IOSR Journal Of Pharmacy
(e)-ISSN: 2250-3013, (p)-ISSN: 2319-4219
Volume 16, Issue 3 Series. I (March 2026), PP. 32-42
www.iosrphr.org

Evaluation of Patient-Centric Gabapentin Or dispersible Tablets: Formulation Development, Physicochemical Characterization, and In-Vivo Studies

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ABSTRACT
Pharmaceutical research has been dedicated to advancing drug delivery methods to enhance therapeutic outcomes and patient adherence. Buccal drug delivery systems, a novel approach, leverage the oral mucosa's unique attributes to provide an alternative to traditional administration routes. This study focuses on the formulation, molecular insights, and therapeutic implications of gabapentin buccal tablets, exploring the potential of this innovative approach. By examining drug formulation, physicochemical attributes, and patient-specific factors, the study reveals the interplay that affects gabapentin buccal absorption. This research contributes to the growing understanding of buccal drug administration's advantages, challenges, and prospects. The study evaluates the rationale for selecting gabapentin, considering its diverse pharmacology and limitations of conventional oral administration. Investigating gabapentin buccal tablets offers promise in optimizing therapeutic efficacy and patient compliance. The comprehensive exploration of preclinical and clinical data highlights potential pharmacokinetic benefits, safety characteristics, and patient adherence. Examining formulation techniques and evaluation methods provides a robust foundation for tablet development. The in vitro dissolution study offers insight into drug release profiles. Compatibility studies through FTIR and DSC analysis affirm formulation stability. This study exemplifies buccal drug delivery's transformative potential, paving the way for personalized healthcare and improved patient experiences. In conclusion, this research underscores the promise of buccal drug delivery as a pathway to revolutionize drug administration and enhance patient-centered care.

KEYWORD
Mouth dissolving Tablet, Orodispersible Tablets, gabapentin, Buccal drug delivery system.

I. Introduction

In recent decades, pharmaceutical research has focused on developing novel drug delivery methods to improve the effectiveness and patient compliance of numerous therapeutic medicines. The invention of buccal drug delivery systems, which provide a viable alternative to standard methods of administration such as oral, intravenous, or transdermal routes, is one such important accomplishment. These systems take use of the oral mucosa's abundant vasculature and permeability, offering a direct conduit for drug absorption into systemic circulation while avoiding the difficulties related to gastrointestinal degradation and hepatic first-pass metabolism. Pharmaceutical research has recently concentrated on creating innovative drug delivery techniques to increase the efficacy and patient compliance of several therapeutic treatments. One such significant achievement is the development of buccal drug delivery systems, which give a feasible alternative to typical ways of administration such as oral, intravenous, or transdermal routes. These methods take use of the extensive vasculature and permeability of the oral mucosa, providing a direct pathway for drug absorption into systemic circulation while bypassing the challenges associated with gastrointestinal degradation and hepatic first-pass metabolism.

This study delves into the formulation techniques, molecular insights, and possible therapeutic implications of gabapentin buccal tablets as a new drug administration route. The purpose of this research is to investigate the delicate interplay between drug formulation, physicochemical qualities, and patient-specific variables that impact gabapentin buccal absorption.[1] This work adds to the expanding body of information

about buccal medication administration and its potential to revolutionise the therapeutic landscape by thoroughly exploring its benefits, problems, and prospects. The following sections of this paper will discuss the rationale for choosing gabapentin for buccal delivery, the anatomical and physiological considerations of the buccal mucosa, the formulation techniques used to design effective gabapentin buccal tablets, and an overview of in vitro and in vivo methods used to evaluate the performance of these tablets.[2] Furthermore, the study will critically examine current preclinical and clinical data in order to shed light on the pharmacokinetic advantages, safety characteristics, and patient adherence related with this novel drug delivery method. This study focuses on gabapentin, a pharmacologically diverse molecule with antiepileptic and analgesic effects.[5] Despite its therapeutic promise, gabapentin's oral administration has drawbacks such as variable absorption, delayed beginning of action, and dose-related adverse effects. The introduction of buccal drug administration as a strategic option provides a chance to overcome these constraints, perhaps optimising gabapentin's pharmacokinetic profile and boosting its overall therapeutic effectiveness. The investigation of gabapentin buccal tablets is an important step towards realising the full therapeutic potential of a well-established medicine.[3] By leveraging the benefits of buccal drug delivery, both researchers and healthcare practitioners have a unique opportunity to overcome challenges posed by traditional administration methods, potentially leading to improved patient outcomes and expanded applications of gabapentin in a variety of clinical scenarios.[6] As the next sections dive into the various features of this research, a holistic picture of the promise represented by gabapentin buccal tablets will emerge, laying the groundwork for future improvements in pharmaceutical sciences and therapeutic practises. The transformational potential of buccal medication delivery appears as a doorway to optimised treatments as a result of our study, ushering in a new era in patient-centered care.[4]

II. MATERIAL AND METHOD

Material

Gabapentin was obtained as gift sample from RMI Laboratory (OPC) Private Limited, Sdium starch glycolate, Crosspovidone, Mag. Stearate, cross-carmelose Sodium, was collected from Research Lab fine chem industries, Mumbai. Talc, Lactose was obtained from Prerana Enterprises, Ahmednagar.

Method

Pre-formulation of Drug

Standardisation of drug: It essentially implies confirming its identification and determining its quality and purity, which will be carried out as part of the drug's pre-formulation research.[8]

Melting Point Determination: The melting point of the medicine determines its identification and purity. Any mixing will cause the drug's melting point to fluctuate. The capillary technique was used to determine it.[9,10]

Identification of Pure Drug:

The identification of pure drugs was conducted using both Differential Scanning Calorimetry (DSC) and Fourier-Transform Infrared Spectroscopy (FT-IR) techniques. These methods are essential for confirming the identity of the drug substance and ensuring its quality and purity.

Differential Scanning Calorimetry (DSC): DSC is a thermal analysis technique that measures the heat flow in a substance as it undergoes temperature changes. The DSC thermogram obtained from the pure drug provides characteristic peaks that correspond to its melting point and thermal behavior. By comparing these peaks with reference data or known standards, the identity of the pure drug can be confirmed. Any variations or inconsistencies in the DSC thermogram can indicate impurities or changes in the drug's crystalline structure.[11]

Fourier-Transform Infrared Spectroscopy (FT-IR): FT-IR spectroscopy is a powerful analytical technique used to identify molecular components by analyzing their infrared absorption patterns. The FT-IR spectrum of the pure drug serves as a unique fingerprint that reflects the functional groups present in the molecule. By comparing the peaks and bands in the FT-IR spectrum of the pure drug with established reference spectra, the identity of the drug can be verified. Any discrepancies or shifts in the absorption peaks might indicate alterations in the molecular structure or the presence of impurities.[11]

Solubility study of Gabapentin: Solubility plays an important part in the Preformulation study as it gives an idea about the BCS class of the drug and plays a pivotal role in the selection of dissolution media, which in turn helps in designing the formulation. Solubility study was performed in Water and buffers with relevant physiological pH (1.2, 6.8) at 37°C.[13]

Calibration

A 100mg amount of Gabapentin was accurately weighed and put to a 100 ml volumetric flask. 70 ml of methanol was added to this, and the mixture was sonicated until the chemical was completely dissolved. Following dissolving, the volume was adjusted with methanol to produce a solution containing 1000 g/ml. Following that, 10 ml of this solution was pipetted into a 100 ml volumetric flask and the volume was adjusted with methanol to produce a standard stock solution with a concentration of 100 g/ml. This standard stock solution was diluted further with methanol to provide a variety of desirable working standard solutions with

concentrations ranging from 5 to 25 g/ml. The absorbance of each prepared solution was measured at its maximum. By graphing absorbance vs. concentration, standard calibration curves were created. For each drug's calibration curve, the linear regression equation (y = mx + c) and coefficient of correlation (R2) were computed.[12]

III. Experimental Method

Table No. 01: Composition of batches of mouth dissolving tablet of gabapentin (F1-F9)

Sr. No.	Ingredients (mg)	F1	F2	F3	F4	F5	F6	F7	F8	F9
1	***Gabapentin(mg)***	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**
2	Lactose	**90**	**90**	**90**	**90**	**90**	**90**	**90**	**90**	**90**
3	SSG (mg)	10	10	10	15	15	15	20	20	20
4	Cross povidone (mg)	20	30	40	20	30	40	20	30	40
5	Mag. Stearate (mg)	6	6	6	6	6	6	6	6	6
6	Talc (mg)	3	3	3	3	3	3	3	3	3

Preparation method of gabapentin mouth dissolving Tablet [14]

The direct compression method and a super dissolving agent, such as cross povidone, were used to create gabapentin tablets. After screening using a 40-mesh screen, the drug, super-disintegrant, diluents, and sweetening agent were appropriately mixed. Talc and SSG were combined and filtered through an 80-mesh screen. As a result, the powder was crushed into tablets using an 8-station punch rotary tablet compression machine. A biconvex punch with a 6 mm diameter was used for tableting.[14]

Evaluation of Mouth dissolving tablet

Pre-compression parameters

Bulk density

2 gm of granules were precisely weighed after passing through a 20# sieve and then transferred to a 10 ml graduated cylinder. Without compacting, the powder was carefully leveled and the apparent unsettled volume (V0) was read. The apparent bulk density in gm/ml was calculated using the following formula [16]

Tapped density

The sample was weighed accurately. 2 grams of granules were taken after passing through a 20# sieve and placed into a 10 ml graduated cylinder. The sample container was then subjected to mechanical tapping, as it was raised and allowed to fall under its own weight using a mechanically tapped density tester at a nominal rate of 100 drops. Following this, the tapped volume was measured to the nearest graduated unit. The formula below was employed to determine the tapped bulk density in gm/ml

Carr's Index

Carr's compressibility index was used to calculate the powder blend's compressibility index. It was a straightforward test to determine a powder's BD, TD, and rate of packing down. The following is the formula for Carr's Index.[17]

Hausner's ratio

The flowability of a powder or granular substance can be measured using Hausner's ratio[18]

Angle of repose

The angle of repose of the powder was calculated via the funnel technique. It was stuffed with the carefully proportioned powder combination. The height of the funnel was set such that the tip just touched the top of the powder mixture. The funnel was left propped open, allowing the powder combination to flow through and across the top. The diameter of the powder cone was measured, and the angle of repose was calculated using the equation below.[17]

Post-compression parameters

Tablet thickness

Tablet thickness is a crucial element in both duplicating appearance and counting with filling machinery. The uniform thickness of the tablets is used as a counting mechanism by some filling equipment. Micrometer was used to measure thickness.[17]

Weight variation

The weight variation test was conducted by weighing 10 randomly selected tablets individually, calculating the average weight and comparing the individual tablet weights to the average. The specification of weight variation is 7.5 %. (As per IP, BP and USP).[19]

Friability

For assessing the friability, Roche friabilator was utilized. Twenty tablets were be precisely weighed before being inserted in the 25 rpm-revolving tumblers. After four minutes, the tablets were be weighed and the % weight loss was be calculated.[20]

Hardness

The tablets' crushing strength was determined using a Monsanto hardness tester. Three tablets were randomly sampled from each formulation batch, and the average reading was recorded.[21]

Wetting time

12 cm × 10.75 cm of double-folded tissue paper was placed in a 9 cm-diameter Petri dish containing 9 ml of buffer solution pH 6.8. On the paper, a tablet was inserted and the time required for complete wetness was recorded. Three tablets were chosen at random from each formulation, and the average wetting time was recorded.[17]

Water absorption ratio (%)

Two-folded tissue paper was placed in a tiny Petri dish holding 6 milliliters of water. On the paper, a tablet was placed, and the time required for complete soaking was measured. The moistened tablet was afterward weighed. R, the water absorption ratio, was calculated using the following equation.[22]

Disintegration time

The disintegration time of each formulation was determined using tablet disintegration testing equipment. Six tablets were inserted individually in each tube of disintegration testing equipment with simulated saliva, followed by the placement of discs. The time required for the full tablet to dissolve was recorded.[23]

Drug content

Twenty tablets were weighed and ground into a powder. The powder corresponding to 10 mg of Ambrisentan was dissolved in 100 ml of 0.1N HCl, filtered with Whatman filter paper No. 42, diluted appropriately, and analyzed for drug concentration at 285nm using a UV-Visible spectrophotometer (UV 160-Shimadzu, Japan)[25]

In vitro drug release study

In vitro, dissolving has been validated for the development of oral dosage forms. It is used to predict in vivo tablet dissolving. The in vitro release of mouth-dissolving tablets was measured using apparatus I of the USP XXIII tablet dissolution test apparatus. The dissolution equipment utilized a phosphate buffer with a pH of 6.8 (900 ml) and a temperature of 37.1 °C. At various intervals, 10 ml samples were extracted and the volume of media was maintained by adding fresh media to the chamber. At 287 nm, the aliquots were analyzed spectrophotometrically for gabapentin.[26]

IR spectral analysis

Through the use of an FTIR spectrophotometer, the FTIR spectra of pure drug, physical mixture, and formulation F3 (after storage under accelerated circumstances) were recorded. The samples were scanned between 4000 and 500 cm-1.[27]

Differential scanning calorimetry (DSC) studies

DSC analysis was used to compare the melting enthalpy, glass transition temperature, and interactions of the medication Ambrisentan (pure drug) with Excipients. The investigation was conducted with DSC Q1000 TA equipment. Approximately 2-5 mg of sample was put in standard aluminum pans and scanned from 5 °C to above its melting point at a rate of 10 °C/min with dry nitrogen (flow rate 50 ml/min) as the effluent gas.

Statistical analysis the data were analyzed using GraphPad Prism 5.0 and displayed as mean (SD) (GraphPad Software, Inc., San Diego, CA, USA). Using Design Expert Software Version 13.0, the formulation was optimized. Using ANOVA, a difference below the probability threshold of P- value = 0.05 was calculated.[28]

IV. RESULTS AND DISCUSSION

RESULTS

Drug-excipient compatibility study

FTIR spectral analysis

The FTIR spectra of the pure drug and physical mixture (Pure drug+Excipient) were recorded using an FTIR spectrophotometer (Shimadzu IRxross). The samples were scanned over a range of 4000-500 cm^{1}.

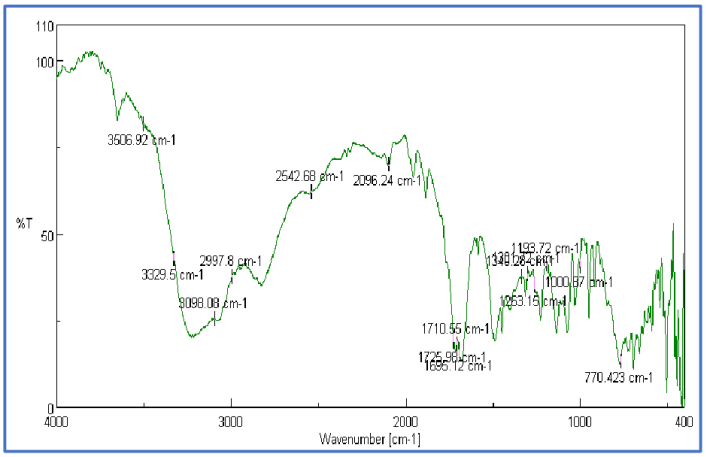


Fig. 01: IR Spectra of Gabapentin (Pure Drug)

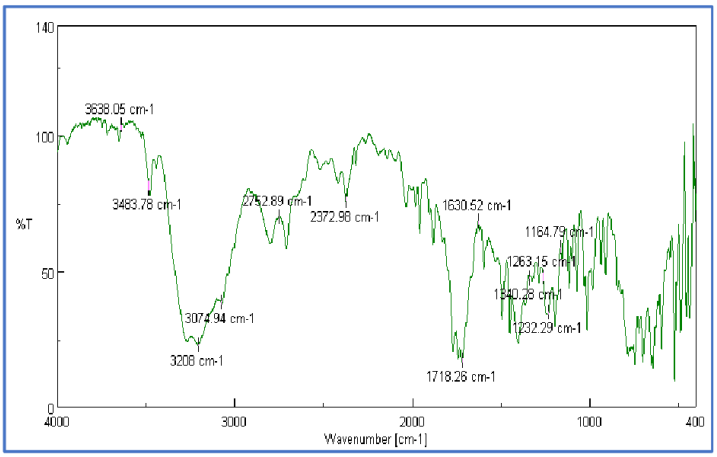


Fig. 02: FT-IR spectra of physical Mixture (Pure drug+ Excipients)

Differential scanning calorimetry (DSC) studies

The DSC thermogram of the Gabapentin pure drug and Tablet physical mixture is depicted in fig. 02,03.

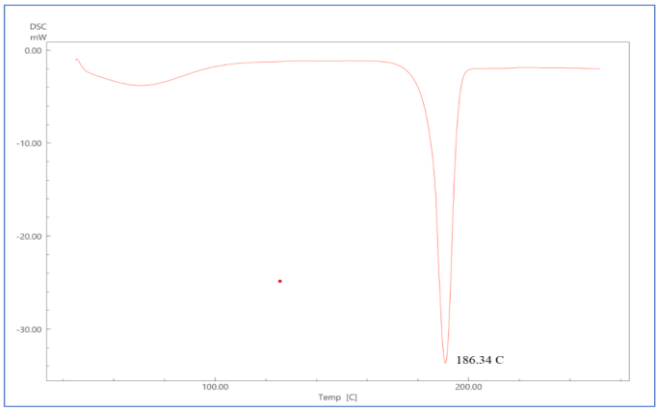


Fig. 03: DSC of Gabapectin (Pure Drug)

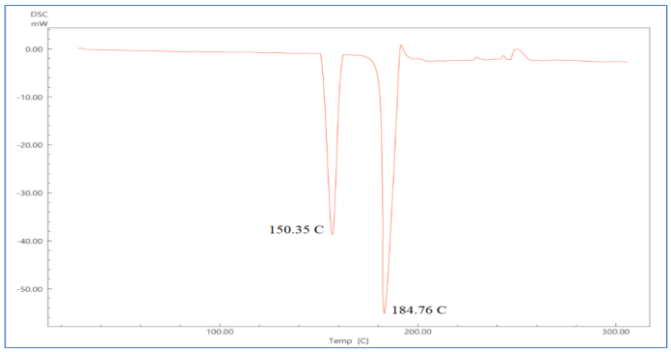


Fig. 03: DSC of Pure drug + All Excipients

Pre-compression parameters of MDT

Table No. 01: Result of Pre-compression parameters of MDT

F. Code	Bulk Density	Tapped Density	% Carr's Index	Hausner's Ratio	Angle of Repose
F1	0.63±0.025	0.54±0.78	8.42±3.22	1.185±0.96	22.63±3.45
F2	0.55±0.041	0.69±0.64	7.46±2.34	1.084±0.78	21.63±3.14
F3	0.65±0.025	0.68±0.34	7.94±2.14	1.078±0.89	22.32±2.45
F4	0.57±0.024	0.64±0.96	7.74±1.47	1.087±0.96	22.84±3.66
F5	0.63±0.078	0.66±0.79	8.56±1.98	1.114±0.94	22.96±3.47
F6	0.68±0.096	0.59±0.93	6.42±1.46	1.144±0.91	22.98±2.14
F7	0.58±0.063	0.63±0.88	9.06±2.45	1.091±0.90	22.83±2.36
F8	0.59±0.015	0.61±0.36	7.44±1.23	1.096±0.88	23.75±2.45
F9	0.57±0.014	0.59±0.78	8.36±2.34	1.083±0.87	23.96±2.96

Post-Compression Parameters of MDT

The post-compression parameters of formulations F1 to F9, such as hardness, friability, weight variation, wetting time, disintegration time, water absorption ratio, and drug content, are given in tables.

Table No. 02: Result of Post-Compression Parameters of MDT

Batch No.	Hardness (Kg/cm²)	Weight variation (mg)	Wetting time (sec)
F1	2.53±0.29	169 ± (5%)	69.8±1.04
F2	2.56±0.29	179 ± (5%)	39.0±0.95
F3	2.61±0.17	189 ± (3%)	42.4±1.15
F4	2.69±0.29	174 ± (5%)	89.0±0.85
F5	2.76±0.29	184 ± (3%)	66.0±1.35
F6	2.87±0.17	194 ± (3%)	36.4±1.48
F7	3.11±0.17	179 ± (5%)	67.8±0.35

F8	2.61±0.17	189 ± (3%)	41.7±1.45
F9	2.69±0.29	199 ± (3%)	29.1±1.05

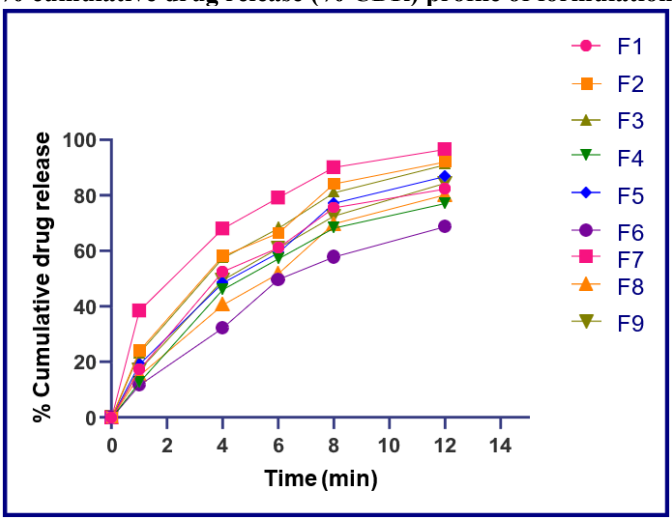
Table No. 03: Result of Post-Compression Parameters of MDT

Batch No.	Disintegration time (sec)	Friability (%)	Water absorption ratio (%)	Drug content (%)
F1	44.24±4.35	0.69	29±1.40	98.21±0.36
F2	51.35±1.52	0.71	28±1.34	99.50±0.43
F3	45.75±1.52	0.55	32±1.09	98.83±0.42
F4	59.56±2.08	0.75	26±1.12	98.30±0.26
F5	46.52±1.52	0.64	30±1.20	98.32±0.53
F6	41.25±1.00	0.49	36±1.59	99.38±0.33
F7	29.75±4.35	0.69	48±2.46	98.21±0.36
F8	37.94±1.52	0.71	45±2.06	99.50±0.43
F9	40.5±1.00	0.43	43±2.01	99.54±0.74

In vitro dissolution study of MDT

The % cumulative drug release (% CDR) profile of formulation F1 to F9 is shown in fig. 5.

Fig. 05.: % cumulative drug release (% CDR) profile of formulation F1 to F9



V. Discussion:

The introduction provided sets the stage for discussing the significant advancements in pharmaceutical research, particularly in the field of drug delivery methods. Over the past few decades, researchers have concentrated their efforts on developing novel approaches to administering therapeutic drugs that not only enhance their effectiveness but also promote patient compliance. [29,30] One such remarkable accomplishment in this domain is the development of buccal drug delivery systems. These systems represent a breakthrough alternative to conventional methods of drug administration, such as oral, intravenous, or transdermal routes. Buccal drug delivery harnesses the unique characteristics of the oral mucosa, which is rich in vasculature and has remarkable permeability. By utilizing the mucosal tissue of the oral cavity as a gateway for drug absorption, buccal delivery offers a direct route into the systemic circulation. This approach circumvents the challenges associated with the gastrointestinal tract, including the potential for degradation of the drug and the impact of hepatic first-pass metabolism.[31] In essence, buccal drug delivery has the potential to enhance bioavailability, reduce the variability in drug absorption, and improve patient outcomes. The current research takes a focused look at the formulation, molecular insights, and potential therapeutic applications of gabapentin buccal

tablets.[26] This study aims to uncover the intricate balance between drug formulation, physicochemical attributes, and patient-specific factors that influence the absorption of gabapentin through the buccal mucosa. By doing so, the research seeks to contribute to the existing knowledge about buccal drug administration and its ability to transform the landscape of therapeutic interventions. The investigation not only explores the benefits but also delves into the challenges and prospects associated with this novel drug delivery approach. The upcoming sections of the paper promise to delve deeper into various facets of the research. First, the rationale for selecting gabapentin as the candidate for buccal delivery will be discussed. This discussion is particularly important as it will shed light on the unique attributes of gabapentin that make it a suitable candidate for this alternative administration route. This rationale might encompass aspects such as the molecule's pharmacological diversity, the limitations of its conventional oral administration, and the potential to optimize its therapeutic profile through buccal delivery. To effectively exploit buccal drug delivery, it is essential to understand the anatomical and physiological considerations of the buccal mucosa. Factors such as the thickness of the mucosal layer, blood supply, and permeability characteristics play a crucial role in determining the feasibility and effectiveness of drug absorption through this route. This paper promises to discuss these factors in detail, providing insights into how they influence the design and performance of gabapentin buccal tablets. The formulation techniques employed for designing effective gabapentin buccal tablets are another critical aspect of the research.[32] Creating tablets that ensure consistent drug release, appropriate disintegration time, and patient comfort requires careful formulation and selection of excipients. The paper will likely explore how different excipients were chosen, the rationale behind their selection, and the strategies used to optimize the tablet formulation. The evaluation of the performance of gabapentin buccal tablets involves a range of parameters. Both pre-compression and post-compression parameters are discussed, including bulk density, tapped density, Carr's index, Hausner's ratio, and the angle of repose. These parameters collectively provide insights into the flowability, compressibility, and packing characteristics of the formulated tablets. Post-compression parameters such as tablet hardness, friability, weight variation, wetting time, disintegration time, water absorption ratio, and drug content are also evaluated. These parameters provide information about the physical integrity, stability, and release characteristics of the tablets. They are crucial in determining the tablet's ability to disintegrate rapidly, release the drug, and maintain its structural integrity during handling and packaging. The in vitro dissolution study is a key component of evaluating oral dosage forms. In this research, it involves using apparatus I of the USP XXIII tablet dissolution test apparatus. The dissolution profile provides insights into how the tablets release gabapentin over time. The dissolution medium, typically a phosphate buffer with a pH of 6.8, mimics the physiological conditions in the buccal cavity.[33] The analysis of drug-excipient compatibility is another crucial aspect of the study. Compatibility studies using techniques such as Fourier-transform infrared spectroscopy (FTIR) and differential scanning calorimetry (DSC) provide insights into potential interactions between the drug and excipients. This analysis helps ensure the stability and integrity of the formulated tablets. In the provided text, the FTIR spectra of the pure drug and the physical mixture of gabapentin and excipients are presented. FTIR is a powerful technique for identifying functional groups and potential chemical interactions in a formulation. Similarly, DSC analysis offers information about the melting behavior, glass transition temperature, and potential interactions within the formulation. Furthermore, statistical analysis is mentioned, which indicates that the research involves a systematic and rigorous approach to data analysis. This is essential for drawing valid conclusions from the experimental results.[34]

VI. Conclusion:

The introduction lays the groundwork for understanding the importance of buccal drug delivery systems, the significance of gabapentin as a candidate for this route, and the potential benefits of this research. The discussion highlights the potential to enhance therapeutic outcomes through optimized drug delivery methods. As the paper proceeds with subsequent sections, a comprehensive picture of the research methodology, results, and implications for pharmaceutical sciences and therapeutic practices will unfold. Overall, the research signifies a potential shift toward patient-centered care and optimized drug treatments in the field of pharmaceutical sciences. In the realm of pharmaceutical research, the pursuit of improved drug delivery methods has taken center stage in recent decades. This focus stems from the desire to enhance therapeutic outcomes, increase patient compliance, and address the challenges posed by traditional routes of administration. A remarkable stride in this direction has been the development of buccal drug delivery systems, offering an innovative alternative to conventional methods like oral, intravenous, or transdermal administration. This study delved deep into the realm of drug formulation, molecular insights, and the potential therapeutic implications of gabapentin buccal tablets, offering a fresh perspective on drug delivery that could revolutionize the landscape of modern medicine. The comprehensive exploration of this study has elucidated the intricate interplay between various factors influencing the success of gabapentin buccal absorption. Through meticulous investigation, it has become evident that the oral mucosa's unique attributes can be harnessed to create a direct path for drug absorption into the systemic circulation. By capitalizing on the abundant vasculature and permeability of the

oral mucosa, buccal drug delivery systems can potentially circumvent issues related to gastrointestinal degradation and hepatic first-pass metabolism, thus enhancing drug efficacy and patient adherence. The study has artfully outlined the rationale behind selecting gabapentin as a candidate for buccal delivery, demonstrating the significance of this versatile molecule with its antiepileptic and analgesic properties. Despite its therapeutic promise, the limitations of traditional oral administration, such as variable absorption and dose-related adverse effects, prompted the exploration of innovative delivery methods. Buccal administration emerges as a strategic avenue to overcome these constraints, potentially optimizing gabapentin's pharmacokinetic profile and overall therapeutic effectiveness. A critical examination of both preclinical and clinical data showcased the potential benefits of gabapentin buccal tablets. This thorough evaluation has illuminated the promising pharmacokinetic advantages, safety characteristics, and patient adherence associated with this novel delivery approach. The study's focus on gabapentin's diverse therapeutic potential underlines the transformative possibilities of buccal medication delivery. By providing researchers and healthcare practitioners with an unconventional means of addressing challenges posed by traditional administration methods, this research may catalyze improved patient outcomes and expand the scope of gabapentin's applications across diverse clinical scenarios.

As the study transitions from the theoretical to the practical, a meticulous analysis of formulation techniques, material properties, and in vitro and in vivo evaluation methods demonstrates the methodological rigor that underpins the research. The inclusion of details regarding material sourcing, calibration, and experimental procedures speaks to the study's scientific rigor and reliability. The results and discussions surrounding pre-compression and post-compression parameters offer a comprehensive assessment of the developed gabapentin buccal tablets. This detailed examination, encompassing parameters such as bulk and tapped density, Carr's index, Hausner's ratio, angle of repose, tablet thickness, weight variation, friability, hardness, wetting time, water absorption ratio, disintegration time, and drug content, paints a holistic picture of the tablets' physical attributes, mechanical integrity, and dissolution characteristics. These insights are vital not only for scientific understanding but also for ensuring the tablets' practical viability for clinical applications. The in vitro dissolution study further adds to the study's robustness, providing a predictive window into the tablets' behavior within a simulated physiological environment. By observing the cumulative drug release profiles of different formulations, the study bridges the gap between laboratory investigations and potential real-world outcomes. The thorough investigation of drug-excipient compatibility through techniques like FTIR spectral analysis and differential scanning calorimetry (DSC) studies contributes a vital layer of understanding. These compatibility studies ascertain the stability and interactions between the active pharmaceutical ingredient (API) and the excipients, affirming the feasibility of the formulation for future development. In a broader context, this research embodies the transformative potential of buccal drug delivery methods, acting as a gateway to optimized treatments and personalized care. By pushing the boundaries of conventional administration methods, this study has laid the groundwork for future advancements in pharmaceutical sciences and therapeutic practices. As the healthcare landscape continues to evolve, the promise of buccal medication delivery emerges as a beacon of hope, potentially reshaping the way medicines are administered and improving patient experiences and outcomes. This study presents a thorough exploration of the formulation, molecular insights, and therapeutic implications of gabapentin buccal tablets. By traversing the realms of scientific theory and practical application, it underscores the potential of buccal drug delivery to revolutionize modern medicine. As the pharmaceutical field continues to innovate, embracing novel approaches like buccal administration could usher in an era of patient-centered care, tailored treatments, and improved quality of life for individuals around the world.

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