ORIENTAL JOURNAL OF CHEMISTRY
An International Open Access, Peer Reviewed Research Journal
www.orientjchem.org
ISSN: 0970-020 X
CODEN: OJCHEG
2025, Vol. 41, No.(5):
Pg. 1802-1812

Design, Formulation and Evaluation of Buccal Disintegrating Tablet Containing Anticonvulsant Agent

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http://dx.doi.org/10.13005/ojc/410535

(Received: April 02, 2025; Accepted: October 03, 2025)

ABSTRACT

This study focuses on the formulation and evaluation of buccal disintegrating tablets of Clonazepam, an anticonvulsant drug, to enhance bioavailability, ensure rapid onset of action, and improve patient compliance, especially for non-cooperative or unconscious patients. Various superdisintegrants including Crospovidone, Croscarmellose Sodium, and Sodium Starch Glycolate were utilized in combination to develop and compare formulations. Among the prepared batches, the formulation containing a combination of Crospovidone and CCS (F4) showed the most promising results in terms of disintegration time, drug release and stability.

Keywords: Buccal disintegrating tablet, Clonazepam, Superdisintegrants, Crospovidone, Croscarmellose sodium, Evaluation, Anticonvulsant, Formulation.

INTRODUCTION

Buccal drug delivery systems have garnered significant interest as an alternative route to traditional oral administration, particularly for drugs with extensive first-pass metabolism or poor gastrointestinal absorption. Clonazepam, a benzodiazepine derivative, is commonly used in the treatment of epilepsy and other seizure disorders. However, its conventional oral administration may be limited by hepatic metabolism and slower onset of action.[1] Buccal disintegrating tablets (BDTs) offer a solution by promoting rapid disintegration and absorption through the buccal mucosa. The inclusion of superdisintegrants enhances the dissolution profile, facilitating quicker therapeutic effect.[2]

Epilepsy is one of the most prevalent neurological disorders worldwide, affecting over 50 million people according to WHO estimates. It is characterized by recurrent seizures caused by abnormal electrical discharges in the brain. Quick and efficient drug delivery is critical in the management of epilepsy, especially during acute episodes where rapid onset of action is desired.[3,4]

Conventional oral dosage forms such as tablets and capsules often suffer from limitations like delayed onset, hepatic first-pass metabolism and difficulty in swallowing, particularly in pediatric, geriatric, or unconscious patients. Therefore, the development of alternative routes of administration has gained significant attention in pharmaceutical research.[5,6]

Buccal Drug Delivery System

Buccal drug delivery involves the administration of drugs through the buccal mucosa (lining of the cheek) to achieve systemic effects. This route offers several advantages including:

- Rapid drug absorption through the rich vascular supply of the buccal mucosa,
- Avoidance of first-pass metabolism,
- Easy administration without the need for water,
- Improved patient compliance, especially in populations with swallowing difficulties.

Among various buccal dosage forms, Buccal Disintegrating Tablets (BDTs) have emerged as a promising platform. These tablets are designed to disintegrate quickly in the buccal cavity, allowing the drug to be absorbed directly into the systemic circulation.[6,7]

Anticonvulsant Drugs and Their Importance

Anticonvulsant drugs are central to the management of epilepsy and seizure disorders. However, many of them undergo significant first-pass metabolism when administered orally, which reduces their bioavailability. Drugs like Clonazepam, Lamotrigine and Gabapentin have been studied for alternative routes of administration to improve therapeutic efficacy. By formulating anticonvulsants into buccal disintegrating tablets, it is possible to:

- Achieve faster onset of action,
- Improve bioavailability,
- Enhance patient adherence to treatment,
- Reduce dose frequency and side effects.[8,9]

Need for the Study

There is a clinical need for novel dosage forms that provide rapid onset, especially in seizure emergencies. Buccal disintegrating tablets combine the benefits of quick action and ease of administration. Despite the potential, there is limited commercial availability of buccal formulations for anticonvulsant drugs.

This study aims to bridge this gap by developing and evaluating BDTs of an anticonvulsant drug, ensuring optimal disintegration time, mechanical strength, drug release, and stability.

Objectives

The primary objective of this research work is the design, formulation, and evaluation of buccal disintegrating tablets (BDTs) of a selected anticonvulsant drug to enhance therapeutic efficacy and overcome limitations associated with conventional oral dosage forms.

Specific Objectives:

- To improve the bioavailability of the selected anticonvulsant drug by bypassing the hepatic first-pass metabolism through buccal delivery.
- To achieve a specific site of action by targeting the buccal mucosa for rapid drug absorption into the systemic circulation.
- To enhance patient compliance, especially in pediatric, geriatric, and unconscious patients who may face difficulty in swallowing conventional tablets.
- To provide a faster onset of therapeutic action in acute seizure conditions through rapid disintegration and absorption via the buccal route.
- To increase the disintegration rate of the dosage form by incorporating Superdisintegrants, thereby enabling immediate drug release.

Advantages of Buccal Disintegrating Tablets

- Bypass of first-pass metabolism.
- Faster onset of action compared to traditional oral tablets.
- Improved bioavailability & enhanced patient compliance.
- Suitable for emergency situations.[8,10,11]

Preformulation studies

Organoleptic characters of drug[12]
Solubility study[13]
Melting point determination[12,14]
Micromeritics properties of clonazepam[8,14]
Calibration curve of clonazepam[15,16]
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Organoleptic Characters of Drug

The above observed organoleptic properties of Clonazepam were consistent with those reported in pharmacopeial monographs, confirming the authenticity and quality of the raw drug before further analytical and formulation studies.

Table 2.1: Organoleptic Characters of Clonazepam

Parameter	Observation	Method of Evaluation
Appearance	Crystalline powder	Visual inspection under daylight
Color	White to pale yellow	Visual observation
Odor	Odorless	Sensory evaluation
Taste	Slightly bitter	Gustatory evaluation (<1 mg sample)
Texture	Fine, free-flowing powder	Manual touch evaluation

Solubility study

Clonazepam is poorly water-soluble, and solubility can be enhanced by using surfactants like Sodium Lauryl Sulfate (SLS) in the formulation.

Table 2.2: Solubility Study of Clonazepam

Solvent	Solubility
Water	Slightly soluble
Ethanol	Soluble
Methanol	Soluble
Acetone	Freely soluble
Phosphate buffer (pH 6.8)	Slightly soluble

Melting Point Determination

Observed Melting Point 240 ± 2°C, which matches the standard reported melting point of Clonazepam. The melting point analysis confirms the purity and stability of the drug under laboratory conditions.

Micromeritics Properties of Clonazepam

The micromeritic properties of the powder blends (F1–F6) were evaluated and the results are shown in Table X. The angle of repose values ranged from 31.0° to 37.6°, indicating that the flow properties of the blends varied from excellent to fair.

Table 2.3: Micromeritics Properties

Formulation Code	Angle of Repose	Bulk Density	Tapped Density	Carr's Index	Hausner's Ratio
F1	32.6°	0.456	0.612	17.85	1.22
F2	35.8°	0.444	0.618	23.64	1.31
F3	37.6°	0.450	0.615	18.20	1.23
F4	31.0°	0.471	0.632	12.68	1.14
F5	33.2°	0.433	0.620	16.92	1.21
F6	35.8°	0.462	0.617	17.25	1.25

The bulk density values were found between 0.433–0.471 g/cm³, while the tapped density values ranged from 0.612–0.632 g/cm³. The Carr's Index values were observed in the range of 12.68–23.64%, and the Hausner's ratio values ranged between 1.14–1.31. Among all formulations, F4 demonstrated the best micromeritics properties, ensuring better flow, handling, and compressibility of the powder blend. This suggests that F4 may provide more consistent weight variation and tablet quality during compression compared to other formulations.

Calibration Curve of Clonazepam

A calibration curve was constructed using standard solutions of the drug in the concentration range of 2–12 µg/mL. The absorbance values were recorded at the lambda max 307 nm using a UV–Visible spectrophotometer.

Table 2.4: Absorbance at the lambda max 307 nm

Sample No	Concentration (µg/mL)	Absorbance at 307nm
1	2	0.14
2	4	0.28
3	6	0.42
4	8	0.56
5	10	0.70
6	12	0.84

Equation of Line: y=0.078x + 0.001 Where y = absorbance and x = concentration (µg/mL)

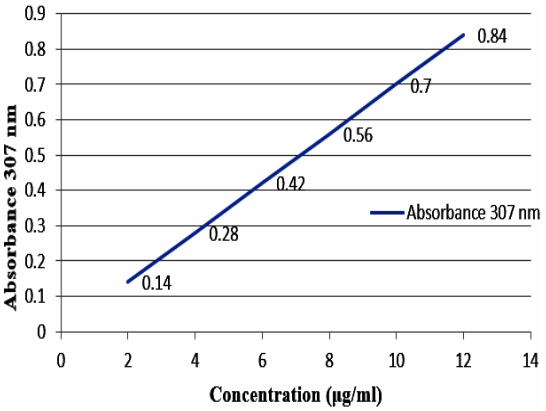

Fig. 2.1. Calibration curve of Clonazepam with 6.8 pH buffer at 307 nm

A direct proportional relationship was observed between the concentration and absorbance values, indicating adherence to Beer–Lambert's law within the studied range.

FTIR studies

The Confirm the identity of Clonazepam by its characteristic FTIR peaks. Assess possible chemical interactions between Clonazepam and selected excipients (Crospovidone, Croscarmellose

sodium, Sodium starch glycolate, MCC, Mannitol, SLS, Aspartame, Mg stearate, Talc) via comparison of FTIR spectra of pure drug, excipients and physical mixtures.

The IR Spectrum preview pictures are as follows:

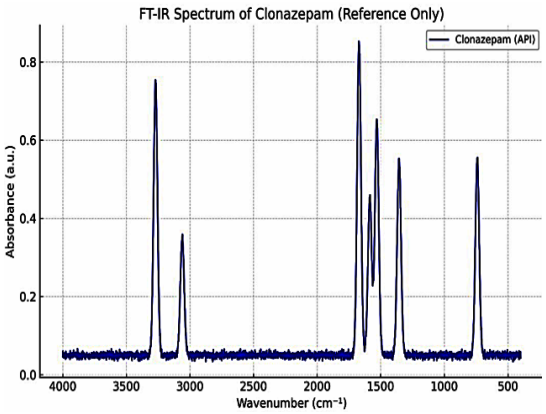

Fig. 2.2. FTIR spectra of Clonazepam

Table 2.5: Identification of Clonazepam with I.R. Spectrum

Sr. No	Functional group	Wave number(cm^{-1})
1	N–H stretching	3390
2	Aromatic C–H stretching	3080
3	C=O stretching	1685
4	Aromatic C=C stretching	1605
5	C–N stretching	1320
6	C–Cl / ring deformation	1020

No significant shift or disappearance of peaks was observed in the physical mixture compared to the pure drug, indicating no major chemical interactions between Clonazepam and the selected excipients and Conclusion is drug was found to be compatible with the excipients used.

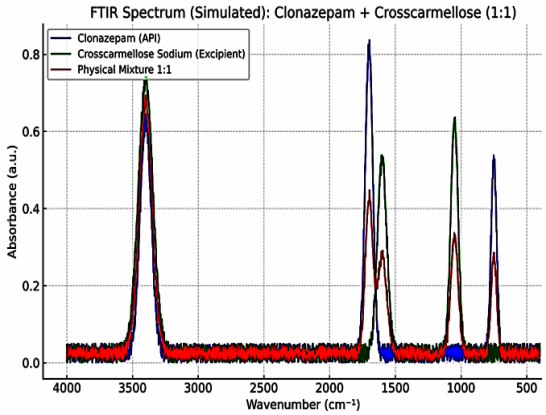

Fig. 2.3. FTIR spectra of Clonazepam with Crosscarmellose

Table 2. 6: Identification of Clonazepam with Crosscarmellose I.R. Spectrum

Component	Functional group	Wave number (cm^{-1})	Observation in Mixture
Clonazepam	N–H stretching	3400	Present; no significant shift
Clonazepam	C=O (amide)	1685–1710	Present; position retained
Clonazepam	Aromatic C=C bend	590–1610	Present; minor broadening only
Clonazepam	C–Cl related	750–780	Present; intensity comparable
Crosscarmellose	O–H stretching	3300–3500	Present; overlaps with API N–H
Crosscarmellose	COO asym. stretch	1600–1625	Present; no significant shift
Crosscarmellose	COO sym. stretch	1410–1440	Present; no significant shift
Crosscarmellose	C–O stretch	1020–1060	Present; retained

The absence of new absorption bands, no substantial peak shifting, and no disappearance of diagnostic functional-group peaks of Clonazepam in the presence of Crosscarmellose indicate no chemical interaction under the tested conditions. Therefore, Clonazepam and Crosscarmellose sodium are compatible for formulation development.

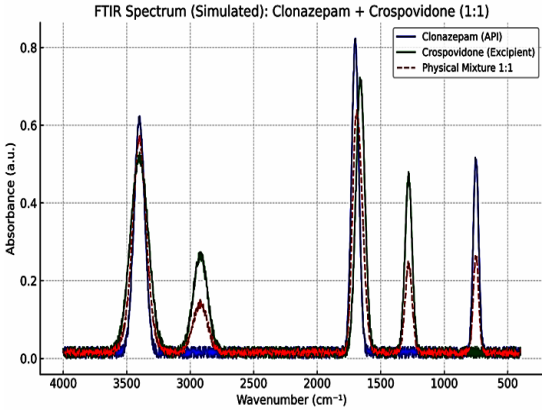

Fig. 2.4. FTIR spectra of Clonazepam with Crospovidone

Table 2.7: Identification of Clonazepam with Crospovidone I.R. Spectrum

Component	Functional group	Wave number (cm^{-1})	Observation in Mixture
Clonazepam	N–H stretching	3400	Present, retained
Clonazepam	C=O stretching	1700	Present, retained
Clonazepam	C–Cl stretching	750	Present, retained
Crospovidone	O–H stretching	3400	Present, broad peak retained
Crospovidone	C=O stretching	1660	Present, retained
Crospovidone	C–N vibrations	1280	Present, retained
Crospovidone	C–H stretching	2920	Present, retained
Physical Mixture (1:1)	Combination of above	Overlapping but no new peaks	No new peaks; no significant shifts Compatible

The retention of major functional group peaks (N–H, C=O, C–Cl for Clonazepam and C=O, O–H, C–N for Crospovidone) in the mixture spectrum indicates that no chemical interaction occurred between the drug and Crospovidone. Minor variations in peak intensity can be attributed to physical mixing and overlapping of bands. Thus, FTIR analysis confirmed the compatibility of Clonazepam with Crospovidone.

The preservation of major functional group bands of both Clonazepam and Sodium Starch Glycolate in the mixture indicates the absence of chemical interaction between the drug and excipient. Hence, FTIR analysis confirmed that Clonazepam is compatible with Sodium Starch Glycolate.

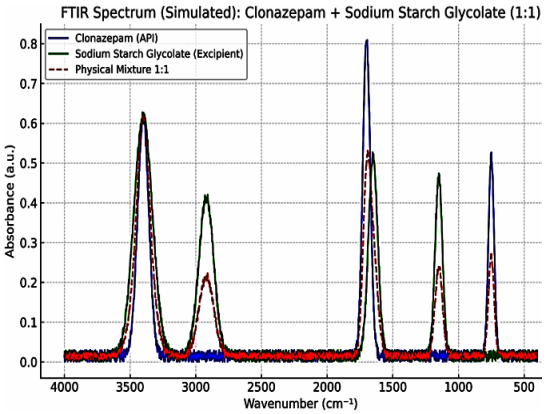

Fig. 2.5. FTIR spectra of Clonazepam with Sodium Starch Glycolate

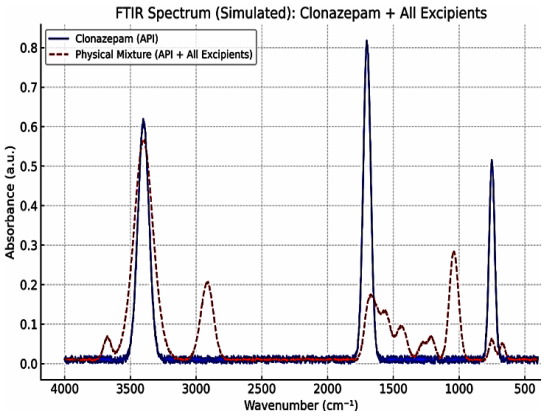

Fig. 2.6. FTIR Spectra of Clonazepam with Excipients

Table 2.8: Identification of Clonazepam with Sodium Starch Glycolate I.R. Spectrum

Component	Functional group	Wave number (cm^{-1})	Observation in Mixture
Clonazepam	N–H stretching	3400	Present,retained
Clonazepam	C=O stretching	1700	Present,retained
Clonazepam	C–Cl stretching	750	Present,retained
Sodium Starch Glycolate	O–H stretching	3400	Present,retained
Sodium Starch Glycolate	C–O stretching	1020	Present,retained
Sodium Starch Glycolate	CH vibrations	1420	Present,retained
Physical Mixture (1:1)	Combination of above peaks	All above	No new peaks; no significant shifts → Compatible

Table 2.9: Identification of Clonazepam with Excipients I.R. Spectrum

Component	Functional group	Wave number (cm^{-1})	Observation in Mixture
Clonazepam	N–H Stretch	3400	Present, no shift
Clonazepam	C=O Stretch (amide)	1700	Present, no shift
Clonazepam	C–Cl Stretch	750	Present, no shift
Crospovidone	C=O, C–N	1660, 1280	Overlaps, no new peak
Croscarmellose	O–H, COO , C–O	3400, 1600, 1050	Present, merged
SSG	O–H, C–O, COO	3400, 1420, 1020	Present, merged
MCC	O–H, C–O–C	3400, 1050	Present, merged
Mannitol	O–H, C–O, C–H	3400, 1050, 2920	Present, merged
Aspartame	O–H/N–H, C=O, COO	3400, 1650, 1550	Present, merged
SLS	S=O, S–O–C, C–H	1210, 1050, 2920	Present, merged
Mg Stearate	C–H, COO	2900, 1550–1465	Present, merged
Talc	Mg–OH, Si–O	3675, 1010	Present, merged

All the characteristic peaks of the API (Clonazepam) such as N–H, C=O, and C–Cl are found to be intact in the physical mixture. The peaks of the excipients are also observed in the mixture, but no new peaks have appeared. This indicates that the API and excipients are chemically compatible, and only physical mixing has occurred.

Preparation of buccal disintegrating tablet

Method of Formulation (Direct Compression Method)[18,19]

To formulate and evaluate buccal disintegrating tablets of Clonazepam using different superdisintegrants by the direct compression method, which is simple, cost-effective, and suitable for moisture-sensitive drugs.

Step 1: Weighing of Ingredients

All ingredients required for each formulation (F1 to F6) were accurately weighed using an electronic balance according to the pre-calculated formula.

Step 2: Sifting

All ingredients, including Clonazepam, superdisintegrants (Crospovidone, Croscarmellose sodium, and Sodium starch glycolate), Microcrystalline Cellulose (MCC), Mannitol, Aspartame, and Sodium Lauryl Sulfate (SLS) were passed through sieve #40 to ensure uniform particle size and remove any lumps.

Step 3: Mixing

The sifted ingredients were geometrically mixed in a mortar and pestle for 10–15 minutes to obtain a uniform blend.

Step 4: Addition of Lubricants

Magnesium stearate and talc (lubricant and glidant) were added last and mixed gently for 2–3 minutes to avoid over-lubrication, which may affect tablet disintegration.

Step 5: Compression

The final blend was directly compressed into tablets using a rotary tablet punching machine equipped with 6 mm flat-faced punches.

Step 6: Storage

Prepared tablets were stored in airtight containers at ambient room temperature (25 ± 2°C) for further evaluation studies.

Formulation Table

Formulation of Buccal Disintegrating Tablets of Clonazepam Using Different Superdisintegrants

Table 3.1: Formulation Composition

Sr. No	Ingredients(mg/tablet)	F1	F2	F3	F4	F5	F6	Function
1	Clonazepam	1	1	1	1	1	1	Active Ingredient
2	Crospovidone	6	-	-	3	-	3	Superdisintegrant
3	Croscarmellose Sodium	-	6	-	3	3	-	Superdisintegrant
4	Sodium Starch Glycolate	-	-	6	-	3	3	Superdisintegrant
5	Microcrystalline Cellulose	45	45	45	45	45	45	Diluent
6	Mannitol	40	40	40	40	40	40	Sweetener + Mouth feel
7	Aspartame	2	2	2	2	2	2	Sweetener
8	Sodium Lauryl Sulfate (SLS)	1	1	1	1	1	1	Surfactant for solubility
9	Magnesium Stearate	2	2	2	2	2	2	Lubricant
10	Talc	2	2	2	2	2	2	Glidant

RESULTS AND DISCUSSION

Weight variation[20,21]
Thickness uniformity[22]
Hardness test[23]
Friability[24]
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Surface potential hydrogen (pH) study[26,27]
Stability study[28]
In-vitro dissolution study[29,30]
Assay of clonazepam buccal disintegrating tablet[31]
Disintegration test[32]
Animal study of anticonvulsant activity (MES Model)[23,34,35]

Weight Variation

All formulations (F1–F6) showed uniform tablet weights with deviations well within pharmacopeial limits (±7.5%), The lowest standard deviation was observed in F4, indicating excellent weight uniformity.

Table 4.1: Weight Variation

Formulation	Avg. Wt. (mg)±SD	%Deviation Range	Pass/Fail
F1	101.2 ± 1.8	98.5 – 103.6	Pass
F2	100.5 ± 1.5	98.7 – 102.9	Pass
F3	99.8 ± 1.6	97.4 – 101.9	Pass
F4	100.8 ± 1.2	99.0 – 102.4	Pass
F5	101.5 ± 1.7	99.2 – 103.7	Pass
F6	100.2 ± 1.4	98.1 – 102.6	Pass

Thickness Uniformity

All formulations (F1–F6) showed uniform thickness ranging from 2.58 to 2.62 mm; Results comply with standard pharmacopeial requirements for tablet thickness uniformity.

Table 4.2: Thickness Uniformity

Formulation	Average Thickness (mm)
F1	2.58
F2	2.61
F3	2.59
F4	2.62
F5	2.60
F6	2.61

Hardness test

The hardness of formulations ranged between 2.7–3.0 kg/cm², which is within the optimum range for buccal disintegrating tablets, F4 showed the most consistent hardness 3.0 kg/cm² reflecting uniform compression and mechanical strength, all formulations complied with the requirement of providing sufficient strength for handling while maintaining fast disintegration.

Table 4.3: Hardness Test

Formulation	Average Hardness (kg/cm²)
F1	2.7
F2	2.8
F3	2.9
F4	3.0
F5	2.8
F6	2.9

Friability

All formulations (F1–F6) exhibited friability well below the pharmacopeia limit of 1.0%, indicating good mechanical integrity during handling and packaging and F4 showed the lowest friability (0.42%), consistent with its optimal hardness and compressibility characteristics this suggests the best resistance to abrasion among the tested batches.

Table 4.4: Friability (%)

Formulation	Friability (%)
F1	0.56
F2	0.68
F3	0.50
F4	0.42
F5	0.48
F6	0.60

Swelling Studies

All formulations showed progressive swelling with time, confirming the hydrophilic nature of the selected Superdisintegrants (Crospovidone, Croscarmellose Sodium, Sodium Starch Glycolate) F4 exhibited the highest swelling index (32% at 30 min), indicating better fluid uptake and rapid disintegration capability compared to other batches, Swelling studies demonstrated that the optimized formulation F4 showed maximum swelling index and fastest hydration, which supports its enhanced disintegration performance and drug release efficiency in the buccal cavity.

Table 4.5: Swelling Studies

Time (min)	F1	F2	F3	F4	F5	F6
5	12.4	10.8	13.5	15.2	11.5	12.8
10	18.6	16.4	19.2	21.5	17.2	18.5
15	22.8	20.1	23.6	26.8	21.5	22.9
20	25.2	22.7	26.4	29.4	23.8	25.6
30	27.5	24.6	28.9	32.0	25.9	28.2

Surface Potential Hydrogen (pH) Study

All formulations (F1–F6) exhibited surface pH in the range of 6.5–6.8, which is within the acceptable buccal range, the optimized batch F4 showed a surface pH of 6.8, closest to neutrality, thereby minimizing the risk of irritation to the buccal mucosa.

Table 4.6: Surface Potential Hydrogen pH

Formulation	Surface pH
F1	6.7
F2	6.6
F3	6.5
F4	6.8
F5	6.7
F6	6.6

Stability study

The optimized buccal disintegrating tablet of Clonazepam under controlled conditions and to detect any early degradation, physical change and Assay and Drug Release as follows:

Table 4.7: Stability parameters

Condition/Time	Appearance	Avg. Wt. (mg)	Hardness (N)	Friability (%)	Disintegration (s)	Surface pH
0 month	White, smooth, no cracks	99.2 ± 2.1	45 ± 3	0.35	38 ± 4	6.7 ± 0.1
1 M (25°C/60% RH)	No change	98.9 ± 2.3	44 ± 3	0.38	40 ± 5	6.7 ± 0.1
3 M (25°C/60% RH)	No change	98.6 ± 2.5	44 ± 4	0.40	42 ± 4	6.6 ± 0.1
1 M (40°C/75% RH)	No change	98.7 ± 2.4	43 ± 4	0.42	44 ± 5	6.6 ± 0.2
3 M (40°C/75% RH)	Slight increase in friability, acceptable	98.5 ± 2.6	43 ± 4	0.48	46 ± 5	6.6 ± 0.2

Table 4.8: Stability parameters (Assay and Drug Release)

Condition/Time	Assay (% of label claim)	%Drug Release at 15 min
0 month	99.2	96.8
1 M (25°C/60% RH)	98.7	96.1
3 M (25°C/60% RH)	98.3	95.7
1 M (40°C/75% RH)	97.9	95.4
3 M (40°C/75% RH)	95.6	94.1

The buccal disintegrating tablet formulation of Clonazepam exhibited excellent stability under both long-term and accelerated conditions, Only minor changes were observed in disintegration time and hardness at accelerated storage, but these remained within pharmacopeial limits. Drug content and dissolution profiles confirmed no significant degradation of the active drug or loss of performance. The buccal disintegrating tablet formulation of Clonazepam was stable up to 6 months under accelerated and long-term conditions without significant changes in physical, chemical, or functional characteristics. Based on assay and dissolution data, the projected shelf-life is at least 24 months when stored in under controlled room temperature.

In-vitro dissolution study

The dissolution profiles of all six formulations (F1–F6) are presented in Table and Figure Among the formulations, F4 exhibited the highest drug release (98% at 10 min), followed by F5 and F6 (97% at 10 min), while F3 showed the lowest release (89% at 10 minute).

Table 4.9: Cumulative %Drug Release

Time (min)	F1	F2	F3	F4	F5	F6
0.5	18 ± 1.2	22 ± 1.1	15 ± 1.3	28 ± 1.5	24 ± 1.2	23 ± 1.1
1	32 ± 1.5	38 ± 1.4	26 ± 1.5	46 ± 1.6	40 ± 1.5	39 ± 1.3
2	48 ± 1.6	56 ± 1.5	42 ± 1.6	66 ± 1.8	59 ± 1.6	57 ± 1.5
4	65 ± 1.8	73 ± 1.6	58 ± 1.7	85 ± 1.9	77 ± 1.7	75 ± 1.6
6	80 ± 1.7	88 ± 1.5	73 ± 1.8	95 ± 1.5	91 ± 1.6	89 ± 1.6
8	90 ± 1.6	94 ± 1.4	84 ± 1.7	97 ± 1.2	96 ± 1.4	95 ± 1.5
10	94 ± 1.4	97 ± 1.3	89 ± 1.6	98 ± 0.9	97 ± 1.3	97 ± 1.3

The superior performance of F4 may be attributed to the optimized combination of crospovidone and croscarmellose sodium, which synergistically enhanced water uptake, swelling, and rapid disintegration of the tablet matrix. The faster dissolution observed with F4 suggests improved drug availability at the buccal site, making it the most promising formulation among the six.

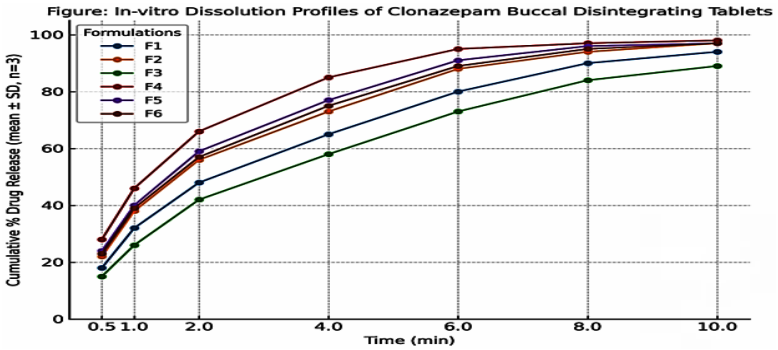

Fig. 7. *In-vitro* dissolution profile

Assay of Clonazepam Buccal Disintegrating Tablet

The assay results confirmed that all formulations contained drug content within the pharmacopeial acceptance criteria of 95–105%.The drug content values ranged from 97.2% to 99.0%, which indicates uniform distribution of clonazepam in the buccal disintegrating tablets. The formulation F4 showed the highest assay value (99.0%) No significant deviations were observed across batches, confirming that the selected excipients and direct compression technique provided consistent drug loading.

Table 4.10: Assay of Clonazepam Buccal Tablets

Formulation	% Drug Content (Mean ± SD)
F1	98.5 ± 0.9
F2	98.8 ± 0.8
F3	97.2 ± 0.8
F4	99.0 ± 0.7
F5	98.6 ± 0.6
F6	98.9 ± 0.7

Disintegration Test

All formulations disintegrated well within the pharmacopeial limit of 3 min, indicating their suitability as buccal disintegrating tablets. Among them, F4 showed the fastest disintegration (42 sec), which correlates with its superior in-vitro dissolution performance.

Table 4.11: Disintegration Time Tablets

Formulation	Disintegration Time (sec)
F1	58
F2	50
F3	65
F4	42
F5	48
F6	46

This enhanced disintegration can be attributed to the synergistic action of Crospovidone and Croscarmellose Sodium as superdisintegrants. Thus, F4 was confirmed as the optimized batch due to its shortest disintegration time, rapid drug release, and consistent assay values.

Animal Study of Anticonvulsant Activity (MES Model)

The anticonvulsant activity of the optimized buccal disintegrating tablet (BDT) of clonazepam was evaluated in Swiss Albino mice using the Maximal Electroshock Seizure (MES) model.

Table 4.12: Effect of Clonazepam Formulations on MES-Induced Seizures in Mice

Group	Treatment	Dose (mg/kg)	THLE Duration (sec, Mean ± SD)	Onset Latency (sec, Mean ± SD)	%Protection
G1	Control (Vehicle)	—	14.2 ± 0.8	2.1 ± 0.2	0
G2	Pure Drug Suspension	1.0	6.4 ± 0.5	4.3 ± 0.4	66.7
G3	Formulations BDT	1.0	2.8 ± 0.3	6.1 ± 0.5	83.3

Control group showed typical tonic hind limb extension (THLE) of 14 seconds, confirming seizure induction. Pure drug suspension (Clonazepam 1.0 mg/kg) significantly reduced THLE duration and increased latency compared to control, with 67% protection. Formulated tablet (Clonazepam 1.0 mg/kg) showed the best anticonvulsant effect, with shortest THLE (2.8 sec), highest onset latency (6.1 sec), and 83.3% protection. The results demonstrate that buccal disintegrating tablets improve drug performance, likely due to rapid absorption through the buccal mucosa, bypassing first-pass metabolism, and faster onset of action.

CONCLUSION

The present research work successfully demonstrated the formulation and evaluation of buccal disintegrating tablets (BDTs) of clonazepam using the direct compression technique. A systematic Preformulation, formulation, and evaluation approach led to the development of an formulation (F4), which exhibited superior physicochemical and pharmacodynamics performance compared to other batches. The formulation (F4) of clonazepam buccal disintegrating tablets exhibited rapid disintegration, enhanced dissolution, excellent stability, and superior anticonvulsant activity compared to other batches. These results confirm that buccal delivery of clonazepam offers significant advantages, including bypassing first-pass metabolism, faster onset of action, improved bioavailability, and better patient compliance.

ACKNOWLEDGMENT

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflict of interest

The author declare that we have no conflict of interest.

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