Electrospraying of Alginate Micro-Beads

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Statement of Purpose: Controlled delivery of protein based biomolecules to repair diseased tissue or cells is always challenging due to their short half-life in the circulatory system, low permeability, rapid proteolysis and immunogenicity. Polymeric microbeads or microspheres provide more efficient drug accumulation at target sites in the human body. Many techniques proposed for preparation of polymeric microspheres for drug administration rely on organic solvents which cause decrease in bioactivity in protein-based drugs and which are generally toxic and therefore require total removal. Thus there is a need for polymeric microbeads which can be formed without the use of organic solvents and which can load water soluble protein drugs in their natural state. For this purpose hydrogel microbeads are found best candidate for this application. Hydrogels have high water content and can be made via a cross-linked polymer networks. Various natural and synthetic polymers have been used to fabricate beads. Sodium alginate, a natural polymer extracted from seaweeds, has been investigated significantly as a drug delivery vehicle due to its low-toxicity, biocompatibility, and biodegradability. This research focuses on fabrication of magnesium/calcium crosslinked and encapsulated micro-beads by using electrospraying technique. We also analyzed released study of Mg^{++} and Ca^{++} from micro-beads.

Materials and Methods: Solutions containing 200-500mM Mg-gluconate/1% Na-alginate (MP Biomedicals) were prepared in deionized water (DI). These solutions were electrosprayed into a 50mM $CaCl_2$ solution using laboratory designed electrospray system (Spellman-CZE 1000R, 10kV, 7.1ml/hr). The beads were washed with D.I. water (3 times) and applied for released study in to 0.1 X phosphate buffer solution (PBS) solutions. Samples were collected for the desired time period and analyzed using inductively coupled plasma mass spectroscopy (ICP-MS). Hydrogel beads were viewed with an inverted light microscope to determine average bead diameter. The beads were then characterized in a scanning electron microscope (SEM, Hitachi SU8000) to observe the surface morphology of the beads.

Results and Discussion: Micro-beads were successfully produced using the electrospraying method. When introduced to a 0.1X PBS solution, the beads released Mg ions. The concentration of Mg ions in the PBS solution increased sharply in the first 12 hours, then leveled out until testing completion at 72 hours (Fig. 1A). Bead size was in the range of 200-500 microns, which was determined using inverted microscopy, and surface characterization was conducted using SEM.

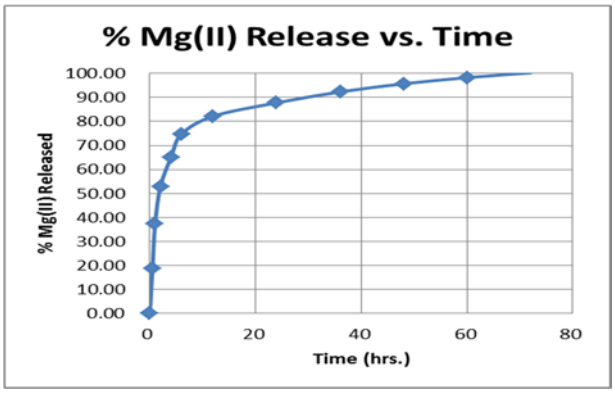

Figure 1. A) Release study of Mg ions via the micro beads in 0.1M PBS. Release data were obtained by using ICP-Mass

Conclusions: Using the electrospraying method, alginate micro-beads were fabricated. Adjustment of electrospraying parameters affected bead size. Mg^{++} were encapsulated via direct addition to the Na-alginate solution. Further research into the in-vivo testing is underway to ensure that the Mg ions are released via the porous hydrogel beads. These microbeads will eventually assist in wound healing applications.

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