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**Research Article**

# Formulation Development And Evaluation Of Mentha Spicata Leaf Powder Orodispersible Tablet

**Pratiksha Jagtap[1], Vaibhav Changediya[2]**

*[1]Dr. Vedprakash Patil Pharmacy College, Gevrai Tanda, Paithan Rd, Aurangabad, Maharashtra (INDIA)- 431 002*
*[2]Dr. Babasaheb Ambedkar Technological University Lonere, Raigad-402 103.*

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## ABSTRACT

This research was focuses on the formulation development and evaluation of Oro-dispersible tablets (ODTs) containing Mentha spicata leaf powder, aiming to explore its potential as a novel herbal formulation for oral administration. Mentha spicata, commonly known as spearmint, possesses various pharmacological properties, including antimicrobial, antioxidant, and anti-inflammatory effects, which make it a promising candidate for pharmaceutical applications. The formulation process involves the wet granulation method for Mentha spicata leaf powder tablet. The Tablet was evaluated for its physical, chemical, and mechanical properties, including tablet hardness, friability, disintegration time, and drug content uniformity. In vitro dissolution studies are conducted to investigate the release profile of bioactive constituents from the tablets. The In vitro release of the tablet was found to be in the range of 75.23±0.14% to 99.67±0.23%. Also, the comparative dispersion and disintegration time study of tablet has been carried out and was found to be 07.89±0.04 min and 12.04± 0.02 min respectively. From the stability study it was observed that, optimized formulations F4 were Stable at 40°C / 75%, 8°C in Refrigerator or 60°C in Incubator. The formulated ODTs offer the advantages of convenience, rapid disintegration, and improved patient compliance, making them suitable for various oral administration scenarios, including paediatric, geriatric, and dysphagic patients. Additionally, the potential pharmacological benefits of Mentha spicata make these ODTs promising candidates for the management of oral diseases, respiratory conditions, and other ailments requiring localized drug delivery via the oral mucosa.

## INTRODUCTION

The quest for effective and patient-friendly drug delivery systems has led to the development of

***Corresponding Author:** Pratiksha Jagtap
**Address**: *Dr. Vedprakash Patil Pharmacy College, Gevrai Tanda, Paithan Rd, Aurangabad, Maharashtra (INDIA)- 431 002.*
**Email** : pratikshajagtap36989@gmail.com
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Oro-dispersible tablets (ODTs), which have gained significant attention in recent years. Oro-dispersible tablets are solid dosage forms that disintegrate rapidly in the mouth, providing a convenient and non-invasive means of drug administration. This unique delivery system offers several advantages, including improved patient compliance, especially for paediatric and geriatric populations who may have difficulty swallowing conventional tablets. The fast disintegration and dissolution characteristics of ODTs enhance the bioavailability of the active pharmaceutical ingredient (API), leading to a quicker onset of therapeutic action. Mentha spicata, commonly known as spearmint, is a medicinal herb renowned for its therapeutic properties, including anti-inflammatory, antimicrobial, and antioxidant effects. Its active compounds, such as menthol, have been shown to exert various pharmacological activities, making it a valuable candidate for formulation development. The incorporation of Mentha spicata leaf powder into ODTs not only capitalizes on its therapeutic potential but also introduces flavour-enhancing properties that can improve the palatability of the dosage form, thereby increasing patient acceptance. The formulation of Oro-dispersible tablets requires careful consideration of various excipients and processing parameters to achieve the desired characteristics, such as rapid disintegration time, mechanical strength, and drug release profile. The choice of excipients plays a crucial role in the tablet's performance, including super disintegrants that facilitate rapid disintegration upon contact with saliva. Moreover, the method of preparation, whether through direct compression, wet granulation, or other techniques, significantly influences the physical and chemical properties of the tablets.[1] This study aims to formulate, develop, and evaluate Oro-dispersible tablets containing Mentha spicata leaf powder. The primary objectives include optimizing the formulation parameters to achieve desirable tablet characteristics such as disintegration time, hardness, and drug release profile. In vitro evaluation methods will be employed to assess the tablets' performance, including disintegration and dissolution tests, which will provide insights into the release kinetics of the active compounds.

By exploring the potential of Mentha spicata leaf powder in the context of Oro-dispersible tablets, this research seeks to contribute to the development of effective and user-friendly dosage forms that leverage the therapeutic benefits of natural products. The successful formulation of these tablets could pave the way for novel drug delivery systems that enhance patient compliance and improve therapeutic outcomes.[2]

## MATERIALS AND METHODS:

### MATERIALS:

The materials used in this study included Mentha spicata leaf powder, which was sourced from Vedashri Herbals in Nashik. Various high-quality solvents were utilized in the formulation process, including methanol (MeOH), ethanol (EtOH), and isopropyl alcohol (IPA), all of which were of HPLC grade and procured from Rankem, India. Additionally, magnesium stearate (M.S) and Aerosil, both of extra pure grade, were obtained from Fine Chem and Kemphasol, respectively. Microcrystalline cellulose (MCC) and cross carmellose sodium (CCS), also of extra pure grade, were supplied by Loba Chemie. Furthermore, polyvinylpyrrolidone (PVP) was sourced from Molychem, while sodium starch glycolate (SSG), another excipient of extra pure grade, was also provided by Loba Chemie. These materials were selected to ensure the optimal formulation and evaluation of the orodispersible tablets containing Mentha spicata leaf powder.

### METHODS:

**Mentha spicata leaf powder excipients compatibility studies**

**Fourier Transform Infrared Spectroscopy (FTIR) study**

FTIR spectroscopy was employed to investigate potential interactions between excipients and Mentha spicata leaf powder. The FTIR spectra of the drug and excipients were recorded by compressing 1 mg of the solid sample with 100 mg of dried potassium bromide into a disc. The sample was then scanned for absorbance over the wave number range of 4000 to 400 $cm^{-1}$.[3-4]

**Differential Scanning Colorimetry (DSC) study of Mentha spicata leaf powder**

Differential scanning Colorimetry (DSC) of Mentha spicata leaf powder was obtained in a DSC-50 cell (Shimadzu) using aluminium crucibles with about 2 mg of samples, under dynamic N2 atmosphere (100 ml ×min –1) and heating rate of 10°C ×min –1 in the temperature range from 25 to 250°C. The DSC cell was calibrated with indium (mp 156.6°C; DHfus =28.54 J ×g–1) and zinc (mp 419.6°C). The DSC curve for Piroxicam was analyzed and result was showed in results and discussion part.[5-6]

**UV-Visible maximum wavelength spectrum determination of Mentha spicata leaf powder**

UV-visible spectrophotometric analysis was conducted on the M. spicata leaf powder using a UV-visible spectrophotometer (Lasany) with a slit width of 2nm, using a 10-mm cell at room temperature. The leaf powder (10 mg) were dissolve in methanol (10ml) and was examined under visible and UV light in the wavelength ranging from 300-800nm for proximate analysis. For UV-VIS spectrophotometer analysis, the sample was centrifuged at 3000 rpm for 10 min and filtered through Whatman No. 1 filter paper and analysed.

**Formulation of Oro-Dispersible Tablet of Mentha spicata leaf powder**

The formulation of oro-dispersible tablets containing Mentha spicata leaf powder involved several key steps. First, the required quantities of Mentha spicata leaf powder, dibasic calcium phosphate, starch, and microcrystalline cellulose (pH 101) were accurately weighed and then sieved through mesh #40 to ensure a uniform powder consistency. Next, the weighed excipients were mixed in a Rapid Mixer Granulator (RMG) for 5 minutes to achieve a homogeneous blend. A binder solution was prepared using polyvinylpyrrolidone (PVP K30), starch, and Col Idacol erythrosine supra color in purified water. This binder solution was then added to the dry powder mix in the RMG and blended at high speed for 5-7 minutes to form variable-shaped granules. The granules were dried in a tray dryer for 30 minutes and passed through sieve #18 to create uniform granules. Finally, the dried granules were lubricated with magnesium stearate, cross carmellose sodium, microcrystalline cellulose, saccharin sodium, and Trusil orange flavor. The prepared granules were then compressed to formulate the tablets, which were evaluated for their performance. Details of the different batches of orodispersible tablets containing Mentha spicata leaf powder, along with the various excipients and their concentrations, are provided in the subsequent table 1.[7-9]

**Table 1: Composition of batches of Mentha spicata leaf powder orodispersible tablet**

| Sr.no | Raw Material | F1 | F2 | F3 | F4 | F5 | F6 |
|---|---|---|---|---|---|---|---|
| | | Qty / Tab (mg) | Qty / Tab (mg) | Qty / Tab (mg) | Qty / Tab (mg) | Qty / Tab (mg) | Qty / Tab (mg) |
| 1 | Mentha spicata leaf powder | 100 | 100 | 100 | 100 | 100 | 100 |
| 2 | Lactose | 50 | 40 | 30 | 110 | 130 | 110 |
| 3 | MCC PH 101 | 110 | 130 | 120 | 30 | 40 | 50 |
| 4 | PVP K 30 | 10 | 10 | 10 | 10 | 10 | 10 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 5 | Cross carmellose sodium | 20 | 10 | 30 | 30 | 10 | 20 |
| 6 | Sacharrine Sodium | 6 | 6 | 6 | 6 | 6 | 6 |
| 7 | Magnesium Stearate | 4 | 4 | 4 | 4 | 4 | 4 |
| | **Total (mg)** | **300** | **300** | **300** | **300** | **300** | **300** |

Table continue…

| Sr.no | Raw Material | F7 | F8 | F9 |
|---|---|---|---|---|
| | | Qty / Tab (mg) | Qty / Tab (mg) | Qty / Tab (mg) |
| 1 | Mentha spicata leaf powder | 100 | 100 | 100 |
| 2 | Lactose | 80 | 80 | 100 |
| 3 | MCC PH 101 | 70 | 80 | 60 |
| 4 | PVP K 30 | 20 | 20 | 10 |
| 5 | Cross carmellose sodium | 20 | 10 | 20 |
| 6 | Sacharrine Sodium | 6 | 6 | 6 |
| 7 | Magnesium Stearate | 4 | 4 | 4 |
| | **Total (mg)** | **300** | **300** | **300** |

Six different compositions of Mentha spicata leaf powder Oro dispersible tablet was formulated by varying the concentration of Lactose, MCC PH 101 and Cross Carmellose Sodium (CCS). Effect of Lactose and MCC PH 101 with the binding of PVP k30 was evaluated. The results were summarized in the form of dispersibility and dissolution of the Mentha spicata leaf powder Oro dispersible tablet.

**Evaluation of Mentha spicata leaf powder Oro dispersible tablet**[10-17]

**Pre-formulation Studies**

Pre-formulation testing is an investigation of physical and chemical properties of Leaf powder alone and when combined with excipients. It is the first step in the rational development of dosage form. The granules of leaf powder were prepared by wet granulation method and evaluated for its bulk density, tapped density, angle of repose, carr's index and hausner ratio properties.

**Angle of Repose**

It is defined as the maximum angle that can be obtained between the free standing of a powder heap and the horizontal plane which is given by the equation

$\theta = \tan - 1h/r$

Where,

θ- Angle of repose

h – Height of the pile

r – Radius of the base of the conical pile

**Loss on Drying**

It was done in Electronic loss on Drying [LOD] apparatus [Sartorius, Germany]. Weighed quantity of 1 gram of tablet granules was placed in the pan and the temperature was increased up to 500°C and the loss on drying in percentage was noted.

**Bulk Density, Tapped Density, Hausner Ratio and Carr's Index**

Weighed quantity of granules was taken in a graduated cylinder and the bulk volume (Vb) was measured, and weight of the blend (M) was determined. The measuring cylinder containing known mass of powder blend was tapped for a fixed time and the tapped volume (Vt) occupied in the cylinder and the weight of the blend (M) was measured. From that bulk density, tapped density, Hausner bulk ratio and carr's index were calculated

Bulk Density = M/ Vb

Tapped Density = M/ Vt

Hausner ratio= Tapped Density/Bulk Density

Carr's Index (I)= Bulk Density- Tapped Density/ Bulk density x 100

**Post Compression Studies**

**Thickness and Diameter**

The thickness and diameter of the Mentha spicata leaf powder orodispersible tablet were carried out using vernier calipers (Mitutoyo corps, Japan). Five tablets were used for the above tests from each batch and results were expressed in millimeters.

**Hardness Test**

Tablets require a certain amount of strength or hardness and resistance to Friability to with stand mechanical shocks of handling in manufacture, packing and shipping. The hardness of tablet was measured by Monsanto hardness tester, five tablets from each batch were used for hardness studies and results were expressed in Kg/cm2.

**Weight variation Test**

Twenty Mentha spicata leaf powder orodispersible tablet were selected at random, individually weighed in a single pan electronic balance [Ax, Shimadzu – corporation, Japan] and the average weight was calculated. The uniformity of weight was determined according to I.P. Specification. As per I.P. not more than two of individual weights would deviate from average weight by more than 5% and none deviates by more than twice that percentage.

**Friability Test**

The friability of Mentha spicata leaf powder orodispersible tablet was determined using Roche friabilator. It is expressed in percentage (%). 20 tablets were initially weighed (Winitial) and transferred in to the Friabilator. The Friabilator was operated at 25 rpm for 4 minutes. The tablets are weighed again (Wfinal). The % Friability was then calculated by

F= Initial Weight- Final Weight/ Initial Weight x100

**Wetting Time Determination**

Wetting time is closely related to the inner structure of tablets and to the hydrophilicity of the excipients. A linear relationship exists between wetting time and disintegration time. Thus wetting time is an important step for disintegration process to take place.

**Method**

A piece of tissue paper folded twice was placed in a small Petridish (internal diameter = 6.5cm) containing 6 ml of water. A tablet was placed on the paper and the time for complete wetting of the tablet was measured in seconds. Three trials for each batch were performed and standard deviation was also determined.

**Water Absorption ratio**

A piece of tissue paper folded twice was placed in a small Petridish (internal diameter = 6.5cm) containing 6ml of water. A tablet was placed on the paper and time required for complete wetting was measured. The wetted tablet was then weighed. Water absorption ratio (R) was determined using following equation

R= Weight of tab after water absorption - Weight of tab before water absorption/ Weight of tab after water absorption x 100

**Uniformity of dispersion test**

Two tablets from each batch were separately kept in 100ml water and gently stirred for 2 minutes. The dispersion was passed through 22 mesh. The tablets were considered to pass the test if no residue remained on the screen.

**Drug Content uniformity test**

Powder equivalent to 50 mg of leaf powder was dissolved in Methanol, sufficient dilutions were made. Absorbance of the resulting solution was measured using Double beam spectrophotometer (Lasany). From the absorbance values, amount of drug present in the given tablet was calculated. Procedure was repeated by using four more tablets from the same formulation and the average value of all five tablets were calculated.

**Moisture Uptake Test**

Ten tablets from each formulation were kept in desiccators, over calcium chloride at 37°C for 24 hours. The tablets were then weighed and exposed

to 75% RH, at room temperature for two weeks. Required humidity was achieved by keeping saturated sodium chloride solution at the bottom of the desiccator for three days. One tablet as a control (without superdisintegrants) was kept to assess the moisture uptake due to other excipients. Tablets were weighed and the percentage increase in weight was recorded.[18]

**In-vitro release study**

**1) *In- Vitro* Dispersion Time**

In-vitro dispersion time was measured by dropping a tablet in a measuring cylinder containing 6ml of pH 6.8 (simulated saliva fluid). The time for the tablet to completely disintegrate into fine particles was noted. Three tablets from each batch were randomly selected and *in-vitro* dispersion time was performed.[19]

**2) *In – Vitro* Disintegration Time**

The disintegration time of the tablets was determined as per Indian Pharmacopoeia monograph. The test was carried out using Tablet disintegration apparatus. Six tablets from each batch were placed and one liter of distilled water was used as the disintegration medium. The time required to obtain complete disintegration of all the six tablets was noted.[20]

**3) *In-vitro* dissolution study**

The USP dissolution test apparatus (Electrolab TDT - 08 L Dissolution testers USP) type 2 (paddle) was used for the study. First, 900mL of the purified water was taken in a vessel, and the temperature was maintained at 37 ± 0.5 ◦C. The speed of the paddle was fixed at 50 rpm. Dissolution samples were withdrawn at 5-minute intervals, and content content was determined by measuring the absorbance at 405 nm. Drug concentration was calculated from the standard calibration curve and expressed as cumulative percent drug dissolved. In vitro dissolution study was also performed similarly on a conventional tablet formulation.[21]

**4) Comparative dissolution study of marketed formulation with formulated formulation**

The USP dissolution test apparatus (Electrolab TDT - 08 L Dissolution testers USP) type 2 (paddle) was used for the study. First, 900mL of the purified water was taken in a vessel, and the temperature was maintained at 37 ± 0.5 ◦C. The speed of the paddle was fixed at 50 rpm. For the study marketed sample tablet Lansoprazole orodispersible tablet (Ranbaxy) were taken for dissolution study.Dissolution samples were withdrawn at 5-minute intervals, and content content was determined by measuring the absorbance at 405 nm. Drug concentration was calculated from the standard calibration curve and expressed as cumulative percent drug dissolved. In vitro dissolution study was also performed similarly on a conventional tablet formulation.[22-24]

**Stability Studies**

Stability studies were carried out for the six months of optimized formulation. The samples were packed in an aluminum foil placed in a tightly closed plastic container and kept at 4°C in refrigerator, 40°C / 75% RH in stability chamber and 60°C in Incubator for 3 month according to ICH guidelines. At the interval of 1 month, the tablets were withdrawn and evaluated for Thickness, Diameter, Hardness, Friability, weight variation, content uniformity and disintegration time and dissolution studies.[25]

## RESULTS AND DISCUSSION:

**Mentha spicata leaf powder and excipients compatibility studies**

FTIR spectra of Mentha spicata leaf powder and excipients revealed that functional group frequencies of Mentha spicata leaf powder have been found similar to previously published reports. The IR 3412.08 cm-1 is assigned to-OH stretch Aromatic and IR 2939.52 cm-1 is assigned to C-H Stretch Aliphatic, suggesting that the cubic form of leaf powder. The main characteristic peak of

powder was the Alkene C=C which was appeared
at 1633.39 cm-1.

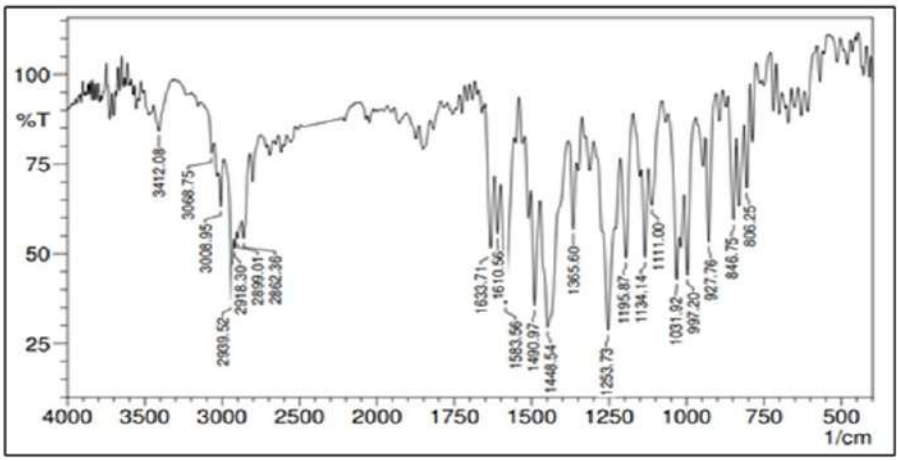


**Figure 1: FTIR Spectra of Mentha spicata leaf powder**

**Table 2: IR absorbance bands of pure Mentha spicata leaf powder**

| Functional Group | Observed frequencies (in $cm^{-1}$) |
|---|---|
| -OH stretch | 3412.08 |
| C-H stretch | 2939.52 |
| Alkene C=C | 1633.39 |
| C=C stretching | 1583.56 |
| C-H bending | 1365.60 |
| C-O stretch | 1253.73 |
| C-O stretch | 1031.32 |

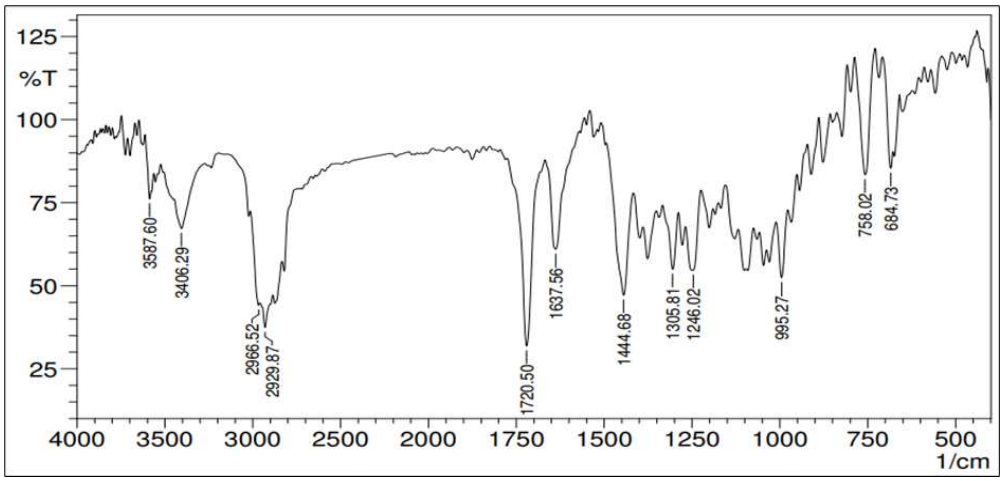


**Figure 2: FTIR Spectra of Mentha spicata leaf powder with Lactose**

**Table 3: IR absorbance bands of pure Mentha spicata leaf powder with Lactose**

| Functional Group | Observed frequencies (in $cm^{-1}$) |
|---|---|
| O-H stretching | 3587.60, 3406.29 |
| C-H stretching | 2966.52,2929.87 |
| C=O stretching (carbonyl) | 1720.50,1637.56 |
| C-O stretching (ether) | 1305.81,1246.02 |
| C-H bending | 1444.68 |

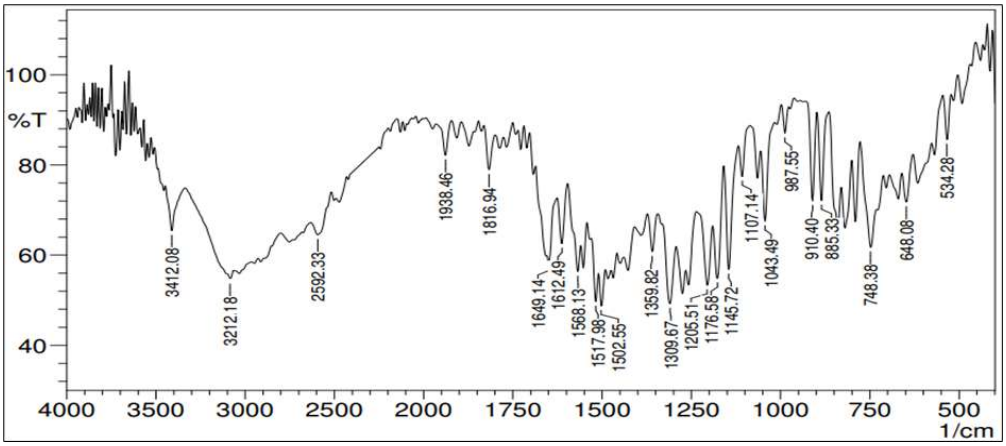


**Figure 3: FTIR Spectra of Mentha spicata leaf powder with MCC PH 101**

**Table 4: IR absorbance bands of pure Mentha spicata leaf powder with MCC PH 101**

| Functional Group | Observed frequencies (in $cm^{-1}$) |
|---|---|
| O-H stretching | 3412.08 |
| C-H stretching | 2592.33 |
| C=O stretching (carbonyl) | 1816.94,1649.14 |
| C-O stretching (ether) | 1309.67,1205.51 |
| C-H bending | 1359.82 |

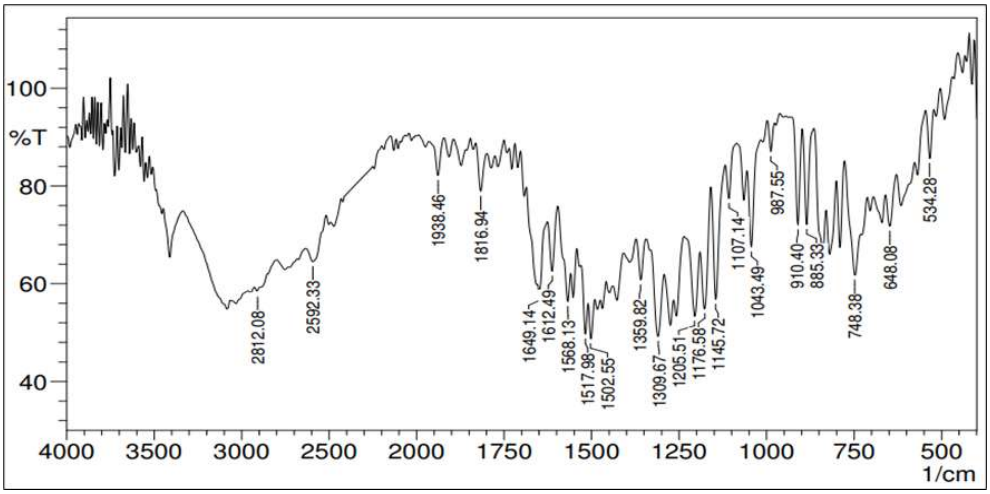


**Figure 4: FTIR Spectra of Mentha spicata leaf powder with PVP K30**

**Table 5: IR absorbance bands of pure Mentha spicata leaf powder with PVP K30**

| Functional Group | Observed frequencies (in $cm^{-1}$) |
|---|---|
| C-H stretching (alkyl) | 2812.08 |
| C=O stretching (amide) | 1649.14 |
| C-H bending (alkyl) | 1359.82 |
| C-N stretching (amide) | 1205.51 |
| C-N-C stretching (pyrrolidone ring) | 987.55, 1043.49 |

**Differential Scanning Colorimetry (DSC) of Mentha spicata leaf powder**

The DSC curve of Mentha spicata leaf powder shows a single endothermic peak corresponding to the melting event of the substance in the range

between 170 – 180°C. The DSC curve of Mentha spicata leaf powder.

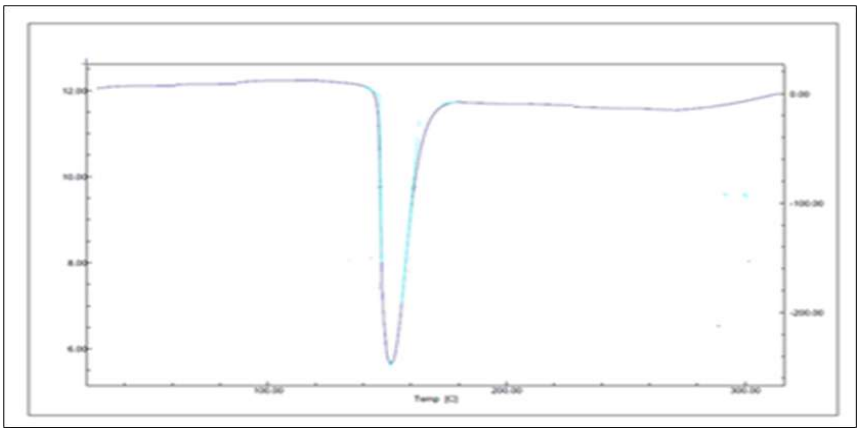

**Figure 5: DSC Thermogram of Mentha spicata leaf powder**

**Preparation of calibration curve of Mentha spicata leaf powder in Methanol**

**Determination of λ max**

The standard solutions of Mentha spicata leaf powder in methanol were scanned between 200-800 nm in UV spectrophotometer.

**Table 6: UV-Vis peak values of Mentha spicata Leaf powder**

| Sr. No. | Wavelenght Maxima (nm) | Absorbance |
|---|---|---|
| 1 | 352 | 1.264 |
| 2 | 405 | 1.467 |
| 3 | 530 | 0.056 |
| 4 | 610 | 0.148 |

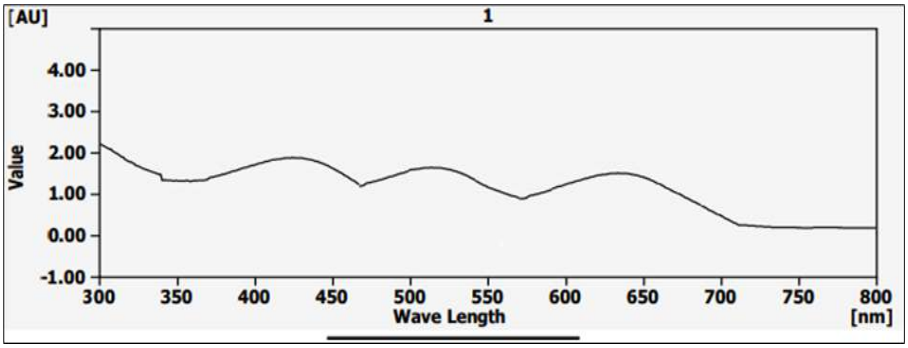


**Figure 6: Absorbance maxima of Mentha spicata Leaf powder**

**Formulation of Orodispersible Tablet of Mentha spicata Leaf powder**

Formulation of Orodispersible tablet of Mentha spicata Leaf powder was prepared by using wet granulation method. The excipients like Lactose, MCC PH 101, PVP K30, Cross carmellose sodium, Sacharrine Sodium and Magnesium Stearate were used in the formulation of leaf powder Orodispersible tablet. Six different compositions containing different concentration of Lactose, MCC PH 101 and superdisingredient like cross carmellose sodium will effects on the dispersibility and release profile of the Mentha spicata Leaf powder.

**Evaluation of Mentha spicata Leaf powder Orodispersible Tablet**

**Angle of repose**

The angle of repose for the powder blends of all batches exhibits good flow properties.

**Loss on Drying**

The moisture content has influence on tableting process in various aspects like sticking and also

affects the moisture sensitive excipients like cros carmellose sodium. The loss on drying for various batches of powder blends varies from 1.53 to 2.17 %. Hence excipient like Colloidal silicon dioxide was selected to maintain the moisture content.

**Table 6: Loss on drying of Formulation batches**

| Formulation code | Loss on Drying (%) |
|---|---|
| F1 | 1.86 |
| F2 | 1.53 |
| F3 | 1.96 |
| F4 | 2.09 |
| F5 | 1.83 |
| F6 | 1.92 |
| F7 | 2.17 |
| F8 | 1.63 |
| F9 | 2.05 |

**Bulk Density, Tapped Density, Hausner Ratio and Carr's Index**

Bulk Density, Tapped Density, Hausner Ratio and Carr's Index were studied. From the obtained Bulk density and Tap density values Hausner ratio and Carr's index were calculated. Since the Hausner ratio was less than 1.25% for all batches of powder blends, the flow property was good. Also, the Carr's index was below 15% for all batches of powder blends, the flow property was good.

**Table 7: Pre-compression parameters of powder blend**

| Formulation code | Angle of Repose θ | Bulk Density (Gm/ml) | Tap Density (Gm/ml) | Houser's Ratio | Car's Index (%) |
|---|---|---|---|---|---|
| F1 | 46.55±0.03 | 0.45±0.32 | 0.50±0.06 | 1.12±0.11 | 10.00±0.23 |
| F2 | 42.26±0.04 | 0.45±0.28 | 0.50±0.05 | 1.12±0.24 | 10.00±0.42 |
| F3 | 46.00±0.03 | 0.35±0.46 | 0.42±0.05 | 1.20±0.26 | 16.6±0.310 |
| F4 | 31.65±0.03 | 0.40±0.31 | 0.52±0.04 | 1.20±0.14 | 23.07±0.24 |
| F5 | 55.00±0.06 | 0.67±0.25 | 0.78±0.03 | 1.16±0.37 | 14.10±0.26 |
| F6 | 21.00±0.04 | 0.72±0.29 | 0.98±0.04 | 1.32±0.21 | 26.53±0.31 |
| F7 | 22.00±0.02 | 0.53±0.17 | 0.76±0.01 | 1.15±0.29 | 25.24±0.28 |
| F8 | 32.00±0.01 | 0.63±0.25 | 0.53±0.03 | 1.27±0.19 | 24.48±0.47 |
| F9 | 30.00±0.08 | 0.74±0.21 | 0.67±0.06 | 1.33±0.26 | 27.10±0.39 |

**Mean±S.D [n = 3]**

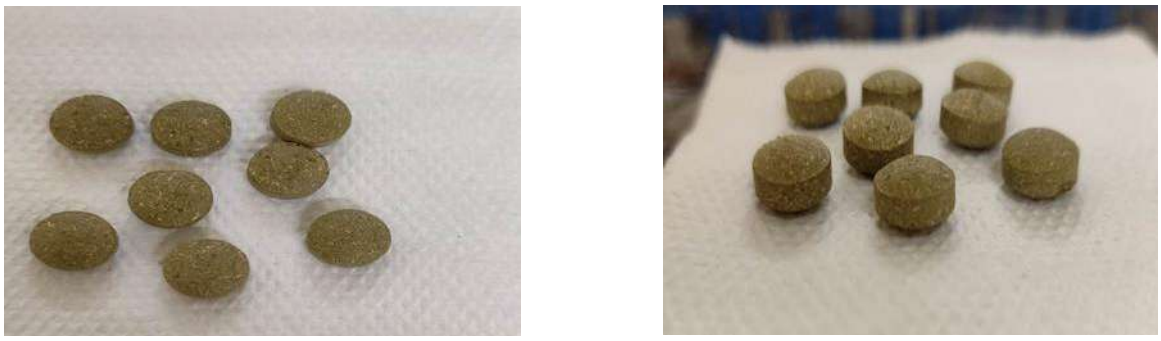

**Figure 7: Mentha spicata Leaf powder Orodispersible Tablet**

**Post Compression Studies**

**Thickness and Diameter**

The Thickness and diameter of all formulation batches was found in the range of 3.8 ± 0.08 to 4.0 ± 0.21 and 7.14 ± 0.08 to 8.11 ± 0.12. The Hardness of the different formulations ranged from 3.8 to 3.9 Kg/cm$^2$.

**Table 8: Thickness, Diameter and Hardness data of Different Formulations**

| Formulation code | Hardness (kg/cms) | Diameter | Thickness (mm) |
|---|---|---|---|
| F1 | 5.9±0.32 | 8.11 ± 0.20 | 3.8±0.12 |
| F2 | 6.5±0.36 | 8.02 ± 0.49 | 3.9±0.23 |
| F3 | 7.0±0.24 | 7.96 ± 0.52 | 4.0±0.17 |
| F4 | 6.8±0.31 | 7.92 ± 0.62 | 3.8±0.26 |
| F5 | 5.4±0.30 | 8.03 ± 0.81 | 4.0±0.24 |
| F6 | 3.3±0.24 | 8.02 ± 0.30 | 4.0±0.16 |
| F7 | 3.5±0.29 | 7.96 ± 0.53 | 3.9±0.19 |
| F8 | 4.8±0.16 | 7.14 ± 0.32 | 4.0±0.25 |
| F9 | 5.2±0.32 | 7.86 ± 0.31 | 3.8±0.22 |

**±S.D [n = 3]**

**Friability and Weight Variation Test**

Depending upon the ingredients of different formulations, the weight of tablet was fixed. In each formulation, weight variation was within the I.P. Limit. Mostly the variation was within ± 1%. All the formulations exhibited less than 1% Friability and were within the I.P. Limit.

**Table 9: Friability and Weight variation data of Different Formulations**

| Formulation code | Friability (%) | Weight variation |
|---|---|---|
| F1 | 0.721 | Pass |
| F2 | 0.542 | Pass |
| F3 | 0.527 | Pass |
| F4 | 0.316 | Pass |
| F5 | 0.842 | Pass |
| F6 | 0.950 | Pass |
| F7 | 0.728 | Pass |
| F8 | 0.568 | Pass |
| F9 | 0.438 | Pass |

**Wetting Time Determination and Water Absorption ratio**

The results of Wetting time and Water absorption ratio are the most important parameter for the evaluation of Orodispersible tablet. The Wetting time ranges from 9.83 sec to 14.26 sec whereas; water absorption ratio ranges from 67.23 to 85.6. Formulation F4 was showing the very less wetting time i.e. this formulation wet instantly when goes into contact with water media and get integrates within a second also this formulation showed good water absorption ration which will help to disperse the tablet very fast. This effect may due to the concentration of superdisintegrant present in the formulation.

**Table 10: Wetting Time and Water Absorption Ratio Data of different formulations**

| Formulation code | Wetting Time (Sec) | Water Absorption Ratio |
|---|---|---|
| F1 | 12.02 ± 0.23 | 67.23 |
| F2 | 14.26 ± 0.32 | 78.69 |
| F3 | 12.06± 0.37 | 75.68 |
| F4 | 09.83± 0.27 | 85.63 |
| F5 | 10.63± 0.37 | 78.64 |

| | | |
|---|---|---|
| F6 | 11.48± 0.15 | 80.36 |
| F7 | 12.39± 0.16 | 82.16 |
| F8 | 11.31± 0.11 | 79.27 |
| F9 | 12.17± 0.31 | 78.27 |

**Mean±S.D [n = 3]**

**Uniformity of Dispersion Test**

Uniformity of dispersion is also main parameter for the dispersible tablet. The uniformity of dispersion test via mesh 22 ensures that the tablet disintegrates and breaks down to granules passable through the 22-mesh size such that all formulation tablets passing this test will show almost uniform breakdown to granules to give a predictable and desirable drug release. The results of test for uniformity of dispersion are presented in Table 11. All the formulated batches showed good uniformity of dispersion. The uniformity of dispersion depends upon the uniformity in the particle size of the active as well as inactive ingredients. If the all the particles of the actives and inactive showed uniform particle size and pass through the sieves, it will ultimately help to get the uniform size particles.

**Table 11: Uniformity of Dispersion Data of different Formulations**

| Formulation code | Residue remaining on Screen | Results |
|---|---|---|
| F1 | NIL | Pass |
| F2 | NIL | Pass |
| F3 | NIL | Pass |
| F4 | NIL | Pass |
| F5 | NIL | Pass |
| F6 | NIL | Pass |
| F7 | NIL | Pass |
| F8 | NIL | Pass |
| F9 | NIL | Pass |

**Moisture Uptake Test**

Moisture content uptake is also the most important factor in the development of dispersible tablet. The moisture uptake test was conducted for all the formulations of dispersible tablets of leaf powder. Any difference in moisture uptake among various formulations occurs that may be due to different concentration of superdisintegrant added into different formulation.

**In-vitro drug release study**

***In- Vitro* Dispersion Time and *In-Vitro* Disintegration Time**

These two tests are very important test for the Orodispersible tablet as these tests are related with time factor. The time limit for dispersible tablet to get disperse is considered to be less than a minute. Also, the disintegration times varies from 5 to 30 seconds for the dispersible tablet. The results of In-vitro dispersion time and In-vitro disintegration time ranges from 7.89 sec to 12.53 sec and 12.04 sec to 26.37 sec respectively. The results were summarizing in the table 12. The figure showed the dispersion way of leaf powder tablet in the media.

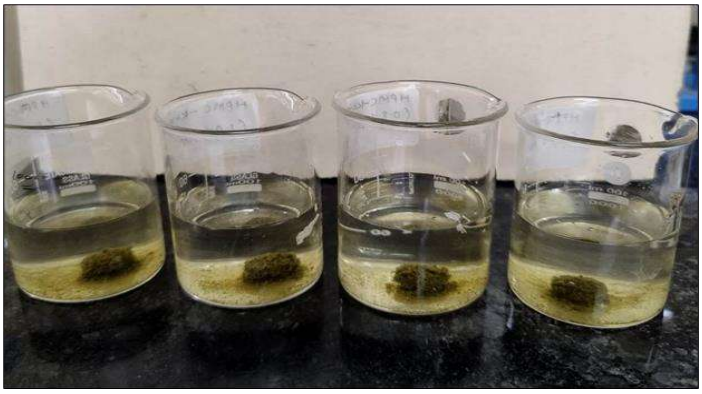

**Figure 8: Dispersion mechanism of Mentha spicata Leaf powder OroDispersible Tablet**

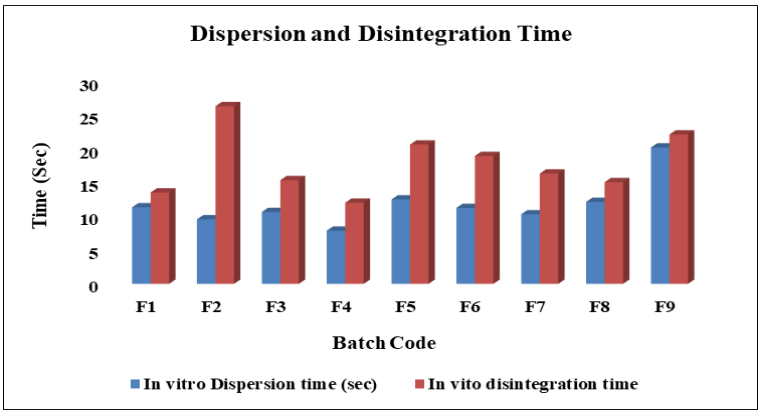


**Figure 9: Showing the comparative dispersion and disintegration time**

**Table 12: *In- Vitro* Dispersion Time and *In-Vitro* Disintegration Time data of Formulations**

| Formulation code | *In-Vitro* Dispersion Time (sec) | *In-vitro* Disintegration Time (sec) |
|---|---|---|
| F1 | 11.36±0.03 | 13.57± 0.03 |
| F2 | 09.58±0.05 | 26.37± 0.05 |
| F3 | 10.67±0.03 | 15.39± 0.02 |
| F4 | 07.89±0.04 | 12.04± 0.02 |
| F5 | 12.53±0.03 | 20.68± 0.03 |
| F6 | 11.27±0.02 | 18.98± 0.04 |
| F7 | 10.32±0.05 | 16.38± 0.03 |
| F8 | 12.16±0.04 | 15.10± 0.03 |
| F9 | 20.24±0.01 | 22.17± 0.02 |

**±S.D [n = 3]**

***In-vitro* dissolution study**

Dissolution studies were conducted for all the formulation via USP dissolution apparatus II paddle type, using water as a dissolution medium. From the dissolution studies it had been observed from the drug release profile more than 90 % constituent form powder was released within 30 min. Formulation F4 that was formulated by sublimation method containing 3.33% Polyvinyle Pirrolidone as sublimating agent showed 90 ± 0.205 % drug release within 15 min. Cumulative percent drug release of all formulations is tabulated below in table 13. Comparative drug release of the all the formulations were showed in the figure 10 & 11.

**Table 13: In-vitro dissolution profile of formulations F1-F6**

| Formulation/Drug Release (%) | Time (min) | | | | | | |
|---|---|---|---|---|---|---|---|
| | **0** | **5** | **10** | **15** | **20** | **25** | **30** |
| **F1** | 0 | 68.17±0.24 | 73.45±0.29 | 79.25±0.32 | 80.10±0.18 | 84.40±0.34 | 85.00±0.24 |
| **F2** | 0 | 70.12±0.42 | 75.00±0.36 | 78.54±0.37 | 81.24±0.41 | 83.20±0.28 | 84.25±0.37 |
| **F3** | 0 | 70.15±0.44 | 74.56±0.30 | 76.40±0.34 | 78.94±0.32 | 85.23±0.36 | 90.15±0.42 |
| **F4** | 0 | 75.23±0.14 | 82.50±0.28 | 85.15±0.16 | 90.21±0.28 | 95.23±0.22 | 99.67±0.23 |
| **F5** | 0 | 78.20±0.32 | 80.75±0.30 | 83.26±0.34 | 88.75±0.28 | 92.00±0.27 | 95.00±0.36 |
| **F6** | 0 | 75.45±0.45 | 82.30±0.42 | 88.15±0.36 | 90.45±0.31 | 92.46±0.45 | 94.25±0.38 |
| **F7** | 0 | 71.21±0.34 | 78.45±0.38 | 82.19±0.38 | 88.61±0.42 | 90.10±0.43 | 92.37±0.46 |
| **F8** | 0 | 70.25±0.46 | 75.29±0.38 | 80.27±0.41 | 85.72±0.30 | 88.42±0.32 | 90.84±0.26 |
| **F9** | 0 | 77.14±0.38 | 86.48±0.31 | 88.54±0.48 | 91.89±0.46 | 94.28±0.40 | 96.46±0.45 |

**Mean±S.D [n = 3]**

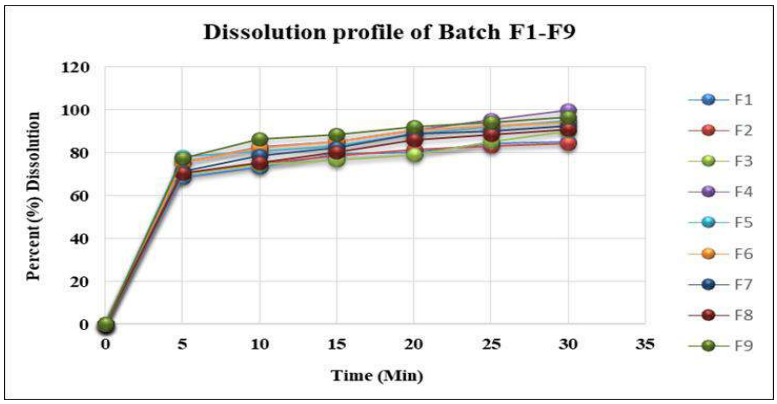


**Figure 10: Dissolution Profile of F1 to F9 formulation of Mentha spicata Leaf powder**

**Comparative dissolution study of marketed formulation with Mentha spicata Leaf powder formulation**

Comparative dissolution study of marketed formulation with Mentha spicata Leaf powder formulation were carried out.

**Table 14: Comparative In-vitro dissolution profile of formulation F4 and Lansoprazole ODT tablet**

| Time | F4 Formulation | Lansoprazole orodispersible tablet (Ranbaxy) |
|---|---|---|
| 0 | 0±0.00 | 0±0.00 |
| 5 | 75.23±0.24 | 76.35±0.29 |
| 10 | 82.50±0.21 | 83.64±0.31 |
| 15 | 85.15±0.18 | 86.94±0.28 |
| 20 | 90.21±0.20 | 91.30±0.24 |
| 25 | 95.23±0.22 | 96.22±0.26 |
| 30 | 99.87±0.21 | 99.18±0.24 |

From the results it was conclude that, the percent release of F4 formulation was 99.87±0.21 and Lansoprazole orodispersible tablet (Ranbaxy) was found to be 99.18±0.24. Both the release was found to be almost similar. Mentha spicata (spearmint) contains essential oils such as carvone and limonene, which exhibit antispasmodic, anti-inflammatory, and soothing effects on the gastrointestinal tract. These effects can begin almost immediately once the active compounds are absorbed. Whereas, Lansoprazole is a proton pump inhibitor (PPI) that works by irreversibly inhibiting the H+/K+ ATPase enzyme in the stomach lining, thereby reducing gastric acid

production. This leads to a longer-lasting reduction in stomach acid.

The faster onset of action of Mentha spicata ODT compared to lansoprazole ODT is primarily due to the rapid disintegration and immediate release of active compounds that provide quick relief through local and systemic effects. In contrast, lansoprazole ODT, while also rapidly disintegrating, requires systemic absorption and subsequent inhibition of proton pumps to exert its therapeutic effect, leading to a slower onset of action.

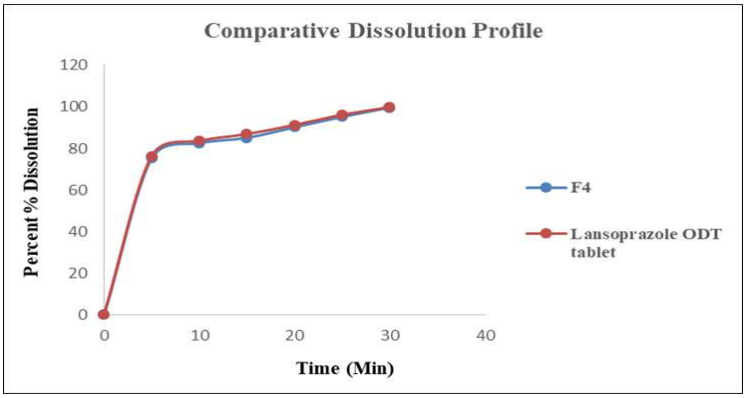


**Figure11: Comparative dissolution profile of F4 formulation and Lansoprazole orodispersible tablet**

## Stability Studies

The optimized formulations F4 were subjected to stability studies for 3 months at 40°C / 75% RH in stability chamber. 8°C in Refrigerator and 60°C in Incubator, at the interval of 30 days, the tablets were withdrawn and evaluated for Thickness, Diameter, Hardness, Friability, weight variation, content uniformity and disintegration time. All the parameters have not shown much variation when compared to the initial data and the results were within the limits. The in-vitro dissolution studies were carried out at 3 months samples. The release profiles were not affected by exposing to higher temperature and the specified humidity conditions.

**Table 15: Dissolution Profile of Oro-Dispersible Mentha spicata Leaf powder tablet formulation (F4)**

| Formulation/ Drug Release (%) | Time (min) | | | | | | |
|---|---|---|---|---|---|---|---|
| | **0** | **5** | **10** | **15** | **20** | **25** | **30** |
| **At 40°C / 75%** | 0 | 74.33±0.23 | 82.36±0.24 | 84.26±0.18 | 90.18±0.31 | 94.43±0.12 | 99.16±0.26 |
| **8°C in Refrigerator** | 0 | 73.45±0.45 | 82.48±0.26 | 83.67±0.20 | 89.46±0.36 | 93.25±0.23 | 98.86±0.18 |
| **60°C in Incubator** | 0 | 73.03±0.25 | 81.46±0.31 | 83.84±0.20 | 89.34±0.31 | 93.06±0.23 | 98.23±0.16 |

**±S.D [n = 3]**

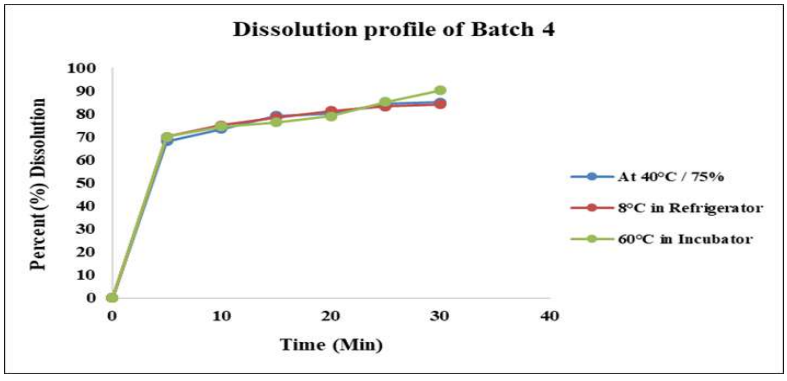


**Figure 12: Dissolution Profile of Formulation F4 Stability Batch after 3 Months**

## CONCLUSION:

The formulation, development, and evaluation of orodispersible tablets of Mentha spicata leaf powder using wet granulation technique present a promising avenue for enhancing drug delivery and patient compliance. Formulation F4 containing concentration of Croscarmellose sodium with appropriate quantity of other excipients was considered to be the optimized formulation with the desired drug release. The Formulation F4 has cumulative percent release up to 99.67±0.23 in 30 minutes. Through meticulous formulation design and systematic evaluation, we have achieved tablets with desirable characteristics such as rapid disintegration, pleasant taste, and adequate mechanical strength. The incorporation of Mentha spicata leaf powder not only offers potential therapeutic benefits but also adds to the natural appeal of the formulation. This study underscores the significance of employing wet granulation as a viable method for producing orodispersible tablets, ensuring uniform drug distribution and robust tablet properties. Furthermore, the comprehensive evaluation of various parameters including disintegration time, hardness, friability, and drug content confirms the reliability and efficacy of the developed formulation.

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## DECLARATION OF CONFLICT:

The authors declare that there are no conflicts of interest related to this study.

## AUTHOR CONTRIBUTION:

All authors contributed equally to the research and the preparation of the manuscript.

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