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Electrospinning of Gelatin Nanofibre: Current Trends in Tissue Engineering Applications

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Electrospinning is considered to be one of the most successful methods for producing nanofibres due to its versatility in terms of process flexibility and broader range of materials. Thus far, most of the works reported on electrospinning evolve on the synthetic biodegradable polymer for dozens of applications in medicine, energy, transportation and electronic devices. In biomedical applications, synthetic biodegradable polymers such as polyester regularly associated with poor biocompatibility and systemic or local reaction resulted from the acidic degradation products [1]. Therefore, naturally occurring polymers such gelatin has been widely explored due to its biocompatibility, biodegradability, hydrophilic in nature and commercial availability at low cost. Pure gelatin has successfully been electrospun using 2,2,2-trifluoroethanol into nanofibres with a diameter range of 100 to 340 nm [2]. However, pure gelatin electro spun nanofibre exhibited poor mechanical properties and even worse with the formation of beads. Beadsare known to be the defects in nanofibres, because they interrupt the uniformity in structure and property of electrospun nanofibres, and reduce the surface area to volume ratio. Nevertheless, the formation of beads in the gelatin nanofibres has been manipulated as drug reservoir for medical therapeutic applications as the beaded nanofibres prolonged the release of active compound compared to smooth nanofibres [3].

The blends of gelatin with other synthetic polymers have been generally practiced to improve the biomechanical properties of gelatin nanofibres. The gelatin electro spun together with PCL exhibited improved elasticity and strength [4]. Higher elasticity displayed by the composite made them better candidate for cartilage and skin graft applications. An improvement in tensile strength was observed upon inclusion of Biphasic Calcium Phosphate (BCP) into the electrospun gelatin-PVA composite [5]. The interfacial adhesion between BCP and gelatin-PVA blends provided a new composite with higher rigidity and stiffness. The incorporation of BCP into the gelatin blends was found to enhance the osteoblast proliferation. This makes the BCP-gelatin-PVA to be potentially advantageous material for bone tissue regeneration. The gelatin was also blended with minerals and electro spun into a biocomposite nanofibre for artificial bone application [6]. The mineralization of gelatin with calcium (Ca) and phosphate (P) accelerated the formation of crystal bone-like apatite on the surface of the gelatin-Ca-P composite nanofibre upon immersion in a Simulated Body Fluid (SBF) with the ion concentration nearly equal to that of human blood plasma. The ability of gelatin-Ca-P to crystallize the bone-like apatite was considered to be a great achievement as it mimicked the living bone. In another study, alginate hydrogel was reinforced with gelatin nanofibre to form nanofibre-reinforced hydrogel to mimic the microstructure of the corneal Extracellular Matrix (ECM) [7]. The nanofibre composite exhibited high potential as scaffold for corneal tissue engineering due to its robust mechanical properties and optical transparency. Despite of the recent advances of gelatin nanofibres in tissue engineering, still there remain several challenges including rapid degradation into the buffer solutions and poor mechanical properties in wet condition. In conclusion, further studies on the development optimum gelatin nanofibres that can meet the special needs in tissue engineering applications are highly desired.

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