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Design and Performance Evaluation of Memantine Hydrochloride Orodispersible Tablets Incorporating Natural and Synthetic Superdisintegrants

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ABSTRACT

Introduction: This study aimed to develop memantine hydrochloride orodispersible tablets (ODTs) to improve medication compliance in geriatric Alzheimer's patients who often face swallowing difficulties.

Materials and methods: ODTs were formulated by direct compression using synthetic superdisintegrants (sodium starch glycolate, croscarmellose sodium) and a natural alternative (mucilage from *Plantago ovata*) at concentrations of 0.5%, 1% and 2%. The formulations were evaluated for flow properties, hardness, friability, wetting time, disintegration time and *in-vitro* drug release.

Results: The optimized formulation (MM3), containing 2% *Plantago ovata* mucilage, demonstrated the most efficient performance with a rapid disintegration time of 28 ± 1.29 sec and 98.83 ± 2.11% drug release within 30 min.

Conclusion: The use of natural *Plantago ovata* mucilage as a super disintegrant provides a superior, biocompatible alternative to synthetic agents, ensuring rapid drug onset and enhanced patient adherence.

Keywords: Alzheimer's Disease, Memantine hydrochloride orodispersible tablets, *Plantago ovata* mucilage

1. Introduction

Alzheimer's disease is a progressive neurodegenerative disorder characterized by cognitive decline, memory impairment and behavioural disturbances, significantly affecting the geriatric population[1]. The pathophysiology involves neuronal degeneration and excitotoxicity mediated by excessive glutamate activity, necessitating long-term pharmacological intervention[2]. Memantine hydrochloride, an N-Methyl-D-aspartate (NMDA) receptor antagonist, plays a crucial role in modulating glutamatergic transmission and is widely prescribed for moderate to severe Alzheimer's disease due to its neuroprotective effects[3,4].

Despite therapeutic benefits, effective disease management is often compromised by poor patient compliance, particularly in geriatric populations. Age-associated physiological conditions such as dysphagia, reduced saliva secretion and impaired neuromuscular coordination make swallowing conventional solid dosage forms challenging. Additionally, cognitive impairment further reduces adherence to medication regimens. These limitations highlight the need for advanced patient-centric

drug delivery systems that ensure ease of administration and rapid onset of action. Recent progress in these delivery systems has been driven by advances in materials and technology, enabling improved therapeutic efficiency[5].

Orodispersible tablets (ODTs) have emerged as a promising and widely accepted alternative to conventional oral dosage forms[6,7]. These formulations rapidly disintegrate in the oral cavity without the need for water, thereby improving patient compliance and convenience[8,9]. Recent advancements in ODT technology have focused on enhancing disintegration efficiency, mechanical strength and drug release profiles through the use of novel excipients and optimized formulation strategies, including direct compression techniques and the incorporation of efficient superdisintegrants[9,10]. Furthermore, the development of biomolecule-responsive systems, such as specialized hydrogels, represents the cutting edge of personalized medicine in this field[11].

Super disintegrants play a critical role in ODT performance by facilitating rapid tablet breakup through mechanisms such as swelling, wicking and deformation[12,13]. Synthetic super disintegrants like sodium starch glycolate and croscarmellose sodium are widely used due to their effectiveness; however, growing concerns regarding cost, biocompatibility and sustainability have driven interest toward natural alternatives[14,15]. In recent years, natural polymers have gained significant attention as pharmaceutical excipients owing to their biodegradability, non-toxicity, economic feasibility and eco-friendly nature[16,17].

Among natural candidates, mucilage derived from *Plantago ovata* (Isabgol) has shown considerable promise as a super disintegrant due to its high swelling index, rapid hydration capacity and excellent water absorption properties[18]. Recent studies have demonstrated that *Plantago ovata* mucilage can enhance disintegration and dissolution performance, sometimes exhibiting comparable or superior efficiency to synthetic superdisintegrants[19,20]. However, systematic comparative evaluations in specific therapeutic contexts, particularly for central nervous system drugs like memantine hydrochloride, remain limited.

Therefore, the present study aims to develop and evaluate orodispersible tablets of memantine hydrochloride using *Plantago ovata* mucilage as a natural super disintegrant and to compare its performance with commonly used synthetic super disintegrants such as sodium starch glycolate and croscarmellose sodium[21]. The study focuses on optimizing formulation parameters to achieve rapid disintegration, enhanced drug release and improved patient compliance. This work contributes to the growing field of natural excipient-based drug delivery systems and provides a potential strategy for developing cost-effective and patient-friendly formulations for geriatric care.

2. Materials and Methods

Memantine hydrochloride was obtained from Sun Pharmaceuticals Industries Ltd, India, as a gift sample. Croscarmellose sodium, sodium starch glycolate, microcrystalline cellulose, mannitol, aspartame and magnesium stearate were procured from SD Fine Chem Ltd., Mumbai, India. *Plantago ovata* seeds were obtained from Yarrow Chem Products, Mumbai, India.

2.1. Procedure

2.1.1. Isolation of mucilage: The seeds of *Plantago ovata* were soaked in distilled water for 48 h and then boiled for a few minutes to completely release the mucilage. The mixture was filtered through a muslin cloth to separate the marc. An equal volume of acetone was added to the filtrate to precipitate mucilage. The obtained mucilage was dried at a temperature below 60°C, powdered, passed through a sieve no # 80 and stored in a desiccator until further use.

2.1.2. Preparation of tablets: Memantine hydrochloride is intended to exert immediate therapeutic effects. Oral dispersible tablets were formulated using super-disintegrants to ensure rapid disintegration. In this study, the mucilage of *Plantago ovata*, sodium starch glycolate and croscarmellose sodium were used as super-disintegrants. The tablets were prepared using the direct compression method. A total of nine formulations were prepared, as presented in **(Table 1)**.

Table 1: Formulations of memantine hydrochloride containing different super-disintegrants.

Formulation	Memantine HCl (mg)	SSG (mg)	CCS (mg)	Mucilage powder (mg)	MCC (mg)	Magnesium stearate (mg)	Talc (mg)	Mannitol (mg)	Aspartame (mg)	Total (mg)
MSG1	5	0.25	-	-	29.75	1	1	11	2	50
MSG2	5	0.5	-	-	29.5	1	1	10	2	50
MSG3	5	1	-	-	29	1	1	9	2	50
MCS1	5	-	0.25	-	29.75	1	1	11	2	50
MCS2	5	-	0.5	-	29.5	1	1	10	2	50
MCS3	5	-	1	-	29	1	1	9	2	50
MM1	5	-	-	0.25	29.75	1	1	11	2	50
MM2	5	-	-	0.5	29.5	1	1	10	2	50
MM3	5	-	-	1	29	1	1	9	2	50

2.2. Analytical methodology

2.2.1. Determination of λ_{max}: A 10 µg/mL solution of memantine hydrochloride was scanned using a double-beam UV-visible spectrophotometer, with 0.1N hydrochloric acid serving as the blank. The maximum absorption wavelength (λ_{max}) was identified at 254 nm, which was selected for all further analytical studies[22,23].

2.2.2. Construction of calibration curve: Standard solutions with concentrations of 2, 4, 6, 8 and 10 µg/mL were prepared by appropriate dilution of Stock III, while the 20 µg/mL solution was derived from Stock II. The absorbance of each concentration was measured at 254 nm using 0.1N hydrochloric acid as the reagent blank. All measurements were performed in hexaplicate (n=6) and the resulting mean absorbance values were utilized to construct the calibration curve[22,23].

2.2.3. Fourier transform infrared spectroscopy: The compatibility between the drug and excipients was studied using FTIR spectroscopy. The spectra of pure drug and its physical mixtures with excipients were recorded in the range of 400 to 4000 cm^{-1}. The obtained spectra were analysed for characteristic peaks corresponding to functional groups and were compared to detect any possible interactions[24].

2.2.4. Angle of repose: The angle of repose was measured using the fixed-funnel technique to assess powder flowability. A known weight of the powder mix was allowed to flow freely through a funnel onto a stationary surface, maintaining the funnel tip at the apex of the powder cone. The height and diameter of the pile were recorded and the angle of repose was determined according to the formula[25,26].

$$\theta = \tan^{-1}\left(\frac{h}{r}\right)$$

where h is the height and r is the radius of the pile.

2.2.5. Bulk density and tapped density: Bulk density was determined by pouring the powder blend into a graduated cylinder and measuring the bulk volume. It was calculated as the ratio of the mass of powder to the bulk volume.

Tapped density was determined by tapping the graduated cylinder containing the powder blend for a fixed number of times until a constant volume was obtained. It was calculated as the ratio of the mass of powder to tapped volume. Bulk density and tapped density were determined using the given formulae[25,26].

Bulk density=Mass of the powder/bulk volume

Tapped density=Mass of the powder/ Tapped volume

2.2.6. Carr's compressibility index and hausner's ratio: The compressibility index was calculated using the formula[25,26].

Carr' s index=[(Tapped density-Bulk density)]/Tapped density] x100

Hausner's ratio was calculated using the following formula

Hausner' s ratio=Tapped density/ Bulk density

2.3. Evaluation of orodispersible tablets

2.3.1. Hardness: Tablet hardness was determined using a Monsanto hardness tester, which measures the force required to break the tablet and indicates its mechanical strength[27,28]. The hardness is expressed in terms of kg/cm^2.

2.3.2. Thickness: The thickness of tablets was measured using a screw gauge for 10 tablets and expressed as mean ± standard deviation. It ensures uniformity and proper packaging[27,28].

2.3.3. Weight variation: Twenty tablets were randomly selected and weighed individually. The average weight was calculated and the percentage deviation of each tablet from the average was determined according to pharmacopeial limits[27,28].

2.3.4. Friability: Friability was evaluated using a Roche friabilator operated at 25 rpm for 100 revolutions. Tablets were weighed before and after the test and percentage weight loss was calculated to assess resistance to abrasion by the given formula[27,28].

Friability=(Initial weight-Final weight/Initial weight)X100

2.3.5. Content uniformity: Tablets were powdered and an amount equivalent to the drug dose was dissolved in 0.1N HCl, filtered and analyzed at 254 nm using a UV spectrophotometer[27-29].

2.3.6. Wetting time and water absorption ratio: A tablet was placed on tissue paper soaked in water containing a dye and the time required for water to reach the upper surface of the tablet was recorded as wetting time[27,28].

The tablet was weighed before and after water absorption and the water absorption ratio was calculated using the standard formula. Water absorption ratio R was determined using the following equation[30,31].

R=Wa-Wb/Wb x100

Where Wa = weight of tablet after absorption, Wb = weight of tablet before absorption.

2.3.7. *In-vitro* disintegration time: The tablet was placed in a petri dish containing 10 mL of water at 37°C and the time taken for complete disintegration into fine particles was recorded[32].

2.3.8. Swelling index: The swelling capacity of various superdisintegrants was evaluated to determine their contribution to rapid tablet disintegration. The swelling index, defined as the volume (mL) occupied by 1 g of material, including any adhering mucilage, after 4 h of hydration in an aqueous medium, was measured for *Plantago ovata*, sodium starch glycolate and croscarmellose sodium. All measurements were performed in triplicate and the final index for each substance was recorded as the mean value[33].

2.3.9. *In-vitro* drug release: *In vitro* drug release was evaluated using a USP dissolution apparatus II (paddle type). The study was conducted in 900 mL of 0.1 N hydrochloric acid, maintained at 37 ± 0.5°C with a paddle rotation speed of 50 rpm. At specified intervals (5, 10, 15, 20, 25 and 30 min), 5 mL aliquots were withdrawn and immediately replaced with an equal volume of fresh medium to maintain sink conditions. Collected samples were filtered and analysed via UV spectrophotometry at 254 nm. The cumulative percentage of drug release was determined using a standard calibration curve to characterize the dissolution profile and release kinetics of the formulated tablets[34].

2.3.10. Similarity and difference factors: To evaluate the comparability of the optimized formulation and the marketed product, dissolution profiles were analysed using model-independent approaches: the difference factor (f1) and the similarity factor (f2). While f1 calculates the percentage difference between the two profiles at each time point to indicate relative error, f2 provides a logarithmic reciprocal square root transformation of the sum-of-squared error, representing the closeness of the profiles. According to regulatory standards, f1 values between 0-15 and f2 values between 50-100 confirm that the optimized formulation exhibits bioequivalent drug release behaviour relative to the marketed reference[35,36].

3. Results and Discussion

3.1. Determination of λ_{max}

The analytical method for Memantine hydrochloride was developed to determine its absorption maximum (λ_{max}) and to enable accurate quantification of the dispersions before experimental studies. The drug was scanned in 0.1 N hydrochloric acid over an appropriate wavelength range to

identify its λ_{max}. An absorption maximum was observed at 254 nm, as shown in Figure 1. Subsequently, a standard calibration curve of memantine hydrochloride in 0.1 N hydrochloric acid was constructed at the determined λ_{max} for quantitative analysis[37].

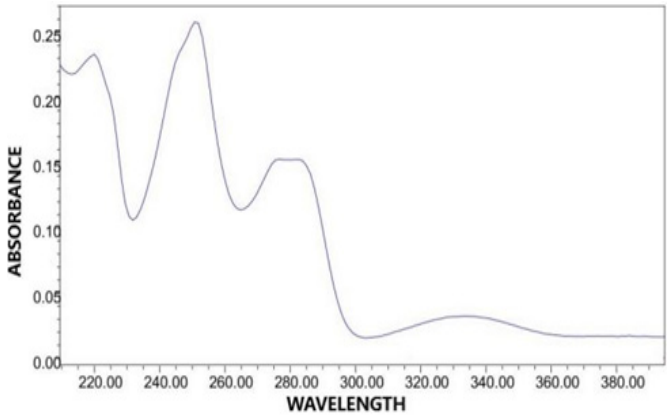

Figure 1: Absorption maximum of Memantine Hydrochloride in 0.1N HCl.

3.2. Standard graph of memantine hydrochloride in 0.1N HCl

Standard solutions of Memantine hydrochloride in the concentration range of 2-20 µg/mL were prepared and their absorbance was measured at 254 nm using an appropriate blank. A calibration curve was constructed by plotting absorbance versus concentration **(Figure 2)**, with absorbance on the Y-axis and concentration on the X-axis[37].

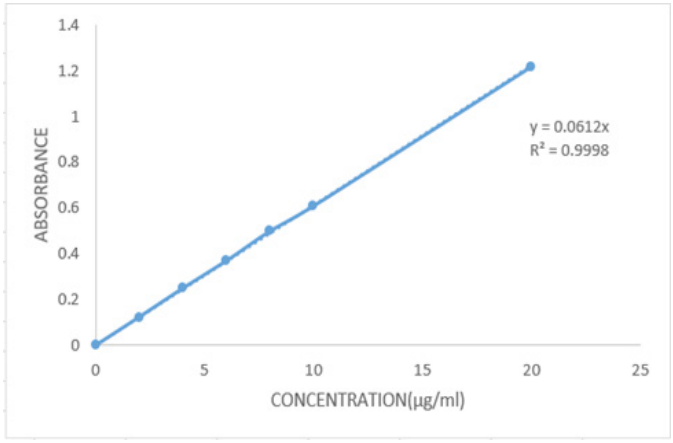

Figure 2: Standard graph of memantine hydrochloride in 0.1N HCl.

3.3. Fourier transform infra-red spectroscopy

The FTIR spectra shown in **(Figure 3)** inferred that the characteristic peaks of the drug were indicated in the formulation FTIR spectrum, implying the drug excipient stability.

Fourier Transform Infrared (FTIR) spectroscopy was performed to investigate the potential interactions between Memantine hydrochloride and the selected excipients, namely sodium starch glycolate, croscarmellose sodium and mucilage of *Plantago ovata*. The spectra of the pure drug, individual excipients and their physical mixtures were recorded and compared.

The characteristic absorption peaks of memantine hydrochloride were observed at 786.39 cm^{-1} corresponding to CH_3 stretching vibrations, 1352 cm^{-1} attributed to C–N stretching, 1646 cm^{-1} indicating amide functional groups and 2940 cm^{-1} corresponding to C–H stretching vibrations. These prominent peaks were retained in the spectra of the drug–excipient mixtures without any significant shift, disappearance or formation of new peaks.

The FTIR spectra of the formulations **(Figure 3)** demonstrated that all major characteristic peaks of the drug were preserved in the presence of excipients, indicating the absence of any chemical interaction between the drug and the excipients. Minor variations in peak intensity were observed, which may be attributed to physical mixing and dilution effects rather than chemical incompatibility[38].

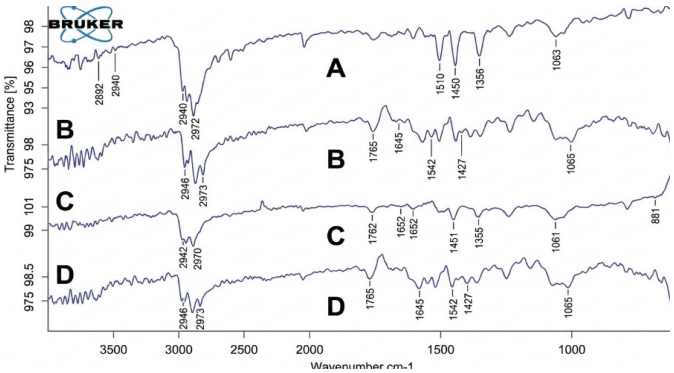

Figure 3: FTIR spectra of (A) Memantine hydrochloride (Drug) (B)Drug + SSG (C) Drug + CCS (D) Drug+ *Plantago ovata* mucilage.

Overall, the FTIR analysis confirms the compatibility and stability of memantine hydrochloride with the selected excipients, supporting their suitability for the formulation of immediate-release dosage forms.

3.4. Pre-compression parameters

As presented in **(Table 2)**, the pre-compression evaluation of all formulation blends included parameters such as angle of repose, bulk density, tapped density, Carr's compressibility index and Hausner's ratio to assess flowability and compressibility, which are critical for direct compression. The angle of repose values ranged from 23.52 ± 0.98° to 25.26 ± 1.03°, indicating excellent flow properties (<30°). Carr's compressibility index values were found to be between 11.24 ± 1.49 and 14.53 ± 0.93, suggesting good compressibility. The Hausner's ratio was approximately 1.17 for all blends, remaining within acceptable limits (<1.25), thereby further confirming good flowability. Overall, the powder blends demonstrated satisfactory flow and compressibility characteristics, making them suitable for direct compression[39].

Table 2: Precompression parameters of the powder blend of all formulations of SSG, CCS and mucilage of *Plantago ovata*.

Formulation	Angle of repose (*θ*)*	Bulk density (gm/cm³)*	Tapped density (gm/cm³)*	Hausner's ratio *	Compressibility Index (%) *
MSG1	25.26±1.03	0.642±0.014	0.735±0.004	1.144±0.019	12.58±1.520
MSG2	23.52±0.98	0.646±0.006	0.735±0.009	1.137±0.003	12.09±0.233
MSG3	24.78±0.82	0.617±0.004	0.722±0.003	1.170±0.013	14.53±0.926

MCS1	24.89±0.80	0.634±0.005	0.720±0.008	1.136±0.022	11.99±1.739
MCS2	24.21±0.72	0.645±0.005	0.742±0.005	1.150±0.001	13.24±0.169
MCS3	24.62±0.53	0.652±0.012	0.740±0.003	1.134±0.021	11.89±0.562
MM1	23.89±0.92	0.669±0.024	0.757±0.002	1.131±0.019	11.62±0.327
MM2	24.47±0.92	0.641±0.004	0.727±0.002	1.134±0.004	11.88±0.332
MM3	24.97±0.86	0.630±0.005	0.710±0.006	1.126±0.019	11.24±1.491

Values are expressed as Mean ±SD, *n = 3, MSG= Formulations of SSG, MCS= Formulations of CCS, MM = Formulation of mucilage

3.5. Evaluation of the memantine HCl orodispersible tablets

In this study orodispersible tablets of memantine hydrochloride were formulated using synthetic superdisintegrants, namely sodium starch glycolate and croscarmellose sodium, along with a natural superdisintegrant, *Plantago ovata* mucilage. All formulations were evaluated for hardness, friability, thickness, weight variation, drug content, wetting time, water absorption ratio, disintegration time and *in vitro* drug release.

As shown in **(Table 3)**, the hardness of the tablets ranged from 3.0 ± 0.62 to 3.1 ± 0.64 kg/cm², while friability was below 1%, indicating adequate mechanical strength. The thickness varied between 2.59 ± 0.04 and 2.77 ± 0.02 mm. All formulations complied with pharmacopeial limits for weight variation (±10%). Drug content ranged from 99.3 to 101.13%, confirming uniform distribution of the drug across all batches[40].

Table 3: Evaluation of memantine HCl orodispersible tablets.

Formulation	Weight variation (mg)****	Hardness (kg/cm²)**	Thickness (mm)***	Friability (%)*	Wetting time (sec)**	Water absorption ratio**	DT (sec)**	Content uniformity (%)*
MSG1	50± 1.19	3.1±0.64	2.77±0.02	0.27±0.12	72±1.21	110±1.23	83±1.21	101.13±0.73
MSG2	52±1.12	3.0±0.62	2.59±0.04	0.23±0.18	56±1.92	118±1.29	76±1.96	99.98±0.69
MSG3	52±0.99	3.1±0.53	2.65±0.01	0.21±0.12	44±1.08	121±1.30	62±1.23	99.80±1.23
MCS1	51±1.05	3.0±0.39	2.71±0.02	0.22±0.15	62±1.29	132±1.42	53±1.28	99.32±1.45
MCS2	49±1.10	3.1±0.32	2.69±0.01	0.25±0.24	53±1.02	135±1.46	48±1.18	100.82±1.12
MCS3	51±1.10	3.1±0.69	2.70±0.02	0.26±0.18	40±1.26	137±1.38	39±1.13	99.98±1.10
MM1	50±0.89	3.1±0.29	2.76±0.05	0.24±0.12	56±1.24	139±1.26	48±1.52	99.86±0.89
MM2	49±0.98	3.1±0.12	2.79±0.05	0.28±0.21	42±1.76	144±1.81	36±1.34	99.24±0.58
MM3	50±1.11	2.9±0.57	2.64±0.02	0.24±0.16	28±1.91	152±1.43	28±1.29	99.85±0.86

Values are expressed as Mean ±SD, *n=3, **n = 6, ***n=10, ****n= 20.

MSG - formulations of sodium starch glycolate, MCS – formulations of croscarmellose, MM – formulations of mucilage powder.

3.6. Determination of swelling index

The mucilage of *Plantago ovata* exhibited a significantly higher swelling index **(Table 4)** compared to the synthetic super disintegrants, sodium starch glycolate and croscarmellose sodium, indicating its superior water uptake and swelling capacity, which may contribute to faster tablet disintegration[41].

Table 4: Swelling index of super-disintegrants.

S.No	Name of super-disintegrants	Swelling index (%v/v)
1	Mucilage of *Plantago ovata*	89±2.1
2	Crosscarmellose sodium	74±1.3
3	Sodium starch glycolate	67±1.6

Values are expressed as mean ± S.D, n=3.

3.7. Disintegration time

Disintegration time is a critical parameter in the development of orodispersible tablets. In the present study, the disintegration time of all batches ranged from 28 ± 1.52 to 83 ± 1.21 sec (Table 4), complying with the official requirement of less than 3 min for dispersible tablets. Figure 4 illustrates the disintegration behaviour of the tablets in water.

A decrease in disintegration time was observed with increasing concentrations of *Plantago ovata* mucilage, croscarmellose sodium and sodium starch glycolate, indicating the effectiveness of these super disintegrants in promoting rapid tablet disintegration. However, for the synthetic super disintegrants, croscarmellose sodium and sodium starch glycolate, this reduction in disintegration time was evident only up to the maximum studied concentration of 2%.

Among all formulations, batch MM3, containing 2% *Plantago ovata* mucilage, was identified as the optimized formulation, exhibiting the shortest disintegration time of 28 sec. The results also demonstrated a direct relationship between swelling index and disintegration efficiency, suggesting that higher swelling capacity enhances the disintegration process. Based on the obtained results, formulation MM3 was considered optimal, as it combined rapid disintegration with satisfactory tablet properties[42].

3.8. Wetting time

(Figure 5) depicts the relationship between the concentration of superdisintegrants and wetting time. Wetting time was evaluated as an indirect parameter to correlate with disintegration behaviour in the oral cavity. It serves as an important criterion for understanding the ability of superdisintegrants to absorb moisture and swell in the presence of a limited amount of water.

Since the dissolution process of a tablet depends on initial wetting followed by disintegration, rapid wetting facilitates

the penetration of the aqueous medium into the tablet matrix. This process replaces the air adsorbed on the particles, weakens intermolecular interactions and promotes the breakdown of the tablet into finer particles. However, disintegration is a multifactorial process influenced by both wetting and swelling mechanisms. The wetting time of the formulated tablets ranged from 28 ± 1.91 to 72 ± 1.21 sec[42].

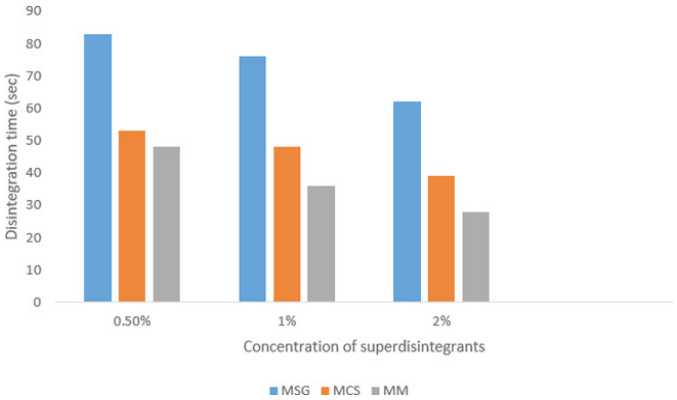

Figure 4: Disintegration time of different super disintegrants with different concentrations.

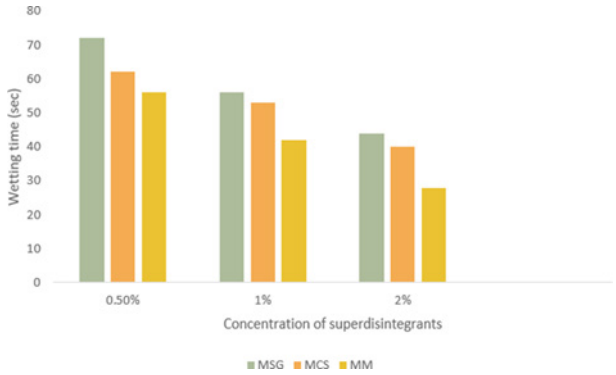

Figure 5: Wetting time of different super disintegrants with different concentrations.

3.9. Water absorption ratio

(Figure 6) illustrates the relationship between the concentration of super disintegrants and the water absorption ratio. The water absorption ratio was evaluated to assess the moisture sorption and water uptake capacity of the super disintegrants. An increase in water absorption ratio was observed with increasing concentrations of super disintegrants, accompanied by a corresponding decrease in both disintegration time and wetting time. This indicates that enhanced water uptake facilitates rapid tablet hydration and promotes faster disintegration. The water absorption ratio of the formulated tablets ranged from 110 ± 1.23 to 152 ± 1.43.

Disintegration time and wetting time of formulations MSG3, MCS3 and MM3 were compared **(Figure 7)**. Among these, formulation MM3 exhibited the shortest disintegration time and wetting time compared to the other formulations[42].

3.9. *In vitro* drug release studies

The *in vitro* drug release studies were conducted for all the formulations containing different super disintegrants. **(Table 5)** and **(Figure 8)** indicate that maximum drug release was observed at 30 min. Among all the formulations, the optimized formulation containing *Plantago ovata* mucilage at 2% concentration reported 98.83 ± 2.11 at 30 min[42].

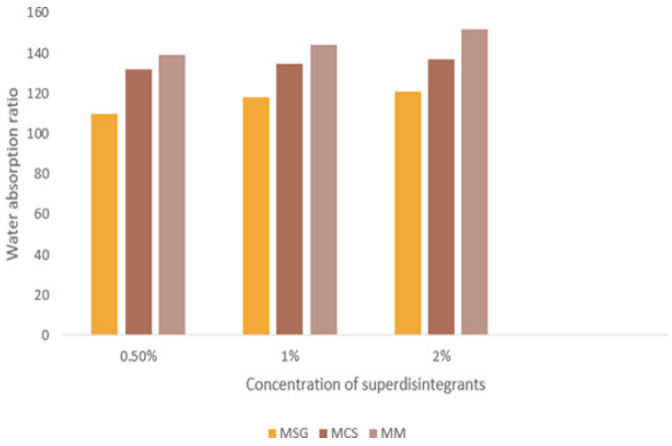

Figure 6: Water absorption ratio of different superdisintegrants with different concentrations.

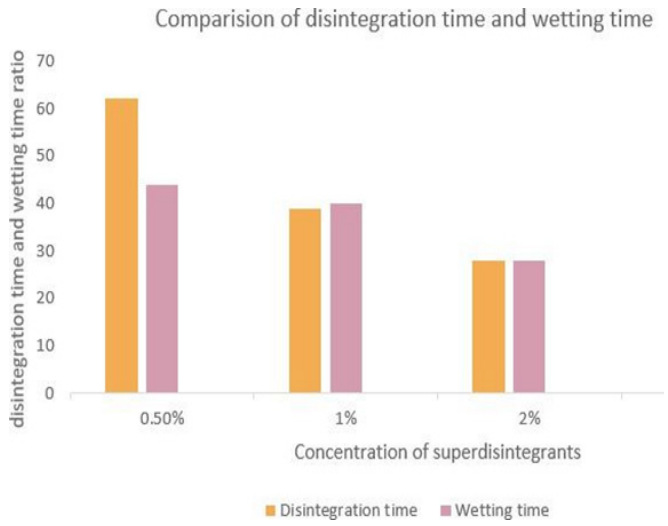

Figure 7: Comparison of disintegration time and wetting time of MSG3, MCS3, MM3.

Table 5: Cumulative Percentage Drug Release of Different Formulations (Mean ± SD, n = 6).

Time (min)	MSG1	MSG2	MSG3	MCS1	MCS2	MCS3	MM1	MM2	MM3	Market formulation
0	0	0	0	0	0	0	0	0	0	0
5	85.29±1.87	85.37±2.27	85.24±1.87	90.86±0.69	91.12±1.31	91.82±1.89	89.89±2.12	89.87±1.28	89.85±1.37	80.25±0.92
10	89.21±1.92	89.26±2.87	89.63±2.19	93.25±0.87	92.82±1.26	92.95±1.28	92.46±2.54	92.52±1.53	93.14±1.46	81.42±1.12
15	90.28±0.98	90.34±2.96	90.83±1.97	94.13±1.23	93.49±1.20	93.98±1.86	94.76±2.98	94.78±1.39	94.85±2.31	83.73±1.98
20	91.25±1.11	92.32±1.19	92.98±2.34	94.37±1.41	94.79±1.12	95.12±1.22	95.28±1.92	95.86±1.23	95.92±1.21	88.05±1.54
25	94.19±1.86	94.58±1.27	95.28±1.23	98.22±1.29	96.99±0.98	96.87±1.62	96.62±1.28	96.98±1.99	96.92±2.34	90.41±1.19
30	96.92±1.28	97.13±1.28	97.98±2.39	99.79±2.57	98.42±0.82	98.97±1.62	98.52±2.34	98.75±2.13	98.83±2.11	96.64±0.89

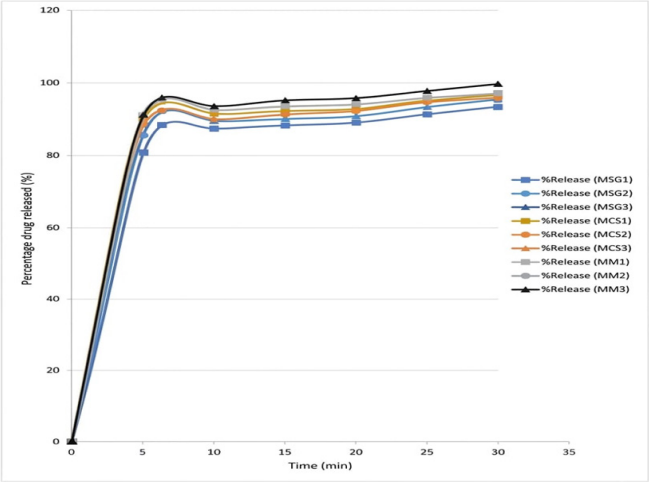

Figure 8: Dissolution profiles of all 9 Memantine HCl orodispersible tablet formulations (MSG1, MSG2, MSG3, MCS1, MCS2, MCS3, MM1, MM2, MM3).

3.10. Calculation of dissimilarity (f1) and similarity factor (f2)

In vitro drug release studies showed that all formulations achieved more than 90% drug release within 30 min. The optimized formulation, MM3, exhibited a drug release of 98.83 ± 2.11%, while the marketed formulation showed 96.64 ± 0.89% release within the same time period **(Table 6)**.

The dissolution profile of the optimized formulation was compared with that of the marketed formulation using similarity (f2) and difference (f1) factors. The calculated f1 and f2 values were found to be 9.62 and 52.46, respectively **(Table 6)**. For two dissolution profiles to be considered similar, the f1 value should be between 0 and 15 and the f2 value should lie between 50 and 100. The obtained values indicate that the optimized formulation is comparable to the marketed formulation in terms of dissolution performance[43].

Table 6: Calculation of dissimilarity (f1) and similarity factor (f2).

Time (min)	Reference	Test	Rt-Tt	$(Rt-Tt)^2$	|Rt-Tt|
	NAMENDA	MM3			
0	0.00	0.00	0.00	0.00	0.00
5	80.25	90.86	-10.61	112.57	10.61
10	81.42	93.25	-11.83	139.94	11.83
15	83.73	94.13	-10.4	108.16	10.4
20	88.05	94.37	-6.32	39.94	6.32
25	90.41	98.22	-7.81	60.99	7.81
30	96.64	99.79	-3.15	9.92	3.15
Sum	520.5			471.54	-50.12
Number of time points or intervals excluding zero					6
Dissimilarity factor (f1)					9.62
Similarity factor (f2)					52.46

4. Summary

The present study focused on the design and evaluation of orodispersible tablets (ODTs) of memantine hydrochloride using both synthetic and natural super disintegrants to enhance patient compliance, particularly in geriatric patients with swallowing difficulties. Formulations were developed by direct compression employing sodium starch glycolate, croscarmellose sodium and *Plantago ovata* mucilage at varying concentrations.

Pre-compression parameters indicated good flow properties and compressibility of all powder blends, making them suitable for direct compression. Post-compression evaluation confirmed that all formulations met pharmacopeial requirements for hardness, friability, weight variation and drug content uniformity. Among the formulations, those containing higher concentrations of super disintegrants exhibited improved wetting, water absorption and faster disintegration.

The optimized formulation (MM3), containing 2% *Plantago ovata* mucilage, demonstrated superior performance with rapid disintegration time, reduced wetting time and enhanced water absorption capacity. *In vitro* drug release studies revealed that all formulations achieved more than 90% drug release within 30 minutes, with MM3 showing the highest release profile. Comparative dissolution analysis with the marketed formulation confirmed similarity, as indicated by acceptable f1 and f2 values.

5. Conclusion

The present study achieved the successful formulation of orodispersible tablets of memantine hydrochloride using both synthetic and natural super disintegrants. Comparative evaluation of the formulations demonstrated that *Plantago ovata* mucilage exhibited superior performance in terms of key parameters, including disintegration time, wetting time, water absorption ratio and *in vitro* drug release. The optimized formulation (MM3), containing 2% *Plantago ovata* mucilage, showed rapid disintegration and enhanced dissolution characteristics. Furthermore, its dissolution profile was found to be comparable to that of the marketed formulation, as indicated by acceptable f1 and f2 values. These findings establish *Plantago ovata* mucilage as an effective natural super disintegrant for the development of orodispersible tablets.

6. Conflict of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

7. References

1. Breijyeh Z, Karaman R. Comprehensive review on Alzheimer's disease: causes and treatment strategies. Molecules, 2020; 25(24): 5789.
2. Yiannopoulou KG, Papageorgiou SG. Current and future treatments for Alzheimer's disease. Ther Adv Neurol Disord, 2020;13: 1-14.
3. McShane R, Westby MJ, Roberts E, et al. Memantine for dementia. Cochrane Database Syst Rev, 2021;3: 003154.
4. Kumar A, Singh A. Pharmacological overview of memantine in Alzheimer's disease. J Clin Pharm Ther, 2021;46(5): 1223-1230.
5. Maitra A, et al. Biomedical Engineering: Materials, Technology and Applications. Weinheim, Germany: Wiley-VCH, 2022.
6. Goel H, Rai P. Recent advances in orodispersible tablets. Saudi Pharm J, 2021;29(5): 441-450.
7. Zhang Y, et al. Orodispersible tablet formulation technologies. Drug Dev Ind Pharm, 2022;48(4): 567-578.
8. Bhowmik D, Chiranjib B, Pankaj K, et al. Fast dissolving tablets: overview and future prospects. J Chem Pharm Res, 2020;12(3): 1-10.
9. Deshmukh VN, Jadhav JK. Evaluation of wetting time in orodispersible tablets. Int J Pharm Sci Rev Res, 2021;68(2): 45-52.
10. Shah RB, Tawakkul MA. Pharmaceutical excipients overview. Pharm Dev Technol, 2020.

11. Lavrador P, et al. Biomolecule-Responsive Hydrogels in Medicine. Advanced Healthcare Materials. 2017: 6:1-35.
12. Singh J, et al. Role of super disintegrants in tablet formulation. J Appl Pharm Sci, 2021;11(6): 001-010.
13. Singh SK, et al. Mechanisms of tablet disintegration. Pharm Dev Technol, 2021.
14. Sharma P, Verma A. Correlation between wetting time and disintegration. Asian J Pharm Sci, 2022;17(1): 89-96.
15. Sharma N, et al. Natural super disintegrants in drug delivery systems. Int J Biol Macromol, 2022; 210: 552-565.
16. Bhusnure OG, et al. Natural polymers as pharmaceutical excipients. Int J Pharm Sci Res, 2022;13(5): 2001-2010.
17. Mandal A, et al. Overview on Natural Hydrophilic Polysaccharide Polymers in Drug Delivery. Polymers for Advanced Technologies, 2018;29: 2564-2573.
18. Pawar HA, et al. Applications of mucilage in pharmaceuticals. Carbohydr Polym, 2021;251: 117090.
19. Abbas S, Sherazi M, Khan A, et al. Investigation of *Plantago ovata* husk as pharmaceutical excipient for orodispersible tablets. J Pharm Res Int, 2021;2021: 5538075.
20. Jyothi S, Madhu R. Exploring the use of *Plantago ovata* mucilage as a natural disintegrant in fast dissolving tablets. Accent J Econ Ecol Eng, 2023;5(3): 152-155.
21. Kumar R, et al. Comparative study of natural and synthetic superdisintegrants. J Drug Deliv Ther, 2022;12(2): 102381.
22. Sharma D, Singh R. Analytical method validation in pharmaceuticals. J Pharm Biomed Anal, 2021;196: 113897.
23. Verma RK, Garg S. Development of calibration curves in drug analysis. Drug Dev Ind Pharm, 2020.
24. Silverstein RM, Webster FX. Spectrometric Identification of Organic Compounds. Wiley, 2020.
25. Kulkarni GT, Gowthamarajan K. Powder flow properties in pharmaceutics. Pharmaceutics, 2021;13(3): 350.
26. Aulton ME, Taylor KM. Aulton's Pharmaceutics: The Design and Manufacture of Medicines. 5th ed. Elsevier, 2021.
27. Khan GM. Evaluation of tablet dosage forms. J Pharm Sci, 2020;109(6): 2050-2060.
28. United States Pharmacopoeia (USP 43–NF 38). Tablet evaluation tests. USP, 2020.
29. British Pharmacopoeia. BP 2021. London: TSO, 2021.
30. Deshmukh VN, Jadhav JK. Evaluation of wetting time in orodispersible tablets. Int J Pharm Sci Rev Res, 2021;68(2): 45-52.
31. Patel DM, Shah SR. Role of water absorption ratio in tablet disintegration. Int J Pharm Investig, 2021;11(2): 123-130.
32. Indian Pharmacopoeia. IP 2022. Ghaziabad: IPC, 2022.
33. Kulkarni U, Patil BS. Evaluation of natural super disintegrants for tablet formulations. Int J Pharm Sci Res, 2020;11(5): 2345-2352.
34. Gohel MC, et al. Dissolution studies of oral dosage forms. AAPS Pharm Sci Tech, 2020.
35. Costa P, Sousa Lobo JM. Modelling and comparison of dissolution profiles. Eur J Pharm Sci, 2021;13(2): 123-133.
36. Shah VP, et al. Dissolution profile comparison using similarity factor (f2). AAPS J, 2020.
37. Amin AH, El Sheikh R, Abdel Fattah GM, et al. Spectrophotometric methods for the quantitative determination of memantine hydrochloride. Int J Appl Pharm, 2022;14(2): 206-214.
38. Patil BS, Kulkarni U. Drug-excipient compatibility studies using FTIR and DSC in solid dosage forms. Int J Pharm Sci Res, 2015;6(3): 1030-1036.
39. Aulton ME, Taylor KM. Aulton's Pharmaceutics: The Design and Manufacture of Medicines. 5th ed. Elsevier, 2018.
40. Ghogari IS, Jain PS. Development of orally disintegrating tablets of memantine hydrochloride a remedy for Alzheimer's disease. Int J Appl Pharm, 2020;12(1): 147-152
41. Ashooriyan P, Mohammadi M, Darzi GN, et al. Development of *Plantago ovata* mucilage-based systems and evaluation of physicochemical properties. Int J Biol Macromol, 2023;248: 125938.
42. Awandekar NB, Tekade R, Dhawas S, et al. Formulation and evaluation of fast dissolving tablets using *Plantago ovata* as natural superdisintegrant. Res J Pharm Technol, 2022;15(2): 633-638.
43. Péterfi O, Kovács B, Casian T, et al. Comparison of surrogate models in tablet dissolution prediction: addressing limitations of f2. AAPS J, 2025;27: 118.