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Synthesis and characterization of interpenetrating polymeric networks based bio-composite alginate film: A well-designed drug delivery platform

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ABSTRACT

This study aimed to develop and characterize the calcium alginate films loaded with diclofenac sodium and other hydrophilic polymers with different degrees of cross-linking obtained by external gelation process. To the formed films different physicochemical evaluation were performed which showed an initial character of the films. The films produced by this external gelation process were found thicker (0.031–0.038 mm) and stronger (51.9–52.9 MPa) but less elastic (2.3%) than those non-cross-linked films (0.029 mm; 39.7 MPa; 4.4%). The lower water vapor permeability (WVP) values of the films were obtained where maximum level of crosslinking occurs. Composite films can be cross-linked in presence of external crosslinking agent to improve the quality of the produced matrices for various uses. The characterization of the film was performed using Differential Scanning Calorimetry (DSC) and Fourier-Transform Infrared Spectroscopy (FT-IR) analysis. The Scanning Electron Microscopy (SEM) study showed the morphology of treated composite films. The kinetic release studies showed a sustained release of the drug from the formulated films as it can be prolonged in composite film. The prepared biodegradable Ca-Alginate bio-composite film may be of clinical importance for its therapeutic benefit.

1. Introduction

Sodium alginate is extensively used in food and pharmaceutical productions such as dispersing, thickening, disintegrating agents [1–3], and as a matrix for the entrapment of drugs, proteins, and cells [4–8]. Now a day's alginate has been used in the biomedical field for controlled drug release, cell encapsulation, scaffolds, tissue engineering and for the preparation of moulds in the dental field [9–12]. It is a water-soluble salt of alginic acid, a naturally occurring non-toxic polysaccharide found in all species of brown algae [13]. Alginate has been shown to have low immunogenicity, biocompatibility, degradability, easily available and low-cost makes alginate suitable for the preparation of natural polymeric films as an alternative to synthetic polymeric films [8,14]. As of a structural information, it contains two uronic acids, β-(1–4)-linked D-mannuronic acid (M) and α-(1–4) linked L-guluronic acid (G), and is composed of homopolymeric blocks M–M or G–G, and blocks with an alternating sequence of M–G blocks [13]. Moreover, sodium alginate has a distinguishing property of cross-linking in the presence of multivalent cations, such as calcium ions in aqueous media [13] through the gelation process [8].

Alginate films have defective moisture barriers due to their hydrophilic nature, but the inclusion of calcium can decrease the water vapor permeability of these films, creating them more hydrophobic in nature. Calcium ions can crosslink with alginate by uniting G; as a result, dissimilar fractions of G produce films showing altered water vapor permeability properties [15,16]. Small drug molecule to biopolymer (proteins) can be released from the alginate gels in an organized fashion, and the drug release dependent on the nature of the cross-linking agent and the procedures used for cross-linking [11].

Over the last few years' many researchers have shown the augmented importance of the use of alginates as a polymer for microspheres preparation and use of calcium chloride as a cross-linking material [17,18] prepared sodium alginate beads comprising with voglibose as a drug candidate using emulsion gelation method. They reported that the oil entrapped calcium alginate gel beads showed

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