was assessed visually.

### *2.5.2. pH*

The pH of the topically applied formulations typically ranges from 6 to 8, which is close to the pH of the skin. Using a pH meter, the pH of every created drug-loaded formulation was determined.

$$\text{Entrapment efficiency } (\%) = \frac{(Ct - Cf)}{Ct} \times 100$$

Where Ct is the concentration of total tenoxicam, and Cf is the concentration of free Tenoxicam.

### *2.5.3. Measurement of Globule size and Zeta Potential*

Using a Zetasizer Nanoseries device from Malvern Instruments, the average hydrodynamic diameter of submicron emulsion was calculated using DLS, and the surface charge of the submicron emulsion was evaluated using zeta potential measurements. Water was used to prepare the samples. The sample was equilibrated for at least three minutes

at each temperature before the DLS measurements were conducted, which were conducted during alternating increasing and decreasing temperature cycles. The Z-average value determined by DLS1 and the average hydrodynamic diameter of the nanogels under investigation were the same. At 25°C, the zeta potential measurements were carried out. Every study was completed in triplicate.

### 2.6. Method of Formulation of Submicron emulsion based Topical gel

The submicron emulsion formulation was improved, and a gel basis was added because the nano-emulsion has a very low viscosity for topical distribution. By adjusting the concentration of carbopol 947 as 1%, 1.5%, and 2%, the gel was produced. The necessary amount of carbopol was soaked in enough water for 24 hours to prepare the gel, and the nano-emulsion formulation was then applied after neutralizing the pH of the carbopol. For Submicron emulsion-based gel optimization, the following factors were assessed.

**Table 2** Composition of different Submicron emulsion gel formulations

| S.no. | Formulation code | Drug Concentration (%w/w) | Concentration of Carbopol 947 (%w/w) | Lipid (Soya lecithin) (%w/w) | Soybean Oil (%w/w) | Tween 80 (%w/w) |
|---|---|---|---|---|---|---|
| 1 | TSE8G1 | 1 | 1 | 3 | 15 | 1 |
| 2 | TSE8G2 | 1 | 1.5 | 3 | 15 | 1 |
| 3 | TSE8G3 | 1 | 2 | 3 | 15 | 1 |

### 2.7. Evaluation of Tenoxicam loaded submicron emulsion gel

#### *2.7.1. Homogeneity*

After being put in the container, all developed gels were visually inspected to determine their homogeneity. For appearance and the presence of any aggregates, they underwent testing.

#### *2.7.2. Measurement of pH*

A digital pH meter was used to measure the pH of different formulations. After being dissolved in 100 ml of distilled water, 1 g of gel was let to stand for two hours. Each formulation's pH was tested in triplicate, and the average values were computed. The topical gel formulation's pH should be between 3–9 to treat the skin infections.

#### *2.7.3. Drug content*

Each gel formulation's weighted 1 gm were added to a 250 ml volumetric flask with 20 ml of alcohol and swirled for 30 minutes. The volume was filtered and increased to 100 ml. Once more, 1 ml of the aforementioned solution was diluted to a final concentration of 10 ml with alcohol after being previously diluted to 1 ml. At 360 nm, the solution's absorbance was determined spectrophotometrically.

#### *2.7.4. Viscosity study*

A Brookfield viscometer DVII model with a T-Bar spindle in conjunction with a helipath stand was used to measure the gel's viscosity. The viscosity of the gels was measured using the T-bar spindle (T95). Temperature, pressure, sample size, and other variables. which affected the viscosity was preserved throughout the procedure. Viscosities were provided at various locations along the path by moving the helipath T-bar spindle up and down. The torque value was consistently higher than 10%. The viscosity of gels was determined by taking an average of three readings in a minute.

#### *2.7.5. In vitro drug release study*

The Franz diffusion equipment was used to measure the release of tenoxicam from its submicron emulsion gel. The membrane was dipped in the medium for 24 hours before to use. The membrane was installed between the donor and receiver compartments of the Franz diffusion cell, on which the gel was evenly spread over the majority of the surface. The donor chamber of the Franz diffusion apparatus was filled with a precisely calculated amount of gel (1gm). The device's receiver chamber filled with 35 ml of phosphate buffer, pH 7.4. The experiment was conducted at a constant speed of 50 rpm at a temperature of 37 °C. At regular intervals, aliquots were taken out, filtered using a sterile Millipore filter (0.2 m cut off, Millipore, Bedford, USA), and the amount of medication was measured spectrophotometrically at 360 nm. The outcomes were the average values across three runs.

## 3. Results and discussion

### 3.1. Organoleptic properties (API)

Tenoxicam is a crystalline powder that is solid, yellow in colour, and odourless.

### 3.2. Melting point

The melting point of tenoxicam was found to be 205±1.52 °C -212±2 °C, which is within the suggested range of 205 °C to 213 °C in the literature.

### 3.3. Determination Absorption Maxima by UV Spectroscopy

Tenoxicam solution was subjected to UV scanning at a specific concentration of 10µg/ml in methanol. The absorption maxima were found to be at 360nm, which is comparable to the value of 368nm reported in the literature.

### 3.4. Standard linearity calibration curve of Tenoxicam in Methanol

By developing a graph between the absorbance and concentration, a standard calibration curve was constructed in the range of 2–20µg/ml. Absorbance of Tenoxicam solutions at various concentrations, as indicated in table 3. The $R^2$ value of 0.999 and the value of the regression equation Y = 0.0402x - 0.0027 indicated good linearity.

**Table 3** Calibration curve of Tenoxicam in methanol

| Concentration (µg/ml) | Absorbance at 360nm |
|---|---|
| 0 | 0±0 |
| 2 | 0.080±0.001 |
| 4 | 0.172±0.001 |
| 6 | 0.228±0.003 |
| 8 | 0.311±0.002 |
| 10 | 0.394±0.002 |
| 12 | 0.474±0.003 |
| 14 | 0.565±0.003 |
| 16 | 0.636±0.004 |
| 18 | 0.727±0.001 |
| 20 | 0.802±0.002 |

### 3.5. Solubility studies of drug:

The solubility of drug was determined in different solvents.

**Table 4** Solubility (mg/ml) of Tenoxicam in different solvents

| Name of solvent | Solubility (mg/ml) |
|---|---|
| Water | 0.61±0.02 |
| 0.1MNaoH | 14.14±0.069 |
| 0.1NHcl | 1.17±0.012 |
| Methanol | 3.25±0.021 |
| Acetone | 2.81±0.021 |
| Dichloromethane | 8.59±0.010 |

### 3.6. Partition coefficient of drug

Table 5 displays the partition coefficient of tenoxicam in the n-octanol: water mixture. Drugs having partition coefficients less than one are indicative of hydrophilic drugs, while those with log P greater than one are lipophilic in nature.

**Table 5** Partition coefficient of Tenoxicam

| S. No. | Drug | Reference partition coefficient | Observed Partition coefficient (Log P) | Nature of the drug |
|---|---|---|---|---|
| 1. | Tenoxicam | 2.40 | 2.5259±0.0049 | Lipophilic |

### 3.7. Identification of pure drug (FT-IR spectra)

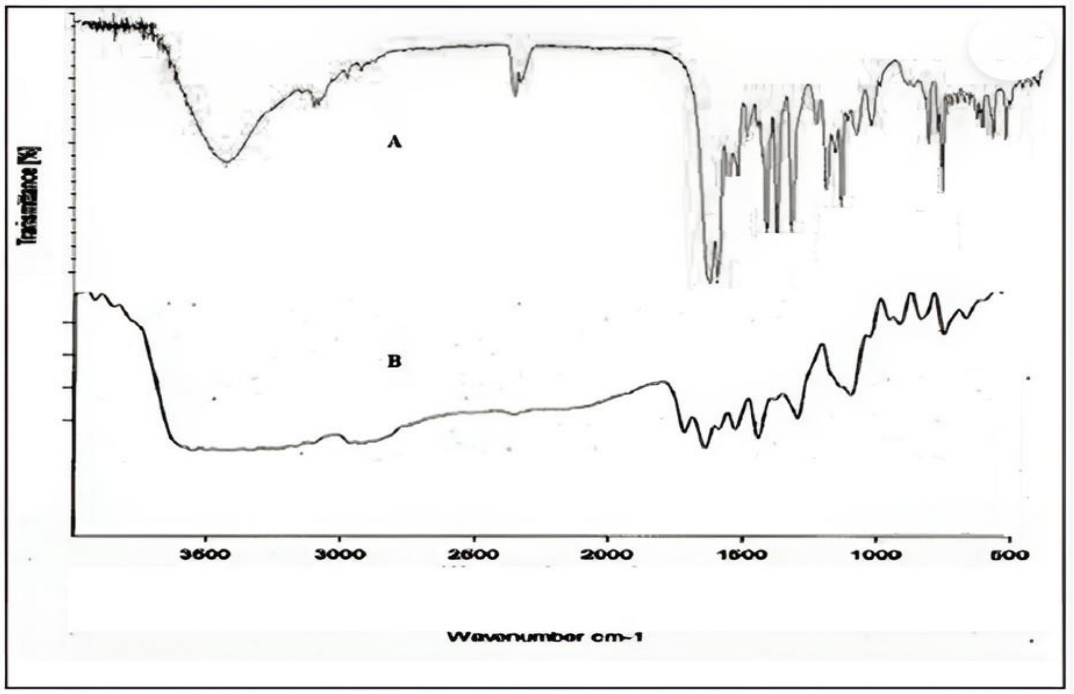


**Figure 1** Graph of FTIR spectrum of A) Tenoxicam B) Optimized submicron emulsion formulation

Pure Tenoxicam FTIR spectrum showed sharp characteristic peaks of Tenoxicam at 3440cm$^{-1}$, 3091$^{-1}$, corresponding to NH and OH groups, and 1,635, 1,598, 1,530 cm-1 corresponding to the amide, C = O, and C = N groups group as shown in Figure 1. The FTIR spectrum of the optimized formulation tenoxicam loaded submicron emulsion demonstrated the characteristic peak of the tenoxicam with very less intensity indicating the encapsulation of the drug into the emulsion globules.

### 3.8. Preparation of Tenoxicam loaded Submicron emulsion

The development of submicron-sized lipid emulsions involved the use of a high-speed mixer and an ultrasonication procedure. Initially, a different oil was used to prepare a tenoxicam-loaded submicron size emulsion. We evaluated the appearance, phase separation, drug entrapment, pH, and globule size of each produced formulation.

### 3.9. Evaluation of Tenoxicam loaded Submicron emulsion

*3.9.1. Visual Appearance*

In contrast to other oils, Table 6 showed that all submicron emulsion were consistent, homogenous, and free from phase separation and drug precipitation.

**Table 6** Visual appearance

| Sr.no. | Formulation code | Appearance |
|---|---|---|
| 1 | TSE1 | Uniform, Homogenous, and no phase separation and Non-precipitation of drug |
| 2 | TSE2 | Non uniform and phase separation |
| 3 | TSE3 | Non uniform and phase separation |
| 4 | TSE4 | Uniform, Homogenous, and no phase separation and Non-precipitation of drug |
| 5 | TSE5 | Uniform, Homogenous, and no phase separation and Non-precipitation of drug |
| 6 | TSE6 | Uniform, Homogenous, and no phase separation and Non-precipitation of drug |
| 7 | TSE7 | Uniform, Homogenous, and no phase separation and Non-precipitation of drug |
| 8 | TSE8 | Uniform, Homogenous, and no phase separation and Non-precipitation of drug |

*3.9.2. pH of prepared formulation*

**Table 7** pH of all prepared formulations

| S. No. | Formulation code | pH |
|---|---|---|
| 1 | TSE1 | 6.285±0.13 |
| 2 | TSE2 | 6.52±0.04 |
| 3 | TSE3 | 6.55±0.35 |
| 4 | TSE4 | 6.30±0.22 |
| 5 | TSE5 | 6.61±0.02 |
| 6 | TSE6 | 6.575±0.09 |
| 7 | TSE7 | 6.34±0.13 |
| 8 | TSE8 | 6.415±0.12 |

Table 7 showed that the pH of all formulations ranged from 6.85±03.135 to 6.61±0.02.

*3.9.3. Percentage drug content*

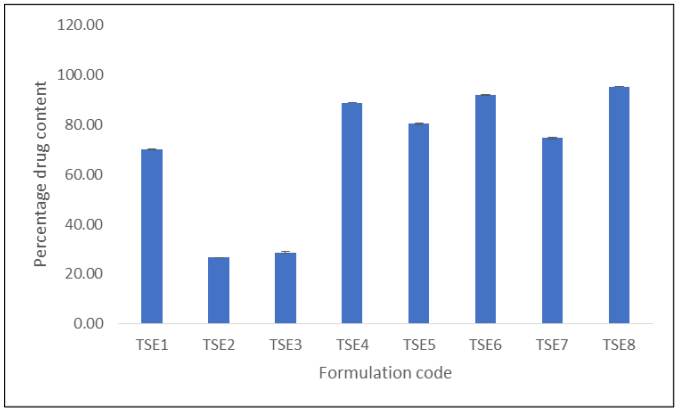


**Figure 2** Percentage drug content of all prepared formulations

Tenoxicam was more soluble in soybean oil when the oil concentration was increased from 5% weight per weight to 15% weight per weight. The maximum percentage of drugs detected in formulation code TSE8 was 95.37±0.04%.

TSE8 formulation was chosen for further evaluation based on the aforementioned evaluation criteria.

*3.9.4. Particle size and Zeta Potential*

**Table 8** Average Globule size, PDI and Zeta Potential of TSE8 formulation

| S.No. | Formulation code | Globule size (nm) | PDI | Zeta Potential (mv) |
|---|---|---|---|---|
| 1 | TSE8 | 379.69 | 0.199 | -24.7 |

Globule size and PDI value were found to be 379.69. nm and 0.199 respectively. with, a negative zeta potential of -24.7 mV was detected.

### 3.10. Incorporation of Tenoxicam loaded Submicron emulsion into Carbopol gel

The optimized TSE8 formulation was added to a gel foundation containing various Carbopol concentrations and tested for several *in vitro* characterization parameters, including pH, drug content, viscosity, and *in vitro* drug release studies.

### 3.11. Evaluation of Tenoxicam loaded Submicron emulsion into Carbopol gel

*3.11.1. Visual Appearance of gel*

**Table 9** Appearance of all submicron emulsion gel formulation

| S. No. | Formulation code | Appearance | Ph |
|---|---|---|---|
| 1 | TSE8G1 | Non uniform, Non Homogenous gel, less thick | 6.92±0.59 |
| 2 | TSE8G2 | Uniform, Homogenous gel | 7.24±0.67 |
| 3 | TSE8G3 | Homogenous, Uniform gel and slightly thick gel | 7.10±1.08 |

The gel's thickness grows as Carbopol concentration is increased. Whereas 2%w/w Carbopol gel was significantly thicker in texture, 1.5%w/w Carbopol gel was homogeneous and consistent in appearance. pH values for all gel formulations ranged from 6.92±0.59 to 7.24±0.67.

*3.11.2. Percentage drug content*

The range of drug content in all produced formulations was found to be between 73.03±0.79% to 98.90±0.26. Drug content will grow in percentage with rising gelling agent concentration up to a certain point after which it will be unaffected by Carbopol concentration. TSE8G2 were chosen for more investigation.

**Table 10** Value and states of percentage drug content of all gel formulations

| S.No. | Formulation code | Percentage drug content |
|---|---|---|
| 1 | TSE8G1 | 73.03±0.79 |
| 2 | TSE8G2 | 98.90±0.26 |
| 3 | TSE8G3 | 97.03±0.61 |

*3.11.3. Viscosity of gel*

Viscosity measurements at various rpm revealed the gel's mechanical strength and flow characteristics. While the gel in a viscosity investigation remained homogeneous, there was no sign of gel disintegration.

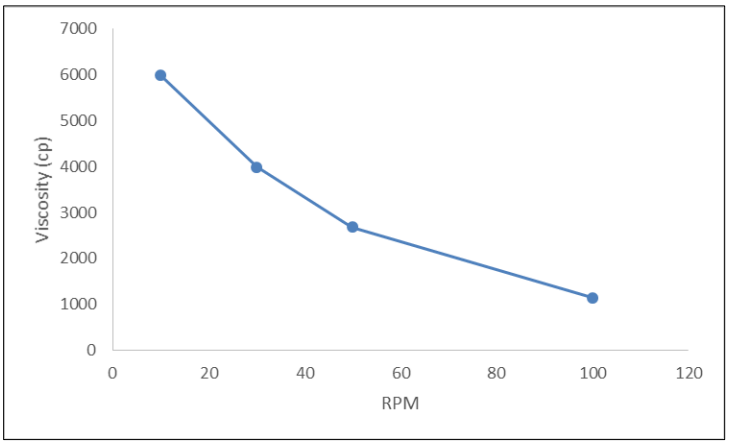


**Figure 3** Graph of Viscosity of Submicron emulsion embedded gel formulations

*3.11.4. Percentage drug release study of Submicron emulsion embedded gel formulations*

**Table 11** Percentage drug study of submicron emulsion embedded gel formulations TSE8G2 and control gel

| Time (Hr.) | Percentage drug release of Control gel | Percentage drug release of TSE8G2 |
|---|---|---|
| 0 | 0±0 | 0±0 |
| 0.25 | 6.50±0.24 | 10.98±0.18 |
| 0.5 | 6.80±0.26 | 20.39±0.30 |
| 1 | 9.24±0.18 | 35.40±0.49 |
| 2 | 16.25±0.61 | 43.89±0.30 |
| 4 | 20.04±0.30 | 61.22±0.43 |
| 6 | 29.18±0.18 | 77.02±0.24 |
| 8 | 32.18±0.20 | 81.44±0.61 |
| 10 | 36.06±0.061 | 90.28±1.23 |
| 12 | 36.54±0.25 | 99.42±0.84 |
| 24 | 36.97±0.29 | 100.29±0.61 |

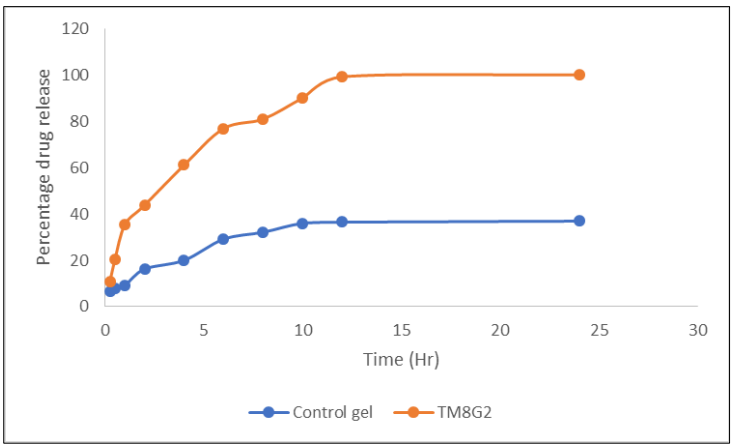


**Figure 4** Comparison Graph of In-vitro drug release of control gel and TSE8G2 formulations

At 24 hours, it was discovered that both submicron emulsion gels had larger drug percentages than the control gel, however the release of tenoxicam was discovered to be higher in the TSE8G2 gel than the control gel.

## 4. Conclusion

The melting point of tenoxicam was found to be 205±1.52 °C -212±2 °C, which is within the suggested range of 205°C to 213°C in the literature. Tenoxicam solution was subjected to UV scanning at a specific concentration of 10µg/ml in methanol. The absorption maxima were found to be at 360nm, which is comparable to the value of 368nm reported in the literature. By developing a graph between the absorbance and concentration, a standard calibration curve was constructed in the range of 2–20µg/ml. Absorbance of Tenoxicam solutions at various concentrations. The $R^2$ value of 0.999 and the value of the regression equation Y = 0.0402x - 0.0027 indicated good linearity. Tenoxicam showed maximum solubility in 0.1MNaoH, followed by dichloromethane, whereas it showed least solubility in distilled water. The partition coefficient of tenoxicam in the n-octanol: water mixture. Drugs having partition coefficients less than one are indicative of hydrophilic drugs, while those with log P greater than one are lipophilic in nature. Pure Tenoxicam FTIR spectrum showed sharp characteristic peaks of Tenoxicam at 3440$cm^{-1}$, 3091$^{-1}$, corresponding to NH and OH groups, and 1,635, 1,598, 1,530 cm-1 corresponding to the amide, C = O, and C = N groups group.78 The FTIR spectrum of the optimized formulation tenoxicam loaded submicron emulsion demonstrated the characteristic peak of the tenoxicam with very less intensity indicating the encapsulation of the drug into the emulsion globules. The development of submicron-sized lipid emulsions involved the use of a high-speed mixer and an ultrasonication procedure. Initially, a different oil was used to prepare a tenoxicam-loaded submicron size emulsion. We evaluated the appearance, phase separation, drug entrapment, pH, and globule size of each produced formulation. All submicron emulsion made were consistent, homogenous, and free from phase separation and drug precipitation. Tenoxicam was more soluble in soybean oil when the oil concentration was increased from 5% weight per weight to 15% weight per weight. The maximum percentage of drugs detected in formulation code TSE8 was 95.37±0.04%. TSE8 formulation was chosen for further evaluation based on the aforementioned evaluation criteria. Globule size and PDI value were found to be 379.69. nm and 0.199 respectively. with, a negative zeta potential of -24.7 mV was detected. The optimized TSE8 formulation was added to a gel foundation containing various Carbopol concentrations and tested for several *in vitro* characterization parameters, including pH, drug content, viscosity, and *in vitro* drug release studies. At 24 hours, it was discovered that both submicron emulsion gels had larger drug percentages than the control gel, however the release of tenoxicam was discovered to be higher in the TSE8G2 gel than the control gel.

## Compliance with ethical standards

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### *Disclosure of conflict of interest*

No conflict of interest to be disclosed.

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