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The Assessment of Mucoadhesivity of Natural Polymer Derived Form Plant Sources

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ABSTRACT

The main aim and objective of my present research work was to determine the various important mucoadhesive parameters such as mucoadhesive force, force of adhesion and bonding strength etc. Mucoadhesive properties of natural polymers were evaluated by formulating gels using Carbopol 940 P as a gelling agent. Mucoadhesive parameters of the prepared Carbopol 940 P gels containing natural polymers were determined by *ex vivo* followed by modified physical balance using excised cock intestinal mucosa. From the recent experimental data it was displayed that the mucoadhesive strength, force of adhesion and bonding strength of gel containing low methoxy pectin (1 % w/v) was found higher than other tested gels. The gel containing *Moringa oleifera* gum (1 % w/v) exhibited less mucoadhesion than other tested gels. The order of mucoadhesion of these plant-derived polymers was found as: low methoxy pectin > jackfruit seed starch > cashew gum/okra gum gum > pumpkin pectin > linseed mucilage > sago starch > gum Arabic > xanthan gum > fenugreek seed mucilage/black palm seed polysaccharide > Moringa oleifera gum.

Keywords: Mucoadhesion, Mucoadhesive strength, gelling agent, intestinal mucosa, and plant derived polymers etc.

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INTRODUCTION

Mucoadhesion is defined as the attachment of synthetic or natural macromolecules to any mucus-lining present on biological epithelial surface [1]. It is mostly achieved by the use of mucoadhesive polymers [2-4]. Mucoadhesion is provided by the formation of non-covalent bonds such as hydrogen bonds and ionic interactions or physical entanglements between the mucus gel layer and polymers.

Classification of mucoadhesive polymers

The classification of various mucoadhesive polymers used in the formulation of various mucoadhesive systems is [1-5]:

(I) Synthetic polymers: (a) Cellulose derivatives: Methylcellulose, Ethylcellulose, Hydroxy-ethylcellulose, Hydroxyl propyl cellulose, Hydroxy propyl methylcellulose, Sodium carboxy methylcellulose. (b) Poly (acrylic acid) polymers: Carbomers, olycarbophil. (c) Poly (hydroxyethyl methylacrylate). (d) Poly (vinyl alcohol), etc.

(II) Natural polymers: (a) Sodium alginate. (b) Guar gum. (c) Xanthan gum. (d) Lectin. (e) Gelatin. (f) Pectin. (g) Chitosan etc.

Natural mucoadhesive polymers obtained from plant sources

The use of natural polymers in various biomedical and food continues to be an area of intensive research despite the advent of several new synthetic polymers [6]. Natural polymers primarily remain attractive for their capability of chemical modifications, biodegradability and biocompatibility [7-8]. Various conventional natural mucoadhesive polymers like guar gum, chitosan, xanthane gum, alginates, locust bean gum, alginate, *etc*, were already well studied and investigated in various drug delivery applications [6, 9-12].

In the literature, there are several reports on natural mucoadhesive agents, which were isolated from various plant materials and have found their use for the development of mucoadhesive systems. The examples of these newer natural mucoadhesive agents, which found their potential application in the development of mucoadhesive applications, are mucoadhesive agents isolated or extracted from: ispaghula husk [13-14], Assam Bora rice [15], Linseed [16], tamarind seed [17], *Dellinia indica* L. fruits [18], *Trigonella foenum-graecum* L. (fenugreek) seeds [19], *Aegle marmelos* fruits [20] etc.

MATERIALS AND METHODS

Materials and chemicals

Gum Arabic, xanthan gum, and low methoxy pectin were commercial available samples. Cashew gum, *Moringa oleifera* gum, okra gum, pumpkin pectin, fenugreek seed mucilage, linseed mucilage, black palm seed polysaccharide, jackfruit seed starch and sago starch were previously extracted in our laboratory. All other chemicals and reagents were commercially available and of analytical grade.

Method

Formulation of isolated natural polymeric gels

Mucoadhesive properties of natural polymers were evaluated by formulating gels using Carbopol 940 P as a gelling agent. Natural polymers (namely, gum Arabic, xanthan gum, low methoxy pectin, cashew gum, *Moringa oleifera* gum, okra gum, pumpkin pectin, fenugreek seed mucilage, linseed mucilage, black palm seed polysaccharide, jackfruit seed starch and sago starch) were employed as mucoadhesive agents. Briefly, Carbopol 940 P (1.5 % w/v) was dispersed into aqueous solutions containing natural polymers (1 % w/v). These dispersions were allowed to hydrate overnight followed by addition of triethanolamine (0.1 % w/v) and glycerin (0.5 % w/v) to form gels.

Evaluation of mucoadhesive potential of gels

Mucoadhesive parameters (mucoadhesive force, force of adhesion, and bonding strength) of the prepared Carbopol 940 P gels containing natural polymers were assessed *ex vivo* by modified physical balance using excised cock intestinal mucosa. The modified physical balance apparatus was comprised of a two-arm balance, one side of which was contained two glass plates (lower plate) was attached permanently to the base of the stage, and the other (upper plate) was glued to the base of one arm of the balance. The membrane used for mucoadhesive testing was fresh cock intestine, which was glued to the lower plate and another was glued to the upper plate by using cyanoacrylate adhesive. Accurately weighed, 1 gram of gels was placed on the goat intestinal mucosa glued to the upper side of the lower plate. Then, the upper plate was placed over the lower plate. A contact pressure by the figure tip was applied for 5 minutes (preload time). After removal of the preload force, a gradually increasing weight was applied on the second arm of the balance by controlled addition of water from the burette till the plates detached from each other. The weight required for the detachment of the glass plates was recorded and the mucoadhesive strength of the prepared gels was calculated [20]. From mucoadhesive strength values (in gram), force of adhesion (Newton) and bonding strength (Newton/meter^2) were easily calculated. Mucoadhesive parameters will be evaluated are as follows: Mucoadhesive strength = the mass (in gram) required to detach the polymer sample from the mucosal surface.

$$Force\ of\ adhesion\ (N) = \frac{(Mucoadhesive\ strength \times 9.81)}{1000}$$

$$Bonding\ strength\ (\frac{N}{M^2}) = \frac{(Force\ of\ adhesion)}{(Mucosal\ surface\ area)}$$

RESULTS AND DISCUSSION

Table-1: Mucoadhesive parameters of various gels containing isolated natural polymers (1 % w/v)

Gels	Mucoadhesive strength (gr)	Force of adhesion (N)	Bonding strength (N/M^2)
Gel containing gum Arabic (1 % w/v)	15.20	1.49×10^{-4}	1.90
Gel containing xanthan gum (1 % w/v)	15.10	1.48×10^{-4}	1.88
Gel containing low methoxy pectin (1 % w/v)	21.00	2.05×10^{-4}	2.60
Gel containing isolated cashew gum (1 % w/v)	18.60	1.82×10^{-4}	2.32
Gel containing *Moringa oleifera* gum (1 % w/v)	14.00	1.37×10^{-4}	1.74
Gel containing isolated okra gum (1 % w/v)	18.60	1.82×10^{-4}	2.32
Gel containing isolated pumpkin pectin (1 % w/v)	18.43	1.82×10^{-4}	2.32
Gel containing isolated fenugreek seed mucilage (1 % w/v)	14.50	1.42×10^{-4}	1.80
Gel containing linseed mucilage (1 % w/v)	16.83	1.64×10^{-4}	2.08
Gel containing isolated black palm seed polysaccharide (1 % w/v)	14.50	1.42×10^{-4}	1.80
Gel containing isolated jackfruit seed starch (1 % w/v)	19.60	1.92×10^{-4}	2.44
Gel containing isolated sago starch (1 % w/v)	15.43	1.51×10^{-4}	1.92

From the recent experimental data (Table-1), it was found that the mucoadhesive strength, force of adhesion and bonding strength of gel containing low methoxy pectin (1 % w/v) was found higher than other tested gels. The gel containing *Moringa oleifera* gum (1 % w/v) exhibited less mucoadhesion than other tested gels. The order of mucoadhesion of these plant-derived polymers was found as: low methoxy pectin > jackfruit seed starch > cashew gum/okra gum > pumpkin pectin > linseed mucilage > sago starch > gum Arabic > xanthan gum > fenugreek seed mucilage/black palm seed polysaccharide > *Moringa oleifera* gum. Actually, native natural polymers are able to hydrate rapidly and bind with the mucous layer through the hydrogen bonding, which could be the mechanism of the mucoadhesion of these gels containing natural polymers as mucoadhesive agents.

Thus, mucoadhesivity of these natural polymers obtained from plant sources prompted us to explore for mucoadhesivity in biomedical and pharmaceutical applications.

CONCLUSION

From the current investigation here we reported that some selected natural polymers isolated from plant sources namely, gum Arabic, xanthan gum, low methoxy pectin, cashew gum, *Moringa oleifera* gum, okra gum, pumpkin pectin, fenugreek seed mucilage, linseed mucilage, black palm seed polysaccharide, jackfruit seed starch and sago starch were evaluated for their mucoadhesive potential. To explore their mucoadhesive applications, Carbopol 940 P (1.5 % w/v)-based mucoadhesive gels containing these natural polymers (1 % w/v) as mucoadhesive agents were formulated and evaluated for their various important mucoadhesive parameters like mucoadhesive strength, force of adhesion and bonding strength. From this investigation, it was observed that the mucoadhesive strength, force of adhesion and bonding strength of gel containing commercially available low methoxy pectin (1 % w/v) were found higher than these of the other gels tested. The promising mucoadhesive properties of these natural mucoadhesive polymers isolated from commonly available sources warrant their further exploration for the use in various mucoadhesive applications in the biomedical field.

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