Formulate and Evaluate Immediate Release Tablet of Antihypertensive Drug

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***Abstract*—The objective of the study was to develop an immediate release tablet formulation of lisinopril and evaluate it. Different formulations were prepared by varying the concentration of the drug and excipients using the direct compression method. The tablets were evaluated for various physical parameters such as hardness, friability, and disintegration time. Among the different formulations the aim of present study is to formulate and evaluate immediate release tablet of antihypertensive drug.**

***Index Terms*—Immediate release tablet, Sodium Starch Glycolate, Lisinopril.**

I. INTRODUCTION

Pharmaceutical preparation that is meant to be consumed by mouth, either whole or after chewing, is referred to as an oral dosage form. These forms, which include tablets, capsules, suspensions, solutions, and syrups, are utilized to provide medication to the body. Because they are simple to use, generally safe, and available in a range of dosages and formulations to meet the needs of varied patient populations, oral dosage forms are a common and practical way to give medication. As the digestive system can swiftly absorb medications from the gastrointestinal tract and transport them throughout the body, they are also a successful method of administering medication to the body. . They are an essential component of contemporary healthcare because they let patients to get the medication they require in a convenient, safe, and efficient way.[1]The oral route remains the perfect route for the administration of therapeutic agents because the low cost of therapy, manufacturing and ease of administration lead to high levels of patient compliance**. [1-2]**

II. TYPES OF TABLET DOSAGE FORM

Tablets are one of the most used commonly dosage forms for administering medication. They are solid dosage forms that contain a compressed powder sor granules of an active drug ingredient along with other excipients such as fillers, binders, disintegrants, lubricants, and coatings.

Based on the method of manufacture

1. Compressed tablets: These tablets are made by compressing a blend of active drug ingredients and excipients into a solid mass using a tablet press.
2. Molded tablets: These tablets are made by molding a moistened mixture of active drug ingredients and excipients into a tablet shape using a die and punch set
3. Chewable tablets: These tablets are designed to be chewed rather than swallowed whole and are usually flavored to make them more palatable.
4. Effervescent tablets: These tablets contain a combination of acids and bicarbonates that react with water to release carbon dioxide, producing an effervescence or fizz

Based on The Route of Administration

- Oral tablets: These tablets are intended to be swallowed whole and are designed to release the active drug ingredient in the gastrointestinal tract.
- Sublingual tablets: These tablets are designed to be dissolved under the tongue, allowing the active drug ingredient to be absorbed directly into the bloodstream.
- Buccal tablets: These tablets are designed to be placed between the cheek and gum, allowing the active drug ingredient to be absorbed directly into the bloodstream.

- Vaginal tablets: These tablets are designed to be inserted into the vagina and release the active drug ingredient locally in the reproductive system.

Based On The Release Pattern

- Immediate-release tablets: These tablets are designed to release the active drug ingredient immediately upon ingestion, providing a rapid onset of action.
- Extended-release tablets: These tablets are designed to release the active drug ingredient slowly over an extended period, providing a sustained release of the drug and reducing the frequency of dosing.
- Delayed-release tablets: These tablets are designed to release the active drug ingredient after a specified delay, usually to protect the drug from degradation by stomach acid or to target specific areas of the gastrointestinal tract.
- Controlled-release tablets: These tablets are designed to release the active drug ingredient at a predetermined rate, maintaining a constant drug concentration in the bloodstream.

Immediate Release Tablet Dosage Form

Immediate release tablets are a type of oral dosage form that is designed to release the active drug ingredient quickly upon ingestion, providing a rapid onset of action. These tablets are among the most used dosage forms in the pharmaceutical industry, owing to their many advantages over other dosage forms such as extended-release tablets, capsules, or injections. The tablet is designed to disintegrate rapidly in the gastrointestinal tract, releasing the active drug ingredient(s)for absorption into the bloodstream. Immediate release tablets are used to treat a wide range of acute and chronic conditions such as pain, fever, allergies, anxiety, depression, and hypertension, among others. Manufacturers must ensure that the tablet is stable, safe, and efficacious, and meets the standards set by regulatory bodies such as the United States Pharmacopeia (USP)or the European Pharmacopoeia (Ph. Eur.). Many patients require quick onset of action in particular therapeutic condition and consequently immediate release of medicament is required. It is estimated that 50%of the population is affected by this problem, which results in a high incidence of ineffective therapy. Recently immediate release tablets have started gaining popularity and acceptance as a drug delivery system, mainly because they are easy to administer and lead to better patient compliance. In the present work, we engage in discussion about formulation, development, and evaluation of immediate release tablets. [4-6]

Formulation of Immediate Release Tablet

Active drug Ingredient The active drug ingredient is the primary component of the tablet and is responsible for providing the desired therapeutic effect.

Excipient.

Diluents: include lactose, mannitol, microcrystalline cellulose, and dibasic calcium phosphate.

Binders: are used to improve the tablet's mechanical strength and cohesion, preventing it from falling apart during handling and transportation.

Lubricant: Lubricants are used to improve the tablet's flowability and prevent it from sticking to the tablet press during compression

Glidants: are added to the tablet formulation to improve the flowability of the powder mixture and reduce the friction between the particles

Coating agents: improve the appearance and stability of the tablet, protect the active drug ingredient from environmental factors such as moisture and light, and mask any unpleasant taste or odor. , including the physicochemical properties of the active drug ingredient, the target patient population, the intended route of administration, and regulatory requirements. [7]

Super Disintegrant: type of excipient used in pharmaceutical formulations to enhance the disintegration and dissolution of tablets, capsules, and other solid dosage forms., allowing the drug to dissolve and be absorbed more quickly and efficiently. [7-8]

Mechanism Of Super disintegrant the mechanism of Super disintegrants involves several processes that aid in tablet disintegration. Super disintegrants work by absorbing water and swelling rapidly, leading to the formation of a gel-like layer around the tablet. The water uptake also causes a rapid increase in the internal pressure, which helps to break apart the tablet.

Swelling / Non – swelling Super detergents

Swelling super disintegrants, such as sodium carboxymethyl cellulose (CMC) and crospovidone, rapidly absorb water and swell to several times their original size. Non-swelling Super disintegrants, such

as sodium starch glycolate (SSG) and croscarmellose sodium (CCS), do not swell but instead, absorb water and rapidly disintegrate by a process called wicking.

Surface – Active / Complexing Super Distegrants

Surface-active Super disintegrants, such as sodium lauryl sulfate (SLS) work by reducing the interfacial tension between the tablet and the dissolution medium. This reduction in interfacial tension facilitates the penetration of the dissolution medium into the tablet, leading to rapid disintegration. [8-9]

Method Of Preparation Of Immediate Release Tablet

1. Tablet molding technique
2. Direct compression technique
3. Wet granulation technique
4. Mass extrusion technique
5. By solid dispersions

Formulation consideration of Immediate release tablet dosage form

.Drug properties (solubility, stability, particle size)

2. Excipient selection (compatibility, solubility enhancement, tablet compression)

3. Manufacturing method (direct compression, wet/dry granulation)

4. Tablet design (size, shape, weight, disintegration, dissolution)

5. Coating (appearance, taste, stability, drug release)

6. Regulatory requirements (safety, efficacy, stability compliance)

Ideal properties Of drug For Immediate Release Tablet

1. High solubility and rapid dissolution rate
2. Stability under various storage conditions
3. Non-hygroscopic properties
4. Low dose for easy compression
5. Non-irritant properties to avoid gastrointestinal issues
6. Wide therapeutic index for safe use
7. Short half-life for frequent dosing
8. High bioavailability for effective therapeutic action

Advantages of Immediate Release Tablet

1. Rapid onset of action
2. Convenient dosage in various strengths and sizes
3. Easy to swallow
4. Improved patient compliance
5. Cost-effectiveness

Disadvantages Of Immediate Release Tablet

1. Short duration of action, requiring frequent dosing
2. Potential side effects due to rapid drug absorption
3. Not suitable for certain drugs requiring sustained release
4. Risk of drug interactions
5. Dose dumping, leading to potential toxicity potential toxicity. [16]

HYPERTENSION

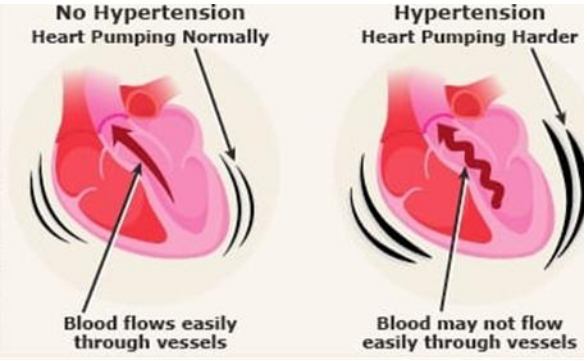


Fig N0 1 Hypertension

Hypertension, also known as high blood pressure, is a common condition that affects millions of people worldwide. It is a chronic medical condition characterized by elevated blood pressure levels that persist over time, putting strain on the heart and blood blood vessels. [23]

Symptoms

1. Headache
2. Fatigue
3. Dizziness
4. Chest pain
5. Palpitations
6. Difficulty breathing [23]

Hypertension can be caused by a combination of factors, including:

1. Lifestyle factors:
   1. Obesity
   2. Smoking
   3. Lack of physical activity
   4. Stress
   5. High-salt and high-saturated-fat diet [23]
2. Genetics
3. Age
4. Race
5. Underlying medical conditions

Etiology

1. Increased peripheral vascular resistance
2. Increased blood volume

3. Renin-angiotensin-aldosterone system dysfunction. [23]

Hypertension's pathogenesis involves

1. Increased vascular resistance → Increased arterial pressure
2. Strain on the heart → Left ventricular hypertrophy, coronary artery disease, heart failure
3. Organ damage: Kidneys, eyes, brain s. [23]

III. MATERIAL & EQUIPMENTS

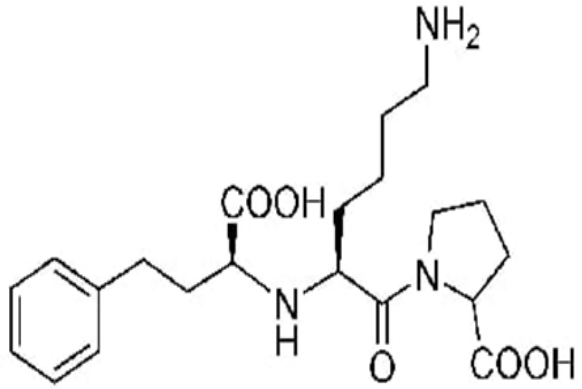
Table No 1: List Of Reagents & Chemicals

Sr. No.	material	source
1.	Lisinopril (API)	Avantor Pvt. Ltd.
2.	Lactose	Loba Chemie Pvt. Ltd.
3.	Microcrystalline cellulose	Loba Chemie Pvt. Ltd.
4.	Dibasic calcium phosphate	Loba Chemie Pvt. Ltd.
5.	Sodium starch glycolate	Loba Chemie Pvt. Ltd.
6.	Polyethylene glycol	Loba Chemie Pvt. Ltd.
7.	Aerosil	HiMedia Laboratories

Table No 2 : List of Major Instruments:

Name of Instruments	Manufacturer
pH Meter	Hanna Instruments
FTIR	Agilent cary 630 ATR FTIR Spectrophotometer.
Electronic balance	Citizen ,mumbai
UV-spectrophotometer	Labtronics Double beam spectrophotometer
Hot air oven	Shital scientific
In Vitro Dissolution	Electrochemical
Vernier Caliper	ICI checking instruments
Single punch Tablet Machine	Cadmach Ahamadabad
Roche Friability Tester	Labshop
Mechanical stirrer	Remi motor Ltd
IR	Shimazdunavimumbai

DURUG PROFIL



LISINOPRIL: [42]

ChemicalName: (S)-1-[N2-(1-carboxy-3-phenylpropyl)-L-lysyl]-L-proline.

Molecular Formula: C21H31N3O5.

Molecular Weight: 441.53 g/mol.

Description: It is a white to off-white crystalline powder.

Melting Point Range: 154-158°C.

Solubility Lisinopril is freely soluble in water, but only slightly soluble in ethanol.

Partition Coefficient: The partition coefficient (Log P) of Lisinopril is approximately 0.8.

Storage and Stability: Lisinopril should be stored at room temperature, protected from light and moisture.

The drug is stable for at least 2 years when stored properly.
Indication: Lisinopril is used for the treatment of hypertension, congestive heart failure, and acute myocardial infarction. It is also used to improve survival in patients with heart failure after a heart attack.

Pharmacokinetics properties Lisinopril
Absorption: Well absorbed orally, peak plasma concentration within 7 hours
Distribution: Low volume of distribution (0.5 L/kg), primarily in extracellular fluid
Biotransformation: Hydrolyzed to active metabolite lisinoprilat, no significant liver metabolism
Elimination: Primarily excreted unchanged in urine (75%), elimination half-life of 12 hours
Dosage: 10-80 mg once daily
Administration: Oral
Side effects: Dizziness, cough, gastrointestinal symptoms, hypotension, hyperkalemia, renal dysfunction

Contraindications
History of angioedema
Hypersensitivity to lisinopril or other ACE inhibitors
Bilateral renal artery stenosis
Available Formulations
Tablet form (2.5 mg, 5 mg, 10 mg, 20 mg)
Marketed under various brand names (Listril, Lisoril, Prinivil) in India.
Experimental Work
preformulation studies of Drugs(36)
preformulation studies involve investigating a drug's physical and chemical properties, both alone and with excipients, to:
1. Establish physicochemical characteristics
2. Determine compatibility with excipients
Preformulation studies for Lisinopril involve:

Characterization of Lisinopril
1. Organoleptic properties: Observing color, odor, and physical appearance
2. Description: Recording product name, manufacturer, lot number, appearance, and texture
3. Melting point determination: Measuring the temperature at which Lisinopril melts (expected range: 148-150°C)
4. Solubility determination: Testing solubility in various solvents (e.g., ethanol)
5. pH determination: Measuring pH of a 0.1 M Lisinopril solution in distilled water (expected range: 3-4)
Micromeritic properties of the pure drug were evaluated, including(38):
1. Angle of repose
2. Loose bulk density
3. Tapped bulk density
4. Carr's index
5. Hausner ratio

Spectroscopy:
U. V. Spectroscopy:
Determination of λ max:
The lambda max of lisinopril can be detected using the following procedure:
Materials:
1. Lisinopril sample
2. Solvent (such as water or methanol)
3. UV-Visible spectrophotometer
4. Cuvette
To determine Lisinopril's λmax:
1. Prepared a 100 µg/ml stock solution
2. Set spectrophotometer to 200-400 nm range using a blank cuvette
3. Measured absorbance of Lisinopril solution across the range
4. Identified λmax as the wavelength with the highest absorbance
This determines the optimal wavelength for analyzing Lisinopril.
Determination of λ max:
Standard stock solution of Lisinopril were prepared by dissolving 10 mg of Lisinopril separately in 10 ml of 0.1 NaOH solution and sonicated for 15 minutes and filtered through whatman filterpaper in order to get dilution of 1 mg/1 ml i.e.1000 µg/ml.
The absorption maxima for Lisinopril was determined:
1. Scanned solutions in the range of 400-200 nm
2. Reference: 0.1 N NaOH
3. Peak observed at 218 nm
The selected wavelength for analysis is 218 nm.
Preparation of calibration curve for lisinopril
1. Calibration Curve: Prepared using phosphate buffer pH 7.5, analyzed at 298 nm

2. Linearity: 2-12 µg/ml, slope 0.0552, regression value 0.9997

IR Spectroscopy

1. Method: Obtained IR spectrum using KBr pellet and FTIR spectrophotometer
2. Region: 400-4,000 cm^-1
3. Purpose: Determine compatibility between drug (Lisinopril) and excipients

Compatibility Studies

1. Objective: Confirm no reaction between drug and polymer/excipients
2. Method: Physical mixture of drug and polymer analyzed using IR spectroscopy3. Importance: Ensures stability and shelf life of the product.

Formulation of Lisinopril tablet: Table no 3

Ingredient In Mg	F1	F2	F3	F4	F5	F6
Lisinopril (API)	5	5	5	5	5	5
Lactose	25	35	45	20	15	10
Microcrystalline cellulose	20	15	10	30	10	20
Sodium starch glycolate	25	20	15	10	12	18
Polyethylene glycol	6	10	5	12	10	5
Aerosil	10	15	10	5	15	10
Dibasic calcium phosphate	10	15	20	10	15	20
Starch	Q. S.	Q. S.	Q. S.	Q. S.	Q. S.	Q. S.

Evaluation[42]:

I. Bulk density and tapped density: Directly compressible blend was poured gently through a glass funnel into a graduated cylinder of bulk density apparatus. Then Bulk density and tapped density were calculated.

$$\text{Bulk density} = \frac{\text{Weight of sample in gram}}{\text{Final volume of sample contained in cylinder}}$$

$$\text{Tapped density} = \frac{\text{Weight of sample in gram}}{\text{Final volume after tapping in cylinder}}$$

Carr's Compressibility Index

1. Formula: I = ((Dt - Db) / Dt) × 100
2. Dt: Tapped density
3. Db: Bulk density
4. Interpretation:
   - < 20-30%: Free-flowing material
   - > 20-30%: Poorly flowing material

Related Measures

1. Hausner Ratio: Also assesses powder flowability
2. Angle of Repose: θ = tan^-1 (h / r), where h = height, r = radius These measures evaluate powder flow properties and interparticulate interactions.

Table No 4: Relationship between angle of repose (θ) and Flowability

Flow Property	Angle of Repose (^{0})
Excellent	25-30
Good	31-35
Fair- aid not needed	36-40
Passable-may hang up	41-45
Poor-must agitate, Vibrate	46-55
Very Poor	56-65
Very, very Poor	>66

Weight Variation Test

1. Procedure: Weigh 20 tablets individually, calculate average weight
2. Criteria:
   - Not more than 2 tablets outside percentage limits

- No tablet differs by more than 2 times the percentage limit

Hardness

The hardness of each batch of TLM was checked by using Monsanto hardness tester. The hardness was measured in terms of kg/cm 2. 3 tablet were chosen randomly and tested for hardness. The average values, standard deviation and relative standard deviation were calculated.

Thickness:

Thickness was measured using Venier Calipers. It was determined by checking the thickness and diameter of ten Tablet of each formulation. The extent to which the thickness of the each tablet deviated from ± 5% of the standard value was determined

Drug Content Analysis

1. Procedure:
   - Crushed 10 tablets, took amount equivalent to 5 mg of drug
   - Dissolved, sonicated, and diluted
   - Measured absorbance at 298 nm using spectrophotometer
2. Method: Used standard graph to determine drug concentration
3. Replicates: n = 6

In-Vitro Release Studies

1. Conditions:
   - Dissolution media: pH 7.5 phosphate buffer or 0.1 N HCl
   - Volume: 900 ml
   - Temperature: 37 ± 0.2°C
   - Rotation speed: 100 rpm
2. Procedure:
   - Withdrew 5 ml samples at 5, 10, 15, and 30 minutes
   - Replaced with fresh medium
   - Analyzed spectrophotometrically
3. Kinetic Analysis:
   - Zero-order and first-order kinetics
   - Calculated dissolution rate constants, correlation coefficient, and dissolution efficiency

Stability Studies of Lisinopril

1. Objective: Evaluate the ability of the dosage form to remain within specifications
2. Evaluations:
   - Physical parameters (appearance, weight gain, thickness, flatness)
   - Chemical parameters (drug content, moisture content)
   - Mechanical parameters (folding endurance, tensile strength)
   - In-vitro release study
3. Conditions: Different temperatures and humidity conditions
4. Outcome: Formulation showed stability under various storage conditions.

recommended long-term and accelerated storage conditions

Study Storage condition Minimum time period covered by data at submission Long term- 25°C ± 2°C/60% RH ± 5% RH or 30°C ± 2°C/65% RH ± 5% RH 12 months

Intermediate-30°C ± 2°C/65% RH ± 5% RH 6 months Accelerated-40°C ± 2°C/75% RH ± 5% RH 6 months

IV. RESULTS & DISCUSSION

Characterization of Lisinopril:

Organoleptic characterization and Melting point determination

The physicochemical characteristics of Lisinopril are described in Table No 5

SR. NO	TEST	OBSERVATION
1.	Appearance	White crystalline powder
2.	Color	White to off-white
3.	Odor	Odorless
4.	Taste	Tasteless
5.	Melting point	148-150°C
6.	pH	Aqueous solutions are acidic with a pH of approximately 3.5

The organoleptic character and melting point was found as per the standard drug so drug used in the formulation was found to be pure according to I.P. specification.

Solubility analysis:
TABLE NO 6 : Solubility analysis

Sr. No.	SOLVENT	SOLUBILITY
1.	water	Freely soluble, 60 mg/mL at 25°C
2.	Methanol	Sparingly soluble, 2.5 mg/mL at 25°C
3.	Ethanol	Practically insoluble 0.5 mg/mL at 25°C
4.	Acetone	Practically insoluble, <0.5 mg/mL at 25°C
5.	Ethyl acetate	Practically insoluble, <0.5 mg/mL at 25°C
6.	Chloroform	Practically insoluble, <0.5 mg/mL at 25°C
7.	Diethyl ether	Practically insoluble, <0.5 mg/mL at 25°C
8.	Hexane	Practically insoluble, <0.5 mg/mL at 25°C
9.	Isopropyl alcohol	Sparingly soluble, 2.5 mg/mL at 25°C
10.	Propylene glycol	Sparingly soluble, 1.3 mg/mL at 25°C
11.	Glycerine	Sparingly soluble, 1.0 mg/mL at 25°C

Micromeritic characterization of drug:
The micromeritic characterizations of drug were carried out and the following observations were made.

Table No 7: Micromeritic Drug Characterization

SR. NO	Property	Value
1.	Bulk density	0.4-0.6 g/mL
2.	Tapped density	0.5-0.7 g/mL
3.	Hausner's ratio	1.25-1.40
4.	Carr's index	10-20%
5.	Angle of repose	28-32°
6.	Particle size	20-50 µm

	distribution (D50)	
7.	Surface area (BET)	~1-2 m^2/g
8.	Porosity	1. ~0.3-0.4 mL/g

Based on micromeritic properties it was confirmed that the drug Lisinopril possessed sufficient Flowability to be used for compression.

Standard calibration curve of Lisinopril.

Table NO 8: CURVE OF LISINOPRIL

SR. NO.	CONCENTRATION (ug/ml)	ABSORBANCE (at 218 nm)
1.	2	0.0591
2.	4	0.1245
3.	6	0.1891
4.	8	0.2987
5.	10	0.4026
6.	12	0.5112
7.	14	0.6512
8.	16	0.7451

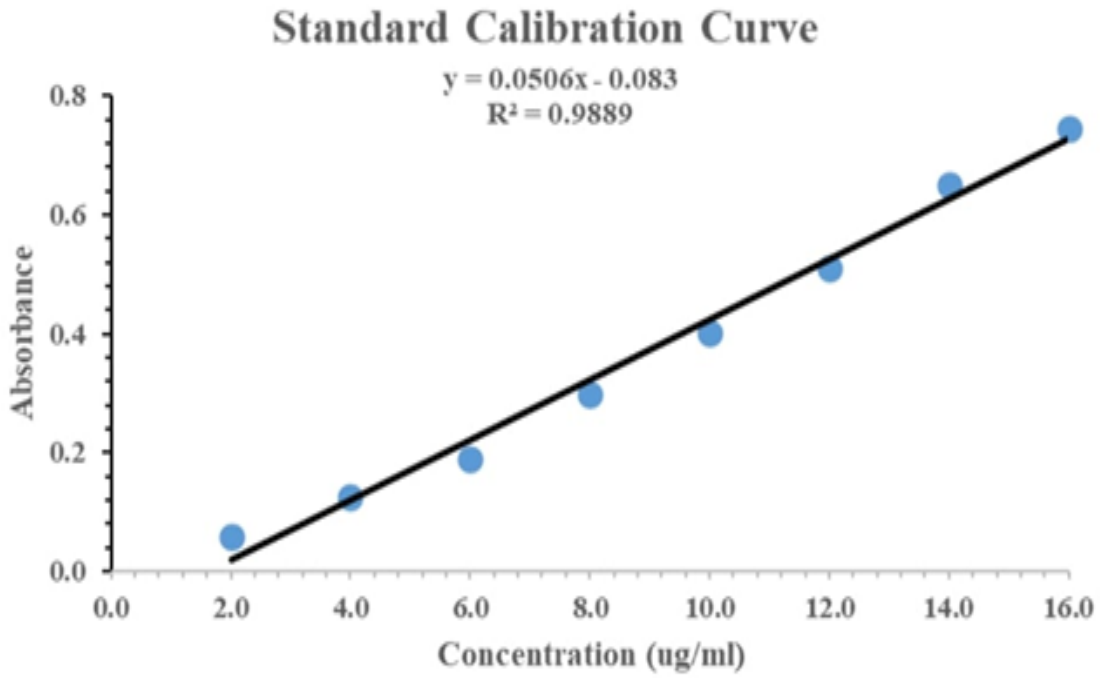


Figure NO 2 : Calibration curve of Lisinopril in Water

Determination of λ max:

The UV spectrum of Lisinopril in water showed maximum absorption at 218nm. Hence drug used in the formulation was found to be pure according to I.P. specification. The UV spectrum of the Lisinopril in methanol is

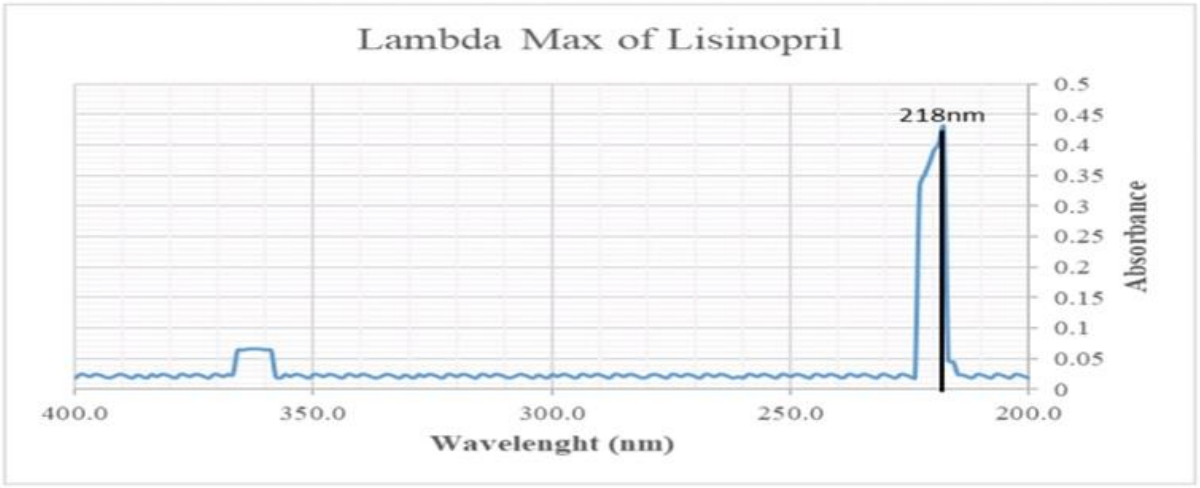


Figure No 3. Lambda Max of Lisinopril

FTIR Analysis

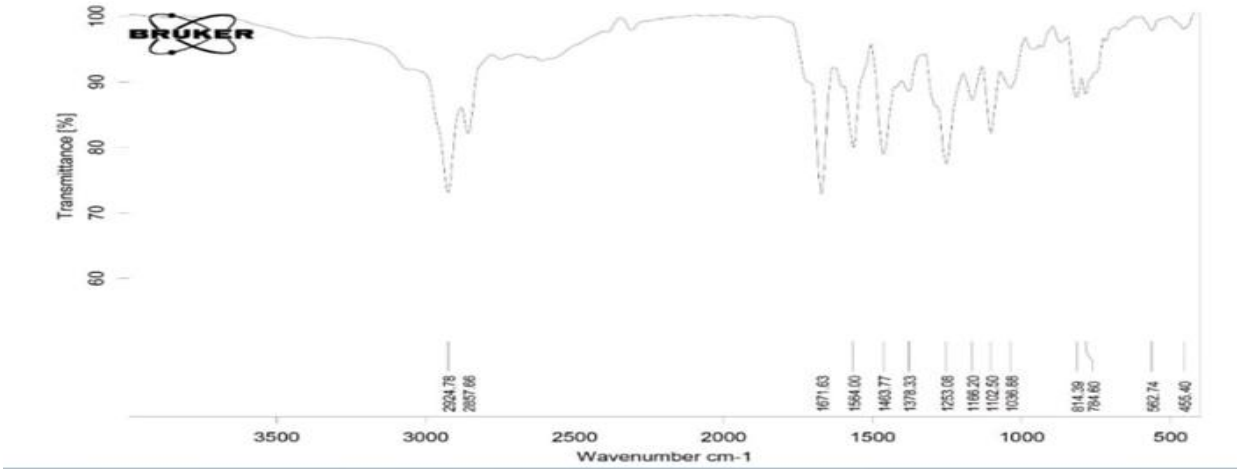


Figure No 4. FTIR of Lisinopril

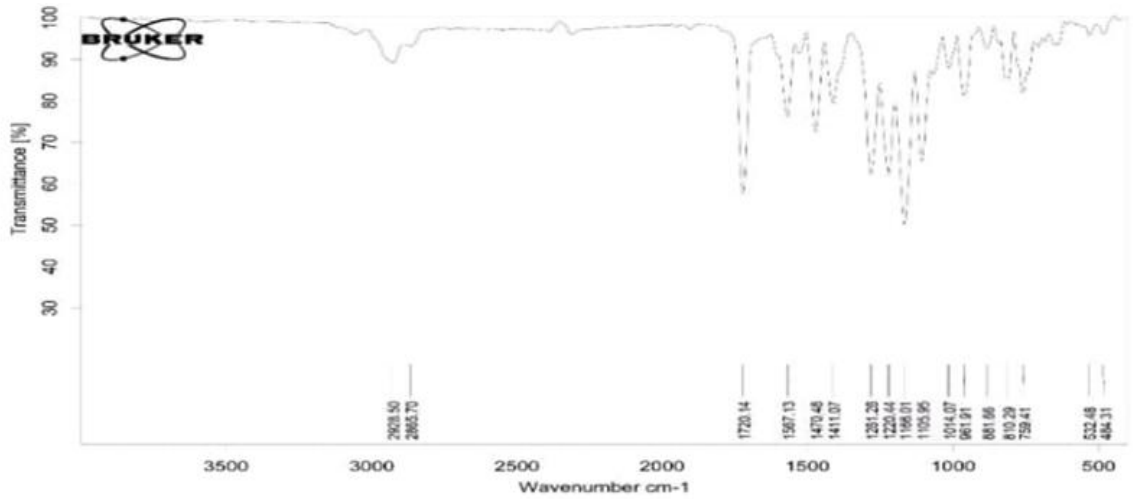


Figure No 5. FTIR of Lisinopril with Sodium Starch Glycolate

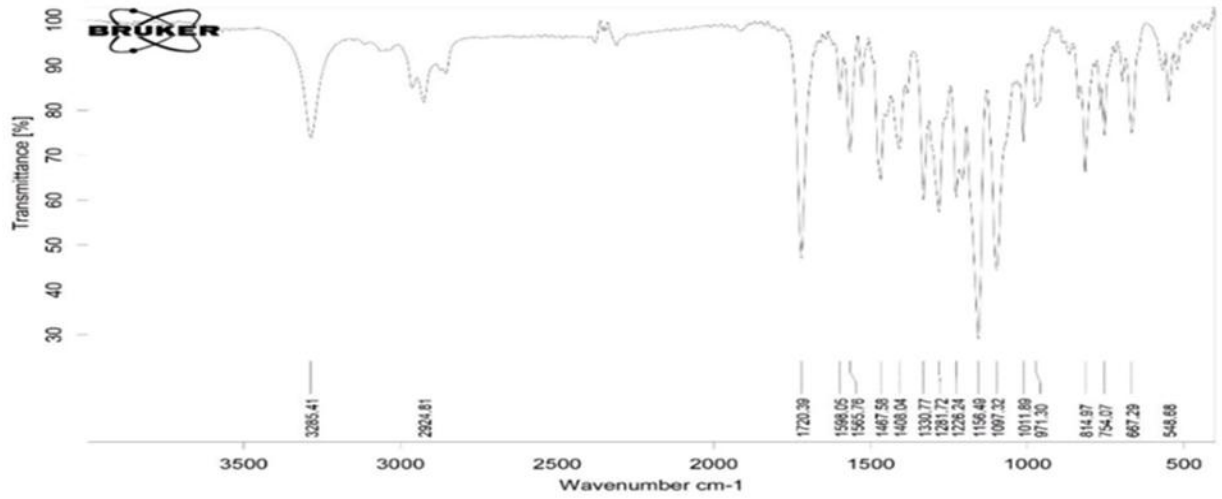


Figure No 6 . FTIR of Prepared Tablet

Characterization of prepared Lisinopril Tablet

Table 9 : Appearance of Lisinopril Tablet.

FORMULATION	APPEARANCE
F1-F6	Clear white, easily removed by die

Evaluation of Lisinopril Table

Table NO 10. Precompression Evaluation of The Powder Blend

SR. NO.	PARAMETER	F1	F2	F3	F4	F5	F6
1.	Bulk density (g/cm³)	0.49	0.53	0.57	0.48	0.52	0.56
2.	Tapped density (g/cm³)	0.60	0.66	0.70	0.59	0.64	0.69
3.	Hausner's ratio	1.2	1.2	1.2	1.2	1.2	1.2
4.	Carr's index (%)	12	15	18	10	13	16
5.	Angle of repose (°)	27	28	30	25	27	29
6.	Flow rate (g/s)	2.5	2.3	2.1	2.4	2.2	2.0
7.	Compressibility index (%)	12	14	16	11	13	15
8.	Moisture content (%)	0.8	0.7	0.9	1.0	0.8	0.6
9.	Particle size distribution (%)	90% passing 100 mesh	95% passing 100 mesh	90% passing 80 mesh	85% passing 100 mesh	90% passing 90 mesh	95% passing 80 mesh

1. Bulk Density
- Range: 0.312 ± 0.12 g/cm³ to 0.321 ± 0.27 g/cm³
- Indicates good packing
2. Compressibility Index
- Range: 5.12 ± 0.29% to 10.33 ± 0.51%

- Indicates acceptable flow property
3. Hausner Ratio
- Range: 1.05 ± 0.21 to 1.11 ± 0.37
- Indicates acceptable flow property and good packing ability
4. Angle of Repose
- Range: 25° 16' ± 0.12 to 28° 38' ± 0.15
- Indicates good flow property

Evaluation of Prepared tablet

Prepared tablet of all formulations (F1 to F6) were evaluated for different parameters such as thickness, hardness, weight variation, drug content and friability

Table NO 11 : Standard physical tests for Table

Parameter	F1	F2	F3	F4	F5	F6
Hardness (kg/cm2)	3.2±0.42	3.6±0.3	3.8±0.2	3.2±0.48	3.7±0.56	4.1±0.34
Thickness (mm)	3.9±0.2	3.9±0.2	3.5±0.2	3.6±0.2	3.6±0.2	3.8±0.2
Weight Variation (mg)	130.0±10	129.7±10	120.5±10	128.0±10	125.0±10	123.1±10
Friability (%)	0.45±0.18	0.81±0.2	0.35±0.2	0.65±0.37	0.12±0.67	0.38±0.62
Drug content (%)	96.18±0.12	93.18±0.54	98.54±0.19	92.18±0.34	94.18±0.69	98.21±0.37
Drug Release (%)	52±0.09	58±0.09	98±0.09	88±0.09	60±0.09	54±0.09

Hardness
- Range: 3.2-4.1 kg/cm²
- Indicates good strength

Friability
- Values: < 1%
- Indicates good strength and durability

Weight Variation
- Range: 299-309 mg
- Within pharmacopoeial limits (± 10%)

Thickness
- Range: 3.6-3.9 mm
- Uniform thickness

Content Uniformity
- Range: 92.18-98.54%
- Indicates uniform drug distribution

In-Vitro Drug Release
- Studied in 0.1 N HCl at 37 ± 0.5°C
- Analyzed using UV-Visible spectrophotometer

Table No 12 : In-vitro drug dissolution data of F1 to F3 formulation

FORMULATION	CUMULATIVE % DRUG RELEASE	TIME	CUMULATIVE % DRUG RELEASE	TIME
F1	48	15	81	30
F2	55	15	85	30
F3	69	15	98	30

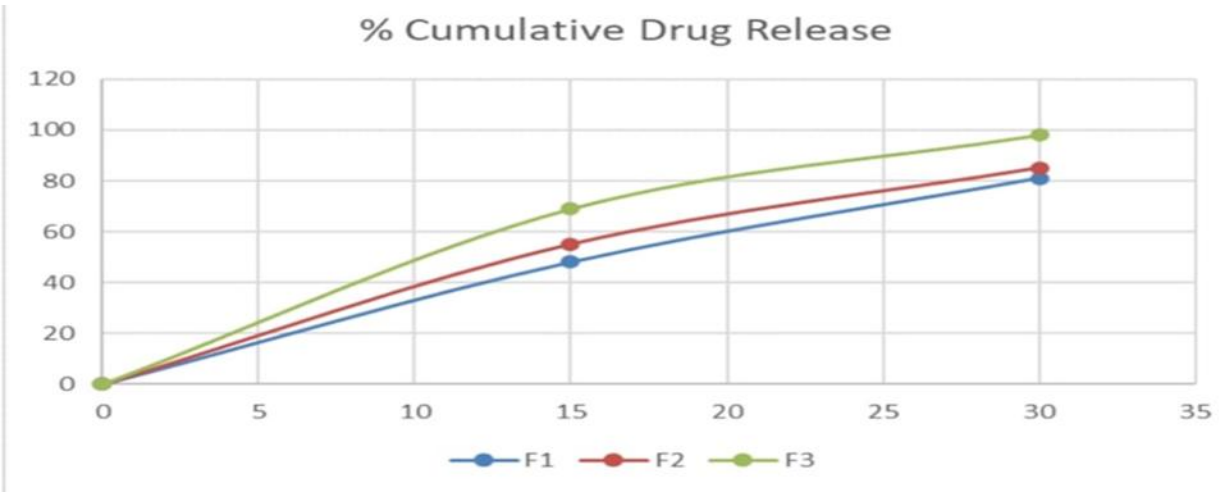


Figure No 7 In-vitro dissolution profile of F1 to F3 formulation

Table No 13: In-vitro drug dissolution data of F4 to F6 formulation

FORMULATION	CUMULATIVE % DRUG RELEASE	TIME	CUMULATIVE % DRUG RELEASE	TIME
F4	58	15	88	30
F5	45	15	72	30
F6	48	15	81	30

All the values are representing as Mean ± S. D. (standard deviation) (n=3)

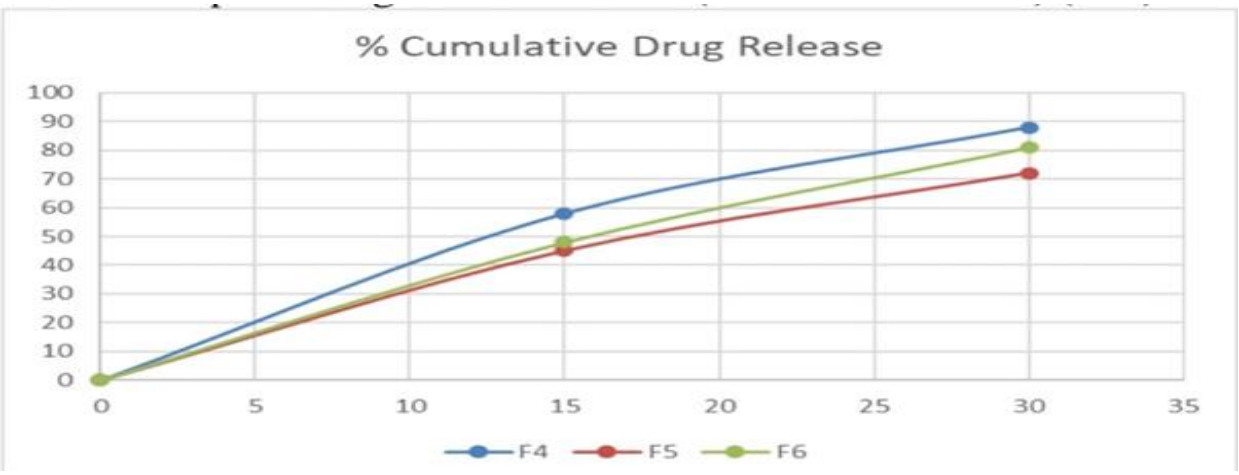


Figure No 8: In-vitro dissolution profile of F4 to F6 formulation

In-Vitro Release Study

1. Method: Wet granulation
2. Optimized Formulation: F3
3. Key Findings:
   - F3 showed 98.06% drug release within 30 minutes
   - Sodium Starch Glycolate increased drug release but affected color
   - Aerosil improved color and increased drug release
4. Conclusion: F3 is the optimized formulation with maximum drug release.

Table No 14: Parameters studied on F3 formulation before and after stability study

PARAMETER	BEFORE STABILITY TESTING	AFTER STABILITY TESTING
	F3	F3
Thickness	3.5+0.2	3.47+0.2
Hardness	3.8+0.2	3.8+0.2
Drug Content	98.54+0.19	98.48+0.21

Stability Study:

Stability studies for the optimized formulation (F3) was carried out in order to determine the physical stability of the formulation. The results were shown in there was no significant change in the parameters which are evaluated during the study period in the accelerated conditions.

Table No 15: Parameters studies on F3 formulation before and after stability study

Parameter	0 Days	30 Days	60 Days
Hardness (kg/cm2)	3.8+0.2	3.7+0.2	3.7+0.2
Thickness (mm)	3.5+0.2	3.5+0.2	3.5+0.2
Weight Variation (mg)	120.5+10	119.9+9	119.9+8
Friability (%)	0.35+0.2	0.36+0.2	0.35+0.2
Drug content (%)	98.54+0.19	98.68+0.19	98.45+0.19
Drug Release (%)	98+0.09	97+0.18	97+0.23

Table No 16: Cumulative percent drug released of optimized formulation before stability study after stability study

Time	Cumulative % Drug Release	
	Before Stability Study	After Stability Study
	F3	F3
30	98+0.09	97.86+14

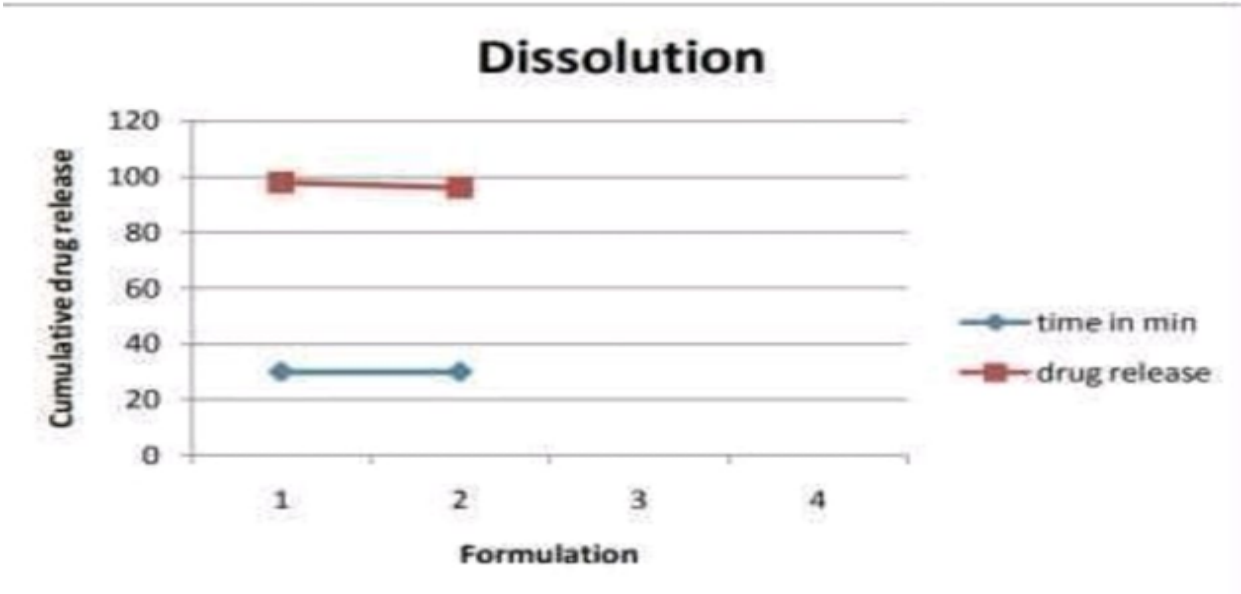


Figure No. 9 : Dissolution profile of formulations F3 before stability & after stability study

V. CONCLUSION

1. Development: Immediate release tablets of Lisinopril were developed with enhanced drug release.
2. Optimized Formulation: F3 complies with innovator specifications.
3. Key Features:
   - Used Sodium Starsch Glycolate as superdisintegrant.
   - Different binder compared to innovator.
4. Stability: F3 showed good stability results within I.P. limits.

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