Silica and alginate-based chitosan beads for removal of lead from water

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Large volumes of industrial discharges contaminate the water resources which often contains harmful organic and inorganic pollutants including heavy metals. The heavy metals get accumulated in the living organisms and finally reach humans. Removal of such contaminants is being addressed from different sources with limited success. Lead is one of the most conspicuous toxic heavy metals having dangerous environmental impacts as per toxicological criteria (Volesky and Holan 1995) which can affect multiple body systems especially in children. Exposure to lead can also results anaemia, hypertension, renal impairment, immunotoxicity and toxicity to the reproductive organs. Biopolymer based adsorbents such as chitosan can be used effectively to remove heavy metals from waste waters. Adsorption based techniques for removal of heavy metals are of high efficiency and economically feasible. Chitosan, a partially N-deacetylated product of chitin carrying positive charges, is an important natural biopolymer due to its biocompatibility and biodegradability.

Two types of chitosan beads were prepared in combination with silica (Bead I) and sodium alginate (Bead II) along with glutaraldehyde cross linking. The characteristics of beads viz., swelling behavior, amine content and pH buffering capacity were evaluated besides FTIR and SEM analysis. Batch adsorption studies of bead I and II were carried out for evaluating the lead (Pb) removal efficiency. Effect of pH (pH 3, 5, 7 & 9), dosage (0.25, 0.5, 1 & 2%) and initial lead concentration (5, 10, 15, 20 & 25 ppm) on the lead removal were also evaluated. The content of lead in water was analysed using Inductively Coupled Plasma photometer (ICP ICAD6300 Duo view, Thermo fisher, USA).

Both the bead types exhibited higher swelling behavior at acidic pH. Bead I exhibited a 326 % swelling at pH of 1.46, while bead II exhibited a 159% swelling at the same pH . Amine content of adsorbent was more in case of bead II (3.27 m mol/g) compared to bead I (0.21 m mol/g). The final pH was ranging from 3.32 to 7.41 during pH equilibration with 1mM

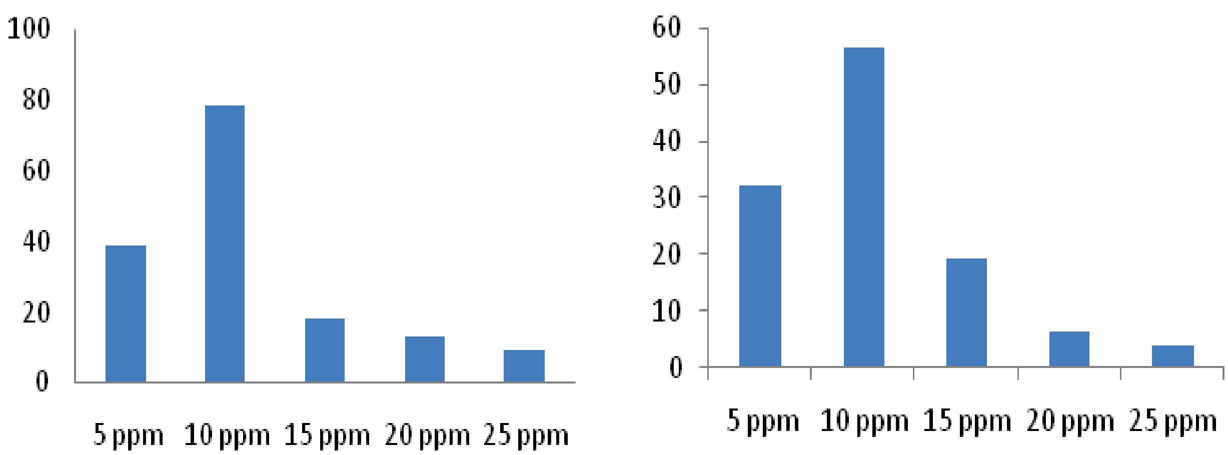

***Fig 2.** Effect of initial Pb concentration (Bead I) and (Bead II)*

to 0.1 mM HCl respectively for 180 minutes in case of bead I and in case of bead II, the final pH was ranging from 3.91 to 7.49 during pH equilibration under identical conditions. Pb removal efficiency was found maximum at pH 5 (95.5%), followed by pH 7 (87%) by bead I. While in bead II, maximum Pb removal efficiency was found at pH 7 (32.2%) followed by pH 9 (19.3%). Both the beads I and II showed maximum lead removal efficiency at dosage of 0.5%. Bead I showed maximum lead removal efficiency of 78.8% at initial concentration of 10 ppm, while bead II showed removal efficiency of 56.9% (Fig 2). Chitosan bead in combination with silica cross linked with glutaral - dehyde is efficient in removal of lead content from water in comparison to alginate-based beads.

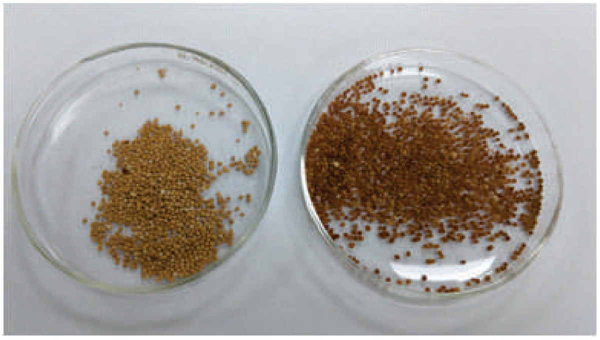

Fig 1. *Chitosan silica bead (Bead 1) and chitosan alginate bead (Bead 2)*

Reference

B. Volesky and Z.R. Holan. (1995)., Biosorption of Heavy Metals. Biotechnol. Prog, 11: 35–250.