Preparation and Characterization of an Oral Vaccine Formulation Using Electrosprayed Chitosan Microparticles

Chitosan particles loaded with the antigen ovalbumin (OVA) and the adjuvant Quil-A were produced by electrospray, using mixtures of water/ethanol/acetic acid as a solvent. Three different chitosans designed as HMC+70, HMC+85, and HMC+90 (called as 705010, 855010, and 905010) were tested and its efficacy to be used in oral vaccine delivery applications was investigated. The morphology, size, and zeta potential of the produced particles were investigated, together with the encapsulation efficiency and release of OVA from the three chitosan formulations. Moreover, the mucoadhesion and cytotoxicity of the chitosan microparticles was examined. All the three formulations with OVA and Quil-A were in the micrometer size range and had a positive zeta potential between 46 and 75 mV. Furthermore, all the three formulations displayed encapsulation efficiencies above 80% and the release of OVA over a period of 80 h was observed to be between 38 and 47%. None of the developed formulations exhibited high mucoadhesive properties, either cytotoxicity. The formulation prepared with HMC+70, OVA, and Quil-A had the highest stability within 2 h in buffer solution, as measured by dynamic light scattering. The electrosprayed formulation consisting of HMC+70 with OVA and Quil-A showed to be the most promising as an oral vaccine system.
The efficacy of chitosan (CS) to be used as drug delivery carrier has previously been reported. However, limited work has been pursued to produce stable and mucoadhesive CS electrosprayed particles for oral drug delivery, which is the aim of this study. Various CS types with different molecular weight (MW), degree of deacetylation (DD), and degree of polymerization (DP) were assessed. In addition, the effect of the solvent composition was also investigated. Results showed that stable CS electrosprayed particles can be produced by dissolving 3% w/v of low MW CS in mixtures of aqueous acetic acid and ethanol (50/50% v/v). The stable CS particles displayed diameters of approximately 1 μm as determined by dynamic light scattering. The zeta potential of these particles was found to be approximately 40 mV confirming the mucoadhesion properties of these CS electrosprayed particles and its potential to be used as drug delivery carrier.

**Development of electrosprayed mucoadhesive chitosan microparticles**

The efficacy of chitosan (CS) to be used as drug delivery carrier has previously been reported. However, limited work has been pursued to produce stable and mucoadhesive CS electrosprayed particles for oral drug delivery, which is the aim of this study. Various CS types with different molecular weight (MW), degree of deacetylation (DD), and degree of polymerization (DP) were assessed. In addition, the effect of the solvent composition was also investigated. Results showed that stable CS electrosprayed particles can be produced by dissolving 3% w/v of low MW CS in mixtures of aqueous acetic acid and ethanol (50/50% v/v). The stable CS particles displayed diameters of approximately 1 μm as determined by dynamic light scattering. The zeta potential of these particles was found to be approximately 40 mV confirming the mucoadhesion properties of these CS electrosprayed particles and its potential to be used as drug delivery carrier.
Morphological, Mechanical and Mucoadhesive Properties of Electrospun Chitosan/Phospholipid Hybrid Nanofibers

This study aimed to develop hybrid electrospun chitosan–phospholipid nanofibers and investigate the effect of phospholipid (P) content and chitosans (Ch) molecular weights (Mw) and degree of acetylation (DA), on the morphological, mechanical and mucoadhesive properties of the nanofibers. Electrospun Ch/P nanofibers exhibited a smooth and uniform surface with average diameters ranging from 300 to 1000 nm, as observed by scanning electron microscopy (SEM). The average diameter of the nanofibers was observed to increase with the increase of the Mw and degree of deacetylation of Ch, and phospholipid content. The elastic and adhesive properties of the nanofibers were determined by atomic force microscopy, and displayed higher values for higher Mw and lower DA Ch used. The elastic modulus of electrospun Ch/P hybrid fibers determined for the different conditions tested was found to be in the range of 500 and 1400 MPa. Furthermore, electrospun Ch/P nanofibers displayed mucoadhesive properties expressed by the work of adhesion calculated after the compression of the nanofibers against a section of pig small intestine. Our results showed that the increase in phospholipid content and DA of Ch decrease the work of adhesion, while the increase of Mw resulted in slightly higher work of adhesion of the nanofibers.
Chitosan/Phospholipids Hybrid Nanofibers and Hydrogels for Life Sciences Applications

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