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Original Research Article

Design and Development of Cefpodoxime Proxetil Dry Suspension Using Fenugreek Powder as Natural Suspending Agent

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Abstract: Dry suspension refers to commercial dry solutions that must be dispensed with water. The bitter taste has had a significant impact on the development of oral preparations and therapeutic uses for numerous toxic medicines. The majority of patients want to take effective treatments that taste good and are easy to administer. It is also defined as an intimate mixture of dry, finely split medication and excipients that, when mixed with an appropriate vehicle, produces a suspension. Reconstitutable suspension is reconstituted at the time of use and can thus be used as a liquid formulation, avoiding swallowing issues. When drug stability is a critical concern, the reconstituted system is the formulation of choice. A variety of commercial and government remedies are available as dry powder combinations or granules that are meant to be suspended in water or another vehicle before being taken orally. The current study attempted to compare assessment criteria by employing three natural gums as a suspending agent in a cefpodoxime proxetil oral dry suspensions: acacia, Trigonella foenum graecum (Family: Leguminosae) seeds, also known as fenugreek seeds, and xanthan gum.

Keywords: Cefpodoxime proxetil, natural suspending agents, dry suspensions, reconstitutable suspension.

INTRODUCTION

Dry suspension refers to commercial dry solutions that must be dispensed with water. The bitter taste has had a significant impact on the development of oral preparations and therapeutic uses for numerous toxic medicines. The majority of patients want to take effective treatments that taste good and are easy to administer. It is also defined as an intimate mixture of dry, finely split medication and excipients that, when mixed with an appropriate vehicle, produces a suspension. Reconstitutable suspension is reconstituted at the time of use and can thus be used as a liquid formulation, avoiding swallowing issues [1].

When drug stability is a critical concern, the reconstituted system is the formulation of choice. A variety of commercial and government remedies are available as dry powder combinations or granules that are meant to be suspended in water or another vehicle before being taken orally. Antibiotics make up the majority of the medications produced as dry powders for oral suspension. The dry mix for oral suspension is commercially prepared and contains the medicine,

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colorants, tastes, sweeteners, stabilizing agents, suspending agents, and preserving agents that may be required to improve the formulation's stability. Because the medication is in a dispersed state at the time of administration, dry syrup for the delivery of medicine has higher bioavailability than tablets and capsules. The granules in the sachets must be consumed as a suspension in a glass of ingestible liquid, primarily water. Despite the fact that tests have shown that the dry oral suspension after constitution in a liquid is stable for 24 hours after preparation, it is recommended that the suspension be ingested immediately after preparation [2].

APPLICATIONS

1. Suspension is typically used for drugs that are insoluble (or weakly soluble).

Example: Prednisolone suspension.

2. To avoid medication breakdown or to promote drug stability.

Example: oxytetracycline suspension.

3. To disguise the bitter taste of an undesirable medicine.

Reason for the Study

Considering the rapid development of the pharmaceutical sector, discovering newer chemicals to suit the demands of the quick development has become a difficulty. The reason for preferring natively derived excipients over synthetic excipients is that natural plant-based excipients are widely available, and natural sources can ensure continuous supply at a low cost. Natural excipients, like synthetic excipients, have gained widespread acceptance. Because of their greater availability in nature, biocompatibility, biodegradability, non-toxicity, environmental friendliness, and cost-effectiveness, naturally derived excipients are employed as alternatives for synthetic excipients. These organically produced excipients can be employed in a variety of dosage forms while posing no risk to the active medicinal components.

The study's goal was to develop and test a new, effective natural suspending agent that can be employed as a viable alternative in the formulation of pharmacological suspensions. Trigonella foenum graecum (Family: Leguminosae) seeds, often known as fenugreek seeds, contain a higher concentration of mucilage and create a viscous tacky mass that swells when exposed to fluids. As a result, the potential of fenugreek seeds as a suspending agent can be used in cefpodoxime proxetil suspensions.

Aim

The purpose of this research is to develop and test a reconstitutable oral pharmaceutical solution of Cefpodoxime proxetil using various natural suspending agents with a simple basic technique and minimal framework.

Objectives

The objectives of the study are as follows:

1. To prepare mucilage from Trigonella foenum graecum seeds (fenugreek seeds).
2. To prepare a variety of formulations of cefpodoxime proxetil reconstitutable suspensions with varying amounts of natural suspending agents such as fenugreek seed powder, xanthan gum, and acacia.
3. To determine the pH, sedimentation volume, redispersibility test, particle size analysis, flow rate, and viscosity of the prepared suspensions.
4. To choose the optimum natural suspending agent by comparing the evaluation parameters in Cefpodoxime proxetil oral suspension formulations.

Plan of Work

Preformulation Studies

Melting point and ultraviolet absorption spectroscopy studies are used to identify Cefpodoxime proxetil.

Mucilage Extraction from Trigonella Foenum Graecum Seeds

Evaluation of Prepared Mucilage

- Determination of swelling index
- Phytochemical tests

Formulation of Cefpodoxime Proxetil Reconsitutable Oral Suspension

Evaluation of Cefpodoxime Proxetil Oral Suspension

- Particle size analysis
- Sedimentation volume
- Viscosity
- Flow rate
- p^H
- Redispersability test

Materials and Equipments

Cefpodoxime proxetil, acacia, fenugreek seed, xanthan gum, sodium chloride, carboxy methyl cellulose sodium, sodium phosphate, sucrose, methyl paraben, electronic balance, pH meter, UV- visible spectrophotometer.

METHODOLOGY

Preformulation Studies

Melting Point

The melting point of cefpodoxime proxetil was determined using a laboratory melting point device and the capillary tube method, in accordance with Indian Pharmacopoeia [3].

Cefpodoxime Proxetil Standard Calibration Curve Development in Methanol

UV- Visible Spectroscopy (λ max)

On a UV-visible spectrophotometer, the absorption maximum of the reference solution of

cefpodoxime proxetil was scanned between 200-400 nm areas.

Preparation of Standard Stock Solution

In a 50ml volumetric flask, a properly weighed quantity of around 50 mg of cefpodoxime proxetil was dissolved in enough methanol to achieve a concentration of 1000g/ml. 5ml of this solution was pipetted into a 50 ml volumetric flask and the capacity was filled with methanol to achieve a concentration of 100g/ml [4].

Preparation of Calibration Curve

Aliquots 1, 2, 3, 4, and 5 ml were pipetted from the stock solution into a series of 10 ml volumetric flasks and the volume was made up to the mark with methanol to obtain a concentration of 10-50g/ml. Using a UV-spectrophotometer, the absorbance at various concentrations was measured at 232 nm with methanol as a blank [5].

Preparation of Mucilage from Trigonella Foenum Graecum Seeds

Initially, Trigonella foenum graecum seeds were ground using a basic mixer. To prepare the slurry, the crushed seeds were steeped in distilled water for 12 hours before being heated in a water bath. The slurry was cooled further and allowed to settle undesirable particles. The upper portion was collected and concentrated in a water bath, and after cooling, acetone was added to it while stirring continuously. The precipitate was collected and dried for 24 hours at room temperature. The air dried material was then size reduced with a mortar and pestle and passed through sieve no.60 before being stored in desiccators for further suspension formulation and evaluation [6-8].

Evaluation of Mucilage

Determination of Swelling Index

In a China dish, 1g of fenugreek seed powder was placed, followed by 10 ml of distilled water, shaken, and allowed to stand for 1 hour. After 1 hour, the leftover water in the China dish was dumped, and the weight of the (natural suspending agent) fenugreek seed increase was calculated [9].

Phytochemical Test for Fenugreek Seed Powder

1. **Test for Carbohydrates:** In a test tube, fenugreek mucilage was mixed with a tiny amount of molisch reagent, and a few drops of strong sulphuric acid were added to the sidewalls. The emergence of a purple ring at the junction layer indicates a favorable reaction.
2. **Test for Tannins:** If tannins are present in the fenugreek mucilage, the ferric chloride blue color will occur.
3. **Test for Proteins:** The fenugreek mucilage was cooked for 2 minutes with a few drops of ninhydrin solution to obtain a violet color.
4. **Test for Alkaloids:** When the fenugreek mucilage test solutions are handled with the wagners reagent (iodine and potassium iodide solution), alkaloids produce a reddish brown precipitate.
5. **Test for Glycosides:** The mucilage of fenugreek was extracted with chloroform and evaporated to dryness. The sides of the test tube were filled with 0.4ml of glacial acetic acid containing trace amounts of ferric chloride and 0.5ml of sulphuric acid. The acetic acid layer was blue in color.
6. **Test for Mucilage:** Pink color was created when fenugreek mucilage was treated with ruthenium red solution.
7. **Test for reducing Sugar:** The fenugreek mucilage was treated for 2 to 3 minutes with a small amount of Fehling's reagent. The precipitate was crimson in color [10].

Formulation of Suspension

Method of Preparation of dry Suspension

An experimental research of nine formulations of cefpodoxime proxetil dry suspension (each of 50 ml) were generated using three suspending agents at various concentrations: acacia, Trigonella foenum graecum mucilage, and xanthan gum. Table 2 shows the amount of each excipient utilized in each formulation.

Table 2: Formulations of cefpodoxime proxetil suspension

Ingredients	F1 (g)	F2 (g)	F3 (g)	F4 (g)	F5 (g)	F6 (g)	F7 (g)	F8 (g)	F9 (g)
Cefpodoxime Proxetil	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Acacia	0.5	1	1.5	-	-	-	-	-	-
Fenugreek seed powder	-	-	-	0.5	1	1.5	-	-	-
Xanthan gum	-	-	-	-	-	-	0.5	1	1.5
Sodium chloride	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Carboxy methyl sodium	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Sodium phosphate	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Sucrose	3	3	3	3	3	3	3	3	3
Methyl paraben	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

Method of Preparation of Cefpodoxime Proxetil Suspension

The cefpodoxime proxetil powder blends (50mg/5ml) were made by triturating all of the ingredients in a mortar and pestle (as shown in Table 2) and passing them through sieve number 40. Distilled water was used to rehydrate the dry powder [11].

Evaluation of Suspension

Particle size Analysis

Optical microscopy was used to determine particle size. The micrometer in the eyepiece had been calibrated. A drop of the formed suspension was placed on a glass slide, covered with a cover slip free of air bubbles, and viewed under a microscope. For at least 100 particles, the diameter of each particle was measured and recorded.

Determination of Sedimentation Volume

The prepared cefpodoxime proxetil suspensions were transferred into a measuring cylinder and left alone, and the height of the sediment was measured at regular intervals of 0, 10, 20, 30, 40, 50, and 60 minutes, and the sedimentation volume was calculated using the following formula. F = 100 Hu/Ho

Where,
Hu is ultimate or final height of sediment as suspension settles
Ho is initial height of suspension [12].

Determination of Viscosity

The viscosity of the suspension sample was evaluated using an Ostwald viscometer. With the pipette, a specific volume of preparation was poured into the bulb. The liquid was sucked up to the top of the following limb. The liquid was then allowed to return to the bulb. The time from A to B of the markings was recorded using a stopwatch. The viscosity was determined using the method [13].

$$\frac{\eta_\rho \; d_\rho \; x \; t_\rho}{} = \frac{}{\eta_w \; d_w \; x \; t_w}$$

where;
ηρ – viscosity of the sample
dρ – density of the sample
tρ – time in seconds to flow from mark A to B
ηw – viscosity of water and dw – density of water.

Determination of flow Rate

The apparent viscosity was computed using the equation after determining the time required for each suspension sample to flow through a 10 ml pipette.

$$\text{Flow rate} = \frac{\text{Volume of pipette (ml)}}{\text{Flow time (s)}}$$

Determination of pH

A digital pH meter was used to determine the pH of the suspension. The pH of the produced dry suspension was evaluated after it was reconstituted with distilled water.

Redispersibility Test

The bottles carrying the suspension were revolved clockwise upside down through 1800 in a semicircular path and back in the anti-clockwise direction (one cycle). This procedure was done indefinitely until the sediment was thoroughly redispersed. A fixed volume of each suspension (50 ml) was stored at room temperature in test tubes for varied time intervals (1, 5, 10, 15, 20 days). One tube was taken at regular intervals and aggressively shaken to redistribute the sediment, and the existence of deposit (if any) was noted [14].

RESULTS AND DISCUSSION

Characterisation of Cefpodoxime Proxetil

Organoleptic Properties

Odour: Odourless or faint odour
Colour: White to light brownish white powder

Loss on Drying (LOD)

Cefpodoxime proxetil had a percentage loss on drying of 0.2%. The LOD of the provided sample was within 0.5% of the limit.

Melting Point

The melting point of cefpodoxime proxetil was discovered to be 1100 degrees Celsius. It meets the Pharmacopoeial standard, implying that the medicine is pure.

Solubility

It was discovered that the medication was easily soluble in dehydrated ethanol, soluble in acetonitrile and methanol, marginally soluble in ether, and very barely soluble in water.

UV- VISIBLE SPECTROSCOPIC STUDIES

Determination of λ_{max} of cefpodoxime proxetil in methanol

Figure 4 depicts the UV-Visible absorption spectrum of cefpodoxime proxetil in methanol, which showed a maximum at 232 nm.

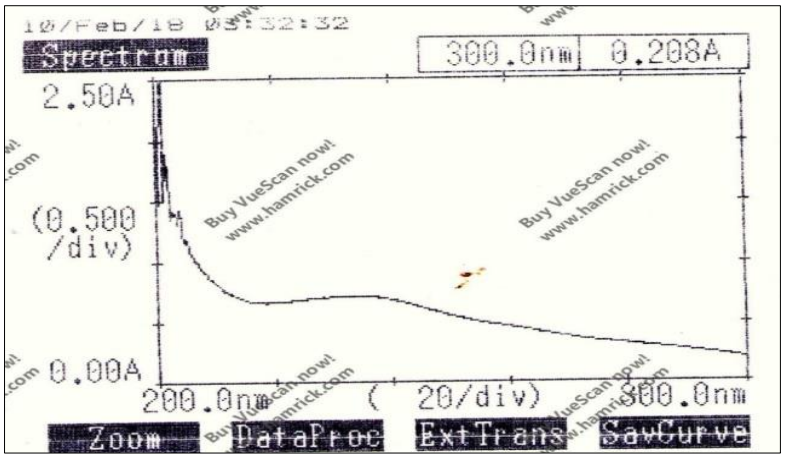

Figure 4: λmax for Cefpodoxime proxetil in methanol

Linearity and Range of Cefpodoxime Proxetil Calibration Curve in Methanol

The straight line calibration graph was obtained in methanol at concentrations of 10-50g/ml of cefpodoxime proxetil. Cefpodoxime proxetil linear regression equation in methanol was y=0.022x-0.010, with a correlation coefficient of 0.9994. Figure 5 depicts the calibration curve, and Table 3 summarizes the calibration results. The linear regression equation and r2 value indicate that the medication solution concentration studied followed linearity.

Table 3: Calibration data for cefpodoxime proxetil in methanol

S.No.	Concentration (µg/ml)	Absorbance
1	10	0.202
2	20	0.426
3	30	0.658
4	40	0.879
5	50	1.103

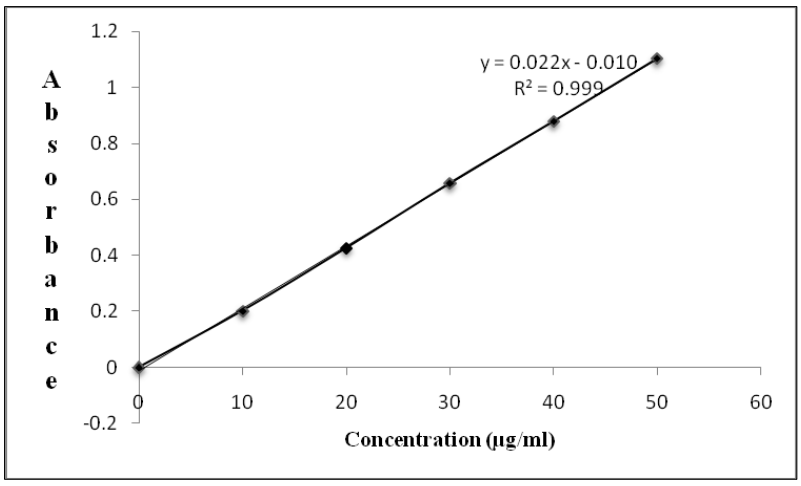

Figure 5: Calibration curve for Cefpodoxime proxetil in methanol

Swelling Index of Fenugreek

Swelling Index % (SI) = (W_2 □ W_1/W_1) x 100

= (25 – 10 / 10) x 10 = 150%

W_1= weight of fenugreek powder at "time o",

W_2= weight of fenugreek powder at "time t"

Because weight gain by mucilage was proportional to rate of hydration, the aforementioned result demonstrated that increasing the duration caused an increase in the swelling index. The swelling index had a direct link with mucilage concentration; as mucilage concentration increased, so did the swelling index.

Phytochemical Test for the Fenugreek Seed Mucilage

Preliminary tests were carried out to validate the type of the acquired mucilage. According to the phytochemical test, fenugreek mucilage contains carbohydrate, alkaloids, and proteins, as shown in Table 4.

Table 4: Phytochemical test for the fenugreek seed mucilage

S. No.	Tests	Observation
1	Test for carbohydrates (Molisch's test)	Positive
2	Test for tannins (Ferric chloride test)	Negative
3	Test for proteins (Ninhydrin test)	Positive
4	Test for alkaloids (Wagner's test)	Positive
5	Test for glycosides (Keller-kiliani test)	Negative
6	Test for mucilage (Ruthenium red test)	Positive
7	Test for reducing sugar (Fehling's test)	Negative

Particle size Determination

The particle size determinations for F1-F9 cefpodoxime proxetil suspension formulations are listed below:

Table 5: Particle size analysis for F1 formulation of Cefpodoxime proxetil Suspension

0	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
10	4	4	2	8	8	7	5	3	8	6
20	3	3	8	6	7	4	6	4	7	7
30	4	2	6	9	6	9	6	5	8	5
40	6	4	7	8	5	8	5	6	4	6
50	5	5	4	6	4	6	5	7	5	2
60	5	4	6	4	2	5	5	2	6	3
70	3	6	5	5	3	3	4	2	7	4
80	9	7	7	6	4	4	7	3	8	5
90	8	8	6	8	5	8	8	4	3	6
100	7	6	8	7	6	7	7	6	2	4

Table 6: Calculation of particle size distribution for F1 formulation of Cefpodoxime proxetil Suspension

S. No.	Size range	Mean size (d)	Number of particles (n)	n x d
1	0 – 10	5	0	0
2	10 – 20	15	0	0
3	20 – 30	25	7	175
4	30 – 40	35	0	0
5	40 – 50	45	10	450
6	50 – 60	55	17	935
7	60 – 70	65	0	0
8	70 – 80	75	16	1200
9	80 – 90	85	20	1700
10	90 – 100	95	13	1235
11	100 – 110	105	0	0
12	110 – 120	115	14	1610
13	120 – 130	125	3	375

Average particle size – $\Sigma nd/\Sigma n$

- 7680/100
- 76.8µm

Table 7: Particle size analysis for F2 formulation of Cefpodoxime proxetil Suspension

0	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
10	4	9	9	4	5	1	4	7	8	9
20	3	8	2	2	3	4	4	9	6	1
30	2	2	3	3	4	6	3	5	7	8
40	4	3	5	6	5	4	4	4	3	3
50	5	3	6	7	6	5	3	2	4	3
60	7	6	7	8	7	3	2	3	5	3
70	6	7	8	8	8	2	8	3	6	1
80	3	8	9	6	9	3	9	3	7	2
90	2	5	3	7	3	3	3	3	8	3
100	9	2	9	8	2	1	3	3	9	4

Table 8: Calculation of particle size distribution for F2 formulation of Cefpodoxime proxetil Suspension

S. No	Size range	Mean size (d)	Number of particles (n)	n x d
1	0 – 10	5	0	0
2	10 – 20	15	3	45
3	20 – 30	25	10	250
4	30 – 40	35	0	0
5	40 – 50	45	27	1215
6	50 – 60	55	12	660
7	60 – 70	65	8	520
8	70 – 80	75	0	0
9	80 – 90	85	10	850
10	90 – 100	95	9	855
11	100 – 110	105	0	0
12	110 – 120	115	11	1265
13	120 – 130	125	10	1250

average particle size – Σnd/Σn

- 6910/100
- 69.1µm

Table 9: Particle size analysis for F3 formulation of Cefpodoxime proxetil Suspension

0	10	20	30	40	50	60	70	80	90	100
10	3	3	4	6	4	6	7	7	6	2
20	4	9	5	4	5	5	3	9	7	3
30	2	8	7	3	6	4	3	5	3	5
40	3	7	3	6	3	3	3	8	2	5
50	4	6	2	5	2	9	5	8	5	5
60	5	5	4	4	4	8	6	8	4	5
70	6	1	6	3	5	7	5	8	5	3
80	7	2	2	7	3	6	5	7	4	2
90	8	3	3	6	2	5	6	9	3	4
100	5	4	4	5	3	4	7	8	4	3

Table 10: Calculation of particle size distribution for F3 formulation of Cefpodoxime proxetil Suspension

S. No.	size range	Mean size (d)	Number of particles (n)	n x d
1	0 – 10	5	0	0
2	10 – 20	15	1	15
3	20 – 30	25	9	225
4	30 – 40	35	0	0
5	40 – 50	45	17	765
6	50 – 60	55	19	1045
7	60 – 70	65	20	1300
8	70 – 80	75	0	0
9	80 – 90	85	12	1020
10	90 – 100	95	10	950
11	100 – 110	105	0	0
12	110 – 120	115	8	920
13	120 – 130	125	4	500

Average particle size – Σnd/Σn

- 6740/100
- 67.4µm

Table 11: Particle size analysis for F4 formulation of Cefpodoxime proxetil Suspension

0	10	20	30	40	50	60	70	80	90	100
10	3	6	5	4	4	9	2	8	2	6
20	4	4	9	5	6	2	3	4	2	2
30	4	2	6	3	5	8	5	9	6	4
40	5	3	4	4	7	6	8	6	4	5
50	6	3	2	5	5	5	9	2	3	6

0	10	20	30	40	50	60	70	80	90	100
60	3	2	6	6	4	4	3	3	2	4
70	2	5	5	3	8	2	8	4	5	2
80	4	5	2	2	6	3	4	8	8	4
90	5	4	2	2	7	4	6	4	3	6
100	7	4	3	3	5	4	2	8	5	5

Table 12: Calculation of particle size distribution for F4 formulation of Cefpodoxime proxetil Suspension

S. No.	Size range	Mean size(d)	Number of particles (n)	n x d
1	0 – 10	5	0	0
2	10 – 20	15	0	0
3	20 – 30	25	17	425
4	30 – 40	35	16	560
5	40 – 50	45	0	0
6	50 – 60	55	23	1265
7	60 – 70	65	17	1105
8	70 – 80	75	13	975
9	80 – 90	85	0	0
10	90 – 100	95	3	285
11	100 – 110	105	8	840
12	110 – 120	115	3	345

Average particle size – $\Sigma nd/\Sigma n = 5800/100 = 58\mu m$

Table 13: Particle size analysis for F5 formulation of Cefpodoxime proxetil Suspension

0	10	20	30	40	50	60	70	80	90	100
10	2	2	2	2	1	6	4	5	3	4
20	4	1	2	4	2	1	2	2	2	2
30	2	4	5	2	4	2	6	1	1	1
40	3	4	3	4	3	3	5	4	7	9
50	4	5	3	2	9	4	4	5	6	8
60	1	2	2	4	4	5	3	6	5	8
70	2	3	2	3	1	5	2	7	8	7
80	4	5	2	4	5	6	1	7	7	6
90	3	4	1	5	5	7	4	5	6	5
100	3	9	1	2	4	3	6	4	5	4

Table 14: Calculation of particle size distribution for F5 formulation of Cefpodoxime proxetil Suspension

S. No.	size range	Mean size(d)	Number of particles (n)	n x d
1	0 – 10	5	0	0
2	10 – 20	15	12	180
3	20 – 30	25	21	525
4	30 – 40	35	0	0
5	40 – 50	45	12	57
6	50 – 60	55	21	1155
7	60 – 70	65	0	0
8	70 – 80	75	14	1050
9	80 – 90	85	8	680
10	90 – 100	95	7	665
11	100 – 110	105	0	0
12	110 – 120	115	3	345
13	120 – 130	125	2	250

Average particle size – $\Sigma nd/\Sigma n$

- $4907/100$
- $49.07\mu m$

Table 15: Particle size analysis for F6 formulation of Cefpodoxime proxetil Suspension

0	10	20	30	40	50	60	70	80	90	100
10	5	1	2	2	2	4	1	1	3	2
20	4	3	4	1	1	5	3	3	3	5
30	3	5	3	4	3	1	4	2	3	6
40	2	4	1	3	4	2	5	5	2	5
50	4	3	4	2	5	3	2	6	1	6
60	3	2	5	1	3	4	3	1	3	1
70	4	1	6	4	4	5	2	2	3	3
80	5	5	5	4	5	4	4	3	3	3
90	3	6	4	5	6	3	3	1	5	1
100	2	3	3	3	3	2	2	3	2	2

Table 16: Calculation of particle size distribution for F6 formulation of Cefpodoxime proxetil Suspension

S.No.	Size range	Mean size(d)	Number of particles (n)	n x d
1	0 – 10	5	0	0
2	10 – 20	15	15	225
3	20 – 30	25	17	425
4	30 – 40	35	0	0
5	40 – 50	45	29	1305
6	50 – 60	55	17	935
7	60 – 70	65	16	1040
8	70 – 80	75	0	0
9	80 – 90	85	6	510
10	90 – 100	95	0	0

Average particle size – Σnd/Σn

- 4440/100
- 44.4µm

Table 17: Particle size analysis for F7 formulation of Cefpodoxime proxetil Suspension

0	10	20	30	40	50	60	70	80	90	100
10	5	1	3	1	5	3	4	7	5	5
20	6	4	2	5	4	6	4	8	4	4
30	4	3	1	8	3	4	1	9	3	3
40	9	1	5	6	2	5	3	2	8	2
50	8	6	8	7	1	9	2	4	5	5
60	7	5	6	8	7	8	1	6	4	6
70	6	4	5	7	6	7	4	1	3	8
80	5	8	4	6	6	6	2	3	9	9
90	3	7	3	9	5	2	5	7	8	4
100	2	6	2	6	4	4	6	6	7	1

Table 18: Calculation of particle size distribution for F7 formulation of Cefpodoxime proxetil Suspension

S.No,	Size range	Mean size(d)	Number of particles (n)	n x d
1	0 – 10	5	0	0
2	10 – 20	15	8	120
3	20 – 30	25	10	250
4	30 – 40	35	0	0
5	40 – 50	45	11	495
6	50 – 60	55	15	825
7	60 – 70	65	0	0
8	70 – 80	75	14	1050
9	80 – 90	85	17	1445
10	90 – 100	95	9	855
11	100 – 110	105	0	0
12	110 – 120	115	10	1150
13	120 –130	125	6	750

Average particle size – Σnd/Σn

- 6940/100
- 69.4µm

Table 19: Particle size analysis for F8 formulation of Cefpodoxime proxetil Suspension

0	10	20	30	40	50	60	70	80	90	100
10	8	4	2	6	3	5	2	2	2	6
20	4	2	6	9	7	4	2	6	3	2
30	6	3	4	5	9	2	2	4	4	3
40	9	4	5	2	8	3	4	2	4	8
50	5	4	8	3	2	3	6	3	5	2
60	8	6	5	8	3	5	4	6	2	4
70	6	8	8	6	6	5	9	5	2	4
80	2	7	2	5	2	6	5	9	3	3
90	5	8	2	2	3	4	8	8	5	4
100	5	4	4	8	8	8	5	4	4	8

Table 20: Calculation of particle size distribution for F8 formulation of Cefpodoxime proxetil Suspension

S.No.	Size range	Mean size(d)	Number of particles (n)	n x d
1	0 – 10	5	0	0
2	10 – 20	15	0	0
3	20 – 30	25	21	525
4	30 – 40	35	12	420
5	40 – 50	45	0	0
6	50 – 60	55	19	1045
7	60 – 70	65	15	975
8	70 – 80	75	12	900
9	80 – 90	85	0	0
10	90 – 100	95	2	190
11	100 – 110	105	19	1470
12	110 – 120	115	15	575

Average particle size – Σnd/Σn

- 6100/100
- 61µm

Table 21: Particle size analysis for F9 formulation of Cefpodoxime proxetil Suspension

0	10	20	30	40	50	60	70	80	90	100
10	8	8	4	8	3	2	2	3	2	4
20	5	5	2	4	2	3	5	2	3	6
30	4	4	4	6	8	8	5	5	8	3
40	2	6	2	5	5	9	3	8	2	2
50	6	9	8	3	9	4	3	7	4	8
60	7	5	4	2	6	6	2	3	6	5
70	8	2	3	2	4	8	2	8	5	9
80	4	6	4	5	5	5	5	2	4	8
90	6	5	4	4	8	4	4	5	3	4
100	4	2	2	4	4	6	8	9	2	5

Table 22: Calculation of particle size distribution for F9 formulation of Cefpodoxime proxetil Suspension

S.No.	Size range	Mean size(d)	Number of particles (n)	n x d
1	0 – 10	5	0	0
2	10 – 20	15	0	0
3	20 – 30	25	19	475
4	30 – 40	35	10	350
5	40 – 50	45	0	0
6	50 – 60	55	27	1485
7	60 – 70	65	16	1040
8	70 – 80	75	10	750
9	80 – 90	85	0	0
10	90 – 100	95	2	190
11	100 – 110	105	11	1155
12	110 – 120	115	5	575

Av erage particle size – Σnd/Σn = 6020/100 = 60µm.

Table 23 and Figure 6 show the comparative particle size distribution for F1-F9 formulations. The average particle size for the F6 formulation was discovered to be 44mm. Furthermore, as compared to other formulations, the F6 with fenugreek seed powder as a suspending agent demonstrated greater homogeneity and ease of absorption.

Table 23: Comparison of particle size analysis for F1-F9 formulations of Cefpodoxime Suspension

S.NO.	F1 (µm)	F2 (µm)	F3 (µm)	F4 (µm)	F5 (µm)	F6 (µm)	F7 (µm)	F8 (µm)	F9 (µm)
1	76.8	69.1	67.4	58	49	44	69.4	61	60

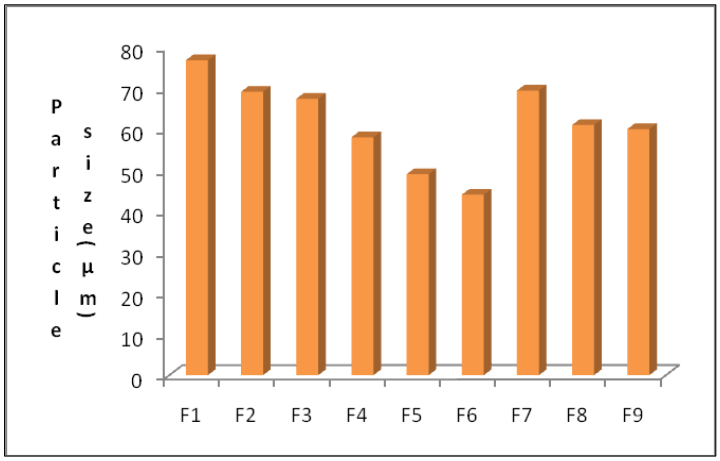

Figure 6: Particle size distribution for F1-F9 of Cefpodoxime proxetil Suspension

Determination of Sedimentation Volume

By comparing the sedimentation volume data of all nine formulations (tabulated in Table 24, 25, 26 and illustrated in Figures 7, 8, and 9), it was determined that F6 is more stable than the other formulations F1, F2, F3, F4, F5, F7, F8, and F9, as it has a higher volume of sedimentation ratio of nearly equal to 1, indicating that it has higher suspendibility and the suspension formed was stable.

Table 24: Sedimentation volume for F1, F2, and F3 of Cefpodoxime proxetil Suspension

Time	H_U/H_O (F1)	H_U/H_O (F2)	H_U/H_O (F3)
0	1	1	1
10	0.5	0.7	0.96
20	0.4	0.4	0.6
30	0.36	0.4	0.48
40	0.34	0.38	0.42
50	0.32	0.36	0.4
60	0.32	0.34	0.38

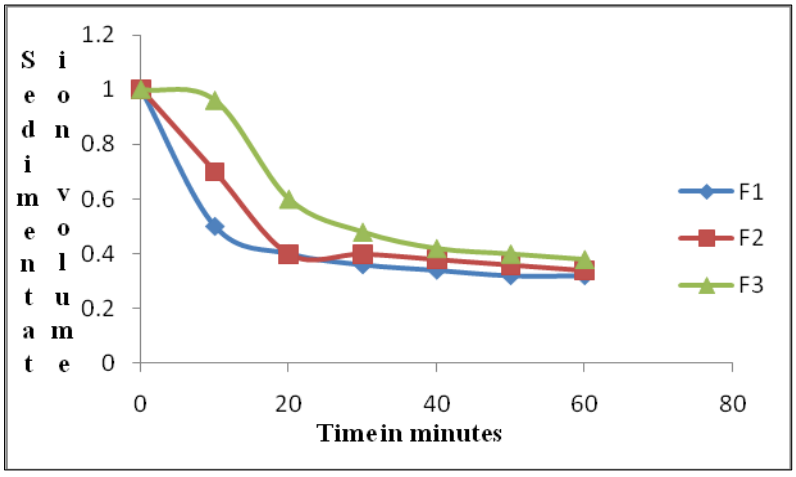

Figure 7: Sedimentation volume comparison of Cefpodoxime proxetil Suspension formulations F1, F2, and F3.

Table 25 : Sedimentation volume for F4,F5,and F6 of Cefpodoxime proxetil Suspension

Time	H_U/H_O (F4)	H_U/H_O (F5)	H_U/H_O (F6)
0	1	1	1
10	0.98	0.98	0.99
20	0.96	0.97	0.99
30	0.93	0.94	0.99
40	0.9	0.92	0.98
50	0.88	0.92	0.98
60	0.84	0.91	0.98

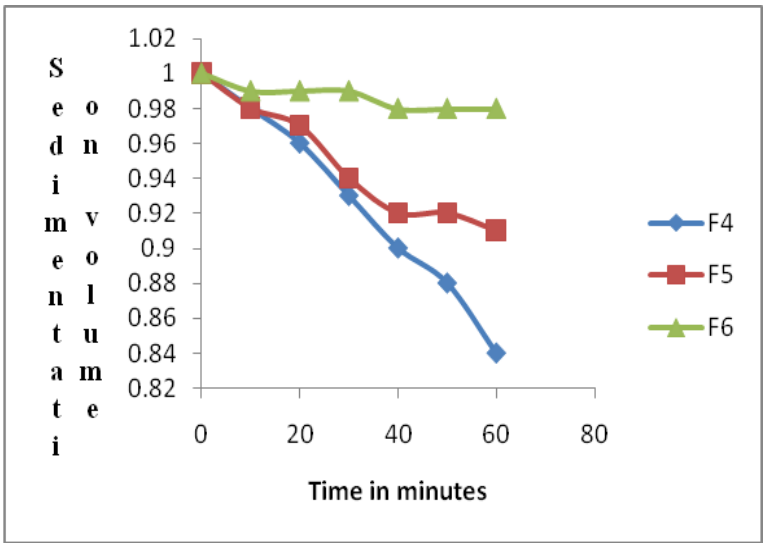

Figure 8: Comparison of sedimentation volume between F4, F5 and F6 of Cefpodoxime proxetil Suspension

Table 26: Sedimentation volume for F7, F8, and F9 of Cefpodoxime proxetil Suspension

Time	H_U/H_O (F7)	H_U/H_O (F8)	H_U/H_O (F9)
0	1	1	1
10	0.84	0.86	0.89
20	0.65	0.72	0.81
30	0.54	0.66	0.76
40	0.48	0.52	0.65
50	0.42	0.44	0.61
60	0.38	0.38	0.58

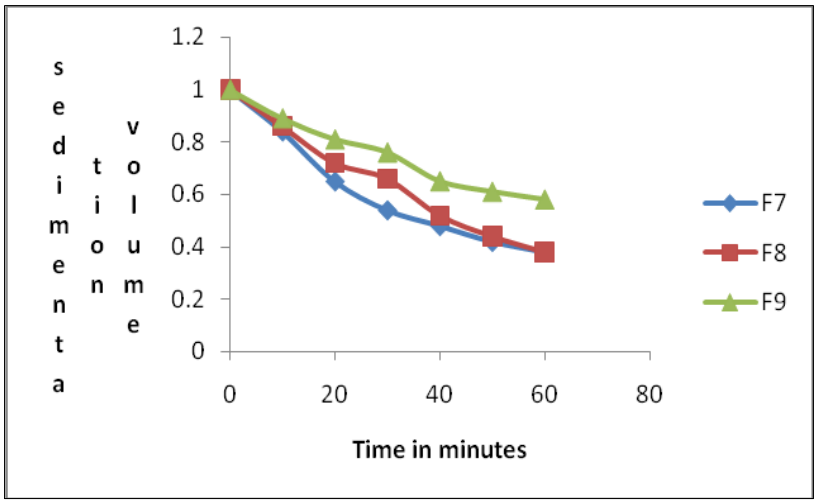

Figure 9: Comparison of sedimentation volume between F7, F8 and F9 of Cefpodoxime proxetil Suspension

Measurement of Viscosity

Table 27: Viscosity for F1-F9 formulations of Cefpodoxime proxetil Suspension

S. No.	Viscosity (poise)
F1	0.0194
F2	0.0248
F3	0.0313
F4	0.0294
F5	0.0318
F6	0.0424
F7	0.0243
F8	0.0288
F9	0.0318

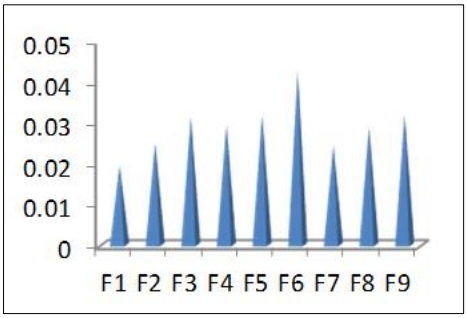

Figure 10: Viscosity for F1-F9 of Cefpodoxime proxetil Suspension

When the viscosity of all nine formulations was compared (as shown in Table 27 and Figure 10), it was determined that F6 had more viscous property than the other formulations.

Flow Rate

Table 28: Flow rate for F1-F9 of Cefpodoxime proxetil Suspension

S. No.	Flow rate (ml/sec)
F1	1.42
F2	1.25
F3	1.11
F4	0.90
F5	0.83
F6	0.714
F7	1.42
F8	1.66
F9	1.66

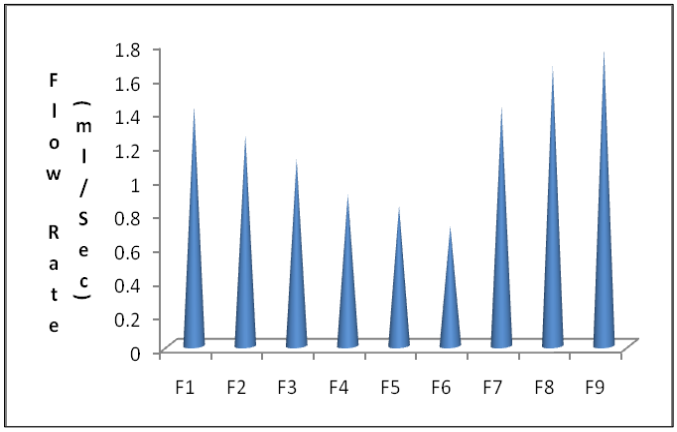

Figure 11: Flow rate for F1-F9 of Cefpodoxime proxetil Suspension

Based on the results provided in Table 28 and Figure 11, it was determined that formulation F6 has a high viscosity since it has the lowest flow rate compared to the other formulations.

pH Determination

The PH of the F1-F9 formed suspensions was determined using a digital pH meter, and the findings are displayed in the table. The pH values of the formulations ranged from 6.21 to 6.39, indicating that all formulations have an optimal pH range.

Table 29: pH for F1-F9 of Cefpodoxime proxetil Suspension

S.No.	pH
F1	6.30
F2	6.29
F3	6.28
F4	6.39
F5	6.25
F6	6.23
F7	6.21
F8	6.28
F9	6.27

Redispersibility Test

The redispersibility test was performed on fenugreek mucilage formulations F4, F5, and F6 (as shown in Table 30) on day 1, 7, 10, and 15 days. With the lower concentration of Trigonella foenum Graecum mucilage (F4), two shakes (as shown in Table 30) were sufficient to completely redistribute the suspension, whereas at the higher concentration, at least four shakes were required. It should be noted that, due to the higher percentage of suspending agent, a greater number of shaking times were predicted to be required to redistribute the suspension formulation, however this was not necessary because they were already flocculated. The redispersibility findings showed that the formed F4-F6 suspension had good physical stability.

Table 30: Redispersibility test of the F4, F5 and F6 of Cefpodoxime proxetil Suspension

Formulation Name	Concentration of fenugreek mucilage	Redispersibility (day 1)	Redispersibility (day 7)	Redispersibility (day 10)	Redispersibility (day 15)
F4	0.5g	Easily Redispersable After shaking 2 Times	Easily Redispersable After shaking 2 times	Easily Redispersable After shaking 3 Times	Easily Redispersable After shaking 3 Times
F5	1g	Easily Redispersable After shaking 2 Times	Easily Redispersable After shaking 2 times	Easily Redispersable After shaking 3 Times	Easily Redispersable After shaking 3 Times
F6	1.5g	Easily Redispersable After shaking 2 times	Easily Redispersable After shaking 2 times	Easily Redispersable After shaking 4 Times	Easily Redispersable After shaking 4 Times

CONCLUSION AND SUMMARY

The current study attempted to compare assessment criteria by employing three natural gums as a suspending agent in a cefpodoxime proxetil oral dry suspensions: acacia, Trigonella foenum graecum (Family: Leguminosae) seeds, also known as fenugreek seeds, and xanthan gum. F1, F2, F3, F4, F5, F6, F7, F8 and F9 suspension formulations with varying proportions of acacia, Trigonella foenum graecum mucilage, and xanthan gum as the suspending agent (0.5g, 1g, 1.5g, respectively) and cefpodoxime proxetil as the active pharmaceutical ingredient were prepared and evaluated. Sodium chloride, carboxy methyl cellulose sodium, sodium phosphate, sugar, and methyl paraben were also utilized as excipients. The suspensions were evaluated using various criteria such as particle size, sedimentation volume, viscosity, pH, flow rate, and, lastly, the redispersibility test. The particle size of all nine formulations was evaluated, and the results showed that the particle distribution for F6 is 44m, indicating that F6 has higher homogeneity and is more absorbable than other formulations due to its tiny particle size. The sedimentation volume for F6 did not change considerably over a 60-minute period, indicating that F6 is more stable than other formulations due to its greater volume of sedimentation ratio, indicating that it has higher suspendibility, a higher degree of flocculation, and good stability. The viscosity of each formulation was determined; in comparison, the F6 formulation had a higher viscosity value, indicating that it has a more

viscous property. The pH of all formulations was determined to be close to 6 (roughly). Even after 15 days, the suspensions were easily redispersible after only two shakes, and the flow rate of the F6 suspensions is low due to its high viscosity nature when compared to other formulations.

Even though F4, F5 formulations outperformed F1, F2, F3, F7, F8, and F9 formulations, it can be concluded that F6 formulation is the optimum formulation with greater flocculation, good flow rate, and easily redispersibility characteristics, as well as small particle size, so the study reveals the potential of Trigonella foenum graecum mucilage as a natural suspending agent and also demonstrated that increasing the concentration increased the suspending property. Because Trigonella foenum graecum offers several benefits such as antidiabetic activity and antilipidemic action, the formulation can be eaten by diabetic patients along with the antibacterial medicine cefpodoxime proxetil. For further examination, these formulations should be compared to market preparations.

It was discovered that the prepared cefpodoxime proxetil suspension with natural suspending agent Trigonella foenum graecum F6 outperformed other formulations in terms of stability. Increases in suspending agent concentration improve suspension viscosity, which lowers sedimentation and adds to suspension stability. The goal of developing a patient-compliant dose form was met. This innovative formulation would be beneficial to people who have dysphagia or have trouble swallowing solid oral dose forms.

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