ABSTRACT

The development of smart, bio-based polymeric materials with biodegradability and biocompatibility is decisive in the material world to address the major shortcomings associated with the sustainability issues to ecological footprints. Further, the massive applicability of polymers in the modern world has drawn huge interest in the development of high-performing materials. Therefore, the thesis focuses on the fabrication, characterization, and property evaluation of polysaccharide-based hydrogels for varied applications in numerous fields. Amongst different polymeric materials, hydrogels are one of the most versatile materials with multipurpose properties, low cost, ease of preparation, and numerous applicability. In line with the prime objective of this study, different polysaccharide-based hydrogels were prepared with diverse properties. The bio-based polysaccharides used for the fabrication of the hydrogels were starch, chitosan, agar, along with synthetic monomers acrylic acid, acryl amide, and stearyl methacrylate. Moreover, completely synthetic monomer free hydrogels were also synthesized by using only polysaccharides with suitable cross-linking strategies. The fabrications of the hydrogels were organized in such a way that the properties of them are suitable for a specific purpose. The hydrogels were synthesized with inbuilt properties which make them suitable for agricultural applications, wastewater treatment, and biomedical applications. The synthesized hydrogels were characterized by different spectroscopic and analytical techniques. Thereafter, various properties such as swelling ability, dye and metal ions adsorption ability, self-healing ability, controlled drug release rate, mechanical toughness, etc. were evaluated. First, a starch and acrylic acid-based high swell-able hydrogel was prepared to utilize it in agricultural fields. Thereafter, a double cross-linking strategy was incorporated into the starch backbone to prepare an amphoteric hydrogel. The positive and negative charges of the amphoteric hydrogels were utilized for the adsorption of cationic and anionic dyes from wastewater. Then the amphoteric property of the synthesized hydrogel was removed and a high cross-linking density was added to obtain a mechanically tough hydrogel. The synthesized hydrogel was utilized for metal ions adsorption with noticeable recyclability due to its remarkable mechanical properties. Further, a starch-based self-healing hydrogel was synthesized using a micellar copolymerization between a hydrophobic and a hydrophilic monomer in the presence of a surfactant.

Further, a synthetic monomer free hydrogel was synthesized by using a self-cross-linking strategy between oxidized starch and chitosan for biomedical application. This hydrogel showed pH sensitive swelling and drug release ability. Moreover, a starch/agar-based mechanically tough hydrogel was also synthesized for wound dressing applications. The hydrogel showed swelling induced mechanical strength and sustained drug release ability. Thus, the overall work of the present thesis described the utilization of starch along with other polysaccharides for the preparation of different hydrogels with numerous properties. In short, the thesis focuses on the modification of polysaccharides like starch backbone to provide some explicit functionality to make it suitable for potential applications.

Therefore, the comprehensive work revealed the pathway for achieving high-performance polysaccharide-based hydrogel with smart properties suitable for a targeted application. Henceforth, the demonstrated works provide several mechanistic ways to achieve high-performing hydrogels to pave a new avenue in the existing material world.

Keywords: Polysaccharide, hydrogel, swelling ability, soil conditioner, controlled release, self-healing, tough hydrogel, metal ion and dye adsorption.