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Enhancing Oral Absorption of Orlistat through Gastroretentive Mucoadhesive Pellets: Formulation and Evaluation

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ABSTRACT

Aim: The aim of this study was to develop gastroretentive mucoadhesive pellets of Orlistat to improve its oral bioavailability and enhance its absorption.

Methods: Orlistat pellets were prepared using Hydroxy Propyl Methyl Cellulose (HPMC) K100M, Sodium Carboxy Methyl Cellulose (NaCMC), Carbopol 934P, and Polyvinyl Pyrrollidone (PVP) K30 in varying ratios. Physical characteristics of the tablets were evaluated, and compatibility studies were performed between Orlistat and the excipients. Swelling index, mucoadhesion strength and drug release were measured for each formulation. Drug release kinetics and stability studies were carried out.

Results: The combination of HPMC K100M, NaCMC, Carbopol 934P and PVP K30 provided balanced release and mucoadhesion with F13 showing sustained release up to 16 hours. The calibration curve demonstrated a good linear relationship between Orlistat concentration and absorbance over the range of 10 to 50 µg/ml. Swelling index increased with time and polymer concentration and mucoadhesion strength increased with polymer viscosity and concentration. Drug release from formulations containing HPMC K100M, NaCMC and Carbopol 934P were 12-14 hours, 10-12 hours and 8-11 hours, respectively. Combination polymers in F10-F13 provided balanced release and mucoadhesion, with F13 showing sustained release up to 16 hours. The drug release followed zero order kinetics with non-Fickian diffusion. Stability studies on the optimized F13 formulation showed no significant changes in appearance, hardness, mucoadhesion or drug release over 3 months.

Conclusion: The combination of HPMC K100M, NaCMC, Carbopol 934P and PVP K30 improved the oral bioavailability and absorption of Orlistat. The study demonstrated the importance of compatibility studies and the use of calibration curves for quantitative analysis. The findings provide valuable insights into the development of drug delivery systems for poorly bioavailable drugs.

Introduction

The oral route is the most convenient route for drug administration as it does not require trained healthcare professionals and patients can self-administer the medication. This leads to high patient compliance with oral medications [1,2]. However, the oral bioavailability of many drugs is limited due to incomplete absorption from the gastrointestinal tract (GIT). This is because different parts of the GIT have varying ability to absorb drugs. The stomach and upper small intestine have the highest absorbency, while the lower GIT has lower absorbency [3]. For drugs that are best absorbed in the upper GIT, when a controlled release oral dosage form reaches the lower GIT before the drug is fully released, the absorption of the drug gets reduced. This is because less drug absorption takes place in the lower GIT. To overcome this problem and to improve absorption of drugs that have an absorption window in the upper GIT, gastroretentive drug delivery systems have been developed [4]. These systems are designed to remain in the stomach for a prolonged period of time, allowing the drug to be released continuously in the small intestine where it gets absorbed efficiently [5].

Orlistat, an anti-obesity drug, acts by inhibiting fat absorption in the GIT. However, its oral bioavailibity is very poor (<1%). The aim of this research was to develop gastroretentive mucoadhesive pellets of Orlistat to improve its oral bioavailability and thereby enhance its absorption.

Materials and methods

Orlistat was obtained from Aurobindo pharma Ltd., Hyderabad. Hydroxy Propyl Methyl Cellulose (HPMC) K100M, Sodium Carboxy Methyl Cellulose

(NaCMC), Carbopol 934P, and Polyvinyl Pyrrollidone (PVP) K30 were procured from Yarrow Chem. Products, Mumbai. Magnesium stearate and talc were sourced from Molychem Industries, Mumbai. Hydrochloric acid and methanol were purchased from Rankem Fine Chemicals Ltd, New Delhi and Merck specialities Pvt Ltd, Mumbai respectively.

Analytical studies

Standard calibration curve

Prior to preparing the standard calibration curve of Orlistat, its absorption maximum (λmax) was determined. A small quantity of Orlistat was dissolved in 0.1N hydrochloric acid (HCl) and further diluted with the same acid. The drug solution was scanned in the UV range of 200-400nm using a double beam UV spectrophotometer. The λ_{max} of Orlistat was found to be 218nm.

The standard calibration curve was plotted using concentrations between 10 and 50 µg/ml of Orlistat. First, a 1000 µg/ml stock solution was prepared by dissolving 100mg of Orlistat in 100ml of 0.1N HCl. From this stock solution, a working standard solution of 100 µg/ml was prepared by diluting 10ml of stock solution to 100ml with 0.1N HCl. Further, 1, 2, 3, 4 and 5 ml of working standard solution were diluted to 10ml using 0.1N HCl to obtain concentrations of 10, 20, 30, 40 and 50µg/ml respectively. The absorbance of these solutions was measured at 218nm versus 0.1N HCl as the blank [6]. Finally, a calibration curve was plotted between concentration and absorbance values to calculate the unknown concentration of Orlistat in samples.

Drug-excipient incompatibility studies

Compatibility studies between drugs and excipients are important for successful formulations. Understanding the properties of the drug and excipients can help in designing stable formulations [7]. When new excipients are used, compatibility studies are crucial. The studies involve mixing the drug with various excipients in ratios and storing them under different conditions. Changes after storage like discoloration or degradation indicate incompatibility [8].

Fourier Transform Infrared spectroscopy (FTIR) is used to study the compatibility between drug and excipients using Bruker FTIR spectrophotometer (IFS 125HR, Mumbai). The IR spectra of the drug and physical mixtures with excipients are compared. Any changes in the chemical composition or peaks of the drug indicate interaction and incompatibility [9].

Preparation of gastroretentive tablets

Gastroretentive mucoadhesive tablets of Orlistat were prepared using a direct compression method. Different ratios of polymers like HPMC K100M, NaCMC, Carbopol 934P and PVP K30 were used in the formulations along with lactose as a diluent, magnesium stearate as a lubricant and talc as a glidant.

The procedure for preparing the tablets involved directly compressing the powders using a rotary tableting machine [3,10]. First, all the ingredients except magnesium stearate and talc were sifted through a 40 mesh sieve and mixed uniformly. Then, magnesium stearate and talc were passed through a 60 mesh sieve and added to the blend. The mix was thoroughly blended to ensure uniformity before compression using the rotary tablet punching machine. The drug to polymer ratios used in the preparation of tablets is shown in Table 1.

Pre-compression parameters

Bulk and tapped density

Bulk and tapped densities were determined to assess powder flowability [11]. The bulk density was measured by filling a graduated cylinder with a known mass of powder through a screen. The volume was noted without compacting. Bulk density was calculated as mass divided by volume [12].

Tapped density was measured by tapping the graduated cylinder containing the powder sample for a fixed time and noting the final volume. Tapped density was calculated as mass divided by tapped volume.

Carr's index and Hausner's ratio:

Carr's index and Hausner's ratio were calculated from the bulk and tapped densities. They indicate the flowability and compressibility of the powder [13]. The angle of repose was measured to determine frictional forces of particles. The powder was allowed to flow through a funnel onto a surface. The angle of repose was calculated from the height and radius of the formed heap. Lower angles indicate better flow properties [14].

Table 1: Formulae for the preparation of gastro retentive mucoadhesive tablets of Orlistat

Ingredients	Quantity of ingredients per formulation (mg)												
	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13
Orlistat	75	75	75	75	75	75	75	75	75	75	75	75	75
HPMC K100M	25	37.5	50	-	-	-	-	-	-	18.8	25	18.8	25
Sodium CMC	-	-	-	25	37.5	50	-	-	-	-	-	18.8	25
Carbopol	-	-	-	-	-	-	25	37.5	50	18.8	25	-	-
PVP K-30	20	20	20	20	20	20	20	20	20	20	20	20	20
Lactose	120	108	95	120	108	95	120	108	95	108	95	108	95
Mg.Sterate	5	5	5	5	5	5	5	5	5	5	5	5	5
Talc	5	5	5	5	5	5	5	5	5	5	5	5	5

Post-compression parameters

Tablet hardness: Tablet hardness was measured using a Monsanto hardness tester. The crushing strength in kg/cm^2 indicates the hardness of the tablets [15].

Tablet thickness: Tablet thickness was determined using a Vernier calliper. The thickness of 10 tablets from each formulation was measured.

Friability: Tablet friability was evaluated using a Roche's friabilator. About 10 tablets were weighed and put into the friabilator that was rotated at 25 rpm for 4 minutes [16]. The tablets were weighed again and the % friability was calculated.

Weight variation: Tablet weight variation test was performed by individually weighing 20 tablets and calculating the average weight. The individual tablet weights were compared to the average. The tablets pass the test if within the specified % difference limits according to the USP [17].

Drug content: Drug content was determined by crushing 5 tablets and dissolving an equivalent of 75 mg of drug in HCl. The solution was diluted and analyzed by UV spectroscopy at 218 nm [6].

In vitro mucoadhesion test

An *in vitro* mucoadhesion test was performed using goat gastric mucosa as a model membrane [18]. A physical balance was modified by removing one pan and hanging a thread with a glass piece at the bottom. The glass piece was placed in an inverted beaker filled with glass beads to weigh it down. The mucosa was attached to the glass piece and a tablet attached to the hanging thread. The balance was adjusted so that the hanging side was 5 g heavier and the force required to detach the tablet was measured [19].

In vitro drug release studies

In vitro drug release of the gastroretentive tablets was performed using USP Type II (paddle) apparatus. About 900 mL of 0.1 N HCl (pH 1.2) was used as the dissolution medium, maintained at 37 ± 0.5°C and stirred at 50 rpm. One tablet was used in each test. About 5 mL of the sample was withdrawn at predetermined time intervals and filtered. An equal volume of fresh dissolution medium was replaced [18,20]. The samples were appropriately diluted and analyzed for drug content by UV spectroscopy at 218 nm.

Drug release kinetics

Various kinetic models were used to analyze the drug release mechanism and rate kinetics. Zero order kinetics assumes the drug release rate is independent of its concentration. The cumulative amount of drug released is plotted against time and if linear, indicates zero order release. This model is used for modified release formulations with constant drug release rates. First order kinetics plots the log of remaining drug against time. If linear, it indicates drug release is concentration dependent. This model is used for soluble drugs in porous matrices. Higuchi model plots cumulative drug release against the square root of time. This model is employed for drug release from semi-solid and solid matrices where diffusion is the release mechanism. Korsmeyer-Peppas model plots log cumulative release against log time. The exponential n value indicates the drug release mechanism - Fickian, non-Fickian, Case II, or anomalous. Hixson-Crowell model plots the cube root

of the remaining drug amount against time. This is used for systems where the tablet dimensions and surface area change during dissolution [21-23].

Stability studies

Stability studies were performed on the optimized batch according to ICH guidelines. Samples were stored at 40°C/75% RH for 3 months [19,24]. Samples were evaluated after each month for hardness, drug content and in vitro drug release.

Results

Standard calibration curve

A calibration curve was plotted using 6 concentrations of Orlistat from 0.1 to 0.5 mg/ml. The curve showed a linear relationship between concentration and absorbance. The absorption maximum was found to be 218 nm. The correlation coefficient was 0.998 indicating a good linear relationship. The slope of the regression line was 0.017 and the y-intercept was 0.009. The x-intercept was calculated to be 0.529 mg/ml. The statistical parameters from the standard calibration curve demonstrate that the calibration curve is precise and accurate for quantitative analysis of Orlistat concentrations within the Beer's law limit 0.1 to 0.5 µg/ml. The concentration versus absorbance plot is shown in Figure 1.

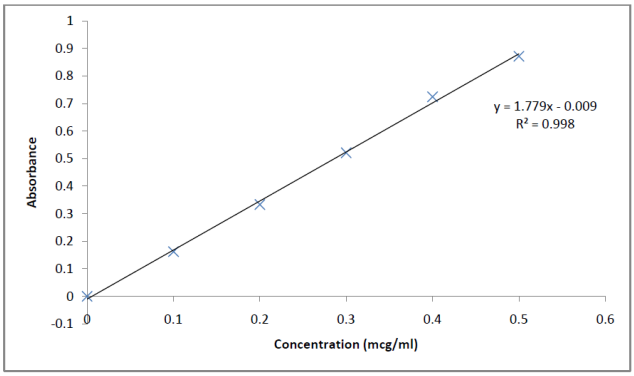

Figure 1: Standard calibration curve

Drug-excipient incompatibility studies

FTIR spectroscopy revealed that there are no new peaks observed in the spectra of the physical mixtures, indicating no interaction or complex formation between the drug and polymers. There is no colour change in the physical mixtures which are stored at different temperatures and humidity. The characteristic peaks of the functional groups in the drug (C=O, C-H, C=C, C-N, C-Cl) remain relatively unchanged in position in the physical mixtures compared to the pure drug. Any major shift in the peak positions would indicate an interaction. The intensities of the peaks may change slightly in the physical mixtures, which can be attributed to the dilution effect of the polymers rather than interaction [1,25]. The maximum variation observed in the peak positions is only about 15-20 cm^{-1}, which is within the error range of the instrument. This small change does not indicate any significant interaction. The C=O stretch, which is usually sensitive to interactions, remains around 1750-1753 cm^{-1} for all formulations, close to the pure drug peak of 1753 cm^{-1}. This study paved path to prepare tablets without having to worry about drug excipient interaction. The FTIR spectrum of various drug and excipient combinations is shown in Figure 2.

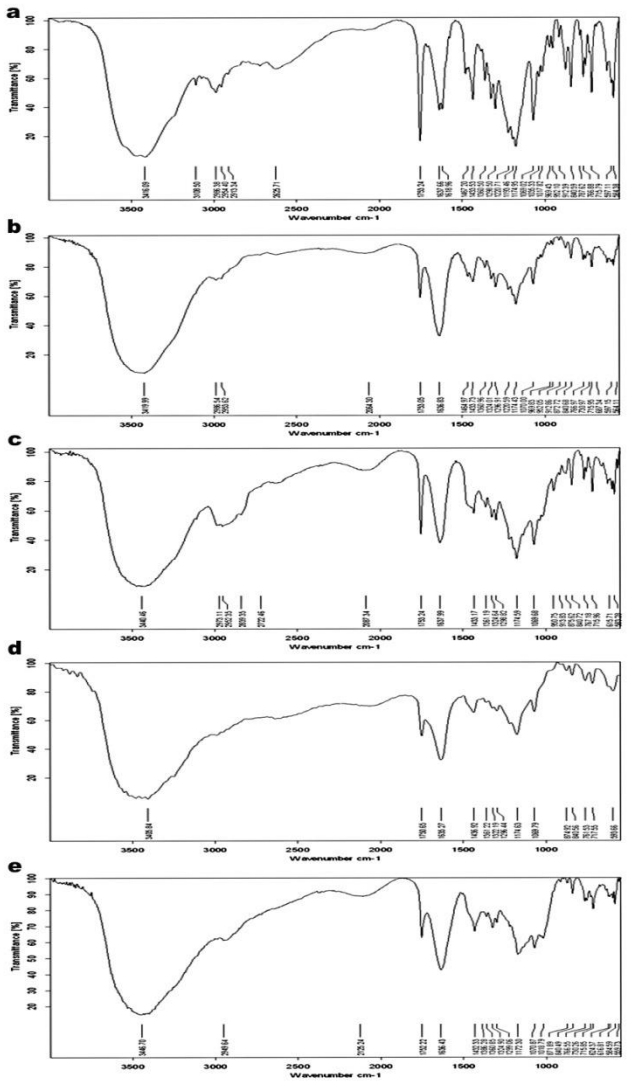

Figure 2: FTIR spectrum of a. Pure drug b. Drug+ HPMC K100M c. DRUG+PVP K30 d. DRUG+ NaCMC and e.DRUG+ Carbopol 934P

Pre-compression parameters

The results of pre-compression parameters are shown in Table 2. The bulk and tapped densities varied across the formulations, with F10 having the highest bulk and tapped densities and F3 the lowest. This can be attributed to the different ratios of ingredients in the formulations. The Carr's index values ranged from 10.86% to 15.69%, indicating fair to passable flow properties according to the scale. Formulations with lower Carr's index (F2 and F6) had better flow than those with higher values. The Hausner's ratios were between 1.122 and 1.186, corresponding to good to fair flowability. The angle of repose values ranged from 14.74° to 20.21°. According to the scale, formulations F1 and F9 had excellent flow, F2, F3 and F11 had good flow and the rest had passable to poor flow. F2 and F6 showed the best flow characteristics among the formulations with relatively lower Carr's index and Hausner's ratio and higher angle of repose [1,2]. The high standard deviations indicate variability in measurements, which may be due to segregation of ingredients.

Post-compression parameters

The results of post-compression parameters are shown in Table 3. Results indicate that all the formulations complied with the specified weight variation limits, indicating uniformity in tablet weights. The standard deviations were within acceptable range. The hardness values ranged from 3.47 to 3.67 kg/cm2, indicating sufficient hardness to withstand mechanical shocks while handling. The thickness was relatively consistent for tablets of the same batch but varied slightly across formulations due to the use of different polymer ratios. All formulations showed low friability values below 1%, indicating good mechanical resistance and ability to withstand abrasion during handling and packaging [26]. The drug content was within the acceptable range of 90% to 110% for all formulations. However, certain batches showed slightly higher (F3, F6 and F10) and some batches showed lower (F5 and F9) drug content with higher variability.

In vitro mucoadhesion test

All the formulations showed mucoadhesive properties, with force of adhesion ranging from 15.68 g to 24.12 g. This indicates that the polymers used - HPMC K100M, NaCMC, PVP K30 and Carbopol 934P - were able to form bonds with the mucosal membrane. F9 showed the highest mucoadhesion strength of 24.12 g, followed by F8, F6 and F5. This suggests that these formulations with higher proportions of mucoadhesive polymers were able to form stronger adhesive bonds. F1 showed the lowest mucoadhesion strength of 15.68 g, indicating a lower concentration of polymers in this formulation resulted in weaker adhesive bonds [27]. In general, there was an increasing trend in mucoadhesion strength with increasing concentration of mucoadhesive polymers, especially NaCMC and Carbopol 934P. The relatively low standard deviations indicate negligible variability in measurements between replicates, confirming consistency and reliability of the results. The results of in vitro mucoadhesion strength are shown in Figure 3.

In vitro drug release studies

All formulations demonstrated sustained release for up to 14-16 hours, though to varying extents. F11 showed the highest drug release of 99.99% after 16 hours. This suggests optimizing the polymer ratios resulted in better control of drug release in this formulation. F1 showed the lowest extent of release at 101.53% after 12 hours, indicating a faster release profile. There was a general trend of increasing drug release with increasing concentration of release modulating polymers like HPMC K100M, Na CMC and PVP K30 [28]. F3, F4 and F5 showed the lowest initial release in the first hour, suggesting better ability to prevent burst release. Standard deviations are relatively low, indicating less variability and reliability of results. The results of *in vitro* drug release are displayed in Figure 4.

Drug release kinetics

Majority of the formulations showed relatively high r2 values (>0.9) for zero order kinetics, indicating drug release is independent of concentration and occurs at a constant rate. F4 and F7 had slightly lower r2 values. All formulations had low r2 values (<0.9) for first order kinetics, suggesting the drug release rate is not concentration dependent. Most formulations showed good fit with r2 values >0.9, indicating drug release occurs by diffusion. Moderate to high r2 values in Hixon-Crowell model indicate drug release involves changes in surface and diameter of tablets. High r2 values (>0.9) in Korsmeyer-Peppas model for all formulations indicate the model can be used to describe the drug release mechanism. As all release exponent (n) values in Korsemeyer-Peppas model are between 0.5 to 1, the drug release mechanism for all formulations follows non-Fickian or anomalous (diffusion & erosion coupled) release kinetics [22]. The results of drug release kinetics are shown in Table 4.

Table 2: Results of pre-compression parameters of Formulations F1-F13

Batch code	Bulk density * (g/cc)	Tapped density* (g/cc)	Carr's index (%)	Hausner's ratio	Angle of repose (Θ)
F1	0.424 ± 0.002	0.487 ±0.002	12.87	1.148	14.74
F2	0.425 ±0.004	0.476 ± 0.004	10.86	1.122	16.31
F3	0.370 ±0.006	0.435 ±0.006	14.94	1.176	15.52
F4	0.408 ±0.005	0.483 ±0.007	15.51	1.184	17.52
F5	0.486 ±0.003	0.572 ±0.002	15.03	1.176	19.35
F6	0.377 ±0.002	0.424 ±0.009	11.08	1.125	19.43
F7	0.413 ±0.006	0.477 ±0.003	13.46	1.156	20.21
F8	0.392 ±0.005	0.465 ±0.008	15.69	1.186	18.43
F9	0.417 ±0.004	0.491 ±0.004	15.19	1.179	14.74
F10	0.555 ±0.006	0.648 ±0.006	14.35	1.171	15.24
F11	0.370 ±0.002	0.435 ±0.005	14.94	1.176	15.52
F12	0.352 ± 0.006	0.413 ±0.007	14.76	1.173	17.52
F13	0.411 ±0.003	0.475 ±0.004	13.47	1.155	16.75

***Mean ± S.D, n=3**

Table 3: Results of post compression parameters of prepared tablets F1 to F13

Batch code	Weight variation (%) *	Hardness (kg/cm²) *	Thickness (mm) *	Friability (%)*	Drug content (%)*
F1	251.22±1.528	3.61 ±0.289	2.78 ±0.13	0.31 ±0.02	98.35 ±0.257
F2	250.45±2.082	3.57 ±0.500	2.81 ±0.05	0.35 ±0.04	99.37 ±0.542
F3	252.35±1.646	3.49 ±0.577	2.86 ±0.08	0.29 ±0.06	100.42 ±0.27
F4	251.69±1.732	3.65 ±0.289	2.91 ±0.12	0.42 ±0.03	99.81 ±0.590
F5	249.69 ±1.528	3.59 ±0.577	2.84 ±0.13	0.39 ±0.08	98.98 ±0.647
F6	250.85 ±1.158	3.63 ±0.289	2.79 ±0.09	0.38 ±0.07	101.12 ±0.46
F7	252.12 ±1.646	3.58 ±0.500	2.85 ±0.10	0.41 ±0.05	99.87 ±0.398
F8	251.35 ±2.082	3.64 ±0.577	2.9 ±0.12	0.36 ±0.03	99.56±0.915
F9	250.98 ±1.732	3.57 ±0.289	2.92 ±0.13	0.31 ±0.06	98.95 ±0.850
F10	251.46 ±1.528	3.67 ±0.577	2.88 ±0.08	0.37 ±0.04	100.21 ±0.28
F11	252.35 ±1.646	3.65 ±0.500	2.79 ±0.10	0.32 ±0.08	99.65 ±0.458
F12	250.46 ±2.082	3.64 ±0.289	2.81 ±0.13	0.4 ±0.07	99.59 ±0.647
F13	251.22 ±1.732	3.47 ±0.289	2.83 ±0.12	0.35 ±0.09	99.19 ±0.398

***Mean ± S.D, n=3**

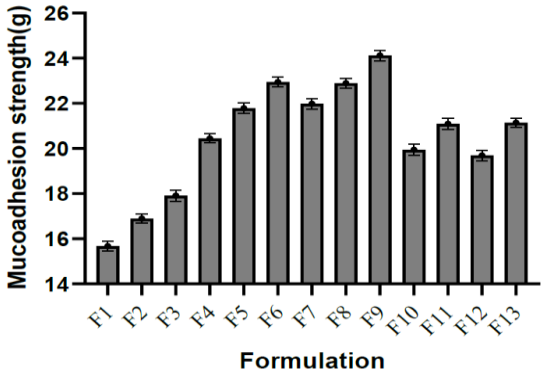

Figure 3: ***In vitro*** **mucoadhesion strength of the formulations**

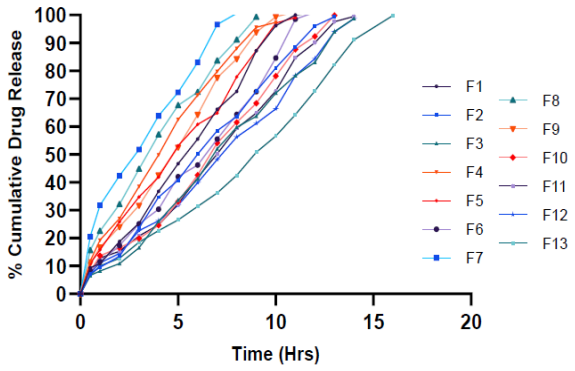

Figure 4: Results of ***in-vitro*** **drug release from the formulations**

Table 4: Summary of the drug release kinetics

Batch code	Zero order (r^2)	First order (r^2)	Higuchi (r^2)	Hixon-crowell (r^2)	Korsemeyer-Peppas	
					Release exponent (n)	r^2
F1	0.993	0.807	0.957	0.810	0.840	0.973
F2	0.996	0.742	0.966	0.914	0.879	0.978
F3	0.995	0.755	0.951	0.905	0.907	0.961
F4	0.983	0.904	0.984	0.974	0.732	0.992
F5	0.992	0.783	0.971	0.918	0.738	0.993
F6	0.992	0.666	0.932	0.733	0.822	0.975
F7	0.967	0.839	0.984	0.818	0.565	0.991
F8	0.981	0.754	0.988	0.930	0.655	0.993
F9	0.989	0.748	0.967	0.842	0.764	0.984
F10	0.990	0.513	0.926	0.836	0.799	0.948
F11	0.992	0.719	0.960	0.889	0.805	0.958
F12	0.994	0.735	0.937	0.886	0.807	0.972
F13	0.981	0.676	0.899	0.864	0.810	0.958

Table 5: Results of stability studies on formulation F13

Sampling time	Physical appearance	Hardness (Kg/cm^2)*	Mucoadhesive strength (g)*	*In vitro* drug release at the end of 16hrs (%)*
Initial	White	3.47±0.289	21.14±0.219	99.99±0.93
After 1 month	White	3.47±0.500	20.98±0.241	99.84±0.58
After 2 months	White	3.35±0.577	20.95±0.224	99.62±0.65
After 3 months	White	3.33±0.500	20.26±0.251	99.15±0.49

***Mean±SD, n=3**

Stability studies: Stability studies on the best formulation F13 demonstrated that the developed gastroretentive tablets can maintain their physicochemical properties and sustained release behavior for at least 3 months of storage at room temperature. The results are shown in Table 5.

Physical appearance: The tablets remained white in color with no visible changes throughout the 3 months storage period, indicating no significant discoloration occurred.

Hardness: The hardness values showed a slight decreasing trend over time, reducing from 3.47 kg/cm^2 initially to 3.33 kg/cm^2 after 3 months. However, the decrease was minor and the tablets still had sufficient hardness to withstand mechanical stresses during handling and storage.

Mucoadhesive strength: The mucoadhesive strength also decreased slightly from 21.14 g initially to 20.26 g after 3 months. Again, the change was marginal and the tablets were able to retain adequate mucoadhesive properties during storage.

***In vitro* drug release:** The extent of drug release after 16 hours showed a gradual decrease from 99.99% initially to 99.15% at 3 months. However, the reduction was minimal and the tablets were still able to sustain the drug release for the studied period.

Discussion

The present study aimed to develop gastroretentive mucoadhesive pellets of Orlistat to improve its oral bioavailability and enhance its absorption. The calibration curve demonstrated a good linear relationship between concentration and absorbance over the range of 0.1 to 0.5 µg/ml, with a correlation coefficient of 0.998. The statistical parameters from the standard calibration curve demonstrated that the calibration curve is precise and accurate for quantitative analysis of Orlistat. Compatibility studies between orlistat and the excipients were performed and Fourier transform infrared spectroscopy (FT-IR) spectra showed that all the characteristic peaks of Orlistat remained unchanged in the drug-excipient mixtures, indicating an absence of interactions. Gastroretentive mucoadhesive tablets were prepared using HPMC K100M, NaCMC, Carbopol 934P and PVP K30 in varying ratios. The powder blend exhibited good flow properties and the tablets were evaluated for physical characteristics such as weight variation, hardness, thickness and friability, which were found to be within acceptable ranges [29].

Swelling index increased with time and polymer concentration and combinations of HPMC and NaCMC yielded optimum swelling. Mucoadhesion strength increased with polymer viscosity and concentration. Drug release from formulations containing HPMC K100M, NaCMC and Carbopol 934P were 12-14 hours, 10-12 hours and 8-11 hours respectively. Combination polymers in F10-F13 provided balanced release and mucoadhesion, with F13 showing sustained release up to 16 hours. Data fitted zero order kinetics better than first order, indicating constant release rate. Higuchi and Hixon-Crowell models suggested a diffusion mechanism, with n values of 0.56-0.90 indicating non-Fickian diffusion. Stability studies on the optimized F13 formulation showed no significant changes in appearance, hardness, mucoadhesion or drug release over 3 months, indicating stability [30]. This study provides valuable insights into the development of gastroretentive mucoadhesive pellets of Orlistat to improve its oral bioavailability and enhance its absorption. The use of combination polymers in achieving balanced release and mucoadhesion is noteworthy. The findings of this study can be useful in further research on the development of drug delivery systems for other poorly bioavailable drugs.

Conclusion

In conclusion, the present study successfully developed gastroretentive mucoadhesive pellets of Orlistat to improve its oral bioavailability and enhance its absorption. The combination of HPMC K100M, NaCMC, Carbopol 934P and PVP K30 in varying ratios provided balanced release and mucoadhesion with F13 showing sustained release up to 16 hours. The study also demonstrated the importance of compatibility studies and the use of calibration curves for quantitative analysis. The findings of this study provide valuable insights into the development of drug delivery systems for poorly bio-available drugs and can be useful for further research in this field.

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