FORMULATION, DEVELOPMENT AND EVALUATION OF SWERTIA CHIRATA EXTRACT BASED NANOEMULSION

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ABSTRACT

The study focuses on the development of allopathic medications and their potential applications in various industries. The stability of S. chirata nanoemulsions, which inhibit bacterial development and multiplication, is crucial for long-lasting impact delivery. Nanoemulsions are gaining popularity as drug carriers for enhancing pharmaceutical delivery and are adaptable to various distribution methods. The study found that NES 5 and NES 6 were the most prominent nanoemulsions among all NE subtypes, demonstrating better stability and ability to maintain pH, % drug release, and in-vitro drug release. The droplet size of the formulated nanoemulsions was estimated using a nanodroplet analyzer, with NES 5 and NES 6 having the lowest droplet sizes. The polydispersity index (PDI) was estimated to be increased in NES 5 and NES 6, possibly due to increased proportion of surfactants used during formulation. NE 0 showed 0% drug content as Nil, while NES 1, NES 2, NES 3, and NES 4 showed % drug content as 98.32±0.39%, 97.50±0.25%, 96.73±0.12%, and 98.91±0.34%, respectively. The formulated nanoemulsion's droplet size was estimated using nanodroplet analyser. Control formulation (NES 0) showed droplet size as 22.19±0.36. NES 1, NES 2, NES 3 and NES 4 showed droplet size in almost similar range as 26.20±0.27, 27.31±0.35, 25.14±0.12 and 28.40±0.26, respectively. Whereas, NES 5 & NES 6 exhibited droplet size as 26.51±1.63 and 24.43±1.27, respectively, which are lowest among all. Whereas NES 1, NES 2, NES 3 and NES 4 showed % drug content as 98.32±0.39 %, 97.50±0.25 %, 96.73±0.12 % and 98.91±0.34 % respectively. In NES 5 and NES 6, it was much more excellent as 99.68±0.21 % and 98.57±0.17 % at the time of formulation. Percentage release was found better in formulations NES 1, NES 3, and NES 4 at 6 hours. After 30 days, the % drug content showed negligible changes, with slight changes in NES 1 and NES 5. All evaluation data showed the nanoemulsion have better stability.

Keywords: Formulation, evaluation, nanoemulsion, *Swertia chirata*, in-vitro drug release.

INTRODUCTION

Ibn Sina, a Persian physician, described topical medications as having two states in his work The Canon of Medicine: a soft component that penetrates within the skin and a hard component which is untreated (6). Effective pharmaceutical delivery relies on getting drugs to the site of action as fast as possible. Topical delivery refers to a local condition treatment module that distributes developed formulation to the skin, eyes, nose, and vaginal area (1, 13, 7). Pre-systemic metabolism, stomach pH abnormalities, and variations in plasma concentration which often occurs when medicine is taken orally are avoided when it is applied topically. (9).

The following are some of the other benefits linked with the topical drug delivery system (3)-

- Patient acceptance and cooperation
- Easy to apply
- Painless
- BA of drugs is being improved
- Physiological and pharmacological responses are improved
- Drug exposure to non-infectious tissue/sites with little systemic toxicity

Drug profile

Traditional medicine has employed a number of herbal plants, such as Swertia chirata, as hepatoprotective agents. This plant has been used for a very long time; In 1839, it was first introduced to Europe. It is sometimes called Nepali Neem since it thrives as an annual or biennial plant in Nepali woods. From Kashmir to Bhutan, this annual shrub or herb reaches a height of 1.5 meters in the sub-temperate Himalayas, mostly between 1200-1500 mtrs (11).

Roxburgh initially identified Swertia, a member of the Gentianaceae family, as Gentiana chrysantha in 1814. This genus encompasses more than 135 distinct species of both annual as well as perennial plants. Various common these species are integral to numerous herbal remedies. In India, there are 40 species of Swertia chirata. The most important medicinal properties of Chirata, Swertia have been determined to be its Anti-inflammatory, Hypoglycemic, Hepatoprotective, Antibacterial, Wound-healing, Antispasmodic, Antioxidant, Anti-diabetic, Antipyretic, and Antitussive properties. Furthermore, natural plants were revealed to have many medicinal compounds with anti-AIDS, anti-tumor, and anticancer activities (12).

Fig. 1 Different parts of *Swertia Chirata*

Taxonomy

Kingdom	- Plantae
Phylum	- Tracheophyta
Class	- Magnoliopsida
Order	- Gentianales
Family	- Gentianaceae
Genus	- Swertia
Spicies	- Chirata
Binomial name	- Swertia chirata

Chemical constituents

One important source of new compounds with possible medical uses is medicinal plants. Worldwide, around 119 pure substances that were isolated from higher plants are utilized in medicine. According to preliminary studies, the plant Swertia chirata includes terpenoids, iridoids, flavonoids, xanthones, and secoiridoid glycosides.

According to earlier research, Swertia Chirata nanoemulsion has not yet been created. Therefore, the development and estimation of Swertia Chirata containing nanoemulsion for topical application were the main objectives of the current work.

MATERIALS AND METHODS

Experimental requirements

Potassium bromide, 3-(45-Dimethylthiazol-2-yl)-25-Diphenyltetrazolium bromide, ethanol, dimethyl sulfoxide, Swertia chirata extract, and PF127 are among the surfactants (DMSO) with a pH of 7.2 (Sigma Aldrich, India).

Preparation of formulation

The first components that were used to test solubility and produce an oily phase were in addition to essential oils like clove, peppermint, and anise, the combination contains mineral oil, fixed soybean oil, olive oil, grape oil, and sweet almond oil. To determine if drug precipitates were present in the oil, the solubility test was conducted. Until we achieved a concentration of 100 milligram in 1,000 liters, then mixed the oil with 100 milligrams of extract at a ratio of 100 liters for every 1,000.

At a concentration of 100 mg per 500 cc, it was shown that S. chirata extract was more soluble in peppermint essential oil. The surfactant in this formulation was PF127, while the oil phase included peppermint oil.

The Spontaneous Emulsification Method

To dissolve the extract of S. chirata, the essential oil was used. For the aqueous phase, water was used to dissolve the surfactant PF127 and the preservative Novamit. The lipophilic ingredients i.e. oil phase was progressively introduced to the water i.e. aqueous phase using an ultrasonic processor in order to create NEs without heating the system. A consistent 15±8°C temperature was kept. The combination was made and kept at room temperature, or 25°C. The amount of PF127 (surfactant) in the hydrophilic phase was increased (5%-15%) and the ratio of peppermint oil was altered from 5%-10% in order to evaluate the stability of the emulsion. We made use of appearance, PDI, and size (mean diameter in nanometres). Moreover, a control nanoemulsion was not made using S. chirata extract.

Table 1. Formulation ingredients (Oil phase)

Creation of	**Phase of oil** ***S. chirata (%)***	***Oil of Peppermint (%)***
NES 0	0	5
NES 1	0.5	5
NES 2	1	5
NES 3	1	5
NES 4	1	5
NES 5	1	7.5
NES 6	1	10

The table 1 shows that peppermint oil was discovered to be highly soluble in S. chirata extract; as a result, this essential oil was employed to create the nanoemulsion. NE 1 and NE 6 were made, with NE 0 serving as a control that did not have any S. chirata extract added, but other excipients, such as surfactants, were added.

Table 2. Formulation ingredients (Aqueous Phase)

Creation of	**Aqueous phase** **PF127 (surfactant)** ***5 %***	***10 %***	***15 %***
NES 0	-	-	94
NES 1	-	-	93.5
NES 2	94	-	-
NES 3	-	94	-
NES 4	-	-	89
NES 5	-	-	92.5
NES 6	-	-	88

In order to create the nanoemulsion of S. chirata extract, an aqueous phase was first created and then added to the oil phase. This stage was created by adding surfactants in varying amounts (5-15%).

Table 3. Formulation Experimental Conditions

Creation of	**Experimental conditions**		
	The amplitude (%)	***Cycle (%)***	***Time (min)***
NES 0	100	1	5
NES 1	100	1	5
NES 2	100	1	5
NES 3	100	1	5
NES 4	100	1	5
NES 5	100	1	5
NES 6	100	1	5

The table 3 confirms the testing parameters needed to produce a nanoemulsion. When creating NES 0-NES 6, the experimental conditions- amplitude (%), cycle (%), and duration (min)- were maintained constant throughout all nanoemulsion subtypes.

CHARACTERIZATION PARAMETERS

To characterize the nanoemulsion (NE), the following factors were assessed-

Physical appearance

Seven different types of nanoemulsion, including NE 0-NE6, were created. The physical characteristics of each type—transparency, homogeneous/heterogenous, white, or turbidity—were estimated. A homogenous nanoemulsion indicates improved nanoemulsion formulation.

Polydispersity index (PDI) and droplet size

The Malvern Zetasizer Nano-ZS was used to measure the nanoemulsion's average size of globule. At a temperature of 25ºC and at a 90-degree angle, measurements were made. To ensure that the light scattering intensity was within the sensor's sensitivity range, the nanoemulsion was diluted twice with distilled water. Every measurement was taken at 25°C. To determine the formulation's polydispersity index, the same process was used. The size distribution's range was depicted using the polydispersity index (8).

Release of drugs in vitro

When the pH of the solution of PBS gets close to 7.4, just a little amount of the nanoemulsion is still dissolved. Following the addition of ethanol to increase the solubility of the polymer, PBS (pH 7.4) is used to bring the residual volume down to 100 ml. One milliliter of the solution is taken out and diluted to ten milliliters. The concentration of the solution is ascertained by measuring its absorbance at 270 nm.

A modified Franz Diffusion Cell was used for in vitro diffusion investigations. The diffusion cell consisted of a 10 cm tall cylinder of glass with an outside diameter of 3.7 cm and an inner diameter of 3.1 cm. A sheep's mucosa was affixed to cylinder’s one end to create the diffusion cell. Before the cell was placed in the receptor compartment of a beaker containing 100 milliliters of pH 6.8 phosphate buffer, one milliliter of the nanoemulsion was given to it.

The whole cell surface was in touch with the receptor compartment, which was being magnetically agitated while the temperature was maintained at 37ºC. Ten millilitres of samples were taken out of the receptor compartment and replaced with an equivalent volume in order to maintain the sink condition.

Drug content as a percentage

A predetermined amount of the developed formulation was taken and then diluted to 10 mL with ethanol in calibrated volumetric flask. After 3 minutes of sonication performed at room temperature, the absorbance of the resulting solution was assessed to be 240 nm when compared to a blank. In 2019, Samadhan and his pals.

The viscosity

A nanoemulsion on room temperature (23±2°C) was tested for viscosity using a Brookfield viscometer. In three separate investigations, viscosity was tested at two spindle speeds (5).

pH

The pH level is an important factor to consider while analyzing nanoemulsions. The pH of the final product as well as the mode of distribution is determined by the excipients used in the formulation. A digital pH meter was used to determine the pH of the formulation. To reduce errors, three copies of the findings were obtained (2).

Consistency

For a month, the nanoemulsion's stability was examined at 37 °C. The sample's transparency was evaluated. Measure the pH, drug content percentage, and three-monthly in vitro drug releases (4).

ASSESSMENT AND RESULTS

RESEARCH ON PREFORMULATION

1. Solubility

The solubility of S. chirata extract in the various solvents listed below was evaluated. It was discovered that S. chirata extract was poorly soluble in peppermint oil and distilled water. It was discovered to dissolve in phosphate buffer, ethanol, and 0.1N HCl. Accordingly, it may be confirmed that S. chirata is more soluble in basic and acidic aqueous environments and more soluble in ethanol, an amphoteric solvent.

Table 3. Solubility of S. chirata extract

Solvent	***S. chirata extract***
Distilled water	Highly Soluble
0.1N HCl	Very Soluble
Ethanol (90%)	Freely Soluble
Peppermint oil	Soluble
Phosphate Buffer	Soluble

2. Drug excipients compatibility studies

Using FT-IR spectra, S. chirata was also examined for drug-excipient compatibility studies both individually and in combination for comparison.

The compatibility was examined and observed as follows-

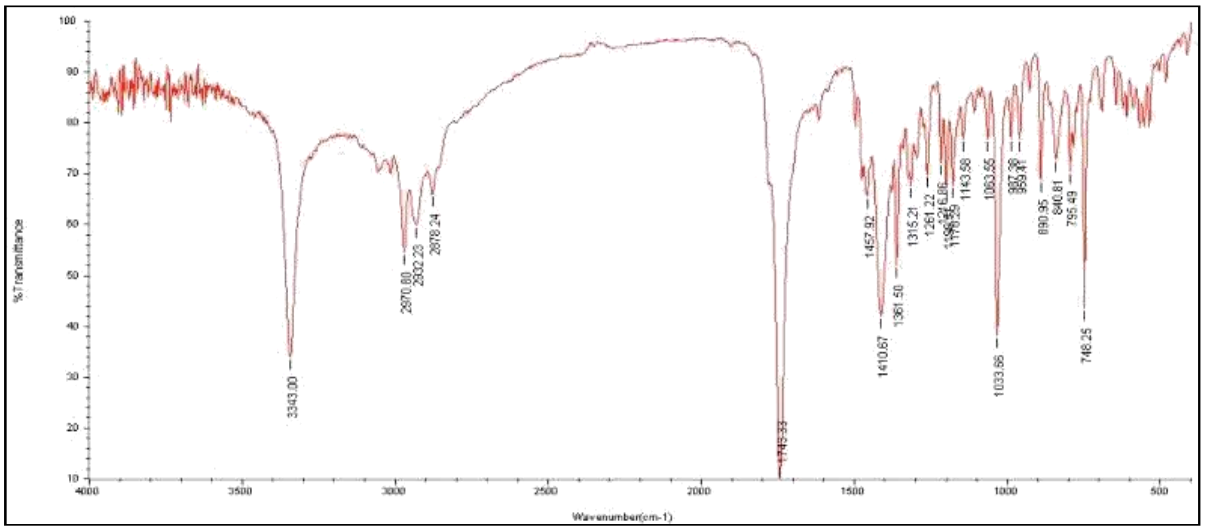

Fig. 2 FTIR spectra of *S. chirata*

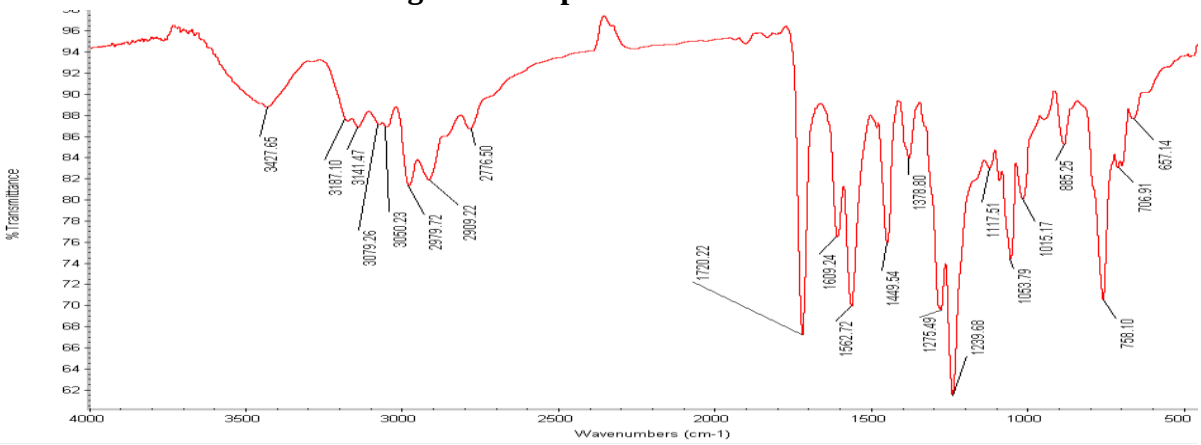

Fig.2 (a) FTIR spectra of NE 1

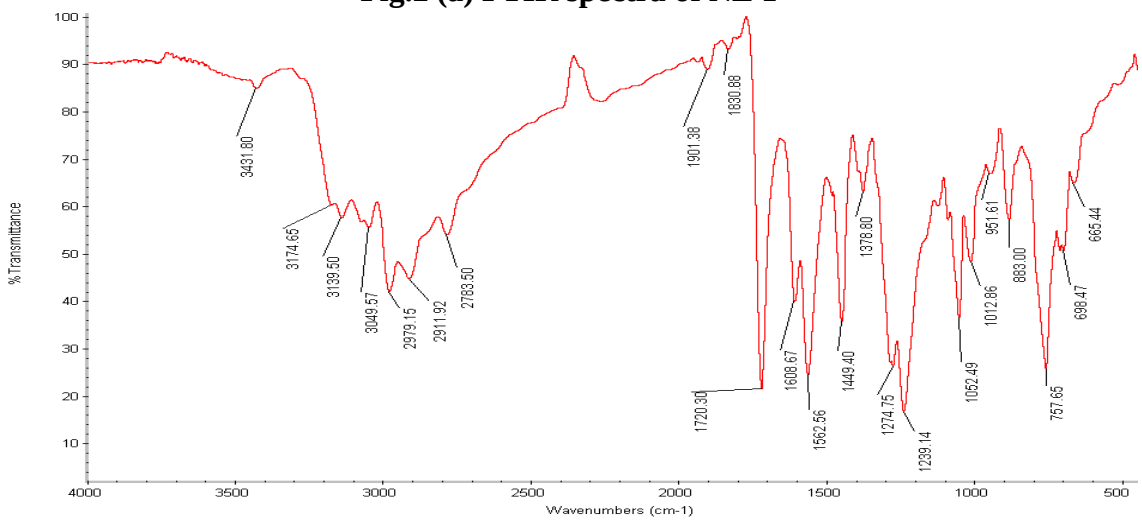

Fig 2 (b) FTIR spectra of NE 2

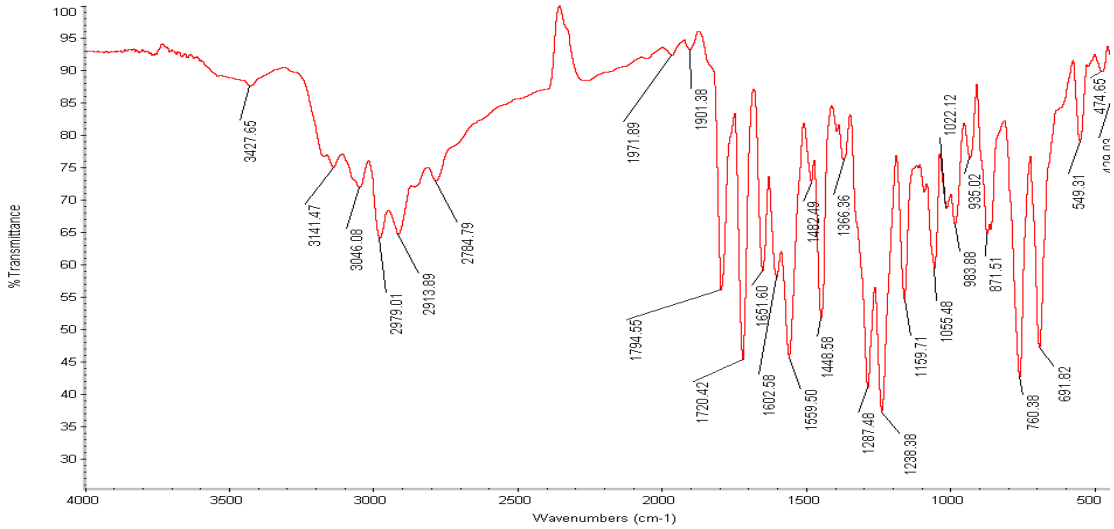

Fig.2 (c) FTIR spectra of NE 3

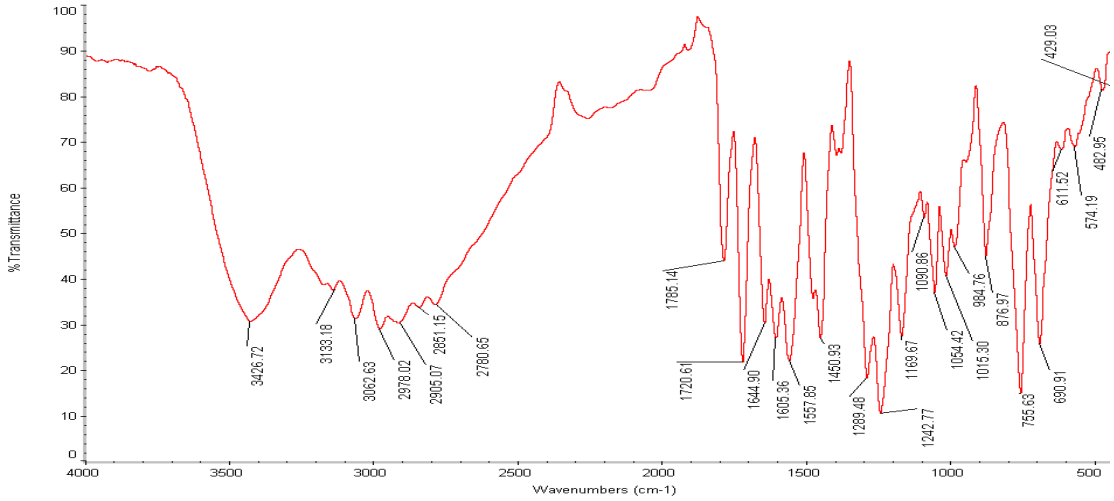

Fig.2 (d) FTIR spectra of NE 4

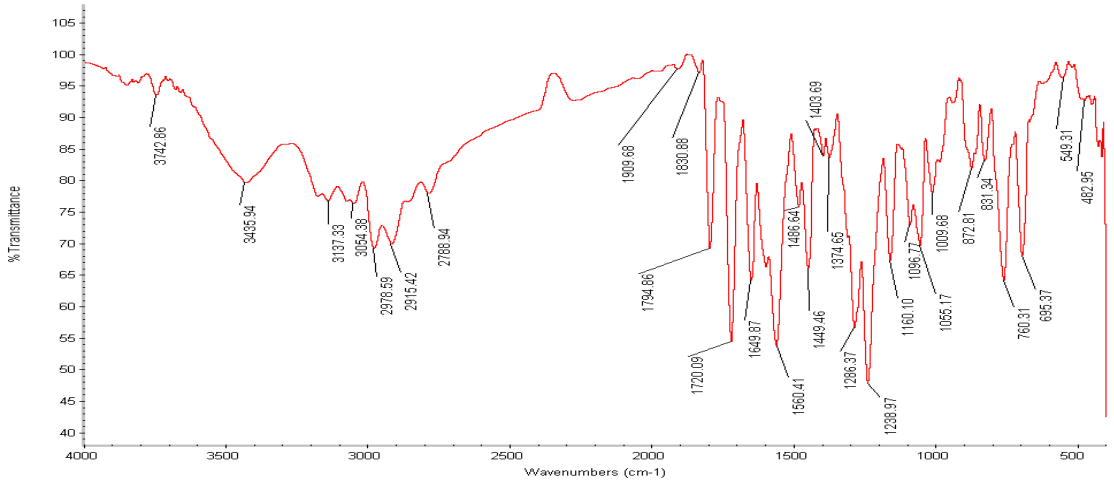

Fig. 2 (e) FTIR spectra of NE 5

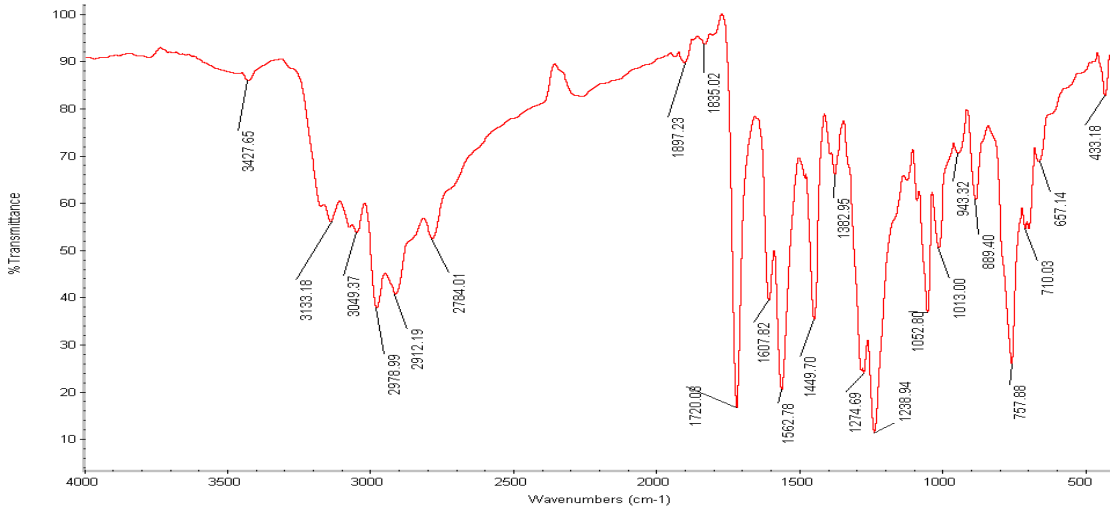

Fig. 2 (f) FTIR spectra of NE 6

Its improved drug-excipient compatibility is confirmed by the finding that the spectra of the drug and *S. Chirata* nanoemulsion do not exhibit any notable changes or functional peak losses.

3. The typical calibration curve

To investigate S. chirata, the UV Spectrophotometric technique was performed. To assess the drug's maximum absorbance at 274 nm, a little amount of methanol was added to phosphate buffered saline pH 7.4. For S. chirata in PBS pH 7.4, the standard curve was linear from the starting value to values ranging from 2 to 10 g/ml. Beer Lambert's law is followed by the curve. The following graphic displays the standard calibration curve.

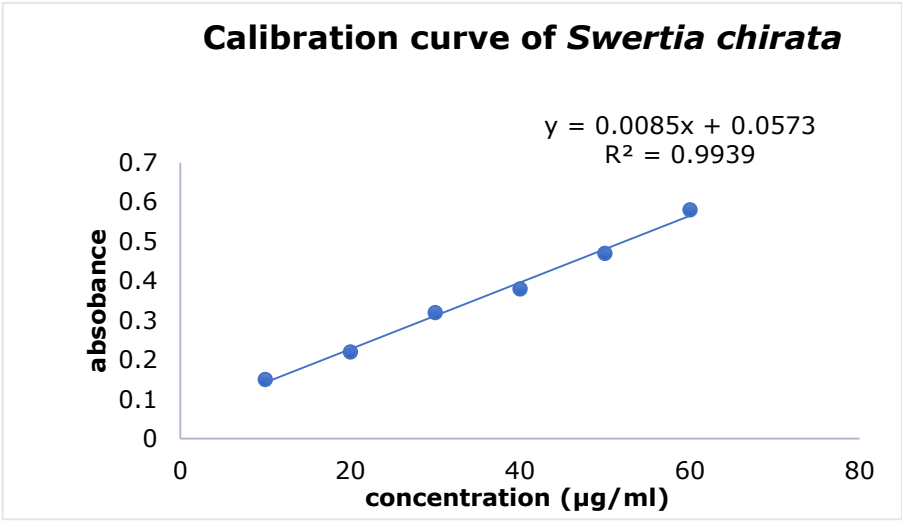

Fig. 3 Standard calibration curve at 7.4 pH (PBS)

4. Physical attributes

To characterize the seven distinct forms of nanoemulsion, the physical properties of NES 0-NES 6—transparency, homogeneity/heterogeneity, whiteness, or turbidity—were evaluated.

It revealed that NES 0, NES 5, and NES 6 were translucent and heterogeneous, but NES 1, NES 2, NES 3, and NES 4 were white and homogeneous. With a clear and uniform look, it indicates that the bulk of the NE subtypes were evolved in a substantial way.

Table 4. Physical characteristics of the prepared nanoemulsion

Creation of	Physical appearance
NES 0	Transparent & homogenous
NES 1	White & heterogenous
NES 2	White & heterogenous
NES 3	White & heterogenous
NES 4	White & heterogenous
NES 5	Transparent & homogenous
NES 6	Transparent & homogenous

n=3,

Mean± SD can be used to express values.

5. An assessment of droplet size (nm)

A nanodroplet analyzer was used to examined the droplet size of the prepared nanoemulsion. The droplet size in the control formulation (NES 0) was 22.19±0.36. The droplet sizes for NES 1, NES 2, NES 3, and NES 4 were 26.20±0.27, 27.31±0.35, 25.14±0.12, and 28.40±0.26, respectively, and fell within a nearly identical range. In contrast, NES 5 and NES 6 had the smallest droplet sizes of all, measuring 26.51±1.63 and 24.43±1.27, respectively.

Table 5. Measurement of droplet size (nm)

Creation of	Droplet size (nm)
NES 0	22.21±0.36
NES 1	26.21±0.27
NES 2	26.92±0.35
NES 3	25.14±0.12
NES 4	28.39±0.26
NES 5	26.61±1.63
NES 6	24.53±1.27

n=3,

Mean± SD can be used to express values.

5. Calculating the Polydispersity Index (PDI)

When assessing topical dose forms for particle homogeneity, the polydispersity index (PDI) is a crucial consideration. The PDI in NES 0 was 0.48±0.04, whereas PDI in NES 1, NES 2, NES 3, and NES 4 was 0.49±0.07, 0.54±0.08, 0.37±0.06, and 0.29±0.09, respectively.

However, PDI was calculated to have grown by 0.76±0.02 and 0.83±0.04 in NE 5 and NE 6, respectively. It might be the result of using a higher percentage of surfactants while creating the nanoemulsion.

Table 5. Calculating the Polydispersity Index (PDI)

Creation of	PDI
NES 0	0.48±0.04
NES 1	0.49±0.07
NES 2	0.54±0.08
NES 3	0.37±0.06
NES 4	0.29±0.09
NES 5	0.76±0.02
NES 6	0.83±0.04

n=3,

Mean± SD can be used to express values.

6. In-vitro medication release

NE 0 had the lowest in-vitro drug release, measuring 54.42±0.54. In contrast, the in vitro drug release values for formulation coded as NES 1, NES 2, NES 3, and NSE 4 were 86.47±0.35, 85.12±0.37, 84.39±0.50, and 83.53±0.72, respectively.

In vitro, the release values for NES 5 and NES 6 were 86.10±0.81 and 85.25±0.65. Out of all the formulations, it is considered to show the most effective in vitro drug release.

Table 6. In-vitro medication release

Creation of	In-vitro medication release
NES 0	54.42±0.54
NES 1	86.47±0.35
NES 2	85.12±0.37
NES 3	84.39±0.50
NES 4	83.53±0.72
NES 5	86.10±0.81
NES 6	85.25±0.65

n=3,

Mean± SD can be used to express values.

7. Calculation of drug content percentage

Excellent drug content was demonstrated by the produced nanoemulsions in terms of improved drug concentration and homogeneity. Since NE 0 did not retain any medication quantity, it displayed a drug content percentage of 0. In contrast, the drug content percentages for NE 1, NES 2, NES 3, and NES 4 were 98.32±0.39%, 96.50±0.25%, 97.73±0.12%, and 98.91±0.34%, respectively. It was much better in NES 5 and NES 6, with 96.68±0.21% and 98.57±0.17%, respectively.

Table 7. Calculation of drug concentration percentage

Creation of	% Drug content
NES 0	Nil
NES 1	98.32±0.39
NES 2	96.50±0.25
NES 3	97.73±0.12
NES 4	98.91±0.34
NES 5	96.68±0.21
NES 6	98.57±0.17

n=3,

Mean± SD can be used to express values.

8. Measurement of viscosity

In formulation NES 0, the minimum viscosity was calculated to be 524.46±0.13. On the other hand, formulations coded as NES 1, NES 2, NES 3, and NES 4 displayed high viscosity, with respective values of 526.25±0.34, 528.29±0.27, 531.31±0.15, and 534.16±0.39. In NES 5 and NES 6, the highest viscosity was determined to be 522.17±0.23 and 537.36±0.27, respectively.

Better adhesion and absorption properties are revealed by high viscosity, as seen in table 4.6 below-

Table 8. measurement of viscosity

Creation of	Viscosity± S.D.
NES 0	524.46±0.13
NES 1	526.25±0.34
NES 2	528.29±0.27
NES 3	531.31±0.15
NES 4	535.16±0.39
NES 5	522.17±0.23
NES 6	537.36±0.27

n=3,

Mean± SD can be used to express values.

9. Measurements of pH

In order to improve absorption and tolerance, the pH was tested. The calculated pH in NES 0 was 6.2±0.1. In contrast, the pH values in NES 1, NES 2, NES 3, and NES 4 were 6.3±0.3, 6.5±0.2, 6.2±0.3, and 6.6±0.3, respectively. In contrast, formulations NES 5 and NES 6 were calculated to have high alkaline pH values of 6.8±0.2 and 6.7±0.1, respectively.

Table 9. pH Measurements

Creation of	**pH± S.D.**
NES 0	6.2±0.1
NES 1	6.3±0.3
NES 2	6.5±0.2
NES 3	6.2±0.3
NES 4	6.6±0.3
NES 5	6.8±0.2
NES 6	6.7±0.1

n=3,

Mean± SD can be used to express values.

10. Percentage of drug release estimated

At 6 hours, the percentage of drug release for NES 1, NES 2, NES 5, and NES 6 was 92.3±0.7, 86.7±0.4, 78.9±0.8, and 74.5±0.8, respectively. In contrast, F3 and F4 had the lowest percentage of drug release of all six formulations, at 80.4±0.1 and 79.8±0.1, respectively.

Percentage release was found better in the formulations NES 1, NES 3 and NES 4 when observed at 6 hours. Although, at various time intervals, the best drug release was demonstrated by each formulation.

Table 10. Percentage of drug discharge estimated

Time (hr)	**% drug release± S.D.** **NES 1**	**NES 2**	**NES 3**	**NES 4**	**NES 5**	**NES 6**
1	34.5±0.3	39.5±0.4	24.7±0.6	21.3±0.4	17.6±0.3	18.5±0.4
2	44.6±0.5	36.3±0.6	32.5±0.3	34.7±0.6	27.8±0.5	30.9±0.5
3	54.5±0.2	44.2±0.4	46.4±0.7	45.8±0.2	35.9±0.1	43.8±0.2
4	65.4±0.7	66.00±0.8	56.9±0.8	59.7±0.9	53.8±0.6	51.5±0.1
5	81.7±0.3	71.7±0.9	68.6±0.3	67.5±0.7	68.7±0.4	63.8±0.6
6	92.3±0.7	86.7±0.4	80.4±0.1	79.8±0.1	78.9±0.8	74.5±0.8

n=3,

Mean± SD can be used to express values.

11. Data on stability

After 30 days, stability tests were conducted to verify its true properties, including pH, in-vitro drug release, and percentage drug content. Since NES 0 did not retain any medication quantity, it displayed a drug content percentage of 0. In contrast, the drug content percentages for NES 1, NES 2, NES 3, and NES 4 were 98.32±0.39%, 97.50±0.25%, 96.73±0.12%, and 98.91±0.34%, respectively. At formulation, it was much better in NES 5 and NES 6, measuring 99.68±0.21 % and 98.57±0.17 %, respectively.

It was examined for drug content again after 30 days, and the results indicated very little change in NES 0-NES 6. NE 1 showed a little shift of 97.12±0.39. However, NES 5 likewise had a drug release percentage of 96.68±0.61. Therefore, it could be because nanoemulsions are more stable.

Table 11. (i) After 30 days, stability data (percentage of medication content)

Creation of	**% Drug content**	
	Perior to	***afterwards***
NES 0	Nil	Nil
NES 1	98.32±0.39	97.12±0.39
NES 2	97.50±0.25	97.50±0.25
NES 3	97.73±0.12	96.73±0.12
NES 4	98.91±0.34	98.91±0.34
NES 5	97.68±0.21	96.68±0.61
NES 6	98.57±0.17	98.54±0.17

n=3,

Mean± SD can be used to express values.

For improved tolerance and absorption properties, the pH was evaluated throughout the formulation NES 0-NES 6 production process. In NES 0, the calculated pH was 6.4±0.1. In contrast, the pH values in NE 1, NES 2, NES 3, and NES 4 were 6.3±0.3, 6.5±0.2, 6.7±0.1, and 6.3±0.3, respectively. In contrast, formulations NES 5 and NES 6 were calculated to have high alkaline pH values of 6.8±0.2 and 6.7±0.1, respectively.

When it was measured again after 30 days, the results were nearly identical, suggesting a superior stability profile.

Table 11.(ii) Data on stability (pH) after 30 days

Creation of	**pH**	
	perior to	**afterwards**
NES 0	6.4±0.3	6.4±0.3
NES 1	6.4±0.1	6.4±0.1
NES 2	6.3±0.3	6.3±0.3
NES 3	6.5±0.2	6.5±0.2
NES 4	6.4±0.1	6.3±0.3
NES 5	6.6±0.3	6.6±0.3
NES 6	6.8±0.2	6.8±0.2

n=3,

Mean± SD can be used to express values.

NES 0 exhibited the lowest in-vitro drug release during nanoemulsion formulation, with a value of 54.42±0.54. NES 1, NES 2, NES 3, and NES 4 had in vitro drug release values of 83.47±0.35, 85.12±0.37, 86.39±0.58, and 84.53±0.72, respectively. The in-vitro release values for NES 5 and 6 were 87.10±0.81 and 89.25±0.65%, respectively.
There was minimal difference in drug release (in vitro) after 30 days compared to when NES 0-NES 6 was produced.

Table 11. (iii) In vitro release of drugs

Creation of	**In vitro release of drugs**	
	Perior to	**afterwards**
NES 0	54.42±0.54	54.42±0.54
NES 1	86.47±0.35	86.47±0.35
NES 2	85.12±0.37	84.12±0.37
NES 3	86.39±0.58	86.39±0.58
NES 4	83.53±0.72	82.53±0.72
NES 5	86.10±0.81	86.10±0.81
NES 6	87.25±0.65	87.25±0.65

n=3,
Mean± SD can be used to express values.

The nanoemulsion demonstrated a great formulation property across all parameters. Physical characteristics gave hope for improved emulsion transparency and clarity.

Particle size and particle size index were shown to be effective in improving the bioavailability and drug release of the integrated medication, confirming the formulation's uniqueness. The quality of designed nanoemulsion is influenced by viscosity and in-vitro drug release. These two elements demonstrated NES 0-NES 6's optimistic behavior in the same situation.

ANALYZATION

Moving to allopathic therapy would be a big step in combating the late and extensive consequences on the lives of millions. Additionally, it could be enhanced to make production more economical and to make it more useful. It would greatly improve the S. chirata nanoemulsion's stability. Delivering the enduring effect will be easier if bacterial growth and multiplication are inhibited.
It comes to the conclusion that out of all the NES subtypes, NES 5 and NES 6 were the most noticeable nanoemulsions. It displayed outstanding stability by keeping its pH, drug release percentage, and in-vitro drug release constant for a month.
The creation of a S. chirata nanoemulsion may have important implications for stability metrics and the treatment of bacterial diseases.

FINANCIAL SUPPORT
Nil.

DISPUTE OF INTEREST
None.

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