ANTIBACTERIAL PROPERTY OF CHITOSAN/ACRYLIC LAMINATE PAD

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EXTENDED ABSTRACT

Skin injury from burns is an awful condition that leads to an increase of fluid loss, hypothermia, scarring and infections. Despite advances in therapy, infections remain a major cause of morbidity and mortality in burn patients. In recent years, wound dressing has developed according to the pathogenesis of different wound. Different types of wound dressing including xerogels, charcoal cloth, alginates, chitosan, and hydrogels have been introduced for this purpose through the last decades. Recently, many researchers have focused on the use of biological materials like chitin and chitosan. Chitosan is a versatile biopolymer rendering it a variety of applications including wound dressing film. However, in a form of film, chitosan possesses poor mechanical properties including tear strength and handle ability. For this reason, chitosan/acrylic laminate pad was prepared, aiming at the wound dressing pad with antibacterial performance. In this work, we prepared chitosan/acrylic laminate pad using a casting method. Chitosan solution was prepared by dissolving chitosan 1% (w/v) in 1% (v/v) acetic acid solution. Then, chitosan solution was poured onto a precast acrylic film (prepared from acrylic emulsion) and allowed to completely dry at room temperature for a couple of days to achieve transparent and flexible laminate film. This film exhibited fast water absorption without loss of mechanical properties. Based on this property, the chitosan/acrylic laminate film is potential for wound dressing application. Antibacterial activity against *Staphylococcus aureus* (ATCC 6538P) of samples was carried out by disk diffusion method on an agar plate. Diameter of the zone of inhibition was measured as per the standard test procedure. The antibacterial activity of the chitosan/acrylic laminate film against *S. aureus* was achieved as expected.

Key Words: chitosan, acrylic, antibacterial activity, laminate film

1. INTRODUCTION

Skin lesions are traumatic conditions that lead to an increase of fluid loss, hypothermia, scarring, locally immunocompromised regions, infections, and a change of body image. Despite advances in therapy, infections remain a leading cause of morbidity and mortality in burn patients [1]. In recent years, wound dressing has evolved according to the pathogenesis of different wounds .Different types of wound dressing including xerogels, charcoal cloth, alginates, chitosan, and hydrogels have been introduced for this purpose through the last decades. Recently, many researchers have focused on the use of biological materials like chitin and chitosan [2].

The chemical structure of chitosan is similar to that of cellulose, differing only in the second carbon position where the hydroxy groups are replaced by an amino acetyl group. Chitosan is the deacetylated form of chitin [3]. Chitosan is not soluble in organic solvents because it has a rigid crystalline structure due to intra -and inter-molecular hydrogen bonds. As a consequence, an acid such as acetic acid is required to break hydrogen bonds to facilitate dissolution [4]. After dissolution in diluted organic and inorganic acids, it forms viscous polyelectrolytes. Chitosan solution are employed for the preparation of fiber, film and coatings [5]. Chitosan has a combination of many unique properties, such as biodegradability, biocompatibility, non-toxicity, wound healing and antimicrobial activity [6]. Chitosan has got wide applications in various fields such as chemistry, biochemistry, medicine, pharmacology, biotechnology, food and textile [3]. In a form of film, chitosan possesses poor mechanical properties including tear strength and handleability.

In this work, easy-to-use chitosan laminate film was prepared by coating chitosan film onto precast acrylic film. Transparent and flexible chitosan/acrylic laminated film was obtained. Water absorption capability was evaluated. Finally, antibacterial activity of the laminate film against *Staphylococcus aureus* was carried out.

2. EXPERIMENTAL

2.1 Materials and Methods

Commercial-grade chitosan flake (85% degree of deacetylation) with a molecular weight of about 106 Da was purchased from Ebase Co., Ltd. Acrylic emulsion (10 wt%) was synthesized in our laboratory using methyl methacrylate and polyvinyl alcohol as protective colloid.

2.2 Preparation of Chitosan/Acrylic Laminate Film

Ten grams of acrylic emulsion was poured into a rectangular glass mold (5 in x 5 in) and left standing for 3 days to obtain transparent acrylic film. Then, 1 wt% chitosan solutions (5 g, 10 g, and 15 g) were put on top of acrylic film and left standing for 2 days to obtain chitosan/acrylic laminate film.

2.3 Characterizations and Testing

Antibacterial activity of samples was carried out by disk diffusion method on an agar plate. Diameter of the zone of inhibition was measured as per the standard test procedure ATCC 6538P. To prepare an agar plate, the agar plate was prepared by pouring the solid culture onto sterile circular plates and allowing it to solidify in the Stericlean Vertical Laminar Flow chamber. One hundred microliters of bacterial culture was uniformly distributed on each plate. Five millimeter disks of samples were placed on the plates. The plates were then placed in an incubator for 24 h at 37 °C. The zone of inhibition was then measured and recorded.

3. RESULTS AND DISCUSSION

3.1 Physical Appearance of Acrylic Emulsion and Morphology of Chitosan/Acrylic Laminate Film

Stable acrylic emulsion was successfully prepared (Figure 1a). Consequently, flexible and transparent film is achievable . Coating of chitosan layer onto acrylic film results in chitosan/acrylic laminate film which is flexible and transparent (Figure 1b). In addition, this film exhibits good water absorption (Figure 1c). Based on this properties, the chitosan/acrylic laminate film is potential for wound dressing application.

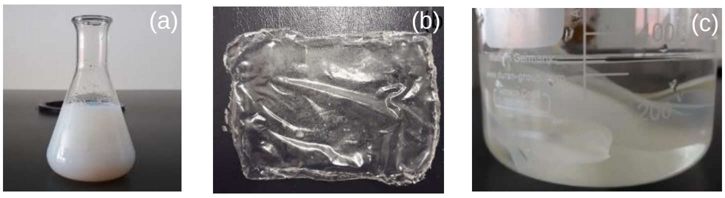

Figure 1. Acrylic emulsion (a), Chitosan/acrylic laminate film (b), Water uptake of chitosan/acrylic laminate film

3.2 Antibacterial activity

Zones of inhibition for samples against *S. aureus* are demonstrated in Figure 2. As shown, acrylic film (Figure 2a) has no antimicrobial activity whilst chitosan/acrylic laminate film (Figure 2b, acrylic side and Figure 2c, chitosan side) exhibits antibacterial activity with the observation of wide clear zone, indicating that chitosan has diffusion capability.

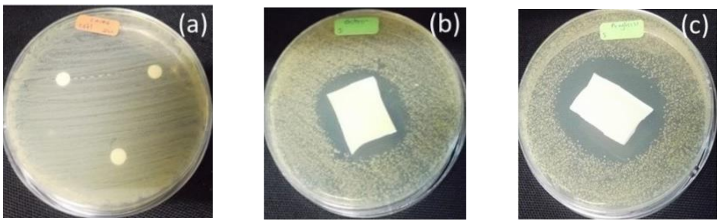

Figure 2. Zones of inhibition for samples against *S .aureus*: acrylic film (a), chitosan/acrylic laminate film (acrylic side) (b), chitosan/acrylic laminate film (chitosan side) (c)

4. CONCLUSIONS

Chitosan/acrylic laminate film was successfully prepared. This film is flexible and transparent. Moreover, the water absorption performance is excellent. Antibacterial activity against *S. aureus* was found. Therefore, this film has potential for wound dressing application.

5. ACKNOWLEDGEMENT

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6. REFERENCES

1. Wyzocki, A.B., Evaluating and managing open skin wounds: Colonization versus infection, *AACN Clinical Issues*, 2002, Vol.13, No.3, 382-397.
2. Ribeiro, M. P. et al, Development of a new chitosan hydrogel for wound dressing, *Wound Repair and Regeneration*, 2009, Vol.17, No.6, 817-824.
3. Oktem, T., Surface treatment of cotton fabrics with chitosan, *Coloration Technology*, 2003, Vol.119, No.4, 241-246.
4. Harkins, A.L., Duri, S., Kloth, L.C., and Tran, C.D., Chitosan–cellulose composite for wound dressing material. Part 2. Antibacterial activity blood absorption ability, and biocompatibility, *Journal of Biomedical Materials Research Part B: Applied Biomaterials*, 2014, Vol.102, No.6, 1199-1206.
5. Sanandam, M.; Salunkhe, A.; Shejale, K.; Patil, D., Chitosan bandage for faster blood clotting and wound healing, *International Journal of Advanced Biotechnology and Research*, 2013**,** Vol.4, No.1, 47-50.
6. Hirano, S., *Chitin and chitosan*, *Elsevier Applied Science, London, UK.*, 2013, 51-69.