FORMULATION AND IN-VITRO CHARACTERIZATION OF SWERTIA CHIRATA EMULGEL FOR TOPICAL USE

Prince Kumar Saini[1*], Mukesh Kumar[2], Shamim[3], Prabhakar Vishvakarma[4]

Abstract

Previous studies suggests that emulgel of *Swertia chirata* leaves extract has not been formulated yet. So, the present study is focused on the formulation and estimation of *Swertia chirata* emulgel for topical use. The fresh leaves of *Swertia chirata* were collected from the local region in western Uttar Pradesh. It was identified and authenticated by a botanist with specimen no. NBRI/PA/2022/12/0027. The powder of *Swertia chirata* was weighed and extracted through Soxhlet apparatus using ethyl alcohol. The preformulation study was performed for the extract in terms of solubility, and extract-excipient compatibility studies. The gel and emulsion were separately prepared then added together to get the Emulgel. Various physical examinations i.e., pH determination, swelling index, drug content estimation, spreadability, and in-vitro drug release were carried out. In results, preformulation study showed that *Swertia chirata* is well compatible to the different polymers used in the formulation of emulgel. Among all 3 preparations of emulgels, formulation F1 was found excellent in terms of pH range, viscosity, % drug release, swelling index, spreadibility and in-vitro drug release. However, physical appearance was found same as brown, translucent for all the emulgels (F1-F3). In conclusion, *Swertia chirata* emulgel F1 is one of the best compatible emulgel formulations with optimum characteristics. It suggests the isolation of active moieties and develop the optimized emulgels for different topical pharmacological uses.

Keywords: *Swertia chirata*, formulation, herbal, emulgel, FTIR.

[1*]Research Scholar, Faculty of Pharmaceutical Sciences, IIMT University Meerut, Uttar Pradesh, IN
[2,4]Associate Professor, Faculty of Pharmaceutical Sciences, IIMT University Meerut, Uttar Pradesh, IN
[3]Assistant Professor, Faculty of Pharmaceutical Sciences, IIMT University Meerut, Uttar Pradesh, IN

***Corresponding Author:** Prince Kumar Saini
*Research Scholar, Faculty of Pharmaceutical Sciences, IIMT University Meerut Uttar Pradesh, IN
Email: - princekumarsaini959@gmail.com

DOI: 10.48047/ecb/2023.12.si10.00307

INTRODUCTION

The subjective, protective, and modifiable nature of pain is influenced by factors such as one's development, behavior, personality, and culture. Pain is discomfort/sensory, and emotional experience typically associated with noxious stimuli and a response of a threatening condition in the tissues of the body, similar to hunger and thirst (WHO 2023). The neurochemicals involved in pain and its critical interactions with other systems like the thermoregulatory, sympathetic, parasympathetic, somatic, and immune systems are becoming increasingly well understood, and research into these systems is expanding. Prostaglandin has a strong effect on the nerve endings that register pain (McKay, 2009). In order to give the best care possible, it is crucial to determine the likely pain mechanism (s) during clinical examinations (Moayedi and Davis, 2013). Nociceptive neural processes refer to the brain's encoding and processing of painful sensations (Baron et al., 2010).

Emulgels are the newer dosage forms that are developed by the combination of emulsions and gels. They are prepared by the entrapment of aqueous or hydro-alcoholic liquid in the matrix system of colloidal solid particles. It acts as a dual controlled delivery system being stable than simple emulsion (Kumar et al. 2017). In recent years, there has been a lot of interest in the usage of new polymers with intricate roles as thickeners and emulsifiers. By lowering surface and interfacial stress and raising aqueous phase viscosity, these chemicals' capacity to gel enables the production of stable emulsions and creams (Patel et al. 2013).

Plant profile

Many medicinal herbs, including *Swertia chirata*, have been used historically as hepatoprotective agents. The herb has been used for centuries, but it wasn't introduced to Europe until 1839 (Kumar & Van, 2016). The genus Swertia was first described by Roxburgh in 1814, but was given the name Gentiana chirata at the time. About 135 endemic and introduced annual and perennial plant species are represented. Common swertia species components are found in many herbal remedies. The most important medicinal properties of C. Swertia are anti-inflammatory, hypoglycemic, hepatoprotective, antibacterial, wound healing, antispasmodic, antioxidant, anti-diabetic, antipyretic, and antitussive activity. Additionally, many pharmaceutical compounds that have anticancer, antitumor, and anti-AIDS properties were identified from natural plants (Laxmi et al. 2011).

The *chirata* plant's entire body can be used for medicinal purposes. Fresh samples of the herb have a specific brilliant yellowish colour all over them. The stem can be up to 1 m long, 6 mm in diameter, and yellowish-brown to purplish in colour. Its surface is smooth and free of hairs or projections. With a large, continuous, and easily separable yellow pith, the stem's lower portion is cylindrical while its top portion is slightly quadrilateral. The plant's leaves are acuminate, cauline, opposite, broad at the base, flattened, narrow oval-shaped, tapering to a point at each end, and typically have 5-7 clearly visible lateral veins.

Taxonomy

Kingdom : Plantae
Class : Magnoliopsida
Order : Gentianales
Family : Gentianaceae
Genus : *Swertia*
Species : *chirata*

Chemical constituents

The medicinal plants are a significant source of novel chemicals with potential applications in medicine. The world uses 119 or so pure chemicals that were derived from higher plants for medical purposes. Early research revealed that the Swertia chirata plant contains flavonoids, xanthones, terpenoids, iridoids, and secoiridoid glycosides (Banerjee et al. 2000).

Based on the available research, an emulgel containing an extract of *Swertia chirata* leaves has not yet been developed. This research therefore aims to formulate and quantify a topical emulgel of *Swertia chirata*.

MATERIALS AND METHODS

Experimental requirements

Swertia chirata leaves, Tween 80, Span 80, Carbopol 934, ethyl alcohol, clove oil, propylene glycol and methyl paraben.
Weight balance, FTIR Spectrophotometer, microscope, Soxhlet apparatus, digital pH meter and rotatory evaporator.

Collection, Identification & Authentication of plant

The fresh leaves of *Swertia chirata* were harvested from the local region in western Uttar Pradesh. It was identified and authenticated by a botanist. These were washed, dried under shade, and sieved for making dust-free and kept at room temperature or shade.

Extraction of plant

The powder of *Swertia chirata* was weighed and extracted through Soxhlet apparatus using ethyl alcohol. After, its filtration with whatman filter paper to get the extract in homogenous manner. The brownish semisolid extract was produced using a partial vacuum, and then dried using a rotary evaporator. The yield of the extract was calculated in percentage.

Pre-formulation determination

Pre-formulation investigations are conducted prior to formulation development and focus primarily on characterizing the pharmacological substance.

Pre-formulation studies are conducted prior to product development with the following primary goals in mind:

✓ To verify the crucial physicochemical nature of the medicine.

✓ To learn how well various excipients work with the medicine being formulated.

Extract and excipients compatibility

To check for any changes in the *Swertia chirata* chemical composition following its combination with the excipients/polymers. The *Swertia chirata* extract mixed with potassium bromide was applied and pressed into the shape of a disc. The disc was examined using Shimadzu FTIR spectroscopy (4000-400cm-1).

Solubility

The solubility of the herbal extract was determined by placing a small amount of it (about 1-2mg) individually in a test tube, adding 5ml of solvent (water, ethanol, PEG, 0.1N HCl, chloroform & phosphate buffer), shaking vigorously, and holding for a while. Take note of the product's solubility in various solvents when it is at room temperature.

Preparation of Standard Calibration Curve

A stock solution is prepared by properly weighing 100mg of *Swertia chirata* extract, dissolving it in 2ml of methanol and then adding 0.1 N HCl solution to bring the amount up to 100ml. To prepare the 100g/ml concentration solution, stock solution (10ml) is further diluted with 0.1N HCl (pH 1.2) in 100ml. Then, to prepare 2g, 4g, 6g, 8g, and 10g of drug/ml solution, 0.2, 0.4, 0.6, 0.8, and 1ml of solution are taken in a 10ml standard volumetric flask and the volume is increased to 10 ml with 0.1N HCl. The absorbance is then measured at 270 nm in a UV spectrophotometer using 0.1N HCl as a blank. Repeating the process with phosphate buffer at pH 6.8, absorbance is measured at 271nm (Gokani et al. 2019).

Formulation of Emulgel

Formulations with varied amounts of gelling agent were developed. Different gel formulations required a somewhat different procedure. In all formulations, emulsion preparation followed the same steps. To make the gel bases, CMC was dispersed in purified water heated to 80 degrees Celsius, and then the mixture was allowed to cool and sit overnight. Emulsifying wax was dissolved in light liquid paraffin to make the oil phase of the emulsion, and Tween 80 was dissolved in distilled water to make the aqueous phase. The aqueous phase was combined with solutions containing propyl paraben dissolved in PEG 200 and Swertia chirata extract dissolved in ethanol. Each component, oil and water, was brought to a temperature of 70 to 80 degrees Celsius before being combined and cooled to room temperature with constant stirring. The emulgel was made by combining the emulsion and gel in a 1:1 ratio and swirling the mixture gently (Pravallika & Reddy (2019).

Table. 1. List of ingredients of *Swertia chirata* extract emulgul

Ingredients	**F1**	**F2**	**F3**
Swertia chirata extract (g)	5.0	5.0	5.0
Liquid paraffin (ml)	2.0	2.0	2.0
CMC	0.5	1.0	1.5
Tween 80 (ml)	0.5	0.5	0.5
Emulsifying wax (g)	0.25	0.25	0.25
PEG 200 (ml)	2.5	2.5	2.5
Ethanol (ml)	5.0	5.0	5.0
Water	q. s.	q. s.	q. s.

EVALUATION PARAMETERS (Pani et al. 2014)

Physical Examination

In context to characterize total 3 forms of emulgels (F1-F3) were evaluated for their physical appearance i.e., colour, consistency, and phase separation.

Measurement of pH
A digital pH metre was used to measure the acidity or alkalinity of the emulgel mixtures. To prepare the emulgel solution, we first weighed out 1 gramme and dissolved it in 100 ml of distilled water, setting the mixture aside for 2 hours. pH levels were determined in triplicate for each formulation, and the average was recorded.

Viscosity
The nanogel's viscosity was measured using a Brookfield viscometer at room temperature (23°C2°C). Two different spindle speeds were used in three separate experiments to determine the viscosity.

Swelling Index
Step one involves placing 1 gramme of emulgel on a sheet of aluminium foil (porous) and dropping it into a beaker with 10 millilitres of 0.1N sodium hydroxide (NaOH). After various intervals, samples were taken from the beakers and stored in a dry location. The samples were reweighed after drying. % Swelling index = W_1-W/W × 100

Drug Content Estimation
The reaction time is 2 hours after 1 gramme of emulgel has been dissolved in 50 millilitres of 0.1N NaOH. After that, a UV visible spectrophotometer is used to measure the absorbance of 5 ml of the sample at a wavelength of 276 nm.

Spreadability
The spreadability value of a formulation affects its medicinal effectiveness as well. The spreading diameter of the emulgel (1g) between two horizontal plates of 20 cm 20 cm was measured to test the gel's ability to spread after one minute. To test spreadability, a standard weight of 125g was added to the upper plate. The spread circle's diameter was measured in centimetres, and the result is an average of three calculations (Gupta et al. 2012).

In-vitro Drug Release
Franz diffusion (FD) cells with phosphate buffer are used to test drug release in vitro. Diffusion occurs through a cellophane membrane, which is semipermeable. Twenty millilitres of medium are added to the receptor compartment until it reaches the mark on the collection limb. The membrane is maintained over the receptor subcellular compartment.

Put 1 g of emulgel on the membrane separating the donor and the receptor compartment and make sure it fits tightly. To create a laminar flow in the medium, the rpm of both the magnetic stirrer in the donor compartment and the external stirrer are modified. The FD cell's temperature is kept constant at 37 degrees Celsius by a water jacket. At regular intervals, 5 ml of material is drawn from the collection arm and the same volume is subsequently replaced with buffer media. The concentrations are then calculated after UV-spectrophotometer analysis of the samples at 276 nm wavelength.

RESULTS AND DISCUSSION

Pre-formulation studies

Solubility
Swertia chirata extract was evaluated for solubility in the various solvents listed below. Both methanol and ethanol showed freely solubility of *Swertia chirata* extract. It was shown to be soluble in phosphate buffer, $CHCl_3$ and CMC. Thus, it may be confirmed that *Swertia chirata* extract is more soluble in amphoteric solvent - ethanol compared to acidic and basic aqueous environments.

Table 2. Solubility of *Swertia chirata* extract

Solvent	***Swertia chirata* extract**
Methanol	Freely soluble
CMC	Soluble
Ethanol	Freely soluble
Distilled water	Insoluble
$CHCl_3$	Soluble
Phosphate Buffer	Soluble

Extract excipients compatibility
Drug-excipient compatibility tests were also conducted on *Swertia chirata* extract, utilizing FT-IR spectroscopy both singly and in formulation. The following is a log and demonstration of this compatibility:

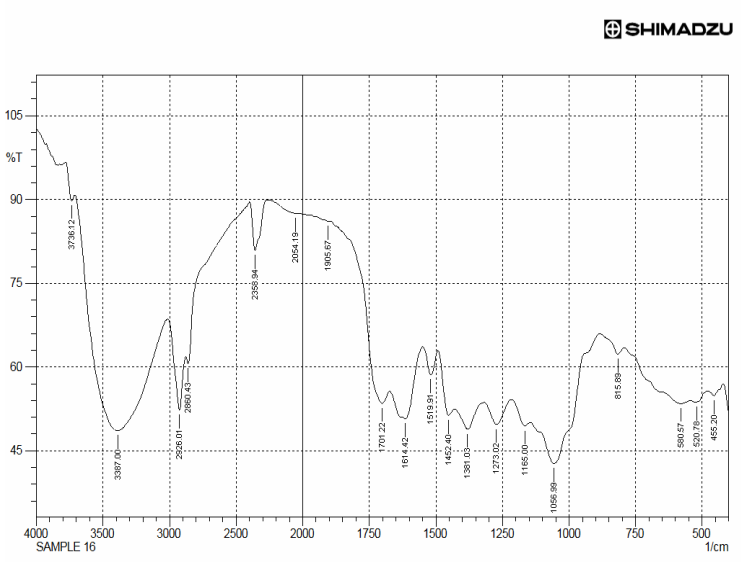

Fig 1. FTIR of *Swertia chirata*

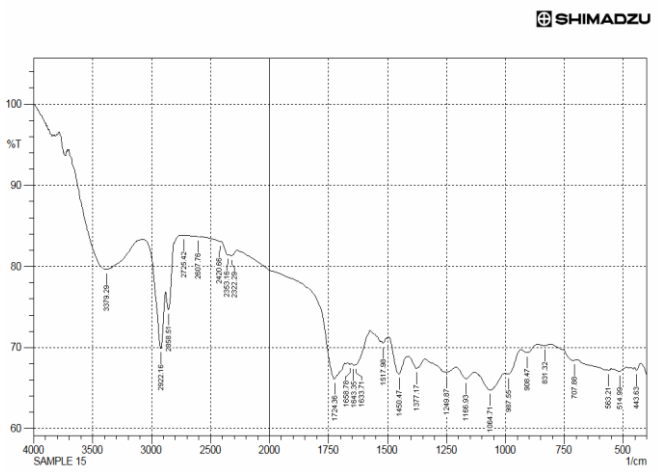

Fig 2. FTIR of *Swertia chirata* + liquid paraffin

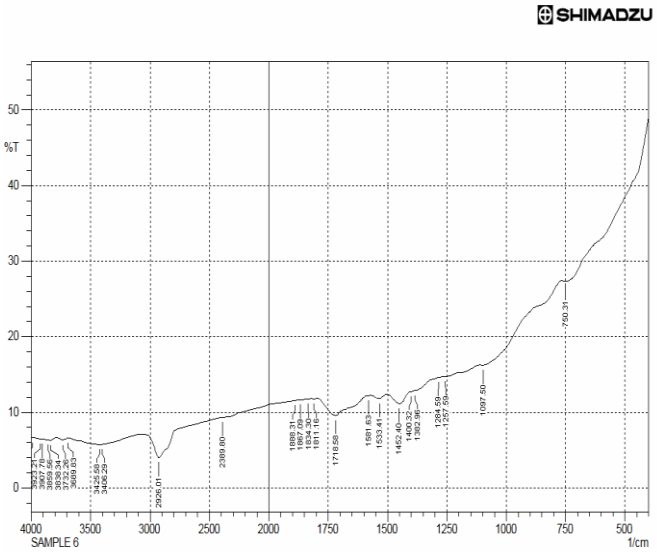

Fig 3. FTIR of *Swertia chirata* extract + Tween 80

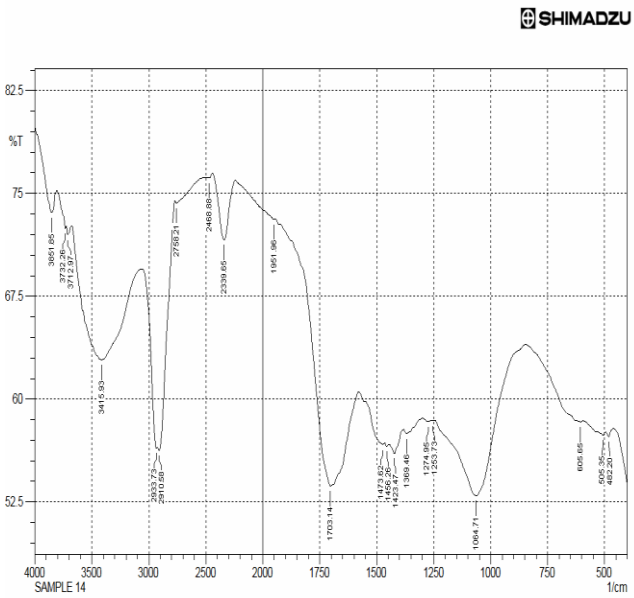

Fig 4. FTIR of *Swertia chirata* extract + PEG 200

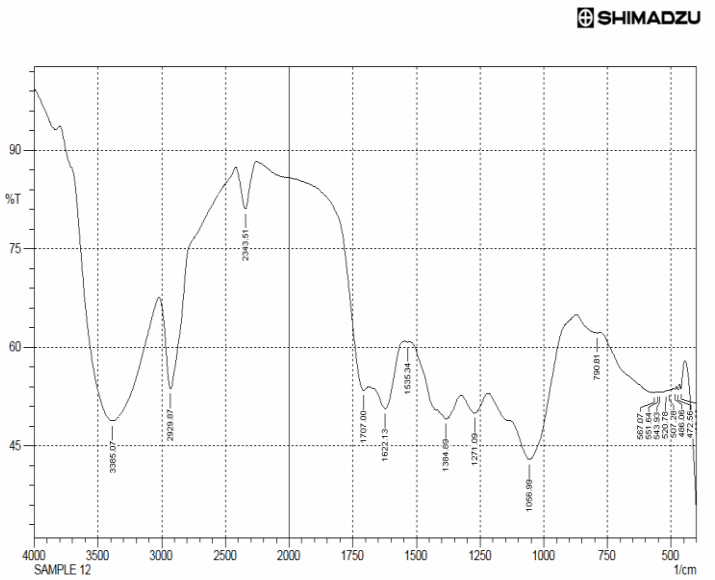

Fig 5. FTIR of *Swertia chirata* extract + CMC

Standard calibration curve

The UV Spectrophotometric method was used to analyse *Swertia chirata* extract. The absorbance of the medication was measured at 274nm in phosphate-buffered saline (pH 7.4) containing a trace quantity of methanol. The standard curve for the herbal extract in PBS at pH 7.4 was linear between 2 and 10g/ml, starting at the origin. The curve follows Beer-Lambert's law.

Table 3. Standard calibration curve- *Swertia chirata*

Conc. (µg/ml)	Absorbance
10	0.12
20	0.21
30	0.29
40	0.35
50	0.4
60	0.50

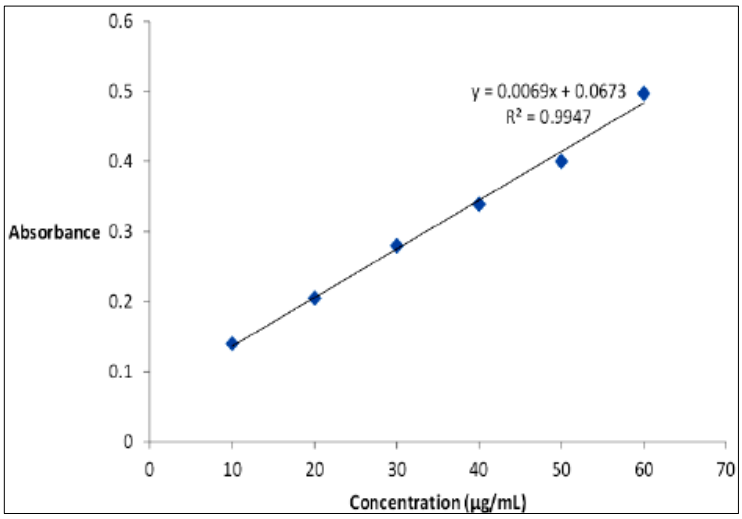

Fig 6. Standard calibration curve at pH 7.4

EVALUATION OF EMULGEL FORMULATION

Physical appearances

In context to characterize total 3 forms of emulgels (F1-F3) were evaluated for their physical appearance i.e., colour, consistency and phase separation. It showed that emulgels were brown in colour and translucent in appearance. These formulations exhibited better consistency and phase separation was absent.

The look of all formulated emulgels is shown in the table below-

Table 4. Physical appearance of emulgels

Emulgel	Colour	Consistency	Phase separation
F1	Brown, Translucent	Better	Absent
F2	Brown, Translucent	Better	Absent
F3	Brown, Translucent	Better	Absent

pH estimation

The pH level was determined to maximise digestibility and absorption. An approximation of pH was 6.5±0.4 in F1. While pH for F2 and F3 was measured as 6.4±0.3 and 6.3±0.2, respectively. Thus, all the preparations showed acidic pH range.

Table 5. Measurements of pH

Formulation	pH± S.D.
F1	6.5±0.4
F2	6.4±0.3
F3	6.3±0.2

Determination of viscosity

Viscosity is the quality factor of every emulgel that assures about its consistency and uniformity. It facilitates the flowability of the formulation and in turn better availability. The lowest viscosity was estimated in F1 as 517.42± 0.20. Whereas formulation F2 showed increased viscosity as 524.31±0.27. While, F3 has shown highest viscosity as 527.28±0.43.

Table 6. Determination of viscosity

Formulation	Viscosity± S.D.
F1	517.42±0.20
F2	524.31±0.27
F3	527.28±0.43

Spreadability

Spreadability defines the absorption capacity through better uniformity of contents. The spreadability data showed a remarkable strength when observed. Emulgel (F1) demonstrated highest spreadability as 16.11±036gem/s. When observed

F2 and F3 were shown spreadability as 13.42±0.28gem/s and 14.32±0.17 gem/s, respectively.

Table 7. Measurements of Spreadability

Formulation	Spreadability (gem/s)
F1	16.11±036
F2	13.42±0.28
F3	14.32±0.17

In-vitro drug release

In-vitro drug release was observed as 71.12±0.23 in emulgel (F1) and 68.30±0.15 in emulgel (F2). While, the maximum in-vitro drug release was seen in formulation F3 76.52±0.18.

Table 8. In-vitro drug release

Formulation	In-vitro drug release
F1	71.12±0.23
F2	68.30±0.15
F3	76.52±0.18

Swelling index

It has demonstrated a remarkable swelling property when observed. Min. swelling index was seen in F1 as 16.37± 0.20. Whereas, almost similar swelling index was calculated in F2 as 17.43± 0.27 and F3 as 17.22± 0.13. The swelling index exhibits the concentration of polymers used for the formulation of herbal emugel.

Below table represents the swelling power the different emulgels (F1-F3)-

Table 9. Swelling index study

Formulation	Weight (g)	Weight after swelling (g)± S.D.
F1	15.0	16.37± 0.20
F2	15.0	17.43± 0.27
F3	15.0	17.22± 0.13

% Drug content estimation

The prepared emulgels showed excellent % drug content in terms of better flowability or rheological properties and concentration of drug. Emulgel F1 exhibited % drug content as 73.24±0.195 as it was minimum. Whereas F2 and F3 were shown increased % drug content as 78.40±0.23% and 82.31±0.16%, respectively. Indicative of consistent drug delivery, all formulations showed a high percentage of active ingredient.

Table 10. Determination of % Drug content

Formulation	% Drug content
F1	73.24±0.19
F2	78.40±0.23
F3	82.31±0.16

To improve therapeutic bioavailability, formulation scientists must solve the challenge of delivering hydrophobic medicines, which are notoriously difficult to dissolve in water. Forty percent of medications are hydrophobic, making it difficult to get them into the body. Emulgel was reported to be particularly important among the many topical formulation techniques in enhancing the topical distribution of such hydrophobic medicines. Gel is a dual control release mechanism since it contains an emulsion. The stability of the emulsion is also enhanced, and issues such phase separation and creaming are eliminated. Although emulgel's main issue is drug permeability because of its large particle size, this can be remedied with the NEG method by incorporating nanoemulsion into the gel foundation.

In results, preformulation study showed that *Swertia chirata* is well compatible to the different polymers used in the formulation of emulgel. Among all 3 preparations of emulgels, formulation

F1 was found excellent in terms of pH range, viscosity, % drug release, swelling index, spreadibility and in-vitro drug release. However, physical appearance was found same as brown, translucent for all the emulgels (F1-F3).

CONCLUSION

Due to significant limitations in oral, parenteral/other routes demonstrating great patient compliance. Emulgel is a hydrophilic gel matrix that allows for the loading of hydrophobic drugs. Emulgel has superior bio-adhesion, the ideal viscosity, and great long-term stability. In this experiment, emulgels were made with two distinct gel-forming polymers. Two of the three formulas were very refined and effective. Emulgels containing *Swertia chirata* are applied topically to treat pain and inflammation. The formulation and testing of an emulgel for genuine and selected parameters were successful. The topical distribution of medications with poor solubility, such as *Swertia chirata* or other herbal extracts, can be improved with the use of emulgel.

This study is part of the New Drug Delivery System initiative, which aims to improve upon the novel strategy of administering a loaded topical emulgel of *Swertia chirata* on a regular basis via the skin. It would have a significant effect on people's perceptions of pain and inflammation if it could be dosed locally and kept at that level for an extended period with little systemic adverse effects.

Emulgel's popularity as a unique pharmaceutical delivery method stems from its potential to enhance spreadability, adhesion, thickness, and ejection. They may also provide a means of extending the stability of hydrophobic drugs in water-based solvent gel bases. There is no doubt that emulgels of *Swertia chirata*, with their superior therapeutic potential and less patient problems, will be the most sought-after dosage form.

In conclusion, *Swertia chirata* emulgel is one of the best compatible emulgel formulations with optimum characteristics.

Future aspects

This study is part of the New Drug Delivery System initiative, which aims to improve upon the novel strategy of administering a loaded Swertia chirata topical emulgel to the skin on a regular basis. As a pain reliever (anti-nociceptive) and bandage adhesive. It would have a significant effect on people's perceptions of pain and inflammation if it could be dosed locally and maintained for an extended period of time with a minimum of systemic adverse effects.

It suggests the isolation of active moieties and develop the optimized emulgels for different topical pharmacological uses.

FUNDING

Nil.

CONFLICT OF INTEREST

None.

REFERENCES

1. Baron R, Binder A, Wasner G. Neuropathic pain: diagnosis, pathophysiological mechanisms, and treatment. The Lancet Neurology. 2010 Aug 1;9(8):807-19.
2. Gokani Preet N, Mittal Maheshwary, Pragnesh Patani. (2019). Formulation development and evaluation of Aceclofenac loaded Emulgel. International Journal of Sciences & Applied Research, 6(4), 06-15.
3. Gupta M, Agrawal U, Vyas SP. Nanocarrier-based topical drug delivery for the treatment ofskin diseases. Expert Opin Drug Delivery 2012;9:783-04.
4. McKay, Warren R. Pain Review. *Anesthesia & Analgesia*, 109(6): 2035.
5. Moayedi M, Davis KD. Theories of pain: From specificity to gate control. J Neurophysiol 2013;109:5-12.
6. Pani P C Sathya Keerthi, C Haranath, C Suryaprakash Reddy, A Chaitanaya Kumar, M Kiran Kumar, D Rushi Kumar Reddy, V Umapathi, B Yamuna, R Raviprakash Reddy. Emulgel: A Novel Approach for Enhancing Topical Delivery of Aceclofenac. 2015(1), 1-5.
7. Patel CJ, Tyagi S, Gupta AK, Sharma P, Prajapati PM, Potdar MB. Emulgel: A combination of emulsion and gel. J Drug Discov Ther 2013;1(6):72-6.
8. Laxmi A., Siddhartha S. and Archana M., Antimicrobial screening of methanol and aqueous extracts of Swertia chirata. Int J Pharm Pharm Sci, 2011; 3(4):142-146.
9. Kumar V. and Van Staden J., A review of Swertia chirayita (Gentianaceae) as a traditional medicinal plant. Frontiers in pharmacology, 2016; 6:308.
10. Pravallika Ala, Ala Priyanka Reddy. (2019). Formulation and Evaluation of Aceclofenac Topical Emulgel. International Journal of Advanced Technology and Innovative Research, 10(2), 43-48.
11. Yadav Sunil Kumar, Manoj Kumar Mishra, Anupamaa Tiwari, Ashutosh Shukla. (2017).

Emulgel: A New Approach For Enhanced Topical Drug Delivery. IJCPR,9(1), 15-19.

12. Banerjee S. et. al. Assessment of the anti-inflammatory effect of *Swertia chirata* in acute and chronic experimental models in male albino rats. Indian Journal of Pharmacology. 32; 2000: 21-24.