STUDIES ON THE PREPARATION, CHARACTERIZATION AND APPLICATIONS OF SILICON ALGINATE BIOCOMPOSITE

PhD (DISSERTATION)

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ABSTRACT

The preparation, characterization and some applications of silicon alginate biocomposite have been studied. One of the constituents in the biocomposite, glycolato silicate, was prepared by a direct and one-step route based on the reaction of silica gel with excess distilled ethylene glycol in the presence of various mole amounts of sodium hydroxide under nitrogen atmosphere at nearly 200 °C (boiling point of ethylene glycol). Percent dissolution of silica gel depends on the mole amount of sodium hydroxide and reaction time. Thus, using the mole ratio of silica gel based on monomer unit to sodium hydroxide equals to 1 : 0.5 and in a 4-hour reaction time; 96 percent dissolution of silica gel was achieved. The product formed showed an actual yield percent of 78 %. It was also found that the glycolato silicate was a crosslinked polymer containing ~ 17.5 % of Si. It was evaluated from a predicted value which was supported by FTIR, EDXRF, percent SiO_2 left and XRD related results. Biocomposite was prepared by mixing sodium alginate solution with various amounts of glycolato silicate at ambient temperature with continuous stirring. It was characterized by FTIR, EDXRF and conductivity measurements. The colour removal property of biocomposite (*i.e.* sorption property) was determined by using biocomposite beads. Methylene blue was used as a model system. It can remove nearly 53 % of methylene blue from 0.01 g L^{-1} of methylene blue solution. It was also used in the uptake of metals (Cu^{2+}, Cd^{2+} and Zn^{2+}) by ion exchange reaction. Pure sodium alginate itself has an ability to bind multivalent cations but the biocomposite could result in enhancing the metal binding capacity. The investigation was carried out up to a definite pH value for a particular metal ion to prevent the hydrolysis of metal ions.

pH 4 is the most probable condition. This result is helpful to select the optimum pH at which metal binding selectivity can be done by using ions mixture solution. The biocomposite with the highest silicate content (16 %) has the binding capacity of 95.00 % for Cu^{2+}, 79.82 % for Cd^{2+} and 85.59 % for Zn^{2+} while the sodium alginate has 17.50 % for Cu^{2+}, 19.38 % for Cd^{2+} and 18.10 % for Zn^{2+} using maximum dose. The metal binding selectivity was also performed by using a solution of mixture of metal ions. From atomic absorption spectrometry data, it was found that biocomposite selects most pronouncedly the Cu^{2+} and least for Cd^{2+}. The ratios of metal binding selectivity of biocomposite can be deduced as Cu^{2+}: Zn^{2+}: Cd^{2+} = 6:4:1. One other application for this biocomposite is bioencapsulation of enzymes or cells. Cellulase (Commercial) enzyme and laccase enzyme are used to study the applications of this biocomposite. Although sodium alginate itself can entrap the enzyme, the use of silicon alginate biocomposite is more effective than sodium alginate.

Keywords: *Glycolato silicate, Biocomposite, Metal binding capacity, Metal binding selectivity, Immobilization*