History of Medicine Studies
ISSN:1300-669
Volume 20 Issue 1 June 2024

The Development and Assessment of Acrylovir's Mucoadhesive Matrix Tablet

DR M Pradeep Kumar[1],DR C S Parameswari[2],M. Vasavi[3], A Hemanth[4],C. Anusha[5]
Department Of Pharmaceutics

Abstract : The purpose of this research was to formulate cinnarizine into mucoadhesive tablets using compression coating technology and to carry out carboxymethylation on guar gum. We used FTIR, SEM, XRD, and DSC to characterize the produced carboxymethyl guar gum. Guar gum and carboxymethylated guar gum were used to crush coat the inner core tablets of cinnarizine. Hardness, friability, content homogeneity, and thickness were some of the tablet parametric tests used to assess the prepared mucoadhesive tablets. Research on medication release in vitro and ex vivo mucoadhesion strength were also carried out. New FTIR peaks, SEM surface morphology study, XRD crystallinity decrease, and the endothermic peak in the DSC thermogram all indicate that the carboxymethylation of guar gum has been effective. When comparing batches of mucoadhesive tablets made using guar gum to those made with carboxymethyl guar gum, the mucoadhesive strength of the F1CGG to F4CGG batches was shown to be greater. In vitro release of cinnarizine from compression coated mucoadhesive tablets was facilitated by carboxymethyl guar gum, demonstrating a prolonged release effect.
Carboxymethylation enhances the mucoadhesive qualities of pure guar gum, as shown by the research. Additionally, carboxymethylated guar gum's compression coating improves cinnarizine's stomach retention time and prolonged release. A variety of mucoadhesive medication delivery systems may be developed using carboxymethyl guar gum as a mucoadhesive polymer.

Keywords: Carboxymethylation; Guar gum; Compression coating; Mucoadhesive tablets; Cinnarizine.

1. Introduction

There are a number of benefits to using mucoadhesive drug delivery methods. These include a longer amount of time that the medicine stays at the application site, better absorption into the bloodstream, and higher bioavailability. There are three stages to the mucoadhesion phenomenon: the first is the polymer being wet and swelling; the second is the polymer and mucin chains interpenetrationand/or entanglement; and the third is the development of the link that causes the polymer to adhere to the mucosal surface. Potentially targeted ocular, buccal, nasal, vaginal, and rectal routes for drug administration might be achieved via the creation of mucoadhesive drug delivery systems [1,2].
To alleviate motion sickness symptoms as nausea and vomiting, cinnarizine is used as an antihistamine. At a pH of 1 (1.5 mg/ml), it dissolves easily, but at pH values over 4, its solubility drops significantly. Its dissolving behavior is pH dependant. Cinnarizine is a kind of The small intestine's basic pH causes the medication, which is mildly basic, to precipitate. Cinnarizine, when added to a mucoadhesive drug delivery system, prolongs the time the medicine stays in the stomach. This has the potential to increase cinnarizine's bioavailability [3]. In order to create cinnarizine mucoadhesive tablets, Singh and Rana used iron oxide and Eudragit RLPO [4].
The seeds of the Leguminosae plant, Cyamopsis tetragonolobus, are the source of the biopolymer known as guar gum. The major components are polysaccharides with a high molecular weight, where (1→4)β-D mannopyranosyl units are connected with (1→6)α-D galactopyranosyl residues. It is a good

History of Medicine Studies
ISSN:1300-669
Volume 20 Issue 1 June 2024

thickener and stabilizer because of its high hydrogen bond formation capabilities in water. The pharmaceutical, food, paper, oil, cosmetic, and paint industries all make use of it because of its thickening, gelling, emulsifying, binding, and film forming capabilities [5,6]. In order to create metronidazole matrix tablets, it was necessary to carboxymethylate guar gum, which was accomplished effectively [7,8].
Coating the inner core with the outer layer by compressing it is called compression coating, and it is a solvent-free coating process. It is possible to vary mechanical strength, change medication release pattern, and improve drug stability by using materials in the outer layer. Using compression coating with traditional polymeric materials, both mucoadhesive and gastro-floating tablets have been created before [9, 10].
To characterize the changed gum, this study used FTIR, SEM, XRD, and DSC methods after carboxymethylating guar gum. Pure guar gum and carboxymethylated guar gum were used to compress the cinnarizine core pills. Several tablet parametric tests were used to assess the prepared compression coated tablets. The researchers also conducted in vitro drug release investigations and ex vivo mucoadhesion experiments.

2. Materials and Methods

2.1. Materials.

Ind-Swift Pharmaceutical, India, generously provided Cinnarizine as a gift. Hydrocolloid Plantations of New Delhi, India, generously sent a sample of guar gum. The following ingredients were purchased from Loba Chemie in Mumbai, India: sodium hydroxide, monochloro-acetic acid, methanol, glacial acetic acid, PVP K30, talc, and magnesium stearate (MCC, Avicel-112). This investigation only made use of analytical-grade chemicals and reagents.

2.2. Carboxymethylation of guar gum.

An adaptation of the procedure outlined by Gong et al. [11] was used to carry out the carboxymethylation reaction on guar gum. The procedure included dissolving 10 grams of purified gum in 500 milliliters of distilled water, then adding sodium hydroxide dropwise while stirring continuously for 30 minutes. The aforementioned concoction was gradually treated with monochloroacetic acid. After being agitated for four hours, the reaction mixture was heated to fifty degrees Celsius. In order to precipitate the carboxymethylated gum, 85% methanol was added to the mixture. We rinsed, dried, and put the modified gum in the desiccator. This is the reaction that produces carboxymethyl guar gum, as shown in Figure 1.

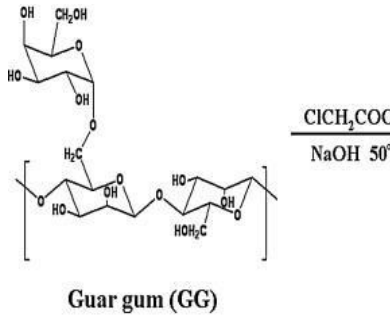

Figure 1. Synthesis reaction for the modification of guar gum into carboxymethylated guar gum.

2.3. Characterization of carboxymethyl guar gum

The carboxymethyl guar gum was characterized by FTIR spectroscopy, SEM, XRD, and DSC techniques.

2.3.1. Fourier transform infrared spectroscopy.

Attenuated total reflectance (ATR)-FTIR spectrophotometers (Alpha, Bruker, Japan) were used to acquire the Fourier transform infrared (FTIR) spectra of the samples. Scan patterns were performed in the spectral range of 4000 cm-1 to 400 cm-1 on both the pure gum and carboxymethylated gum samples.

2.3.2. Scanning electron microscopy.

Scanning electron microscopy (SEM) photomicrographs weretaken for studying surface morphology of pure gum and carboxymethylated gum by scanning electron microscope (Hitachi S 4300 SE/N) equipped with a secondary electron at an accelerating voltage of 10 kV. Samples were mounted

directly ontothe SEM sample stub using double-sided sticking carbon tape under reduced pressure (0.001 mm Hg).

2.3.3. X-ray diffraction analysis.

Samples of pure gum and carboxymethylated gum were mounted in the sample cell and scanned between 2 θ of 0-60º with a counting time of 0.1 seconds step size. X-ray patterns of the films were obtained with XPERT-PRO equipment (PANalytical, Netherland).

2.3.4. Differential scanning calorimetry.

Samples of pure gum and carboxymethylated gum were sealed hermetically in flat bottom aluminum cells and were subjected todifferential scanning calorimetry (DSC) analysis (MettlerToledo Star System, 305, Switzerland) at a heating rate of10 ºC/min under nitrogen atmosphere.

2.4. Preparation of core tablets of cinnarizine.

Core tablets were prepared as per the formula given inTable 1. All the ingredients were passed through 60# sieve,followed by mixing for 15 minutes by tumbling. Tablets with atheoretical weight of 80 mg were obtained using multipunchtableting machine (A K Industries, Nakodar, India) fitted with6-mm concave round die-punch tooling [12].

Table 1. Composition of core tablet of cinnarizine.

Constituents	Quantity (mg)
Cinnarizine	15
Avicel-112	58
PVP K-30	5
Talc	1
Magnesium Stearate	1
Total weight	80

2.5. Compression coating of core tablets.

The formulated core tablets were press coated with anappropriate blend of coating polymer as shown in Table 2. Avicel-112 was added quantity sufficient for making the total tablet weight equal to 600 mg. Half the quantityof the coating polymer was filled into the die cavity (8.5 mmdiameter). The core tablet was placed in the centre of the diecavity, which was then filled with the remainder of the coatingmaterial. Then, it was compressed around the core tablets at an applied force of 5000 kg using 8.5 mm concave punchesfitted to multipunch tableting machine [13].

History of Medicine Studies
ISSN:1300-669
Volume 20 Issue 1 June 2024

Table 2. Compression coating composition for mucoadhesive tablet batches of pure guar gum and carboxymethylated guar gum

Batches	Guar Gum (mg)	Carboxymethylated Guar Gum (mg)	PVP K30 (mg)	Talc (mg)
F1GG	350	-	20	5
F2GG	400	-	20	5
F3GG	450	-	20	5
F4GG	500	-	20	5
F1CGG	-	350	20	5
F2CGG	-	400	20	5
F3CGG	-	450	20	5
F4CGG	-	500	20	5

2.6. Evaluation of core and compression coated tablets.

To ensure the uniformity and mechanical integrity of the prepared tablets, the following parameters like weight variation, hardness, friability, and drug content were measured using the parameters calculated as per standard parameters.

2.6.1. Hardness and friability.

Hardness and friability were determined using the validated Monsanto hardness tester and the Roche friabilator (Campbell Electronics, Mumbai, India), respectively.

2.6.2. Thickness.

The thickness of the tablets was determined using Digital Vernier Caliper (Mitutoyo Absolute Digimatic Caliper, Japan). Five tablets from each formulation were used and the average values were calculated.

2.6.3. Drug content.

Five tablets were weighed individually and powdered. The powder equivalent to the average weight of tablets was weighed and drug was extracted in 0.1N HCL, the drug content was determined to measure the absorbance at 254 nm after suitable dilution using UV- Vis double beam spectrophotometer (AU 2701, Systronics, Mumbai, India).

2.6.4. *Ex vivo* determination of mucoadhesive strength.

Mucoadhesion testing of the prepared compression coated tablets was performed using texture analyzer (TA.XT plus, Stable MicroSystems, UK). Sample tablet was fixed to the cylindrical probe with the help of double side adhesive tape. The pig stomach tissue (about 20x20 mm) was equilibrated for 15 min at 37.0 ± 0.5 ºC before placing onto the holder stage. The probe with the sample tablet attached was immersed in the test medium for a specified time prior to the test, the hydrated disc was then moved downward to contact with soaked tissue at a specified force and maintained until a specified time. The probe was withdrawn at a specified test speed and the maximum detachment force (Fmax) required to separate the sample tablet fitted probe from the tissue could be obtained directly from Texture Exponent32 software. The preliminary settings of the instrument were: test speed 0.5 mm/s, contact force

1.0 N, contact time 60 s and return distance 15 mm. The probe without a sample tablet was also tested to check the uniformity of the animal tissue [14].

2.6.5. *Invitro* drug release.

The *in vitro* dissolution study on compression coated mucoadhesive tablets of cinnarizine was carried out in a paddle-type six station dissolution apparatus (DS 8000, LabIndia, India) with a stirring speed of 50 rpm at 37 ± 0.5C using 900 ml of 0.1 N HCl (pH 1.2) as dissolution medium. At predetermined time intervals, 5 ml samples were withdrawn, filtered through a 0.45 µm membrane filter, diluted and analyzed at 254 nm using a UV/VIS double beam spectrophotometer (2202, Systronics, India).Cumulative percentage of drug release was calculated using an equation obtained from the calibration curve. The dissolution profile data of all formulated batches of tablets were fitted to various models such as zero-order (cumulative % drug release vs time), first-order (log cumulative % drug remaining vs time), Higuchi [15] (cumulative % drug release vs square root of time), Korsmeyer et al. [16] (log cumulative % drug release vs log time) and Hixon and Crowell [17] (cube root of cumulative % drug remaining vs time) models to ascertain the kinetic modeling of drug release.

3. Results and Discussion

3.1. Characterization techniques.

For characterizing the synthesized carboxymethylated guar gum, various techniques were employed and are discussed here under.

3.1.1. FTIR

The FTIR spectra of native guar gum and carboxymethylated guar gum are shown in Figure 2 and Figure 3. In the FTIR spectra of guar gum, broad band at 3444.89 cm^{-1} is attributed to O−H stretching vibration. A symmetrical stretching vibration due to -CH_2- group was observed at 2925.24 cm^{-1}. Band at 1639.18 cm^{-1} was assigned to O−H bonds of absorbed water molecules and the bands between 800-1000 cm^{-1} were due to skeletal stretching vibrations of guar gum.

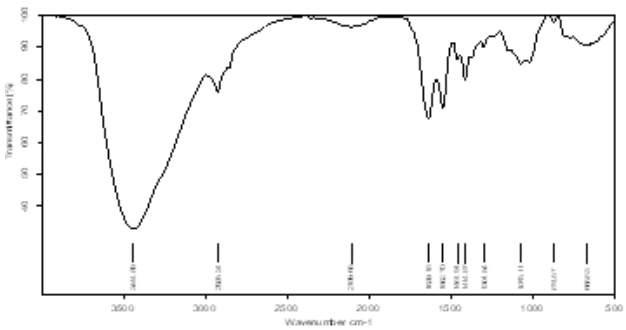

Figure 2. FTIR spectra of pure guar gum.

The carboxymethylated guar gum shows broad band of around 3438.52 cm^{-1} is attributed to O-H stretching vibration. The reduced intensity of absorption band at 3438.52 cm^{-1} indicates the carboxymethylation of O-H groups of guar gum. Increased intensity and

History of Medicine Studies
ISSN:1300-669
Volume 20 Issue 1 June 2024

sharpness peaks at 1078.81 cm^{-1} (C−O symmetrical and asymmetrical vibrations) and 1374.30 cm^{-1} (COO− symmetric stretching vibrations) indicate that the hydroxyl groups of guar gum molecules were carboxymethylated.

3.1.2. SEM

Scanning electron microscopy was performed for investigating the surface morphology of the pure guar gum and carboxymethylated guar gum (Figure 4,5). Pure gum exhibited irregular but smooth surface with round edges. However, carboxymethylated gum depicts surface roughness with relatively irregular edges. The carboxymethylation process could be accounted for these structural changes.

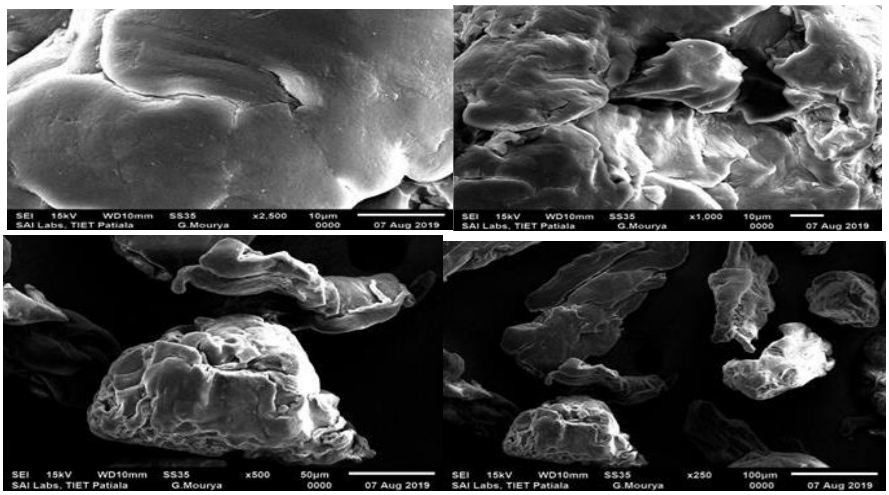

Figure 4. SEM micrographs of pure guar gum at different magnifications.

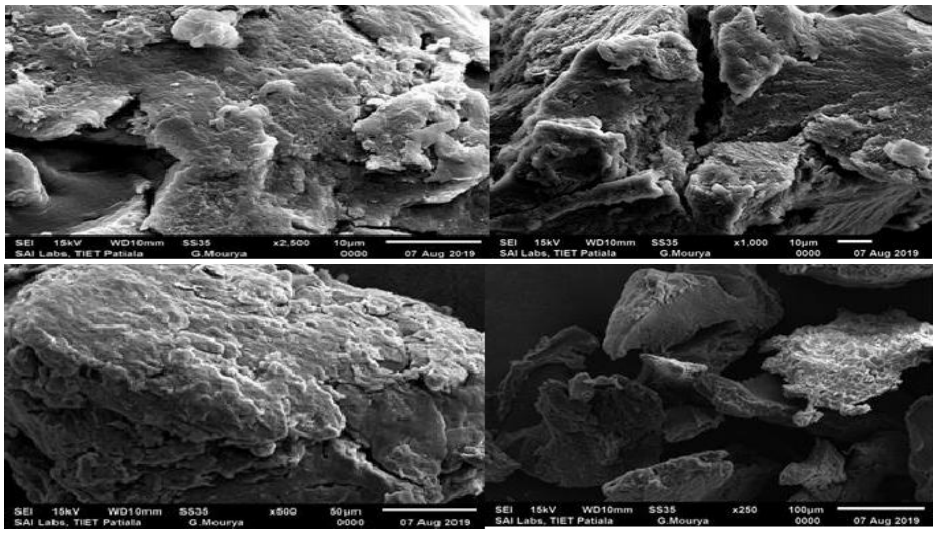

Figure 5. SEM micrographs of carboxymethylated guar gum at different magnifications.

3.1.3. XRD.

The X-ray diffractogram of pure guar gum and carboxymethylated guar gum is shown in Figure 6 and Figure 7 Details of the different peaks as shown in the table. The pure guar gum exhibited low crystalline behavior similar to other galactomannan reported in the

History of Medicine Studies
ISSN:1300-669
Volume 20 Issue 1 June 2024

literature. After carboxymethylation of the guar gum reduction in the crystalline behavior was reported (Table 3 and 4). This could be due to the replacement of the hydroxyl group of the guar gum by the carboxymethyl group [11].

Table 3. X-ray diffractogram of Pure Guar gum.

Pos. [°2Th.]	d-spacing [Å]	Rel. Int. [%]	Area [cts*°2Th.]
3.62	24.37	2.38	22.71
17.64	5.02	56.77	1433.95
20.38	4.35	100.00	3021.91
26.53	3.35	1.31	0.00

Table 4. X-ray diffractogram of Carboxymethylated Guar gum.

Pos. [°2Th.]	d-spacing [Å]	Rel. Int. [%]	Area [cts*°2Th.]
3.64	24.23	0.01	0.00
20.15	4.40	85.66	246.71
20.47	4.33	100.00	4102.38
26.71	3.33	0.77	107.81

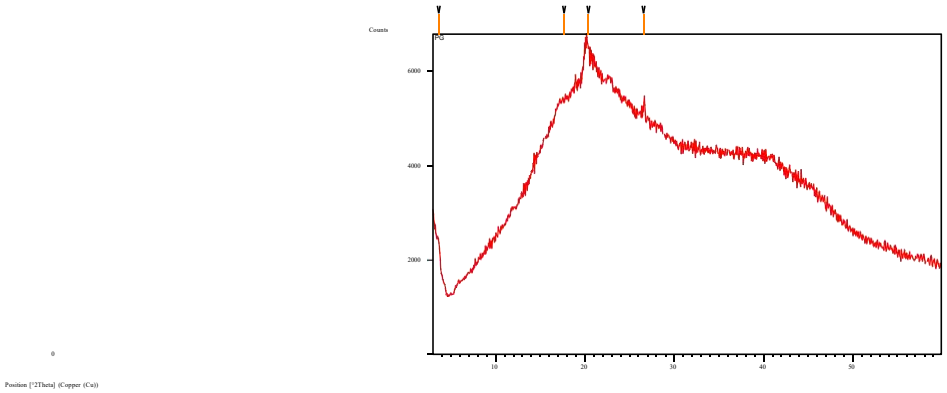

Figure 6. X-ray diffractogram of pure guar gum.

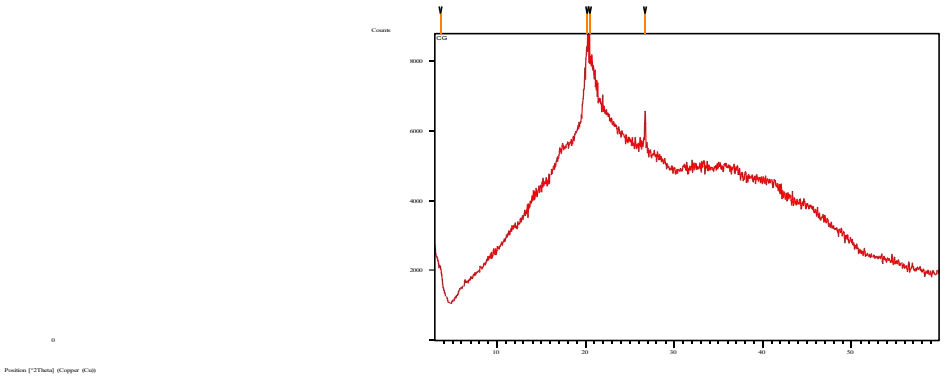

Figure 7. X-ray diffractogram of carboxymethylated guar gum.

3.1.4. DSC.

Differential scanning calorimetry (DSC) thermograms of pure guar gum and carboxymethylated guar gum are shown in Figure 8 and 9 respectively. Pure guar gum shows endothermic peak at 68.96 ºC with -29.76 mJ enthalpy. However, carboxymethylated guar gum

History of Medicine Studies
ISSN:1300-669
Volume 20 Issue 1 June 2024

shows endothermic peaks at 62.96 ºC and 267.09 ºC with -12.25 mJ and 0.020 mJ enthalpies respectively. The endothermic peak at 267.09 ºC in the modified gum could be attributed to the thermal degradation of chemical compounds inserted on the gum structure after carboxymethylation.

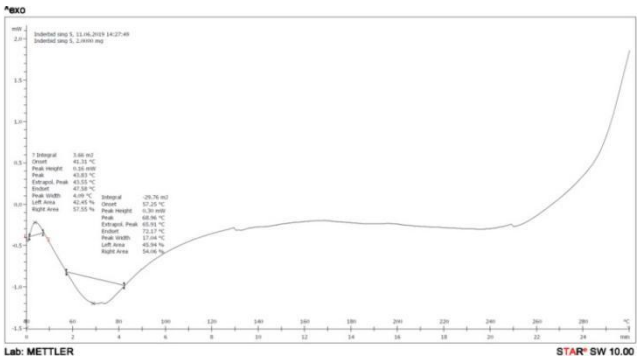

Figure 8. DSC thermogram of purified Guar gum.

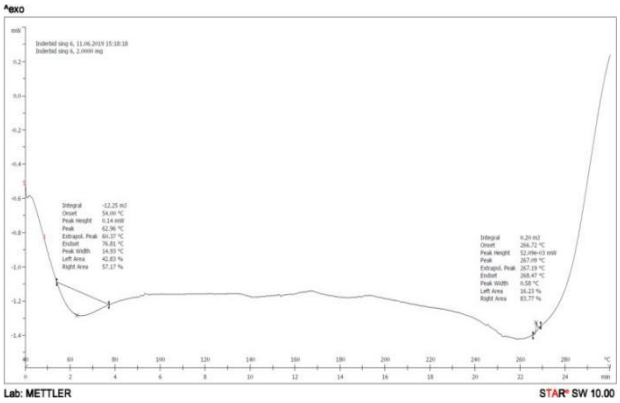

Figure 9. DSC thermogram of carboxymethylated guar gum.

3.2. Evaluation of core tablets.

The results of various evaluation parameters for core tablets are depicted in Table 5. The weight of the inner core tablets of cinnarizine was 80±5 mg. Hardness and friability of tablets were3.0±0.50 kg/cm^2 and 0.80±0.17 % respectively. The thickness of the core tablets was 1.75 ±0.10 mm.

Table 5. Evaluation parameters of inner core tablets

S.No.	Parameters	Results
1	Weight Variation	80±5 mg
2	Hardness	3.0±0.50 kg/cm^2
3	Friability	0.80±0.17 %
4	Thickness	1.75±0.10 mm

3.3. Evaluation of compression coated tablets.

The results of compression coated tablets prepared using pure gum and carboxymethylated gum in different proportions for coating the previously prepared inner core tablets of cinnarizine are depicted in Table 6. The mucoadhesive detachment force of F1GG to F4GG was found to be ranging between 4.32±0.89 and 8.99±0.75 g. For F1CGG to F4CGG

History of Medicine Studies
ISSN:1300-669
Volume 20 Issue 1 June 2024

the value of F_{max} was found to be 10.86±1.23 and 18.53±2.08 g. A significant increase in mucoadhesive property of carboxymethyl guar gum was noticed when compared with pure guar gum. Moreover, mucoadhesive strength was found to increase with increasing in concentration of carboxymethyl guar gum as a coating material in the compression coated mucoadhesive tablets of cinnarizine.

Table 6. Evaluation Parameters of Pure Guar gum and carboxymethylated guar gum used compressed coated tablet.

Batch No.	Zero order		First Order		Higuchi		Korsmeyer-Peppas			Hixon-Crowell	
	r^2	K_0	r^2	K_1	r^2	K_H	r^2	n	K_{KP}	r^2	K_{HC}
F1GG	0.6716	25.5517	0.9221	-0.8088	0.9738	9.197	0.9684	0.443	6.4395	0.8485	0.1742
F2GG	0.6700	18.5263	0.9572	-0.6396	0.9661	9.2616	0.9941	0.476	6.2728	0.8828	0.1331
F3GG	0.6679	12.4491	0.9682	-0.5173	0.9535	9.3337	0.9994	0.4438	6.0458	0.9138	0.0988
F4GG	0.7278	9.4375	0.9814	-0.3504	0.9315	9.4787	0.9922	0.493	5.6119	0.928	0.0711
F1CGG	0.5038	6.5153	0.8480	-0.3941	0.9552	9.8677	0.9300	0.588	6.267	0.7561	0.0644
F2CGG	0.6627	7.1735	0.9601	-0.3151	0.9356	9.7096	0.9855	0.460	5.7304	0.8967	0.0596
F3CGG	0.7316	7.2908	0.9730	-0.2776	0.9266	9.5731	0.9977	0.515	5.4627	0.9346	0.0557
F4CGG	0.8290	7.7194	0.9233	-0.2629	0.9113	9.6104	0.9926	0.534	4.9473	0.9469	0.0547

3.4. In vitro drug release.

In vitro drug release profiles of core tablet and different batches of compression coated mucoadhesive tablets prepared with guar gum (F1GG to F4GG) and carboxymethyl guar gum (F1CGG to F4CGG) are shown in Figure 10 and 11. Carboxymethylated guar gum depicts sustained release behaviour in the compression coated tablets of cinnarizine.

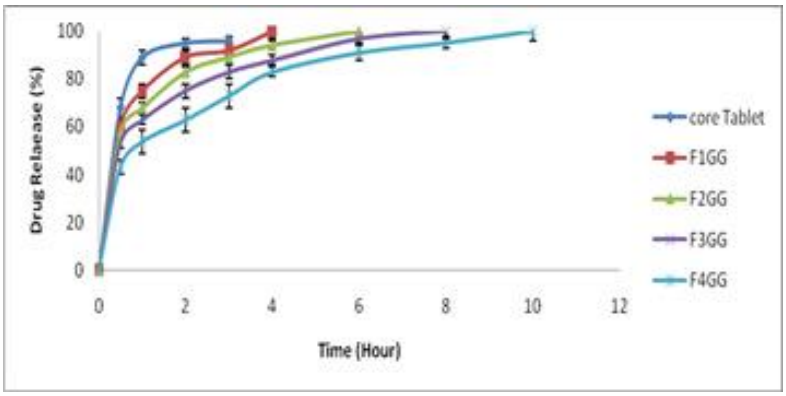

Figure 10. *In vitro* drug release from core tablet and different batches of compression coated tablets of guar gum.

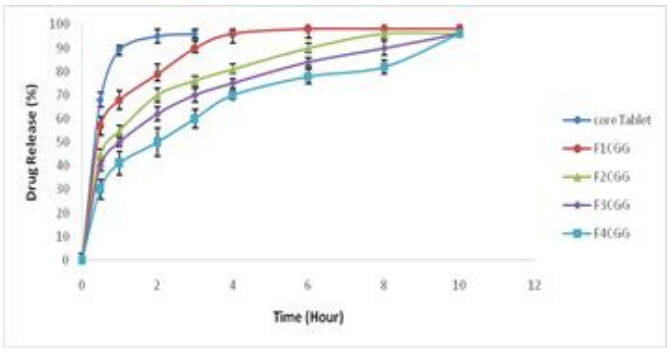

Figure 11. *In vitro* drug release from core tablet and different batches of compression coated tablets of carboxymethylated guar gum.

History of Medicine Studies
ISSN:1300-669
Volume 20 Issue 1 June 2024

Table 7. *In vitro* drug release (kinetic modeling) data of the formulated batches.

Batch No.	Zero order		First Order		Higuchi		Korsmeyer-Peppas			Hixon-Crowell	
	r^2	K_0	r^2	K_1	r^2	K_H	r^2	n	K_{KP}	r^2	K_{HC}
F1GG	0.6716	25.5517	0.9221	-0.8088	0.9738	9.197	0.9684	0.443	6.4395	0.8485	0.1742
F2GG	0.6700	18.5263	0.9572	-0.6396	0.9661	9.2616	0.9941	0.476	6.2728	0.8828	0.1331
F3GG	0.6679	12.4491	0.9682	-0.5173	0.9535	9.3337	0.9994	0.4438	6.0458	0.9138	0.0988
F4GG	0.7278	9.4375	0.9814	-0.3504	0.9315	9.4787	0.9922	0.493	5.6119	0.928	0.0711
F1CGG	0.5038	6.5153	0.8480	-0.3941	0.9552	9.8677	0.9300	0.588	6.267	0.7561	0.0644
F2CGG	0.6627	7.1735	0.9601	-0.3151	0.9356	9.7096	0.9855	0.460	5.7304	0.8967	0.0596
F3CGG	0.7316	7.2908	0.9730	-0.2776	0.9266	9.5731	0.9977	0.515	5.4627	0.9346	0.0557
F4CGG	0.8290	7.7194	0.9233	-0.2629	0.9113	9.6104	0.9926	0.534	4.9473	0.9469	0.0547

k_0: Zeroorder release rate constant, k_1: Firstorder release rate constant, K_H: Higuchi release rate constant, K_{KP}: Korsemeyer–Peppas release rate constant, K_{HC}: Hixson–Crowell release rate constant, r^2: Regression line value

The *in vitro* release data was fitted to different kinetic models such as zero-order, first-order, Higuchi, Korsmeyer-Peppas and Hixon-Crowell as shown in Table 7. The value of n (release exponent) $0.45 < n < 0.89$ indicates non-Fickian drug release transport. Drug release from the biopolymer coated tablets follows diffusion and erosion of the polymer (anomalous non-Fickian drug release behavior). When the formulation is in contact with the dissolution media, the media penetrates the polymer matrix leading to disentanglement and subsequent dissolution/erosion of polymer chains resulting in the release of the drug molecules from the dosage form. According to another theory, the glass-rubbery transition of the polymer matrix leads to an increase in the mobility of polymeric chains allowing the drug molecules to dissolve and diffuse through the gel layer [18,19].

4. Conclusions

Guar gum was carboxymethylated using an effective and easy chemical process. The modified gum was characterized using FTIR, DSC, XRD, and SEM methods. To create sustained release mucoadhesive pills, the core cinnarizine tablets were coated using the compression coating process. Coating the core tablets using compression is an efficient method that does not include solvents. Modifying biopolymers using carboxymethylation is an easy and cheap process. The ophthalmic, lung, buccal, rectal, vaginal, and gastrointestinal tracts may be targeted using various mucoadhesive drug delivery methods that use carboxymethylated biopolymers. Commercial use of carboxymethylated biopolymers requires proper handling of regulatory and toxicological concerns.

References

Mucoadhesive polymeric platforms for regulated drug delivery were developed by Andrews, G.P., Laverty, and Jones, D.S. Article cited as 2009, 71, 505-518 in the European Journal of Pharmaceutics and Biopharmaceutics (https://doi.org/10.1016/j.ejpb.2008.09.028).

Singh and Rana (2017) conducted a comprehensive evaluation on improving the mucoadhesive properties of polymers for use in medication administration. The article is published in Reviews on Adhesion and Adhesives 2013, volume 1, pages 271–290, and the DOI for the article is 10.7569/RAA.2013.097307.

Using polyacrylamide-g-corn fiber gum, Sethi, Mangla, Kamboj, and Rana (2003) developed a QbD method for making rapid and prolong buoyant cinnarizine tablets. Article 117, pages 350–361, published in 2018 in the International Journal of Biological Macromolecules; DOI: 10.1016/j.ijbiomac.2018.05.178.

The authors of the article are Singh and Rana. Eudragit RLPO's mucoadhesive capability is enhanced by iron oxide: a mucoadhesive drug delivery system is developed, tested, and optimized. Article published in 2013 by Expert Opinion on Drug Delivery, volume 10, pages 1179–1191, with the DOI: 10.1517/17425247.2013.790361.

Paul A. Shah and Parasuraman S. Shrivastav were the authors of the fifth article. The natural polymer guar gum has several uses, one of which is in the delivery of drugs.
Article published in the 2019 issue of the European Polymer Journal, volume 112, pages 722–735, with the DOI number 10.1016/j.eurpolymj.2018.10.042.
In their study titled "Guar gum and its composites as potential materials for diverse applications," the authors Sharma et al. (2016) examined the versatility of guar gum and its derivatives. Article published in Carbohydrate Polymers in 2018, volume 199, pages 534-545, with the DOI: 10.1016/j.carbpol.2018.07.053.
The synthesis and characterisation of guar gum using carboxymethylation was published by Dodi, Hritcu, and Popa in 2007. Vol. 45, Issue 1, Pages 171–176, Cellulose Chemistry and Technology, 2011.
Section 8. Singh, R.; Maity, S.; Sa, B. Modulation of metronidazole release from a partly carboxymethylated guar gum tablet by ionic crosslinking. "Carbohydrate Polymers" (2014, 106, 414–421), https://doi.org/10.1016/j.carbpol.2014.01.033.
Sa, Biswanath; Mukherjee, S.; Roy, S.K. 9. The viscosity of a polysaccharide coating on compression-coated tablets is affected by effects of polymer concentration and solution pH. The full text of the article may be found at this link: International Journal of Biological Macromolecules 2019, 125, 922-930, https://doi.org/10.1016/j.ijbiomac.2018.12.101.
Gong, L., Yu, M., Gao, Y., Zou, M., and Cheng, G. wrote the paper. Create and test a zero-order controlled-release alfuzosin hydrochloride compression-coated gastro-floating tablet. 29(2018), 3277–3286, AAPS PharmSciTech. The link to the article is https://doi.org/10.1208/s12249-018-1168-z.
11.Gong, H.; Liu, M.; Chen, J.; Han, F.; Gao, C.; and Zhang, B. 12-Raza, A.; Shen, N.; Li, J.; Chen, Y.; Wang, J.Y. Formulation of zein-based compression coated floating tablets for enhanced gastric retention and tunable drug release. Carbohydrate Polymers 2012, 88, 1015-1022, https://doi.org/10.1016/j.carbpol.2012.01.057.
1.
Published in 2019, volume 132, pages 163–173, with the DOI: 10.1016/j.ejps.2019.01.025.
Karak, D.; Singh, I. 13. The development and testing of esomeprazole press coated tablets for intracolonial administration.
Pages 252-258 of the 2012 edition of the Asian Journal of Pharmaceutics.
Karadhari, K.; Koradia, H. Ex vivo and in vitro assessment of mirtazapine's unidirectional buccal tablet formulation. Higuchi, T. Mechanism of sustained-action medicine. Journal of Drug Delivery Science and Technology 2018, 43, 233-242, https://doi.org/10.1016/j.jddst.2017.10.012. Page 15. Hypothetical investigation of the release rate of solid pharmaceuticals distributed in solid matrix. Publication date: 1963, volume 52, pages 1145–1149. DOI: 10.1002/jps.2600521210.
This sentence is a citation for a paper by 16. Korsmeyer et al. Exploring the process of solute release from hydrophilic polymers with pores. Article published in the 1983 issue of the International Journal of Pharmaceutics, pages 25–35, with the DOI number 10.1016/0378-5173(83)90064-9. 7. Reaction velocity as a function of surface area and agitation (I) theoretical considerations by Hixson and Crowell. The citation for this article is "Ind Eng Chem 1931, 23, 923-931" with the DOI number 10.1021/ie50260a018.

Hydrophilic matrix-tablets: statistical moments in swelling, erosion, and drug release modeling (Barmpalexis, Kachrimanis, & Malamataris, 2018). Publication date: 2018-01-05, volume 540, pages 1-10, online access: https://doi.org/10.1016/j.ijpharm.2018.01.052.
Hattori, Y., Takaku, T., and Otsuka, M. (1986). I used X-ray computed tomography to study the mechanochemical effects on swelling and medication release of tablets made of a natural polymer matrix. Publication date: 2018-01-20, volume 539, pages 31–38, online citation: https://doi.org/10.1016/j.ijpharm.2018.01.020.