



Research Article

IN VITRO STUDY OF MUCOADHESIVE STRENGTH OF POLYMERS FOR MUCOADHESIVE DRUG DELIVERY SYSTEMS

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ABSTRACT

The aim of the present study was to determine the comparative mucoadhesive strength of some polymers by simple in vitro method. Various polymers were selected in the current study. Tablets of these different polymers were prepared by direct compression method. The mucoadhesive strength of these polymers was measured as the force of detachment against the fundus tissue of sheep by using modified balance. The study reveals that mucoadhesive strength of different polymers was found in following order: Gelatine < Gum dammar< Gum copal< Ethyl cellulose< Sodium alginate< Xanthun gum < Chitosan < Hydroxy propyl methyl cellulose < Carbopol. Gelatine (1.42) and Carbopol 934 p (2.40) showed the lowest and highest mucoadhesive strength respectively.

Keywords: Mucoadhesive strength, detachment force, force of adhesion, fundus tissue, polymers.

INTRODUCTION

The term “Mucoadhesion” describes materials that bind to biological substrates, such as mucosal members. Adhesion of bioadhesive drug delivery devices to the mucosal tissue offers the possibility of creating an intimate and prolonged contact at the site of administration. This prolonged residence time can result in enhanced absorption and in combination with a controlled release of drug also improved patient compliance by reducing the frequency of administration. Carrier technology offers an intelligent approach for drug delivery by coupling the drug to a carrier particle such as microspheres, nanospheres, liposomes, nanoparticles, etc., which modulates the release and absorption of the drug. .Microspheres constitutes an important part of these particular drug delivery systems by virtue of their small size and efficient carrier capacity. However, the success of these microspheres is limited due to their short residence time at site of absorption. It would, therefore, be advantageous to have means for providing an intimate contact of the drug delivery system with the absorbing membranes. This can be achieved by

coupling bioadhesion characteristics to microspheres and developing bioadhesive microspheres.¹⁻³

Mucoadhesion is the relatively new and emerging concept in drug delivery. Mucoadhesion keeps the delivery system adhering to the mucus membrane. Transmucosal drug delivery systems show various merits over conventional drug delivery systems. Mucoadhesive polymers facilitate the mucoadhesion by their specific properties. The development of NDDS has been made possible by the various compatible polymers to modify the release pattern of drug. In the recent years the interest is growing to develop a drug delivery system with the use of a mucoadhesive polymer that will attach to related tissue or to the surface coating of the tissue for targeting various absorptive mucosa such as ocular, nasal, pulmonary, buccal, gastric, vaginal etc. This system of drug delivery is called as Mucoadhesive Drug Delivery System.

Transmucosal delivery of therapeutic agents is a popular method because membranes are relatively permeable, allowing for the rapid uptake of a drug into the systemic circulation and

avoiding the first pass metabolism. The efficient uptake offers several benefits over other methods of delivery and allows drugs to circumvent some of the body's natural defense mechanism. The main idea of mucoadhesive was derived from the need to localize drugs at a certain site in the body. Often the extent of drug absorption is limited by the residence time of the drug at the absorption site. For eg.in ocular drug delivery system, less than 2 min. are available for drug absorption after instillation of a drug solution into the eye, since it is removed rapidly by the solution drainage and hence the ability to extend the contact time of an ocular delivery system in front of the eye would undoubtedly improve the bioavailability. In oral drug delivery, the drug absorption is limited by the GI transit time of the dosage form. Since many drugs are absorbed only from the upper small intestine, localizing oral drug delivery system in the stomach or in the duodenum would significantly improve the drug absorption. To overcome the relatively short GI retention time and improve localization for oral controlled drug delivery system, bioadhesive polymers which adhere to the mucin or the epithelial surface are effective and lead to significant improvement in oral drug delivery. Improvements are also expected for

Evaluation of the mucoadhesive tablets

The prepared tablets of all polymers were evaluated for the official parameters including Hardness, friability, thickness and weight variation.⁵

Measurement of mucoadhesive strength and force of adhesion⁶⁻¹⁰

The mucoadhesive forces of the tablets were determined by means of mucoadhesive measuring device shown

other mucus covered sites of drug administration and this is only possible due to mucoadhesive polymers.

MATERIAL AND METHODS

Ethyl cellulose and Hydroxy Propyl Methyl Cellulose (E15LV), Gelatine Xanthan gum, Carbopol, were procured from Thomas Baker, Mumbai and Loba Chemie Pvt. Ltd. respectively. Chitosan was obtained a gift sample from CIFT, Cochine., Gum dammar & Gum copal were kind gift from Genuine chemical co. Mumbai. Lactose & Magnesium Stearate were procured from Research lab Pune. For determination of mucoadhesive strength fundus tissue of sheep was obtained from local butcher shop.

Preparation of Mucoadhesive tablets⁴

Mucoadhesive tablets of different polymers were prepared by direct compression method. In all cases the amount of a polymer is 100 mg except a blank tablet containing 225 mg of directly compressible Lactose (Batch F 1). All the ingredients of the tablet were blended to obtain uniform mixing. The tablets were prepared by using Lab Press tablet machine (M/S Cips Machinery, Ahmedabad, India) with 8 mm flat surface punches. Compositions of all tablets are shown in table 1.

in Figure 1. The pieces of fundus tissues of sheep were stored frozen in saline solution and thawed to room temperature before use. At time of testing a section of tissue (C) was secured keeping the mucosal side out, on the upper glass vial (B) using a rubber band and aluminum cap. The diameter of each exposed mucosal membrane was 1 cm. The vial with the fundus tissue (C) was stored at 37°C for 10 min. Then one vial with section of tissue (C) was connected to the balance (A) and another vial was fixed on height

adjustable pan (E). To a lower vial a tablet of polymer (D) was

TABLE 1: Composition of the mucoadhesive tablets

Batch code	Ingredients (Mg)		Lactose (Dc)*	Magnesium stearate	Total (mg)
F1	-- --	--	226	4	230
F2	Ethyl cellulose	100	126	4	230
F3	Hydroxy Propyl Methyl cellulose	100	126	4	230
F4	Chitosan	100	126	4	230
F5	Gum damar	100	126	4	230
F6	Gum copal	100	126	4	230
F7	Xanthan gum	100	126	4	230
F8	Gelatine	100	126	4	230
F9	Carbopol 934p	100	126	4	230
F10	Sodium alginates	100	126	4	230

*Directly compressible

TABLE 2: Physical parameters of the mucoadhesive tablets

Batch code	Hardness (kg/cm ²)	Friability (%)	Thickness (mm) (mean ± sd)	Weight variation (mg) (mean ± sd)
F1	6 -7	0.52	5.52 ± 0.86	230 ± 0.46
F2	6 -7	0.46	5.26 ± 0.65	230 ± 0.23
F3	6 -7	0.53	5.66 ± 0.23	230 ± 0.54
F4	6 -7	0.25	5.30 ± 0.59	230 ± 0.86
F5	6 -7	0.58	5.92 ± 1.00	230 ± 0.23
F6	6 -7	0.25	5.14 ± 0.48	230 ± 0.25
F7	6 -7	0.44	5.04 ± 0.63	230 ± 0.62
F8	6 -7	0.48	5.26 ± 0.56	230 ± 0.52
F9	6 -7	0.36	5.84 ± 0.56	230 ± 0.66
F10	6 -7	0.53	5.43 ± 0.55	230 ± 0.45

*Mean of triplicate study

placed with the help of cello tape. The height of the lower vial was adjusted so that a tablet could adhere to the mucosal tissue on the upper vial. A constant force was applied on the upper

vial for 2 minutes after which it was removed and the upper vial was then connected to the balance. Then, the weight on right side pan was slowly added in an increment of 0.5 g till the

two vials just separated from each other. The total weight (gm) required to detach two vials was taken as a measure of mucoadhesive strength. From this

mucoadhesive strength, the force of adhesion was calculated using the following formula

$$\text{Force of adhesion (N)} = \frac{\text{Mucoadhesive strength} \times 9.81}{100}$$

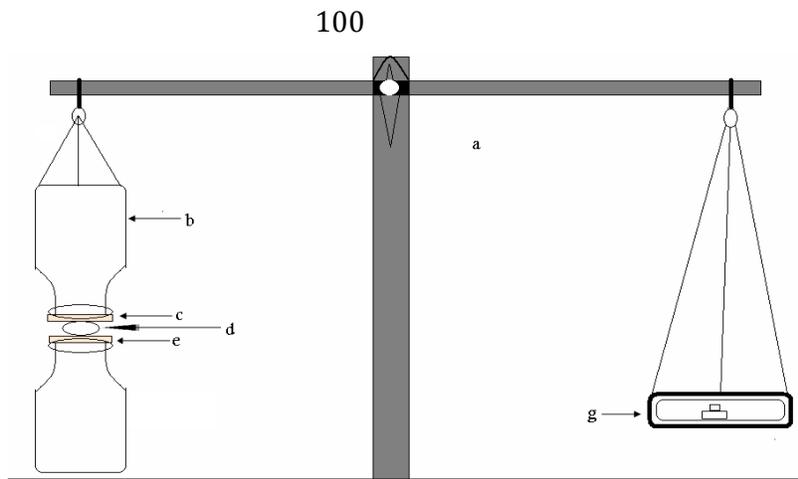


Fig. 1: Modified physical balance

TABLE 3: IN VITRO MUCOADHESIVE STRENGTH STUDY OF PREPARED MUCOADHESIVE TABLETS

BATCH CODE	MUCOADHESIVE STRENGTH (gm) (MEAN ± SD)	MUCOADHESION FORCE (N)
F1	02.00 ± 0.32	0.19
F2	16.50 ± 0.61	1.60
F3	23.50 ± 0.55	2.25
F4	19.50 ± 0.24	1.91
F5	15.00 ± 0.56	1.47
F6	15.50 ± 0.28	1.52
F7	18.50 ± 0.81	1.81
F8	14.50 ± 0.42	1.42
F9	24.50 ± 0.26	2.40
F10	17.50 ± 0.45	1.71

*Mean of triplicate study

RESULT AND DISCUSSION

The present study was carried out to determine the in vitro mucoadhesive strength of different polymers Ethyl Cellulose, Hydroxy Propyl Methyl Cellulose, Chitosan, Gum dammar, Gum copal, Xanthan gum, Gelatine, Carbopol 934p, and Sodium alginates. All the batches were evaluated for the physical properties along with hardness of the

tablets in the range of 6 - 7kg/cm². Percentage friability was less than 0.6% in all the batches with the thickness in the range of 5 -6mm.

The in vitro mucoadhesive strength was determined on the modified balance to measure the force of adhesion (N) required to detach the tablet. From the overall study it was concluded that the mucoadhesive strength of polymers is

depend on their structure and other physicochemical properties. The force of adhesion (N) of different polymers was found in the order of Gelatine (1.42) < Gum dammar (1.47) < Gum copal (1.52) < Ethyl cellulose(1.60) < Sodium alginate (1.71) < Xanthun gum (1.81) < Chitosan (1.91) < Hydroxy propyl methyl cellulose (2.25) < Carbopol (2.40) . Gelatine and Carbopol 934 p showed the lowest and highest mucoadhesive strength respectively

CONCLUSION

The development of NDDS has been made possible by the various compatible polymers to modify the release pattern of drug. In the recent years the interest is growing to develop a drug delivery system with the use of a mucoadhesive polymer that will attach to related tissue or to the surface coating of the tissue for targeting various absorptive mucosa such as ocular, nasal, pulmonary, buccal, gastric, vaginal etc.

Therefore, in the present study an attempt was made to study the mucoadhesive strength of the different mucoadhesive polymers by simple in vitro method. The force of adhesion (N) of different polymers was found in the order of Gelatine (1.42) < Gum dammar (1.47) < Gum copal (1.52) < Ethyl cellulose(1.60) < Sodium alginate (1.71) < Xanthun gum (1.81) < Chitosan (1.91) < Hydroxy propyl methyl cellulose (2.25) < Carbopol (2.40) . These mucoadhesive polymers can be exploited in the successful development of Mucoadhesive Drug Delivery Systems.

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