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Solid Dispersions with Polyethylene Glycol for the Improvement of Simvastatin's Dissolving Rate and Solubility.

Prachi Ahirwar[1*], Dr. A. K. Uppadhyay[2], Mr Yogesh Sharma[3], Mr Ramdarshan Parashar[3], Mr Ajay Thakur3

1* M Pharma Student, Department of Pharmaceutics, Vedic Institute of Pharmaceutical Education and Research, Babupura, Sagar (M.P.) – 470001.
2 Professor, Vedic Institute of Pharmaceutical Education and Research, Babupura, Sagar (M.P.) – 470001

3 Associate Professor, Vedic Institute of Pharmaceutical Education and Research, Babupura, Sagar (M.P.) – 470001

Abstract

Simvastatin, which is in BCS Class II, is poorly soluble in water, which means that it has poor oral bioavailability. The aim of this study was to improve the solubility and dissolution rate of simvastatin as solid dispersions (SDs) in PEG 4000 and PEG 6000. Solid dispersions were prepared by solvent evaporation at different drug-to-polymer ratios (i.e., 1:1:1 to 1:1:3). The SDs were then characterized by FTIR, DSC, and PXRD prior to conducting solubility studies and in vitro dissolution studies. The best formulation (F3) showed a marked improvement in the dissolution rate in comparison to the pure drug. This study demonstrates the ability of PEG-based solid dispersions to improve the bioavailability of poorly water-soluble drugs.

Keywords: Simvastatin, Solid Dispersion, PEG 4000, PEG 6000, Solubility Improvement, Dissolution Rate.

1. Introduction

Simvastatin, a cholesterol-reducing agent, falls under the BCS Class II category and is known for its high permeability and poor solubility. The low ability of the drug to dissolve in water makes it hard for the body to absorb it when taken by mouth, which is a big problem for developing BCS class II drugs. The recently published literature approaches and class II drug product development methods have shown that solid dispersion (SD) with hydrophilic polymers (e.g., polyethylene glycols (e.g., PEGs)) will produce very favorable dissolution rate and bioavailability. These approaches use the poorly soluble drug demonstrated above and various solid dispersions with the previously mentioned hydrophilic polymers in different proportions, prepare the solid dispersions utilizing the appropriate hydrophilic polymer, establish, study, and evaluate the physicochemical and dissolution profiles of the solid dispersions, and utilize PEG 4000 and PEG 6000 in specific ratios for the solubility enhancement studies.

2. Materials and Methods

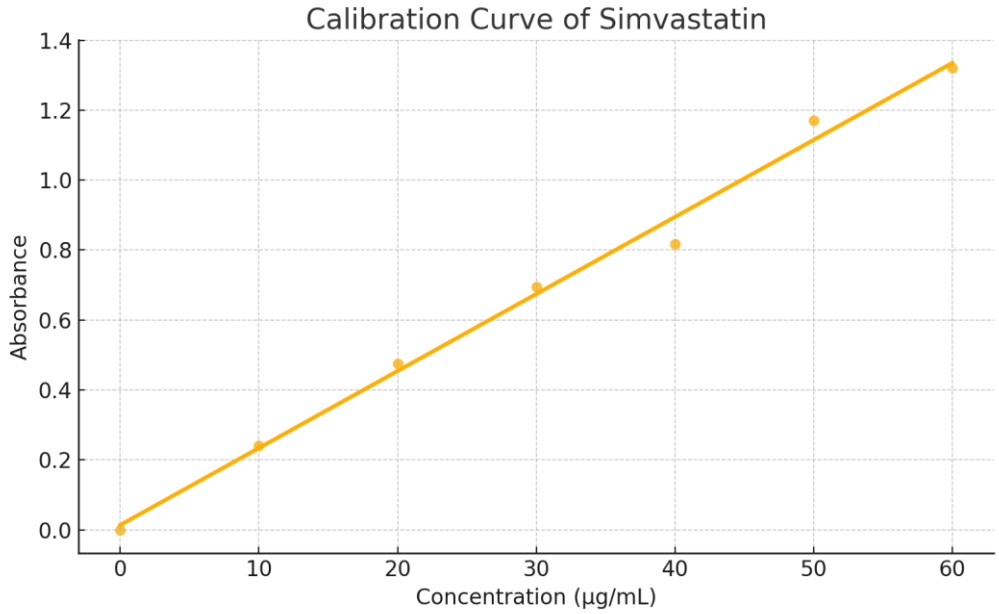
2.1 Materials

- **Simvastatin**: Micro Labs
- **PEG 4000/6000**: Qualikems Fine Chem Pvt. Ltd.
- **Other reagents**: Analytical grade

2.2 Methods

2.2.1 Calibration Curve

A standard curve was established at 238 nm using UV-Visible spectrophotometry in phosphate buffer (pH 7.0) with 0.5% SLS. Linear regression was applied to obtain the calibration equation (R^2 >0.998).



[Figure 1: Calibration Curve of Simvastatin]

2.2.2 Preparation of Solid Dispersions

Formulations F1–F3 were prepared via the solvent evaporation method at various PEG 4000/6000 ratios. The mixtures were dried at 45°C and stored in airtight containers.

2.2.3 Compatibility Studies

- **FTIR Spectroscopy** was used to detect drug-polymer interactions.
- **DSC** determined the melting behaviour and crystallinity.
- **PXRD** assessed the physical state of the drug.

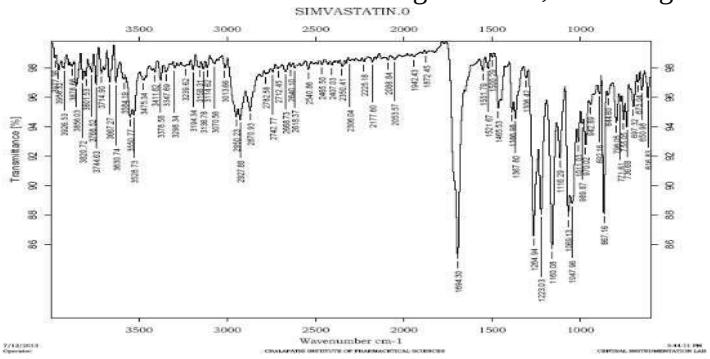
2.2.4 In Vitro Dissolution Study

Conducted using USP Type II apparatus in phosphate buffer (pH 7.0) with 0.5% SLS. Samples were withdrawn at fixed intervals and analysed spectrophotometrically.

3. Results

3.1 FTIR Analysis

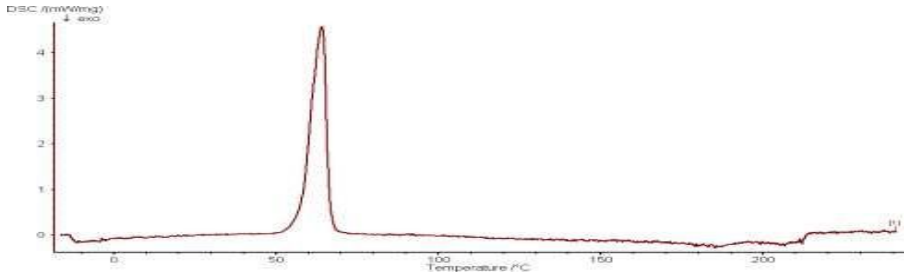
Characteristic peaks of simvastatin remained unchanged in SDs, indicating no chemical interaction.



[Figure 2: FTIR Spectra of Pure Drug]

3.2 DSC Analysis

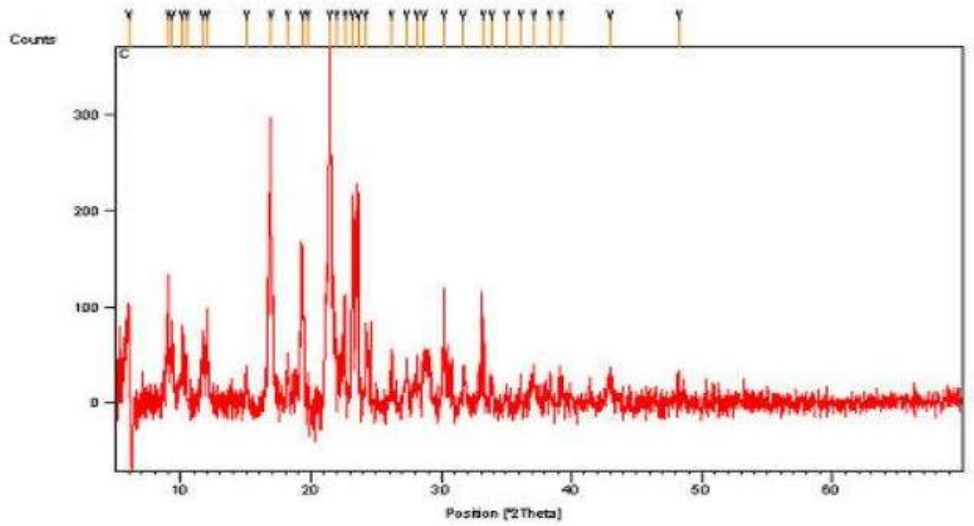
The disappearance or broadening of the drug's endothermic peak in F3 suggested transformation into the amorphous state.



[Figure 3: DSC Thermograms]

3.3 PXRD Analysis

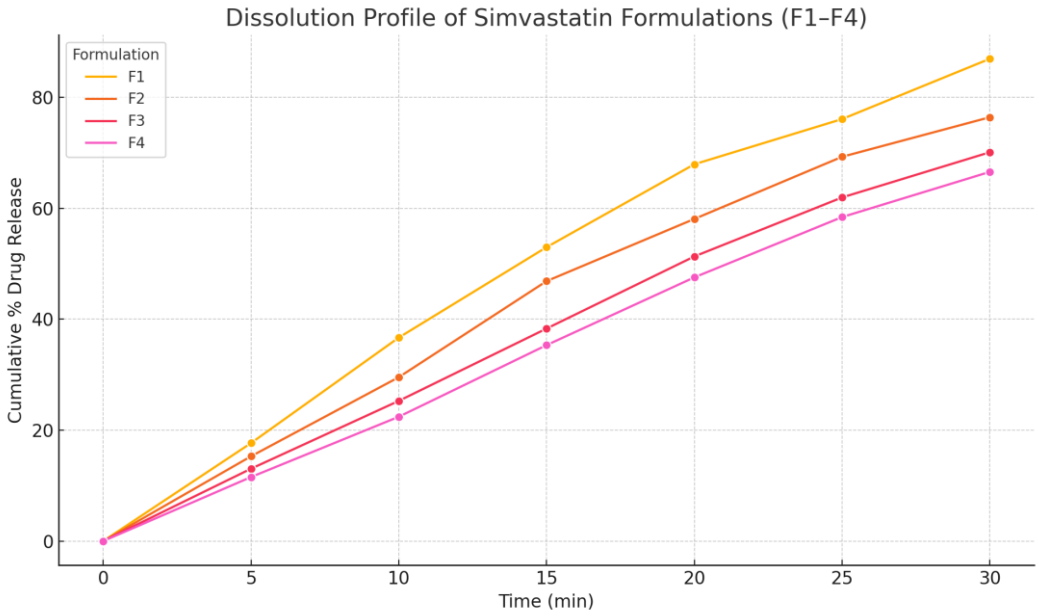
Reduced intensity of diffraction peaks confirmed decreased crystallinity in SDs.



[Figure 4: PXRD Patterns of Pure Drug]

3.4 In Vitro Dissolution

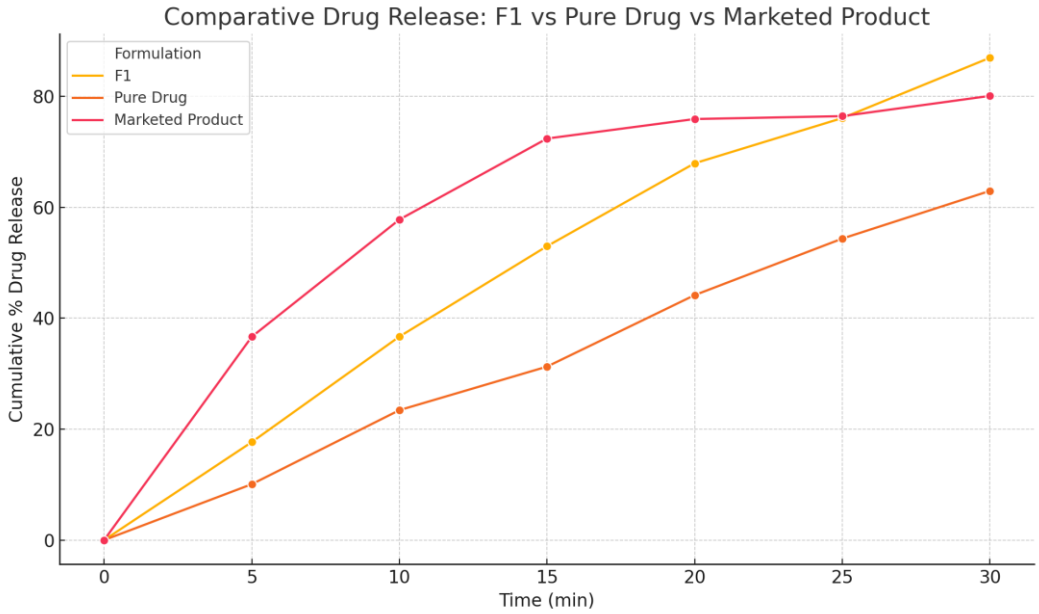
Formulation F3 (1:1:3 PEG6000:PEG4000) showed 92.5% drug release within 60 min vs. 18.2% from the pure drug.



[Figure 5: Dissolution Profile of Simvastatin Formulations]

3.5 Comparative Study

F1 showed superior release compared to pure drug (62.95%) and marketed product (80.08%).



[Figure 6: Comparative Drug Release (F1 vs. Pure Drug vs. Marketed Product)]

3.6 Stability Studies Formulation F1 remained stable with minimal change in drug content (95.65%) and drug release (81.85%) after 3 months.

Table 1: Stability Studies

S.no.	Characteristics	Initial	At the end of 1 month	At the end of 2 months	At the end of 3 month
1.	Physical appearance	Almost White	NC*	NC*	NC*
2.	Drug content (%)	99.57%	99.43%	97.83%	95.65%
3.	*In vitro* drug release at the end of 30min	88.78%	86.95%	83.98%	81.85%

4. Discussion

The enhancement in solubility and dissolution rate can be attributed to reduced crystallinity, improved wettability, and increased surface area from solid dispersion. PEG 6000, in particular, demonstrated superior solubilizing power compared to PEG 4000.

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5. Conclusion

Solid dispersion of simvastatin with PEG 4000 and PEG 6000 significantly enhanced the dissolution rate and solubility, especially in the 1:1:3 ratio (F3). This method offers a promising solution to enhance the bioavailability of poorly water-soluble drugs.

References:

1. Chiou WL, Riegelman S. Pharmaceutical applications of solid dispersion systems. J Pharm Sci. 1971.
2. Dhirendra K, Lewis S, Udupa N, Atin K. Solid dispersions: A review. Pak J Pharm Sci. 2009.
3. Mandal D, et al. Enhancement of the dissolution rate of simvastatin using solid dispersions. Int J Pharm Sci. 2018.
4. Amidon GL. A theoretical basis for a biopharmaceutic drug classification: the correlation of in vivo drug product dissolution and in vivo bioavailability. *Pharm Res*. 1995;12(3):413–20.
5. Chaudhari PD. Current trend in solid dispersion techniques. *Pharmainfo.net*. 2006;2:2–12.
6. Dhirendra K, Lewis S, Udupa N, Atin K. Solid dispersions: a review. *Pak J Pharm Sci*. 2009;22(2):234–46.
7. Brahmankar DM, Jaiswal SB. *Biopharmaceutics and pharmacokinetics: A treatise*. 2nd ed. New Delhi: Vallabh Prakashan; 2009. p. 29–34, 345–6.
8. Sugimoto M, Okagaki T, Narisawa S, Koida Y, Nakajima K. Improvement of dissolution characteristics and bioavailability of poorly water-soluble drugs by novel cogrinding method using water-soluble polymer. *Int J Pharm*. 1998;160(1):11–9.

9. Molcanyiova A, Stancakova A, Javorsky M, Tkac I. Beneficial effect of simvastatin treatment on LDL oxidation and antioxidant protection is more pronounced in combined hyperlipidemia than in hypercholesterolemia. *Pharmacol Res*. 2006;54(3):203–7.
10. Shinde SS, Patil MV, Mevekari FI, Shete AS, Bhagwat DA, D'Souza JI. Physicochemical characterization and solubility enhancement of simvastatin using solid dispersion technique. *World J Pharm Res*. 2012;1(2).
11. Saindane DS. Solid dispersion and solubility enhancement of simvastatin. *Int J Biopharm*. 2011;2(1):22–30.