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Development of Carrageenan-Psyllium/Montmorillonite Clay Hybrid Hydrogels for Agriculture Purpose

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Abstract : Limited water resources on the earth come first among the most alarming issues. In this respect, several solutions from treatment of waste water to water management have been proposed. Recently, use of hydrogels as soil additive, which is one of the water management ways in agriculture, has gained increasing interest. In traditional agriculture applications, water used with irrigation aim, rapidly flows down between the pore structures in soil, without enough useful for soil. To overcome this fact and increase the abovementioned limit values, recently, several natural based hydrogels have been suggested and tested to find out their efficiency in soil. However, most of these researches have dealt with grafting of synthetic acrylate based monomers on natural gelling agents, most probably due to reinforced of the natural gels. These results motivated us to search a natural based hydrogel formulations, not including any synthetic component, and strengthened with montmorillonite clay instead of any grafting polymerization with synthetic monomer and examine their potential in this field, as well as characterize of them. With this purpose, carrageenan-psyllium/ montmorillonite hybrid hydrogels have been successively prepared. Their swelling capacities were determined both in deionized and tap water and were found to be dependent on the carrageenan, psyllium and montmorillonite ratios, as well as the water type. On the other hand, mechanical tests revealed that especially carrageenan and montmorillonite contents have a great effect on gel strength, which is one of the essential features, preventing the gels from cracking resulted in readily outflow of all the water in the gel without beneficial for soil. They found to reach 0.23 MPa. The experiments carried out with soil indicated that hydrogels significantly improved the water uptake capacities and water retention degrees of the soil from 49 g to 85 g per g of soil and from 32 to 67%, respectively, depending on the ingredient ratios. Also, biodegradation tests demonstrated that all the hydrogels undergo biodegradation, as expected from their natural origin. The overall results suggested that these hybrid hydrogels have a potential for use as soil additive and can be safely used owing to their totally natural structure.

Keywords : carrageenan, hydrogel, montmorillonite, psyllium
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