The First-aid strip of copolymer, produced by electrospinning

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ABSTRACT

In the study of biomimetic material design, mimicking nanostructured thin film components can take the place of the extracellular matrix. The new types of thin film were fabricated by polylactic acid (PLA) and Chlorhexidine composite nano-fibers with three different polylactic acid (PLA) to Chlorhexidine ratios (PLA: Chlorhexidine = 50:50 wt % and 90:10 wt %). The composite nano-fibers produced by electrospinning has high tensile strength. The materials analysis with nano-fibers was demonstrated via Fourier transform infrared (FT-IR) and scanning electron microscope (SEM). In the present study, we assessed the response of bacteria to different ratios of composite nano-fibers with regard to antibacterial activity and scanning electron microscope (SEM) observation. These results suggested that the composite nano-fibers have good antibacterial ability and release for a long period.

Keywords: polylactic acid (PLA), Chlorhexidine, electrospinning,

Introduction

Recent advances in biodegradable polymers have been spurred by intense interest in biomedical application [1,2]. Biodegradable polymers break down in physiological environments by macrmolecular chain scission into smaller fragments, and ultimately into simple stable end-products [3]. Degradable polymers derived from three monomers, lactide, glycolide and caprolactone, are commonly used clinically. They are characterized by degradation times ranging from days to years, depending on formulation and initial molecular weight [3,4,5]. Polylactide (PLA) is one of the most promising biodegradable polymers owing to its mechanical property profile, thermoplastic processibility and biological properties, such as biocompatibility and biogegradability. Electrospinning is interesting technique for spinning PLA . The process offers an excellent opportunity for designing the surface morphology and porosity of the fiber to provide the most appropriate interface for biomedical application [6,7]. Since it was introduced in the early 1930s, electrospinning has been activity explored due to its simplicity. It produces ultrafine polymers fibers with diameters typically in the range of several microns down to tens of nanometers.Electrospinning is the process in which a polymer solution is ejected from (i.e., syringe) that has a nozzle (i.e. needle or a capillary tube) directly attached to a high power supply. This power source generates a high voltage difference, usually selected between 5-30kV, which promotes the ejection of a liquid jet followed by solvent evaporation and the formation of a dry polymer fiber.

The majority of the studies on electrospinning fibers of PLA to add Chlorhexidine from solutions [8], we have reported that molecular structures and antiseptic of electrospinning nanofibers. Chlorhexidine is a chemical antiseptic. It kills (is bactericidal to) both gram-positive and gram-negative microbes, although it is less effective with some gram-negative microbes.It is also bacteriostatic. The mechanism of action is believed to be membrane disruption, and not ATPase inactivation as previously thought. Products containing chlorhexidine in high concentrations must be kept away from eyes (corneal ulcers) and the inner ear (deafness), although it is used in minute concentrations in some contact lens solutions.

Materials and method

Strains and chemical

Polylactic acid or polylactide (PLA) is a biodegradable, thermoplastic, aliphatic polyester derived from renewable resources, such as corn starch or sugarcanes The E. coli strain for antibacterial activity is XL1-blue. E. coli were purchased from ATCC amd stored at -80℃ prior to use. Chlorhexidine (CHX) (99%).

Electrospinning

The polymer fibers were injected using a 10ml glass syringe with a 20 needle gauge at a flow rate of 1 ml/hr, which was controlled using a pump and the high power supply. The equipment was attached to the needle tip through an alligator clip and a voltage difference of 25kV was used; the aluminum grounded target was placed at10 cm from the needle tip.

SEM

SEM was used to investigate the diameters of the fibers using a JOEL 6700. The samples were coated with a thin layer of palladium in two 30 secs consecutive cycles at 10mAwith the Desk II Denton Vacuum Cold Sputter.

FTIR

FTIR spectra were measured from 450 (cm^{-1}) to 4000 (cm^{-1}) wavelength. It measure the PLA fibers and PLA/ 50%Chlorhexidine fibers.

UV-OD

UV OD 600(nm) optical density measure the bacterial growth rate. Agilent 8453 UV-visible Spectroscopy System.

Result and Discussion

SEM micrographs of PLA and PLA containing 50% Chlorhexidine electrospinning fibers morphologies. The fibers diameters were calculate at micrometer degree. The PLA fibers diameters are large than containing 50% Chlorhexidine electrospinning fibers. Chlorhexidine can influence the viscidity pf the electrospinning fibers. The PLA fibers and PLA/ 0.5% Chlorhexidine fibers were characterized by FTIR in Fig: 3. The characteristic pecks of PLA fibers observed between 500 and 4000 cm^{-1} and PLA/ 0.5 %Chlorhexidine fibers also observed in the same range of PLA fibers. Both of the two fibers have the similar peaks in the FTIR results. The antibacterial activity of UV OD results in Fig.4. The ampicillin inhibits the bacteria growth (black line), the 50% Chlorhexidine inhibit bacteria growth 9 hours and start to growth from 9 hours (blue line), 10% Chlorhexidine as the same growth as (green line), PLA only. The (green line), PLA only sample is the control of the antibacterial activity experiments. The meshes size of the electrospiining fibers as the area of the cover slide.

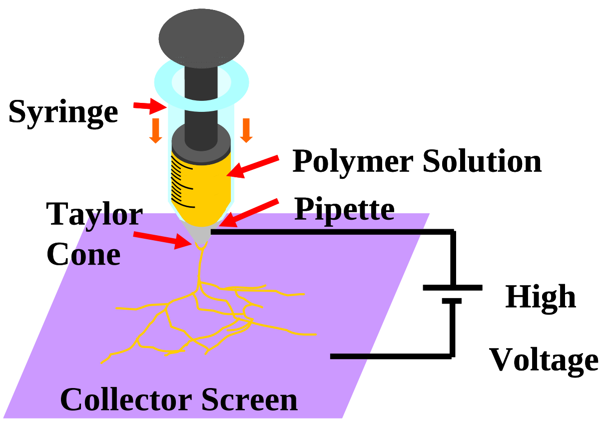
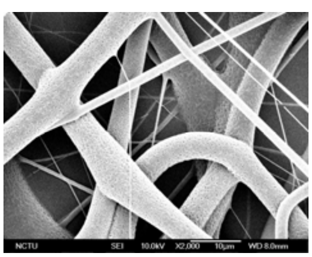
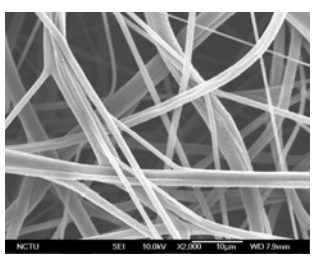


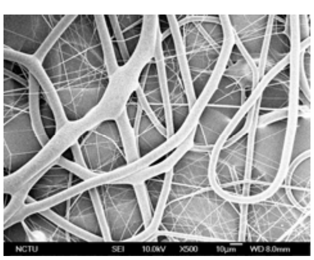
Figure 1: Electrospinning setup.



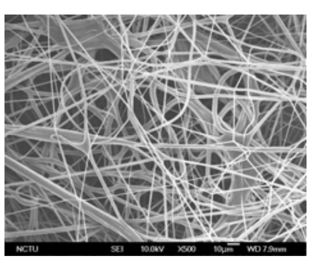
(A) PLA 500X



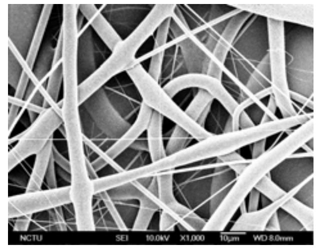
(D) 0.5% Chlorhexidine 500X



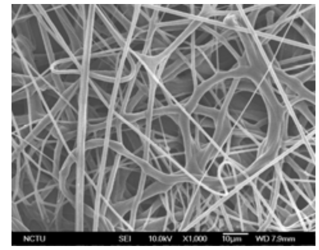
(B) PLA 1000X



(E) 0.5% Chlorhexidine 1000X



(C) PLA 2000X



(F) 0.5% Chlorhexidine 2000X

Fig: 2. Scanning electron micrographs of electrospinning PLA and PLA containing 50% Chlorhexidine. (A), PLA 500X (B), PLA 1000X (C), PLA 2000X (D), PLA/ 50%Chlorhexidine 500X (E), PLA/ 50%Chlorhexidine 1000X (F), PLA/ 50%Chlorhexidine 1000X.

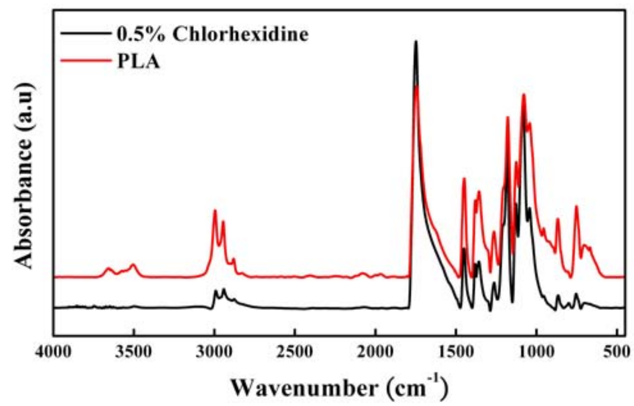


Fig: 3. FTIR spectra of PLA fibers and PLA/ 0.5%Chlorhexidine fibers.

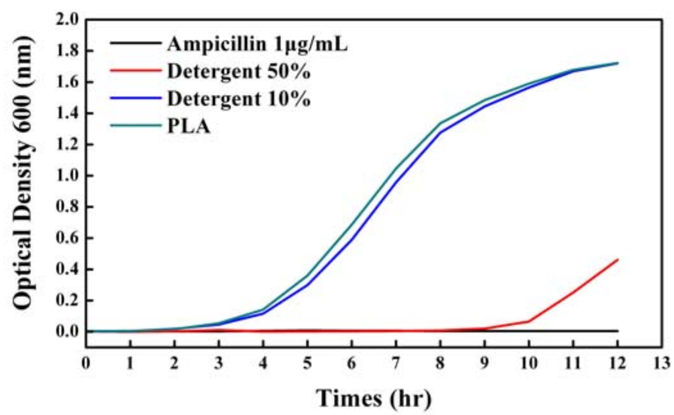


Fig: 4. antibacterial activity (black line), ampicillin 1 ug/ml (red line), 50% Chlorhexidine (blue line), 10% Chlorhexidine (greenline), PLA.

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