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Application of Natural and Synthetic Polymer-Based Disintegrants in the Design of Fast Dissolving Cefuroxime Axetil Tablet Composites

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Abstract

The current paper examines how natural and synthetic polymer-based disintegrants can be used to design fast-soluble types of tablet composites. A model drug was chosen and tablets were prepared by the direct compression method using different polymeric excipients, such as guar gum, locust bean gum, sodium starch glycolate (SSG) and cross povidone. Eight formulations were prepared and tested on the basis of critical material and performance characteristics including thickness, hardness, friability, disintegration time, in-vitro drug release, and drug content uniformity.

The findings showed that the use of polymeric super disintegrants had a considerable effect on the composite matrix structure and functional behaviour of the pills. It is notable that locust bean gum, a natural polysaccharide, had similar or better disintegration performance and release performances in comparison with the synthetic polymers, including SSG and cross povidone. This brings out its promise as an environmentally friendly and efficient polymeric excipient in pharmaceutical blends.

In general, the work shows that the performance of the fast-dissolving drug delivery system is determined by the physicochemical interactions of natural and synthetic disintegrant polymers. The results also indicate that biodegradable gums such as locust bean gum can be useful to replace synthetic polymers in the creation of environmentally-friendly and effective composite arrangements.

Keywords: Locust bean gum, Disintegrantion, Fast dissolving tablets, Super disintegrants, antimicrobial efficacy, Natural gums.

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INTRODUCTION

In order to improve drug release and patient acceptance, this introduction describes the creation and evaluation of fast dissolving tablets using synthetic and natural polymeric disintegrants**.**

Fast Dissolving Tablets (FDT)

Fast-dissolving tablets (FDTs) constitute polymer-based composite systems that begin to disintegrate very quickly, frequently within the context of the oral cavity, that is, in a few seconds. In terms of material science these systems are porous polymeric matrices that are intended to integrate mechanical strength, fast hydration and disintegration [1]. Their production has attracted a lot of attention since the 1980s because of the necessity to have dosage forms that are patient-friendly, especially in cases of paediatric and

geriatric patients who have trouble with swallowing [2,3]. The excipient polymers are hydrophilic so that they interact with saliva instantly to be dispersed, and additional water is not needed.

The issue with the creation of such polymeric composites is how to simultaneously create the mechanical strength to facilitate the management and transportation processes, whilst at the same time, disintegrating the material immediately upon administration. Direct compression has been the most popular of the different methods that can be used to fabricate drugs, due to its simplicity, cheapness and its ability to work with thermolabile drugs. Polymeric disintegrants, both natural and synthetic, are also a key factor in the control of water uptake, swelling and capillary action in the composite matrix, thus determining overall performance in these systems [4].

Natural polysaccharides are increasingly finding their way to the research table as possible alternatives to the traditional synthetic disintegrants. In less than ten seconds, natural polymers wick and swell four to eight times [5]. and some others shrink back to their original measurements, show little swelling, and work via capillary action. We can turn it into a porous tablet since they are spongy and insoluble in water [6]. A member of the galactomannan group, locust bean gum polysaccharide is derived from carob tree seeds [7]. It has strong gelling properties, swelling properties, and biocompatibility and is used in a variety of medication delivery systems [8]. Its structural characteristics allow quick wicking of water and swelling which are useful in quickly dispersing polymeric matrices. Synthetic superdisintegrants, e.g., sodium starch glycolate (SSG) or crospovidone, by contrast, are crosslinked and capillary based. These natural and synthetic polymeric excipients need to be evaluated comparatively to learn how structure and physicochemical interactions in polymer dictate disintegration kinetics and drug release behaviour.

Cefuroxime axetil, a second-generation cephalosporin that has low solubility in water was selected as a model drug in this research to determine the interactions of polymer excipients in fast-dissolving composite tablets. Usually there are many traditional methods for FDT, including the addition of disintegrants, freeze drying or lyophilization [9-11], tablet molding [12], sublimation [13] spray-drying [11], direct compression, mass extrusion[14], cotton candy process, nanonization [13], compaction (melt granulation), phase transition process, and fast dissolving films. Here, eight formulations (F1–F8) were made by direct compression with different disintegrant types and concentrations while maintaining a consistent 500 mg tablet weight. Lactose and vanilla were used as diluents and to disguise tastes, respectively. The research will assess the excipience of natural polysaccharide-based excipients as functional disintegrant polymer and position them as greener options to synthetic polymers when designing new advanced drug delivery composites.

METHODS

A rotary tableting machine (12 HUK-AW, Kikusui Seisakusho, Ltd., Japan) was used to create the 500 mg weight, 8 mm diameter, flat-faced direct compression tablet compositions That Are Mentioned In Table 1 [15].

Cefuroxime Axetil FDTs Preparation:

Weighing the cefuroxime axetil was done precisely. As indicated in Table 1, locust bean gum and additional excipients were mixed in a mortar for formulations F1–F8, and after five minutes, magnesium stearate was added. A twelve-station rotating tablet compression machine and 5 mm round flat punches were used to compress the mixture as soon as it satisfied precompression standards.

Preformulation Studies: Physical appearance, solubility, melting point, precompression parameters, and post-compression characteristics like thickness, hardness, friability, wetting time, drug content, and weight uniformity were all evaluated as part of the preformulation studies.

Physical Appearance

The drugs physical appearance, its colour, smell, shape, and other organoleptic characteristics were evaluated.

Point of Melting

The drug-filled, one-sided closed capillary was inserted into the melting point apparatus using a capillary fusion technique in order to determine the melting point of cefuroxime axetil.

Solubility

After weighing and adding 25 mg of the medication to 25 mL of a volumetric flask, the volume was adjusted with 6.8 phosphate buffer. After filtering the solution combination, the absorbance was measured. The calibration curve was then used to determine the solubility.

Table 1. Formulation of Cefuroxime Axetil

Excipients/Formulations	F1	F2	F3	F4	F5	F6	F7	F8
Cefuroxime axetil	250	250	250	250	250	250	250	250
Locust bean gum	20	30				10		10
Cross povidone			20				10	10
Sodium starch glycolate				20			10	10
Guar gum					20	10		
Vanilla	5	5	5	5	5	5	5	5
Lactose	225	215	225	225	225	225	225	215
Total weighing	500	500	500	500	500	500	500	500

Precompression Parameter Studies

Angle of Repose [16,17]**:** The internal angle formed between the blend pile's surface and the horizontal surface is known as the angle of repose. The angle of repose of the blend was obtained using below equation .

$$Angle\ of\ repose\ tan\ \theta = \frac{h}{r}$$

Where h=Pile's height; r= Pile's radius

Bulk Density: Bulk density is the connection between a powder's mass and bulk volume. The calculation was done using the equation below [18, 19].

$$\text{Bulk density} = \frac{\text{Mass of the powder}}{\text{Bulk volume}}$$

Tapped Density

The tapped density was computed by dividing the mixture's mass by the tapped volume[19]. The tapped density can be obtained using below equation.

$$\text{Tapped density} = \frac{\text{Mass of the blend}}{\text{Tapped volume}}$$

Carr's Index

The following formula was used to determine the blend's compressibility percentages based on the perceived bulk density and tapped density.

$$\text{Carr's Index } = \frac{\text{Tapped density} - \text{Bulk density}}{\text{Tapped density}} \times 100$$

Hausner's Ratio [16,17]**:** The Hausners ratio, which can be calculated using the following formula, is the ratio of the powder's bulk density to its tapped density.

$$\text{Hausners ratio} = \frac{\text{Tapped density}}{\text{Bulk density}}$$

Thickness of Tablets

A Vernier calliper was used to measure the tablets' thickness. Each batch contained three tablets, and the average was determined.

Hardness: Tablet hardness, which should fall between 30 and 80 N [20], is a reasonable measure of the physical strength of FDTs. A minimum hardness of 25N is ideal for FDTs. The tablet's hardness has been determined using a Monsanto hardness tester [21].

Friability [17,22]: A Roche Friabilator has been used to assess the friability of tablets. Friability can be calculated using the equation below.

$$\%\ Friability\ x = \frac{W1-W2}{W1} \times 100$$

W1= Initial weight of tablets, W2= Tablets weight after friability

Wetting Time of Tablet: To simulate the pH of saliva, a tiny petridish with an internal diameter of 8 cm was filled with 10 ml of phosphate buffer pH 6.8 and a piece of folded paper tissue. The amount of time required to achieve total wetness was determined after one tablet was placed on the paper. Each batch underwent three trials before the average soaking time was established.

Water Absorption Ratio [22,23]: Six millilitres of the liquid were put into a small petridish container, to which a piece of double-folded tissue paper was fastened. A tablet was placed on the paper to measure the time required for complete wetting. The moist tablet was then weighed. The ratio, or R, of water absorption was calculated using the following formula.

$$R = \frac{100\ (Wa-Wb)}{Wb}$$

Wb– Weight of tablet before absorption, Wa– Weight of tablet after absorption

Weight Variation [17]**:** The batch consisted of twenty randomly selected tablets, each of which was weighed independently before the average weight was calculated. An equation can be used to calculate the % weight variation.

$$\%\ \text{Weight variation} = \frac{\text{Weight of the tablet}}{\text{Average weight}} \times 100$$

Uniformity of Drug Content: Twenty tablets were carefully weighed and broken into a powder for each batch. A 100 ml volumetric flask was filled with 50 mg of the drug powder. Sonicate for 10 minutes using a phosphate buffer with a pH of 6.8. Each tablet's drug content was determined by filtering the resulting solution and measuring the absorbance at 230 nm using a UV spectrophotometer (1800, Shimadzu, Kyoto, Japan).

Antimicrobial Efficacy: Nutrient agar was produced and put into twenty sets of petri dishes. Different strains of carefully selected bacteria (*E. Coli, Staphylococcus aureus, Bacillus subtillis, Putida vulgaris, and Aspergillus niger*) were added to each of these petriplates, and they were then incubated for a whole day at 37°C. The bacterial growth was tracked after incubation. 9mm-diameter wells were made using a sterile cork borer, and test (Cefuroxime axetil) and standard antibiotic (Streptomycin) solutions were then added. The zone of inhibition was then manually assessed while the wells were in incubators for two days.

***Invitro* Dispersion Time**

In order to find out how long it would take for a tablet to dissolve entirely, one tablet was put in a beaker with 10ml of pH 6.8 phosphate buffer that was maintained at 37 ± 0.5ºC. The results were added up.

Disintegration Test [24]

Disintegration test was conducted, provided pH 6.8 phosphate buffer as the medium, and the time it took for each tablet to dissolve completely at 37ºC ± 0.5ºC was noted.

***Invitro* Dissolution Studies [25]**

The USP Dissolution Type II was used with nine hundred millilitres of 6.8 phosphate buffer at 37 ± 0.5ºC. The paddle speed was kept at 100 rpm, at regular intervals, a 5-milliliter aliquot was removed, and to maintain a consistent volume, the same volume of new medium was added. Using a UV visible spectrophotometer (1800, Shimadzu, Kyoto, Japan), each sample was examined spectrophotometrically against a blank.

RESULTS: All examined parameters, including preformulation, precompression, post-compression, antimicrobial activity and *in vitro* performance assessments of the created formulations, are presented in the results section.

Preformulation Studies

Physical attributes: White crystals packed into a powder. a bit overpowering in both taste and scent.

Melting point: It has been observed that cefuroxime axetil melts between 94 and 96°C.

Solubility: Cefuroxime axetil is insoluble in organic solvents and only weakly soluble in water.

Precompression Evaluation Parameters For Cefuroxime Axetil Fast Dissolvingtablets:

The parameters of the generated formula data prior to compression are displayed in Table 2.

Angle of Repose: Angle of repose between 22.52 ± 0.044 and 29.91 ± 0.020 was recorded for the prepared tablets. This suggests that the blended powder has advantageous flow quality.

Bulk / Tapped Density: The ranges of the different formulations bulk and tapped densities were determined to be 0.15 ± 0.003 to 0.51 ± 0.005 (g/cc) and 0.34 ± 0.001to 0.55 ± 0.005 (g/cc), respectively.

Carr's Index: The compressibility index, which varies from 2.70 ± 0.69 to 10.52 ± 0.54 indicates that the resulting mixer or granules have good compressibility.

Hausner's Ratio: The Hausner's ratios of the resultant blends, which range from 1.04 ± 0.55 to 2.51 ± 0.32 demonstrate that they possess the required compressive strength and flow properties.

Table 2. Precompression Parameters of Developed Formulations

Formulation code	Angle of repose(θ)	Bulk density (g/cc)	Tapped density (g/cc)	Carr's index (%)	Hausner's ratio
F1	23.96 ± 0.068	0.49 ± 0.005	0.52 ± 0.011	6.66 ± 0.63	1.07 ± 0.14
F2	25.68 ± 0.091	048 ± 0.002	0.51 ± 0.006	6.06 ± 0.04	1.06 ± 0.45
F3	27.14 ± 0.051	0.51 ± 0.005	0.53 ± 0.007	3.84 ± 0.32	1.04 ± 0.55
F4	22.52 ± 0.044	0.36 ± 0.005	0.40 ± 0.004	10.52 ± 0.54	1.11 ± 0.76
F5	29.91 ± 0.020	0.49 ± 0.003	0.55 ± 0.005	10.34 ± 0.13	1.11 ± 0.53
F6	28.99 ± 0.020	0.15 ± 0.003	0.34 ± 0.001	6.02 ± 0.98	2.51 ± 0.32
F7	28.82 ± 0.019	0.38 ± 0.017	0.45 ± 0.035	2.70 ± 0.69	1.02 ± 0.08
F8	29.89 ± 0.012	0.37 ± 0.015	0.40 ± 0.052	5.71 ± 0.54	1.06 ± 0.03

Post Compression Parameters: All post compression parameters are presented in Table 3.

Thickness: For each formulation, the mean thickness in Table 3 was nearly identical, ranging from 4.52 ± 0.01 to 5.31 ± 0.02 mm.

Hardness Test: According to the findings, the tablets hardness ranged from 2.03 ± 0.05 to 4.91 ± 0.04kg/cm^2 and found to be within the limits.

Friability Test: The data revealed that the tablets friability ranged from 0.48 ± 0.03 until 0.82 ± 0.09%, this showed that the tablets have good mechanical resistance in accordance with IP regulatory norms.

Weight Variation Test: Since the average tablet weighs 500 mg, the permissible limit is ± 7.5%. The test findings demonstrated that the weight of the tablet was within the pharmacopoeial limit.

Table 3. Post compression Parameters for Developed Formulations

Formulation code	Thickness (mm)	Hardness (kg/cm^2)	Weight variation (mg)	Drug content (%)	Friability (%)
F1	3.02 ± 0.02	1.90 ± 0.15	496.45 ± 0.97	94.6 ± 0.08	0.57 ± 0.01
F2	2.99 ± 0.01	1.45 ± 0.05	497.35 ± 0.12	96.8 ± 0.22	0.65 ± 0.06
F3	4.01 ± 0.05	1.80 ± 0.17	499.90 ± 0.51	96.9 ± 0.14	0.68 ± 0.03
F4	3.02 ± 0.08	1.23 ± 0.05	500.02 ± 0.33	97.3 ± 0.18	0.64 ± 0.01
F5	4.02 ± 0.06	1.76 ± 0.15	500 ± 0.80	98.7 ± 0.26	0.65 ± 0.07
F6	4.91 ± 0.04	1.66 ± 0.14	499.01 ± 0.12	97.6 ± 0.12	0.71 ± 0.05
F7	3.02 ± 0.05	1.73 ± 0.01	500.21 ± 0.51	97.2 ± 0.16	0.82 ± 0.09
F8	2.03 ± 0.05	1.82 ± 0.11	501.28 ± 0.23	98.7 ± 0.1	0.48 ± 0.03

The disintegrant used affected the mechanical properties of the tablets. Tablets with natural gums (F1, F2, F5, F6) were generally harder (1.45–1.90 kg/cm²) and less friable (0.57–0.71%), while tablets with synthetic disintegrants (F3, F4, F7) were slightly less hard (1.23–1.80 kg/cm²) but still within acceptable pharmacopeial limits. The combination formulation F8 (locust bean gum + crospovidone + SSG) hit the sweet spot, with a hardness of 1.82 ± 0.11 kg/cm² and a friability of 0.48 ± 0.03%. This means that synthetic superdisintegrants help things break down quickly, while natural polymers make things stronger.

Post Formulation Studies: The evaluation findings of all pertinent parameters evaluating the formulated tablet formulations performance are included in the post-formulation investigations.

Wetting Time: The results showed that formulations F3, F2, and F8 had wetting times of 1.28 ± 0.12, 1.25 ± 0.15, and 1.21 ± 0.10 seconds, respectively. When all variables were taken into account, the F8 formulation containing locust bean gum, cross povidone, and SSG showed the quickest wetting time. This is due to the pills' disintegrant's high capillary action and potent hydration capacity. Formulation F6 had a longer wetting time; this could be due to the disintegrants propensity to scatter and swell in water. These all post formulation studies results are shown in Table 4.

Water Absorption Ratio: According to the findings, the tablets water absorption ratio ranged from 116.7 ± 0.03 to 151.0 ± 0.19.

Disintegration Time: The created tablets broke down in 9.6 ± 0.14 to 64.6 ± 0.24 minutes, according to the data. It is believed that the disintegration process, specifically the expansion of the disintegration ingredient and the entry of water into the tablet, originates from the internal structure of tablets. The formulation containing locust bean gum, cross povidone, and SSG broke down the quickest, taking 9.6 ± 0.14 minutes, according to measurements of the disintegration times of each formulation. This is due to the tablet's disintegrants potent capillary nature.

Table 4. Post Formulation Studies

Formulation code	Wetting time (sec)	Water absorption ratio (%)	Disintegration (Sec)
F1	1.33 ± 0.06	116.7 ± 0.03	40.9 ± 0.05
F2	1.25 ± 0.15	151.0 ± 0.19	40.1 ± 0.04
F3	1.28 ± 0.12	118.9 ± 0.17	30.2 ± 0.64
F4	1.46 ± 0.11	119.6 ± 0.17	33.3 ± 0.13
F5	1.33 ± 0.10	120.1 ± 0.09	64.6 ± 0.24
F6	1.49 ± 0.10	113.7 ± 0.02	40.1 ± 0.02
F7	1.47 ± 0.10	112.1 ± 0.03	17.5 ± 0.12
F8	1.21 ± 0.10	118.5 ± 0.04	9.6 ± 0.14

Disintegration times of tablets made using locust bean gum were relatively longer than disintegration times of tablets made using sodium starch glycolate (SSG) and crospovidone in our study. Locust bean gum tablets made of F1 and F2 took 40.9 ± 0.05 and 40.1 ± 0.04 seconds to disintegrate under the same experimental conditions, while SSG tablets (F4) and crospovidone tablets (F3) disintegrated faster in 33.3 ± 0.13 and 30.2 ± 0.64 seconds, respectively.

This can mainly be attributed to the swelling power and capillary interaction of the synthetic super disintegrants that would break up the pills faster than the slower rate of hydration and higher viscosity of the natural polymer. However, locust bean gum offered satisfactory disintegration times to use in fast-dissolving preparations.

Antimicrobial Activity: *Escherichia coli, Staphylococcus aureus, Bacillus subtilis, Proteus vulgaris, and Aspergillus niger* were among the microbial strains against which the antibacterial activity was assessed.

Zone of Inhibition For Test Drug and Standard Drug

By evaluating the zone of inhibition against a variety of bacteria species, the test formulation's antimicrobial efficiency was assessed and contrasted with that of a conventional antimicrobial agent. Both Gram-positive and Gram-negative bacteria as well as a type of fungus were among the organisms examined

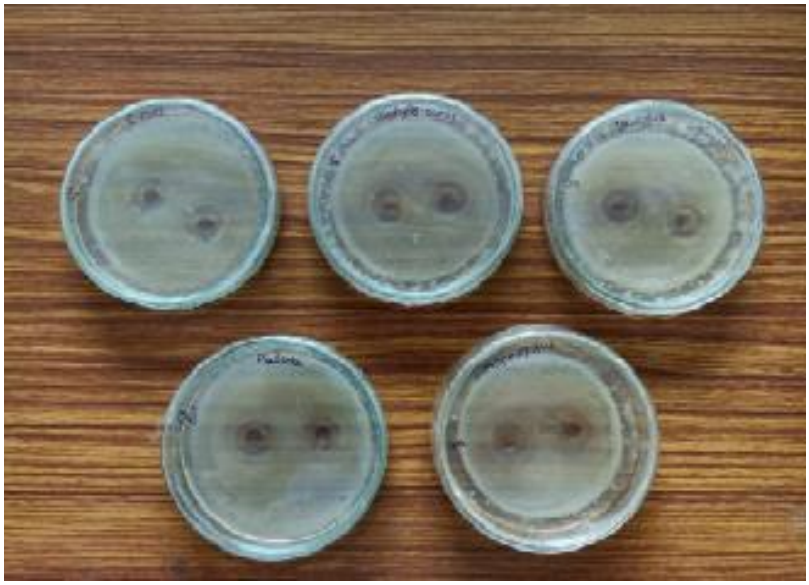

Figure 1. Zone of Inhibition of Test Drug and Standard Drug

Table 5. Zone of Inhibition for Test Drug and Standard Drug

S. No	Name of the organism	Zone of Inhibition in mm (Test)	Zone of Inhibition in mm (Standard)
1	*E.Coli*	17 ± 0.5	17 ± 0.4
2	*Staphyllococcus aureus*	18 ± 0.23	19 ± 0.54
3	*Bacillus subtillis*	12 ± 0.32	13 ± 0.65
4	*Putida vulgaris*	15 ± 0.4	16 ± 0.7
5	*Aspergillus niger*	10 ± 0.51	17 ± 0.13

Escherichia coli, a type of gram-negative bacteria, showed a Zone of Inhibition (ZOI) of 17 mm for both the test and the standard, indicating that the test formulation's ability to fight germs was similar to that of the standard. These results are shown in Figure 1and Table 5.

Staphylococcus aureus, a gram-positive bacterium, displayed a marginally lower ZOI (18 mm) for the test than for the standard, which was 19 mm. The test formulation appears to be almost as effective against *S. aureus* as the standard, based on this slight difference.

Another Gram-positive bacterium, *Bacillus subtilis*, showed a ZOI of 12 mm using the test formulation rather than 13 mm using the norm. With the test formulation demonstrating a somewhat reduced efficacy, this finding also suggests moderate antibacterial activity.

The ZOI of the gram-negative bacteria *Proteus vulgaris* was 15 mm for the test and 16 mm for the standard. Once more, the test formulation showed close effectiveness, falling just short of the requirement by a little margin. This results are shown in Figure 1 and Table 5.

The test formulation produced a 10 mm ZOI for the fungal strain Aspergillus niger, while the standard displayed a noticeably higher 17 mm ZOI. So, the test formulation might need to be better or stronger for antifungal purposes because it works less effectively against fungi, particularly *A. niger*.

With only marginally lower efficacy than the normal, the test formulation showed excellent antibacterial action overall, particularly against *E. coli, S. aureus, and P. vulgaris*. Nevertheless, antifungal activity was significantly reduced, suggesting a possible restriction in the formulations range of action.

The antimicrobial study found that the test formulation is very effective against bacteria, showing similar results to the standard antimicrobial agent, but it was much less effective against fungi like *Aspergillus niger*, indicating that it needs further improvement for wider use. These findings support the test formulation's promise as a strong antibacterial agent, while also highlighting the need for more research to enhance its antifungal effectiveness. Its effectiveness against fungi such as *Aspergillus niger*, however, was much lower, suggesting that more optimisation is required for broad-spectrum uses. These results bolster the test formulation's potential as a strong antibacterial agent while also pointing to the need for more research to improve its antifungal capabilities.

Compatability Studies Using FTIR

FTIR spectrum of Locust bean gum: To find out if there were any interactions between the medication and the excipients, the FTIR spectra of pure locust bean gum was analysed and results were shown in Table 6 and Figure 2.

O-H stretching, which is typical of polysaccharide hydroxyl groups, manifests at 3421 cm^{-1}.The C-H stretching is visible at 2924 cm^{-1}. A moisture content or slight oxidation is indicated by a C=O peak at 1726 cm^{-1} and a H–O–H bending at 1631 cm^{-1}. Around 1057 cm, we detect the characteristic stretching vibrations of polysaccharide backbones, C–O and C–O–C.

Table 6. FTIR Characteristics Peaks of Locust Bean Gum

S. No	Functional group	Characteristic peak (cm^{-1})	Functional group observed (cm^{-1})
1	O-H stretching	3400-3200 cm^{-1}	3421 cm^{-1}
2	C-H stretching	2920-2850 cm^{-1}	2924 cm^{-1}
3	C=O stretching	1730-1700 cm^{-1}	1726 cm^{-1}
4	H-O-H Bending	1650-1600 cm^{-1}	1631 cm^{-1}
5	C-O-C & C-O stretching	1150-1000 cm^{-1}	1057 cm^{-1}

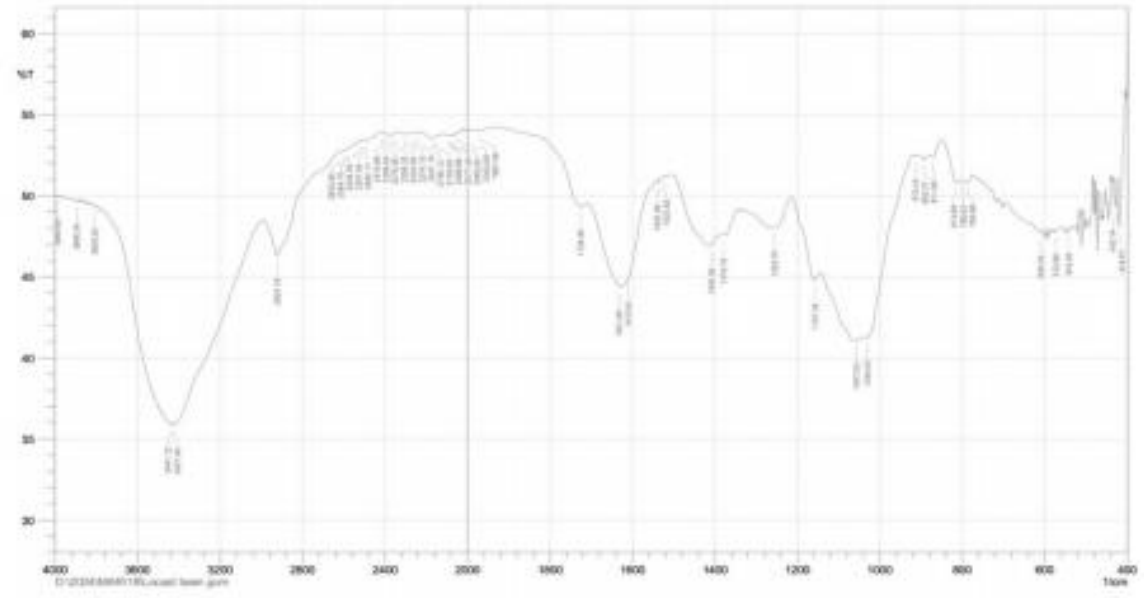

Figure 2. FTIR Spectrum of Locust Bean Gum

Table 7. FTIR Characteristic Peaks of Cefuroxime Axetil Tablet

Sl. No	Functional group	Characteristic peak (cm^{-1})	Functional group observed (cm^{-1})
1	O-H stretching	3600-3200 cm^{-1}	3282 cm^{-1}
2	C-H stretching	2950-2850 cm^{-1}	2850 cm^{-1}
3	C=O stretching (ester axetil moiety)	1740-1720 cm^{-1}	1747 cm^{-1}
4	C=O stretching (amide – β-lactam ring)	1710-1650 cm^{-1}	1718 cm^{-1}
5	N-H Bending	1650-1600 cm^{-1}	1639 cm^{-1}
6	C-O-C & C-O Stretching	1150-1000 cm^{-1}	1097 cm^{-1}

FTIR Spectrum of Cefuroxime Axetil Tablet (With Excipients)

To find out if there were any interactions between the medication and the excipients, the FTIR spectra of the Cefuroxime Axetil tablet and the pure locust bean gum were analysed. The FTIR findings of the Cefuroxime Axetil tablet are shown in Figure 3 and Table 7.

O-H stretching shows a big peak at 3282 cm^{-1}, indicating that hydroxyl groups are likely present, possibly from the medicine and other ingredients. The C-H stretching characteristic of aliphatic chains is confirmed by a signal at 2850 cm^{-1}. The stretching of the C=O bond in the ester part (axetil group) shows a clear peak at 1747 cm^{-1}, while the C=O bond in the β-lactam amide ring is indicated by another peak at 1718 cm^{-1}. The N–H bending, visible at 1639 cm, supports the presence of amide functional

groups. At 1097 cm^{-1}, C–O–C and C–O stretching vibrations are seen, indicating ether or ester-like connections. The drug's C=O stretching peaks, which are 1747 cm^{-1} and 1718 cm^{-1}, are unaltered. The O-H stretching peak of the formulation (3282 cm^{-1}) is quite similar to the gum's peak (3421 cm^{-1}), which means that the medication and locust bean gum do not create a hydrogen bond or complex. The C–O stretching zones for the gum (1057 cm^{-1}) and the medication (1097 cm^{-1}) remain distinct from each other.

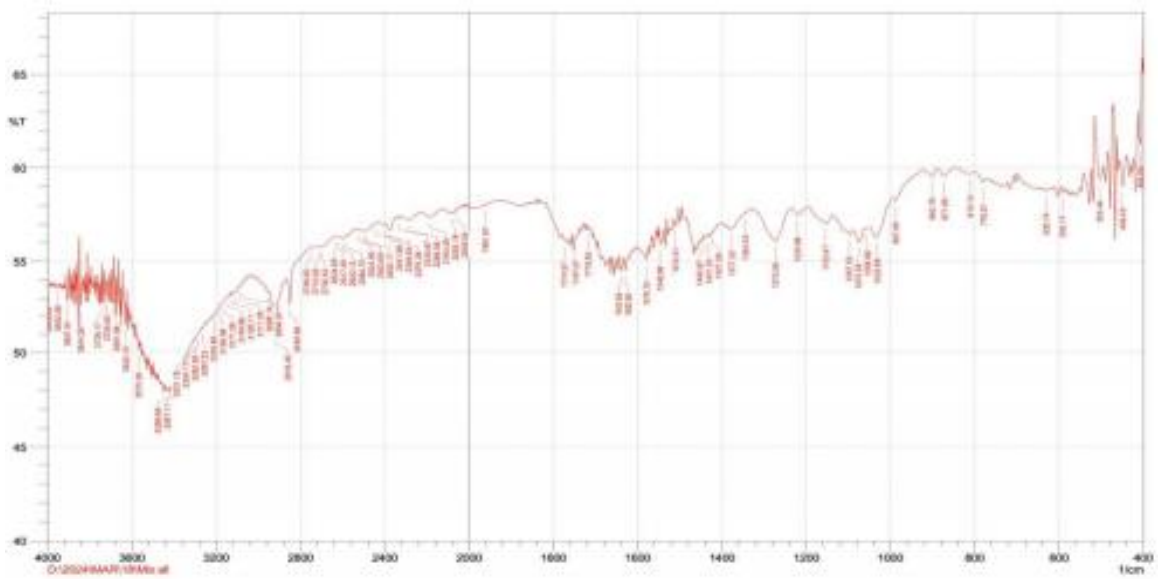

Figure 3. FTIR Spectrum of Cefuroxime Axetil Tablet

In contrast to its pure spectrum, the tablet formulation's FTIR spectrum displayed all of Cefuroxime Axetil's distinctive peaks without any notable change or removal of the main peaks. Similarly, locust bean gum's distinctive peaks were seen in their respective areas of the excipient spectrum but did not overlap, drastically change, or vanish in the spectrum of the tablet formulation. Additionally, a spectral comparison between the formulation of Cefuroxime Axetil tablets and locust bean gum shows that there were no notable interactions between the medicine and the excipient. The chemical compatibility of Cefuroxime Axetil with Locust Bean Gum in the formulation is confirmed by the retention of distinctive peaks without significant shifts or the appearance of new peaks. This guarantees the drug's integrity and stability during formulation and storage.

***In-Vitro* Dissolution Studies:** The maximum drug release of 99.86 ± 0.0232% in 40 min was obtained from formulation F8. The average drug release immediately after dispersion for all the formulations was in the range of 48.96% to 99.1%.

These findings are shown in Table 8 and Figure 4. Formulation F7 *in-vitro* drug release was 99.1% in 50 min, but F8 has released in 40 min. Hence F8 is considered as optimized formulation, which will be potential in fast release of hydrophobic drugs.

The differences in drug release between the eight formulations (F1–F8) were statistically significant. The type and combination of disintegrants had a big effect on how drugs were released. This was shown by the significant differences ($p < 0.05$) between formulations that were confirmed by a two-way ANOVA on triplicate dissolution data (n=3) at each time point (10–60 min). Formulations with synthetic super disintegrants (F3, F4, F7, F8) released the drug faster than those with natural polymers (F1, F2, F5, F6). F5 (guar gum) released the least amount of drug over time (about 64.5% in 60 minutes), while F8 (locust bean gum + crospovidone + SSG) released the most (about 99.8% in 40 minutes).

Table 8. Cumulative Drug Release of Formulations

Time (min)	Cumulative percentage of drug release (%)							
	F1	***F2***	***F3***	***F4***	***F5***	***F6***	***F7***	***F8***
0	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
10	4.37 ± 0.17	13.47 ± 0.15	9.59 ± 0.12	13.56 ± 0.14	1.27 ± 0.13	22.27 ± 0.12	30.23 ± 0.12	43.14 ± 0.09
20	9.99 ± 0.15	25.67 ± 0.18	17.9 ± 0.15	27.45 ± 0.17	6.75 ± 0.25	39.29 ± 0.17	45.45 ± 02.9	61.93 ± 0.27
30	23.72 ± 0.23	39.31 ± 0.19	30.79 ± 0.17	42.32 ± 0.18	20.38 ± 0.25	55.15 ± 0.019	65.43 ± 0.39	84.25 ± 0.27
40	37.38 ± 0.25	54.31 ± o.19	44.04 ± 0.18	57.62 ± 0.19	34.20 ± 0.26	63.19 ± 0.25	85.29 ± 0.39	99.86 ± 0.023
50	51.34 ± 0.26	69.96 ± 0.20	55.76 ± 0.19	74.82 ± 0.20	48.96 ± 0.27	80.29 ± 0.25	99.10 ± 0.44	
60	67.96 ± 0.27	87.96 ± 0.24	75.64 ± 0.20	91.32 ± 0.27	64.48 ± 0.25	98.25 ± 0.29		

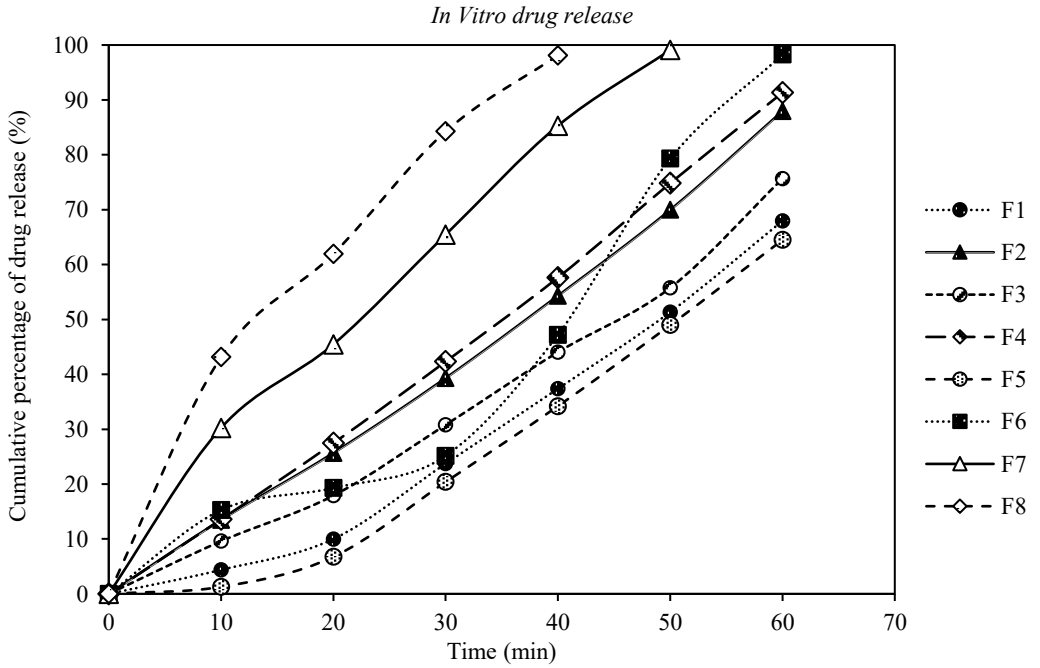

Figure 4. Invitro Release of Different Formulations

$p < 0.05$ for both *Time* and *Formulation* factors. This means the cumulative drug release significantly changes with time. The drug release profiles differ significantly among formulations (F1–F8). Hence, the differences in drug release profiles across formulations F1–F8 are statistically significant ($p < 0.001$).

CONCLUSION

This research shows that natural and synthetic polymer-based disintegrants can be used as functional ingredients in designing fast-dissolving tablet composites. A locust bean gum, sodium starch glycolate (SSG) and cross povidone formulations had better disintegration and release properties than single disintegrant systems and demonstrated the significance of polymer interactions in composite performance. The results have emphasized the contribution of the structural characteristics of natural polysaccharides like locust bean gum to synthetic polymers in bringing about additive effects in the uptake of water, swelling, and disruption of the matrix. On the whole, the findings place the fast-dissolving tablets not only as pharmaceutical dosage forms but as model systems in the study of the functionality of polymer composites, in which the interaction between the natural and synthetic polymers determines mechanical stability and rapid disintegration. The potential of using biodegradable, renewable gums like locust bean gum also highlights the possibilities of using polymeric

excipients that are healthy and environmentally friendly and sustainable in the future in composite-based drug delivery systems.

FINANCIAL ASSISTANCE
Nil

AUTHORS CONTRIBUTIONS
All authors contributed equally.

AVAILABILITY OF SUPPORTING DATA
On reasonable request, the corresponding author will make the datasets used in this study available.

CONFLICT OF INTEREST
Regarding the publishing of this paper, the authors hereby declare that they have no conflicts of interest.

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