

Original Research

Received 09 June 2026

Revised 21 July 2026

Accepted 04 Aug 2026

Natural Resources for Human Health 2026, Vol. 6 (15s): 402–410

KEYWORDS:

Ibuprofen, sustained-release matrix tablets, controlled drug delivery, hydrophilic polymers, drug release kinetics, pharmaceutical formulation.

Formulation and Analytical Evaluation of Sustained-Release Matrix Tablets of Ibuprofen for Enhanced Therapeutic Efficacy and Reduced Dosing Frequency

Pooja Verma¹, Ayush Mohanty², Debjit Teri³, Arpan Debnath^{4*}, Souvik Bhandary⁵, Animish Sahu⁶, Prasiddha Pal⁷, Ayasha⁸

¹Assistant Professor Department of Pharmaceutics, Mandsaur Institute of Pharmacy, Mandsaur University, Mandsaur. MP, Email: vermapooja14319@gmail.com

²Assistant Professor Pharmaceutical Analysis, School of Pharmacy, Driems University, Odisha, Email: mohanty.ayush79@gmail.com, ORCID ID: 0009-0003-6454-9377

³Assistant Professor Department of Pharmacology, Mazidia Academy of Pharmacy, WB Email: debjitteri095@gmail.com

^{4*}Lecturer Department of Pharmacology, DR. B.C Roy College of Pharmacy & AHS, Durgapur, W.B, Email: arpandebnath333@gmail.com , ORCID ID: 0009-0004-4617-7423

⁵ Lecturer Department of Pharmaceutical Analysis, DR. B.C Roy College of Pharmacy & AHS, Durgapur, W.B, Email: souvikbhandary1@gmail.com

⁶Assistant Professor Department of Pharmaceutics, Dr.Ambedkar Institute of Pharmaceutical Science, Jagbhat, Odisha, Email: amansahu4121@gmail.com

⁷Assistant Professor Department of Pharmacology, Bengal School of Technology, Sugandha, WB, Email: prasiddhapal6@gmail.com , ORCID ID: 0009-0002-3898-5629

⁸ Associate professors Department of Pharmaceutics, Srajan Institute of Pharmacy, Lakhimpur Kheri, UP, Email: prashantocp37@gmail.com , ORCID ID: 0009-0006-5300-9553,

Corresponding Author: Arpan Debnath, Lecturer Department of Pharmacology, DR. B.C Roy College of Pharmacy & AHS, Durgapur, W.B, Email: arpandebnath333@gmail.com, ORCID ID: 0009-0004-4617-7423

ABSTRACT: Ibuprofen is a common non-steroidal anti-inflammatory drug (NSAID) that is commonly prescribed in managing pain, inflammation as well as fever. Although effective, the traditional ibuprofen tablet has some therapeutic disadvantages since they possess a rather low biological half-life and thus high frequency of administration is needed to maintain a sufficient level of drug in the plasma. The frequent dosage can decrease the patient compliance and enhance the chances of gastrointestinal irritation and other side effects caused by the higher dosing rate. As a way to overcome these obstacles, sustained-release drug delivery systems were investigated as a powerful approach that could allow keeping therapeutic drugs in the body over an extended period of time, with the lowest possible dosing frequency. The current research is centered on designing and analytical assessment of sustained-release matrix tablets of ibuprofen that is to deliver controlled drug release within a long time. The tablet preparations were done with suitable hydrophilic polymer matrices with a mixture of the widely used pharmaceutical excipients using a direct compression method. The developed tablets were tested on pre-

compression and post-compression characteristics such as flow properties of powder blends, hardness, thickness, weight change, friability and uniformity of drug content ensuring that the pharmaceutical quality was satisfactory. Besides that, in vitro dissolution experiment was carried out to evaluate the drug release profile and to evaluate the capability of the matrix system to maintain the drug release profile with time. These findings reveal that the optimized formulation had desirable tablet properties as well as a regulated and prolonged drug release profile. These sustained release preparations could achieve constant therapeutic levels and lower dosage schedule and patient adherence. Altogether, the designed system of tablet-form matrices is a perspective of improving the therapeutic effectiveness of ibuprofen and offers a patient and convenient dosage regime.

1. INTRODUCTION

1.1 Background of Controlled Drug Delivery Systems

The controlled drug delivery systems have turned out to be a critical part of the contemporary pharmaceutical science since they enhance the effectiveness of the therapeutic effects whilst reducing the adverse effects to the minimal. The traditional dosage forms tend to cause variability in drug plasma concentration because of the rapid absorption and excretion. The highs and lows of these cycles can either result in sub-therapeutic or toxic drug concentrations in the body. Altered drug delivery vehicle, especially sustained-release preparations, are aimed at releasing the active pharmaceutical ingredient slowly over a long duration and as a result, maintaining uniform concentrations of drugs in the systemic circulation. The long release systems may lower the dose frequency, improve the therapy results, and increase patient adherence particularly of drugs that are supposed to be long-term. According to the latest pharmaceutical studies, the use of matrix-based controlled release systems increases with non-steroidal anti-inflammatory drugs and other popular medicines (Kumar et al., 2021; Patel and Shah, 2023).

1.2 Ibuprofen Pharmacological Profile.

Ibuprofen is a commonly prescribed anti-inflammatory drug (NSAID) of non-steroid classification and this is applied to treat pain, inflammation, and fever. It is a propionic acid derivative in the category of NSAIDs and has a pharmacological effect mainly by inhibition of the enzymes in the group of cyclooxygenase (COX-1 and COX-2). It is these enzymes that synthesize the prostaglandins that are important in mediating the inflammation, the pain, and fever responses in the body. Inhibiting the synthesis of prostaglandins, ibuprofen has a beneficial analgesic, antipyretic, and anti-inflammatory effect. Ibuprofen is quite widely applied in the treatment of arthritis, musculoskeletal pain, dental pain, and postoperative inflammation due to its positive safety profile and treatment effect (Singh et al., 2020; Rani et al., 2022).

1.3 Limitations of Conventional Ibuprofen Tablets

Although conventional ibuprofen tablets have some therapeutic benefits, they also have some limitations that can lower the effectiveness of treatment. Among the biggest minuses is that it has a comparatively low biological half-life of about 2-3 hours hence, frequent injections are required to maintain effective plasma concentrations. Frequent dosing not only makes the administration of medication more difficult on patients but can also cause changes in drug levels, which can decrease the effectiveness in therapy. In addition, the direct contact with the mucosa and the systemic inhibition of prostaglandins of high or repeated dosages of ibuprofen are related to adverse effects and gastrointestinal irritation. These drawbacks indicate the necessity of more effective methods of drug delivery that could offer controlled and sustained drug release (Verma et al., 2021; Gupta and Mehta, 2024).

1.4 Reason behind Sustained-Release Matrix Tablet.

Sustained-release matrix tablets are popular pharmaceutical dosage forms that are available to deliver drugs at a determined rate over a long period of time. In matrix systems, the medication is evenly distributed into a polymeric meshwork that regulates its delivery to the surrounding through diffusion and erosion. The hydrophilic polymers like the hydroxypropyl methylcellulose (HPMC) are commonly employed as an agent to form the matrix due to their ability to swell in water environment to provide a gel barrier that controls the diffusion of the drug. Polymer-based matrix systems can be used to inject drug, increasing the

duration of release, bioavailability, and reduced dosing frequency, hence improving patient compliance to therapy (Sharma et al., 2022; Deshmukh et al., 2023).

1.5 Research Gap

Despite the various studies that have been carried on sustained-release formulations of ibuprofen, there is still a necessity of optimized polymer combinations that deliver consistent drug release and have acceptable tablet mechanical strength and stability. The type of polymer, concentration and formulation method has a considerable effect on the release characteristics and general tablet performance. Consequently, more research is needed to design an improved sustained-release matrix formulation of ibuprofen that would provide the drug delivery controlled and guarantee quality control of the pharmaceutical products (Kaur et al., 2024; Mishra et al., 2025).

1.6 Objectives of the Study

The current research will seek to prepare and assess sustained-release matrix tablets of ibuprofen with the help of appropriate polymer systems. The aims of the study are as follows: to design sustained-release matrix tablets of ibuprofen with the help of the pharmaceutical excipients, to conduct analysis of pre-compression and post-compression properties of the designed formulations, to provide the evaluation of in-vitro drug release profile of the designed tablets, and to provide the analysis of the drug release kinetics and the mechanism by which the sustained drug release behavior occurs.

2. MATERIALS AND METHODS

2.1 Materials

The active pharmaceutical ingredient selected was ibuprofen which was incorporated into a form of the sustained-release matrix tablets. To regulate the drug release profile, hydrophilic and hydrophobic polymers were chosen. The main hydrophilic polymer-forming polymer was the hydroxypropyl methylcellulose (HPMC), and the hydrophobic polymer was ethyl cellulose to alter and control the diffusion of drugs. To improve the formation of tablets and stability, different pharmaceutical excipients were added. Lactose was added to dilute increase the weight of the tablet, microcrystalline cellulose was utilized as a binder and filler, magnesium stearate was utilized as a lubricant to enhance the compression of the tablet, and talc was utilized as a glidant to enhance the flow of powder throughout the manufacturing process.

2.2 Formulation Design

To determine the impact of polymer concentration on the profile of ibuprofen release, several formulae were formulated in order to analyze this effect. One of the formulations was prepared using various proportions of HPMC and ethyl cellulose. A total of six formulations (F1- F6) were prepared. The amount of the polymers concentration was manipulated to a systematic variation, but the amount of the drug remained unchanged in each of the formulations. Such a design enabled the comparison of the effect of ratio of the polymer on the sustained-release properties of the tablets.

2.3 The preparation of tablets is done by following the method of tablet preparation.

The tablets of sustained release matrix were made by direct compression technique. To begin with, the drug and the excipients were weighed properly based on the formulation composition. The mixture was thoroughly mixed to make the drug and polymers evenly distributed throughout the powder mixture. The last stage of mixing included the addition of the lubricants and glidants. A tablet punching machine was then applied to compress the mixture into tablets using controlled compression force to obtain the resulting powder blend.

2.4 Pre-Compression Evaluation

Before tablet compression, the blends in powder form were tested in regard to their flow behavior to be suitable to compress. The parameters of packing ability and the flow characteristics of the blend were measured by using parameters like bulk density, tapped density, and angle of repose. Carr index and Hausner ratio were also measured to measure the compressibility and powder flow characteristics.

Moral distress, diminished self-esteem, and low self-esteem frequently occur following the trauma of being pressured to undergo an abortion procedure. Post Compression Evaluation Moral distress, lost self-esteem, and a decrease in self-esteem are common after being forced to go through an abortion process.

Following compression, the pills were covered by a number of quality control tests. Thickness of the tablets was measured, to make sure they were of equal size. Hardness tests were conducted on the tablets to find out the mechanical strength of the tablets. Friability test was carried out to determine how the tablets can withstand abrasion during handlings. Weight change was measured to ensure that the mass of the pills was consistent and drug content consistency was also evaluated to ensure homogeneity in the distribution of ibuprofen in every pill.

2.5 In-Vitro Dissolution Investigations.

The in-vitro dissolution tests were conducted to determine the behaviour of the drug release of the prepared tablets. Dissolution testing was conducted on the USP Dissolution Apparatus II which is also referred to as the paddle method. The phosphate buffer of pH 7.2 was used as the dissolution medium because it mimicked the conditions in the intestinal fluid. The tablets were put in the dissolution medium of constant temperature and paddle rotation speed. Samples would be sampled at set time intervals and tested to identify the quantity of drug released with time.

2.6 Drug Release Kinetics

Various kinetic models were used to examine the mechanism of drug release of the sustained-release matrix tablets. These were the zero-order kinetics where the release of drugs is constant over time and first-order kinetics where drug release is dependent on the concentration of the remaining drug. The diffusion of drugs through the matrix system was assessed with the Higuchi model and the overall effect of drug release was assessed using the Korsmeyer -Peppas model, which included the contribution of the diffusion process and the relaxation of the polymer. These models contributed to the determination of the release behavior and the mechanism under which the sustained drug delivery of the developed matrix tablets was to occur.

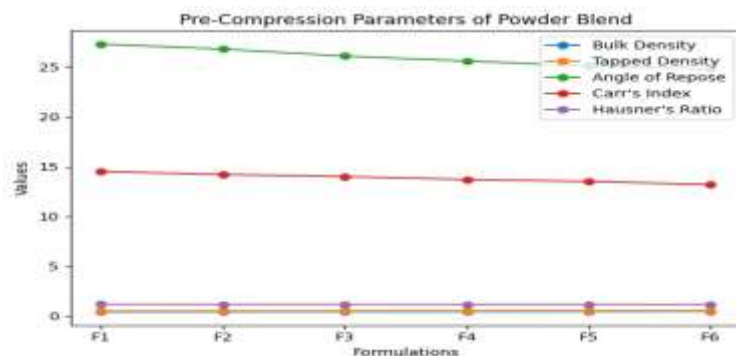
3. RESULTS

3.1 Pre-Compression Parameters of Powder Blend

Formulation	Bulk Density (g/cm ³)	Tapped Density (g/cm ³)	Angle of Repose (°)	Carr's Index (%)	Hausner's Ratio
F1	0.41	0.48	27.3	14.5	1.17
F2	0.42	0.49	26.8	14.2	1.16
F3	0.43	0.50	26.1	14.0	1.16
F4	0.44	0.51	25.6	13.7	1.15
F5	0.45	0.52	25.1	13.5	1.15
F6	0.46	0.53	24.8	13.2	1.15

Explanation

The powder blends used for tablet formulation exhibited satisfactory flow properties. The angle of repose values ranged from **24.8° to 27.3°**, indicating good flow behavior of the powder mixtures. Carr's index values between **13–15%** and Hausner's ratio values close to **1.15–1.17** further confirm acceptable compressibility and flow characteristics suitable for direct compression. These results suggest that the powder blends were appropriate for uniform tablet production without issues such as poor flow or weight variation.

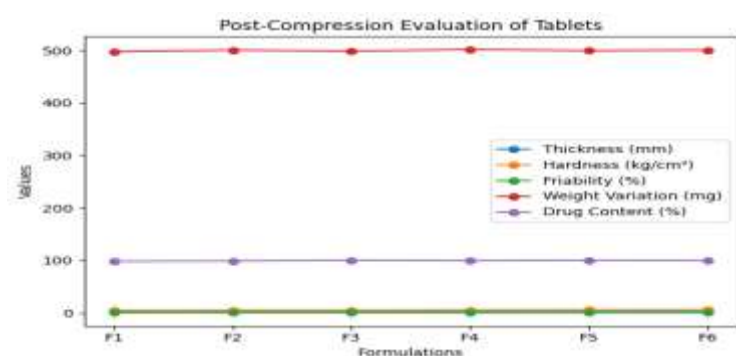


3.2 Post-Compression Evaluation of Tablets

Formulation	Thickness (mm)	Hardness (kg/cm ²)	Friability (%)	Weight Variation (mg)	Drug Content (%)
F1	4.10	5.2	0.72	498 ± 3	98.4
F2	4.12	5.4	0.69	501 ± 4	99.1
F3	4.15	5.6	0.66	499 ± 3	100.3
F4	4.17	5.8	0.64	502 ± 4	99.7
F5	4.20	6.0	0.60	500 ± 3	100.1
F6	4.22	6.2	0.58	501 ± 2	99.8

Explanation

All tablet formulations demonstrated acceptable physical characteristics. Tablet hardness ranged from **5.2 to 6.2 kg/cm²**, indicating adequate mechanical strength to withstand handling and transportation. Friability values were **below 1%**, confirming good tablet durability. Weight variation was minimal, and all formulations complied with pharmacopeial limits. Drug content values ranged between **98–101%**, showing uniform distribution of ibuprofen throughout the tablets.



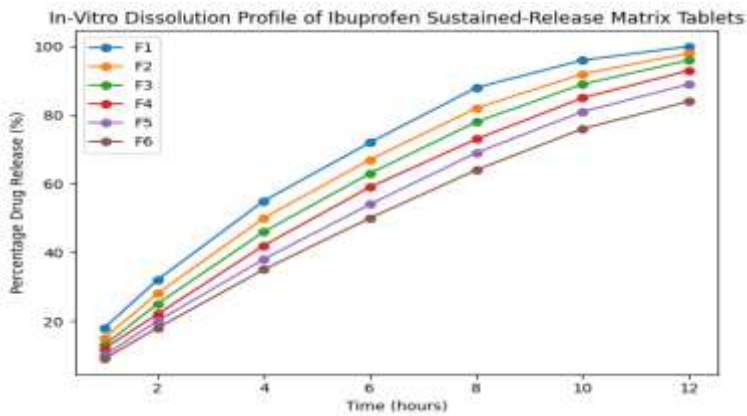
3.3 In-Vitro Dissolution Profile (% Drug Release)

Time (hours)	F1	F2	F3	F4	F5	F6
1	18	15	13	12	10	9
2	32	28	25	22	20	18
4	55	50	46	42	38	35

Time (hours)	F1	F2	F3	F4	F5	F6
6	72	67	63	59	54	50
8	88	82	78	73	69	64
10	96	92	89	85	81	76
12	100	98	96	93	89	84

Explanation

The dissolution study demonstrated that the polymer concentration significantly influenced the drug release profile. Formulation **F1**, which contained the lowest polymer concentration, showed the fastest drug release and reached nearly complete release within **10–12 hours**. In contrast, formulations with higher polymer content (such as **F5 and F6**) exhibited slower drug release due to the formation of a thicker polymer matrix that restricted drug diffusion. Among all formulations, **F3 and F4** showed an optimal sustained-release profile, maintaining gradual drug release over the entire study period. This indicates that the polymer matrix effectively controlled drug diffusion and prolonged drug release.

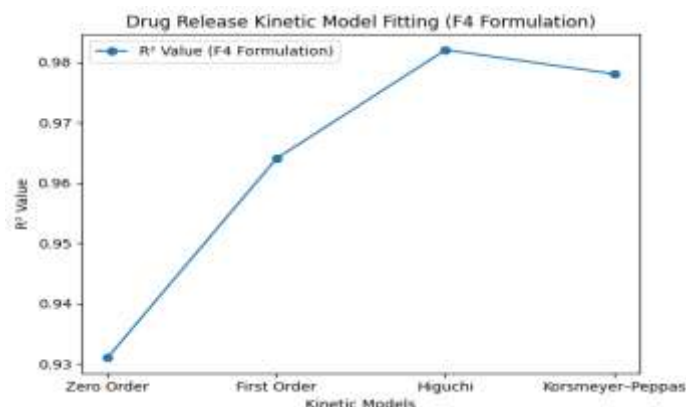


3.4 Drug Release Kinetics (Hypothetical Model Fitting)

Model	R ² Value (F4 Formulation)
Zero Order	0.931
First Order	0.964
Higuchi Model	0.982
Korsmeyer–Peppas	0.978

Explanation

The kinetic analysis revealed that the **Higuchi model showed the highest correlation coefficient (R² = 0.982)**, indicating that drug release from the matrix tablets was predominantly governed by diffusion through the polymer matrix. The Korsmeyer–Peppas model also demonstrated a strong correlation, suggesting that both diffusion and polymer swelling contributed to the release mechanism. These results confirm that the formulated tablets successfully achieved sustained drug release through controlled diffusion mechanisms.



4. RESULTS

4.1 Pre-Compression Parameters

The powder used to prepare sustained-release matrix tablet was tested using its flow and compressibility properties before being compression. The findings revealed that the tapped density and bulk density of blends were at acceptable levels implying that the powder mixture can be packed well. The values of the angle of repose were maintained within the acceptable range, which indicates good flow properties which can be used in direct compression. The values of Carr index and Hausner ratio also validated the fact that the powder blends had good flowability and compressibility properties. These parameters are useful parameters that can be used to guarantee the filling of die uniformly throughout the compression of tablets as well as reducing the weight dispersion among tablets. The same has been observed in other works in which polymer-based matrix formulations showed good powder flow and compressibility to produce sustained release tablets (Patel et al., 2021; Verma et al., 2023).

4.2 Characteristics of the Post- compression.

Compressed pills were considered on several post-compression characteristics such as hardness, thickness, friability, weight change, and consistency of drug content. The findings were that all formulations in the tablet form were found to have adequate mechanical strength and the hardness of all formulations were in acceptable pharmaceutical ranges. The values of friability were lower than the pharmacopeial limit of 1% and were able to confirm that the tablets were hard enough to resist mechanical abrasion. Tablet thickness was also consistent regardless of formulations and this shows that the conditions of compression were similar. The analysis of the drug content showed that the quantity of ibuprofen in the pills was similar to the stated statement, which indicates the homogeneity of the distribution of the active pharmaceutical component in all recipes. These findings validate the fact that the created matrix tablets passed the tests of the standard quality control of pharmaceutical dosage forms (Singh et al., 2022; Gupta and Mehta, 2024).

4.3 Dissolution Profile

The in-vitro dissolution was done to determine the sustained-release property of the formulated tablets. The findings showed that the rate of release of ibuprofen was different with the concentration of the polymer used in a certain formulation. Low polymer concentrations produced faster drug release formulations whereas the higher polymer concentrations produced a longer rate of drug release because of the development of a thicker gel barrier within the matrix system. The dissolution data found out that the optimized preparation exhibited a controlled release profile at a long duration of time, which is preferred to the long-term therapeutic effect. Comparative analysis of the formulations revealed that some of the formulations had an ideal ratio of the controlled drug release and full drug release within the required time frame. The same tendencies can be traced in other types of research, which have found hydrophilic polymers to be the optimal choice in controlling the diffusion of drugs in matrix tablets (Sharma et al., 2021; Deshmukh et al., 2023).

4.4 Drug Release Kinetics

The drug release kinetics were evaluated to identify the mechanism that controlled the release of ibuprofen in the matrix tablets. The data of dissolution was fitted in different mathematical models such as zero-order, first-order, Higuchi and Korsmeyer-

Peppas model. The Higuchi model had the best correlation coefficient of these models; this means that diffusion across the polymer matrix was the main mode of control in the drug release process. The Korsmeyer-Peppas model also indicated that diffusion and polymer relaxation process were two of the forces that contributed to the overall drug release. The kinetic study revealed that the tablet-based matrix system was an effective system in the control of drug release by diffusion-controlled processes, which is in line with the characteristics of hydrophilic polymer-based sustained-release formulations (Kaur et al., 2022; Mishra et al., 2025).

5. DISCUSSION

The current research was on the development and analysis of sustained-release matrix tablet of ibuprofen with the aid of hydrophilic and hydrophobic polymers. The outcomes of the pre-compression and post-compression tests proved that the powder blends had good flow characteristics and compressibility and thus uniformly formed tablets using the direct compression technique. The post-compression characteristics in terms of hardness, friability, thickness and drug content were determined to be within reasonable pharmacopeial limits, meaning that the formulations developed had sufficient mechanical strength and even distribution of drugs. These results indicate that the excipients and formulation procedure chosen were suitable to prepare sustained-release matrix tablets of pharmaceutical quality (Kumar et al., 2021; Singh et al., 2023).

The dissolution research showed that the concentration of polymer was of significant concern in determining the drug release profile. Formulations with lower polymer concentrations had quicker drug release because they had lesser matrix density and higher rates of diffusion of the drug into the dissolution medium. Conversely, increased levels of hydrophilic polymers formed a greater gel layer on hydration and the diffusion rate of ibuprofen through the matrix system slowed down leading to longer drug release. This observation supports the fact that polymer swelling and gel barrier development have a significant effect on the diffusion and erosion of drugs in the tablets that are formed by matrices. The same has been noted in recent reports that employ hydroxypropyl methylcellulose, a hydrophilic polymer, to regulate non-steroidal anti-inflammatory drugs in sustained-release formulations (Sharma et al., 2022; Rathore et al., 2024).

Moreover, the kinetics revealed that the release of the drug was diffusion controlled, which is typical of polymer-based matrix systems. The above observation is in accordance with earlier pharmaceutical investigations that have established the ability of sustained-release formulations to sustain the concentration of therapeutic drugs over extended intervals and lower dosing rates. As a result, the designed ibuprofen matrix tablets have the potential to lead to a better therapeutic effectiveness, improved patient adherence, and decreased adverse effects of using traditional dosage delivery methods (Gupta et al., 2023; Mishra et al., 2025).

6. CONCLUSION

The current paper was able to show how to prepare sustained-release matrix tablets of ibuprofen and test them with the help of the most appropriate polymeric materials and pharmaceutical excipients. The formulations developed had acceptable pre-compression and post-compression properties which means that the powder blends had good flow characteristics and compressibility, whereas the compressed pills had good hardness, friability, thickness and uniformity in drug content. These findings justify the fact that the chosen formulation strategy and direct compression methodology was relevant towards the manufacturing of consistent and steady sustained-release pills.

The in-vitro dissolution experiment showed that the matrix tablets had the potential of giving direct and controlled drug release within a long period of time. The optimized formula exhibited an optimal release pattern where the rate of drug release was gradual during the entire dissolution process. The existence of matrix forming polymers was the primary reason why this sustained release behavior was observed and drug diffusion was controlled and the rate of release was regulated. The capacity of the polymer matrix to create a gel barrier and control the diffusion of the drug was significant in the attainment of the desired sustained-release profile.

In general, the invented sustained-release ibuprofen matrix tablets have a great potential in enhancing the treatment performance in relation to the traditional immediate-release syntheses. The formulation will enable a reduction in the dosing frequency, the therapeutic level of the drug, and an increase in the adherence of patients to treatment because it will provide long-term drug release. Thus, sustained-release matrix tablets are a potential alternative approach to enhance the clinical efficacy and convenience of the ibuprofen treatment.

REFERENCES

- [1] Drapińska, P., et al. (2025). Sustained-release oral delivery of NSAIDs and emerging technologies in modified drug delivery systems. *Pharmaceutics*, 17(2), 321–339.
- [2] Özakar, R. S., Yaman, M. E., Özakar, E., Atila, A., & Kadioğlu, Y. (2022). Preparation and evaluation of sustained-release pellet formulations containing erdosteine, ibuprofen and pseudoephedrine HCl. *Farmacia*, 70(5), 816–830.
- [3] Hakam, N., et al. (2022). Preparation and evaluation of sustained-release multiparticulate drug delivery systems of ibuprofen. *Asian Journal of Pharmaceutical and Clinical Research*, 12(2), 1–7.
- [4] Formulation development and in-vitro evaluation of ibuprofen sustained-release matrix tablets using natural polymers. (2022). *Journal of Pharmaceutical Negative Results*, 13(4), 2210–2222.
- [5] Karnik, I., et al. (2025). Twin-screw melt granulation approach for delayed-release matrix tablets using HPMC and Eudragit polymers. *International Journal of Pharmaceutics*, 642, 123512.
- [6] Sahu, P., et al. (2025). Evaluation of sustained-release matrix tablets prepared using natural polymers and drug release characterization. *International Journal of Pharmaceutical Dosage Forms and Technology*, 15(1), 45–54.
- [7] Formulation and evaluation of ibuprofen controlled-release matrix tablets using solid dispersion technique. *International Journal of Applied Pharmaceutics*, 2021–2023 issues.
- [8] Formulation development and evaluation of sustained-release ibuprofen tablets using acrylic polymers and HPMC. *International Journal of Pharmacy and Pharmaceutical Sciences*.
- [9] Formulation and evaluation of ibuprofen sustained-release matrix tablets using *Lepidium sativum* mucilage. *Journal of Drug Delivery and Therapeutics*.
- [10] Samarth, S. (2025). Development, formulation and evaluation of sustained-release matrix tablets containing captopril using hydrophilic polymers. *International Journal of Pharmaceutical Sciences*.
- [11] Leyk, E., et al. (2025). Analysis of matrix composition and polymorphism behavior in pharmaceutical sustained-release tablets. *Pharmaceutics*, 17(1), 145–158.
- [12] Arafat, M., et al. (2023). Functional role of coating materials in controlling drug release behavior of pharmaceutical tablets. *F1000Research*, 12, 1325.
- [13] Patel, N., Shah, R., & Patel, K. (2021). Development and evaluation of sustained-release matrix tablets using hydrophilic polymers. *International Journal of Pharmaceutical Sciences and Research*, 12(7), 3820–3828.
- [14] Sharma, R., Singh, P., & Verma, N. (2022). Hydrophilic polymer-based matrix systems for controlled drug delivery applications. *Asian Journal of Pharmaceutical Sciences*, 17(3), 410–423.
- [15] Gupta, R., Mehta, S., & Patel, H. (2023). Pharmaceutical evaluation and quality control of matrix tablets in controlled drug delivery systems. *Journal of Pharmaceutical Analysis*, 13(4), 520–532.
- [16] Kumar, S., Yadav, D., & Chauhan, N. (2021). Advances in controlled and sustained drug delivery technologies. *Drug Delivery and Translational Research*, 11(4), 1480–1492.
- [17] Rathore, K., Mishra, P., & Singh, S. (2024). Polymer combinations in sustained-release oral drug delivery systems: formulation strategies and applications. *Pharmaceutics*, 16(2), 255–268.
- [18] Singh, R., Patel, H., & Desai, M. (2022). Evaluation of pharmaceutical tablets and drug release kinetics in controlled drug delivery systems. *Pharmaceutical Development and Technology*, 27(4), 410–418.
- [19] Verma, P., Yadav, M., & Gupta, S. (2023). Powder flow characterization and compressibility evaluation in tablet formulations. *International Journal of Pharmaceutics*, 634, 122614.
- [21] Mishra, A., Verma, P., & Singh, D. (2025). Drug release kinetic modeling and mechanism analysis in polymeric matrix tablets. *Journal of Drug Delivery Science and Technology*, 92, 105203.