RESEARCH PAPER

Formulation and Evaluation of Irbesartan-Loaded Buccal Films: A Novel Approach to Enhance Patient Compliance in Hypertension Management

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ABSTRACT

Hypertension is a leading cardiovascular disorder, increasing the risk of stroke, heart failure, and renal diseases. Despite effective drugs, conventional oral therapies often face poor patient compliance due to complex regimens and side effects. Irbesartan, an angiotensin II receptor blocker (ARB), has limited oral bioavailability (60–80%) due to extensive first-pass metabolism. To overcome this, mucoadhesive buccal films were developed to enhance its pharmacokinetic profile and patient compliance. Using the solvent casting method, ten Irbesartan buccal film formulations (F1–F10) were prepared with Hydroxypropyl Methylcellulose (HPMC E15) and Eudragit L100 as polymers and PEG 400 as plasticizer. The films were evaluated for thickness, weight uniformity, surface pH, drug content, folding endurance, swelling index, and in vitro drug release. Formulation F5 emerged as optimal, showing high drug content (~99.4%), excellent folding endurance, and sustained drug release for over 10 hours. Its physicochemical properties were within pharmacopeial limits and suitable for buccal retention. In contrast, F9 exhibited surface pores, leading to inconsistent release. This study demonstrates that F5 buccal films can improve Irbesartan bioavailability and offer a patient-friendly approach for hypertension management. Further in vivo studies are suggested to confirm clinical efficacy.

Keywords: Irbesartan, Buccal film, Hypertension, Mucoadhesive, HPMC E15, Eudragit L100, PEG 400, Sustained release, Solvent casting, First-pass metabolism.

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INTRODUCTION

Hypertension, often referred to as high blood pressure, is a chronic medical condition marked by a consistent increase in the pressure exerted by blood against the walls of the arteries. It is typically identified when the systolic blood pressure (SBP) is equal to or exceeds 140 mmHg and/or the diastolic blood pressure (DBP) is 90 mmHg or higher **(WHO, 2021)**. Known as the "silent killer" due to its lack of obvious symptoms, hypertension poses a significant public health challenge globally and notably elevates the risk of serious cardiovascular issues, including heart attacks, strokes, chronic kidney disease, and premature death **[1].** Currently, approximately 1.28 billion adults aged between 30 and 79 are affected by hypertension worldwide, but only about 20% manage to keep their blood pressure within healthy limits. In India, the scenario is similarly concerning, with around 220 million individuals living with this condition and control rates lingering below 12% (Gupta et al., 2019). The condition is slightly more prevalent in men (24%) than in women (21%), and its rates are steadily increasing across all age demographics **[2]**.

Hypertension is primarily classified into two categories:

1. Primary (Essential) Hypertension: This type accounts for the vast majority of hypertension cases. It arises from a combination of various lifestyle choices and genetic predispositions, including smoking, excessive alcohol consumption, high salt intake, obesity, a sedentary lifestyle, and chronic stress.

2. Secondary Hypertension: Representing about 5–10% of cases, secondary hypertension is linked to specific and often treatable underlying conditions, such as kidney disease, endocrine disorders, or the use of certain medications. It is more commonly found in younger populations.

Given its widespread occurrence and potential for severe health ramifications, hypertension continues to be a focal point for preventive initiatives and innovative therapeutic solutions. This highlights the urgent need for the development of effective drug delivery systems aimed at enhancing treatment outcomes and ensuring better patient adherence to prescribed regimens.

Buccal Drug Delivery System

The oral cavity is an easily accessible region of the human body, characterized by a rich blood supply and a large surface area, which makes it an attractive site for both local and systemic drug administration **[3]**. Among the different regions within the oral cavity, the buccal region refers to the inner lining of the cheeks and plays an important role in oral health and overall function. Its anatomical and physiological features provide unique advantages for drug delivery. The buccal mucosa offers a permeable surface that allows direct drug absorption into the systemic circulation, bypassing hepatic first-pass metabolism. This property has supported the development of innovative dosage forms such as buccal films, which are thin and flexible systems designed to adhere to the buccal mucosa **[4]**. These films may either dissolve completely or remain in the oral cavity for a specified period, enabling the drug to be absorbed directly through the mucosal lining. Buccal drug delivery systems provide several advantages, including rapid onset of action, the possibility of controlled drug release, and avoidance of first-pass metabolism, which significantly improves bioavailability. These systems also enhance patient compliance, especially in populations with difficulty swallowing, such as elderly or pediatric patients. Additional benefits include accurate dosing, minimal discomfort, and high stability of the formulation.

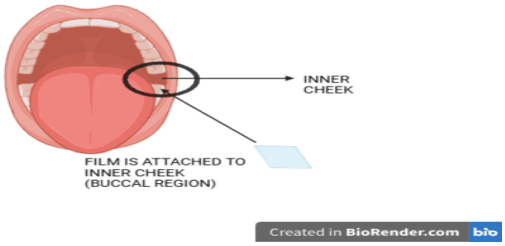

Fig 1: Buccal Film

Clinically, buccal films are suitable for drugs with poor oral bioavailability, those requiring a rapid therapeutic effect, or patients with altered swallowing abilities. These characteristics make buccal films a promising strategy for systemic drug delivery, particularly in conditions such as hypertension where improved bioavailability and patient compliance are essential.

MATERIALS AND METHODS

2.1 Materials

Irbesartan was received as a gift sample from XYZ Pharmaceuticals Ltd., India. Hydroxypropyl methylcellulose (HPMC 15 cps) from Qualikems Fine Chem Pvt.Ltd.,Vadodara, India and Eudragit L-100 were purchased from Molychem, Mumbai, India , Polyethylene glycol 400 (PEG 400), propylene glycol, and ethanol were procured from Merck India Pvt. Ltd., Mumbai, India. Distilled water was prepared in the laboratory. All other reagents used were of analytical grade

2.2 Preformulation studies

Preformulation studies are an essential step in the rational development of pharmaceutical formulations. The primary objective of these studies is to generate data that helps in understanding the physicochemical properties of the drug substance, excipient compatibility, and the potential behavior of the drug in a dosage form. These parameters significantly influence the selection of appropriate formulation strategies and processing methods **[5]**.

1.Organoleptic Evaluation

Objective: To observe the basic sensory characteristics of the drug such as color, odor, and texture.

Methodology: A small amount of the pure drug was taken and observed under natural light for color and physical form. Odor was evaluated by gently inhaling the sample. These parameters provide preliminary information regarding the appearance and acceptability of the final dosage form **[6]**.

2. Determination of Melting Point

Objective: To determine the purity and thermal stability of the drug.

Methodology: The melting point of the drug was determined using the capillary tube method or digital melting point apparatus. A small quantity of the powdered drug was filled into a capillary tube, sealed at one end, and placed in the instrument. The temperature at which the drug begins and completes melting was recorded **[7]**.

3. Determination of pH

Objective: To determine the pH of the drug solution and understand the environment in which the drug remains stable.

Methodology: A 1% w/v aqueous solution of the drug was prepared and the pH was measured using a calibrated digital pH meter.

4. Solubility Study

Objective: To determine the solubility of the drug in different solvents.

Methodology: Excess amount of drug was added to different solvents like distilled water and ethanol shaken for 24 hours at room temperature in a mechanical shaker. After equilibrium, solutions were filtered and analyzed using UV spectroscopy to quantify the dissolved drug.

5. IR-Analysis (FTIR Spectroscopy)

This method was used to identify the functional groups of the drug and to study the interaction and compatibility between the drug and excipients using Fourier-Transform Infrared (FTIR) Spectroscopy over the wave number range of 4000–400 cm^{-1}, and the characteristic bands were recorded.

6. UV absorption maxima Irbesartan in ethanol

UV scanning was done for 5µg/ml drug solution from 200-400 nm in methanol as a blank using Shimadzu UV 1800 double beam UV/Visible spectrophotometer.

7. Standard curve of Irbesartan in ethanol

7.1 Preparation of stock solution

10 mg of Irbesartan was accurately weighed and transferred in 10 ml volumetric flask. It was dissolved in ethanol and volume was made up to the mark with ethanol to get 1000 µg/ml solution. Then from the solution of 1000 µg/ml, 1 ml sample is transferred in to 10 ml of volumetric flask and diluted up to the mark to get 100 µg/ml.

7.2 Preparation of standard curve in ethanol

From the stock solution 0.1, 0.2, 0.3, 0.4, 0.5 ml samples were transferred to 10 ml volumetric flask and diluted with the water up to the mark to obtain Irbesartan concentration of 1-µg/ml respectively. The absorbance of each solution was measured spectrophotometrically at 244 nm and a standard curve was plotted between the concentration and the absorbance.

2.2 Methodology

2.2.1Preparation of Buccal Films [8]

Buccal films were prepared by the solvent casting method. Initially, the required amount of film-forming polymer (HPMC) was dispersed in a portion of distilled water and allowed to swell completely. Separately, the drug (Irbesartan) was dissolved in a suitable solvent system comprising ethanol, along with plasticizers propylene glycol, and surfactants like Tween 80.In another beaker, Eudragit L100 was dispersed/dissolved using ethanol with the help of mild stirring. The drug solution and polymer solutions were then mixed thoroughly under continuous stirring to form a uniform casting solution. Other excipients such as citric acid, sweeteners (e.g., saccharin sodium), and Triethanolamine (used for pH adjustment and solubility enhancement) were then added and mixed well.The final homogeneous solution was sonicated briefly to remove entrapped air bubbles. The solution was then poured onto a leveled Petri dish or glass plate and dried at room temperature or in a hot air oven (not exceeding 40–45°C) until a flexible film was formed. The dried films were carefully peeled off and stored in desiccators for further evaluation.

Table 1: Composition of Formulations

Component	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10 (Placebo)
Irbesartan (mg)	375	375	375	375	375	375	375	375	375	—
HPMC 15 cps (g)	2.0	2.2	2.4	2.6	3.0	3.2	3.4	2.0	3.8	3.0

Eudragit L100 (mg)	100	100	100	100	100	100	100	100	100	100
Propylene Glycol (ml)	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.0	2.5	2.5
Ethanol (ml)	10	10	10	10	10	10	10	12	10	4
Citric Acid (mg)	45	45	45	45	45	45	45	45	45	45
Saccharin Sodium (mg)	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
Distilled Water (ml)	25	25	25	25	25	25	25	30	25	25

2.3 Evaluation parameters of buccal film [4]

The prepared buccal films were subjected to various physicochemical evaluations to determine their suitability for drug delivery. The following parameters were assessed:

1.Weight Uniformity

Three films from each formulation were weighed individually using an electronic balance. The mean weight and standard deviation were calculated to ensure uniformity **[9]**.

2.Folding Endurance

Folding endurance was determined by repeatedly folding a film at the same place until it broke. The number of folds before breaking was recorded as the folding endurance value **[10]**.

3.Surface pH

The surface pH of the films was determined to ensure the films are non-irritant to the buccal mucosa. Films were allowed to swell in 1 mL of distilled water for 2 hours, and the pH was measured using a digital pH meter **[11]**.

4.Moisture Absorption

Pre-weighed films were placed in a desiccator containing saturated potassium chloride (maintains ~75% RH) for 72 hours. The films were then reweighed, and the percent moisture absorption was calculated.

$$\% \text{ Moisture Uptake} = \text{Final weight} - \text{Initial weight} / \text{Final weight} \times 100$$

5. Moisture Loss

Films were weighed and placed in a desiccator containing fused calcium chloride (dry conditions) for 72 hours. The difference in weight was used to calculate moisture loss **[12]**.

$$\% \text{ Moisture Content} = \text{Initial weight} - \text{Final weight} / \text{Initial weight} \times 100$$

6. Drug Content Uniformity

The drug content was evaluated by dissolving a known weight of film in methanol, followed by suitable dilution and measurement of absorbance using a UV-Visible spectrophotometer at 227 nm **[13]**.

7. Scanning Electron Microscopy (SEM) [14]

The surface and cross-sectional morphology of the prepared buccal films were examined using Scanning Electron Microscopy (SEM) to evaluate their structural characteristics, such as smoothness, porosity, and internal uniformity. Small pieces of each film formulation were carefully cut, and for cross-sectional analysis, the films were fractured using liquid nitrogen to obtain a clean break.The samples were mounted on aluminum stubs using double-sided conductive carbon tape and were coated with a thin layer of gold using a sputter coater to ensure surface conductivity and prevent charging. SEM analysis was performed using a scanning electron microscope operated at an accelerating voltage of 15 kV with a working distance of approximately 13 mm. Images were captured at different magnifications (×40, ×100, and ×300) to observe both surface and internal structures of the films.

The SEM analysis was carried out at the University Sophisticated Instrumentation Centre (USIC), Panjab University, Chandigarh.

8. In-vitro Drug Release [15]

The in-vitro drug release study of Irbesartan buccal films was conducted using a self-designed diffusion setup, where a test tube acted as the donor compartment and a beaker served as the receptor, simulating a Franz diffusion cell. An egg membrane, pre-soaked in phosphate buffer pH 6.8, was used as the diffusion barrier. The buccal film was placed over the receptor

beaker, covered with the membrane, and the test tube was inverted and secured tightly. The receptor contained 250 ml of phosphate buffer (pH 6.8), maintained at 37 ± 0.5°C and stirred at 50 rpm. Samples were withdrawn at set time intervals (5–60 min), replaced with fresh buffer, and analyzed at 227 nm using a UV spectrophotometer. Drug release was calculated using a standard curve, and cumulative release was plotted against time

9. Kinetic drug release

There are number of kinetic models, which show the overall release of drug from the various dosage forms. Based on the results of *in-vitro* drug release studies; graphs were plotted for the models to interpret the kinetic behavior from developed vesicular carriers **[16]**

The models studied were:-

- **Zero order rate kinetics –** Zero order kinetics defines the process of constant drug release from a drug delivery system and drug level in the blood remains constant throughout the delivery. In others words, It describes the system in which the drug release rate is independent on its concentration. According to the principles of pharmacokinetics, drug release from the dosage form can be represented by the Equation:

$$\mathbf{Q_t = Q_0 + K_0}$$

Q_t=amount of drug release at time t,

Q_O=initial concentration of drug at time t=0,

K_O = zero-order rate constant,

t = time in hours.

Hencetostudythedrugreleasekineticsthegraphisplottedbetweenthecumulative percent drug releases with respect to time.

- **First order rate kinetics** – It can be defined as that first order process is the one whose rate is directly proportional to the concentration of drug undergoing reaction i.e., greater the concentration faster the reaction.

The release of drug which follows first order kinetics can be represented by the,Equation:

$$\mathbf{\log Q = \log Q_O + K_t / 2.303}$$

K = first order rate equation expressed,

Q_O = initial concentration of the drug,

Q=percent of drug remaining at time t,

t = time in hours.

Hence to study the drug release kinetics the graph is plotted between log cumulative percentage drug remaining with respect to time.

Higuchi s kinetics – It is also called as the Higuchi's classical diffusion equation/ Higuchi matrix. It describe the fraction of drug release from a matrix is proportional to square root of time

$$\mathbf{Q_t = KHt_{1/2}}$$

Q_t=cumulative amount of drug release at time t

KH = Higuchi constant

t = time in hours

Hence to study the drug release kinetics the graph is plotted between the cumulative percent drug releases with respect to square root of time.

- **Korsmeyer peppa's –** To understand the dissolution mechanisms from the matrix, the release data were fitted using the well-known empirical equation proposed by Korsmeyer and Peppas.

The release of drug can be represented by the Equation:

$$\mathbf{Q_t / Q_\infty = Kkptn}$$

Q_t=amount of drug released in time t,

Q_∞=amount of drug released after time∞,

n=diffusional exponent or drug release exponent,

Kkp = Korsmeyer release rate constant.

Hence to study the drug release kinetics the graph is plotted between log cumulative percentage drug released with respect to log time **[17]**. Hence, n value is used to characterize different release mechanisms as given in table form.

Table 2: Release mechanism by 'n' value

Release exponent(n)	**Drug transport mechanism**
Less than 0.45	Quasi Fickian
0.45	Fickian diffusion
0.45<n<0.89	Anomalous diffusion or non- Fickian diffusion

0.89-1	Case II transport
Higher than 1	Supercase II transport

10. Kinetic Model Graphs

To determine the release kinetics, in-vitro drug release data of all formulations were fitted into four mathematical models: Zero-order, First-order, Higuchi, and Korsmeyer–Peppas. The respective graphs were plotted as follows:

- Zero-order plot: Cumulative % drug released vs. time
- First-order plot: Log cumulative % drug remaining vs. time
- Higuchi plot: Cumulative % drug released vs. square root of time
- Korsmeyer–Peppas plot: Log cumulative % drug released vs. log time

The correlation coefficient (R^2) values obtained from these plots were used to identify the best-fit model for each formulation. Among the models, the one with the highest R^2 indicates the predominant release mechanism. The n value from the Korsmeyer–Peppas model was further analyzed to characterize the mechanism (Fickian, anomalous, or case II transport).

RESULT AND DISCUSSION

5.1.1 Physical characterization

Table 3: Physical characterization of Irbesartan

Parameter	Result
Appearance	White to off-white crystalline powder
Odour	Odourless
Taste	bitter

5.1.2 Melting Point Determination

Table 4: Melting point of Irbesartan

Actual melting point	186-188 °C
Observed melting point	185-188°C

5.1.3 IR analysis of Irbesartan

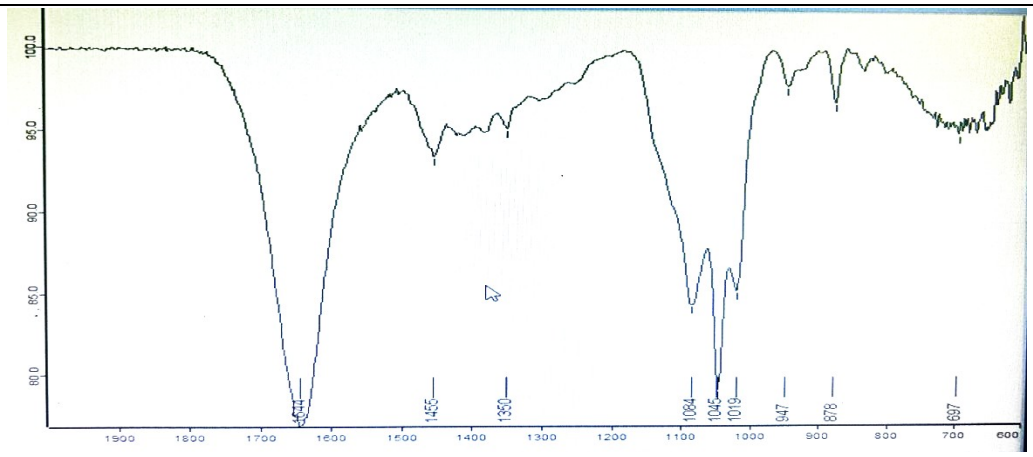

Fig 2 : FTIR of Irbesartan

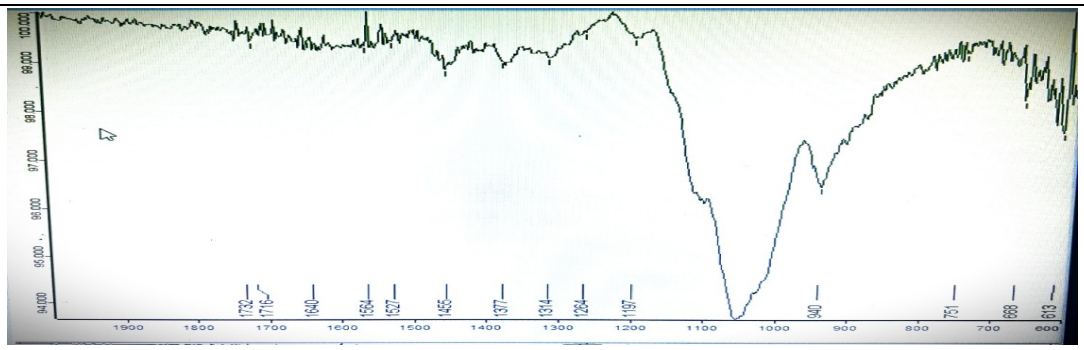

Fig 3: FTIR of HPMC

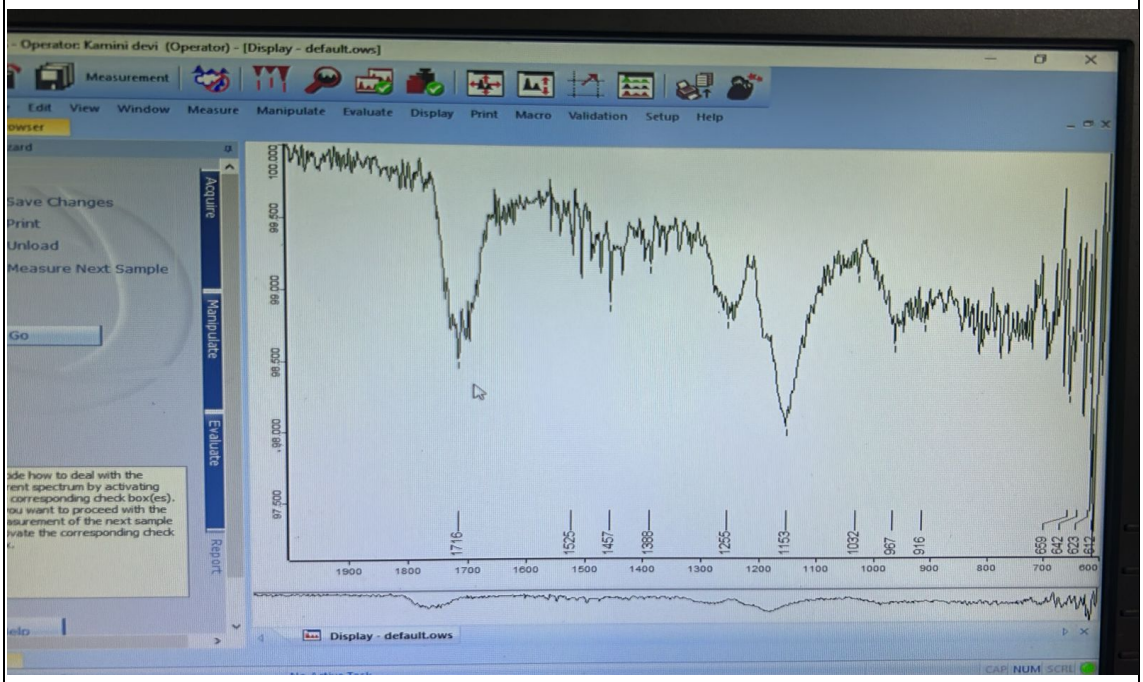

Fig 4: FTIR of Eudragit L-100

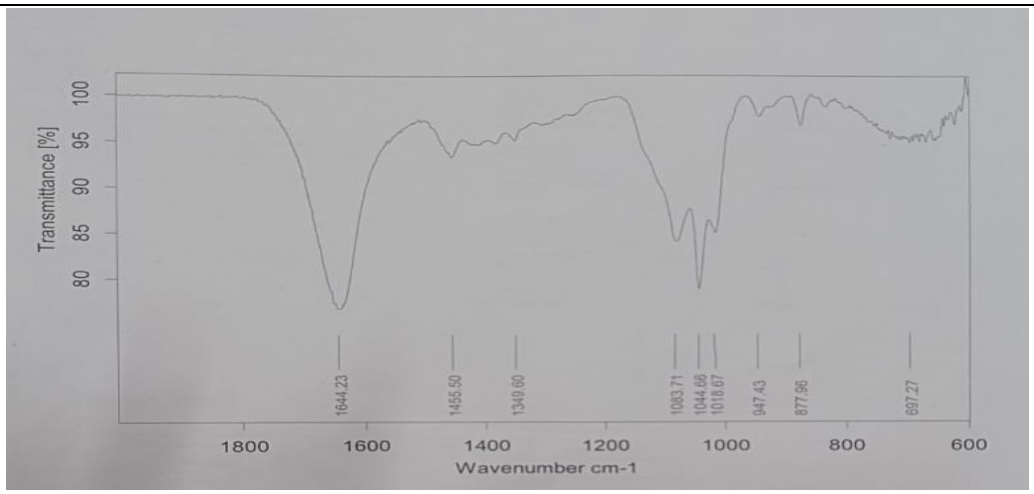

Fig 5: FTIR of drug + excipient

5.1.4 UV Analysis

A UV spectrophotometric analysis of Irbesartan was performed using a double-beam UV-Vis spectrophotometer (Model: UV1900i, Shimadzu) with Lab Solutions software (v1.13). A 20 ppm solution in methanol was scanned between 200–400 nm. The drug showed two absorbance maxima at 227.0 nm (1.5277) and 250.0 nm (0.9663), with 227.0 nm selected as the primary λmax due to its higher intensity. This confirms the presence of chromophoric groups in Irbesartan and validates 227 nm as suitable for its quantitative analysis. Thus, this wavelength was used for further evaluation of drug content and release studies.

Table 5: UV Analysis of drug

S. No.	Wavelength (λmax)	Absorbance	Observation/Result
1	**227.0 nm**	1.5277	Primary λmax observed; selected for further drug analysis.
2	**250.0 nm**	0.9663	Secondary peak; less intense than 227.0 nm.

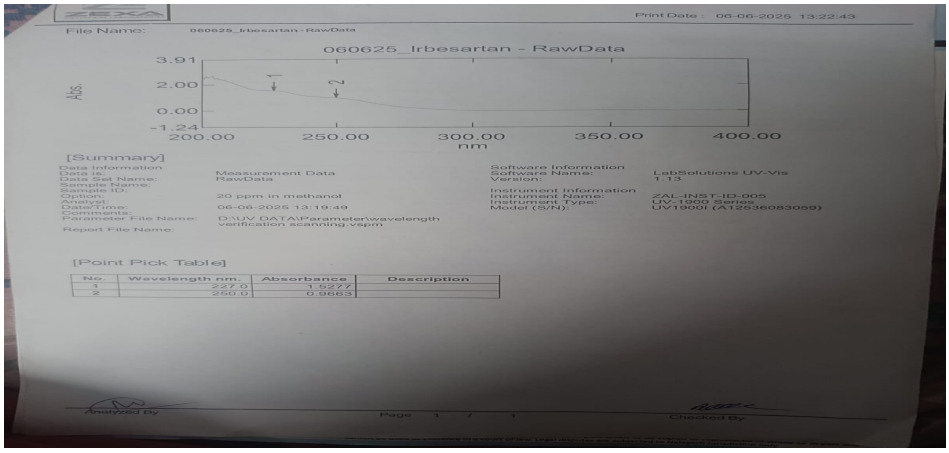

Fig 6: UV spectrophotometric analysis of Irbesartan

Development of Calibration curve of Irbesartan

Standard curve plot of the Irbesartan was prepared in ethanol at 227 nm.Plotting a standard curve in MS-Excel involves using the obtained absorbance values at various concentrations.

Table 6: Standard curve data of Irbesartan in ethanol

S.No	Absorbance (at 227 nm)	Concentration (µg/ml)
1.	0.142	1
2.	0.271	2
3.	0.399	3
4.	0.532	4
5.	0.667	5

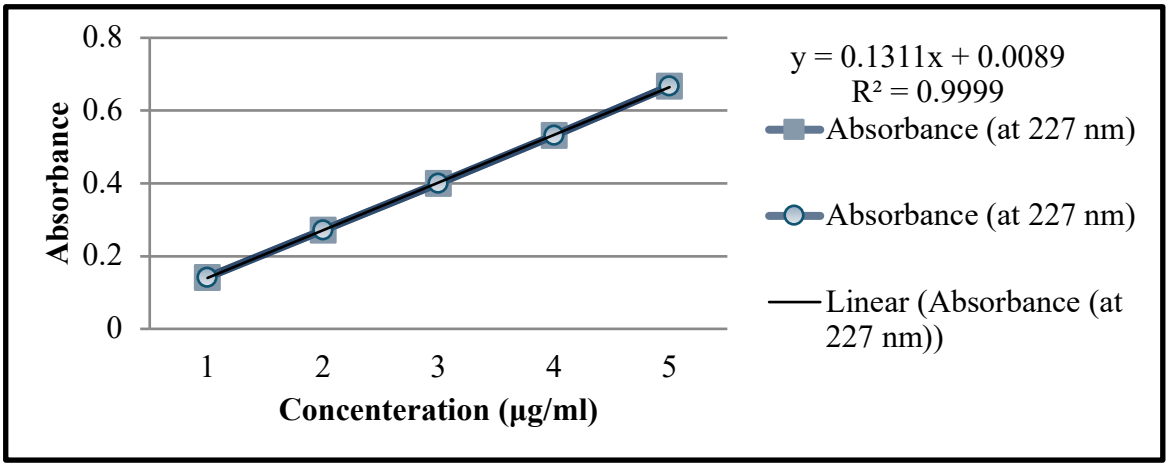

Fig 7: Calibration curve of Irbesartan

5.3 Evaluation parameters of buccal film

5.3.1 Visual appearance

The buccal films were mostly transparent, smooth, and flexible, indicating good film-forming properties. F5 showed the best appearance, being clear, uniform, and highly flexible. F9 was also flexible but had a porous texture, which may aid drug release. A few formulations showed minor issues like slight roughness or stickiness; but overall, all films were visually acceptable and suitable for buccal application.

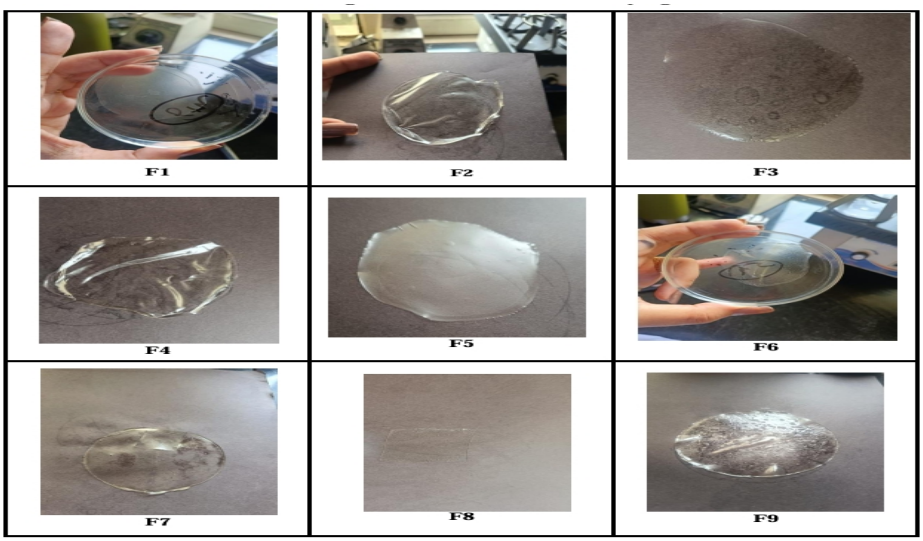

Fig 8 : Buccal films after drying

5.3.2 Uniformity of weight
Uniformity of weight was determined by weighing the different formulations of transdermal patch individually and the average weight was calculated and taken as a weight of the patch. It was shown that the weights of the various formulations were reliable and exhibited small standard deviations.

5.3.3 Surface Ph
The surface pH of all buccal film formulations was measured to ensure compatibility with the buccal mucosa and to avoid irritation. All formulations showed surface pH values in the range of 6.4 to 7.0, which is considered acceptable for buccal administration. This indicates that the films are non-irritant and suitable for prolonged contact with the mucosal surface.The results are shown below:

5.3.4 Folding endurance
All buccal films showed good flexibility, with most formulations having folding endurance above 150 folds. F8 was an exception, showing slightly lower values between 98 to 105 folds, likely due to its porous structure. However, all formulations demonstrated sufficient strength and were mechanically stable for buccal application.

5.3.5 Moisture uptake
Moisture uptake studies were performed to assess the hygroscopic nature and storage stability of the buccal films. All formulations showed low to moderate moisture uptake, indicating good resistance to humidity. Formulations with more hydrophilic polymers like HPMC absorbed slightly more moisture. While films containing Eudragit L100 showed comparatively lower moisture uptake. F8, due to its porous structure, showed slightly higher moisture uptake than others. Overall, the results suggest that the films are stable under normal environmental conditions.

5.3.6 Moisture loss
Moisture loss results indicated that the films were properly dried and physically stable. Most formulations showed minimal moisture loss. F8 exhibited slightly higher moisture loss because of its porosity, which allowed faster evaporation during drying. Despite this, the film retained its flexibility and did not become brittle.

5.3.7 Drug content
All buccal film formulations showed uniform and acceptable drug content, indicating proper drug distribution. F5 had the highest drug content, while F8, despite being porous, also showed satisfactory results. This confirms the effectiveness of the formulation method in ensuring dosage accuracy.

5.3.8 Scanning Electron Microscopy
SEM analysis was carried out to study the surface and cross-sectional morphology of the buccal films. Formulation F5 exhibited a smooth and homogeneous surface with negligible pores, along with a dense internal structure. These features suggest uniform drug-polymer dispersion and support its sustained release profile. In contrast, Formulation F9 showed a rough, porous surface and irregular internal matrix, which likely contributed to its rapid drug release. The SEM results clearly correlate film morphology with drug release behavior.

5.3.8 In vitro drug release
The In-vitro drug release of Irbesartan from the prepared buccal films was studied using a Franz diffusion cell mimic. The receptor compartment contained 250 mL of phosphate buffer (pH 6.8) maintained at 37 ± 0.5 °C, and samples were withdrawn at regular intervals for analysis. The drug concentration was determined using UV-Visible spectrophotometry at 227 nm, with a calibration curve equation of $y = 0.131x + 0.008$ ($R^2 = 0.999$).

5.3.9 Release kinetics study
Formulations F5 and F2 were selected for in-depth drug release kinetics modeling based on their release behavior and formulation characteristics. F5 exhibited a sustained and nearly complete release (98.74% at 240 minutes), representing a controlled-release system ideal for prolonged therapeutic action. F2, with moderate and steady release (86.82%), serves as a representative formulation for comparing different release mechanisms. These two were chosen to explore and compare kinetic models such as Zero-order, First-order, Higuchi, and Korsmeyer-Peppas.

Table 7: Evaluation Parameters of Formulations

Formulation	Weight Uniformity	Surface pH (Mean±SD)	Folding Endurance (Mean±SD)	Moisture Uptake (%Mean±SD)	Moisture Loss (% Mean±SD)	Drug Content (%)
F1	0.1531 ±	6.21 ± 0.03	144.3 ± 2.5	4.29 ± 0.07	3.86 ± 0.04	84.5

	0.00045					
F2	0.1581 ± 0.00025	6.25 ± 0.03	165.0 ± 3.0	5.03 ± 0.06	4.18 ± 0.03	90.2
F3	0.1620 ± 0.00030	6.30 ± 0.04	181.7 ± 3.1	5.63 ± 0.08	4.50 ± 0.03	87.6
F4	0.1667 ± 0.00030	6.35 ± 0.02	200.0 ± 2.0	6.15 ± 0.05	4.82 ± 0.03	88.4
F5	0.1714 ± 0.00020	6.40 ± 0.02	215.0 ± 3.0	6.72 ± 0.08	5.15 ± 0.05	93.8
F6	0.1762 ± 0.00030	6.38 ± 0.03	210.0 ± 2.0	6.40 ± 0.05	4.92 ± 0.03	88.1
F7	0.1807 ± 0.00025	6.36 ± 0.02	205.7 ± 1.5	6.20 ± 0.05	4.72 ± 0.03	86.9
F8	0.0954 ± 0.00082	6.34 ± 0.02	101.7 ± 3.5	8.34 ± 0.06	4.69 ± 0.03	74.2
F9	0.1895 ± 0.00025	6.32 ± 0.03	192.3 ± 2.5	5.65 ± 0.05	4.18 ± 0.03	84.9

Table 8: In vitro Drug release of all Formulation

Time (min)	**F1**	**F2**	**F3**	**F4**	**F5**	**F6**	**F7**	**F8**	**F9**
5	6.53	6.89	5.94	6.33	7.15	6.42	6.11	6.05	12.24
15	18.92	20.41	17.85	19.32	22.56	18.21	17.36	18.1	31.78
30	32.11	34.28	30.12	31.5	36.78	32.03	30.91	32.64	49.64
40	43.65	45.72	41.89	43.21	50.34	44.25	42.67	43.86	64.92
55	58.12	60.01	55.37	56.94	65.89	59.14	57.58	58.1	76.45
60	69.24	68.72	63.08	65.02	74.52	67.82	65.1	66.45	81.13

90	74.1	73.98	69.45	70.93	85.42	73.4	70.44	71.52	85.42
120	79.84	78.56	74.62	76.71	91.76	77.92	75.63	76.74	88.14
150	83.02	81.25	78.88	80.32	95.42	81.11	79.08	80.82	89.45
180	85.76	83.67	81.41	83.06	96.85	83.69	81.43	83.06	90.02
210	87.43	85.24	83.38	84.95	97.86	85.27	82.99	84.32	90.45
240	88.9	86.82	85.1	86.54	98.74	86.5	84.1	85.2	91.04

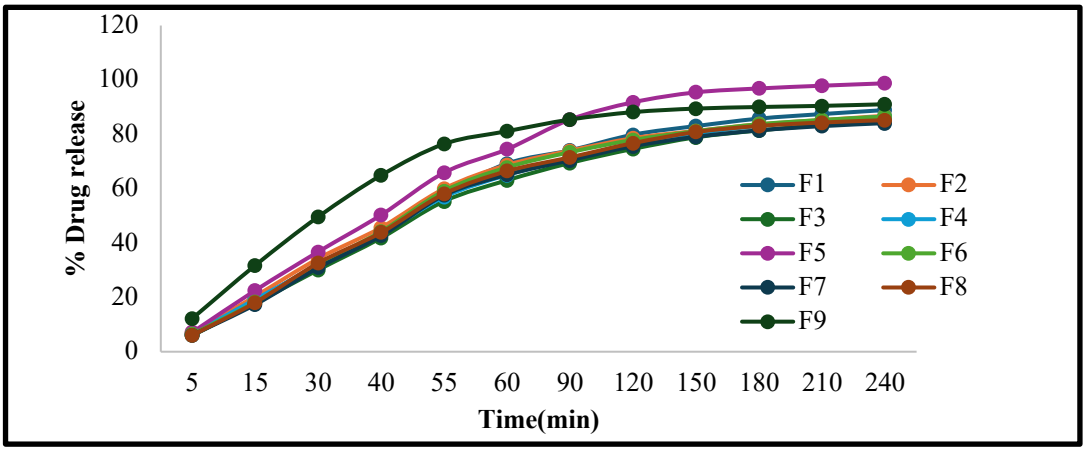

Fig 9: In vitro drug release of all formulation F1-F9

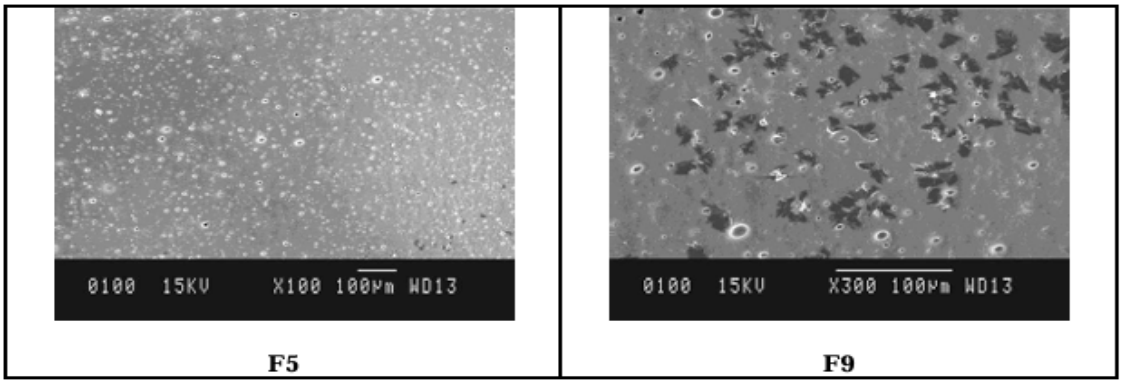

Fig 10: SEM of F5 & F9

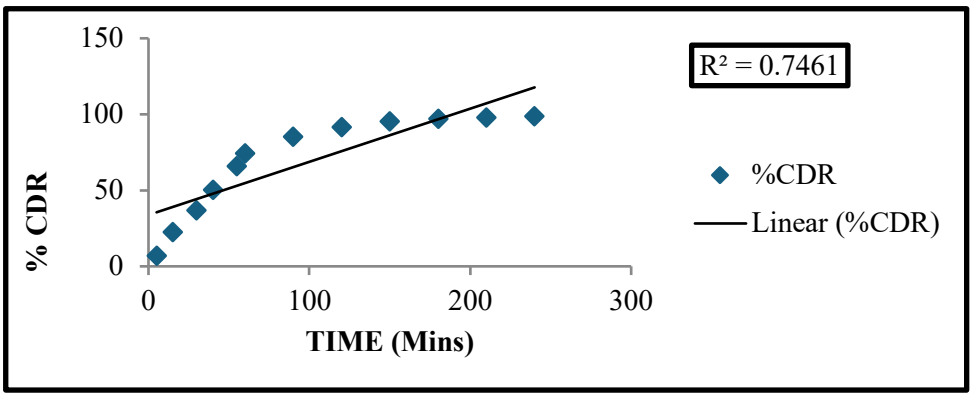

Fig 11: Zero Order (F5)

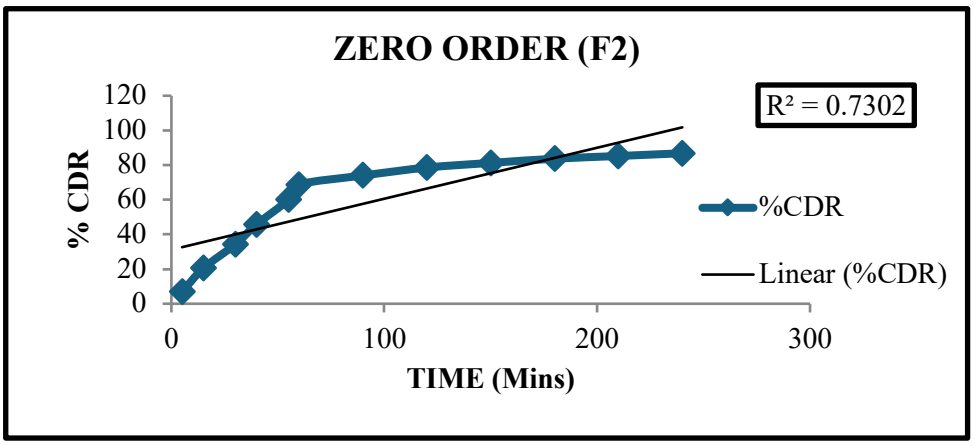

Fig 12: Zero Order (F2)

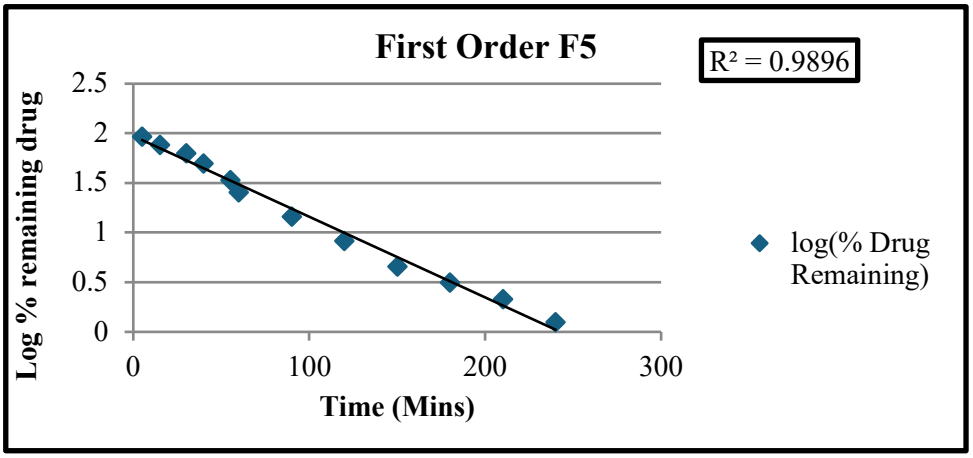

Fig 13: First Order (F5)

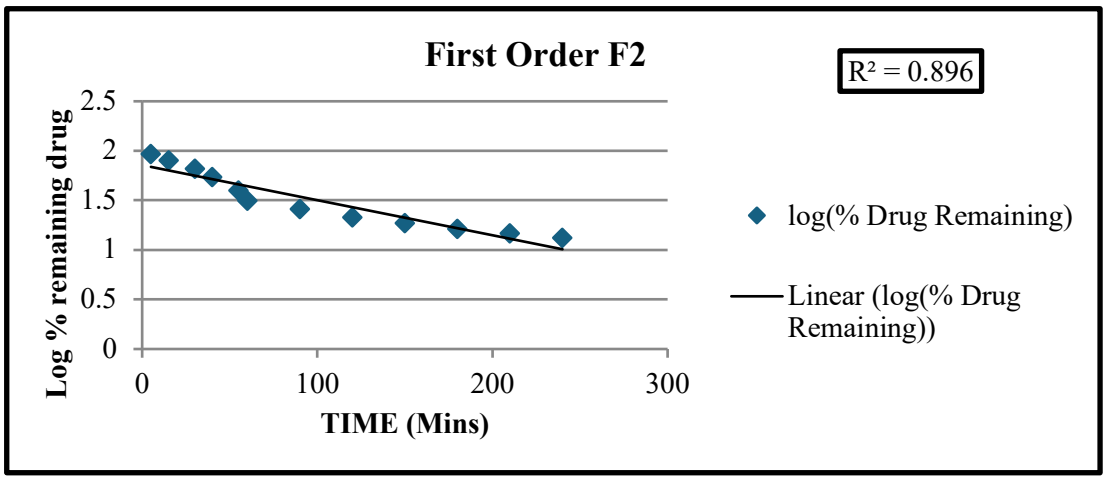

Fig 14: First Order (F2)

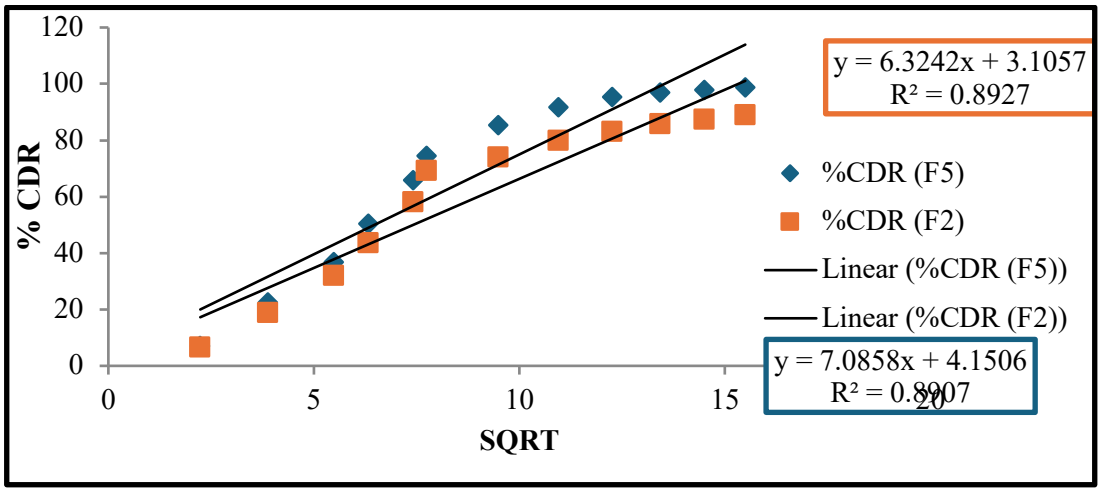

Fig 15: Higuchi model (F5 & F2)

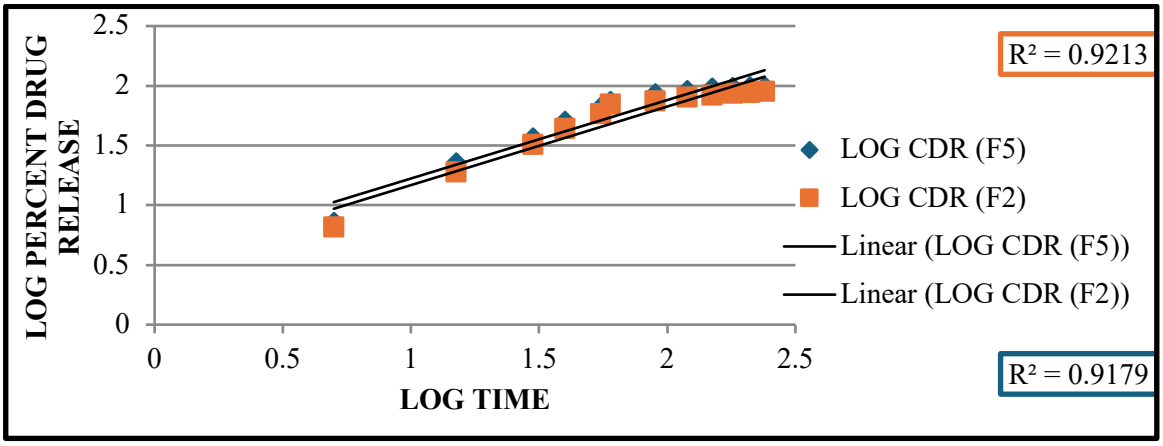

Fig 16: Korsmeyer peppas model (F5 & F2)

Table 9: Release Kinetics study

S.No.	Model	Regression coefficient value for formulation 5	Regression coefficient value for formulation 2
1.	**Zero Order**	0.746	0.730
2.	**First Order**	0.989	0.896
3.	**Higuchi order**	0.890	0.892
4.	**Korsmeyer peppas**	0.917	0.921

Formulation F5 showed the best fit to the First-order kinetics (R^2 = 0.989), indicating a concentration-dependent release. F2 also followed First-order release (R^2 = 0.896). Both formulations showed good correlation with the Korsmeyer–Peppas model**,** suggesting a diffusion-based (anomalous) release mechanism.

SUMMARY

The study focused on developing Irbesartan-loaded buccal films to improve patient compliance and efficacy in hypertension management. Initial preformulation studies confirmed the drug's compatibility with HPMC and Eudragit L-100, indicating no significant interactions. A placebo buccal film was created to establish a control for comparison. Nine formulations (F1 to F9) were developed using the solvent casting method, varying polymer ratios for optimal drug delivery. Evaluation involved assessing physical properties, drug content, and in vitro drug release. Formulation F5 was identified as the most effective, exhibiting good moisture content, high folding endurance, and consistent drug release characteristics. SEM analysis showed F5 had a smooth surface, while F9 had cracks and a porous surface leading to rapid drug release. In vitro studies revealed that F5 provided sustained release of approximately 99% of the drug over 240 minutes, demonstrating that these films could be a beneficial alternative to traditional oral forms for hypertension management.

CONCLUSION

In conclusion, the present study demonstrates that Irbesartan-loaded buccal films represent a novel and effective strategy for managing hypertension. Through comprehensive Preformulation studies, the compatibility of Irbesartan with the selected polymers—HPMC 15 cps and Eudragit L-100—was confirmed, which laid a solid foundation for the formulation. The development of a placebo film was crucial in optimizing the film-forming process and establishing key physical parameters.Among the nine drug-loaded formulations evaluated, formulation F5 emerged as the most promising, showcasing excellent mechanical strength, drug content uniformity, and bioadhesive properties, along with balanced moisture control and ideal surface pH. Its sustained release profile, achieving approximately 99% drug release over 240 minutes, underscores its potential as an optimized formulation for therapeutic applications. In contrast, formulation F9's porous and cracked surface led to a quicker drug release, emphasizing the importance of formulation design in achieving desired release characteristics. The findings of this study highlight that the developed buccal films, particularly formulation F5, can serve as a viable alternative to conventional oral dosage forms, enhancing patient compliance and providing effective therapeutic outcomes in the treatment of hypertension.

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