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Original Article

Praparation of Tannin Based Hydrogel for Biological Application

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Abstract:

Polymeric blends as potential wound dressing were prepared. Natural polymer (Tannin) and synthetic polymers (PVA and PEG) used to prepared heterogeneous blends. The product was identified by spectrophotometry. A diaphragm cell was used to measure the diffusion coefficient (D). The result showed that the PEG-PVA disk was faster in permeability for all solution. The D of PVA/ PEG-Tannin blend was 0.184×10-3 cm^2/s higher than Tannin-PEG blend was 0.038×10^{-3} cm^2/s. The natural phenolic compounds can be used as artificial membrane to inhibit growth or kill microorganism such as bacteria or fungi.

Keyword: Diffusion Coefficient; Polymeric blend; Tannin.
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1. Introduction

A wound dressing is applied to stop bleeding, absorb exudates, ease pain and facilitate epiderm resurfacing. Generally the type of dressing used in particular situation is based on its adhesiveness and transparency [1]. A varity of biological polymers including collagen, fibrin, fibronectin and hyaluronic acid have been studied as dressings for dermal wounds.

Unlike synthetic polymers, which at the very best act as inert coverings for the wound, biological polymers have unique properties that play a role in normal wound healing. Synthetic polymers can be easily manufactured using conventional technologies into films, fibers, sheets and sponges. For this reason these materials have received attention as potential wound dressings for deep wounds, and natural polymers have been developed for biomedical applications [2].

Polymeric blends are produced by physical mixing of two or more existing polymers. It is a convenient route to develop new polymeric materials, which combine the properties of more than one existing polymer. A wide range of material properties can be obtained by changing the blend composition. Polymer blends are either homogeneous or heterogeneous. In homogeneous blends, both blend components lose parts of their identity and the final properties usually are the arithmetical average of both blend components. In heterogeneous blends, on the

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other hand, the properties of all blend components are present [3].

The hydrophilic property of polymers was used to modify the surfaces of catheter materials with reduced bacterial adhesion and less encrustation. The adherence of hydrophobic *enterococcus faecalis* isolate to the polyvinyl pyrrolidone (PVP) coated polyurethane was significantly less than adherence to uncoated polyurethane [4]. Tannins are polyphenolic compounds which have defence mechanisms against insects and microbes by binding to extracellular polymer, causing substrate and ion deprivation and by inhibiting enzymes [5]. The dressings are used as coverings for deep (full-thickness) burns and skin ulcers. In these applications, synthetic polymeric dressings create an inert environment that controls water and passage from the wound while preventing bacterial infiltration [6].

The goal of use of natural phenolic compounds topically is to inhibit or kills microorganism such bacteria and fungi. Polyphenolic compounds (Tannins), extracted from different part of plants, can be used against fungi (cultures of *Gliocladium reseum*) [7]. The essential oil and phenolic acid extracts of pepperfruit inhibited the growth of tomato-rot fungi, and the extracts of higher plants contain a variety of phenolics and essential oil that have inhibitory effects against microorganisms [8].

2. Material and methods

2.1. Materials

Poly ethylene glycol (PEG), poly vinyl alcohol (PVA), tannic acid, salicylic acid, sodium bicarbonate were all of pharmaceutical grade available in local market.

2.2. Preparation of PVA-PEG blend

Two-necked flask equipped with mechanical stirrer and condenser, was charged with (0.44 g; 0.01 mol) of PEG dissolved in 10 ml water, 0.5 ml of diluted H2SO4 (10%) and (0.45 g; 0.01 mol) of PVA. The mixture was refluxed with vigorous stirring. The reaction was continued for 1 h then cooled and neutralized by 10% $NaHCO_3$ and the solvent was evaporated. The product was dissolved in ethanol and filtered to remove the salt. Care was taken to eliminate entrapment of air bubbles during mixing process. The mixture was used to obtain a membrane by the conventional solution casting method at room temperature [1].

2.3. Preparation of PEG-Tannin blend

Tannic acid (2.98 g; 0.01 mol) was dissolved in 10 ml water in tow-necked flask, then a solution (0.44 g, 0.01 mol) of PEG in 10 ml water was added. The reaction mixture was refluxed for 1 h with vigorous mechanical stirring, and after cooling the solvent was evaporated at room temperature to obtain a membrane [2].

2.4. Preparation of PVA-PEG-Tannin blend

PVA-PEG blend (0.89 g; 0.01 mol) was dissolved in 10 ml water, after complete dissolution, (2.98 g; 0.01 mol) of tannin was added with mechaniccal stirring. The mixture was reflexed for 1 h, and then cooled and the solvent was evaporated at room temperature. The membrane was obtained by the conventional casting method temperature [3].

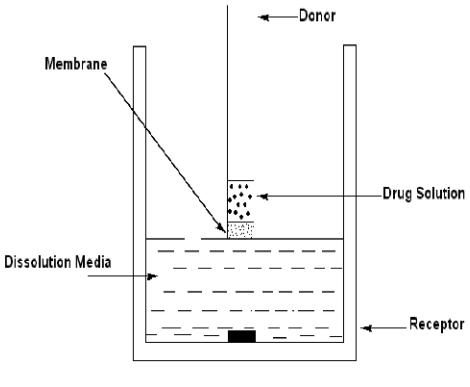

Figure 1. Diaphragm of the cell used to measure diffusion coefficient.

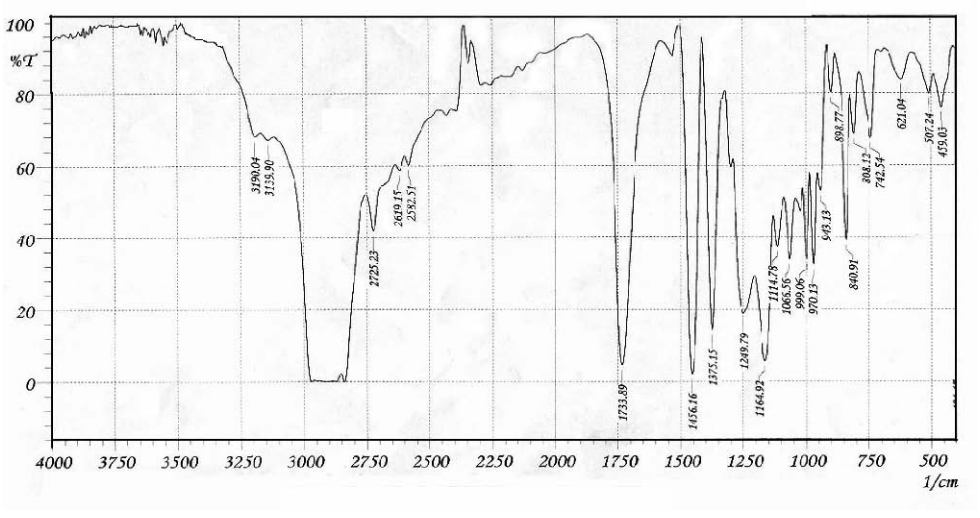

Figure 2. Show IR spectre of PEG-PVA copolymer..

2.5. Measurment of diffusion coefficient

A diaphragm cell shown in Figure 1 was used to measure the diffusion coefficient. The cell consisted of two chambers separated by the hydrogel (≈0.2-mm thick). The first chamber, donor, contained 5 ml of salicylic acid (SA) solution in water (1.6 mg/ml). The other chamber consisted of distilled water (receptor). The system was placed in a constant- temperature water bath [9]. A pipette was used to draw 0.1 ml sample from donor and 1.0 ml sample from the receptor compartment periodically. The samples withdrawn were replaced by the same amount of distilled water. The samples were analyzed by acidic ferric chloride solution at (λ= 450 nm) to determine the concentration of SA in each chamber as a function of time. The diffusion coefficient (D) of the drug through the hydrogel was calculated.

3. Result and discussion

The composition of the PVA/PEG copolymer, PVA/ Tannin and copolymer/ Tannin were evaluated by FT.IR spectroscopy by KBr disk in 500-4000 cm^{-1} region. The free OH vibration occurs as a sharp IR peak at above 3600 cm^{-1}. The OH peak is broadened

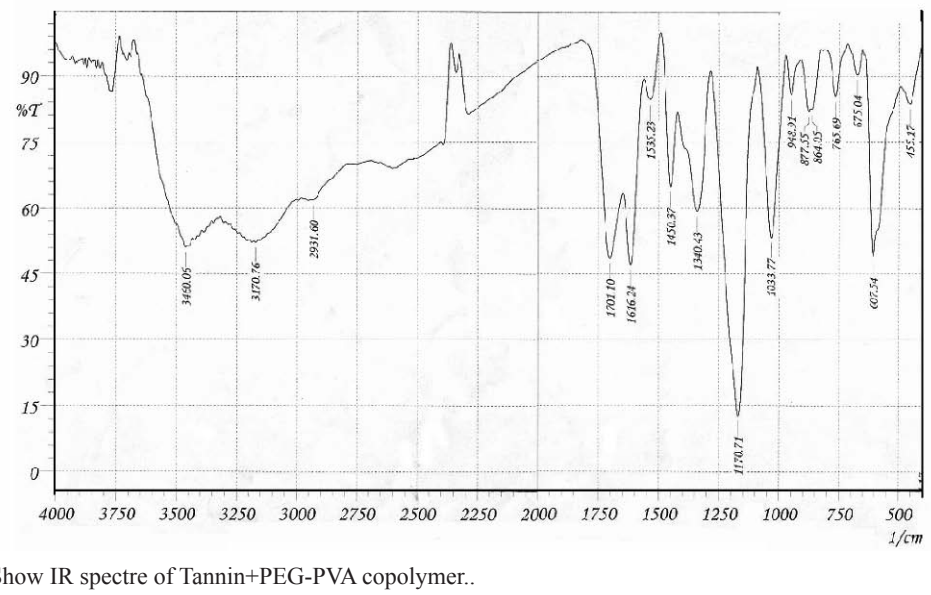

Figure 3. Show IR spectre of Tannin+PEG-PVA copolymer..

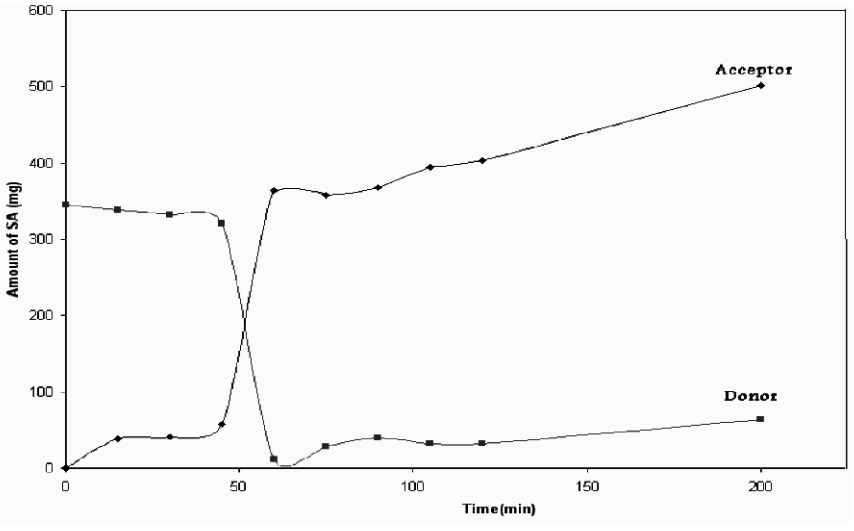

Figure 4. The effect of time of permability of SA in donor and receptor cells (PEG-PVA/ Tannin membrane).

and shifted to 3500-2500 cm^{-1} due to various types of hydrogen bond formation and the interaction can be intermolecular, intramolecular or both. As a result of formation of hydrogen bonds, the streach peak of OH shifts to lower frequency from the unassociated sharp absorption at 3600 cm^{-1}. The peaks at 1415 cm^{-1} and 1325 cm^{-1} are C-O-H bend peaks, while the intense peak at 1085 cm^{-1} is C-C-O streach peak, as shown in Figures 2 and 3.

The main propose of this research was to develop a polymer system which can be used as biomedical devices, especially as artificial skin [10].

Figures 4 and 5 show typical variations of the concentration of SA in two chambers. As can be expected, the concentration of SA in donor decreases over time while there is a corresponding increase in concentration in receptor expect PVA/PEG gel. The PVA/PEG membrane was pearmible for all solutions after few minutes may be due to linearity of hydrophilicity of the polymer. At any time, t, the concentation values were used to calculate the diffusion coefficient (D), from the following equation:

$D = 1/B * \ln [C_R(t)\text{-}CD(t)/ C_R(o)\text{-}C_D(o)]$

$\beta = A_H/W_H * [1/V_1 + 1/V_2]$

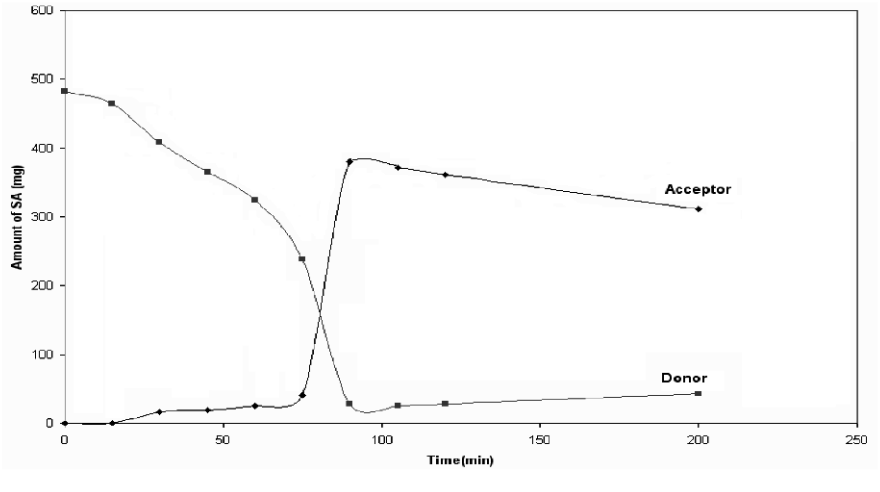

Figure 5. The effect of time of permability of SA in donor and receptor cells (PEG-Tannin membrane).

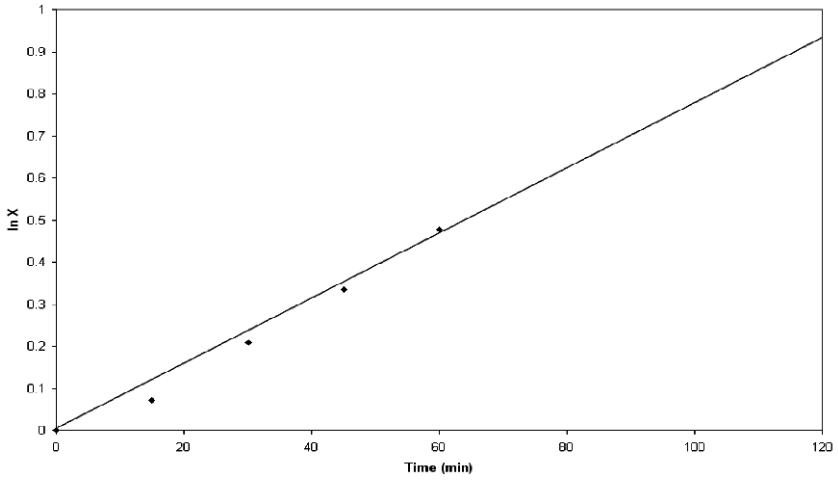

Figure 6..Represent calculation of diffusion coefficient (D) of PEG-Tannin.

Where C_D, C_R = concentration of SA in donor and receptor at initial C(o) and after time t, C(t).

A_H= effective cross-sectional area and diffusion in the hydrogel samples; W_H= width of the hydrogel sample; and V=volume of SA solution in receptor and volume of dissolution media in receptor.

Figures 6 and 7 show the plot of ln X Vs time, whose slope was used for determination of diffusion coefficient (D). The D of SA through the PEG-Tannin hydrogel membrane was found to be 0.038×10^{-3} cm^2/s. While the D of SA through the PVA-PEG-Tannine membrane was found to be 0.184×10^{-3} cm^2/s. The larger D of PVA-PEG/Tannin blend due to more hydrophilicity of this membrane compared with PEG/ Tannin membrane [9].

The membrane could be tried as artificial skin and various nutrients/healing factors and medicaments can be delivered directly to the wound surface by putting a swab/hydrophilic matrix.

4. Conclusion

Membrane obtained by formation strong hydrogen bounding between the chains. The FT.IR spectra showed the formation of ester linkage. The diffusion coefficient, D, of SA through the polymeric blends membrane. The diffusion coefficient of PEG/PVA-Tannin

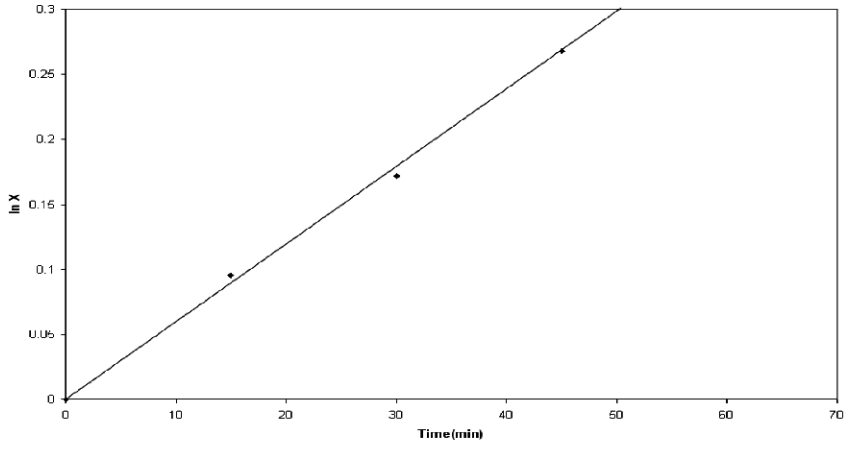

Figure 7. Represent calculation of diffusion coefficient (D) for PED/PVA-Tannin.

membrane was found to be 0.184×10^{-3} cm^2/sec while the D of PEG-Tannin membrane was found to be 0.038×10^{-3} cm^2/sec.

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