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Topic of Research: Superabsorbent hydrogels based on polysaccharides for application as nutrient carriers

Findings

The present research work is based on the Superabsorbent hydrogels based on polysaccharides for application as nutrient carriers. The thesis comprises of five chapters. Chapter I is the introductory chapter, explained various aspects of the work, which covers the detailed literature review on superabsorbent hydrogels (SAHs), their classification, properties and applications. A detailed literature survey has also been presented to discuss the chemical modification of natural gum polysaccharides towards hydrogel formation, radiation processing of polymeric hydrogels, and graft copolymerization technique for the synthesis of polymeric hydrogels. Finally, the chapter is concluded by defining the objectives of the research work. Chapter II deals with the synthesis of Glycerol-crosslinked guar gum monoaldehyde based superabsorbent hydrogels for vitamin B6 (pyridoxine hydrochloride) delivery. A simple reaction was carried out to oxidize the plant polysaccharide, guar gum (GG) using a mixture of nitric acid and sodium nitrite. Superabsorbent hydrogels (SAH) were obtained by reacting the synthesized guar gum monoaldehyde with glycerol used as a crosslinker. The oxidation and crosslinking reactions were followed by spectroscopic methods, and the SAH were characterized by swelling studies, thermal analysis, scanning electron microscopy and porosity measurements. The hydrogels were able to absorb and retain a large quantity of water and artificial biological fluids without undergoing degradation and loss of their physical stability; the equilibrium degree of swelling was measured to be > 1500. The SAH were responsive toward pH and temperature changes, possessed thermal stability and good mechanical strength and were suitable for use in the delivery system for vitamin B6 (VB6). The stability of VB6-loaded gels was checked in simulated body fluids at lower pH, and the in vitro release of VB6 was studied in water and the acidic intestinal and gastric fluids. The release depended on the pH of the medium and the crosslinking density of the SAH; the concentration of released vitamin was measured to be 79.2%, 69.1% and 51.7% at pH 7.0, 4.5 and 1.5, respectively, from GEL-3, the lowest crosslinked polymer. The release kinetics study revealed that it followed a non-Fickian diffusion mechanism. The results indicate that the functionalized and crosslinked GG-based SAH could function as a delivery vehicle for food nutrients. Chapter III discusses the preparation of novel polymeric superabsorbent hydrogels comprised of carboxymethyl gum arabic (CMGA) and 2-hydroxyethyl methacrylate (HEMA). The SAHs were prepared under an aqueous environment via graft copolymerization using ^{60}Co-gamma irradiation. CMGA with varying substitution degrees (DS; 0.342-0.782) was prepared by treating it with mono-chloroacetic acid (MCA) in alkaline environment and were characterized by FTIR, ^{1}H, and ^{13}C NMR. The effect on the

degree of substitution was optimized by changing the concentration of MCA while keeping the other reaction parameters constant. The influence of irradiation doses and copolymer (CMGA/HEMA) composition on gel content was also studied. Swelling behavior was investigated in different media at varied temperatures (25 and 40 °C) and some other properties like water retention, reswelling, and surface hydrophilicity were also evaluated. The obtained superabsorbent hydrogels (SAHs) were characterized using standard analytical tools such as FTIR, TGA, DSC, XRD, etc. The rheological behavior of SAHs was investigated using a frequency sweep test, and morphological characteristic features were performed by scanning electron microscopy (SEM). Folic acid as a model nutrient was loaded into these SAHs and investigated its *in vitro* sustained release profile under different pH at ambient temperature (34±2 °C) using UV visible spectroscopy and release of folic acid followed the mechanism of non-Fickian diffusion. The SAHs achieved better compatibility and negligible cytotoxicity with human erythrocytes and HEK-293 cells, indicating that this polymer system design is effective for use in food/nutrient delivery applications. Chapter IV reports the synthesis of citric acid cross-linked CMGA-g-p(HEMA) SAHs via free radical polymerization technique. The influence of reaction parameters such as, time of reaction, temperature of reaction, crosslinker concentration on grafted crosslinked SAHs were also studied. The swelling behaviors of SAHs were studied in different media at varying temperatures (25 °C and 40 °C). Riboflavin was chosen as the model nutrient to load into synthesized SAHs and investigate its in vitro sustained release profile in different pH mediums at an ambient temperature of 37 °C. Conventional testing methods such as FTIR, DSC, TGA, XRD, UV visible spectroscopy, and so on were used to characterize the obtained SAHs. The rheological behavior of SAHs was inspected using a sweep frequency test, and morphological analyses were performed by scanning electron microscopy. Chapter V of the thesis includes the synthesis of Citric acid crosslinked carboxymethyl gum arabic-chitosan (CMGA-CHT) based superabsorbent hydrogels for the sustained delivery of thiamine. The stoichiometry of the synthesized SAHs were optimized by keeping the CMGA and chitosan molar ratio constant and varied the reaction parameters such as crosslinker concentration, temperature and time of the reaction in order to study their effect on hydrogel properties. As a control, hydrogel blends without crosslinker were also prepared to investigate the difference in properties between crosslinked and uncross linked SAHs. Swelling studies were investigated in different mediums like water, SIF and SGF to observe the crosslinking density and pH responsive behavior of SAHs. Hydrolytic degradation was also studied to determine the weight loss of hydrogels during the process of degradation. The prolonged and sustained release behavior of thiamine from the loaded hydrogels was evaluated under *In Vitro* conditions in order to provide information on their application in nutrient delivery systems. Structural, mechanical and physicochemical properties of citric acid crosslinked CMGA-CHT based SAHs such as chemical structure, morphological studies and rheological properties were analyzed.