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ORIGINAL PAPER

Manufacturing and structural analysis of antimicrobial kefiran/polyethylene oxide nanofibers for food packaging

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Abstract Kefiran, a branched glucogalactan, is a useful microbial polysaccharide produced by lactic acid bacteria. The aim of this study was to evaluate the antimicrobial activity of kefiran nanofibers as a biocontrol agent for food packaging as well as food preservation. Thus, kefiran/polyethylene oxide (PEO) nanofibers were fabricated using the electrospinning method. Kefiran was produced from raw milk with 0.5% fat and 10 g of kefir grain and was separated from it by ethanol. Structural analysis of kefiran was detected by means of nuclear magnetic resonance and Fourier transforms infrared spectroscopy (FTIR). Antimicrobial properties of kefiran were assayed against *Rhizoctonia*, *Pseudomonas* sp. (isolated from soil at Isfahan University) and *Staphylococcus aureus* (*S. aureus*). Electrospun kefiran/PEO nanofibers were characterized by scanning electron microscopy, optical microscopy and ATR-FTIR techniques. Hydrophilicity and in vitro biodegradation of the kefiran/PEO nanofibers were investigated, as well. The results showed that the mean diameter of the nanofibers was 607.5 nm. The contact angle measurement result was 51.5° ± 0.71 with normal hydrophilicity. First of all, antimicrobial properties of kefiran were confirmed against different types of microorganisms. Moreover, the result obtained in this study showed that kefiran/PEO nanofibers with oxidizing functional groups on them have antimicrobial activity against *S. aureus*. Biodegradation of kefiran/PEO nanofibers was also confirmed by FTIR.

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Introduction

In electrospinning, electrostatic forces is used to produce polymeric, ceramic and composite continuous ultrafine fibers with diameters ranging from microns to few nanometers. This technique is versatile, simple and convenient [1]. Using this method, many kinds of nanofibers from polymers, e.g., polyethylene oxide (PEO), polyacrylonitrile (PAN) and polyvinyl alcohol (PVA), have been made with optoelectronic properties.

Electrospun nanofibers can simulate the nanofibrous structure of the native extracellular matrix. Moreover, the scaffolds produced by electrospinning offer a high surface area to volume ratio, high length/diameter ratio which would improve mechanical performance and flexibility in surface functionalities. There has been much interest in extending this technique to prepare uniform fibers with novel compositions and morphologies for several applications [2].

In recent years, increasing demand for natural polymers in several applications has led to interest in exopolysaccharides of microorganisms [3, 4]. Some of the microbial polysaccharide characteristics are biological degradation, biocompatibility, cost-effectiveness, availability, and similarity to extracellular matrix, their capability of inherent cellular reaction and connectivity to cells [5]. They are applied in food, pharmaceutical, and chemical industries as bioflocculants, bioabsorbents, heavy metal removal agents, and drug delivery agents.

Lactic acid bacteria that excrete polysaccharide with high molecular weight have been extensively studied in