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Synthesis and hydrophilic properties of a novel pH sensitive PAAm/PMAA/CMC hydrogels

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Abstract – A novel hydrogel composed of poly (acrylamide) (PAAm) / poly (methacrylic acid) (PMAA) / carboxymetilcellulose (CMC) hydrogel was synthesized through by the free radical polymerization reaction. The hydrophilic properties, determined by swelling degree (SD), were dependent on the pH of external swelling medium, indicating that this hydrogel is pH sensitive. The possibility of producing PAAm/PMAA/CMC pH sensitive hydrogels is of key importance to optimize its use in several applications in agricultural field, such as carrier vehicle for controlled release of nutraceuticals, pesticides and fertilizers.

In the last decades, considerable attentions have been focused on the ability of hydrogels that are able to alter their volume and properties in response to environmental stimuli such as pH, temperature, and ionic strength [1]. Recently, the application of hydrogels in agricultural field has been extensive proposed as delivery vehicles for the controlled release of pesticides and fertilizers. Controlled release of agrochemicals (pesticides, herbicides, nutrients) is used to maintain the local concentration of active ingredients in the soil within the optimum limits over a specified period of time, and to reduce run off [2]. In this work, a novel poly (acrylamide) (PAAm) / poly (methacrylic acid) (PMAA) / carboxymetilcellulose (CMC) hydrogel was synthesized through by the free radical polymerization reaction. The variation of the hydrophilic properties of hydrogel depending on pH was evaluated by measuring their swelling degree (SD), which is calculated by the ratio between weights of the swollen to equilibrium at specific pH and dried hydrogel, at 25.0 ºC. Figure 1 shows the variation of the swelling degree for hydrogel with pH of external swelling medium. The pKa value of hydrogel was estimated from the sigmoid-curve and it is around 4.2, being intermediate the pKa values of individual components, i.e., pKa of CMC ≈ 4.0 and pKa of PMAA ≈ 4.9. It was observed that SD of hydrogel is small when the pH is lower than 3.0. The swelling degree increases sharply to 9 when the pH was increased to 6.5. These behaviors are interpreted as follows: pH < hydrogel pKa: $–COO^-$ groups can convert to –COOH groups, and the hydrogen bonding can be formed among –OH, –COOH (present in PMAA and CMC), and $–CONH_2$ (present in PAAm), which is responsible for the small swelling ratio [3]; pH > hydrogel pKa: the COOH groups dissociate to COO^-, and the electrostatic repulsion between the molecular chains is predominated which leads to the network more expanding. The possibility of producing PAAm/PMAA/CMC pH sensitive hydrogels is of key importance to optimize its use in several applications, such as carrier vehicle for controlled release of nutraceuticals, pesticides and fertilizers.

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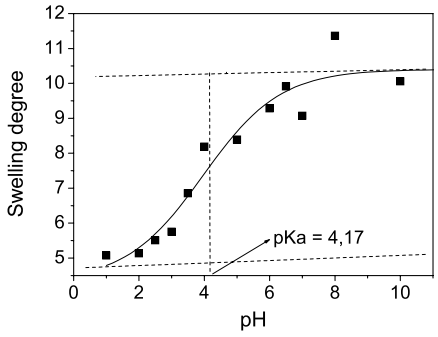

[1], T = 25.0 ºC.

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