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Research article ***Pharmaceutics***

Formulation and evaluation of curcumin tablets for colon drug delivery systems

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ABSTRACT

Objective of the current study is to develop colon targeted drug delivery systems for Curcumin. Eudragit S-100 and Ethyl cellulose is used as polymers in this drug delivery system. The colon targeted tablet was prepared by direct compression technique. Study of the preformulation characteristics and FTIR studies indicates that there was no interaction between Curcumin and excipients used. The formulated tablets were tested for both pre-compression parameters and post compression parameters as per requirements of standards. Pre-compression parameters such as bulk density, tapped density, compressibility index, Hausner's ratio and compressibility index. The results obtained indicate that it has good flow property for direct compression. From among the entire batches, formulation F4 showed 98.90% drug release at 24 hrs. Since it provide greater protection to the core under acidic condition while at the same time show the fastest drug release under intestinal pH. So the trial F4 was considered as best formulation.

Keywords: Curcumin, Eudragit S-100, Ethyl cellulose, and colon targeted drug delivery systems.

INTRODUCTION

Oral drug delivery has been known for decades as the most widely utilized route of administration among all the routes that have been explored for systemic delivery of drugs via pharmaceutical products of different dosage forms. Oral route is considered most natural, uncomplicated, convenient and safe due to its ease of administration, patient acceptance and cost effective manufacturing process. The reasons that the oral route achieved such popularity may bein part attributed to its ease of administration, belief that by oral administration of the drug iswell absorbed.

All the pharmaceutical products formulated for systemic delivery via the oral route of administration irrespective of the mode of delivery and the design of dosage forms must be developed within the intrinsic characteristics of GIT physiology, pharmacokinetics and pharmacodynamics and formulation design to achieve a systemic approach to the successful development of an oral pharmaceutical dosage form.

TABLETS [5]

Tablets are solid dosage forms each containing a unit dose of one or more medicaments. They are intended for oral administration. Some tablets are swallowed whole or after being chewed, some are dissolved or dispersed in water before administration and some are retained in the mouth where the active ingredient is liberated. Because of their composition, method of manufacture or intended use, tablets present a variety of characteristics and consequently there are several categories of tablets.

Tablets are usually solid, the end surfaces of which are flat or convex and the edges of which may be bevelled. They may exist in other shapes like triangular, rectangular, etc also. They may have lines or break-marks and may bear a symbol or other markings. They are sufficiently hard to withstand handling without crumbling or breaking.

Advantages of Tablets [6]

They are unit dosage form and offer the greatest capabilities of all oral dosage form for the greatest dose precision and the least content variability.

- ✓ They are in general the easiest and cheapest to package and strip of all oral dosage forms.
- ✓ They may provide the greatest ease of swallowing with the least tendency for "hang-up" above the stomach, especially when coated, provided that tablet disintegration is not excessively rapid.
- ✓ They lend themselves to certain special release profile products, such as enteric or delayed release products.
- ✓ They are better suited to large-scale production than the other unit oral forms.
- ✓ They have the best-combined properties of chemical.
- ✓ Cost is low.
- ✓ Lighter and compact.
- ✓ Easy to swallowing with least tendency for hang-up.
- ✓ Sustained release product is possible by enteric coating.
- ✓ Objectionable odour and bitter taste can be masked by coating technique.
- ✓ Suitable for large scale production.
- ✓ Greatest chemical and microbial stability over all oral dosage form.
- ✓ Product identification is easy and rapid requiring no additional steps whenemploying an embossed and or monogrammed punch face.

Disadvantages of the tablets

- ✓ Some drugs resist compression in to dense particles, owing to their amorphous nature or flocculent, low density character.
- ✓ Drugs with poor wetting, slow dissolution properties, intermediate to large dosages, optimum absorption high in the GIT or any combination of these features are very challenging for the formulators.
- ✓ Difficult to swallow in case of children and unconscious patients.
- ✓ Bitter tasted drugs, drugs with an objectionable odour or drugs that are sensitive to oxygen may require encapsulation or coating. In such cases, capsule may offer the best and lowest cost.

Various Types of Tablets

Based on the route of administration or the function, the tablets are classified as follows.

Pharmaceutical ingredients used in the formulation oftablets

Active ingredients

A drug substance is the Active Pharmaceutical Ingredient (API) or component that produces pharmacological activity.

Fillers/diluents

Diluents are used as excipients for direct compression formulas have been subjected to prior processing to give them flow ability and compressibility.

Eg: Lactose, Dibasic calcium phosphate, Dextrose, Calcium carbonate, Magnesium carbonate, Starch, Sucrose, Mannitol.

Binders

Binders are agents which are used to impart cohesive qualities to the powdered material. Binders are added either dry or in liquid form during wet granulation to form granules or to promote cohesive compacts for directly compressed tablets.

Eg: Povidone, Acacia, Gelatin, HPMC, Polyvinyl pyrrollidone, Hydroxypropylcellulose.

Disintegrants

Disintegrants are substances or a mixture added to a tablet formulation to facilitate its breakup or disintegration of the tablet after administration. The active ingredient must be released from the tablet matrix as efficiently as possible to allow rapid dissolution.

Eg: Microcrystalline cellulose, Starch, Crosscarmellose sodium, Sodium starch glycolate.

Lubricants [8]

During compression lubricants acts as to reduce the interface between the face of the die and the surface of the tablet and act to reduce the friction at this interface during ejection of the tablet from the tablet press. Inadequate lubrication of this interface results in the production of tablets with a pitted surface and is due to their ability of the tablet surface to detach from the surface of the tablet die. There are two main categories of lubricants: (1) insoluble and (2) soluble. Insoluble lubricants are added to the final mixing stage prior to the tablet compression. Eg: Magnesium stearate, Stearicacid, Glycerylpalmitostearate.

Soluble lubricants are principally employed to overcome the possible deleterious effects of their insoluble counterparts on the time required for tablet disintegration and drug dissolution. Eg: Polyethylene glycol, Polyethylene stearate, Lauryl sulphate salt.

Glidants [9]

Glidants are added to the formulation in order to improve the flow properties of the material to be fed into the die and sometimes aid in particle rearrangement within the die during the early stages of compression. They may act by interposing their particles between those of the other components and so, by virtue of their reduced adhesive tendencies, lower the overall interparticulate friction of the system. Eg: Talc, Colloidal silicon dioxide.

Adsorbents

Adsorbents are used whenever it is required to include a liquid or semisolid component, e.g. a drug or a flavour, within the tablet formulation. As the production of tablets requires solid components, the liquid/semisolid constituent is adsorbed on to a solid component which, in many cases, may be one of the other components in the tablet formulation (e.g. diluent) during mixing. If this approach is not possible, an adsorbent is specifically included in the formulation. Eg: Magnesium oxide/Carbonate, kaolin/Bentonite.

Sweetening agents/flavours

Sweetening agents and flavours (in accordance with other dosage forms) are employed to control the taste and hence the acceptability of tablets. These agents are of particular importance if the conventional tablet contains a bitter drug or, more importantly, if the tablet is a chewable tablet.

Eg: Aspartame, Sucralose, Sucrose, Glycerine, Mannitol, Sorbiltol, Acesulfame potassium. Flavouring agents are

incorporated into the formulation to give the tablet a more pleasant flavouror mask an unpleasant one. Eg: Chocolate, Peppermint, Pineapple and Vanilla flavour.

Colours

Colorants do not contribute to the therapeutic activity and to improve the product bioavailabilityor stability. Their main role is to facilitate identification and to enhance the aesthetic appearance of the product. All colorants used in pharmaceuticals must be approved and certified by the FDA. Some commonly used Pharmaceutical colorants are, *Eg:* Erythrosine, Tartrazine, Sunset Yellow, Brilliant blue.

Matrix table

Matrix tablets may be defined as the "oral solid dosage forms in which the drug or active ingredient is homogeneously dispersed throughout the hydrophilic or hydrophobic matrices which serves as release rate retardants". These are the type of controlled drug delivery systems, which release the drug in continuous manner by both dissolution controlled as well as diffusion controlled mechanisms. To control the release of the drugs, which are having different solubility properties, the drug is dispersed in swellable hydrophilic substances, an insoluble matrix of rigid non swellable hydrophobic materials or plastic materials.

Advantages of matrix tablet

- Can be made to release high molecular weight compounds
- The sustained release formulations may maintain therapeutic concentrations over prolonged periods.
- The use of sustain release formulations avoids the high blood concentration.
- Sustain release formulations have the potential to improve the patient compliance.
- Reduce the toxicity by slowing drug absorption.
- Increase the stability by protecting the drug from hydrolysis or other derivative changesin gastrointestinal tract.
- Minimize the local and systemic side effects.
- Improvement in treatment efficacy.
- Minimize drug accumulation with chronic dosing.
- Usage of less total drug.
- Improve the bioavailability of some drugs.
- Improve of the ability to provide special effects.

Disadvantages of matrix tablet

- The remaining matrix must be removed after the drug has been released.
- High cost of preparation.
- The release rates are affected by various factors such as, food and the rate transit throughthe gut.
- The drug release rates vary with the square root of time. Release rate continuously diminishes due to an increase in diffusional resistance and/or a decrease in effective area at the diffusion front. However, a substantial sustained effect can be produced throughthe use of very slow release rates, which in many applications are indistinguishable from zero-order.

Colon targeted drug delivery system

Colon Targeted Drug Delivery System (CTDDS) may be following the concept of Controlled or Sustained drug Delivery System. For CTDDS oral route of administration has received most attention. Local delivery allows topical treatment of inflammatory bowel disease. Colon is highly desirable for local treatment of a variety of bowel diseases such as ulcerative colitis, Crohn's disease, colonic cancer, local treatment of colonic pathologies and systemic delivery of protein and peptide drugs.

For effective and safe therapy of these colonic disorders, colon specific drug delivery is necessary i.e. drug release and absorption should not occur in the stomach as well as the small intestine, and neither the bioactive agent should be degraded in either of the dissolution sites but only released and absorbed once the system reaches the colon[26]. Today, colon specific drug delivery is challenging task to pharmaceutical technologist. The colon is believed to be a suitableabsorption site for peptides and protein drugs for the following reasons,

i. Less diversity,
ii. Intensity of digestive enzymes,

Comparative proteolytic activity of colon mucosa is much less than that observed in the small intestine, thus CTDDS protects peptide drugs from hydrolysis, and enzymatic degradation in duodenum and jejunum, and eventually releases the drug into ileum or colon which leads to greater systemic bioavailability[27]. The concentration of drug reaching the colon depends on formulation factors, the extent of retrograde spreading and the retention time[28]. Coating of the drugs with pH-sensitive polymers provides simple approach for colon-specific drug delivery [29].

The bioactive agent should be degraded in either of the dissolution sites but only released and absorbed once the reaches the colon. Because the colon has a long residence time 72 hours and high water content it favors absorption of poorly absorbed drug molecule may have an improved bioavailability, CTDDS has been employ to achieve following objectives,

i) Sustained delivery to reduce dosing frequency
ii) Delay delivery of drug to achieve high concentration in treatment of disease of distal gut
iii) To delay deliver to a time appropriate to treat acute phase of disease
iv) Deliver drug to that region that is less hostile metabolically, drug which is acid andenzyme labile such as proteins.

MATERIALS

Curcumin-Provided by SURA LABS, Dilsukhnagar, Hyderabad, Eudragit S-100- Merck Specialities Pvt Ltd, Mumbai, India, Ethyl cellulose- Merck Specialities Pvt Ltd, Mumbai, India Lactose - Merck Specialities Pvt Ltd, Mumbai, India, Talc-Merck Specialities Pvt Ltd, Mumbai, India, Magnesium stearate- Merck Specialities Pvt Ltd, Mumbai, India.

METHODOLOGY

Preformulation studies

Preformulation is the first step in the rational development of dosage form of a substance and is defined as an investigation of physical and chemical properties of drug substance alone and when combined with excipients. This initial learning phase is known as preformulation. The basic purpose of the preformulation activity is to provide a rational basis for the formulation approaches, to minimize the chances of success in formulating an acceptable product and to ultimately provide a basis for optimizing drug product quality and performance. The first step in any formulation activity is careful consideration of a complete physicochemical profile of the active ingredients available, prior to initiating a formulation development activity.

Contents of preformulation studies

Organoleptic properties – Appearance, colour and odour.
Microscopic examination – Crystal habit, crystal shape and size.
Physical properties – Density, particle size, surface area, flow properties, hygroscopicity. Solvent properties – pH of solution, solubility and dissolution rate, drug excipient¬ compatibility study.

Important parameters evaluated during preformulation studies

1. Evaluation of API

The Evaluation of Curcumin was done according to IP. Following are some of the important parameters evaluated during Preformulation studies and results are tabulated in Table.

A. Description

It is the initial evaluation during Preformulation studies which assess the colour of the substance. This was only a descriptive test.

B. Determination of Curcumin Solubility

Determination of solubility of drug by visual observation. An excess quantity of Curcumin was taken separately and adds in 10 ml of different solutions. These solutions were shaken well for few minutes. Then the solubility was observed and observations are shown in the Table.

Determination of Curcumin Melting point

The melting point of Curcumin was determined by capillary tube method according to the USP. A sufficient quantity of Curcumin powder was introduced into the capillary tube to give a compact column of 4-6 mm in height. The tube was introduced in electrical melting point apparatus and the temperature was raised. The melting point was recorded, which is the temperature at which the last solid particle of Curcumin in the tube passed into liquid phase**.**

Analytical method development

Dissolution media Preparation

Preparation of 0.1N HCl - 8.5 ml of concentrated HCl was added to 1000 ml of purified water and the pH is 1.2.
Preparation of pH 7.4 phosphate buffer-Dissolved 6.8g of potassium Dihydrogen phosphate in 1000 ml of purified water and adjusted the pH to 7.4 by using 0.1 N sodium hydroxide solution.
Formulation Development: Drug and different concentrations for super Disintegrates and required ingredients were accurately weighed and passed through a 40-mesh screen to get uniform size particles and mixed in a glass mortar for 15 minutes. The obtained blend was lubricated with Magnesium Stearate and glidant (Talc) was added and mixing was continued for further 5 minutes. The resultant mixture was directly compressed into tablets by using punch of rotary tablet compression machine. Compression force was kept constant for all formulations.

FORMULATION CHART

S. No	INGREDIENTS	QUANTITY OF INGRIDIENTS (mg/tab)					
		F1	F2	F3	F4	F5	F6
1	Curcumin	100	100	100	100	100	100
2	Eudragit S-100	50	100	150	-	-	-
3	Ethyl cellulose	-	-	-	50	100	150
4	Lactose	50	50	50	50	50	50
5	Talc	10	10	10	10	10	10
6	Magnesium stearate	8	8	8	8	8	8
Total weight (mg)		400	400	400	400	400	400

RESULTS & DISCUSSION

The present study was carried out to formulate colon targeted matrix tablet of Curcumin using direct compression method. In this method, the powder blend was subjected to various evaluation studies such as bulk density, tapped density, compressibility index and hausner's ratio and was compressed into tablets. The compressed tablets were evaluated such as thickness, hardness, friability, weight variation, assay, *in-vitro* dissolution studies, and accelerated stability studies. The tablets are coated using Enteric coating polymers (Eudragit FS 30 D) to target the release of pH 7.4. The uncoated and coated tablets are evaluated for *in-vitro* dissolution studies and the tablets are packed in bluster pack and were subjected to accelerated stability studies. The results are presented in appropriate tables and figures.

Evaluation of ibuprofen (API)

Table 1: Physical Characteristics Of API

S. No	Tests	Specification	Results
1	Colour	Bright yellow-orange powder	Bright yellow-orange powder
2	Solubility	Practically insoluble in water, freely solublein acetone, methanol and in methlyene chloride. It dissolves in dilute solution of alkali hydroxide and carbonates	Complies
3	Melting point	75.0° -78.0°C	76.4°C
4	Moisture content	NMT 0.5 w/w%	0.3% w/w

The colour, solubility, melting point and moisture content of the API were evaluated. It was found to be within the range of the monograph.
Formulation and evaluation of Curcumin tablets for colon drug delivery systems.

Analytical Method

Graphs of Curcumin were taken in 0.1N HCL and in pH 6.8 phosphate buffer at 415 nm and 418 nm respectively.

Table 2: Observations for graph of Curcumin in 0.1N HCL

Concentration (µg/ml)	Absorbance
0	0
2	0.176
4	0.314
6	0.452
8	0.593
10	0.738

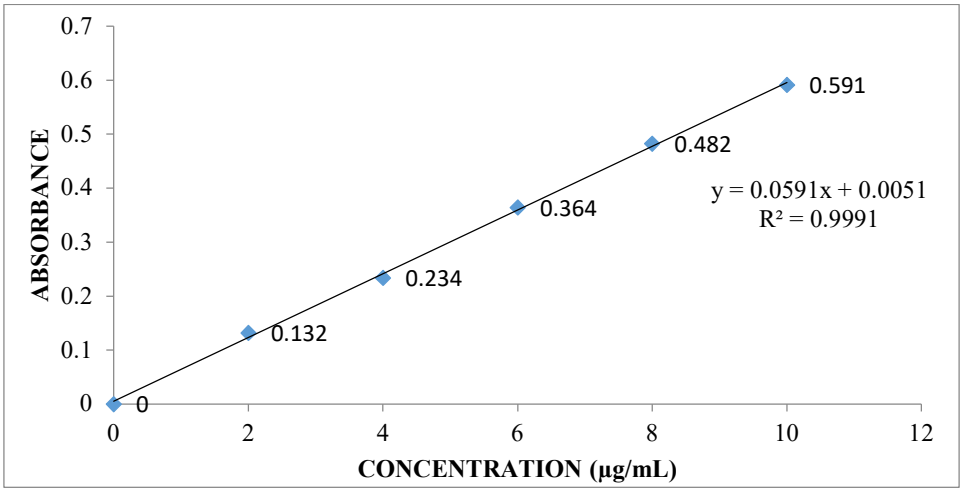

Fig 1: Standard curve of Curcumin

Table 3: Standard graph values of Curcumin at 418 nm in pH 7.4 phosphate buffer

Concentration (µg/ml)	Absorbance
0	0
2	0.132
4	0.234
6	0.364

8	0.482
10	0.591

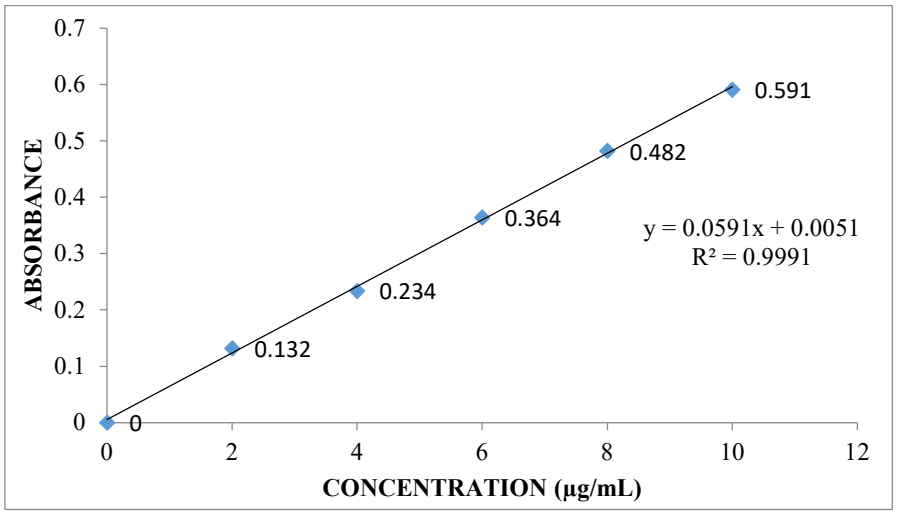

Fig 2: Standard curve of Curcumin

Drug - excipients compatibility studies

It was determined as per procedure given in material and method part

Table 4: drug - excipients compatibility

Composition	Initial	After 15days At 25°C	After 30days At 25°C	Conclusion
Curcumin	Bright yellow-orange powder	NCC	NCC	Complies
Curcumin + Excipients	Bright yellow-orange powder	NCC	NCC	Complies

- ***NCC-*** *No Characteristic Change.*

From the drug excipients compatibility study, it was observed that there was no characteristic change or interaction between drug and excipients. Thus it was concluded that the excipients selected for the formulation were compatible with Curcumin.

IR spectral analysis

The FTIR studies of Curcumin and Curcumin with Excipients

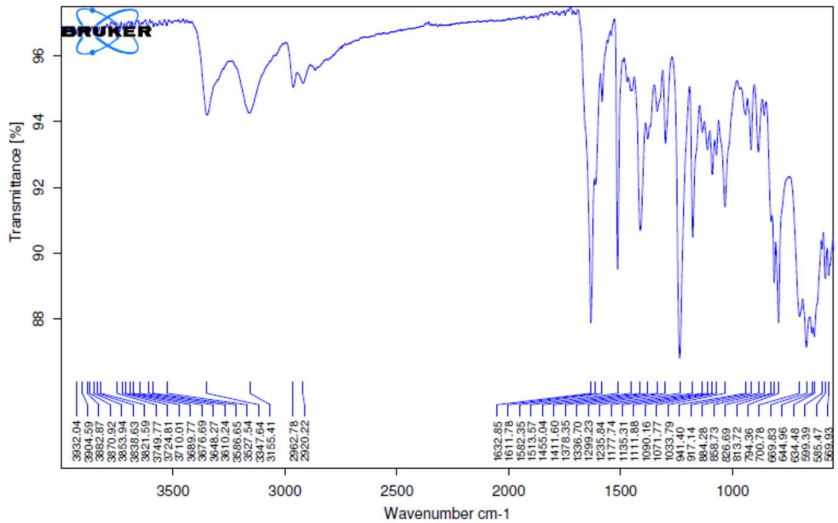

Fig 3: FT-TR Spectrum of Curcumin pure drug

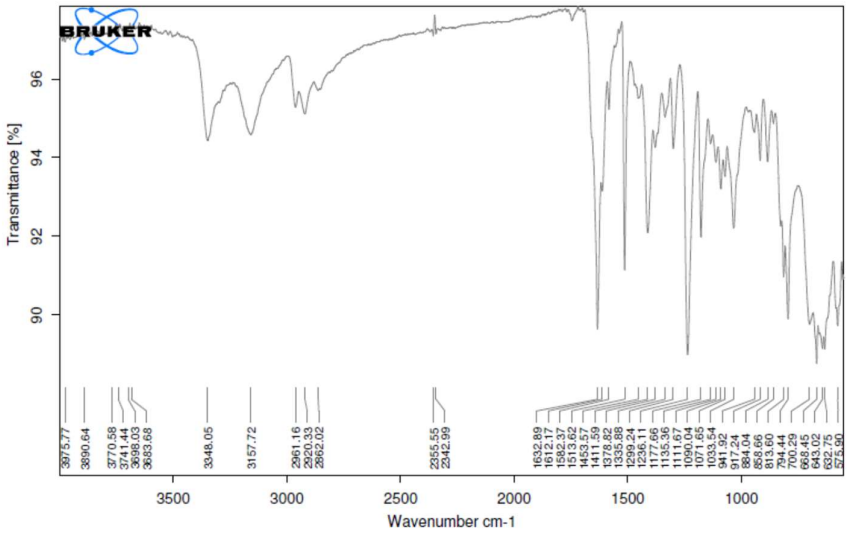

Fig 4: FT-IR Spectrum of Optimised Formulation

Pure Curcumin spectra showed sharp characteristic peaks. These peaks are also prominent in the FTIR spectra's of the physical mixtures containing Curcumin and other excipients in the final formula. This indicates that there is no interaction between the drug and excipients from both Physical observation and FT-IR studies.

Preformulation parameters of powder blend

Table 5: Pre-formulation parameters of Core blend

Formulation code	Angle of repose (Θ)	Bulk density (gm/cm^3	Tapped density(gm/cm^3)	Carr's index (%)	Hausner's ratio
F1	28.46	0.5710	0.6897	17.21	1.121
F2	28.48	0.5698	0.6701	14.96	1.176
F3	28.46	0.5725	0.6909	17.14	1.206
F4	28.40	0.5702	0.6782	15.92	1.189
F5	28.71	0.5620	0.6787	17.99	1.207
F6	28.70	0.5602	0.6698	17.11	1.196

Tablet powder blend was subjected to various pre-formulation parameters. The angle of repose values indicates that the powder blend has good flow properties. The bulk density of all the formulations was found to be in the range showing that the powder has good flow properties. The tapped density of all the formulations powders has good flow properties. The compressibility index of all the formulations was found to be below 17.99 which show that the powder has good flow properties. All the formulations have shown the Hausner ratio below 1.121 indicating the powder has good flow properties.

Evaluation of finished product (uncoated)

Formulations	Parameters					
	Weight variation (mg)	Thickness (mm)	Hardness (kg/cm2)	Friability (%)	Disintegrationtime (min)	Assay (%)
F1	398.15	4.92	5.6	0.26	6.54	96.18
F2	400.25	4.69	5.3	0.32	8.21	99.82
F3	399.39	4.87	5.0	0.46	15.37	97.60
F4	397.52	4.35	4.9	0.51	4.42	99.72
F5	400.10	4.16	5.2	0.63	6.09	100.05
F6	396.57	4.61	4.8	0.72	10.72	98.76

The tablets are evaluated for different parameters are given in *Table*

- ✓ The thickness of the tablets was in the range of 4.16 to 4.92 mm. This is due to the upper and lower punch adjustments during compression process.
- ✓ The prepared tablets in all the trials possessed good

mechanical strength with sufficient hardness in the range of 4.8 to 5.6 kg/cm^2.

✓ The friability of the tablets was found to be within 1%. All the above trail formulations have passed the friability test.

✓ The weight variation of all the formulations was found to be within the permissible range.

✓ The percentage of drug content was found among different batches of the tablets and ranged from 96.18 to 100.05 which were within the acceptable limits.

Evaluation parameters of curcumin enteric coated tablets

Formulation	Thickness(mm)	Weight variation(mg)	Disintegration time (min)	Assay (%)
F4	6.12 ± 0.02	453±0.42	210.41±2.14	99.48 ± 0.06

Curcumin tablet of the above trial (F4) was satisfied of all the parameters. It was coated by using enteric coating method. The coated tablets were evaluated for the following parameters including thickness, weight variation, Disintegration, assay and *in-vitro* studies.

Comparative datas of uncoated and enteric coated curcumin tablets

Formulation	Thickness (mm)	Weight variation (mg)	Assay (%)
F4 Un coated	4.35± 0.16	397.52±0.02	99.72±0.12
F4 Enteric coated	6.12 ±0.03	453±0.42	99.48 ± 0.06

All values are expressed as mean ± standard deviation, n=3

Curcumin Enteric coated tablets were compared with the same trial of uncoated Curcumin tablets. The thickness of enteric coated tablets was found to be more than uncoated tablets. Weight variation was increased in enteric coated tablets than the uncoated tablets. This is due to the coating of core tablet.

Table 6: *In-Vitro* Dissolution profile of Enteric coated Tablets

TIME (H)	CUMULATIVE % OF DRUG RELEASE					
	F1	**F2**	**F3**	**F4**	**F5**	**F6**
In dissolution media 0.1 N HCL						
0	0	0	0	0	0	0
2	1.05	1.68	1.25	2.31	1.84	1.23
In dissolution media Simulated Intestinal Fluid (7.4pH Phosphate buffer)						
5	6.71	8.03	10.85	12.58	14.10	10.28
8	10.14	13.96	16.96	28.76	21.65	18.10
12	28.89	31.24	45.69	57.18	50.96	43.37
16	46.63	49.73	51.52	64.44	60.25	57.05
20	63.56	70.19	76.07	91.16	86.79	82.83
24	76.12	82.88	83.61	98.90	96.91	91.95

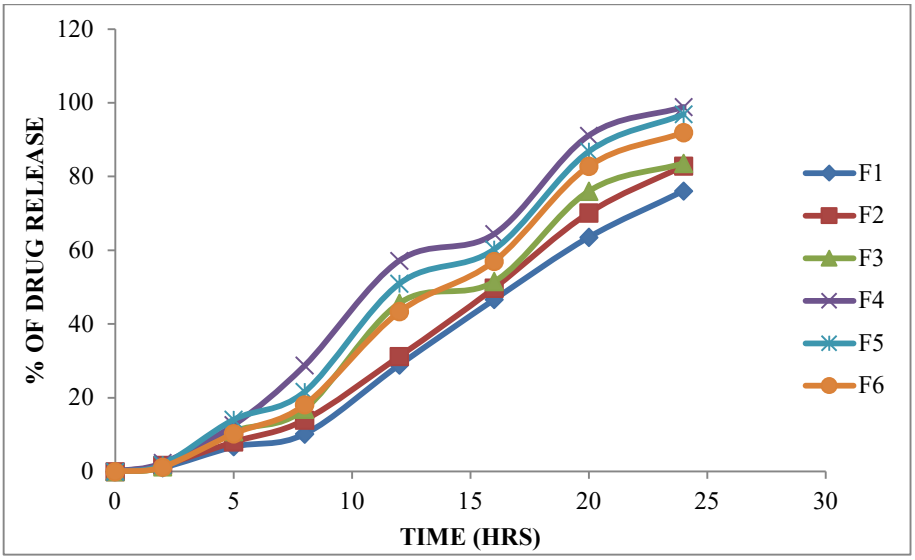

Fig 5: Graphical representation of *in-vitro* drug release

F1: The method used in this trial is direct compression. The concentration of Eudragit S 100 used was 50 mg/unit, and the concentration of Talc and magnesium stearate used. The hardness of the tablet were crossed the specification limit.

F2: Same as procedure of F1. But in this formulation the concentration of Eudragit S100 and was increased to 100 mg/unit. The hardness of this formulation were better than the above formulation but the time required to disintegrate tablets were crossed the specification limit.

F3: The hardness was achieved. But the time required to disintegrate tablets were crossed the specification limit. In this formulation the concentration of Eudragit S100 was increased to 150 mg/unit.

F4: In trial 4 the concentration of Ethyl cellulose was further decreased to 50mg/unit and The disintegration time of tablet was better than the above formulations limits. The tablets were subjected to *in-vitro* dissolution study. The tablets are subjected to *in-vitro* dissolution study. The percentages of drug release were found to be 98.90 at 24 hrs. It was better than the earlier trials.

F5: The concentration of Ethyl cellulose was further increased to 100mg/unit. The disintegration time of tablet was found to be within the limit. The tablets are subjected to *in-vitro* dissolution study. The percentages of drug release were found to be 96.91 at 24 hrs. It was better than the earlier trials.

F6: The concentration of Ethyl cellulose was further increased to 10mg/unit. The tablets of this trial are subjected to *in-vitro* dissolution study. The percentage of drug release showed 91.95 at 24 hrs.

Hence from the above dissolution data it was concluded that F4 formulation was considered as optimised formulation because good drug release (98.90 %) in 24 hours.

Table 7: Release Kinetics

CUMULATIVE (%) RELEASE Q	TIME (T)	ROOT (T)	LOG(%) RELEASE	LOG (T)	LOG (%) REMAIN	RELEASE RATE (CUMULATIVE % RELEASE / t)	1/CUM% RELEASE	PEPPAS log Q/100	% Drug Remaining	Q01/3	Qt1/3	Q01/3-Qt1/3
0	0	0			2.000				100	4.642	4.642	0.000
2.31	2	1.414	0.364	0.301	1.990	1.155	0.4329	-1.636	97.69	4.642	4.606	0.036
12.58	5	2.236	1.100	0.699	1.942	2.516	0.0795	-0.900	87.42	4.642	4.438	0.203
28.76	8	2.828	1.459	0.903	1.853	3.595	0.0348	-0.541	71.24	4.642	4.145	0.496
57.18	12	3.464	1.757	1.079	1.632	4.765	0.0175	-0.243	42.82	4.642	3.499	1.143
64.44	16	4.000	1.809	1.204	1.551	4.028	0.0155	-0.191	35.56	4.642	3.288	1.353
91.16	20	4.472	1.960	1.301	0.946	4.558	0.0110	-0.040	8.84	4.642	2.068	2.574
98.9	24	4.899	1.995	1.380	0.041	4.121	0.0101	-0.005	1.1	4.642	1.032	3.609

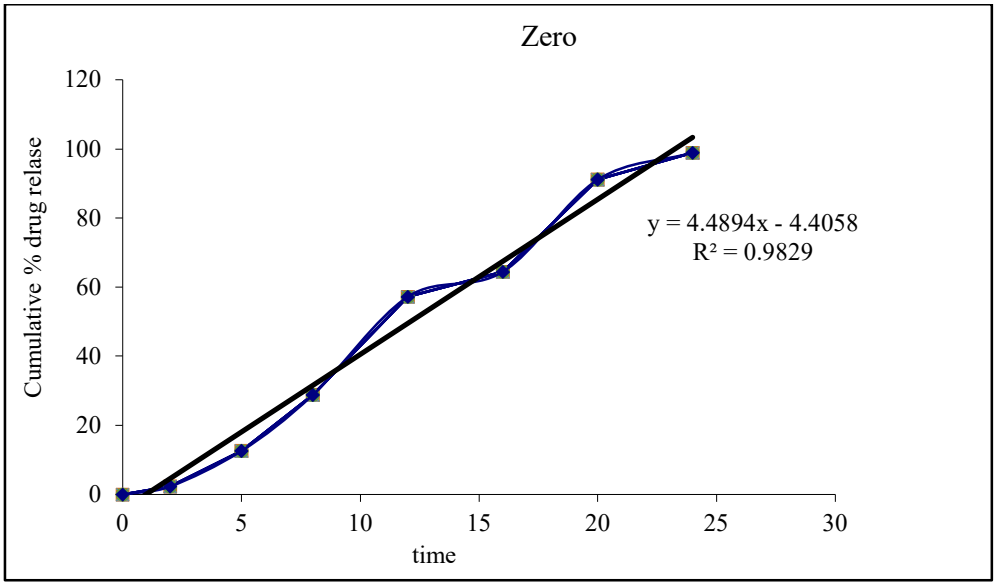

Fig 6: Zero order release kinetics graph

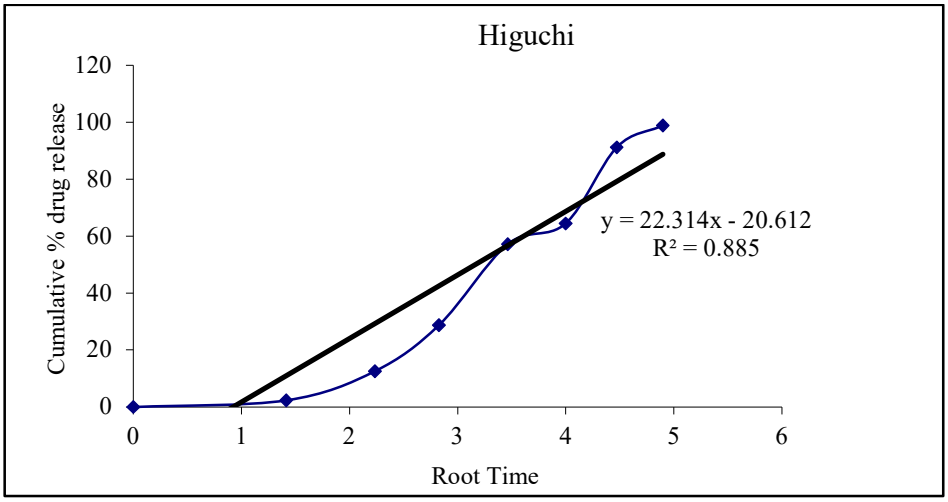

Fig 7: Higuchi release kinetics graph

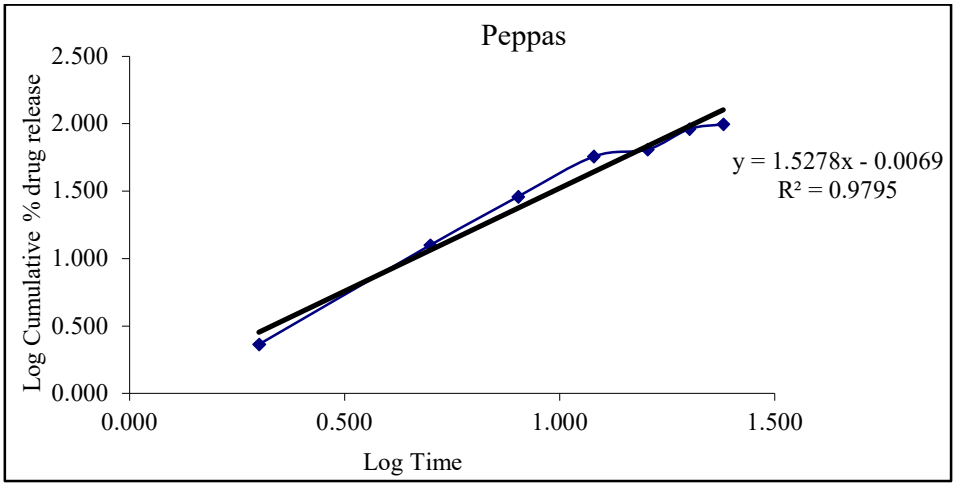

Fig 8: Peppas release kinetics graph

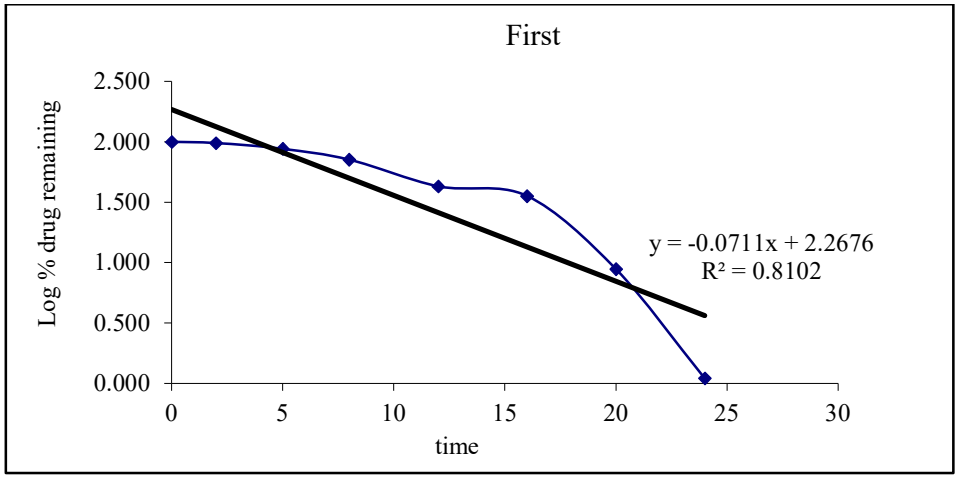

Fig 9: First order release kinetics graph

Optimised formulation F4 was kept for release kinetic studies. From the above graphs it was evident that the formulation F4 was followed **Zero order release** kinetics mechanism.

CONCLUSION

Preformulation studies were performed to study the nature of Curcumin and compatibility of Curcumin with excipients by physical observation and FT-IR studies. The results showed that there was no interaction between Curcumin and all the excipients selected.

The Curcumin matrix tablets were successfully formulated by direct compression method using the selected excipient quantities. The formulated tablets were evaluated for both pre-compression and post-compression parameters as per requirements of standards. And the results were complied with the pharmacopoeia specification. The formulated Curcumin matrix tablets were coated with enteric polymer Eudragit FS 30D and Ethyl cellulose by pan coating method. From among the entire batches, formulation F4 showed 98.90% drug release at 24 hrs. Since it provide greater protection to the core under acidic condition while at the same time show the fastest drug release under intestinal pH. So the trial F4 was considered as best formulation. From the results obtained, it can be concluded that formulation F4 containing enteric coated matrix tablet of Curcumin would be a promising formulation to achieve the purpose which treat inflammatory bowel diseases (ulcerative colitis) without any gastric irritation.

REFERENCES

1. Ansel H. Allen L and Jr. Popovich N. Ansel's Pharmaceutical Dosage Forms and Drug delivery systems. 8th ed. Baltimore: Lippincott Williams & Wilkins; 2004; p.g 260- 268.
2. Lachmann L, Liberman HA, Kanig JL. The theory and practice of industrial pharmacy. 3rd ed. Vol. 171. Bombay: Varghese publishing House; 1998: p.g. p. 201-13, 285-6, 293, 313-4, 400-56.
3. Chien YW. Novel drug delivery systems. Revised and expanded. 2nd ed; 1992: p.g 1-2. p. 139-40.
4. Mehta RM. Pharmaceutics. 3rd ed. Vol. 1.Vallabh Prakashan. New Delhi: p.g.; 2002. p. 238-9.
5. Indian pharmacopoeia. Vol. 2 p.g 662. Ghaziabad: Indian Pharmacopoeia Commission; 2007.
6. Bhowmik D. Tablet manufacturing process and defects of tablets, Elixir Pharmacy. 2014 p.g;70:24368-74.
7. Lachmann L, Lieberman HA, Kanig JL. The theory and practice of industrial pharmacy. 4th ed. New Delhi: CBS publishers; 2006: p.g. p. 293-303.
8. Jones D. Pharmaceutics Dosage form and Design. 1st ed p.g: 227. London, Chicago: Pharmaceutical Press; 2008.
9. Gilbert, Banker S, Christopher T. Rhodes, modern pharmaceutics. 4th ed, NewYork. Basel: pg; 1980. p. 17.
10. Lachman. L, Liberman H. A, Joseph L Kanig. The Theory and Practice of Industrial pharmacy. New Delhi: Varghese publishing house, 3rdedition, 1989; p.g. 331-332.