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Short Communication

pH-Sensitive Hydrogels for Specific Targeted Drug Delivery

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Abstract

The recent increase in the popularity of pH-sensitive hydrogels has opened up new avenues in the field of modern medicine with their ability of exhibit immediate and reversible changes in its physical form with respect to the pH conditions have made them suitable options for specific body-site targeting drug delivery, food industry, agriculture and chemical industries. Like an old wine in a new bottle, pH-sensitive hydrogels offer medical professionals with an array of choices for site targeted drug delivery.

Keywords: *Hydrogels; pH-Sensitive; Site Targeted Drug Delivery; Polymeric Matrix Systems; Intelligent Formulations*

First reported by Wichterle and Lim in 1960, hydrogels are hydrophilic, three-dimensional polymeric systems with high absorption capacity [1]. They have a wide application in the field of drug delivery systems due their versatility and capacity to adjust their matrix structures based on their pH, polymerization method, temperature and surfactant etc [2]. Various natural polymers have been utilized to deliver drugs to the exact site required for pharmacological activity, which include the likes of gelatin, cellulose, starch and chitosan [3]. Hydrogels are those polymeric pharmaceutical formulations which facilitate the delivery of drugs by allowing body fluids to penetrate the polymer matrix, dissolve the loaded drugs and diffuse back into the body circulation via the swollen hydrogel matrix [4]. Among these hydrogel systems, pH specific hydrogels are the most fascinating ones which have a stimuli dependent response. Hydrogels composed of polyacrylic acid, acrylic acid copolymerized with other monomers, acrylic acid grafted to hemicellulose or chitosan and crosslinked with glutaraldehyde and N,N-methylenebisacrylamide; has been used for the targeted drug delivery of drugs like theophylline, insulin and dexamethasone [3].

A copolymer hydrogel composed of starch-methacrylic acid containing ketoprofen was designed by El-Hag Ali., *et al*. to deliver the drug in the colon. The hydrogel had the function of retaining the drug ketoprofen at pH 1 (acidic) and releases the drug at pH 7 (neutral) [5]. Zhang., *et al*. successfully utilized acrylic acid grafted onto the chains of insulin loaded-carboxymethyl chitosan for the safe delivery of insulin via the oral route [6]. Cross-linked hydrogel obtained by the copolymerized from acrylic acid and agar loaded with antimicrobial agents have been designed for the localized delivery of silver nanoparticles or ciprofloxacin in patients with infectious wounds or burns [7]. pH-sensitive hydrogel beads composed of two different systems of sodium carboxymethyl cellulose (CMC)/chitosan (CS) and sodium alginate (SA)/calcium chloride; has been designed to deliver probiotics into the gut via the oral route. *Bacillus subtilis* natto embedded in such beads was found to be released only in pH 6.8 with a sustained release for more than 10 hours [8]. pH-sensitive chondroitin sulfate-co-poly(acrylic acid) hydrogels prepared via free radical polymerization technique has been prepared for the controlled release

of diclofenac sodium at pH 7.4 [9]. A hyaluronic acid (HA)-based composite hydrogel crosslinked with an antimicrobial peptide [AMP, KK(SLKL)3KK] has been designed to facilitate the release of the peptide AMP in an acidic environment; i.e. when the pH of a wound changes due to bacterial infection (~ 5.5 - 5.6) [10]. The delivery of methotrexate into the colon was achieved by loading it onto a pH-sensitive gelatin and polyvinyl alcohol hydrogel matrix, which facilitated the release of the drug at higher pH levels [11]. A dual functional pH-sensitive hydrogel composed of peptide DP7 and oxidized dextran loaded with ceftazidime is found to be effective against multidrug-resistant bacteria infested wounds which can promote scarless wound healing. The formulation is designed to deliver the antimicrobial agent at lower pH than that of intact skin which is an indication of septic infection of the wounds [12].

pH-sensitive hydrogels have evolved to be an intelligent pharmaceutical tool for the delivery of a range of drugs to targeted sites by exploiting the difference in pH between the site of administration and site of action. The change in the swelling property of the hydrogels at different pH facilitates the release of the drugs in different pH conditions. It is evident that these systems have been experimented upon quite expansively in the recent years. Albeit there is a scope for major research from the toxicity point of view, along with the selection of polymers and mutual interference is the need of the hour. Although pH sensitive hydrogels are not a recent innovation, it possesses immense scope and utility in the field of modern medicine where targeted drug delivery is becoming increasingly indispensible.

Conflict of Interest

The author declare no conflict of interest, financial or otherwise.

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