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Formulation and *in-vitro* Assessment Study of Oro-Dispersible Metoprolol Tartrate Tablet Using Different Super Disintegrating Agents

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Abstract

Metoprolol tartrate serves as a primary treatment option for hypertension, along with angina and heart failure, because it belongs to the β-blocker class of drugs. Researchers have developed Oral Disintegrating Tablets (ODT) to avoid patient non-compliance and dysphagia, especially for elderly and pediatric patients. The unique form of ODT enables patients to administer medications easily and achieve better therapeutic outcomes. A research study developed metoprolol tartrate ODT supported by three superdisintegrant agents, which included Croscarmellose Sodium (CCS), Sodium Starch Glycolate (SSG), and Crospovidone (CP), with the main purpose of enhancing drug release and disintegration performance. A direct compression method is used to formulate ODT to evaluate different superdisintegrant ratios and their influence on tablet characteristics alongside disintegration durations. The pre-compression studies of this powder blend measured bulk density and tapped density, together with compressibility index an angle of repose and Hausner's ratio to evaluate proper flowability and compressibility characteristics. Fourier Transform Infrared Spectroscopy (FTIR) analysis proved that metoprolol tartrate showed no chemical reactions with the superdisintegrants while demonstrating their ability to work together successfully. Post-compression studies examined weight variation, hardness, friability, drug content uniformity, wetting time, and *in vitro* disintegration time, together with dissolution efficiency. The *in vitro* disintegration study confirmed that tablets dissolved rapidly within seconds and exhibited efficient drug substance release. The most optimal formulation, F5, has shown 99.8% of the drug release within 8 minutes, thus considered as the best formulation for metoprolol therapeutic delivery. The optimised formulation demonstrates an effective solution for conventional solid dosage forms by achieving consistent drug delivery for cardiovascular disease management.

Major Findings: The study successfully developed an Oral Disintegrating Tablet (ODT) of Metoprolol Tartrate using three key superdisintegrants: Croscarmellose Sodium, Sodium Starch Glycolate, and Crospovidone. These agents played a vital role in enhancing tablet disintegration and accelerating drug release. The optimized formulation (F5) showed excellent flow properties, uniformity, and rapid disintegration, releasing 99.8% of the drug within just 8 minutes. This formulation offers a patient-friendly solution, particularly beneficial for elderly and pediatric patients with swallowing difficulties, and supports improved adherence in cardiovascular therapy.

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1. Introduction

Hypertension, along with cardiovascular disorders, represents a long-term medical conditions that comprise a major global health challenge[1-4]. Heart disease stands as one of the main risk factors, which includes cardiovascular conditions, since high blood pressure serves as a frequent cause. The World Health Organisation (WHO) reports that hypertension affects 1.28 billion adults between the ages of 30 and 79 years old[5-7]. The development of hypertension stems from multiple genetic together with environmental along physiological elements. Three main mechanisms of hypertension development consist of elevated vascular resistance with excessive renin Angiotensin Aldosterone System (RAAS) activation and hyperactive sympathetic nervous system functioning[8-11]. Heart structures, together with blood vessels, experience functional and structural modifications because of persistent high blood pressure, such as arterial stiffness alongside left ventricular hypertrophy and endothelial dysfunction.

Modern pharmaceutical research makes drug delivery systems that maintain drug safety alongside stability and a patient-friendly design, its main target. The pharmaceutical sector created ODT for medical administration since it provides a convenient solution that remains quick to dissolve and improves treatment adherence. The easily disintegrating quality benefits pediatric, geriatric, and immobile patients because they cannot swallow traditional tablets or capsules. ODT are pharmacological formulations that are solid and intended to improve the rate at which drugs dissolve and disintegrate[12]. These tablets must have properties like high porosity, low density, and low hardness to dissolve quickly. This dose form is especially intended for people who have difficulty swallowing, therefore, it is appropriate for patients with dysphagia problems. When this tablet comes into contact with the tongue, it dissolves rapidly, releasing the drug, which then dissolves or diffuses in saliva[13]. Several formulations were originally developed in various dosage forms and transformed into Orally Disintegrating Tablets (ODT) due to the benefits offered by this type of formulation. Orodispersible tablets, quick-dissolving tablets, oral dissolving pills, fast disintegrating tablets, fast-dissolving tablets, and rapid dissolving tablets are some of the many additional names for ODT. The United States Pharmacopoeia (USP) has officially acknowledged and accepted the phrase "oral disintegrating tablets," or ODT. ODT are defined as solid dosage forms with active chemicals or pharmaceutical compounds that dissolve quickly, typically in a couple of seconds. They are approved by the Food and Drug Administration (FDA) of the United States. Pharmacological preparations that prioritise the patient's demands are visually appealing; such as tablets that rapidly dissolve in saliva[14]. Saliva facilitates the dissolved substance's easy passage down the oesophagus, making it easy to swallow and chew for even people who have swallowing difficulties[15,16]. The special advantages of oral disintegrating tablets, which include[17,18], patient compliance; enhanced bioavailability; rapid onset of action; avoidance of pain; water-free consumption; pregastric absorption; versatility; and cost-effectiveness, are combined with the advantages of both liquid and solid dosage forms[19-21]. The main benefit of ODT is pre-gastric absorption, which prevents the medicines from going through hepatic first-pass metabolism[22]. To create ODT tablets, several techniques are used, including mass extrusion, compaction, lyophilisation, moulding, cotton candy method, spray drying, and other proprietary technologies. Tablet disintegration is aided by the generation of localised tension caused by capillary air expansion in disintegrants with exothermic characteristics that get moist. Nevertheless, this hypothesis is restricted to a small number of disintegrants and is unable to explain the behaviour of the majority of disintegrating agents used today.

A beta-blocker called metoprolol is used in the treatment of angina (chest pain) and high blood pressure. To increase survival following an acute heart attack, it is also employed. Blood pressure reduction can help prevent kidney problems, heart attacks, and strokes. This drug works by stopping your body's natural hormones, such as adrenaline, from affecting your blood vessels and heart. The heart's stress, blood pressure, as well as heart rate all decrease as a result. This drug may also be employed in treating tremors, heart failure, irregular heartbeats, or migraine headache prophylaxis. In summary, formulating Metoprolol as an oral disintegration tablet holds significant clinical and practical significance. It addresses common challenges connected to pharmaceutical adherence,

particularly for patients with difficulty swallowing, and ensures rapid drug delivery, making it a valuable option in various clinical scenarios.

Patient-friendly drug delivery systems have become essential because recent pharmaceutical technology innovations focus on serving people with dysphagia who cannot take conventional tablets. Rapid disintegration combined with better patient compliance makes ODT an effective drug delivery system. The β-blocker metoprolol tartrate needs an optimised formulation which would improve both its drug onset speed and therapeutic effectiveness because it serves patients with hypertension and cardiovascular disorders. The rapid dissolving behaviour of tablets and medication release depends significantly on three superdisintegrants, which are Croscarmellose Sodium (CCS), Sodium Starch Glycolate (SSG), and Crospovidone (CP). The evaluation of how these superdisintegrants perform relative to one another within ODT formulations represents a major research interest. A few studies analysed the tablet performance changes from superdisintegrants, but the full systematic assessment of their effects on metoprolol tartrate ODT remains insufficient. The research gap regarding ODT of metoprolol tartrate will be filled by this study, which evaluates different superdisintegrants in their formulation development process. The determination of optimal formulation depends on assessments before compression and after compression, which include measurement of disintegration time and in vitro dissolution results. Research findings from this work will advance the development of a therapeutic ODT formulation with increased bioavailability for patient use. The findings of this study focused on the potential of ODT as an effective platform for metoprolol tartrate administration, offering improved patient adherence, rapid disintegration, and enhanced bioavailability.

2. Experimental

2.1 Materials

Several substances of analytical grade were acquired from Nice Laboratory in India: metoprolol tartrate, CS, CP, and SSG. Analytical research-grade microcrystalline cellulose, mannitol, magnesium stearate, talc, and camphor were acquired from Sigma Aldrich and utilised exactly as supplied. The other excipients were utilised exactly as received and were of the analytical research grade.

2.2 Preformulation Study

2.2.1 Bulk Density

The mass-to-volume ratio of an untapped powder sample is called bulk density. The unit of measurement for bulk density is g/ml. The bulk density is determined by the density and particle arrangement of the powder. The bulk density affects how the sample is prepared and stored[23]. The following mathematical depiction is mentioned below.

$$Bulk\,density = \frac{Weight\ of\ the\ drug}{bulk\ volume}$$

2.2.2 Tapped Density

When a bulk powder is tapped mechanically in a graduated cylinder, a volume difference is noticed. Here, the tapped density is computed by dividing the mass by the powder's ultimate volume [24].

$$Tapped\,density = \frac{Weight\ of\ the\ gblends}{Tapped\ volume}$$

2.2.3 Angle of Repose

It provides a sense of how easily a powder or bulk material would flow[25]. The flowability of powders is influenced by several factors, including surface area, shape, size distribution, and particle size. The powder's flowability varies depending on the surroundings and is readily adjustable. The following formula was used to get the angle of repose.

$$\grave{e} = \tan^{-1}\frac{h}{r}$$

Where
θ = is the angle of repose
h = is the produced cone's height
r = is the circular base's radius on the produced cone

2.2.4 Compressibility Index (or) Carr's Index (I)

It is among the most crucial parameters for describing the characteristics of granules and powders. One significant metric that may be derived from both tapped and bulk densities is compressibility[26]. It is computed using the following formula and given as a percentage.

$$Carr's\ index(\%) = \frac{Tapped\ density - Bulk\ density}{Tapped\ density} \times 100$$

2.2.5 Hausner's Ratio

Determining the powder and granules' flow properties is a crucial characteristic[26]. This can be computed using the formula that follows.

$$Hausner's\ ratio = \frac{Tapped\ density}{Bulk\ density}$$

A value of 1.25 or less denotes poor flow, whereas a value of 1.25 or above denotes good flow.

2.2.6 Drug-Polymer Interaction Studies by FTIR

There are two methods to work with infrared radiation: either the radiation passes through the sample, or it is absorbed by it. This characterisation is quite beneficial for numerous sample analyses. The material was examined in the wave number range of 4000-400 cm^{-1} using FTIR analysis. Pallets of KBr were prepared for FTIR analysis. After adding KBr to the sample, the pallet was produced and ready for FTIR evaluation. FT-IR analysis is a useful tool for identifying unknown compounds and assessing the sample's quality and compatibility in a mixture[27]. FTIR absorption spectra of pure drug, superdisintegrants, and their mixing were taken to confirm the identity and interaction of the drug with the excipients.

2.3 Formulation of Metoprolol Tartrate ODT

The tablet production involved a direct compression approach[28] with several superdisintegrant combinations. (Table 1). To generate a uniform mixture, the components of the various combinations were precisely weighed and combined in a mortar and pestle. After that, the mixture was run through a 60µm mesh. For compression, a hydraulic press with a flat-faced punch with a 9mm diameter was operated at 15 psig. The buccal ODT tablets were developed with the individual and various compositions of CS, CP, and SSG superdisintegrants, as indicated in Table 1. Consideration has been given to the effect of individual superdisintegrants and their compositions at various ratios when studying the percentage of drug release.

2.4 Evaluation Study of Metoprolol Tartrate ODT

2.4.1 Weight Variation Test

Twenty pills from every formulation were selected at random and weighed on a digital weighing balance (Shimadzu AUY 220, Uni Bloc, Germany) individually. Mean values were calculated together with average weights. Approximately 5% deviation is the maximum allowed by the Indian Pharmacopoeia (IP).

2.4.2 Tablet Thickness Test

Using Vernier callipers, the thickness of 20 randomly chosen tablets from each formulation is measured to assess the consistency and physical dimensions of the tablet.

2.4.3 Hardness Test

A Monsanto hardness tester was used to measure the tablets' hardness. One of the key elements that plays a big part in transportation is hardness. Using a Monsanto hardness tester, the ten tablets' levels of hardness were determined. It is stated as kg/cm^2.

2.4.4 Tablet Friability

Using a Roche friabilator, the tablets' friability was examined. Twenty tablets each from the different

Table 1. Formulation of metoprolol tartrate containing ODT

Batch No.	Drug (mg)	CS (mg)	CP (mg)	SSG (mg)	Lactose (mg)	MS (mg)	Aspartame (mg)	Total Weight (mg)
F1	25	30	-	-	50	5	10	120
F2	25		30	-	50	5	10	120
F3	25			30	50	5	10	120
F4	25	10	10	10	50	5	10	120
F5	25	20	10	-	50	5	10	120
F6	25	-	20	10	50	5	10	120
F7	25	5	5	20	50	5	10	120

formulations have been chosen for this test. Each medicine was precisely weighted and spun for 4 minutes at 25rpm in the plastic friabilator chamber, dusted, and then weighed once more. As per IP, the percentage loss was computed. Less than 1% is anticipated.

The formula listed below was used to calculate the friability.

$$\% \, loss = \frac{Initial \; wt.of \; tablets - Final \; wt.of \; tablets}{Initial \; wt.of \; tablets} \times 100$$

2.4.5 Drug Content Uniformity

Twenty tablets were broken up into a powder, and then the powder was weighed, added to a volumetric flask, and dissolved in 100 millilitres of pH 6.8 to get the amount corresponding to the formulation's average weight. After that, 1ml of the solution was extracted using Whatman filter paper to filter the mixture. An Ultraviolet (UV) spectrophotometer (Jasco V-670, Japan) was then used to quantify the drug concentration at 223nm using a suitable dilution of metoprolol tartrate.

2.4.6 Surface pH for ODT

Studies on surface pH were done to look for any irritation or adverse effects. This must be because of the pH, which can be either acidic or alkaline and irritate the buccal mucosa.

2.4.7 In-vitro Dissolution Study

To determine the percentage of drug release from the buccal cavity at regular intervals, the USP type II dissolving device was utilised. Phosphate buffer (6.8) in 900 millilitres makes up the dissolving media. The temperature was kept at 37 ± 0.5°C with 50 revolutions per minute as the goal. Dissolution was done, and at regular intervals, 5ml of the sample was pipetted and replaced in the basket with an equal volume of fresh buffer media. The obtained samples were examined at 223nm using an appropriate dilution in a UV Spectrophotometer. The pH 6.8 phosphate buffer was selected as a blank to measure absorbance.

3. Results

3.1 Pre-Formulation Study (Formulation F1-F7)

The size and composition of the compound are the primary determinants of bulk density and tapped density. A compound's characteristics can change as a result of formulation, milling, or crystallisation. Additionally, it offers accurate information on the final dose form's size. Table 2 reports the metoprolol tartrate pre-compression data. The formulations' bulk densities ranged from 0.55 to 0.37 gm/ml, their tapped densities from 0.64 to 0.43 gm/ml, their angles of repose from 24.01 to 30.21, their Carr's indices from 13.53 to 15.83, and their Hauser's ratio values from 1.15 to 1.18. Results were obtained with precision, and good flow characteristics were noted.

3.1.1 FTIR Study

A non-invasive and non-destructive technique called FTIR is used to look at how a medicine interacts with polymers. FTIR can also pick up electrostatic, hydrogen bonds and van der Waals interactions between the drug and the polymer. These interactions may have an impact on the mechanical and thermal characteristics of the polymer in addition to the stability, solubility, and bioavailability of the medication. The FTIR spectrum of individual superdisintegrants (CS, CP, and SSG), drug (Metoprolol tartrate), and their compositions are shown in Figures 1 to 7. Obtained spectra of mupirocin confirm that the peak position and intensity of the peaks don't alter due to the addition of superdisintegrants in different formulations.

Table 2. Preformulation study for metoprolol tartrate Formulation F1-F7

Pre-Compression Parameters	F1	F2	F3	F4	F5	F6	F7
Bulk Density	0.55±0.01	0.45±0.08	0.41±0.11	0.38±1.02	0.37±0.07	0.39±1.24	0.42±0.29
Tapped Density	0.64±0.73	0.53±1.52	0.49±0.91	0.44±1.72	0.43±0.83	0.45±0.51	0.49±0.31
Angle of Repose	27.21±0.1	24.01±0.72	29.8±0.09	25.32±0.11	27.09±0.84	24.01±0.02	30.21±0.05
Carr's Index	14.4±0.76	14.54±0.03	15.83±1.99	13.84±1.09	13.53±1.71	14.84±0.04	13.67±0.02
Hausner's Ratio	1.16±0.06	1.17±0.01	1.18±0.02	1.16±0.01	1.15±0.03	1.17±0.02	1.15±0.03

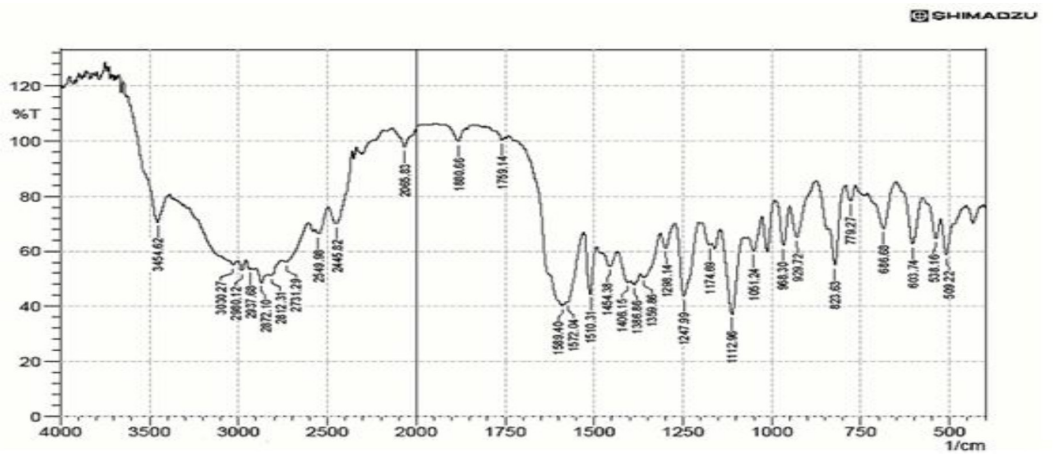


Figure 1. FTIR spectra of metoprolol tartrate.

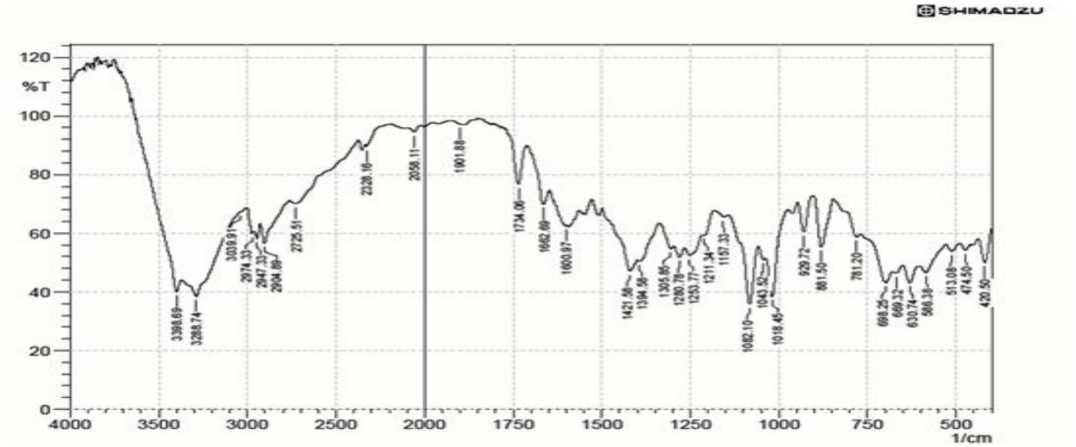


Figure 2. FTIR spectra of croscarmellose sodium.

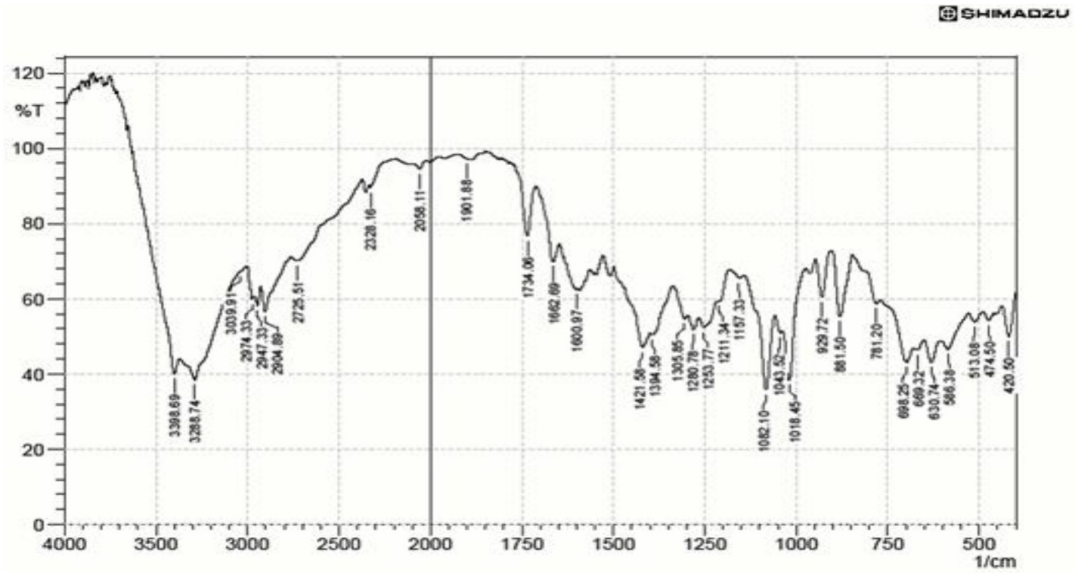


Figure 3. FTIR spectra of crospovidone.

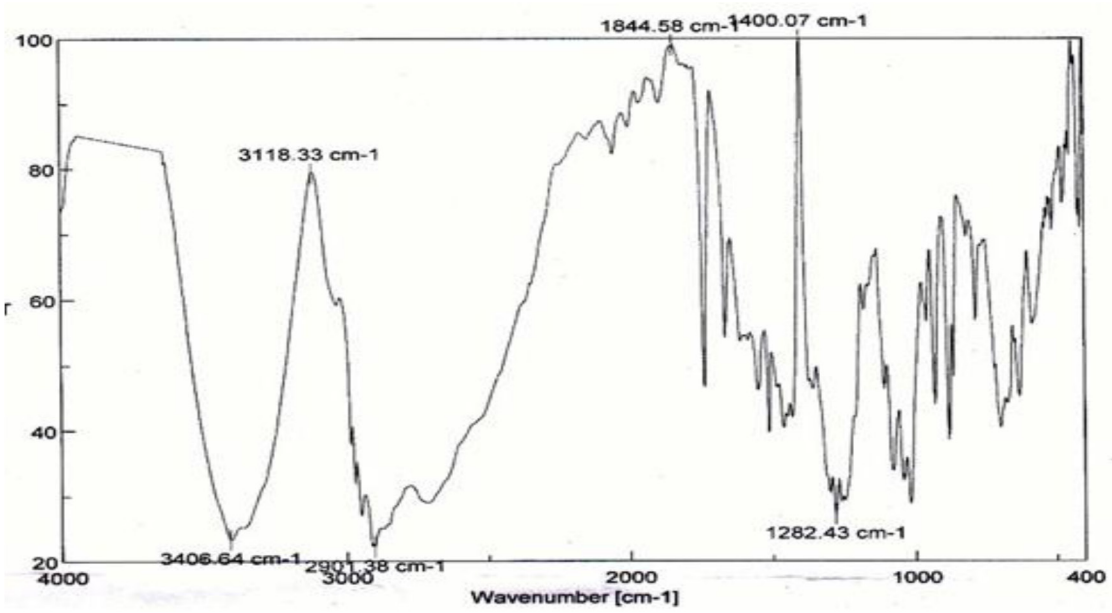


Figure 4. FTIR spectra of sodium starch glycolate.

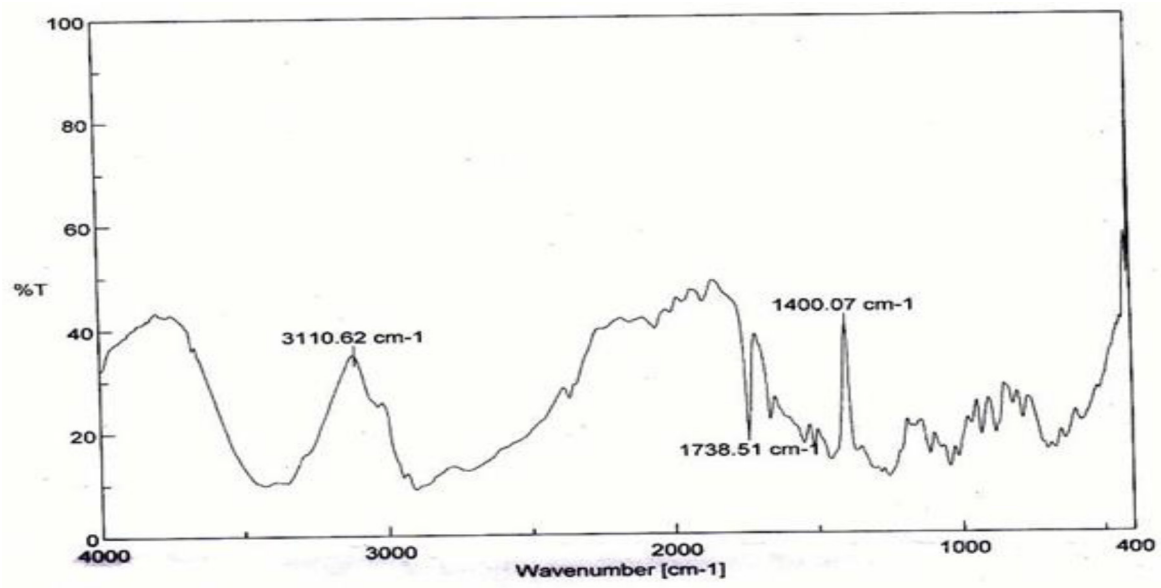


Figure 5. FTIR spectra of metoprolol tartrate and croscarmellose sodium.

Metoprolol tartrate shows major peaks at 3454.95,3010.88 cm^{-1} corresponding to OH- stretching 2870.08 cm^{-1}, CH-stretching 1697.35, 1465.90 cm^{-1} belong to C=C. Croscarmellose sodium spectra appear at 3420.41,3129.62 cm^{-1}, corresponding to OH-stretching 2941.32,2581.60 cm^{-1}, CH-stretching 1711.61 cm^{-1} belongs to C=O stretching 1417.21 cm^{-1} for C=C stretching. Crospovidone shows major peaks at 3398.21cm^{-1} corresponding to OH, stretching 2936.82 cm^{-1} CH-stretching, 1645.29 cm^{-1} belongs to C=C 1466.20,1367.08 cm^{-1} belong to CH_2, CH_3 stretching. Sodium starch glycolate spectra appear at 3450.71 cm^{-1} corresponding to NH-stretching 2956.02 cm^{-1} CH_3-stretching 1634.32 cm^{-1} belongs to C=C stretching 1491.70,1372.01 cm^{-1} for CH_2, CH_3 stretching. Metoprolol tartrate and croscarmellose sodium show spectra at 3110.62 cm^{-1} corresponding to OH stretching, 2920.51 cm^{-1}, CH stretching, 1629.73 cm^{-1} belongs to C=C

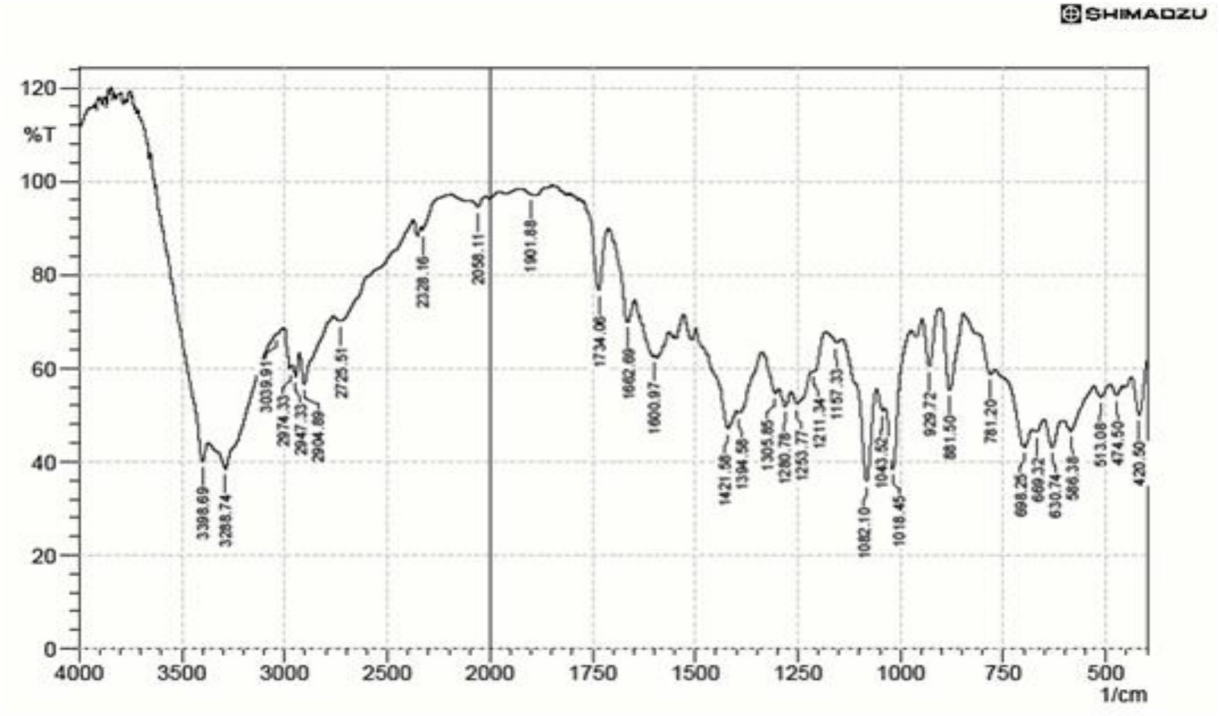


Figure 6. FTIR spectra of metoprolol tartrate and crospovidone.

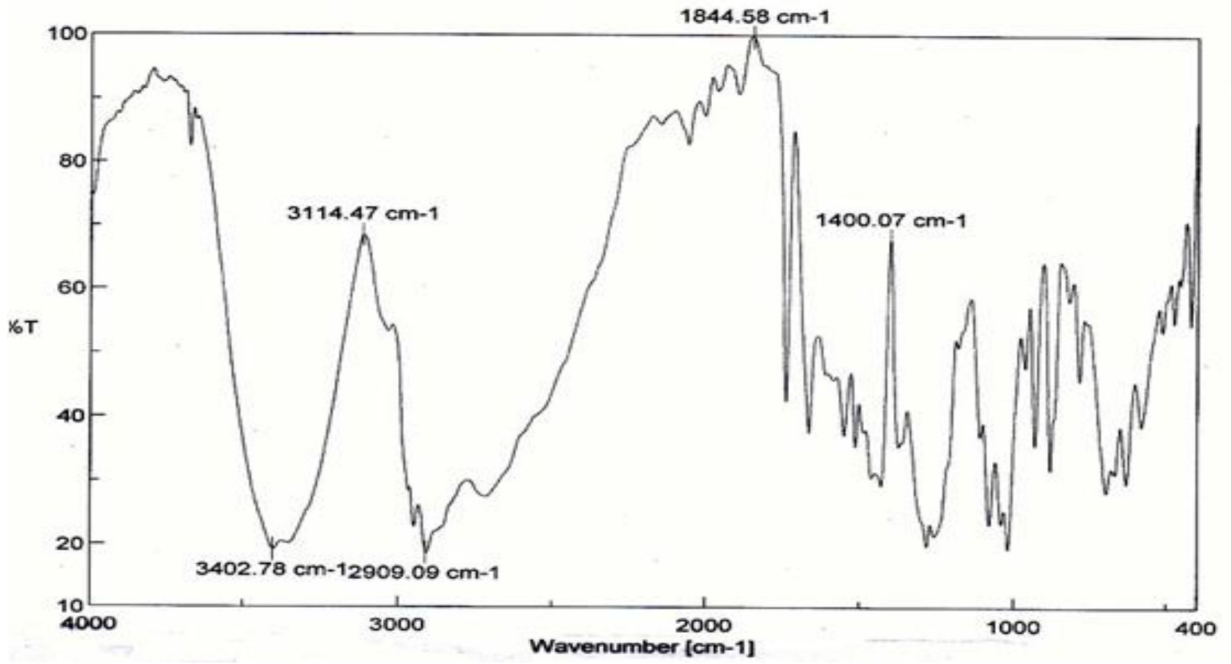


Figure 7. FTIR spectra of metoprolol tartrate and sodium starch glycolate.

stretching, 1321.63 cm^{-1}, for CO stretching. Metoprolol tartrate and crospovidone show spectra at 3461.84 cm^{-1} corresponding to OH-stretching 2978.01, 2924.62 cm^{-1} CH-stretching 1449.32,1377.14 CH_2, CH_3 stretching. Metoprolol tartrate and sodium starch glycolate show spectra at 3543.23 cm^{-1} corresponding to NH stretching, 2970.38, 2929.87, 2883.58 cm^{-1} CH-stretching 1697.36,1573.91 cm^{-1} belong to C=O stretching. FTIR

results with a minor change reveal that the metoprolol tartrate is compatible and has retained its functionality.

3.1.2 Post-Compression Study of Metoprolol Tartrate ODT

The physicochemical features of metoprolol tartrate ODT (Formulation F1-F7) were assessed because they are critical to the drug release pattern. Table 3 presents a comparison of the physicochemical parameters of each formulation. It was discovered that the weight variation ranged between ± 7%. All formulations were determined to have an average weight ranging from 118 and 121 mg. Using a Vernier calliper, the thickness was measured. Tablet swallowing is made easier by several factors, one of which is thickness. The obtained results showed that all metoprolol tartrate ODT formulations showed a uniform thickness within the 2.98–3.93mm range. Both hardness and friability of the produced tablets satisfied regulatory standards; for metoprolol tartrate ODT, friability was less than 1%, and hardness varied from 2.31 to 3.93 kg/cm^2. Comparably, the range of the drug content% % and surface pH for all formulations is between 97 and 99%, and for metoprolol tartrate ODT, it is between 5.71 and 6.31. The disintegration time is 4 to 9 minutes. The results obtained verify that all formulations' evaluation parameters fall within the Indian Pharmacopoeia's limits.

3.1.3 In-vitro Drug Release

The dissolution process was run in triplicate using phosphate buffer, a pH 6.8 diffusion medium. Table 4 and Figure 8 demonstrate that at the end of 20 minutes, the percentage of drug release for all metoprolol tartrate ODT formulations, F1 to F7, ranged from 95% to 99.91%. Every formulation from F1 to F3 has a different super disintegrant. Formulation F1 containing CS has shown better drug release at 97% at 12 min, whereas formulations F2 and F3 show 97% at 16 min and 98% at 20 min, respectively. SSG, as a superdisintegrant, shows delayed drug dissolution properties as compared to CS and CP. Similarly, formulations F4 to F7 contain different concentrations of superdisintegrants at different proportions in each formulation. Formulation F5 was found to be the best formulation, achieving 99.8% drug release within 8 minutes. Formulation F4 and F6 have shown 99% in 14 min and 10 min, respectively. In formulation F7, where SSG concentration is higher as compared to CS and CP has shown a dissolution rate of 100% is shown at 16 min. Dissolution study confirms that formulations with higher concentrations of CS produce better disintegration and dissolution properties.

4. Discussion

Quality assessment of metoprolol tartrate ODT must occur after compression to ensure their effectiveness and rapid medication delivery potential, along with their quality attributes. The physicochemical measurements of formulations F1 to F7 were evaluated due to their direct influence on ODT disintegration and dissolution processes. All formulations demonstrated conformance to Indian Pharmacopoeia (IP) specifications according to weight variation, along with thickness measurements, hardness tests, friability measurements, drug content evaluations and surface pH assessments, while disintegration time results were also within limits as shown in Table 3.

Table 3. Post-evaluation study for metoprolol tartrate ODT formulation F1-F7

Formulation	Tablet Weight Variation (mg)	Tablet Hardness (kg/cm^2)	Tablet Thickness (mm)	Tablet Friability (%)	Drug Content (%)	Surface pH	Disintegration Time in (min)
F1	118.42±2.01	3.71±0.08	2.98±1.06	0.61±0.23	97.31±0.16	6.15±0.01	6
F2	119.14±1.31	2.31±0.05	3.08±0.13	0.53±0.13	98.03±0.54	5.98±0.07	7.5
F3	118.62±1.76	3.57±1.1	3.93±0.37	0.39±0.75	99.63±0.05	6.25±0.81	9
F4	120.08±0.61	3.93±1.52	3.81±1.09	0.68±0.32	98.93±0.76	6.14±0.51	7
F5	118.81±0.31	2.87±1.81	3.78±0.83	0.65±0.62	97.76±0.81	6.21±0.16	4
F6	121.83±1.74	3.73±0.63	3.19± 1.76	0.47±0.13	99.81±0.32	5.71±0.51	5
F7	119.74±1.51	3.06±0.53	3.76±0.53	0.65±0.23	99.11±0.42	6.31±0.04	7

Results are expressed as mean ±SD (n=3)

Table 4. In vitro dissolution study for metoprolol tartrate ODT formulation F1-F7

Formulation	2 min	4 min	6 min	8 min	10 min	12 min	14 min	16 min	18 min	20 min
F1	49.71	64.71	76.22	85.18	90.33	97.19	-	-	-	-
F2	35.12	44.77	53.82	65.12	74.17	82.21	90.87	97.22	-	-
F3	19.45	25.61	34.27	47.71	61.87	71.52	78.22	84.32	90.31	98.21
F4	44.12	56.77	71.82	78.12	86.17	92.21	99.87			-
F5	78.38	83.31	89.91	98.29	-	-	-	-	-	-
F6	57.68	68.35	81.39	93.12	99.91	-	-	-	-	-
F7	42.98	51.37	64.8	77.22	84.53	91.09	96.01	100.01	-	-

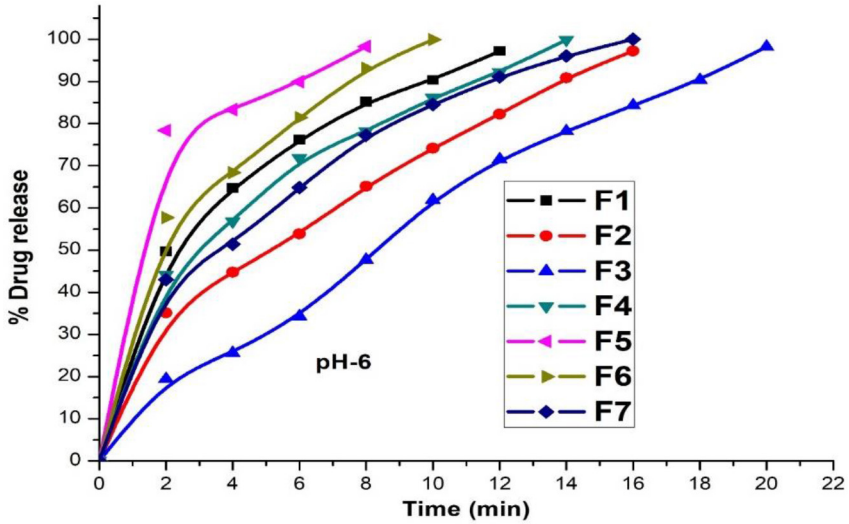


Figure 8. In vitro drug release of metoprolol tartrate ODT (Formulations F1-F7).

The weight variation test showed that tablets maintained a consistent weight range between 118mg to 121mg per unit. The measurements from a Vernier calliper showed that all tablets had consistent thickness levels between 2.98mm and 3.93mm, which simplifies drug administration. The hardness of the tablet for all formulations was demonstrated in the range between 2.31 kg/cm^2 and 3.93 kg/cm^2, but they exhibited quick breakable properties. All the formulations exhibited below 1% effect on friability, indicating an adequate level of mechanical stress tolerance during product handling and transportation. The drug content in the formulations ranged between 97% and 99%, ensuring uniformity of dose distribution. The surface pH levels of ODT ranged from 5.71–6.31, which matches the oral cavity pH, creating safe conditions for patients. Each formulation disintegrated within a time frame ranging from 4 to 9 minutes, which fulfilled all the requirements for ODT.

All formulations (F1–F7) released their therapeutic components between 95% and 99.91% when tested with phosphate buffer (pH 6.8) as the dissolution medium within 20 minutes. The drug release profile of F1 with croscarmellose sodium released 97% of its content within 12 minutes, whereas F2 with sodium starch glycolate released 97% of its drugs at 16 minutes. But F3 with crospovidone reached 98% drug delivery at 20 minutes. The delayed drug release process observed for sodium starch glycolate matches its ability to absorb water and swell because of its characteristics. Superdisintegrants were added to the formulations F4 to F7 at different concentrations and combination levels. An optimised drug release efficiency of 99.8% occurred within 8 minutes from formulation F5, including the optimised concentration of croscarmellose sodium. The drug release reached 99% after 14 minutes for F4 and 10 minutes for F6. The drug dissolution rate of 100% was established at 16 minutes by Formulation F7

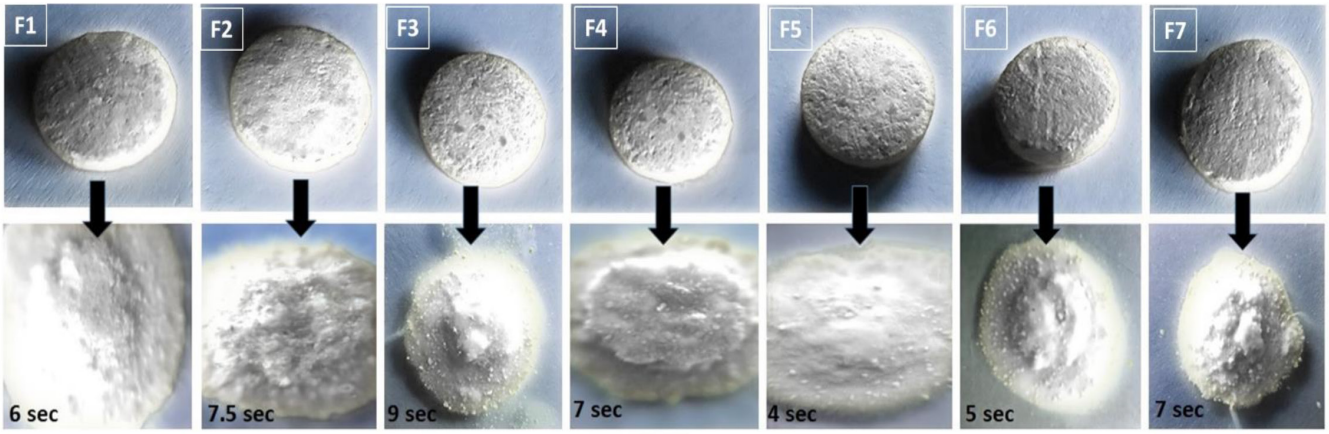


Figure 9. Images show the *in-vitro* dispersion time for all formulations, where tablets are breaking down.

due to its increased sodium starch glycolate addition beyond croscarmellose sodium and crospovidone levels. The efficacy studies demonstrate that increased croscarmellose sodium concentrations lead to better disintegration functions, together with enhanced dissolution results than sodium starch glycolate and crospovidone formulations.

The variations in drug dissolution performance due to different mechanisms of action exhibited by the superdisintegrants within the formulations are shown in Figure 9. The key features of croscarmellose sodium lead to the quick disintegration of tablets along with faster drug dissolution. The swelling behaviour of Crospovidone leads to quick dispersion when it encounters water without developing a gel structure during this process. Sodium Stärchenglykolate produces slow dissolution rates because its high water absorption capacity results in excessive swelling that creates a viscous gel structure. The results of this research support earlier investigations that examined how various superdisintegrants affect drug release kinetics[29,30].

Selection and concentration levels of superdisintegrants determine how well metoprolol tartrate ODT disintegrate and dissolves according to experimental results. Croscarmellose sodium achieves the best outcome for both fast disintegration speed and optimal drug release performance when applied in high concentrations. Metoprolol tartrate ODT demonstrate the potential to function as patient-friendly formulations that demonstrate quick onset but improved bioavailability, which constitutes them as a suitable replacement for regular solid dosage forms.

5. Conclusions

The study focused on metoprolol tartrate Oral Disintegrating Tablets (ODT) made with superdisintegrants at various concentrations to improve disintegration properties and dissolution release profile for rapid drug availability. The individual superdisintegrants CS, SSG, and CP were added at different concentrations to ODT to understand their influence on tablet operation. The FTIR analysis validated the compatibility of metoprolol tartrate with all chosen superdisintegrants because no interactions were detected. The formulated tablets were subjected to pre-compression and post-compression evaluations, with all parameters meeting the standards set by the Indian Pharmacopoeia (IP). F5 demonstrated the optimal formulation characteristics because it showed fast disintegration while releasing 98% of the drug content after 8 minutes. The obtained results confirm that croscarmellose sodium produced superior disintegration and dissolution effects on tablets when used at higher concentrations, when compared to both crospovidone and sodium starch glycolate. Dissolution studies proved that formulations containing two superdisintegrants beat those that used individual superdisintegrants in terms of dissolution efficiency. Data reveals that ODT can be a successful replacement for commercially available solid dosage forms because they produce fast drug onset and higher patient compliance for patients who struggle with swallowing. The obtained results validate the superdisintegrant formulation approach for creating effective metoprolol tartrate ODT and demonstrate F5 as the most promising candidate for medical use.

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