ABSTRACT

In recent decades, hydrogels with excellent properties and derived from bio-based materials have been considered as interesting polymeric materials and are occupying a decent position in the scientific community because of their potential uses in different fields of applications. They are mainly produced from polysaccharides and proteins along with grafting hydrophilic monomers using different physical and chemical methods. They possess many fascinating properties which in turn aid in extending their potential in various fields such as wastewater treatment, biomedical, hygiene, agriculture, sensor, commodity, etc. However, further modification is required to enhance their many intrinsic properties, which can be obtained by incorporating different reinforcing agents into the bare hydrogel matrices. Thus, the development of bio-based hydrogel and corresponding biocomposites and nanocomposites with the introducing of various reinforcing agents utilized for different applications are summarized in the entitled thesis. From various analytical, microscopic and spectroscopic analyses, the formation of the hydrogels was observed. Thereafter, starch and itaconic acid-based hydrogel was prepared using the free radical polymerization method and used as a soil conditioner and slow-release fertilizer system for agricultural application. Thereafter, the hydrogel composite was prepared with the incorporation of wastepaper-derived cellulosic micro-reinforcing agent and observed enhanced water swelling as well as slow-release properties. Further, the hydrogel matrix was modified with the incorporation of nanomaterials like modified-cellulose nanofiber (mCNF) as well as zinc oxide/cellulose nanofiber (CNF) nanohybrid (ZONH). The mCNF-incorporated hydrogel nanocomposite (HNC) showed excellent dye removal capacity. Further, hydrogel modified with ZONH was utilized for heavy metal ion removal from aqueous media and for *in vitro* drug delivery. The prepared HNCs showed excellent metal ion removal capacity due to the introduction of ZONH. Moreover, a prolonged drug release profile was observed in the case of ZONH-incorporated HNC.

Thus, the present research work demonstrates the development of bio-based HNCs with the incorporation of wastepaper-derived cellulosic reinforcing agents and their utilizations for various potential applications. Therefore, it can be said that the prepared HNCs can be used as eco-friendly polymeric materials for multifaceted applications.

Keywords: Starch, itaconic acid, gelatin, bio-based hydrogel, soil conditioner, wastepaper, slow-release fertilizer, modified-cellulose nanofiber, dye adsorption, zinc oxide/cellulose nanofiber nanohybrid, heavy metal ion removal, drug delivery.