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# Formulation and Characterization of Blend Microspheres of Dexrabeprazole

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**ABSTRACT**

Dexrabeprazole blend microspheres were developed using a solvent evaporation technique to achieve controlled drug release for therapeutic applications. The microspheres were prepared by emulsifying a polyblend solution of polylactic acid (PLA) and polycaprolactone (PCL) in a polyvinyl alcohol (PVA) solution. The formulations were evaluated for their percentage yield, entrapment efficiency, flow properties, stability in acidic conditions, and drug release profiles. Among the formulations, F3 showed the highest entrapment efficiency (82.25%) and an optimal drug release profile with a slow, sustained release over 12 hours. Scanning electron microscopy (SEM) revealed spherical, smooth microspheres, indicating well-formed drug carriers. The drug release followed zero-order kinetics, demonstrating the potential of the microspheres for prolonged drug release. The results suggest that the blend microspheres of Dexrabeprazole are suitable for controlled release applications, improving therapeutic efficacy and patient compliance.

***Keywords:*** *Dexrabeprazole, blend microspheres, controlled release, solvent evaporation, polyblend, polylactic acid, polycaprolactone, entrapment efficiency, sustained release, scanning electron microscopy.*

## 1. INTRODUCTION

Dexrabeprazole is a potent proton pump inhibitor (PPI) used in the treatment of conditions such as gastroesophageal reflux disease (GERD), peptic ulcers, and Zollinger-Ellison syndrome. Despite its therapeutic benefits, dexrabeprazole suffers from certain limitations, such as poor bioavailability and short half-life, necessitating frequent dosing. To overcome these challenges, various novel drug delivery systems (DDS) have been developed, among which microspheres have gained significant attention. Microspheres offer several advantages, including controlled drug release, enhanced bioavailability, and targeted delivery, making them an attractive option for the formulation of dexrabeprazole. Microspheres are small spherical particles ranging from a few micrometers to hundreds of micrometers in diameter. These particles can be designed to encapsulate the drug, allowing for controlled release over an extended period, which is beneficial in reducing the frequency of drug administration and improving patient compliance. The incorporation of dexrabeprazole into a microsphere formulation can effectively address the limitations associated with conventional oral drug forms by providing sustained release and reducing the drug's peak plasma concentration fluctuations (Baginski & Adamczak, 2019). Polymeric microspheres, specifically those made from biodegradable polymers such as poly(lactic-co-glycolic acid) (PLGA), polycaprolactone (PCL), and other polymers, have been widely studied for their drug delivery applications. These polymers are biocompatible and capable of achieving the controlled release of encapsulated drugs. The use of such polymers in the preparation of dexrabeprazole microspheres allows for the optimization of the drug release profile, ensuring prolonged therapeutic effects while minimizing side effects (Sharma & Rathi, 2021). The aim of this study is to formulate and characterize blend microspheres containing dexrabeprazole using a combination of biodegradable polymers. The preparation of these microspheres will focus on achieving a controlled release profile, enhancing the solubility of the drug, and optimizing stability and drug loading. Additionally, various parameters such as particle size, morphology, entrapment efficiency, drug release rate, and in vitro release kinetics will be evaluated to understand the performance of the microspheres (Patel & Patel, 2018; Gupta & Bansal, 2020). By developing a dexrabeprazole microsphere formulation, the study aims to enhance the therapeutic efficacy of the drug, improve patient adherence, and provide a promising alternative to conventional oral drug delivery systems.

## 2. MATERIAL AND METHODS

### Material

For the formulation development of blend microspheres, various chemicals were used. Dexrabeprazole, the active pharmaceutical ingredient, was obtained as a gift sample from a pharmaceutical company. Chitosan, a biodegradable polymer, was sourced from Research Lab Fine Chem Industries in Mumbai. Ethanol and methanol, both used as solvents, were provided by Qualigens Fine Chemicals, Mumbai, along with dichloromethane and chloroform, which facilitated the microsphere preparation. Disodium hydrogen phosphate, dipotassium hydrogen orthophosphate, and sodium chloride, all from S.D. Fine Chem Ltd., Mumbai, were employed for buffer preparation and maintaining the appropriate pH conditions during the formulation process. These chemicals together contributed to the successful development of the dexrabeprazole-loaded microspheres.

### Methods

#### Preparation of Dexrabeprazole Blend Microspheres

The Dexrabeprazole blend microspheres were prepared by incorporating Dexrabeprazole into a polymeric matrix to achieve a controlled drug release profile. The microsphere preparation aimed to encapsulate Dexrabeprazole uniformly within a biodegradable polymeric blend. The solvent evaporation method was utilized, where Dexrabeprazole was dissolved in a suitable organic solvent and emulsified with the polymer blend solution. This process allowed the drug to be entrapped within the polymeric matrix, ensuring its stability and release in a controlled manner over time.

#### Preparation of Polyblend Solutions

The polyblend solution was created by mixing two biocompatible polymers, polylactic acid (PLA) and polycaprolactone (PCL), in a 1:1 ratio. The polymers were dissolved in dichloromethane, a volatile organic solvent, and stirred for 30 minutes to achieve a homogeneous solution. The resulting 1% polyblend solution was used to prepare the microspheres. PLA and PCL were chosen for their biodegradability and their ability to provide a sustained release of Dexrabeprazole. The blend of these polymers ensures that the microspheres are stable and effective for drug delivery purposes.

#### Preparation of 1% PVA Stock Solution

To prepare the polyvinyl alcohol (PVA) stock solution, 1 g of PVA was dissolved in 90 mL of distilled water. The solution was heated to 60°C and stirred using a magnetic stirrer until the PVA dissolved completely. After achieving a clear, homogeneous solution, it was allowed to cool to room temperature. This resulted in a 1% PVA solution, which is crucial for the emulsification step in the microsphere preparation. PVA serves as an emulsifying agent to stabilize the polyblend emulsion, allowing for the formation of microspheres with well-defined characteristics.

#### Optimization of Concentration and Volume of PVA in Microspheres Preparation

The optimization of PVA concentration and volume was an important step to enhance the efficiency and characteristics of the microspheres. In this step, five milliliters of the 10% polyblend solution (containing PLA and PCL) were emulsified in 100 mL of PVA solutions at varying concentrations. The emulsification was carried out by stirring the mixture at 500 rpm for 15 minutes. Following emulsification, the mixture was dispersed in 500 mL of distilled water, and stirring continued for another 15 minutes. This allowed the dichloromethane solvent to evaporate completely over the course of an additional hour of stirring. The microspheres were then separated by filtration, washed with distilled water to remove residual solvents, and dried in an oven. The different PVA concentrations and volumes were optimized to determine the most effective conditions for microsphere preparation. These variations are outlined in Table 1, which shows the different concentrations and volumes of PVA used for preparing the microspheres (Sharma *et al.*, 2017).

**Table 1: Formulations of chitosan mucoadhesive blend microspheres**

| S. No. | Formulation Code | Dexrabeprazole (mg) | Polyblend solutions (%) | PVA (%) | Dichloromethane (ml) |
|---|---|---|---|---|---|
| 1. | **F1** | 10 | 1 | 6 | 5 |
| 2. | **F2** | 10 | 2 | 5 | 5 |
| 3. | **F3** | 10 | 3 | 4 | 5 |
| 4. | **F4** | 10 | 4 | 3 | 5 |

| | | | | | |
|---|---|---|---|---|---|
| 5. | **F5** | 10 | 5 | 2 | 5 |
| 6. | **F6** | 10 | 6 | 1 | 5 |

**Evaluation of blend microspheres**

**Percentage Yield**

The prepared blend microspheres (F1-F6) were collected and weighed for each formulation code (Priyadarshini *et al.*, 2014). The percentage yield (%) was calculated using formula given below:

$$\% \text{ Yield } = \frac{\text{Actual weight of product}}{\text{Total weight of drug and polymer}} x\ 100$$

**Entrapment Efficiency**

Amount of Dexrabeprazole in each formulation was calculated according to procedure given below. Equivalent to 10mg of chitosan blend microspheres from each batch were accurately weighed (Berthold *et al.*, 1996). The powder of chitosan blend microspheres were dissolved in 10 ml 0.1 N HCl and centrifuged at 1000 rpm. This supernatant solution is then filtered through whatmann filter paper No. 44. After filtration, from this solution 0.1 ml was taken out and diluted up to 10 ml with 0.1 N HCl. The supernant was analyzed for drug content by measuring the absorbance at 256nm.

**Stability of chitosan blend microspheres in 0.1 N HCl**

The stability of chitosan blend microspheres in 0.1 N HCl was determined by incubating 0.5% wt/vol suspension of the blend microspheres in 0.1N HCl for 12 hrs. and measuring the transmission of the samples at 244nm (Labindia 3000+ spectrophotometer) as reported by Dhanaraju *et al.*, (2009). Chitosan is soluble in acidic pH, therefore, the purpose of carrying out this study was to determine the effect of different cross-linking methods on the solubility of chitosan, which in turn reflects the stability at acidic pH.

**Measurement of mean particle size**

The mean particle size of the blend microspheres was determined by Photon Correlation Spectroscopy (PCS) on a submicron particle size analyzer (Malvern particle size analyser**)** at a scattering angle of 90°. A sample (0.5mg) of the microsphere suspended in 5 ml of distilled water was used for the measurement (Thejeswini *et al.*, 2014).

**Determination of zeta potential**

The zeta potential of the drug-loaded blend microspheres was measured on a zetasizer (Malvern particle size analyser) by determining the electrophoretic mobility in a micro electrophoresis flow cell. All the samples were measured in water at 25°C in triplicate.

**Flow property determination of the blend microspheres**

**Bulk density:** Both loose bulk density (LBD) and tapped bulk density (TBD) were determined. Accurately weighed amount of granules taken in a 50 ml capacity measuring cylinder was tapped for 100 times on a plane hard wooden surface and estimated the LBD and TBD, calculated by using following formulas.

$$\textbf{LBD (Loose bulk density)} = \frac{\text{Mass of powder}}{\text{Volume of Packing}}$$

$$\textbf{TBD (Tapped bulk density)} = \frac{\text{Mass of powder}}{\text{Tapped Volume of Packing}}$$

**Compressibility index**: Percent compressibility of powder mix was determined by Carr's compressibility index, calculated by using following formula:-

$$\textbf{Carr's Index} = \frac{\text{TBD} - \text{LBD}}{\text{TBD}} \text{X100}$$

**Hausners ratio:** It is determined by comparing tapped density to the bulk density by using following equation:-

$$\textbf{Housner's ratio } = \frac{\text{Tapped bulk density}}{\text{Loose Bulk density}}$$

**Shape and surface characterization of blend microspheres by Scanning Electron Microscopy (SEM)**

From the formulated batches of microsphere, formulations (F3) which showed an appropriate balance between the percentage drug release was examined for surface morphology and shape using scanning electron microscope (Jeol Japan 6000). Sample

was fixed on carbon tape and fine gold sputtering was applied in a high vacuum evaporator. The acceleration voltage was set at 10KV during scanning. Microphotographs were taken on different magnification and higher magnification (200X) was used for surface morphology.

***In-vitro* drug release studies**

The prepared blend microspheres were evaluated for *in vitro* drug release. The drug release studies were carried out using USP I Basket type dissolution test apparatus. The dissolution study was carried out in 900 ml dissolution medium which was stirred at 100 rpm maintained at 37±0.2°C. The scheme of using the simulated fluids at different timing was as follows: A weighed quantity of formulation (equivalent to 10mg) was filled in capsule and kept in basket of dissolution apparatus with dissolution media 0.1 N HCl (900 ml) at 37±0.2°C. Samples were withdrawn at different time interval and compensated with same amount of fresh dissolution medium. Volume of sample withdrawn was made up to 5ml by media. The samples withdrawn were assayed spectrophotometrically at 256nm for percent of release from mucoadhesive blend microspheres using UV visible spectrophotometer. The release of mucoadhesive microsphere was calculated with the help of Standard curve of Dexrabeprazole (Higuchi, 1963; Korsmeyer *et al.*, 1983).

## 3. RESULTS AND DISCUSSION

The preparation of Dexrabeprazole blend microspheres using the solvent evaporation technique has been a promising approach to achieve controlled drug release for therapeutic applications. The results obtained from the various formulations and their evaluations provide valuable insights into the formulation's characteristics, drug release behavior, and overall effectiveness.

Table 2 shows the percentage yield of different formulations of Dexrabeprazole microspheres. The percentage yields ranged from 72.23% to 85.65%, with formulation F3 showing the highest yield (85.65±0.19). This suggests that the solvent evaporation process used for microsphere preparation was efficient in encapsulating the drug. A higher percentage yield implies the efficient use of the materials and lower loss during the formulation process. The variation in yield among the formulations could be attributed to differences in polymer composition, solvent evaporation rate, and the emulsification process. Regarding the entrapment efficiency, as seen in Table 3, formulation F3 again showed the highest efficiency (82.25±0.15%). This indicates that F3 formulation effectively entrapped the maximum amount of Dexrabeprazole within the microspheres. Entrapment efficiency is a crucial parameter for drug-loaded microspheres as it impacts the drug release profile. The higher the entrapment efficiency, the better the microspheres can provide a sustained drug release. This could be due to the optimal polymer combination and preparation conditions that contributed to effective drug encapsulation. Table 4 provides data on the stability of the blend microspheres in 0.1 N HCl, which simulates the gastric environment. All formulations showed a decrease in transmittance over time, indicating some level of degradation or dissolution of the microspheres. However, formulation F4 demonstrated better stability, maintaining a transmittance of 26.65% after 12 hours, compared to formulation F3, which showed the lowest transmittance of 11.25% after the same time period. The stability of the microspheres in acidic conditions is vital for ensuring that they remain intact in the stomach, thus preventing premature drug release. This suggests that formulation F4 may be more stable under gastric conditions, providing better protection to the encapsulated drug during transit through the stomach.bTable 5 shows the flow properties of the different microsphere formulations. The formulations displayed good flow properties, as indicated by the Hausner's ratio values (ranging from 1.323 to 1.384), which are generally considered acceptable for powders with good flow. Formulation F3 exhibited the best flow properties, with a Hausner's ratio of 1.329 and a Carr's index of 24.74%, indicating its suitability for further processing and formulation into tablet or capsule dosage forms.nThe SEM images of the optimized formulation (F3) in Figure 3 reveal that the microspheres have a spherical morphology with a smooth surface, which is a desirable characteristic for achieving uniform drug release. The smooth surface also suggests that the polymeric matrix is well-formed, providing an effective barrier for controlled drug release. Table 6 presents the cumulative drug release data of Dexrabeprazole from both plain drug and blend microspheres (F3). The microspheres exhibited slower drug release compared to the plain drug. While the plain drug released 23.35% of the drug in the first hour, formulation F3 released only 11.25% in the same time. Over time, the release rate of the microspheres remained slow and sustained, with 73.32% cumulative release at 8 hours, compared to 97.78% for the plain drug. This controlled release profile is desirable for therapeutic use, as it helps to maintain a consistent drug concentration in the body, reducing the frequency of dosing and potentially improving patient compliance. The regression analysis data of the release profiles (Table 7) show that the drug release from the microspheres (F3) follows a zero-order kinetics model ($R^2$ = 0.9816), which indicates that the drug is released at a constant rate over time. This is a desirable characteristic for controlled-release formulations, as it ensures a steady release of the drug without the fluctuations seen with other release mechanisms. The first-order kinetic model and Pappas plot also provide significant correlation values ($R^2$ = 0.9268 and $R^2$ = 0.9754), further supporting the controlled release behavior of the microspheres.

**Table 2: Percentage yield for different formulation**

| S. No. | Formulation | Percentage Yield* (Mean ± S.D) |
|---|---|---|
| 1 | F1 | 73.32±0.15 |
| 2 | F2 | 78.85±0.32 |
| 3 | F3 | 85.65±0.19 |
| 4 | F4 | 74.44±0.22 |
| 5 | F5 | 72.23±0.14 |
| 6 | F6 | 73.36±0.33 |

*Average of three determinations (n=3)

**Table 3: Entrapment efficiency for different formulations**

| S. No. | Formulation | % Entrapment Efficiency* (Mean ± S.D) |
|---|---|---|
| 1 | F1 | 70.45±0.32 |
| 2 | F2 | 76.45±0.25 |
| 3 | F3 | 82.25±0.15 |
| 4 | F4 | 72.22±0.33 |
| 5 | F5 | 70.32±0.25 |
| 6 | F6 | 71.15±0.14 |

*Average of three determinations (n=3)

**Table 4: Stability of blend microspheres in 0.1 N HCl**

| S. No. | Formulation code | % Transmittance | | |
|---|---|---|---|---|
| | | 2 hrs | 8 hrs | 12 hrs |
| 1 | F1 | 72.23 | 55.65 | 20.25 |
| 2 | F2 | 71.12 | 53.32 | 18.85 |
| 3 | F3 | 68.85 | 32.25 | 11.25 |
| 4 | F4 | 76.65 | 55.32 | 26.65 |
| 5 | F5 | 73.32 | 45.65 | 18.98 |
| 6 | F6 | 71.12 | 66.65 | 19.98 |

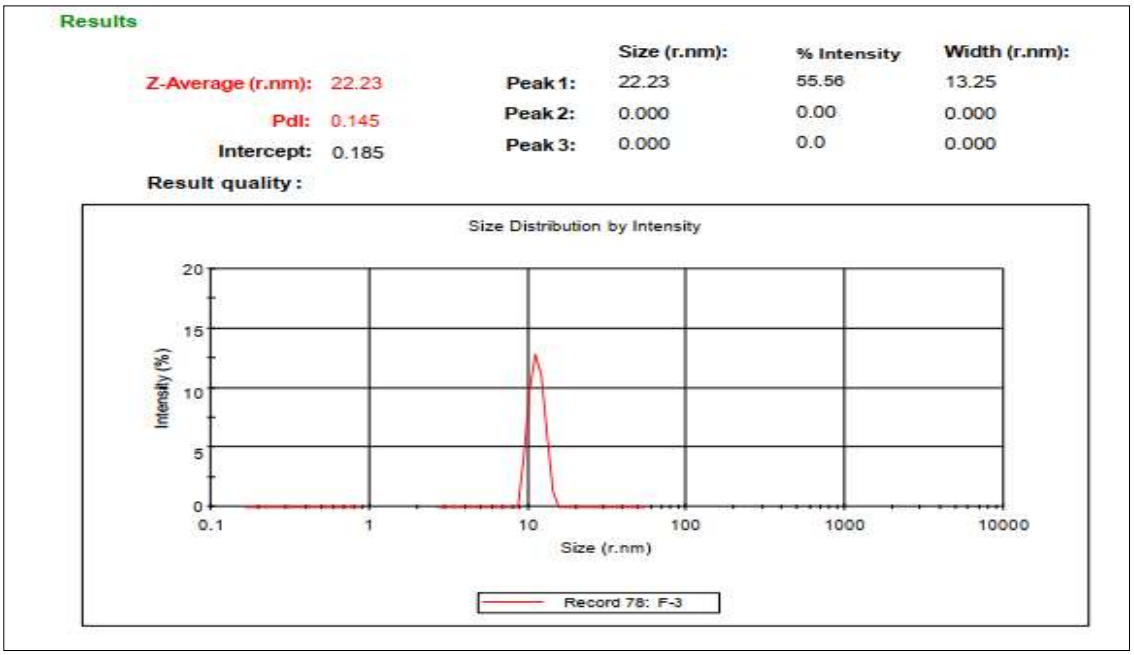


**Figure 1: Particle size data of blend microspheres (F3)**

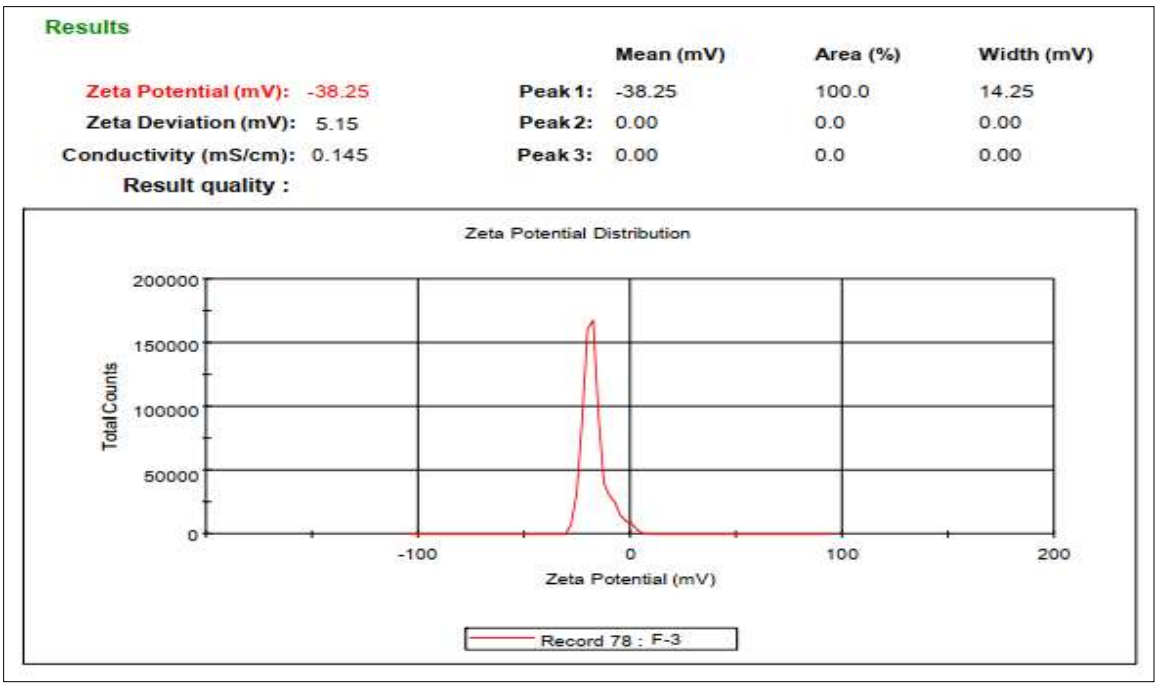


**Figure 2: Zeta potential data of blend microspheres (F3)**

**Table 5: Result of Flow Properties of different blend microspheres formulations**

| Formulation code | Parameters | | | |
|---|---|---|---|---|
| | Loose Bulk density(gm/ml) | Tapped bulk density(gm/ml) | Carr's Index (%) | Hausner's Ratio |
| F1 | 0.315 | 0.436 | 27.75 | 1.384 |
| F2 | 0.345 | 0.458 | 24.67 | 1.328 |

| | | | | |
|---|---|---|---|---|
| F3 | 0.365 | 0.485 | 24.74 | 1.329 |
| F4 | 0.318 | 0.436 | 27.06 | 1.371 |
| F5 | 0.332 | 0.454 | 26.87 | 1.367 |
| F6 | 0.347 | 0.459 | 24.40 | 1.323 |

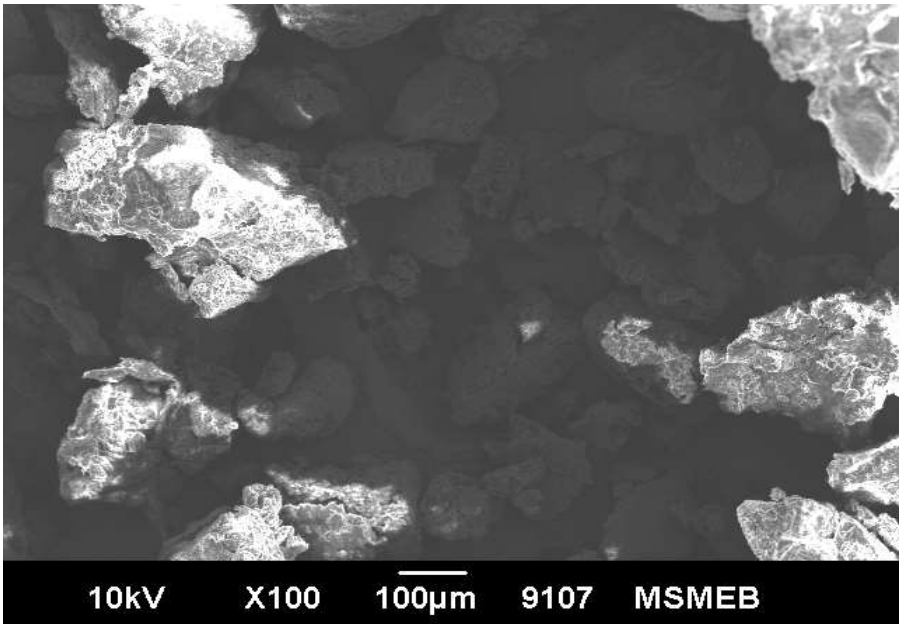


**Figure 3: Scanning Electron Microscope of optimized formulation (F3)**

**Table 6: Cumulative % drug release of Dexrabeprazole from plain drug and blend microspheres**

| S. No. | Dissolution medium | Time (hrs) | % Cumulative Drug Release | |
|---|---|---|---|---|
| | | | Plain drug | Blend microspheres (F3) |
| 1 | SGF (pH 1.2) | 1 | 23.35 | 11.25 |
| 2 | | 2 | 46.65 | 18.98 |
| 3 | | 3 | 73.32 | 22.32 |
| 4 | | 4 | - | 29.98 |
| 5 | | 5 | - | 39.45 |
| 6 | | 6 | - | 49.96 |
| 7 | | 7 | - | 66.65 |
| 8 | | 8 | - | 73.32 |
| 9 | | 9 | - | 80.23 |
| 10 | | 10 | - | 89.98 |
| 11 | | 12 | - | 97.78 |

***Simulated gastric fluid (SGF)**

**Table 7: Regression analysis data of microsphere formulation**

| Formulation | Zero order | First order | Pappas plot |
|---|---|---|---|
| **F3** | $R^2 = 0.9816$ | $R^2 = 0.9268$ | $R^2 = 0.9754$ |

## 4. CONCLUSION

The blend microspheres of Dexrabeprazole prepared using the solvent evaporation technique have shown promising results in terms of yield, entrapment efficiency, stability, flow properties, and controlled drug release. The formulation F3 demonstrated the best overall performance, with high entrapment efficiency, good stability in acidic conditions, and a slow, sustained release profile. These findings suggest that Dexrabeprazole blend microspheres have the potential to provide an effective, controlled-release formulation for the treatment of conditions requiring prolonged drug therapy, such as acid reflux or gastric ulcers.

## REFERENCES

[1] Baginski, M., & Adamczak, A. (2019). Polymeric Microspheres: Recent Advances in Drug Delivery. Journal of Controlled Release, 275, 161-182.

[2] Gupta, R. R., & Bansal, M. (2020). Microsphere-Based Drug Delivery Systems: A Review. Journal of Drug Delivery Science and Technology, 57, 1017-1028.

[3] Patel, S., & Patel, R. (2018). Controlled Release of Dexrabeprazole from Polymeric Microspheres: Preparation and In-vitro Evaluation. International Journal of Pharmaceutics, 535(1-2), 94-101.

[4] Sharma, S., & Rathi, R. (2021). Biodegradable Polymeric Microspheres for Controlled Release Drug Delivery: A Review. International Journal of Pharmaceutics and Drug Analysis, 9(4), 8-15.

[5] Maya Sharma, Choudhury PK, Suresh Kumar Dev. Formulation and In-vitro-in-vivo evaluation of alginate-chitosan microspheres of Glipizide by ionic gelation method. Asian Journal of Pharmaceutical and Clinical Research. 2017; 10(7):385-390.

[6] Priyadarshini M K, Parthiban S, Senthil Kumar G P, Tamizh Mani T. Preparation and evaluation of microspheres encapsulating Zidovudine, Int J Res Pharma and Nano Sci,3(5), 2014, 461- 468.

[7] Berthold A, Cremer K, Kreuter J. Influence of crosslinking on the acid stability and physicochemical properties of chitosan microspheres. STP Pharm Sci. 1996; 6:358-364.

[8] Dhanaraju M D, Mani Kumar R, Nithya P, Kishan J V N, Thirumurugan G. Controlled delivery of anti-retroviral drug loaded Chitosan cross linked microspheres, Arch Appl Sci Res, 1(2), 2009, 279-86.

[9] Thejeswini K, Sowmya C, Sunitha J, Surekha R. Formulation development and evaluation of microspheres containing Lopinavir, Int J Innovative Pharm Sci Res, 2(8), 2014, 1638-648.

[10] Higuchi T. Mechanism of sustained-action medication: theoretical analysis of rate of release of solid drugs dispersed in solid matrices. J Pharm Sci 1963; 52:1145-49.

[11] Korsmeyer RW, Gurny R, Doelker E, Buri P, Peppas NA. Mechanisms of solute release from porous hydrophilic polymers. Int J Pharm.1983; 15: 25–35.