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Chitosan/banana peel powder nanocomposites for wound dressing application: Preparation and characterization

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ABSTRACT

Wound infection is a serious infection has been spread worldwide. In order to provide fast aid treatments for such infection, banana peels have been incorporated within chitosan as wound dressing. Banana was collected from Egyptian markets peeled and the dried peels were grounded to powder, Incorporated as nano fillers within chitosan matrix with different concentrations (0, 2, 5 and 10 wt%). Glycerol was added as plasticizer and crosslinker to the membranes. The banana peel powder (BPP) particle shape and size were determined using Transmission Electron Microscope (TEM), The homogeneity and distribution of BPP in the membranes were investigated through Scanning Electron Microscope (SEM). The interaction between BPP and chitosan was characterized by Fourier Transform Infrared (FTIR). The dielectric properties of chitosan and BPP-chitosan membranes studied via dielectric constant, dielectric loss and conductivity measurements over a frequency range 100 Hz up to 100 kHz. The curves relating ε″ and the applied frequency are broad enough reflecting more than one relaxation process. These processes may be attributed to the relaxation processes of the main chain and its related motions. The higher values of ε″ at low frequency range may be a combination of the losses due to the electrical conductivity and the interfacial polarization process called "Maxwell Wagner Sillers" effect. By increasing BPP content in the sample a pronounced shift towards lower frequency was noticed. This shift may be due to some sort of polymer/filler interaction which causes an increase in the relaxed units and consequently the relaxation time. The addition of BPP decreases the swelling degree of chitosan matrix. The antimicrobial properties of the membranes were done against Gram positive, Gram negative bacteria and yeast. The results showed that chitosan/BPP membranes have a synergistic action with the highest activity at 10 wt%. Moreover, *Candida albicans* was the most sensitive strain recorded for these membranes.

1. Introduction

Many Pharmaceutical formulations are used as dressings for wounds and burns such as ointments, gels, sprays, and polymer films. However, the microbial contamination is the most confront of using these materials. Severe complications may result from these infections like premature device failure, tissue destruction, or the spread of the infection to other areas [1].

Perfect injury dressing materials must give protection against microbes, it must be nonallergic, nontoxic, nonadherent to the injury and effortlessly evacuated, retain wound scent and overabundance exudates [2].

Polymeric materials including manufactured or natural were utilized to treat the harmed area and shield the injury and blaze tissues from external factors [3].

Chitosan, produced from deacetylation of chitin, it is a linear polysaccharide composed of randomly distributed β-(1-4)-linked D-glucosamine and N-acetyl-D-glucosamine [4]. It has a lot of medical applications because of its biocompatibility and hemocompatibility, low toxicity and its biodegradation products [5,6]. Chitosan films have been assessed as curative wound dressing and also as scaffolds for tissue engineering [7]. Moreover, it has a role in industrial food application, as coating for extending shelf-life and as food preservative [8]. The weak mechanical properties are a disadvantage of using this polymer as a wound dressing. A variety of trials are provided to overcome the shortcoming of chitosan based polymeric films [9].

Chellamani et al., developed wound care materials from Poly vinyl alcohol (PVA) blended with chitosan using electrospinning technique. The time taken for wound healing when using these composites is just 50% of that in the case of an open wound [10].

Biodegradable composite films based on chitosan and lignin were prepared and studied by Chen Long et al., to be used in food packaging or wound dressings. Results indicate that the tensile strength, storage

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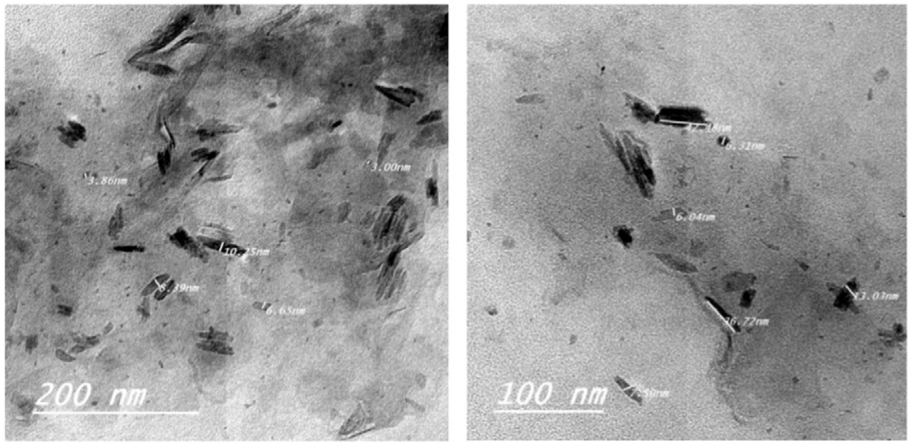

Fig. 1. TEM micrographs for banana peel powder

modulus, thermal degradation temperature and Tg of chitosan have been mainly enhanced by adding lignin [11].

Banana peels represent 40% of the total weight of fresh banana [12]. These peels when decomposed may produce toxic gases such as hydrogen sulphide and ammonia. Application of banana peels as food for livestock can create severe environmental hazard [13]. There is slight mention of their use in the literature. Onkuwa et al., used them for production of methane [14]. Palma et al., for the production of bioadsorbant for dyes in wastewater [15]. Emaga et al., reported that pectin extracted from banana peel could use as a gelling agent in food industry [16].

According to several authors, banana peel has stronger antioxidant activity, greater phenolic compounds and higher minerals content than banana pulp [17] additionally, banana peels were evaluated as powerful antimicrobial activity against bacteria, fungi and yeast [18–20].

Banana peels are usually used as a home medication for many skin problems such as allergies, bruises and skin irritation. It can treat acne, treat poison ivy rashes irritation from mosquito bites, cure warts and reduce wrinkles.

Franco et al., studied the antibacterial activity of chitosan membranes associated with banana peels extract. Their results demonstrated that the membranes can inhibit *S. aureus* and *E. coli* growth by contacting [21].

The aim of this work is to prepare new nanocomposites from chitosan and banana peel powder with different concentrations. Characterize the new nanocomposite by different tools such as FTIR, TEM, SEM, dielectric spectroscopy, swelling properties, in addition to study the antimicrobial effect of these membranes against different microorganisms especially that involved in skin infection as *Candida albicans*, MDR *Staphylococcus aureus* and *Pseudomonas aeurigonsa* in order to evaluate these membranes as wound dressing materials.

2. Materials and method

2.1. Materials

Chitosan: poly(D-glucosamine), beta-(1,4)-2-Amino-2-deoxy-D-glucose ($C_6H_{11}NO_4$)n (degree of deacetylation (DD) = 75–92%). Houston, Texas USA.

Glycerol anhydrous (1,2,3-propanetriol) supplied from Biochemika-Fluka, Germany.

2.1.1. Strains and culture condition

2.1.1.1. Strains and culture condition. The strains used in this study were *Staphylococcus aureus* ATCC 25923, *Escherichia coli* ATCC 25988, *Pseudomonas aeruginosa* ATCC 25619 and *Candida albicans* ATCC10231.

Multi-drug resistant bacteria with ability of biofilm formation were used in this study as follows *E. coli*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Acinetobacter* sp.

2.1.1.2. Preparation of banana peel powder. The banana peels were collected, washed by water to remove dirt, cut into small pieces and dried in oven at 120 °C for 24 h. After drying, the peels grounded by micro grinder. Then the grounded peels were sieved to obtain steady particle size and stored at room temperature in plastic container until use.

2.1.1.3. Preparation of chitosan and chitosan dopped BPP membranes. 1 g of chitosan powder dissolved in a 2% aqueous acetic acid solution under continuous stirring for 4 h at room temperature. 1 ml of glycerol added as crosslinker and plasticizer. The chitosan solution was cast into Teflon mold and dried at 40 °C for 24 h to evaporate the solvent and form the membranes. The prepared membranes were peeled off

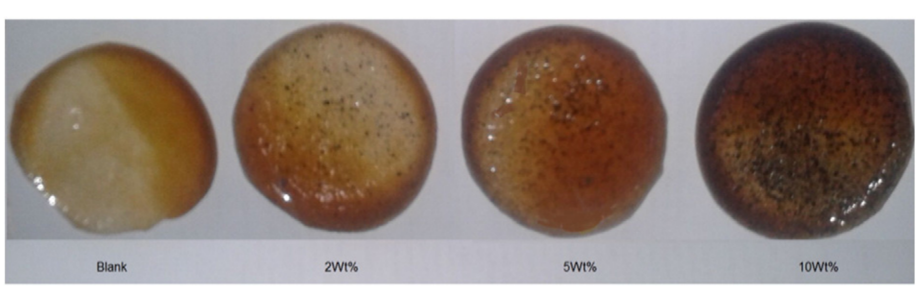

Fig. 2. Optical photograph of the chitosan and chit-BPP membranes.