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Porous poly(DL-lactic acid) matrix film with antimicrobial activities for wound dressing application

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ABSTRACT

Poly(lactic acid) (PLA) is polymeric biomaterial that has been used for wound dressing due to its biodegradability and biocompatibility. However, PLA has some limitations including poor toughness, low degradation rate and high hydrophobicity. The aim of this study is to develop an antibiotic drug-loaded PLA porous film as wound dressing with antibacterial activity. PLA porous film was fabricated by temperature change technique using solvent casting method. Polyethylene glycol (PEG) 400 was added for improving the pore interconnectivity of film. Gentamicin sulfate (GS) or metronidazole (MZ) was incorporated into PLA porous films. PLA containing PEG 400 exhibited the more amorphous form than plain PLA film and contained 55.31 ± 2.85% porosity and 20 μm of the pore size which significantly improved the water vapor transmission rate, oxygen transmission rate, degradation rate and percentage of drug release, respectively. Drug-loaded porous films efficiently inhibited the bacteria growth. GS-loaded film inhibited *Staphylococcus aureus, Proteus mirabilis, Pseudomonas aeruginosa* , whereas MZ-loaded film inhibited *Bacteroides fragilis* and the sustainable antibacterial activity was attained for 7 days.

1. Introduction

Infection is a common problem in chronic wounds which have the complex microbiological environments. The initial wound is habitat of the coagulase-negative staphylococci, *Streptococcus* spp., *Corynebacterium* spp., and *Staphylococcus aureus*. Afterwards, usually days to weeks later the facultative anaerobic Gram-negative bacilli, such as *Escherichia coli*, *Klebsiella* spp. or *Proteus* spp. settle down. The frequent anaerobic colonizers include *Prevotella*, *Bacteroides*, *Peptostreptococcus* and *Porphyromonas*[1,2]. Normally, the major indications for beginning topical antibiotics are for superficial compartment infections or critical colonization [2]. However, superficial acute wounds from dermatologic procedures were customarily treated with the prophylactic topical antibiotics which resulted in a decreased infection rates and improved the healing [3]. Topical antibiotics commonly used in wound infections include bacitracin, mupirocin, retapamulin, neomycin, erythromycin, gentamicin, polymyxin, indolmycin, nadifloxacin, rifalazil and fusidic acid [4]. In addition, the short course treatment with metronidazole gel for odoriferous ulcers was already accepted [1].

For effective local treatment, it is essential to choose a suitable dressing. The consideration for the choice of wound dressings is based on their debridement. They should provide or maintain the moist wound environment, gaseous exchange and thermal insulation. The excess exudates should be absorbed without leakage. Trauma/pain should be avoided in dressing changes from wounds. They should prevent the infection and minimize the toxicity to surrounding skin [5–7]. Accordingly, a porous structure comprising of additional layers of the dressing can reduce the wound contact area to avoid an adherence when the wound is dried.

Antimicrobial polymeric materials have attracted a tremendous interest because of their great potential in many applications. There are many techniques to achieve these aimed materials, such as self-assembly of polymers, emulsion-evaporation, precipitation, electrospinning, spray, gelation and polymerization. These technologies can be employed with antimicrobial polymers or loading antimicrobial compounds to establish antimicrobial delivery systems or used as combination for a synergic effect. The application of these materials including biomedical devices, packages of food or healthcare products, textiles, cosmetics and membranes for water remediation [8]. Poly(lactic acid) (PLA) is polymeric biomaterial that is used for wound dressing [9–11], due to its biodegradability, biocompatibility and thermal processability. However, PLA has some limitations including poor toughness, low degradation rate and high hydrophobicity [12–14]. Many researches have been carried out to overcome these problems, for instance, by using copolymers and polymer blends [15–20]. Nanofibrous mats prepared from poly(L-lactide) (PLLA) and gelatin/PLLA solutions controlled the evaporative water loss and promoted the fluid drainage ability with excellent biocompatibility [16].

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