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Development of electro-sprayed multi-composite particles for prospective drug delivery

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Abstract

Ever since the introduction and pharmaceutical development of antibiotics (~1940's), public health and well-being has improved significantly. (Hajipour MJ, 2012). However, due to drug misuse, mismanagement and poor patient compliance, bacterial antibiotic resistant now poses a serious threat to global healthcare. Antibiotic resistance is a new and upcoming threat to global healthcare. Many novel methods have been developed and tested to combat and prevent this resistance; one such technique involves the use of nanotechnology, specifically nanoparticles created using the Electro Hydrodynamic atomization (EHDA) technique (Huh AJ, 2011) and the use of metallic Nanoparticles (NP). Electrospraying process (ESy) is a method of atomizing droplets acquired by an electrically forced liquid (e.g. polymeric solution) jet through a needle/nozzle into a collecting platform. The advantages of such nanoparticles and nano-based drugs are enhanced bioavailability and better target-specificity. In this piece of work, we have successfully prepared PLGA and silver composite particle containing Amoxicillin (AMX) using the electrospraying technique. The morphology, chemical structure and the thermal behavior of the prepared formulations were investigated. The SEM images showed that particle sizes of the prepared particles are below 10 μm, which is essential for further biological use. The results confirmed that Amoxicillin was successfully entrapped in the prepared particles. A drug-delivery system consists of a formulation or a device that enables introduction of a therapeutic agent in the body and enhances its efficacy and safety by controlling the rate, time, and site of release within the body.1 This system is aimed at delivering and retaining a sufficient amount of drug for an adequate period of time, and it is also expected to avoid degradation of non-released drugs within the body. As a result, adverse effects associated with undesired fluctuations in drug concentration or ineffectiveness of damaged drug molecules can be alleviated. During the past few decades, polymeric micro/nanostructures have gained huge interest as drug-delivery systems. Drug delivery using polymeric micro/nanostructures is based on the principle that an increased surface area of the drug carrier enhances the drug-dissolution rate. Various methods have been employed to fabricate micro/nanostructures for drug-delivery purposes. For electrospinning, a strong electrical potential is applied to the polymer liquid (solution or melt), and as a result the electrical charges accumulate on the surface of the liquid droplet at the tip of the capillary. At a critical voltage, the Coulombic repulsion of the charges overcomes the surface tension of the polymer droplet, and a charged jet is ejected from the tip of the droplet. The jet travels towards a grounded electrode, while the solvent gets evaporated, and the resultant fibers are collected on a grounded target. Using the technique of electrospraying, the drawbacks associated with conventional particle-producing methods might be overcome. Similar to the electrospinning process, fabrication of drug-loaded polymeric particles via electrospraying can be performed using a solution of polymer and drug in a sufficiently conductive solvent. The principle of electrospraying is similar to the electrospinning process, and by altering the solution properties, eg, concentration, as well as processing parameters such as flow rate and applied voltage, a continuous and charged jet can be broken down into droplets, resulting in particles of different size and shape. This is especially required for incorporation of DNA, RNA, or GFs into the nanofibrous scaffolds for delivery of these biomacromolecules in a way very similar to the natural biological context. For this purpose, both the protein-release profile and bioactivity of the released protein need to be optimized. Also, the use of polymer blends or surface modification of nanofibers aiming to enhance the diffusion of medium to large drug molecules would bring additional advantages for TDDS. To date, most of the studies on drug release and cell nanofibrous membranes or cell–particle interactions have been performed in vitro, and in vivo studies are essentially needed to confirm the capability of the drug-loaded devices for clinical applications.

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