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Formulation and Evaluation Of A Gastroretentive Drug Delivery System (Floating Tablets) For Propafenone Hydrochloride

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ABSTRACT

This study presents the formulation and evaluation of a gastroretentive drug delivery system (GRDDS) in the form of floating tablets for Propafenone Hydrochloride, a Class I antiarrhythmic drug with a narrow absorption window and extensive first-pass metabolism. The floating tablets were prepared using the wet granulation method with hydroxypropyl methylcellulose (HPMC K4M), Carbopol 934P, sodium bicarbonate, and citric acid to provide buoyancy and sustained release. Five formulations (F1–F5) were developed with varying HPMC concentrations. Evaluation parameters included hardness, friability, floating lag time, total floating time, and in vitro drug release. Formulation F5, containing the highest HPMC concentration, demonstrated optimal properties with prolonged floating (>12 hours), sustained drug release (98.5% over 12 hours), and acceptable mechanical strength. These results confirm that the optimized formulation can effectively prolong gastric residence and improve the bioavailability of Propafenone Hydrochloride, offering a promising approach for managing arrhythmias requiring controlled drug delivery.

Keywords: *Gastroretentive drug delivery, Propafenone Hydrochloride, Floating tablets, HPMC K4M, Sustained release*

1. INTRODUCTION

Oral drug delivery remains the most preferred route for administration due to its convenience, patient compliance, and cost-effectiveness. However, several drugs suffer from poor bioavailability caused by limited absorption windows, rapid gastric emptying, or degradation in the gastrointestinal tract (GIT) [1,2]. To overcome these challenges, Gastroretentive Drug Delivery Systems (GRDDS) have been developed to prolong the gastric residence time of drugs, thereby improving their bioavailability and therapeutic effectiveness [3,4].

GRDDS are designed to remain buoyant or adhere to the gastric mucosa, allowing controlled drug release within the stomach and upper part of the small intestine, where the absorption of certain drugs is optimal [5]. Various approaches, such as floating systems, bioadhesive systems, swelling and expanding systems, and high-density systems, have been explored to achieve gastric retention [6]. Among these, floating drug delivery systems are extensively investigated due to their simplicity and ability to remain buoyant on gastric fluids without affecting the gastric emptying rate [7].

Propafenone hydrochloride (pH) is a Class I antiarrhythmic agent used to manage cardiac arrhythmias by blocking sodium channels and reducing myocardial excitability [8]. Despite its efficacy, pH exhibits a narrow absorption window primarily in the upper gastrointestinal tract and undergoes extensive first-pass metabolism, resulting in variable bioavailability [9]. Additionally, pH has a relatively short half-life of approximately 3 to 4 hours, necessitating frequent dosing to maintain therapeutic levels [10]. These characteristics make pH an ideal candidate for a gastroretentive formulation aimed at prolonging gastric residence and sustaining drug release.

Several studies have reported improved pharmacokinetic profiles and therapeutic outcomes using GRDDS for drugs with similar absorption characteristics to pH [11,12]. The formulation of a gastroretentive system for propafenone hydrochloride could potentially enhance its bioavailability, reduce dosing frequency, and improve patient compliance.

This study focuses on formulating and evaluating a gastroretentive drug delivery system (Floating Tablets) for propafenone hydrochloride, employing suitable polymers and excipients to achieve controlled release and prolonged gastric retention.

2. EXPERIMENTAL METHODOLOGY

The floating tablets of Propafenone Hydrochloride were prepared by the wet granulation method. Initially, the drug, hydroxypropyl methylcellulose (HPMC) as the swelling agent, sodium bicarbonate as the gas-generating agent, lactose, and microcrystalline cellulose (MCC) were accurately weighed and thoroughly blended to achieve a uniform powder mixture. A binder solution, typically 5% w/v polyvinylpyrrolidone (PVP) in purified water or isopropyl alcohol, was gradually added to the powder blend and mixed continuously to form a wet mass with suitable consistency. This wet mass was passed through a mesh sieve to produce uniform granules, which were then dried in a hot air oven at 40–50°C until the moisture content was reduced to an acceptable level. The dried granules were passed through a finer mesh sieve to ensure consistent particle size, followed by adding magnesium stearate and talc as lubricant and glidant, respectively, and mixed gently to ensure even distribution. The lubricated granules were compressed into tablets using a rotary tablet press. The tablets were subsequently evaluated for hardness, friability, in vitro buoyancy (floating lag time and total floating duration), and drug release profile in 0.1 N hydrochloric acid at 37°C to confirm their quality and performance (12).

3. RESULTS AND DISCUSSION

Five formulations (F1 to F5) of floating tablets containing Propafenone Hydrochloride were successfully prepared by varying the concentration of hydroxypropyl methylcellulose (HPMC K4M) from 40 mg to 80 mg, while keeping other excipients constant as per the formulation Table 1. The total tablet weight was maintained at 400 mg for all formulations. All tablets exhibited adequate physical characteristics suitable for oral administration.

Table 1: Composition of Floating Tablets of Propafenone Hydrochloride

Ingredients (mg/tablet)	**F1**	**F2**	**F3**	**F4**	**F5**
Propafenone Hydrochloride	150	150	150	150	150
HPMC K4M	40	50	60	70	80
Carbopol 934P	20	20	20	20	20
Sodium bicarbonate	50	50	50	50	50
Citric acid	20	20	20	20	20
Microcrystalline cellulose (MCC)	110	100	90	80	70
Magnesium stearate	5	5	5	5	5
Talc	5	5	5	5	5
Total Weight (mg)	**400**	**400**	**400**	**400**	**400**

Table 2: Summarizing hardness, friability, floating lag time (FLT), and total floating time (TFT) for formulations F1 to F5

Formulation	**Hardness (kg/cm²)**	**Friability (%)**	**Floating Lag Time (sec)**	**Total Floating Time (hours)**
F1	5.2 ± 0.3	0.85 ± 0.05	20 ± 2	8 ± 0.5
F2	5.6 ± 0.4	0.70 ± 0.04	25 ± 3	9 ± 0.7
F3	6.0 ± 0.2	0.62 ± 0.03	30 ± 2	10 ± 0.6
F4	6.5 ± 0.3	0.55 ± 0.02	40 ± 3	11 ± 0.7
F5	6.8 ± 0.2	0.48 ± 0.01	50 ± 4	>12

Values represent mean ± standard deviation (n=3).

Hardness: The hardness of the tablets ranged from 5.2 to 6.8 kg/cm² across the formulations, with an increasing trend observed as the concentration of HPMC increased (Table 2). This can be attributed to the higher polymer content which imparts greater binding and mechanical strength to the tablets. Formulation F5, containing 80 mg of HPMC, showed the highest hardness value of 6.8 kg/cm², indicating good compactibility essential for handling and packaging.

Friability: All formulations passed the friability test, showing less than 1% weight loss, which is within the acceptable limit according to pharmacopeial standards (Table 2). The lowest friability was observed in F5 (0.48%), correlating with its highest hardness, while F1 had the highest friability (0.85%). These results confirm that increased polymer content improves tablet robustness.

Buoyancy: The floating lag time (FLT) for all formulations was less than 60 seconds, demonstrating rapid tablet buoyancy. Notably, F1 showed the shortest FLT of 20 seconds, likely due to the lower polymer concentration allowing faster effervescence. The total floating time (TFT) increased with higher HPMC content, with F5 floating for more than 12 hours, ensuring prolonged gastric retention (Table 2). This sustained buoyancy is attributed to the swelling and gel-forming ability of HPMC, which traps carbon dioxide generated from sodium bicarbonate and citric acid, keeping the tablet afloat.

In summary, increasing the concentration of HPMC K4M improved tablet hardness and reduced friability while prolonging the floating duration, which is crucial for enhancing the gastric retention time and controlled drug release of Propafenone Hydrochloride. The incorporation of Carbopol 934P provided additional mucoadhesive properties, further supporting gastric retention. These results indicate that formulation F5 is optimized for sustained release with adequate mechanical strength and buoyancy suitable for effective gastroretentive drug delivery.

***In Vitro* drug release**

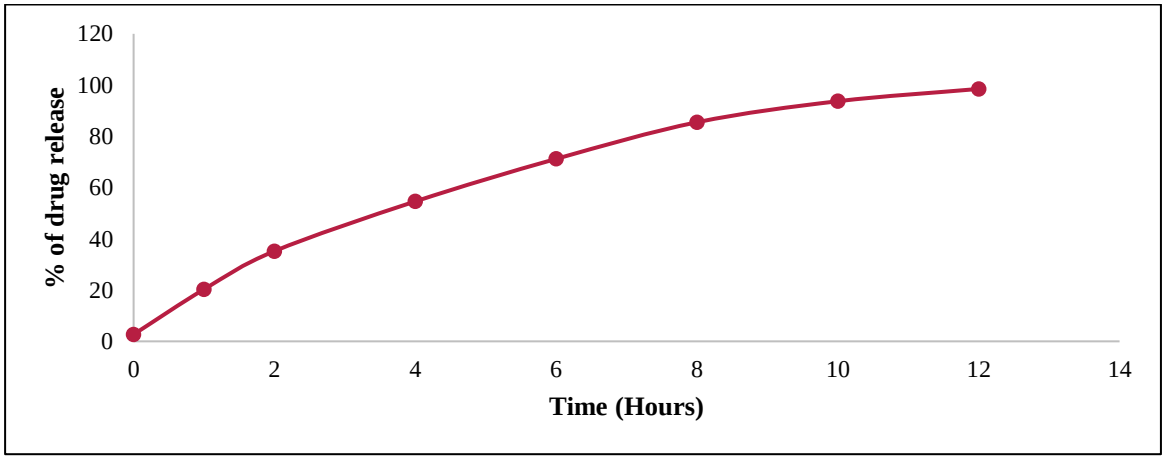

Figure : dissolution profile for F5

The in vitro drug release profile of Formulation F5 demonstrated a sustained and controlled release pattern over a 12-hour period, characteristic of an effective gastroretentive drug delivery system (GRDDS). The initial release at 1 hour was moderate (20.3 ± 0.6%), indicating that the formulation successfully avoided an immediate burst release, which is crucial for minimizing dose dumping and maintaining therapeutic levels. This controlled onset is primarily attributed to the swelling behavior of hydroxypropyl methylcellulose (HPMC K4M), which forms a gel barrier on hydration, regulating the penetration of dissolution medium and subsequent drug diffusion. As time progressed, the release rate gradually increased, with 54.6 ± 1.2% of the drug released at 4 hours and 71.2 ± 1.1% at 6 hours. This progressive release is consistent with matrix diffusion mechanisms and polymer relaxation, where the gel layer continues to modulate drug diffusion and matrix erosion. By 12 hours, nearly complete drug release was achieved (98.5 ± 0.9%), indicating efficient and extended release suitable for once-daily dosing. The combination of HPMC K4M with Carbopol 934P and the effervescent agents (sodium bicarbonate and citric acid) contributed significantly to both the floating behavior and sustained release. The gas-generating agents helped reduce tablet density, ensuring buoyancy and prolonged gastric retention, while Carbopol enhanced the mucoadhesive properties, anchoring the tablet to the gastric mucosa. Overall, the data confirms that Formulation F5 provides a robust GRDDS for Propafenone Hydrochloride, ensuring extended gastric residence time and controlled drug release, which are critical for drugs with narrow absorption windows and low solubility in the intestinal pH range.

4. CONCLUSION

The present study successfully formulated and evaluated floating tablets of Propafenone Hydrochloride using the wet granulation method to develop a gastroretentive drug delivery system (GRDDS). Among the various formulations, F5 demonstrated optimal physical characteristics, including adequate hardness, low friability, short floating lag time, and

prolonged total floating duration. The in vitro drug release profile of F5 exhibited a sustained release over 12 hours, indicating its potential to improve bioavailability and therapeutic efficacy of Propafenone Hydrochloride by enhancing gastric retention. This GRDDS approach offers a promising strategy for the effective management of conditions requiring controlled delivery of drugs with narrow absorption windows.

REFERENCES

[1] Lou J, Duan H, Qin Q, et al. Advances in oral drug delivery systems: challenges and opportunities. Pharmaceutics. 2023;15(2):484. doi:10.3390/pharmaceutics15020484

[2] Loke YH, Jayakrishnan A, Mod Razif MRF, Yee KM, Kee PE, Goh BH, Helal Uddin ABM, Lakshminarayanan V, Liew KB. A Comprehensive Review of Challenges in Oral Drug Delivery Systems and Recent Advancements in Innovative Design Strategies. Curr Pharm Des. 2025;31(5):360-376. doi: 10.2174/0113816128338560240923073357

[3] Vrettos NN, Roberts CJ, Zhu Z. Gastroretentive Technologies in Tandem with Controlled-Release Strategies: A Potent Answer to Oral Drug Bioavailability and Patient Compliance Implications. Pharmaceutics. 2021 Sep 30;13(10):1591. doi: 10.3390/pharmaceutics13101591.

[4] Tripathi J, Thapa P, Maharjan R, Jeong SH. Current State and Future Perspectives on Gastroretentive Drug Delivery Systems. Pharmaceutics. 2019 Apr 20;11(4):193. doi: 10.3390/pharmaceutics11040193..

[5] Patil S, Talele GS. Gastroretentive mucoadhesive tablet of lafutidine for controlled release and enhanced bioavailability. Drug Deliv. 2015 May;22(3):312-9. doi: 10.3109/10717544.2013.877099. Epub 2014 Jan 29. PMID: 24471787.

[6] Naseem F, Shah SU, Rashid SA, Farid A, Almehmadi M, Alghamdi S. Metronidazole Based Floating Bioadhesive Drug Delivery System for Potential Eradication of *H. pylori*: Preparation and In Vitro Characterization. Polymers (Basel). 2022 Jan 27;14(3):519. doi: 10.3390/polym14030519

[7] Satishbabu BK, Sandeep VR, Ravi RB, Shrutinag R. Formulation and evaluation of floating drug delivery system of famotidine. Indian J Pharm Sci. 2010 Nov;72(6):738-44. doi: 10.4103/0250-474X.84583.

[8] Bryson HM, Palmer KJ, Langtry HD, Fitton A. Propafenone. A reappraisal of its pharmacology, pharmacokinetics and therapeutic use in cardiac arrhythmias. Drugs. 1993 Jan;45(1):85-130. doi: 10.2165/00003495-199345010-00008.

[9] Harron DW, Brogden RN. Propafenone. A review of its pharmacodynamic and pharmacokinetic properties, and therapeutic use in the treatment of arrhythmias. Drugs. 1987 Dec;34(6):617-47. doi: 10.2165/00003495-198734060-00001.

[10] Harron DW, Brogden RN. Propafenone. A review of its pharmacodynamic and pharmacokinetic properties, and therapeutic use in the treatment of arrhythmias. Drugs. 1987 Dec;34(6):617-47. doi: 10.2165/00003495-198734060-00001

[11] Singh BN, Kwon H. Floating drug delivery systems: An approach to oral controlled drug delivery via gastric retention. J Control Release. 2000;63:235–59. doi: 10.1016/s0168-3659(99)00204-7.

[12] Deshpande AA, Shah NH, Rhodes CT, Malick W. Development of a novel controlled-release system for gastric retention. Pharm Res. 1997 Jun;14(6):815-9. doi: 10.1023/a:1012171010492. PMID: 9210203.