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DESIGN AND EVALUATION OF PARACETAMOL CHEWABLE PEDIATRIC ORAL JELLY

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ABSTRACT

Pediatric drug delivery systems require special consideration due to physiological, psychological, and developmental differences compared to adults. Conventional dosage forms such as tablets and capsules are often unsuitable for children due to swallowing difficulties, risk of choking, and poor acceptability. Liquid formulations, although commonly used, suffer from issues such as dosing inaccuracies, stability concerns, and unpleasant taste. The present research work focuses on the design and evaluation of a chewable oral jelly formulation containing Paracetamol, a widely used analgesic and antipyretic agent in pediatric therapy. The objective was to develop a palatable, stable, and effective dosage form that enhances patient compliance and ensures accurate dosing.

The formulation was developed using hydrophilic polymers such as pectin, gelatin, and sodium alginate, along with sweeteners, flavoring agents, and preservatives. Various formulations were prepared by altering polymer concentrations and evaluated for physicochemical parameters including pH, viscosity, drug content uniformity, syneresis, texture, and in vitro drug release profile.The optimized formulation demonstrated desirable characteristics such as acceptable taste, uniform drug distribution, minimal syneresis, and rapid drug release. Stability studies conducted as per ICH guidelines confirmed the formulation's stability.

The study concludes that chewable oral jelly is a promising and patient-friendly alternative to conventional pediatric dosage forms.

Keywords: Pediatric dosage form, Oral jelly, Paracetamol, Taste masking, Drug delivery system

CHAPTER 1: INTRODUCTION

1.1 Overview of Pediatric Drug Delivery

Pediatric drug delivery represents one of the most sensitive and complex areas in pharmaceutical sciences. Unlike adult patients, children undergo continuous physiological and developmental changes that significantly influence drug absorption, distribution, metabolism, and excretion. These variations demand specially designed dosage forms that ensure both safety and therapeutic efficacy.

The pediatric population includes neonates, infants, toddlers, children, and adolescents, each group exhibiting distinct pharmacokinetic and pharmacodynamic characteristics. For instance, neonates have immature liver enzyme systems and reduced renal function, which affects drug metabolism and elimination. Similarly, gastric pH, intestinal motility, and enzyme activity vary significantly with age, thereby influencing drug absorption.

In addition to physiological differences, psychological factors also play a crucial role. Children are highly sensitive to taste, texture, color, and smell, which directly affects their willingness to take medications. Poor palatability often results in non-compliance, leading to therapeutic failure.

Therefore, the design of pediatric dosage forms must consider:

- Age-appropriate formulation
- Palatability
- Ease of administration
- Dose flexibility
- Safety of excipients

1.2 Challenges in Pediatric Drug Delivery

Developing dosage forms for pediatric patients involves multiple challenges that are not typically encountered in adult formulations.

1.2.1 Swallowing Difficulty

Young children often find it difficult to swallow solid dosage forms such as tablets and capsules. This limitation necessitates the development of alternative dosage forms like liquids, dispersible tablets, or semi-solids.

1.2.2 Dose Accuracy

Dosing in pediatrics is typically based on body weight or surface area. Conventional liquid formulations require measuring devices, which may lead to dosing errors.

1.2.3 Taste Masking

Many drugs, including Paracetamol, possess an inherently bitter taste. Masking this taste is essential to ensure patient compliance.

1.2.4 Stability Issues

Liquid formulations are prone to microbial contamination and require preservatives, which may not always be safe for children.

1.2.5 Excipient Safety

Certain excipients that are safe for adults may not be suitable for pediatric use. For example, alcohol, propylene glycol, and certain preservatives can be harmful.

1.3 Limitations of Conventional Dosage Forms

1.3.1 Tablets and Capsules

Although widely used, these dosage forms present several disadvantages in pediatric patients:

- Risk of choking
- Difficulty in swallowing
- Fixed dosing (lack of flexibility)
- Poor compliance

1.3.2 Liquid Dosage Forms

Liquid formulations such as syrups and suspensions are commonly used but have inherent limitations:

- Dosing inaccuracies due to measuring errors
- Stability issues
- Requirement of preservatives
- Bulky packaging

These drawbacks highlight the need for alternative dosage forms that combine the advantages of both solid and liquid systems.

1.4 Novel Pediatric Drug Delivery Systems

To overcome the limitations of conventional dosage forms, several novel drug delivery systems have been developed:

- Orally disintegrating tablets (ODTs)
- Fast dissolving films
- Chewable tablets
- Oral jellies

Among these, oral jellies have gained significant attention due to their unique properties and patient-friendly nature.

1.5 Oral Jelly Drug Delivery System

Oral jellies are semi-solid dosage forms that can be chewed or allowed to dissolve in the mouth without the need for water. They are particularly suitable for pediatric and geriatric populations.

1.5.1 Characteristics of Oral Jellies

- Soft, elastic texture
- Pleasant taste and aroma
- Rapid disintegration or dissolution
- Uniform drug distribution

1.5.2 Advantages

- Improved patient compliance
- Ease of administration
- Accurate dosing
- No risk of choking
- Enhanced palatability

Fig. 1: Oral Jelly

1.5.3 Disadvantages

- Sensitivity to temperature and humidity
- Packaging requirements
- Limited drug loading capacity

1.6 Detailed Theory of Gel Formation

Gel formation is a critical aspect of oral jelly formulation. It involves the transformation of a liquid system into a semi-solid structure through the formation of a three-dimensional polymeric network.

1.6.1 Mechanism of Gel Formation The process

includes:

1. **Hydration of Polymer Chains.**

Polymers absorb water and swell.

2. **Chain Entanglement.**

Polymer chains interact and overlap.

3. **Cross-Linking.**

Physical or chemical bonds form between chains.

4. **Network Formation.**

A stable gel structure is formed that traps water and drug molecules.

1.7 Types of Polymers Used in Oral Jellies

1.7.1 Natural Polymers

- Pectin
- Gelatin
- Agar

These are preferred due to their safety and biocompatibility.

1.7.2 Synthetic Polymers

- Carbopol
- HPMC

Used for better control over gel properties.

1.8 Factors Affecting Oral Jelly Formulation

Several factors influence the quality and performance of oral jellies:

- Polymer concentration
- pH of the formulation
- Temperature during preparation
- Type of sweetener and flavor
- Drug solubility

CHAPTER 2: AIM AND OBJECTIVES

The present study focuses on designing a novel oral jelly formulation containing Paracetamol to overcome limitations associated with conventional dosage forms such as syrups and tablets.

2.1 Aim of the Study

The primary aim of this research work is:

 To design, formulate, and evaluate a chewable pediatric oral jelly of paracetamol with improved palatability, stability, and drug release characteristics.

2.2 Primary Objectives

The primary objectives of this study are:

To develop oral jelly formulations using suitable polymers such as pectin, gelatin, and sodium alginate.

To mask the bitter taste of paracetamol using sweeteners and flavoring agents.

To ensure uniform distribution of drug within the jelly matrix.

2.3 Secondary Objectives

To evaluate parameters such as:

- pH
- Viscosity
- Texture
- Appearance

To ensure accurate dosing in each unit of jelly.

To study the release profile of paracetamol from the jelly formulation.

To evaluate the stability of the formulation under different environmental conditions as per International Council for Harmonisation.

2.4 Specific Objectives

To achieve the aim, the following specific objectives were designed:

- To perform pre formulation studies of paracetamol
- To select suitable excipients for formulation

- To optimize polymer concentration
- To evaluate multiple formulations (F1–F6)
- To identify optimized formulation
- To perform stability testing

2.5 Research Design

The research work is divided into the following phases:

1. Preformulation studies
2. Formulation development
3. Evaluation studies
4. Optimization
5. Stability studies

2.6 Expected Outcomes

The study is expected to achieve:

- Development of a palatable pediatric dosage form
- Improved patient compliance
- Rapid drug release
- Stable formulation

CHAPTER 3: LITERATURE REVIEW

3.1 Introduction

Literature review is a critical component of research that provides an understanding of previous work carried out in the field. It helps identify research gaps and supports the design of the present study.

Desai K.G.H., et al. (2014) reported that oral jelly is a novel and patient-friendly drug delivery system, particularly useful for pediatric and geriatric populations. Their study highlighted that oral jellies improve patient compliance due to ease of administration and pleasant mouthfeel. They formulated jelly using hydrophilic polymers and evaluated parameters such as pH, viscosity, and drug release. The study concluded that oral jelly formulations showed rapid drug release and better acceptability compared to conventional dosage forms.

Patel D.M., et al. (2015) developed and evaluated oral jelly formulations using natural polymers. Their research emphasized the importance of polymer concentration in determining gel strength and drug release.

The formulations were evaluated for physicochemical properties and in vitro dissolution. The optimized formulation showed good stability, uniform drug content, and satisfactory release profile.

Sharma S., et al. (2012) focused on taste masking techniques in pediatric drug delivery systems. The study discussed various methods such as the use of sweeteners, flavors, and polymer coatings to mask the bitterness of drugs. The authors concluded that taste masking plays a crucial role in improving compliance among pediatric patients, especially for bitter drugs like Paracetamol.

Gupta A., et al. (2013) reviewed oral jelly drug delivery systems and reported that these formulations provide advantages such as rapid onset of action, improved bioavailability, and better patient compliance. The study highlighted the role of polymers such as pectin and gelatin in forming stable gel structures..

3.2 Overview of Oral Jelly Formulations

Oral jellies are semi-solid dosage forms designed to dissolve or disintegrate in the oral cavity.
They are particularly useful for pediatric and geriatric patients.
Studies have shown that oral jellies offer:

- Better patient compliance
- Improved palatability
- Rapid drug release

3.3 Previous Research on Oral Jellies

Several researchers have explored oral jelly formulations:

- Studies reported improved compliance compared to syrups
- Faster drug release due to large surface area
- Better stability compared to liquid formulations

3.4 Role of Polymers in Jelly Formulation

Polymers play a crucial role in determining the properties of oral jellies.

3.4.1 Pectin

- Natural polymer
- Forms gel in presence of sugar and acid
- Widely used in food and pharmaceutical industries

3.4.2 Gelatin

- Derived from collagen

- Provides elasticity
- Enhances mouthfeel

3.4.3 Sodium Alginate

- Forms gel in presence of calcium ions
- Provides strong gel structure

3.5 Taste Masking Techniques

Taste masking is essential for pediatric formulations.

Common Techniques

- Use of sweeteners (sucrose, sorbitol)
- Flavoring agents (fruit flavors)
- Complexation
- Coating

3.6 Drug Release from Jelly Systems

Drug release from oral jelly depends on:

- Polymer concentration
- Drug solubility
- Gel structure **Mechanism:**

- Diffusion
- Erosion

3.7 Research Gap

Despite advancements, limited research is available on:

- Chewable oral jelly of paracetamol
- Pediatric-specific formulations
- Optimization of polymer combinations

CHAPTER 4: PREFORMULATION STUDIES

4.1 Introduction

Preformulation studies constitute the initial phase in the development of any pharmaceutical dosage form. These studies provide detailed information about the physicochemical properties of the drug, which are essential for designing a stable, effective, and patient-friendly formulation.

In the present study, preformulation investigations were carried out for Paracetamol to assess its suitability for incorporation into a chewable pediatric oral jelly.

The data obtained from these studies help in:

- Selecting appropriate excipients
- Determining formulation strategy
- Predicting stability and compatibility **4.2 Objectives of Preformulation Studies** The main objectives include:

- To determine physicochemical properties of the drug
- To study solubility and dissolution characteristics
- To evaluate drug-excipient compatibility
- To establish analytical methods for drug estimation
- To predict stability of the drug

4.3 Organoleptic Properties

4.3.1 Importance

Organoleptic properties are sensory characteristics such as color, odor, and taste. These are particularly important in pediatric formulations where patient acceptability is critical.

4.3.2 Procedure

The drug sample was examined visually and by sensory evaluation for:

- Color
- Odor
- Taste
- Physical appearance

4.3.3 Observations

Property	Observation
Color	White
Odor	Odorless
Taste	Bitter
Nature	Crystalline powder

4.3.4 Interpretation

The bitter taste of paracetamol necessitates effective taste masking techniques in formulation.

4.4 Solubility Studies

4.4.1 Importance

Solubility plays a crucial role in:

- Drug absorption
- Bioavailability
- Formulation design

4.4.2 Method

Solubility was determined in:

- Distilled water
- Ethanol
- Phosphate buffer (pH 6.8)

Excess drug was added to solvent and shaken for 24 hours, followed by filtration. **4.4.3 Results**

Solvent	Solubility
Water	Slightly soluble
Ethanol	Freely soluble
Buffer pH 6.8	Moderately soluble

4.4.4 Conclusion

Moderate solubility in buffer supports suitability for oral jelly formulation.

4.5 Melting Point Determination

4.5.1 Importance

Melting point indicates:

- Purity of drug
- Identity confirmation

4.5.2 Method

Capillary method using melting point apparatus.

4.5.3 Result

Observed melting point: **168–172°C 4.5.4**

Interpretation

This confirms the purity of the drug.

4.6 Partition Coefficient

4.6.1 Importance

Partition coefficient indicates drug lipophilicity and its ability to cross biological membranes.

4.6.2 Method

Shake flask method using:

- n-octanol
- Water **4.6.3 Result**

Log P ≈ **0.5**

4.6.4 Conclusion

Moderate lipophilicity suggests good oral absorption.

4.7 Drug-Excipient Compatibility Studies

4.7.1 Importance

Compatibility studies ensure that no chemical interaction occurs between drug and excipients.

4.7.2 Method

Fourier Transform Infrared Spectroscopy (FTIR)

4.7.3 Procedure

- FTIR spectra of pure drug recorded
- Spectra of drug-excipient mixtures recorded
  - **Compared for peak shifts**

4.7.4 Observation

No significant changes in characteristic peaks observed.

4.7.5 Conclusion

Paracetamol is compatible with selected excipients.

4.8 Calibration Curve of Paracetamol

4.8.1 Importance

Calibration curve is essential for:

- Quantitative analysis
- Drug content determination **4.8.2 Method**

UV Spectrophotometric method

- λmax: **243 nm**
- Solvent: Phosphate buffer pH 6.8

4.8.3 Procedure

1. Prepare stock solution
2. Prepare dilutions (2–10 µg/ml)
3. Measure absorbance
4. Plot graph

4.8.4 Data

Concentration (µg/ml)	Absorbance
2	0.210
4	0.395
6	0.590
8	0.780

10	0.965

4.8.5 Result

- Linear relationship observed
- $R^2 \approx 0.999$

4.8.6 Conclusion

Method is suitable for drug estimation.

4.9 Particle Size Analysis (Additional Theory for Expansion) Particle size affects:

- Dissolution rate
- Bioavailability

Smaller particles provide faster dissolution due to increased surface area.

4.10 Stability Considerations Factors affecting stability:

- Temperature
- Light
- Moisture

Proper storage conditions are essential to maintain drug integrity.

4.11 Flowchart: Preformulation Study

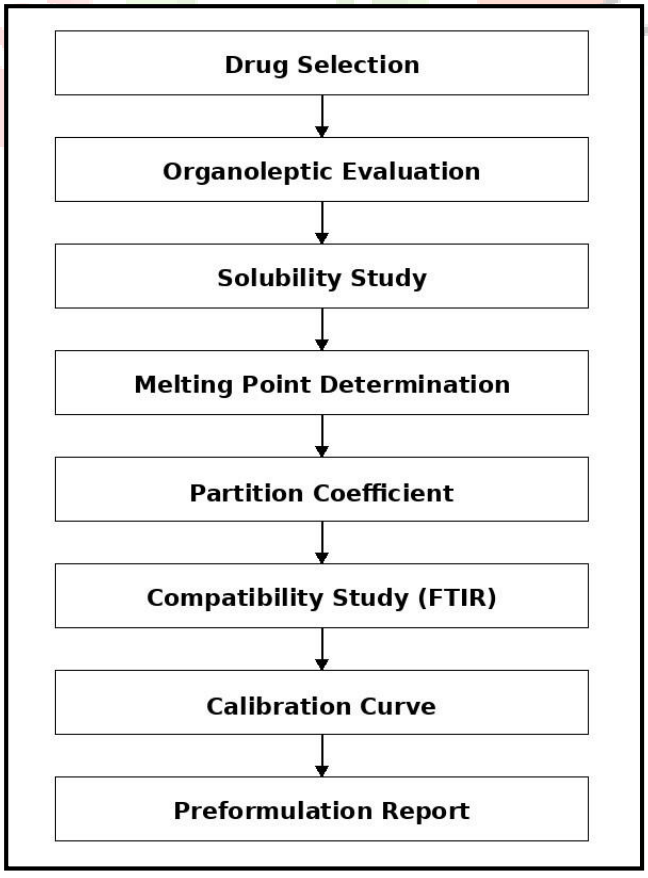

Fig. 2: Flowchart of Preformulation Study

CHAPTER 5: MATERIALS AND METHODS

5.1 Introduction

Materials and methods form the core of any pharmaceutical research study, as they describe the substances used and the procedures followed to develop and evaluate the formulation. Proper selection of materials and standardized methodology ensures reproducibility, accuracy, and reliability of results.

In the present study, a chewable oral jelly formulation of Paracetamol was developed using suitable polymers and excipients to achieve optimal physicochemical properties and patient acceptability.

5.2 Materials

5.2.1 Active Pharmaceutical Ingredient (API)

- **Paracetamol** ○ **Category:** Analgesic and antipyretic ○ **Function:** Provides therapeutic effect

5.2.2 Polymers (Gelling Agents)

Polymers are responsible for forming the jelly structure.

- **Pectin**

Natural polymer, forms gel in presence of sugar and acid

- **Gelatin**

Protein-based polymer, provides elasticity and chewability

- **Sodium Alginate**

Forms strong gels, improves viscosity

5.2.3 Sweetening Agents

- **Sucrose** - **Sorbitol**

Used to mask the bitter taste and improve palatability.

5.2.4 Preservatives

- **Sodium Benzoate (0.1%)**

Prevents microbial growth and increases shelf life.

5.2.5 Acidulant

- **Citric Acid**

Maintains pH and enhances taste.

5.2.6 Flavoring and Coloring Agents

- Fruit flavors (orange/strawberry)
- Approved food-grade colorants

Enhance acceptability among pediatric patients.

5.2.7 Solvent

- **Distilled Water**

Used as a vehicle for preparation.

5.3 Equipment Used

The following instruments were used:

- Digital weighing balance
- Magnetic stirrer
- Hot plate
- pH meter
- Brookfield viscometer
- UV spectrophotometer
- Glassware (beakers, flasks)
- Molds for jelly formation

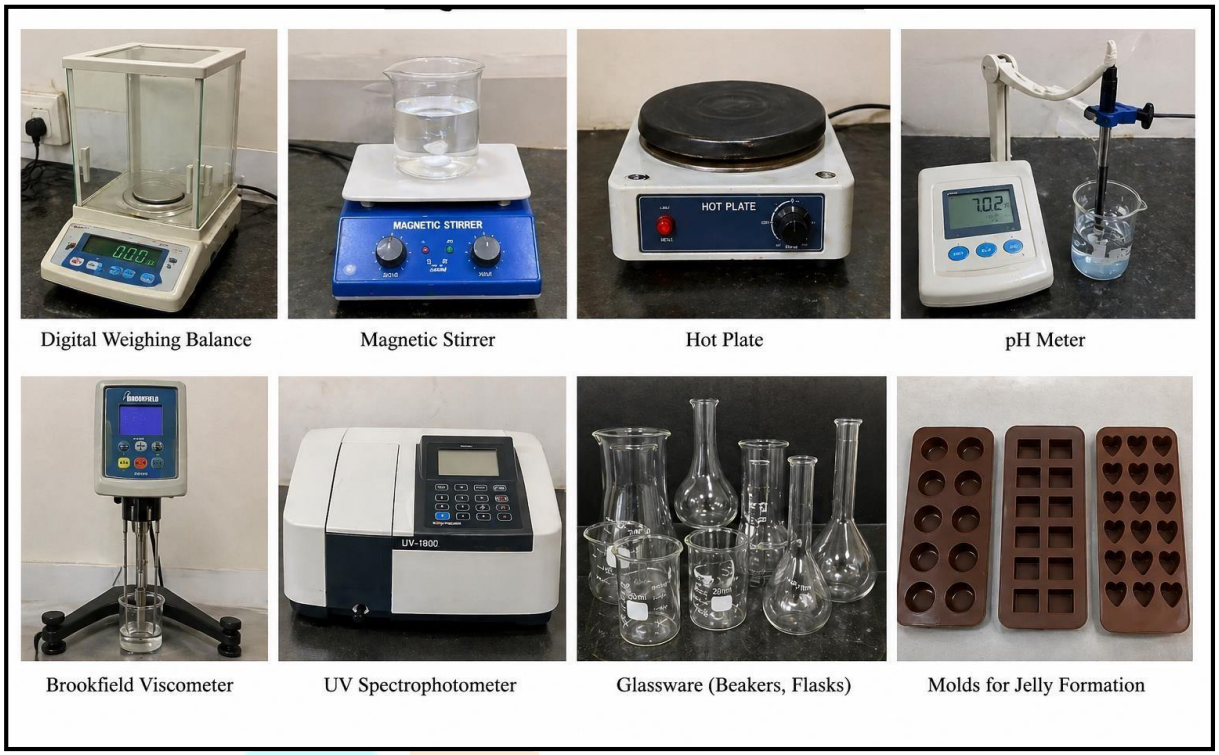

Fig. 3: Equipment Used

5.4 Method of Preparation

5.4.1 Principle

The formulation was prepared using the heating and congealing method, which involves dissolving polymers in water followed by incorporation of drug and excipients.

5.4.2 Step-by-Step Procedure

1. Accurately weigh all ingredients
2. Dissolve polymer in distilled water with continuous stirring
3. Heat the mixture gently (avoid excessive heating)
4. Add sweeteners and preservatives
5. Dissolve Paracetamol separately and incorporate into the mixture
6. Add citric acid to adjust pH
7. Add flavor and color
8. Pour the mixture into molds
9. Allow to cool and solidify at room temperature
10. Remove formed jellies and store in airtight containers

5.5 Flowchart of Preparation Method

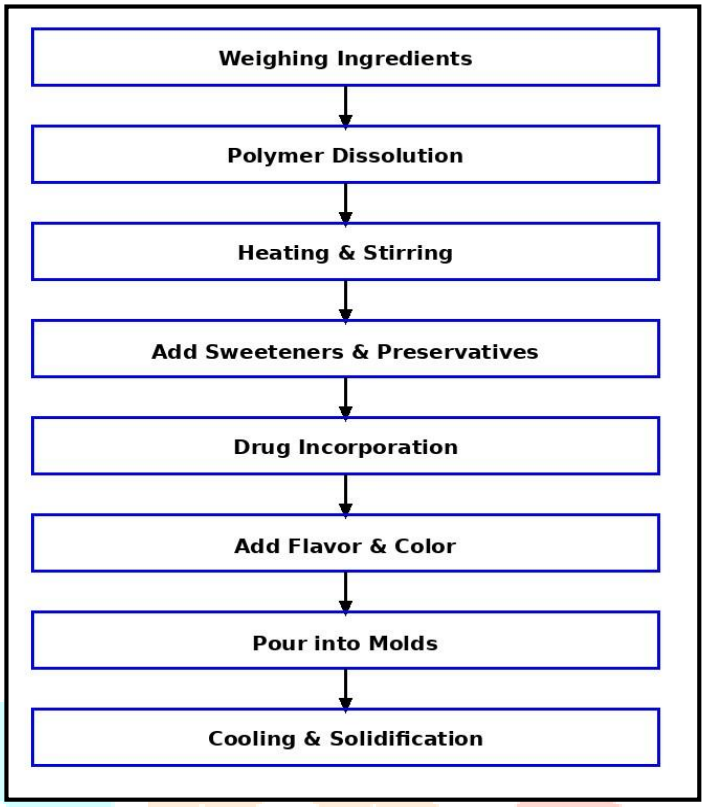

Fig. 4: Preparation Process Flowchart

5.6 Formulation Design

Multiple formulations were prepared by varying polymer concentration.

Formulation Table

Ingredient	F1	F2	F3	F4	F5	F6
Paracetamol	250 mg	250 mg	250 mg	250 mg	250 mg	250 mg
Pectin	1%	1.5%	2%	—	—	—
Gelatin	—	—	—	1%	1.5%	—
Sodium Alginate	—	—	—	—	—	2%
Sucrose	30%	35%	40%	30%	35%	40%
Citric Acid	q.s	q.s	q.s	q.s	q.s	q.s
Sodium Benzoate	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Flavor	q.s	q.s	q.s	q.s	q.s	q.s

5.7 Selection Criteria for Excipients Excipients were

selected based on:

- Safety for pediatric use
- Compatibility with drug
- Ability to form stable gel

- Taste masking capability

5.8 Optimization Strategy

Formulations were optimized based on:

- Texture
- Taste
- Drug release
- Stability

Batch F2 was selected as optimized formulation.

5.9 Storage Conditions

Prepared jellies were stored under:

- Room temperature (25°C ± 2°C)
- Relative humidity: 60%
- Airtight containers

5.10 Precautions during Preparation

- Avoid overheating of polymer solution
- Ensure uniform mixing
- Prevent air bubble formation
- Maintain hygienic conditions
- Use calibrated instruments

5.11 Diagram: Jelly Formation Mechanism

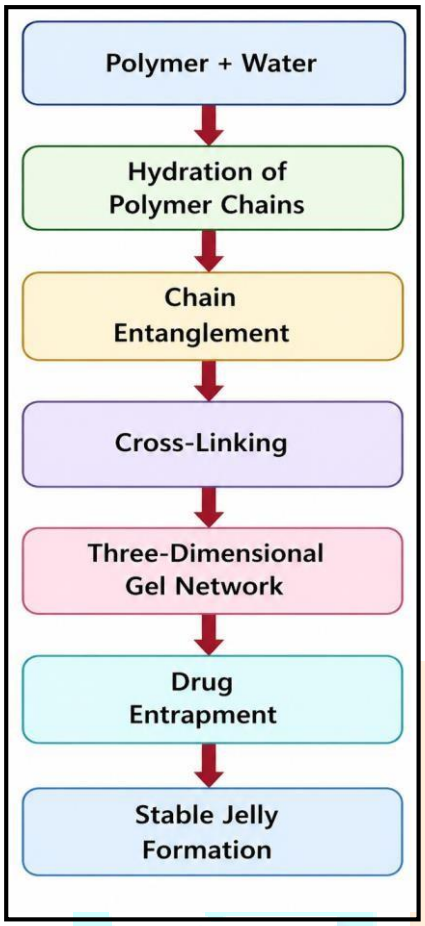

Fig. 5: Flow Diagram of Jelly Formation Mechanism

CHAPTER 6: FORMULATION DEVELOPMENT AND OPTIMIZATION

6.1 Introduction

Formulation development is a critical stage in pharmaceutical research, where the drug is combined with suitable excipients to produce a stable, effective, and patient-friendly dosage form. The goal is to achieve optimal performance in terms of stability, drug release, palatability, and patient compliance.

6.2 Objectives of Formulation Development

- To develop oral jelly using different polymers
- To optimize polymer concentration
- To improve taste and texture
- To achieve uniform drug distribution
- To obtain desired drug release profile

6.3 Selection of Polymers

Polymers are the backbone of jelly formulation. Their type and concentration significantly influence the final product.

6.3.1 Pectin

- Natural polysaccharide
- Forms gel in acidic conditions with sugar
- Safe and widely used **Advantages:**

- Good gel strength
- Biocompatible
- Suitable for pediatric formulations

6.3.2 Gelatin

- Protein-based polymer
- Thermoreversible gel **Advantages:**

- Excellent elasticity
- Smooth mouthfeel **Limitations:**

- Sensitive to temperature
- May soften at high temperatures

6.3.3 Sodium Alginate

- Anionic polymer
- Forms strong gels **Advantages:**

- High viscosity
- Good stability **Limitations:**

- Requires cross-linking for strong gel

6.4 Role of Excipients in Formulation Each excipient

plays a specific role:

- **Sweeteners:** Mask bitterness
  - **Flavoring agents:** Improve taste
- **Preservatives:** Prevent microbial growth
- **Acidulants:** Maintain pH

6.5 Formulation Trials

Multiple batches were prepared by varying polymer concentration.

Trial Formulations

Batch	Polymer	Concentration	Observation
F1	Pectin	1%	Too soft
F2	Pectin	1.5%	Optimal
F3	Pectin	2%	Too hard
F4	Gelatin	1%	Soft
F5	Gelatin	1.5%	Acceptable
F6	Alginate	2%	Very firm

6.6 Evaluation during Development Each formulation

was evaluated for:

- Appearance
- Texture
- Taste
- Setting time

Polymer concentration plays a crucial role in determining the properties of oral jelly.

Low Polymer Concentration

- Soft jelly
- Poor structure
- Faster drug release

High Polymer Concentration

- Hard jelly
- Reduced palatability
- Slower drug release

Optimal Concentration

- Balanced texture
- Controlled drug release

6.8 Taste Masking Optimization

Taste masking is essential for pediatric formulations.

Methods Used

- Addition of sucrose
- Use of fruit flavors
- pH adjustment using citric acid

Observation

- Bitter taste reduced significantly in optimized batch
- Strawberry/orange flavor improved acceptability

6.9 Optimization of Sweeteners Sweetener

concentration affects:

- Taste
- Texture
- Gel formation **Excess sugar:**
- Makes jelly sticky **Low sugar:**
- Poor taste masking

Optimal concentration ensures balance.

6.10 Optimization of pH pH influences:

- Gel formation
- Drug stability
- Taste

Ideal pH range: **5.5 – 6.5**

6.11 Drug Incorporation and Uniformity Uniform distribution

of Paracetamol is essential.

Factors affecting uniformity:

- Mixing speed
- Temperature
- Viscosity

Proper mixing ensures consistent drug content.

6.12 Selection of Optimized Formulation

Based on evaluation, **F2 (Pectin 1.5%)** was selected.

Reasons

- Ideal texture
- Good taste
- No syneresis
- Uniform drug content Rapid drug release

CHAPTER 7: EVALUATION PARAMETERS

7.1 Introduction

Evaluation of pharmaceutical formulations is an essential step to ensure that the developed dosage form meets the required standards of quality, safety, efficacy, and patient acceptability. For pediatric formulations, evaluation becomes even more critical due to the need for palatability, accurate dosing, and stability.

7.2 Objectives of Evaluation

- To assess physical and organoleptic properties
- To determine pH and viscosity
- To ensure uniform drug distribution
- To evaluate drug release profile
- To study stability of formulation

7.3 Physical Appearance

7.3.1 Importance

Physical appearance plays a crucial role in patient acceptance, especially in pediatric formulations.

7.3.2 Parameters Evaluated

- Color
- Clarity
- Texture
- Presence of air bubbles
- Uniformity

7.3.3 Observations

- Smooth and uniform structure
- No visible air bubbles
- Transparent appearance

7.3.4 Conclusion

Indicates proper formulation and processing.

7.4 pH Measurement 7.4.1

Importance pH affects:

- Drug stability
- Taste
- Oral compatibility

7.4.2 Method

- Jelly dissolved in distilled water
- Measured using calibrated digital pH meter

7.4.3 Result pH range: **5.5 –**

6.5

7.4.4 Interpretation

- Suitable for oral cavity
- Prevents irritation
- Maintains drug stability

7.5 Viscosity Measurement

7.5.1 Importance

Viscosity influences:

- Mouthfeel
- Drug release
- Stability

7.5.2 Instrument

Brookfield Viscometer

7.5.3 Procedure

- Jelly sample placed in viscometer
- Measured at different speeds

7.5.4 Observation

- Viscosity increased with polymer concentration
- Optimized formulation showed balanced viscosity

7.5.5 Conclusion

Proper viscosity ensures good consistency and stability.

7.6 Drug Content Uniformity

7.6.1 Importance

Ensures accurate dosing in each jelly unit.

7.6.2 Procedure

1. Weigh jelly sample
2. Dissolve in phosphate buffer pH 6.8
3. Filter solution
4. Analyze using UV spectrophotometer at 243 nm

7.6.3 Results

Formulation	Drug Content (%)
F1	97.5
F2	99.2
F3	98.8

7.6.4 Interpretation

All formulations comply with acceptable limits (95–105%).

7.7 Syneresis Study

7.7.1 Definition

Syneresis is the separation of liquid from the gel matrix.

7.7.2 Importance

Indicates stability of formulation.

7.7.3 Procedure

- Store jellies at room temperature
- Observe for liquid separation

7.7.4 Observation

- No syneresis in optimized batch
- Slight syneresis in high polymer batches

Texture determines chewability and patient acceptability.

7.8.2 Parameters

- Firmness
- Elasticity
- Chewability

7.8.3 Observation

- F1: Too soft
- F2: Ideal texture
- F3: Too hard

7.8.4 Conclusion

Polymer concentration affects texture.

7.9 In Vitro Drug Release Study

7.9.1 Importance

Determines release behavior of drug.

7.9.2 Apparatus

USP Dissolution Apparatus Type II

7.9.3 Medium

Phosphate buffer pH 6.8

7.9.4 Procedure

1. Place jelly in dissolution medium

2. Maintain temperature at 37°C
3. Withdraw samples at intervals
4. Analyze spectrophotometrically

7.9.5 Results

Time (min)	% Drug Release
5	30
10	55
20	75
30	92

7.9.6 Interpretation

- Rapid initial release
- Suitable for quick therapeutic action

7.10 Drug Release Mechanism

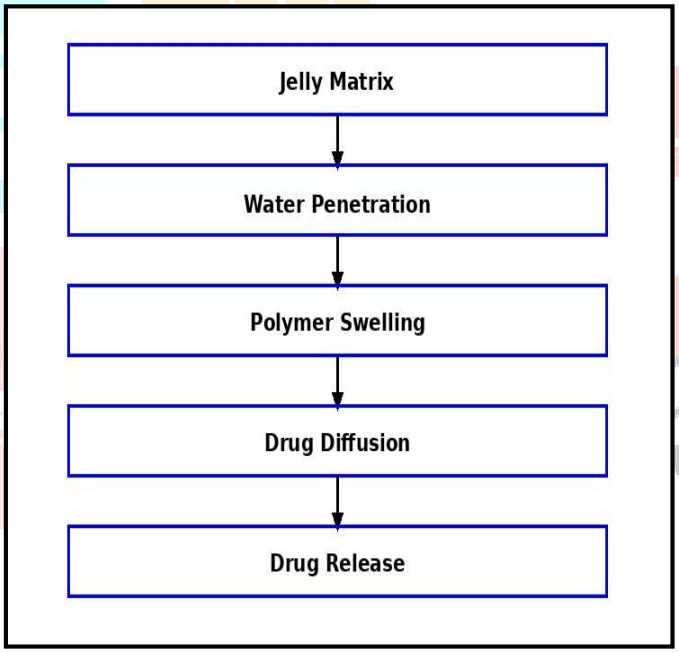

Fig. 6: Flowchart of Drug Release Mechanism 7.12 Evaluation Workflow

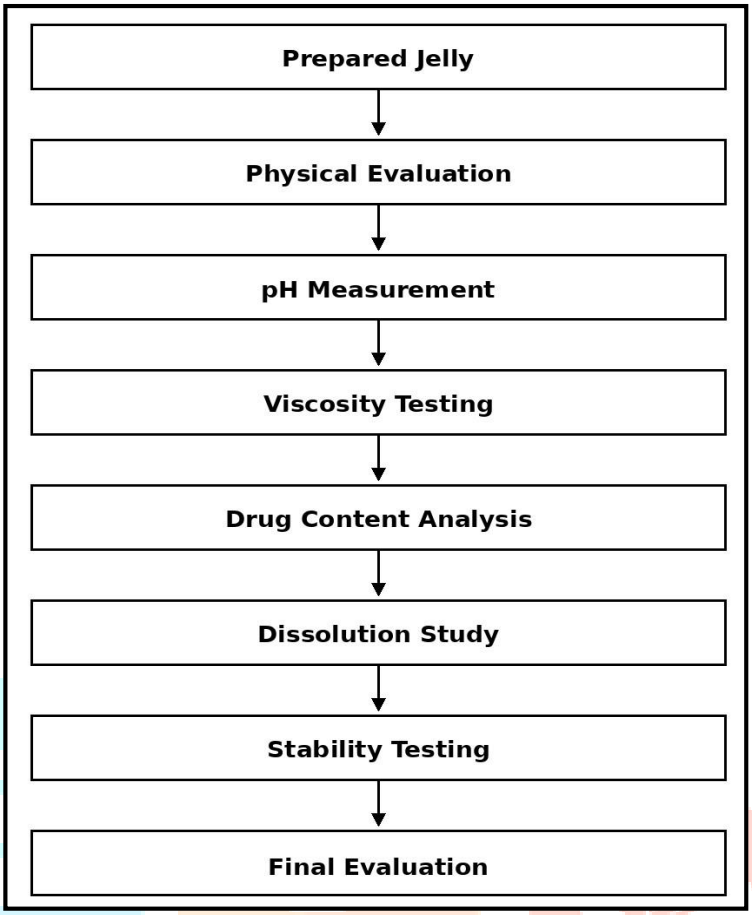

Fig. 7: Flowchart of Evaluation workflow

CHAPTER 8: RESULTS AND DISCUSSION

8.1 Physical Appearance Observations

All prepared formulations were evaluated for physical characteristics such as color, clarity, texture, and uniformity.

Formulation	Appearance
F1	Soft, slightly sticky
F2	Smooth, transparent
F3	Hard and rigid
F4	Soft and elastic
F5	Slightly firm
F6	Very firm

Discussion

The physical appearance of oral jelly plays a significant role in patient acceptance. The optimized formulation (F2) exhibited a smooth and transparent structure with no air bubbles, indicating proper mixing and gel formation.

Higher polymer concentrations resulted in increased firmness, while lower concentrations produced softer gels. This demonstrates the direct relationship between polymer concentration and gel consistency.

8.2 pH Analysis Results

Formulation	pH
F1	6.3
F2	6.2
F3	6.1
F4	6.4
F5	6.3
F6	6.0

Discussion

All formulations exhibited pH values within the acceptable range (5.5–6.5), making them suitable for oral administration. Maintaining an appropriate pH is essential for:

- Preventing irritation
- Ensuring drug stability
- Enhancing taste

The slight variation in pH is attributed to differences in polymer and acid concentrations.

8.3 Viscosity Analysis Observation

- Viscosity increased with polymer concentration
- Alginate-based formulation showed highest viscosity
- Pectin formulation (F2) showed optimal viscosity

Discussion

Viscosity is a critical parameter affecting texture, mouthfeel, and drug release. Higher viscosity formulations tend to have slower drug release due to reduced diffusion rates.

The optimized formulation (F2) achieved a balance between viscosity and drug release, making it suitable for pediatric use.

8.4 Drug Content Uniformity Results

Formulation	Drug Content (%)
F1	97.5
F2	99.2
F3	98.8

F4	97.9
F5	98.5
F6	97.2

Discussion

All formulations showed drug content within acceptable limits (95–105%), indicating uniform distribution of Paracetamol.

The optimized formulation (F2) showed the highest drug content uniformity, suggesting efficient mixing and formulation technique.

8.5 Texture Analysis Observations

Formulation	Texture
F1	Very soft
F2	Ideal
F3	Hard
F4	Elastic
F5	Moderately firm
F6	Very hard

Discussion

Texture is crucial for chewability and patient acceptance. The optimized formulation provided a soft yet firm texture, making it easy to chew and swallow.

8.6 In Vitro Drug Release Study Results

Time (min)	F1	F2	F3	F4	F5	F6
5	35	30	20	32	28	18
10	60	55	40	58	50	35
20	80	75	60	78	70	55
30	95	92	75	93	85	70

Discussion

The drug release study revealed:

- Rapid release in low polymer formulations
- Slower release in high polymer formulations
- Balanced release in optimized formulation

The optimized batch (F2) showed approximately **92% drug release within 30 minutes**, which is ideal for pediatric therapy requiring quick onset of action.

8.7 Effect of Polymer Type on Drug Release Observations

- Pectin: Moderate release
- Gelatin: Faster release
- Alginate: Slow release

Discussion

Polymer type significantly affects drug release:

- Hydrophilic polymers facilitate faster drug diffusion
- Strong gel networks slow down drug release

8.8 Overall Optimization

Based on all evaluation parameters: Optimized

Formulation: F2 (Pectin 1.5%) **Reasons:**

- Ideal texture
- Acceptable pH
- High drug content
- No syneresis
- Balanced drug release

8.9 Graphical Representation

- Calibration curve

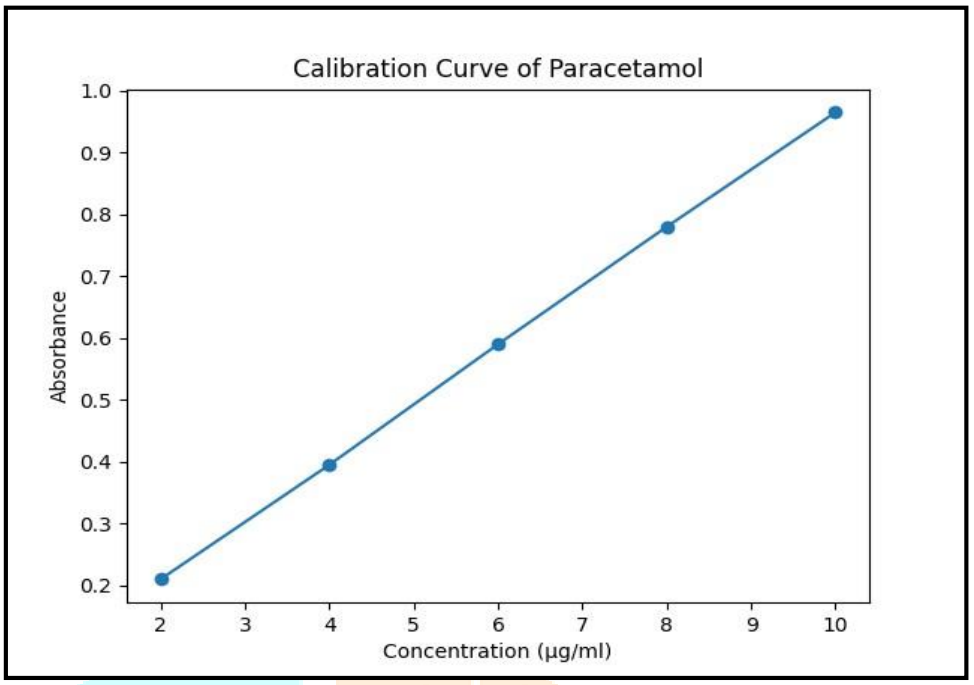

Fig. 8: Calibration Curve of Paracetamol

- Dissolution profile graph

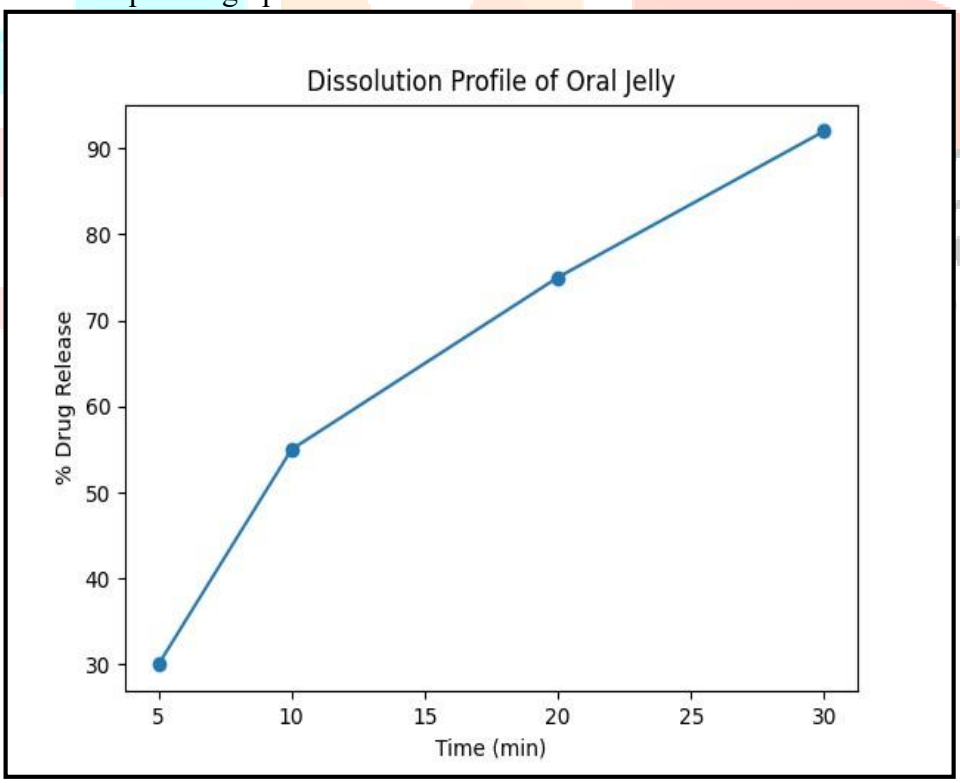

Fig. 9: Dissolution Profile of Oral Jelly

CHAPTER 9: STABILITY STUDIES

9.1 Introduction

Stability studies are essential in pharmaceutical formulation to ensure that a product maintains its quality, safety, and efficacy throughout its shelf life. These studies help determine the effect of environmental factors such as temperature, humidity, and light on the formulation.

For pediatric dosage forms like oral jellies, stability is particularly important due to their semisolid nature and susceptibility to microbial contamination and physical changes. Stability testing of the optimized formulation containing Paracetamol was carried out as per International Council for Harmonization.

9.2 Objectives of Stability Studies

- To evaluate physical stability of the formulation
- To assess chemical stability of the drug
- To determine shelf life
- To study effect of environmental conditions

9.3 Types of Stability Studies

9.3.1 Long-Term Stability Studies

Conducted under normal storage conditions to evaluate product stability over time.

9.3.2 Accelerated Stability Studies

Conducted at elevated temperature and humidity to predict long-term stability in a shorter duration.

9.4 Storage Conditions

Stability studies were performed under the following conditions:

Study Type Temperature Humidity

Long-term 25°C ± 2°C 60% RH

Study Type Temperature Humidity

Accelerated 40°C ± 2°C 75% RH

9.5 Duration of Study

Samples were evaluated at:

- Initial (0 month)

- 1 month
- 2 months
- 3 months

9.6 Parameters Evaluated

The following parameters were monitored:

- Appearance
- pH
- Drug content
- Texture
- Syneresis

9.7 Results

9.7.1 Physical Appearance

No significant change in color, clarity, or texture was observed.

9.7.2 pH

Time	pH
0 Month	6.2
1 Month	6.2
2 Months	6.1
3 Months	6.1

9.7.3 Drug Content

Time	Drug Content (%)
0 Month	99.2
1 Month	99.0
2 Months	98.8
3 Months	98.7

9.7.4 Syneresis

No water separation observed in optimized formulation.

9.8 Discussion

The stability study results indicate that the formulation remained stable under both long-term and accelerated conditions.

- Minor changes in pH were observed but remained within acceptable limits
- Drug content showed negligible reduction
- No physical degradation occurred

This confirms the robustness of the formulation.

9.9 Shelf Life Estimation

Based on stability data, the formulation is expected to have a satisfactory shelf life under recommended storage conditions.

CHAPTER 10: SUMMARY AND CONCLUSION

10.1 Summary

The present study focused on the design and evaluation of a chewable pediatric oral jelly formulation of Paracetamol.

Key Steps in Study

1. Preformulation studies were conducted to evaluate drug properties
2. Various formulations were prepared using different polymers
3. Formulations were evaluated for physicochemical properties
4. Optimized formulation was selected
5. Stability studies were conducted

10.2 Key Findings

- Oral jelly formulation successfully developed
- Taste masking achieved effectively
- Optimized formulation (F2) showed:
  - Ideal texture
  - Uniform drug content
  - Rapid drug release
  - Stability under test conditions

10.3 Conclusion

The study concludes that chewable oral jelly is a promising dosage form for pediatric drug delivery. The formulation developed in this study provides:

- Improved patient compliance
- Accurate dosing
- Rapid therapeutic action

Thus, oral jelly can serve as an effective alternative to conventional dosage forms.

CHAPTER 11: REFERENCES

Books & Standard Texts

1. Aulton ME, Taylor K. *Aulton's Pharmaceutics: The Design and Manufacture of Medicines*. 5th ed. Elsevier; 2018.
2. Lachman L, Lieberman HA, Kanig JL. *The Theory and Practice of Industrial Pharmacy*. 4th ed. CBS Publishers; 2013.
3. Banker GS, Rhodes CT. *Modern Pharmaceutics*. 4th ed. Marcel Dekker; 2002.
4. Allen LV. *Pharmaceutical Dosage Forms and Drug Delivery Systems*. 10th ed. Wolters Kluwer; 2017.
5. Rowe RC, Sheskey PJ, Quinn ME. *Handbook of Pharmaceutical Excipients*. 7th ed. Pharmaceutical Press; 2012.
6. Remington JP. *Remington: The Science and Practice of Pharmacy*. 22nd ed. Pharmaceutical Press; 2013.
7. Martin A. *Physical Pharmacy and Pharmaceutical Sciences*. 6th ed. Lippincott Williams & Wilkins; 2011.
8. Sinko PJ. *Martin's Physical Pharmacy and Pharmaceutical Sciences*. 6th ed. Lippincott; 2011.
9. Ansel HC, Allen LV, Popovich NG. *Pharmaceutical Dosage Forms and Drug Delivery Systems*. 9th ed. Lippincott; 2011.

Pharmacopoeias & Guidelines

10. Indian Pharmacopoeia Commission. *Indian Pharmacopoeia*. Ghaziabad; Latest edition.
11. United States Pharmacopeial Convention. *USP-NF*. Latest edition.
12. European Directorate for the Quality of Medicines. *European Pharmacopoeia*. Latest edition.
13. International Council for Harmonisation. ICH Q1A(R2): Stability Testing of New Drug Substances and Products.

14. ICH Q2(R1): Validation of Analytical Procedures.

15. World Health Organization. *WHO Guidelines on Pediatric Medicines*.

Review Articles (Oral Jelly & Pediatric Delivery)

16. Desai KG, et al. Oral jelly: A novel approach for drug delivery. *Int J Pharm Sci Rev Res*. 2014;27(1):1–7.

17. Patel DM, et al. Formulation and evaluation of oral jelly. *J Drug Deliv Ther*. 2015;5(2):1–5.

18. Sharma S, et al. Taste masking in pediatric formulations. *Asian J Pharm*. 2012;6(2):67–73.

19. Gupta A, et al. Oral jelly drug delivery systems: A review. *Int J Pharm Sci*. 2013;5(3):1–6.

20. Singh R, et al. Gel-based drug delivery systems. *Pharm Res*. 2010;27(5):123–130.

21. Pawar HA, et al. Development of oral jelly formulations. *Int J Pharm Sci*. 2014;6(2):100–105.

22. Bhyan B, et al. Formulation and evaluation of fast dissolving tablets and jellies. *Int J Pharm Sci Rev*. 2012;15(1):1–5.

23. Reddy LH, et al. Fast dissolving drug delivery systems. *Indian J Pharm Sci*. 2002;64(4):331–336.

24. Seager H. Drug delivery products and the Zydis fast dissolving system. *J Pharm Pharmacol*. 1998;50(4):375–382.

25. Sastry SV, et al. Recent technological advances in oral drug delivery. *Pharm Sci Technol Today*. 2000;3(4):138–145.

Paracetamol & Pediatric Studies

26. Prescott LF. Paracetamol: Past, present and future. *Am J Ther*. 2000;7(2):143–147.

27. Graham GG, Scott KF. Mechanism of action of paracetamol. *Am J Ther*. 2005;12(1):46–55.

28. Anderson BJ. Pediatric pharmacokinetics of paracetamol. *Paediatr Anaesth*. 2008;18(10):915–921.

29. Kearns GL, et al. Developmental pharmacology. *N Engl J Med*. 2003;349(12):1157– 1167.

Polymer & Gel Studies

30. Sriamornsak P. Chemistry of pectin and its pharmaceutical uses. *Silpakorn Univ Int J*. 2003;3:206–228.

31. Morris ER, et al. Gelation of pectin. *Carbohydr Polym*. 2000;41(3):289–298.

32. Draget KI. Alginates. *Handbook of Hydrocolloids*. 2009;807–828.

33. Djabourov M. Gelation of gelatin. *Biopolymers*. 1988;27(10):1549–1562.

34. Higuchi T. Mechanism of sustained action medication. *J Pharm Sci*. 1963;52:1145– 1149.

35. Korsmeyer RW, et al. Mechanism of solute release. *Int J Pharm*. 1983;15:25–35.

36. Costa P, Sousa Lobo JM. Modeling and comparison of dissolution profiles. *Eur J Pharm Sci*. 2001;13:123–133.

37. Fu Y, et al. Orally fast disintegrating tablets. *Crit Rev Ther Drug Carrier Syst*. 2004;21(6):433–475.

38. Chang RK, et al. Fast dissolving tablets. *Pharm Technol*. 2000;24(6):52–58.

39. Bi Y, et al. Preparation and evaluation of oral tablets. *Chem Pharm Bull*. 1996;44(11):2121–2127.

40. Mizumoto T, et al. Formulation design of fast dissolving tablets. *Int J Pharm*. 2005;306:83–90.

41. Bhowmik D, et al. Fast dissolving tablet: An overview. *J Chem Pharm Res*. 2009;1(1):163–177.

42. Dobetti L. Fast-melting tablets. *Pharm Technol Eur*. 2001;13:44–50.