Formulation And Evaluation of Tablet in Capsule Drug Delivery System

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***Abstract*— The tablet-in-capsule dosage form is a modern way of giving medicine where a tablet is placed inside a hard gelatin capsule. This method combines the benefits of both tablets and capsules. It helps protect the medicine, improves drug release, and makes it easier for patients to take. This system is useful when two medicines cannot be mixed directly or when one medicine needs to work quickly and another needs to release slowly over time. The capsule also hides the bad taste and smell of the medicine, which improves patient comfort. First, tablets are prepared using methods like direct compression or wet granulation. Then, these tablets are placed inside hard gelatin capsules. Special ingredients are added to give strength to the tablet and control how the medicine is released in the body.**

Overall, the tablet-in-capsule system is a useful and flexible drug delivery method. It improves medicine stability, increases treatment effectiveness, and provides better convenience for patients.

***Index Terms*— Table.1.1. tablet of composition**

Sr.no	ingredients	quantity
1	curcumin	100gm
2	Ethyl cellulose	37.5gm
3	Lactose monohydrate	75gm
4	Magnesium stearate	25gm
5	talc	12.5gm

I. INTRODUCTION

Rheumatoid Arthritis (RA) is a long-term autoimmune disease that mainly affects the joints. In this condition, the body's immune system mistakenly attacks healthy joint tissues, leading to pain, swelling, stiffness, redness, and gradual joint damage. If not properly treated, RA can reduce mobility and affect the quality of life of patients. [1,2]

The treatment of RA usually requires long-term use of anti-inflammatory and disease-modifying medicines to reduce pain, control inflammation, and slow down disease progression. Conventional dosage forms such as tablets and capsules are commonly used, but they have several limitations. Many drugs require frequent dosing, which decreases patient compliance. In addition, some drugs cause gastrointestinal side effects such as gastric irritation and ulcers. [1,2]

Different classes of drugs are used in the management of RA:

1. Non-Steroidal Anti-Inflammatory Drugs (NSAIDs)

These drugs are mainly used for pain relief and reduction of inflammation.[1]

Examples include:

- Ibuprofen
- Diclofenac
- Naproxen

Limitations of NSAIDs:

✓ Gastric irritation and ulcer formation
✓ Frequent dosing requirement
✓ Unable to stop disease progression

2. Corticosteroids

These drugs provide rapid anti-inflammatory action and are often used during severe inflammation.[1]

Example:

- Prednisolone

Limitations of Corticosteroids:

✓ Long-term use may cause osteoporosis, weight gain, and other side effects

3. Disease-Modifying Anti-Rheumatic Drugs (DMARDs)

These drugs help slow the progression of RA and prevent joint damage.[1]

Examples include:

- Methotrexate
- Sulfasalazine

Limitations of DMARDs:

- ✓ Slow onset of action
- ✓ Requires long-term therapy
- ✓ Problems Associated with Conventional Dosage Forms
- ✓ Traditional dosage forms used in RA therapy have several disadvantages:
- ✓ Frequent dosing reduces patient compliance
- ✓ Gastrointestinal side effects are common, especially with NSAIDs
- ✓ Difficulty in combining drugs having different release patterns
- ✓ Drug incompatibility problems
- ✓ Fluctuation in plasma drug concentration levels

To overcome these limitations, the tablet-in-capsule dosage form has been developed as an innovative drug delivery system. In this approach, a compressed tablet is placed inside a hard gelatin capsule. This system allows separation of different drugs or release mechanisms within a single dosage unit.[5]

The tablet-in-capsule system offers several advantages:

- ✓ Combination of immediate-release and sustained-release drugs in one formulation
- ✓ Better control over drug release
- ✓ Improved patient compliance
- ✓ Reduced gastrointestinal side effects
- ✓ Improved drug stability and compatibility
- ✓ For example, an immediate-release drug present in the capsule can provide quick pain relief, while the inner sustained-release tablet maintains prolonged therapeutic action.
- ✓ The present formulation focuses on the use of Curcumin in a tablet-in-capsule system. Curcumin possesses anti-inflammatory and antioxidant properties that may help in the management of RA

Formulation Concept:

- Inner tablet: Curcumin sustained-release tablet for prolonged therapeutic effect
- Outer capsule: May contain immediate-release excipients or another drug for rapid action
- Thus, the tablet-in-capsule system represents a promising and patient-friendly approach for effective management of rheumatoid arthritis.

Oral Controlled Release Drug Delivery Systems (DDS)

Oral controlled release drug delivery systems are mainly divided into two types:

1. Single Unit Dosage Forms (SUDFs)

Single unit dosage forms include tablets and capsules that contain the complete drug dose in one unit. In these systems, the drug is released slowly and continuously as the tablet or capsule passes through the gastrointestinal (GI) tract. The dosage form usually remains intact during drug release, and the empty shell or matrix is later removed from the body. Since the entire dose is present in a single unit, the tablet or capsule should not be broken or crushed because it may cause rapid release of the drug and lead to unwanted effects.[3]

2. Multiple Unit Dosage Forms (MUDFs)

Multiple unit dosage forms consist of many small units such as pellets, granules, or mini-tablets filled inside a capsule or compressed into a tablet. After administration, the outer capsule or tablet disintegrates and releases these small units throughout the GI tract. Each small unit contains a portion of the drug and acts as an individual drug reservoir. Because the dose is divided into many subunits, MUDFs provide more uniform drug distribution, reduced risk of dose dumping, and better control of drug release.[4]

Tablet-in-Capsule Dosage Form

Tablet-in-capsule is a modern medicine delivery system where small tablets are placed inside a hard gelatin capsule. This method helps in better drug release, improved patient comfort, and controlled delivery of medicine. [6,7]

1. Compressed Mini Tablets

Compressed mini tablets are very small tablets, usually 2–6 mm in size. They are prepared by compressing powder or granules into tiny tablets.

Because of their small size: [6,7]

- They are easier to swallow.
- They spread evenly in the stomach and intestine.

They can release the drug in different ways such as:

- Immediate release
- Sustained release
- Delayed release
- Pulsatile release

2. Encapsulated Mini Tablets
In this system, many mini tablets are filled inside one hard gelatin capsule.[6]
Benefits:

- drugs can be combined in one capsule.
- Different Drugs with different release patterns can be used together.
- Incompatible drugs can be separated safely.
- It improves patient compliance.
- It reduces sudden release of the entire drug dose (dose dumping).

3. Biphasic Drug Delivery System
A biphasic system releases the drug in two stages:

- Fast release phase
- Slow-release phase
- This helps provide quick action first and then maintain the effect for a longer time.[7]

Types of Biphasic Systems
a) Quick/Slow-Release System
Drug is released quickly at first.
Then the remaining drug is released slowly over time.

b) Slow/Quick Release System
Drug is released slowly in the beginning.
Later, rapid release occurs.[6]
These systems help reduce frequent dosing and improve treatment effectiveness, especially in diseases like hypertension.[6]
Capsules as Carriers for Multiple Unit Drug Delivery Systems (MUDDS)
MUDDS are dosage forms that contain many small units such as:

- Pellets
- Granules
- Beads
- Mini tablets

Thousands of small particles are filled into one capsule to provide the required dose. [6,7]

II. STUDY AIM AND OBJECTIVE:

Aim: To formulate and evaluate a tablet-in-capsule drug delivery system containing curcumin for improved therapeutic effectiveness and controlled drug release. [8,9]

Objectives:

- To develop a curcumin-based tablet formulation for providing anti-inflammatory, anti-rheumatoid arthritis, and antioxidant activities.[8]
- To design a modified drug delivery system capable of sustained or delayed release of the drug for prolonged therapeutic action.[8]
- To develop a combination dosage form by incorporating tablet and capsule technologies into a single delivery system. [8,9]
- To improve the stability of curcumin by protecting it from environmental factors such as light, moisture, and oxidation.[9]
- To enhance the bioavailability of curcumin, which is naturally poorly water-soluble and poorly absorbed in the gastrointestinal tract.[9]

III. MATERIAL AND METHODS

Table.1.2. material

Sr.no	ingredients	properties
1	Curcim extract	API
2	Ethyl cellulose	Sustained release polymer
3	Lactose monohydrate	diluent
4	Magnesium stearate	lubricant
5	talc	glidant

The materials used in the formulation of the tablet-in-capsule drug delivery system were selected based on their functional role in achieving sustained drug release, stability, and proper tablet compression. The details of ingredients and their pharmaceutical functions are given below:[7]

Sr. No.
Ingredient
Role/Function in Formulation
1. Curcumin extract
Active pharmaceutical ingredient (API) used for its anti-inflammatory, antioxidant, and anti-rheumatoid arthritis activity.[10]

2 Ethyl cellulose
Hydrophobic polymer used as a sustained-release agent to control and prolong drug release.[11]

3 Lactose monohydrate
Diluent/filler used to increase tablet bulk and improve compressibility.[12]

4 Magnesium stearate
Lubricant used to reduce friction during tablet compression and ejection.[13]

5 Talc
Glidant used to improve powder flow properties during tablet manufacturing.[13]

IV. METHODS

All the ingredients were accurately weighed according to the required formulation composition. The drug and excipients were passed through a suitable sieve to obtain uniform particle size. The weighed ingredients were mixed thoroughly to achieve a homogeneous blend. Ethyl cellulose was incorporated as a sustained-release polymer to regulate the release of curcumin from the tablet matrix. Lactose monohydrate was used as a diluent to improve tablet weight and compressibility, while talc and magnesium stearate were added to enhance flow properties and lubrication during compression.[14]
The prepared powder blend was compressed into mini tablets using a tablet compression machine. The compressed tablets were then filled into hard gelatin capsules to prepare the tablet-in-capsule dosage form.[15]

V. EVALUATION PARAMETRS OF TABLETS

Tablet evaluation is an important step in pharmaceutical formulation. It helps to ensure that tablets are safe, effective, stable, and of good quality. Different tests are performed to check the physical appearance, strength, drug content, and release characteristics of tablets.[7]
1. General Appearance
The general appearance of tablets includes shape, colour, surface texture, and overall elegance. It helps in identifying manufacturing defects and improves patient acceptance.[7]
Shape: Circular
Colour: Pale yellow
A good appearance indicates proper manufacturing and uniformity of tablets.

2. Weight Variation Test
The weight variation test is performed to check whether all tablets contain a uniform amount of drug and excipients.[7]
Procedure
- Take 10 tablets.
- Weigh each tablet individually.
- Calculate the average weight.
- Compare individual tablet weights with the average weight.
- Acceptance Limit
- According to Indian Pharmacopoeia (IP), the acceptable variation limit is ±10% for tablets of certain weight ranges.This test ensures dose uniformity in tablet formulations.

Table.1.3. weight variation

Sr.no	Weight of tablet in (mg)
1	198
2	205
3	192
4	209
5	187
6	202
7	215
8	191
9	215
10	195

Avg.wt.: 201mg

3.weight variation (capsule)
Individual weight of 10 capsules ranges from 590 – 610 mg. [7]
The net weight of the encapsulated tablet using capsule size zero was found to be 300 +-.
The equivalent weight of the lactose Monohydrate, ethyl cellulose, magnesium stearate, talc determines to be 225 mg, 112.5 mg, 75mg, 37.5 mg. respectively.
The average weight of the tablet is 200mg and such a three tablet are encapsulated in 0 size capsule, hence weight of tablet is 600 mg. [7,6]

Table.1.4. weight variation (capsule)

Sr.no	Weight variation capsule in (mg)
1	598
2	605
3	610
4	595
5	602
6	590
7	608
8	600
9	603
10	591

4.Disintegration test:
One important quality control test for capsule is the disintegration test that determines if FC break out within a specified time when place in an immersion medium. The typical time of disintegration of shell is 15 min due to more hydrophobic polymer ethyl cellulose disintegration time increase. For tablet in capsules, disintegration time is upto 2 hrs. [7]

5.Dissolution test tablet in capsule:
The dissolution test for tablet filled in size "0" capsule is performed using USP apparatus (basket preferred) in 900 mL medium at 37°C. Immediate release formulations show ≥80% release within 45 minutes, whereas sustained release systems exhibit controlled drug release over 8–12 hours depending on polymer concentration.[7]

VI. RESULT AND DISCUSSION

The parameter for assessing the properties of powders which includes bulk and tapped density, angle of repose, hausner's ratio, carr`s index is shown in the following table.[16]

Table.1.5. flow properties of powdered MP and FC

Sr.no	parameter	MP	FC
1	Bulk Density	0.3-0.6g/Cm3	0.3-0.6g/Cm3
2	Tapped Density	0.4-0.8g/Cm3	0.4-0.8g/Cm3
3	Angle Of Repose	15%	10-20%
4	Hausner's Ratio	1.0-1.25	1.1-1.25
5	Carr's Index	25°C 35°C	25°C 35°C
6	Flow	Good	Good

The flow properties of the FC as well as the Powder MP where investigated to avoid problems of irregular flow and flow obstruction during in calculation.The result are reported in above tablet that FC have good flow property file MP powder has a also good flow property.This mean that MC and FC granule would flow better during encapsulation.In addition they would not required vibration agitation or any mechanical AD to flow during their manufacture.[16]

Discussion
The developed tablet-in-capsule drug delivery system showed satisfactory results in all evaluation parameters. The powder blend exhibited good flow and compressibility, ensuring uniform tablet formation. The tablets showed acceptable hardness, low friability, and uniform drug content, indicating good mechanical strength and consistency. [6,7]

VII. CONCLUSION

Rheumatoid Arthritis is a long-term inflammatory disease that affects millions of people around the world and often causes joint pain, swelling, stiffness, and difficulty in daily activities. Although many conventional medicines are available, several patients also prefer complementary and alternative therapies for better symptom management. Among natural compounds, Curcumin, the active component of turmeric, has gained attention because of its anti-inflammatory and antioxidant properties. The developed tablet-in-capsule drug delivery system proved to be a promising approach for improving the therapeutic effectiveness of curcumin in the management of rheumatoid arthritis. Curcumin normally shows poor water solubility, low absorption, and rapid metabolism, which reduce its effectiveness in the body. The tablet-in-capsule system helps to overcome these limitations by providing controlled and sustained drug release. In this formulation, the tablet core provides sustained or controlled release, while the outer capsule shell can offer immediate or delayed release depending on the formulation design. This dual-release mechanism improves drug absorption, prolongs drug action, and helps maintain a consistent drug concentration in the body for a longer period. As a result, the formulation may help reduce inflammation, joint pain, and oxidative stress more effectively while improving patient compliance.

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