Development And In Vitro Evaluation of Dexlansoprazole Controlled Release Tablets Containing Natural Polymers

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***Abstract*—The aim of the present work is to formulate and evaluate controlled release of Dexlansoprazole matrix tablets used for treatment of gastroesophageal reflux disease (GERD). Development of CR Dexlansoprazole is proposed considering the adverse event profile and high fluctuation index of Dexlansoprazole observed with CR dosage forms. Dexlansoprazole was subjected to Preformulation studies, based on the results obtained Dexlansoprazole controlled release tablets were successfully formulated. Formulations prepared by direct compression technique. Set of trials were formulated for which Dexlansoprazole evaluated parameters (bulk density, tapped density, compressibility index, hausner's ratio, weight, thickness, hardness) were found to lie within the specifications. Dissolution study was performed in USP type II apparatus at 100 RPM in pH 6.8 phosphate buffer. From the results of the in vitro study it appears that the release of the Dexlansoprazole was significantly influenced by the characteristics of the polymer used.**

***Keywords*— Dexlansoprazole, natural polymers, FTIR studies, Direct compression technique, in vitro drug release studies.**

I. INTRODUCTION

Oral drug delivery remains the most preferred route of administration due to its convenience, patient compliance, and cost-effectiveness. However, conventional oral dosage forms often fail to maintain therapeutic drug concentrations for extended periods, particularly for drugs with short biological half-lives and pH-dependent stability.[1] Controlled-release tablet formulations provide an effective approach to modulate drug release over an extended period while protecting acid-sensitive drugs from degradation in the gastric environment. Polymers play a crucial role in the design of such systems, as they govern drug release kinetics, matrix integrity, and swelling behaviour.[2] In recent years, natural polymers have gained significant attention as pharmaceutical excipients due to their biodegradability, biocompatibility, low toxicity, renewability, and cost-effectiveness.[3] Polymers such as guar gum and sodium alginate have demonstrated promising potential in controlled-release formulations owing to their hydrophilic nature and gel-forming ability.[4] The incorporation of natural polymers in controlled-release matrices can offer additional advantages, including reduced dependence on synthetic polymers, improved patient safety, and environmental sustainability. Moreover, the release profile can be effectively tailored by optimizing polymer concentration and combinations, thereby achieving sustained drug release with desired in vitro performance.[5] Dexlansoprazole, the R-enantiomer of lansoprazole, is a proton pump inhibitor (PPI) widely used in the management of gastroesophageal reflux disease (GERD), erosive esophagitis, and other acid-related disorders.[6] The study aims to formulate matrix tablets capable of providing prolonged drug release while ensuring physicochemical stability and acceptable tablet characteristics.[7] In vitro evaluation parameters such as pre-compression characteristics, post-compression quality attributes, drug content uniformity, and dissolution behavior were systematically investigated to assess the suitability of natural polymers in controlling the release of dexlansoprazole.[8] The outcomes of this study are expected to contribute to the development of a cost-effective, safe, and efficient controlled-release oral dosage form for the improved management of acid-related disorders.

II. MATERIALS

Dexlansoprazole was obtained from Hetero Labs, Hyderabad. Guar gum and Sodium alginate were

procured from Synpharma Research Labs, Hyderabad. Other chemicals and the reagents used were of analytical grade.

III. METHODOLOGY

Fourier Transform Infrared Spectroscopy (FTIR)
FTIR spectroscopy Dexlansoprazole discs were created by compressing the Dexlansoprazole with KBr and the spectra was scanned in the range between 4000 to 400 cm-[1]. Perfect operational conditions were maintained. The absorption maxima which is denoted as max in spectrum obtained with the drug substance is compared with the intensity to those of reference spectrum. [9]
Formulation development

Table-1: Formulation table of Dexlansoprazole controlled release tablets

S.NO.	INGREDIENTS	F1	F2	F3	F4	F5	F6
1	Dexlansoprazole	50	50	50	50	50	50
2	Guar gum	25	50	75	-	-	-
3	Sodium alginate	-	-	-	25	50	75
4	Microcrystalline Cellulose	120	95	70	120	95	70
5	Magnesium stearate	3	3	3	3	3	3
6	Talc	2	2	2	2	2	2
7	Total weight	200	200	200	200	200	200

Preparation method:
Tablets of Dexlansoprazole were prepared by direct compression method as per the formulae given in Table. All the materials required as per the formulae were blended in a closed polyethylene bag. The blends were compressed into tablets on a tablet punching machine to a hardness of 6 kg/cm ^{2} using 8 mm concave punches.[10]

Evaluation of tablet
Weight Variation : Weight variation is one of the official quality control tests for tablets. This is important because it directly relates with drug content. To do this test, minimum 20 tablets were weighed separately and average weight was calculated and compared with individual weight. The deviation gives the report of the weight variation. Usually it is expressed in percentage. Weight variation should be done in process checking and for finished products.[11]

Thickness: The dimensions like thickness and diameter of the tablets may have important effect in the drug content and other parameters. Hence it is required to maintain the thickness and diameter in the optimum acceptable range. This can be done by means of Vernier caliper. 10 tablets prepared from each trial were used. The average values were noted. [12]

Tablet Hardness: Monsanto hardness tester was utilized to find the tablet hardness. In each formulation, 10 tablets were taken and the hardness was measured. The tablet was kept in the perfect position in the axis in the two jaws of instrument. The measurement should be zero kg/cm^2 at this stage. The knob is rotated to apply force to the tablet, the force is continued until there is fracture in the tablet. The point at which tablet breaks is break point and it was noted in kg/cm^2. [13]

Friability : Tablet strength can be measured by using friabilator. This is performed to know the impact of shock abrasion on tablets when on travelling and handling. The test involves keeping the tablets in a plastic chamber and allowing it to revolve at 25rpm for 4 minutes that is equivalent to 100 rotations. In this test the tablets are subjected to drop at heights of 6 inches in each revolution. The initial weight and final weight of the tablets after dedusting were noted. The limit acceptable is less than 1% weight variation.[14] It was calculated as follows. The percentage friability was measured using the formula,

$$\% F = \{1-(Wo/W)\} \times 100$$

Where,

% F = friability in percentage

W o = Initial weight of tablet

W = weight of tablets after revolution

Drug Content: The drug content directly relates to the pharmacological efficacy, so it is mandatory to do the drug content test. It is an official quality control test. The drug content in all formulations were analyzed by triturating 20 tablets in mortar and pestle, then from the powder 75 mg equivalent of Dexlansoprazole was taken and transferred to 100ml standard volumetric flask. Then the volume was prepared to 50ml with pH 6.8 phosphate buffer. This was shaken for 15 min to mix. Then the volume was prepared to 100ml with phosphate buffer. The solution was strained by using whatmann filter paper and then it is diluted and absorbance was determined by using UV-Visible spectrophotometer at 260 nm using pH 6.8 phosphate buffer as blank. [15]

In vitro release studies: This in vitro release can be done by using USP dissolution apparatus I. The test is performed at 50 rpm. The media used were pH 1.2 buffer for initial 2 h, followed by 8 h in pH 6.8 phosphate buffer. The temperature was maintained at 37 ± 0.5°C. The samples were taken at predetermined time and the dissolution basket is replenished with the buffer. The taken samples were filtered through filtered through a 0.45 membrane filter. The absorbance was measured at 260 nm. [44]

Stability studies: The stability studies are performed to analyze the quality of drug and drug product with exposure to different temperature and humidity conditions on estimated time. General conditions like light, environment and other general parameters are maintained and the general evaluation tests were performed at different time interval periods. It is undesirable and time consuming to do full shelf life period study. To avoid this accelerated stability studies has been adopted.[16]

IV. RESULTS AND DISCUSSION

Drug - excipient compatibility studies (FT-IR):

The compatibility between the drugg and the selected polymers was evaluated using FTIR peak matching method. There was no appearance or disappearance of peaks in the drug-polymer mixture, which confirmed the absence of any chemical interaction between the drug, polymer and other chemicals.

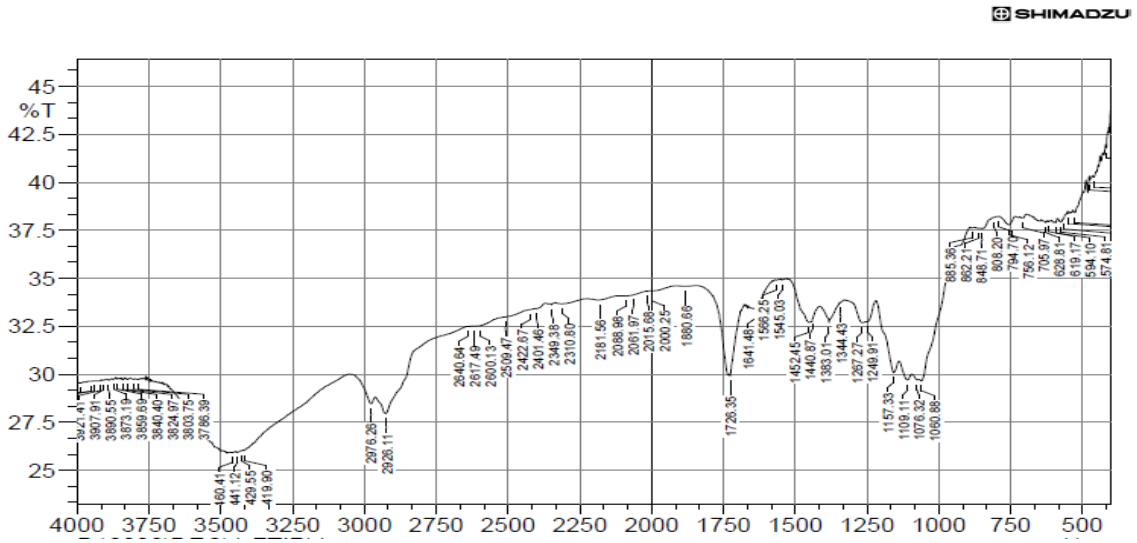

Fig-1: FTIR spectra of Dexlansoprazole

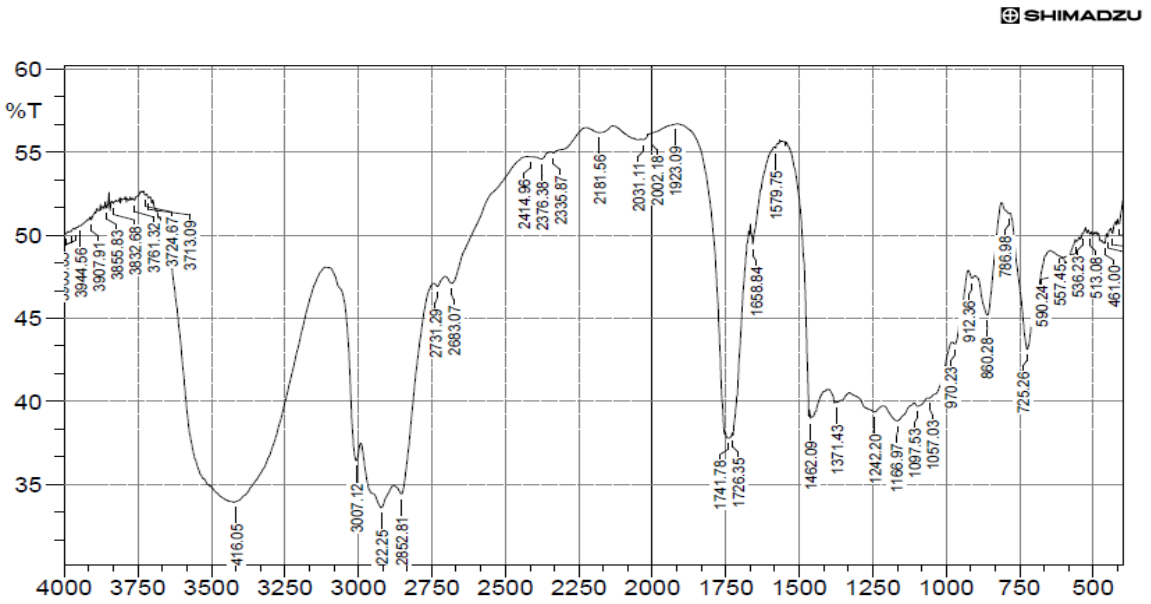

Fig-2: FTIR Spectra of physical mixture of drug and excipients

Compatibility studies were performed using IR spectrophotometer. The IR spectrum of Pure drug and physical mixture of drug and excipients were studied. The characteristic absorption of peaks were obtained as above and as they were in official limits (±100 cm^{-1}) the drug is compatible with excipients.

EVALUATION STUDIES

Weight variation: All the formulated (F1 to F6) tablets passed weight variation test as the % weight variation was within the pharmacopoeial limits of ±7.5% of the weight. The weights of all the tablets were found to be uniform with low standard deviation values.

Thickness: Tablets mean thickness were uniform in F1 to F6 formulations and were found to be in the range of 4.15 mm to 4.22 mm.

Hardness: The measured hardness of tablets of each batch ranged between 5.10 to 5.22 kg/cm^2. This ensures good handling characteristics of all batches.

Friability: The % Friability was less than 1% in all the formulations ensuring that the tablets were mechanically stable.

Content Uniformity: The percentage of drug content for F1 to F6 was found to be between 80.19 % and 86.19 % of Dexlansoprazole it complies with official specifications.

Table-2: Results of Evaluation parameters of tablets

F. No.	Weight variation (mg)	Thickness (mm)	Hardness (kg/cm^2)	Friability (%)	Drug content (%)
F1	100	4.15	5.15	0.39	80.19
F2	99	4.18	5.13	0.41	85.14
F3	100	4.20	5.10	0.43	82.49
F4	98	4.19	5.22	0.45	84.58
F5	100	4.20	5.17	0.49	86.19
F6	100	4.22	5.20	0.50	85.27

In-vitro Dissolution Study

Table-3: *In vitro* release data of tablet F_1 to F_6

Time (hrs)	F_1	F_2	F_3	F_4	F_5	F_6
0	0	0	0	0	0	0
1	19.68	18.10	19.59	18.46	20.70	18.24
2	26.48	27.95	28.28	29.47	30.42	29.24
3	35.80	36.27	38.85	38.25	42.80	39.16
4	46.85	45.16	46.69	49.75	51.90	46.69
5	58.59	56.85	59.61	58.80	61.24	59.98
6	72.25	71.32	70.49	72.82	74.15	73.45
7	81.60	80.13	81.75	82.51	85.21	83.54
8	92.58	93.63	94.85	95.75	97.27	96.48

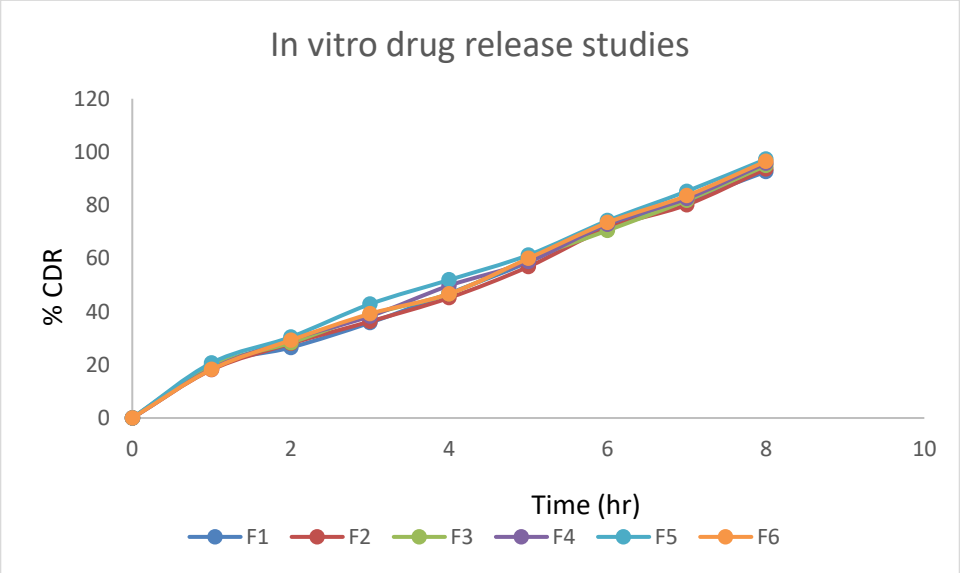

Fig-3: In vitro drug release studies of F1-F4 formulations

Stability studies

There was no significant change in physical and chemical properties of the tablets of formulation F-5 after 3 months. Parameters quantified at various time intervals were shown;

Table-4: Results of stability studies of optimized formulation F5

Formulation Code	Parameters	Initial	1st Month	2nd	3rd	Limits as per Specifications
F-5	25^0C/60%RH	97.27	96.83	95.48	94.76	Not less than 85%
F-5	30^0C/75% RH	97.27	96.71	95.36	94.5	Not less than 85%
F-5	40^0C/75% RH	97.27	96.5	95.27	94.37	Not less than 85%

V. CONCLUSION

In the present study, an effort was initiated to prepare the oral CR matrix tablets of Dexlansoprazole to provide a dosage form for prolonged period of time, in order to improve pharmacologic efficacy, reduce the total dose frequency and improved patient compliance. In the current research work, matrix formulation F5 containing Sodium alginate were perhaps show maximum delay of drug release as optimum formulation among all formulations Stability study was carried out with F5 formulation as per ICH guidelines and found to be stable both in accelerated and long term stability conditions.

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