International Journal of Pharmaceutics xxx (2015) xxx–xxx

Contents lists available at ScienceDirect

International Journal of Pharmaceutics

journal homepage: www.elsevier.com/locate/ijpharm

Evaluation of kappa carrageenan as potential carrier for floating drug delivery system: Effect of cross linker

Suguna Selvakumaran[a], Ida Idayu Muhamad[a,b,*]

[a] Department of Bioprocess Engineering, Faculty of Chemical Engineering, Johor Bahru 81310, Johor, Malaysia
[b] IJN-UTM Cardiovascular Engineering Centre, V01 FBME, Universiti Teknologi Malaysia, Johor Bahru 81310, Johor, Malaysia

ARTICLE INFO

Article history:
Received 3 June 2015
Received in revised form 17 September 2015
Accepted 3 October 2015
Available online xxx

Keywords:
Floating hydrogel
Genipin cross linking
Kappa carrageenan/sodium carboxymethyl cellulose
Characterization

ABSTRACT

Genipin, a natural and non-toxic cross linker, was used to prepare cross linked floating kappa carrageenan/sodium carboxymethyl cellulose hydrogels and the effect of genipin on hydrogels characterization was investigated. Calcium carbonates were employed as gas forming agents. Ranitidine hydrochloride was used as drug. Fourier transform infrared spectroscopy (FTIR), X-ray diffraction (XRD) and thermogravimetric analysis (TGA) were carried out to study the changes in the characteristics of hydrogels. Furthermore, scanning electron microscope (SEM) was performed to study microstructure of hydrogels. The result showed that all formulated hydrogels had excellent floating behavior. It was discovered that the cross linking reaction showed significant effect on gel strength, porosity and swelling ratio compared to non-cross linked hydrogels. It was found that the drug release was slower and lesser after being cross linked. Microstructure study shows that cross linked hydrogels exhibited hard and rough surface. Therefore, genipin can be an interesting cross linking agent for controlled drug delivery in gastrointestinal tract.

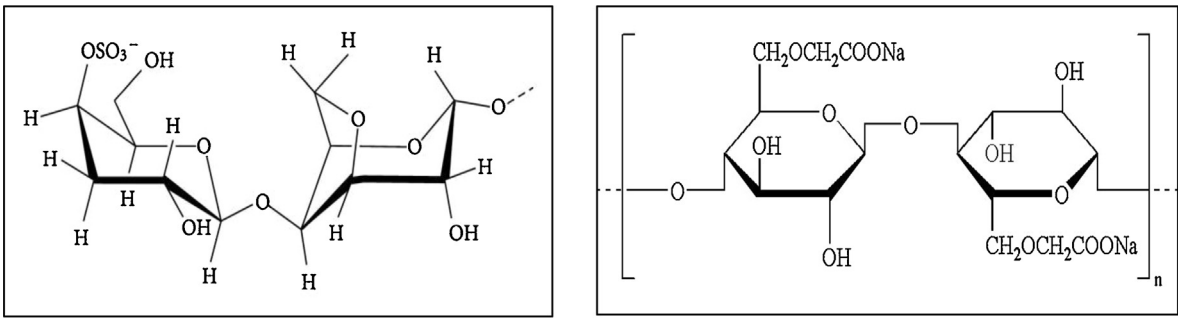
1. Introduction

Hydrogel is in increasing demand in the biomedical and pharmaceutical applications due to their biocompatibility, biodegradability and non-toxic properties (Ratner et al., 1976; Ratner & Williams, 1981; Peppas, 1987; Muhamad et al., 2011). Hydrogel is a polymeric three dimensional network obtained from a class of synthetic and natural polymers which can absorb and retain significant amount of water (Rosiak and Yoshii, 1999). The hydrogel structure is created by the hydrophilic groups (—OH, —COOH, —NH_2,—$CONH_2$, and —SO_3H) present in a polymeric network upon the hydration in an aqueous environment. Hydrogel is an excellent biomaterial that is capable of exhibiting significant volume changes in response to small changes in pH, temperature, electric field, and light (Nho et al., 2005). Hydrogel made from kappa carrageenan act as a good drug carrier for drug delivery system, especially in the gastrointestinal tract. Kappa carrageenan is a linear, sulfated polysaccharide, composed of repeating D-galactose and 3,6-anhydro-D-galactose units (Zhai et al., 2004). Kappa carrageenan hydrogel has its own specific advantages such as nontoxicity, easy availability, easy gelling properties, thermo reversibility of the gel network and appropriate viscoelastic properties (Liu et al., 2006) that enables it to undergo harsh condition. This behavior makes the kappa carrageenan hydrogel as an extraordinary carrier in the drug delivery system.

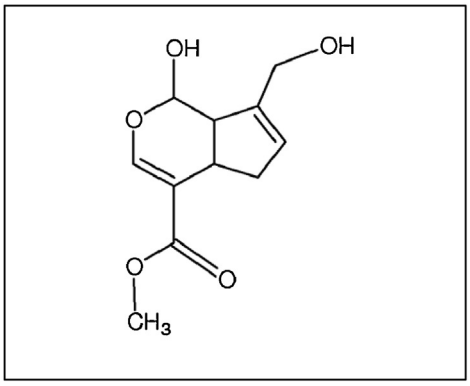
Kappa carrageenan based floating hydrogel has currently gained wide attention among researchers. Incorporation of carbonates and bicarbonates salt into hydrogels allow the hydrogels to constantly float in the stomach and deliver drug in a controlled manner. In this work, calcium carbonates were used as gas forming agents. Compared to normal hydrogel, floating hydrogel has its own advantages as it can constantly float in the stomach for long period meanwhile normal hydrogel is removed *via* antrum due to peristaltic waves with poor drug release pattern. Floating hydrogels not only prolong the residence time of carrier but also maximize the amount of drugs reaching their absorption site in solution and hence ready for absorption (Dolas et al., 2011). In addition, floating hydrogel results in dissolution of drugs in the gastric fluid, this would then make them available for absorption in the small intestine after emptying of the stomach content. It is expected that the drugs will be fully absorbed from floating dosage forms if it remains in a solution form even at the alkaline pH of the intestine system (Mayavanshi and Gajjar, 2008; Chordiya et al., 2011).

* Corresponding author at: Department of Bioprocess Engineering, Faculty of Chemical Engineering, Johor Bahru, 81310, Johor, Malaysia. Fax: +60 75558553.
E-mail address: idaidayu@utm.my (I.I. Muhamad).

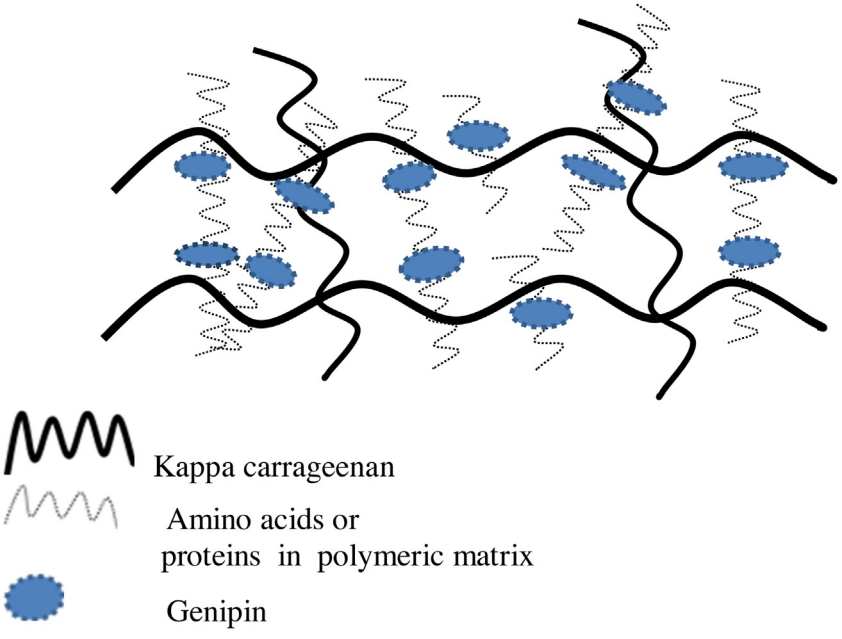
http://dx.doi.org/10.1016/j.ijpharm.2015.10.005
0378-5173/



(a) (b)



(c)



(d)

Fig. 1. Chemical structures of kappa carrageenan (a), sodium carboxymethyl cellulose (b), genipin (c) and mechanisms of genipin (d).

Please cite this article in press as: Selvakumaran, S., Muhamad, I.I., Evaluation of kappa carrageenan as potential carrier for floating drug delivery system: Effect of cross linker. Int J Pharmaceut (2015), http://dx.doi.org/10.1016/j.ijpharm.2015.10.005