

Preformulation Characterization of Piroxicam for the Development of a Niosomal Drug Delivery System

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ABSTRACT :

The present study was undertaken to evaluate the pre-formulation characteristics of Piroxicam as a preliminary step in the development of a Piroxicam-loaded niosomal drug delivery system using the thin-film hydration technique. The physical properties of Piroxicam were evaluated based on colour, odour, taste, melting point, and solubility. Piroxicam was obtained as a fine, white, odourless and tasteless powder. The drug showed solubility in organic solvents such as dimethyl sulfoxide (DMSO) and dimethylformamide, while it was insoluble in water. The melting point of Piroxicam was found to be 198–200°C, which was within the reported range and supported the identity and purity of the drug sample. The maximum absorption wavelength (λ_{max}) of Piroxicam was determined by UV-visible spectrophotometry and was found to be 354 nm in phosphate buffer pH 7.4. A calibration curve was prepared over a concentration range of 10–50 µg/mL, and good linearity was obtained with a correlation coefficient (R^2) of 0.998. FTIR analysis of Piroxicam showed the characteristic functional group peaks of the drug. Comparison of the FTIR spectra of Piroxicam with the optimized formulation indicated retention of the characteristic peaks without major changes, suggesting the absence of significant chemical interaction between the drug and formulation components. Overall, the pre-formulation studies established the physicochemical characteristics of Piroxicam and provided essential information for its further incorporation into the niosomal drug delivery system.

Keywords: Piroxicam; Pre-formulation studies; Solubility; Melting point; UV-visible spectroscopy; λ_{max} ; Calibration curve; FTIR; Niosomes; Thin-film hydration.

I. INTRODUCTION

(NDDS) has been the attention of extensive study and advancement for many years. There are 2 requirements that the NDDS should ideally meet. First, throughout therapy, it should provide the medication at a pace dictated by the body's requirements.

NIOSOMES- Aqueous hydration of an alkyl or dialkyl polyglycerol ether class non-ionic surfactant with cholesterol forms tiny lamellar structures called Niosomes or non-ionic surfactant vesicles. A little quantity of a charge inducer, such diacetyl phosphate, and cholesterol are often added to stabilise the vesicles that form the amphiphile in Niosomes. Amphiphiles include spans, tweens, and brijes, which are non-ionic surfactants. In their lipid vesicle membranes or aqueous layers, Niosomes may entrap hydrophilic and lipophilic medications, respectively. Reportedly, it achieves higher stability compared to liposomes. A longer time for the entrapped medications to circulate is possible. Lipids containing non-ionic surfactants allow for more precise medication delivery to organs such the liver, brain, and tumours. The drug's targeting capabilities might be further enhanced, leading to more effective treatment of cancer, parasites, viruses, and other microbial diseases.

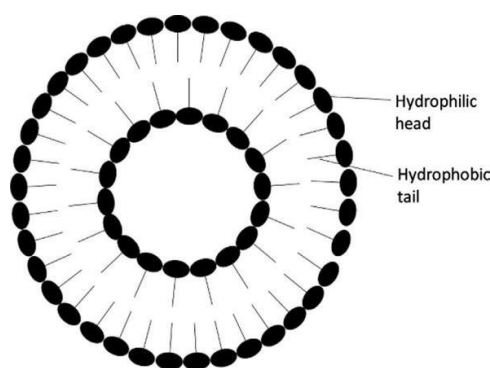


Figure-1: Niosomestructure

Hydrophilic head may comprise of the following groups:

1. Ethylene Oxide head groups
2. Polyhydroxy head groups
3. Glycerol head groups
4. Crown ether head groups
5. Sugar head groups i.e., mannose, lactose, glucose & galactose.

Hydrophobic tails may be grouped into the following types:

1. Surfactants having a carboxyalkyl group that have the ability to join themselves to vesicles that have C10-chain lengths
2. Two or more steroidal groups, one or more alkyl or perfluoroalkyl groups, or perhaps both, might be present.
3. A steroidal C14 or C16 alkyl in the crown ether of an amphiphile is another interesting finding.
4. Using hydrophobic units, vesicle production has been shown.
5. Alkyl chain lengths usually fall between C12 and C18, and they may be three, two, or one.

NIOSOME COMPOSITION:

Niosomes are made up of cholesterol and nonionic surfactants such as alkyl ethers and alkyl esters, while liposomes are often made of phospholipids, either natural or synthetic. Niosomes, or nonionic surfactant vesicles, are now the focus of a great deal of study as a potential alternative to liposomes. The peculiar form of Niosomes allows them to encapsulate medications that are either hydrophilic or hydrophobic. Similar to liposomes, Niosomes have the potential to improve the delivery of hydrophobic or hydrophilic drugs.

The hydration medium and additives are the two primary components of Niosomes, which also include a nonionic surfactant. Lipids, including cholesterol, are the most prevalent additions in niosomal systems.

Important ingredients in the Niosome production include:

- Surfactants
- Cholesterol
- Charged molecules
- Hydration medium

II. EXPERIMENTAL WORK

Piroxicam was procured from Hetero Laboratories Ltd. Span-20 Cholesterol procured from Synpharma Research Lab, HYD. Span-80, Sodium hydroxide, Di-Sodium Hydrogen Ortho Phosphate, Potassium Dihydrogen Phosphate procured from A.R. chemicals, HYD, Chloroform, Methanol procured from Vijaya Enterprises, HYD. Other chemicals and the reagents used were of analytical grade.

Pre-Formulation Studies

Approaches of API characterisation

Physical properties: The colour, odour, taste of the observed.

Solubility studies: Piroxicam is soluble in dimethyl sulfoxide (DMSO), ethanol, and methanol.

Determination of melting point: Using the capillary technique, the M.P. of Piroxicam was determined.

Determination of λ_{max} :

A UV spectrophotometer was used to scan for maximum absorbance in the 200–400 nm region after 100 mg of Piroxicam was dissolved in 10 ml of methanol and then diluted with pH 7.4 buffer. Three separate readings were averaged.

Estimation of Piroxicam:

The spectrophotometric approach was utilised in this investigation to calculate Piroxicam using a UV spectrophotometer.

Making a Phosphate Buffer with a pH of 7.4:

In a 1000 mL volumetric flask, 250 mL of potassium dihydrogen phosphate and 195.5 mL of sodium hydroxide, both at 0.2M concentration, were added. To lower the pH to 7.4, a 0.2M solution of potassium dihydrogen phosphate and sodium hydroxide was added to the volume.

Ground work of 0.2 MKHPO₄ Solution:

A 0.2M solution is obtained by dissolving 27.218 grammes of potassium dihydrogen phosphate in 1000 millilitres of water.

Planning of 0.2 M Sodium hydroxide:

To produce 1000 millilitres of 0.2M sodium hydroxide, 8 grammes of NaOH were dissolved in a small quantity of water and then diluted.

ESTIMATION OF DRUG (STANDARD GRAPH):

Procedure: For the planning of calibration curvature, Stock Solution was organized by dissolving 100mg of accurately balanced Piroxicam in 100ml of methanol (stock solution- It contains 1mg/ml of drug. From stock solution-1, 2ml of solution was taken into a 100ml volumetric flask & volume was complete up through phosphate buffer pH 7.4 (stock solution-2). It contains 20 μ g/ml. From this stock solution-2, pipette out 1, 2, 3 & 4, 5, and 6ml were taken in 10ml volumetric flask & make up with 7.4 pH phosphate buffer. It contains 2, 4, 6 & 8, 10, 12 μ g/ml respectively. The absorption maxima obtained at 354 nm and absorbance's were detected by using UV-visible spectrophotometer.

III.RESULTS AND DISCUSSION

Investigations before Formulation:

Evaluation of the Smell and Taste of an Organ:

Table-1: Organoleptic Features of Piroxicam

Properties	Results
Description	Fine powder
Taste	Tasteless
Odor	Odorless
Color	White color

Determination of melting point:

Since Piroxicam's melting point fell within the prescribed range of 198-200°C, it was concluded that the pharmaceutical sample was pure.

Solubility:

It readily dissolves in organic solvents such as DMSO and dimethyl formamide, insoluble in Water.

GROUNDWORK OF STANDARD CURVE OF PIROXICAM:

A standard curve for Piroxicam was made by plotting absorption vs. concentration at 354 nm using a phosphate buffer with a pH of 7.4. And Beer's law says it should be. It's worth 0.998, which is R^2 .

Table-2: Calibration Curvature of Piroxicam in 7.4 Phosphate Buffer

S. no	Concentration ($\mu\text{g/ml}$)	Absorbance
1	0	0
2	10	0.16
3	20	0.301
4	30	0.429
5	40	0.557
6	50	0.688

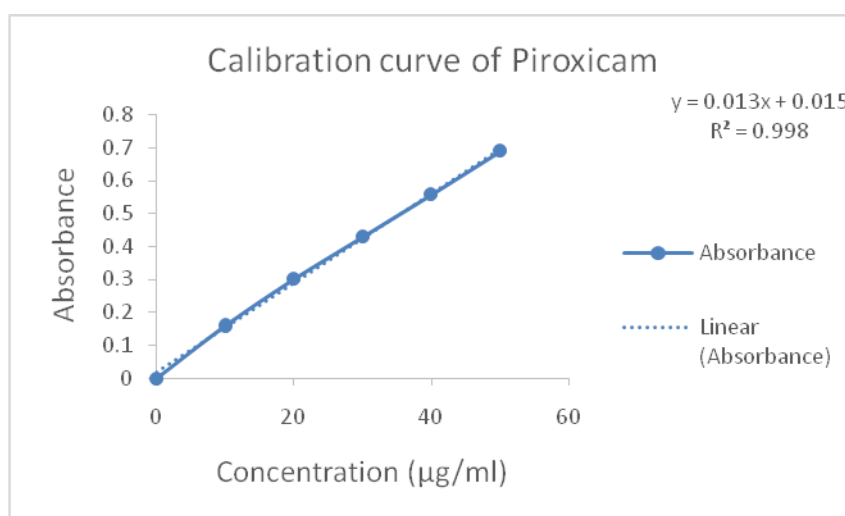


Figure-2: Calibration Curve of Piroxicam

The Standard Curve for Piroxicam in a 7.4 pH Phosphate Buffer is shown here. The peak absorption was found at a wave-length of 354nm. In the Concentration Ranges of 10 to 50 $\mu\text{g/ml}$, Lambert-Beer's law was satisfied by Piroxicam.

Excipient Interaction Studies (FT-IR) of Drugs:

The IR spectrum of the mixture of Piroxicam and other ingredients is shown below. It was seen in this study that the drug and the plastics used do not react chemically with each other. The graphs showed that these main points in the IR spectrum of the drug and polymer mixture did not change. This means that there were no physical interactions because the drug and polymer formed bonds. This is more proof that the pure drug is real and that it works well with the excipients.

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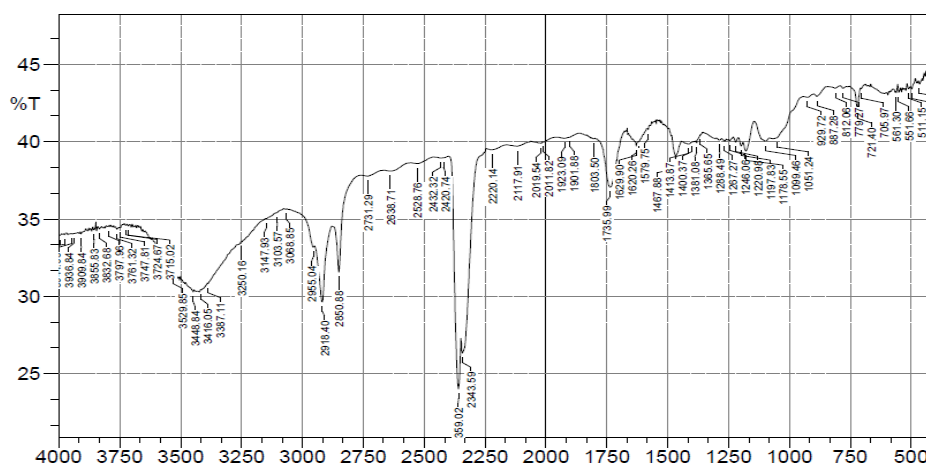


Figure-3: FTIR Studies of Drug

Table-2: Representative Peaks for Drug

S.No.	Characteristic Peaks	Frequency range (cm-1)	Frequency (cm-1)
1.	OH Stretching	3500-3540	2972.18
2.	OH Bending	1000-1500	1049.31
3.	C-H stretching	3540-2500	3547.50
4.	C=O stretching	2000-1500	1692.11

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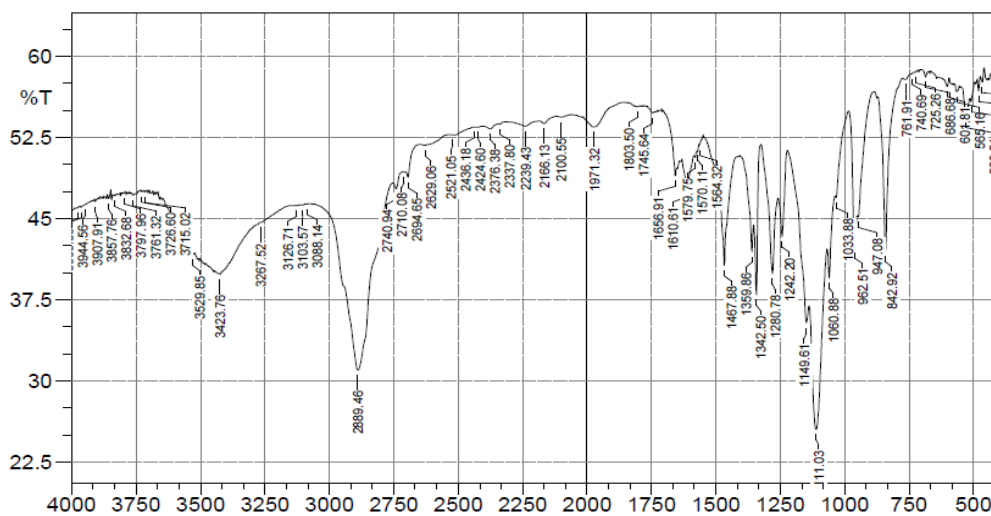


Figure-4: Optimized Formulation FTIR Studies

Table-3: Characteristic Peaks for Optimised Formulation

S.No	Characteristic Peaks	Frequency ranges (cm-1)	Frequency (cm-1)
1	Stretching of OH	4000-3500	3423.76
2	Bending of OH	3540-2750	2889.46
3	C=O stretching	2000-1500	1656.20

SUMMARY

Pre-formulation studies of Piroxicam were carried out to establish its basic physicochemical characteristics before formulation development. Piroxicam was observed as a fine, white, odourless and tasteless powder. The drug was soluble in organic solvents such as DMSO and dimethylformamide and was insoluble in water. The melting point of Piroxicam was found to be 198–200°C, which was within the prescribed range and indicated the satisfactory purity of the drug sample. UV-visible spectrophotometric analysis showed that Piroxicam exhibited maximum absorption at 354 nm in phosphate buffer pH 7.4. The standard calibration curve of Piroxicam was prepared in phosphate buffer pH 7.4 over the concentration range of 10–50 µg/mL. The drug showed good linearity within the selected concentration range, with an R^2 value of 0.998, indicating a strong correlation between concentration and absorbance. FTIR analysis was performed to identify the characteristic functional groups of Piroxicam and to assess drug–excipient compatibility. The characteristic peaks observed for Piroxicam included peaks corresponding to hydroxyl and carbonyl groups. The FTIR spectrum of the optimized formulation retained the characteristic drug peaks without major changes, indicating the absence of significant chemical interaction between Piroxicam and the formulation components.

CONCLUSION

The pre-formulation studies established the important physicochemical and analytical characteristics of Piroxicam required for formulation development. The drug was obtained as a fine, white, odourless and tasteless powder and showed a melting point of 198–200°C. Piroxicam was soluble in selected organic solvents but showed poor aqueous solubility. The drug exhibited a maximum absorption wavelength of 354 nm in phosphate buffer pH 7.4. The calibration curve demonstrated good linearity over the concentration range of 10–50 µg/mL, with an R^2 value of 0.998. FTIR studies confirmed the characteristic functional groups of Piroxicam, while comparison with the optimized formulation indicated no major changes in the characteristic peaks, suggesting the absence of significant chemical incompatibility between the drug and formulation components. These findings provided the necessary pre-formulation information for the subsequent development and characterization of Piroxicam-loaded niosomes using the thin-film hydration technique.

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