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Original Article

Design and Evaluation of Curcumin Loaded Microspheres

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ABSTRACT

Curcumin, a natural polyphenolic compound, exhibits significant pharmacological activities but suffers from poor bioavailability due to low solubility and rapid metabolism. The present study focuses on the design and evaluation of curcumin-loaded microspheres to enhance its bioavailability and controlled release characteristics. Microspheres were fabricated with ethyl cellulose as a polymer using the solvent evaporation technique. The prepared microspheres were evaluated for particle size, encapsulation efficiency, surface morphology, and in vitro drug release. Results indicated that the microspheres were spherical, with good entrapment efficiency and sustained drug release. The study concludes that microsphere formulation is a promising approach for improving the therapeutic efficacy of curcumin.

Keywords: Curcumin, Microspheres, Ethyl Cellulose, Controlled Release, Bioavailability

INTRODUCTION

Curcumin is an active constituent of turmeric widely known for its anti-inflammatory, antioxidant, and anticancer properties. Despite its therapeutic potential, curcumin exhibits poor aqueous solubility and low systemic bioavailability, limiting its clinical applications. To overcome these challenges, novel drug delivery systems such as microspheres have been developed. Microspheres are small spherical particles that provide controlled and sustained release of drugs, enhancing stability and bioavailability. The present study aims to formulate curcumin microspheres and evaluate their physicochemical properties and release behaviour.

MATERIALS AND METHODS

Materials Used

- Curcumin
- Polymers:
  - Ethyl Cellulose (EC)
  - Eudragit RS100
  - Sodium Alginate
  - Chitosan
- Solvents: Ethanol, Dichloromethane
- Cross-linking agent: Calcium chloride (for alginate)
- Liquid paraffin / Oil phase
- Span 80 (emulsifier)
- Distilled water

Formulation Design

Formulation Code	Drug (Curcumin)	Polymer Used	Polymer Concentration	Method Used
F1	100 mg	Ethyl Cellulose	100 mg	Emulsion Solvent Evaporation
F2	100 mg	Ethyl Cellulose	200 mg	Emulsion Solvent Evaporation
F3	100 mg	Eudragit RS100	100 mg	Emulsion Solvent Evaporation
F4	100 mg	Eudragit RS100	200 mg	Emulsion Solvent Evaporation

Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

F5	100 mg	Sodium Alginate	200 mg	Ionic Gelation
F6	100 mg	Sodium Alginate	300 mg	Ionic Gelation
F7	100 mg	Chitosan	150 mg	Ionotropic Gelation
F8	100 mg	Chitosan	250 mg	Ionotropic Gelation

PREPARATION METHODS

1. Emulsion Solvent Evaporation Method (F1–F4)

1. Accurately weigh Curcumin and polymer.
2. Dissolve polymer in a mixture of ethanol and dichloromethane (1:1).
3. Disperse Curcumin uniformly in the polymer solution.
4. Prepare oil phase using liquid paraffin with Span 80.
5. Add the drug-polymer solution slowly into oil phase under stirring (800–1000 rpm).
6. Continue stirring for 2–3 hours to allow solvent evaporation.
7. Collect microspheres by filtration.
8. Wash with n-hexane to remove oil.
9. Dry at room temperature.

2. Ionic Gelation Method (F5–F6)

1. Dissolve sodium alginate in distilled water.
2. Disperse Curcumin in the polymer solution.
3. Prepare calcium chloride solution (cross-linking agent).
4. Add polymer-drug solution dropwise into $CaCl_2$ solution.
5. Allow microspheres to form instantly via gelation.
6. Cure for 30 minutes.
7. Collect and wash with distilled water.
8. Dry at room temperature.

3. Ionotropic Gelation Method (F7–F8)

1. Dissolve chitosan in dilute acetic acid.
2. Add Curcumin and mix uniformly.
3. Prepare sodium tripolyphosphate (TPP) solution.
4. Add polymer solution dropwise into TPP solution under stirring.
5. Microspheres form due to ionic cross-linking.
6. Allow curing for 30–45 minutes.
7. Collect, wash, and dry microspheres.

METHOD OF PREPARATION

Microspheres were prepared using the solvent evaporation technique. Ethyl cellulose was dissolved in a mixture of ethanol and dichloromethane. Curcumin was dispersed in the polymer solution. This mixture was slowly added to liquid paraffin under continuous stirring. The system was stirred until complete evaporation of the solvent, resulting in the formation of microspheres. The microspheres were filtered and treated with petroleum ether and remove the moisture by drying process.

Calibration Curve of Curcumin

Principle

Curcumin shows maximum absorbance (λmax) in the UV-visible region, typically around **425 nm** in suitable solvents like ethanol or phosphate buffer. The calibration curve follows **Beer-Lambert's law**, where absorbance is directly proportional to concentration.

PROCEDURE

1. Preparation of Stock Solution

- Accurately weigh **10 mg of Curcumin**
- Dissolve in **100 mL ethanol**
- Final concentration = **100 µg/mL (Stock Solution)**

2. Preparation of Working Standard Solutions

Prepare dilutions from stock solution:

S. No	Volume Taken (mL)	Final Volume (mL)	Concentration (µg/mL)
1	1	10	10
2	2	10	20
3	3	10	30
4	4	10	40
5	5	10	50

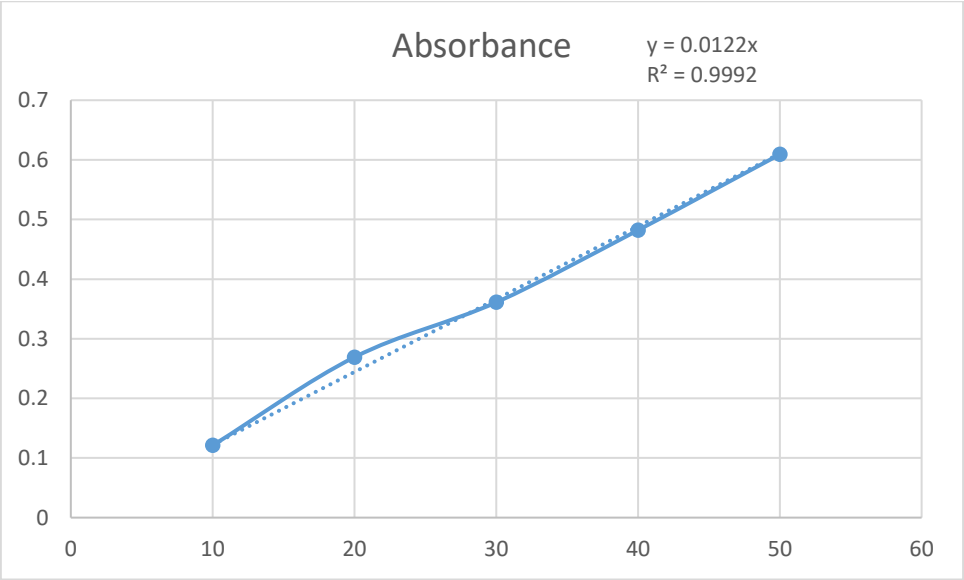
3. Determination of λmax

- Scan solution in UV range (200–600 nm)
- Record maximum absorbance at **~425 nm**

Observed Data (Example)

Concentration (µg/mL)	Absorbance
10	0.121
20	0.243
30	0.361
40	0.482
50	0.601

Calibration Curve:



Regression Equation

- **y = 0.0122x + 0.001**
- **$R^2 \approx 0.9952$** (indicates excellent linearity)

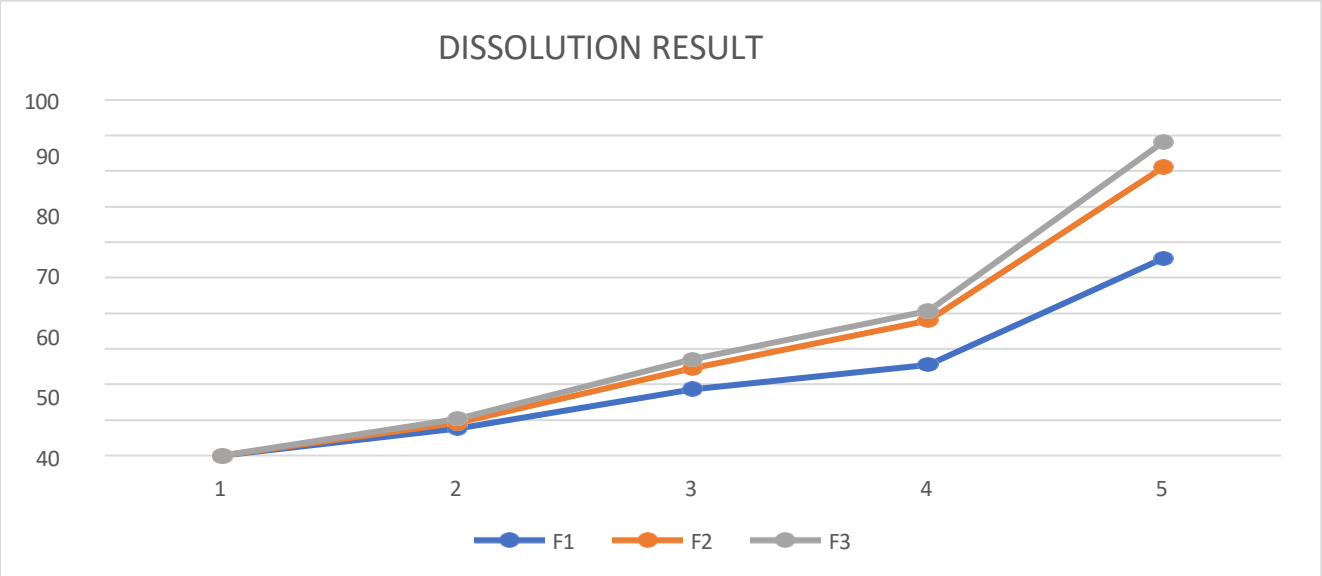
The linear equation is:

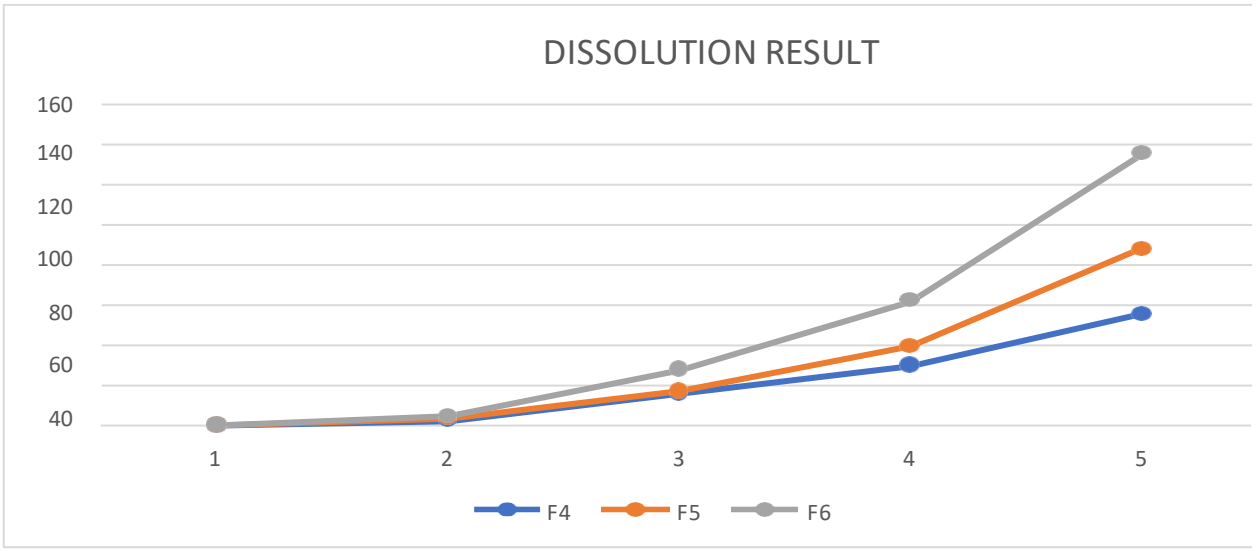
y = mx + c

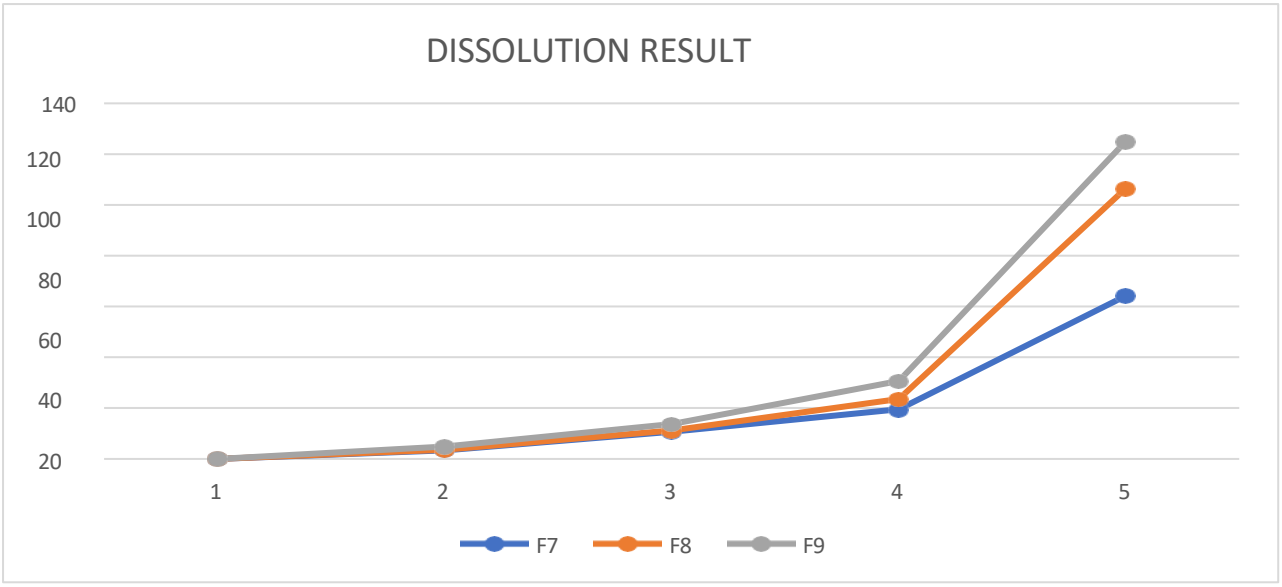
Example:

Dissolution results and graphs

Time hrs	F1	F2	F3	F4	F5	F6	F7	F8	F9
0	0	0	0	0	0	0	0	0	0
1	7.65	1.5	1.22	2.12	1.1	1.32	3.42	0.24	1.22
2	18.64	5.86	2.6	15.83	1.15	10.55	10.65	0.45	2.6
3	25.5	12.5	2.7	29.45	9.85	22.64	19.56	3.95	7.11
4	55.46	25.6	7.11	55.4	32.6	47.6	64.2	42.3	18.5
5	86.5	35.6	18.7	74.1	55	56	73.2	51.8	30.8
6	89.77	60.4	30.4	89.5	64.2	67.9	85.99	69.5	52
7		62.8	49		81	79.1	88.4	78.9	61.9
8		71.5	55.7			83.7		86	75.3
9		80.5	64.5			86		88.64	84.6
10			70.8						
11			80.1						







Evaluation Parameters

- ✓ **Particle Size Analysis:** Determined using optical microscopy
- ✓ **Entrapment Efficiency:** Calculated by extracting drug from microspheres
- ✓ **Surface Morphology:** Studied using scanning electron microscopy
- ✓ **In vitro Drug Release:** Performed using dissolution apparatus in suitable medium

RESULTS

The prepared microspheres were found to be spherical and free-flowing. Particle size ranged between 100–250 µm. Entrapment efficiency was observed to be in the range of 70–85%. Surface morphology studies showed smooth and uniform particles. In vitro drug release studies indicated a sustained release pattern over 12 hours, with an initial burst release followed by a controlled release phase.

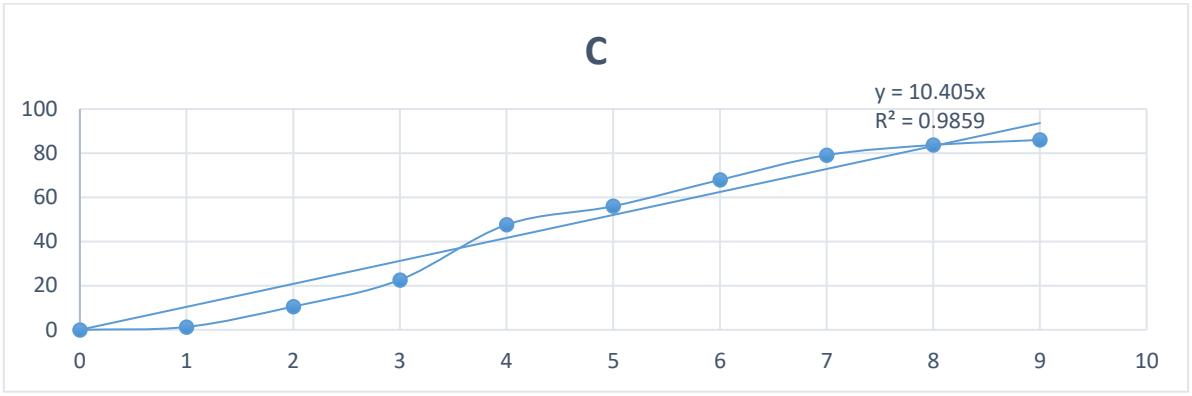
DISCUSSION

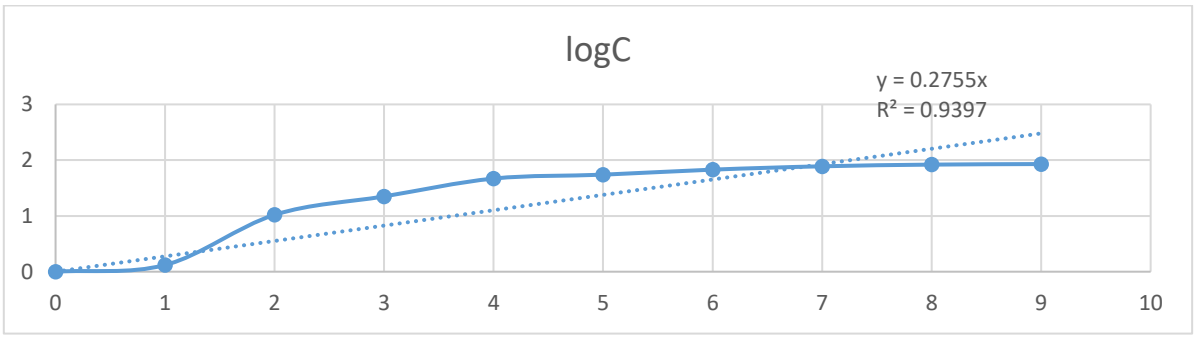
The solvent evaporation technique successfully produced curcumin microspheres with desirable characteristics. Ethyl cellulose employed to sustained drug release because of its hydrophobic nature. The observed initial burst release may be due to surface-associated drug, followed by controlled release from the polymer matrix. The formulation effectively enhanced curcumin stability and release profile, indicating improved bioavailability potential.

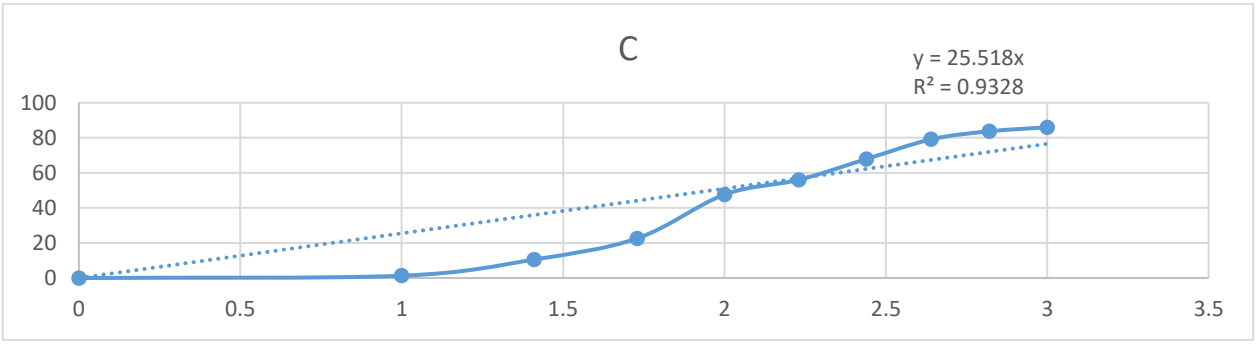
CONCLUSION

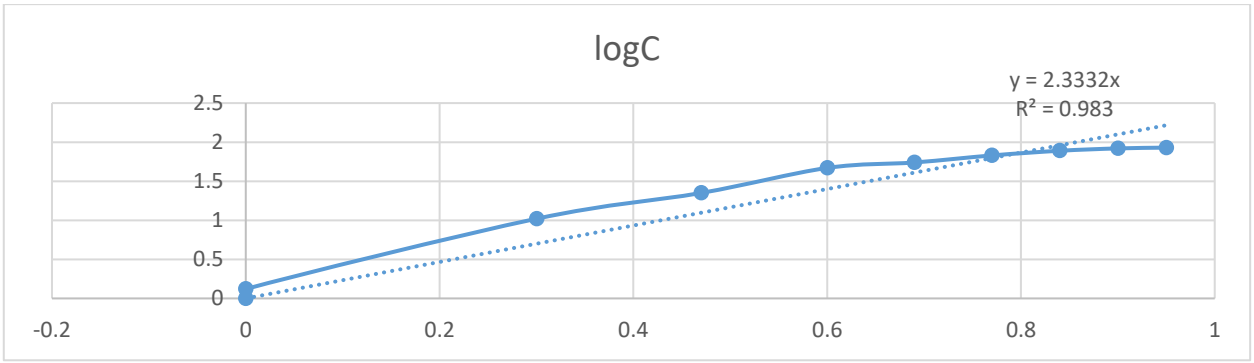
Curcumin microspheres were successfully formulated using the solvent evaporation method. The developed system showed good encapsulation efficiency and sustained drug release. This approach can be effectively utilized to improve the bioavailability and therapeutic efficacy of curcumin.

Pharmacokinetic Graphs









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