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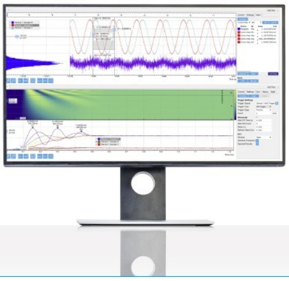

Preparation and Characterization of Blend Film Based on Chitosan-Poly Lactic Acid (PLA) Composites

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Abstract. Blend film is a thin layer made of biomaterial. One of the ingredients commonly used as blend film is chitosan. In the manufacture of blend films, chitosan can be used as a basic component of film manufacture. Chitosan has magnificent features due to its biodegradable and biocompatible and non-toxicity, but unfortunately chitosan is fragile material and generally insoluble in water. Poly Lactic Acid (PLA) and Glycerol was added to improve the characteristics of the film. The purpose of this study was to get the optimum ratio between chitosan and PLA, and get the characteristics of blend film from chitosan-PLA blended. The study was conducted in three step processes: (1) chitosan preparation, which was derived by deacetylation of chitin in the sodium hydroxide solution 50% w/w (2) PLA preparation, which was performed by direct polycondensation mechanism and (3) synthesis chitosan-PLA blend film. Blend film formation that was used the concentration ratio of chitosan: PLA (2:0 to 2:2 w/w), concentration of glycerol 0.03% v/v of chitosan solution, and drying temperature 70 ^{0}C for 10 hours. The analysis shows that the more percent of PLA added will decrease the value of tensile strength and elongation at break. The more percent of PLA added will increase the permeability of the film. The results showed that the best combination of chitosan: PLA concentration was on the ratio 2:0.4 of chitosan: PLA with the value of tensile strength and elongation of break of the film were 23.74 MPa and 14.82%.

INTRODUCTION

Plastic pollution has become one of the most imperative environmental problem in the world [1]. Millions tons of plastic are manufactured every year being used in almost all industry sectors. Plastics are used extensively as a packaging material and other applications. They have numerous advantages compared to other materials such as low price, multipurpose, long term use, lightweight and chemically inert. Furthermore, the plastics have many various shapes, are heat-sealable, and easy to print on [2]. Unfortunately, the persistent characteristics of the plastics induce long term plastic pollution [3]. One of the simplest way of tackling this problem is involves the use of biodegradable plastics or blend film especially for food packaging, generally can be degraded by the microbe [4]. Blend film is a thin layer made of biomaterial. There are three main constituent components, namely fat, protein and polysaccharide. One of the ingredients commonly used as blend film is chitosan.

Chitosan is the second most abundant biopolymer after cellulose, it is a natural material derived by deacetylation of chitin [5]. Chitosan has magnificent features due to its biodegradable, biocompatible and non-toxicity [6] however, chitosan is fragile material and generally insoluble in water [7]. One alternative methods to improve the chitosan strength and barrier characteristics was by adding Poly Lactic Acid (PLA) into chitosan composite.

PLA is a biodegradable materials, a thermoplastic polyester, which commonly obtained by polycondensation process of lactic acid [8]. PLA can be acquired from cellulose, corn starch, tapioca roots, sugarcane, and glycerin from biodiesel by-products [9]. It has been attracted considerable recent interest for different purposes, including materials packaging such as dairy products, bread and poultry products. PLA also used in biomedical as matrix for drug active

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agent delivery [10]. Unfortunately, combining the chitosan and PLA can decreased the chitosan elasticity, so the hydrophilic plasticizer (glycerol) were needed to improve the elasticity of Chitosan-PLA matrix [11]. Plasticizer relatively known as non-volatile organic compound [12]. A change in level of glycerol will affect the flexibility, thickness, and elongation of blend film [13]. Early studies reported by [14] glycerol has low molecular weight, so it can be the adding of glycerol could be simply mixed to film matrix.

MATERIALS AND METHODS

Materials

Chitin was obtained from Nano Center Indonesia, L-lactic acid (90%), NaOH, anhydrous acetic acid, and glycerol were purchased from Merck (Indonesia).

Chitosan Preparation

Chitosan was prepared by dissolved 5 g chitin into 50 ml NaOH solution 50% w/w. The chitosan solution was isolated using the ultrasonic irradiation 40 kHz for about 25 minutes and 30^0C, the solution was then discharge and the precipitate was washed and dried [15].

Chitosan Dissolution Mechanism

2 g of chitosan was dissolved in 100 ml of 1% acetic acid. The solution was stirred carefully for 4 hours.

Poly Lactic Acid (PLA) Preparation

PLA was performed by direct polycondensation mechanism. PLA was poured into 50 ml of lactic acid into four-neck flask. For the first step it was condensed in 120^0C and 1 hour, then was gently heated about 2 hours 150^0C and finally was heated in 180^0C for 2 hours [16].

Synthesis Chitosan-PLA Blend Films

The PLA conducted from the preparation process, were heated using a hot plate in 120^0C until melted. Heated chitosan solution was then pour into PLA. For the next, 3% v/v of glycerol were added into this solution. The solution was continue stirred in 2 hours. Finally, the initial solution was been casting on a flat glass and carefully heated in the oven 70^0C for 10 hours [16]; [17].

Analytical Methods

PLA characteristics, blend film mechanical characteristics include tensile strength, elongation of break and the permeability of the film analysis. Molecular bonding and function groups were tested by FT-IR spectrophotometry (Agilent Technologies type Cary 630), and blend film morphology was investigated by SEM.

RESULT AND DISCUSSION

PLA Visualization through a Polycondensation Mechanism

PLA was conducted from direct lactic acid polycondensation under vacuum process at 120 ^{0}C for 1 hour. The processes then continued by heating the lactic acid at 150 ^{0}C and 180 ^{0}C during 2 hours, to avoid lactic acid degradation. PLA obtained from the process above was in liquid phase at 180 ^{0}C and changed into yellow solid phase when PLA was stored at room temperature, it also has very fragile and non-hygroscopic characteristics. PLA visualization can be seen in Fig. 1.

FIGURE 1. Poly Lactid Acid conducted through polycondensation mechanism

Mechanical Properties of Blend Film

Mechanical properties of chitosan and chitosan-PLA blend film are shown in Fig. 2 below.

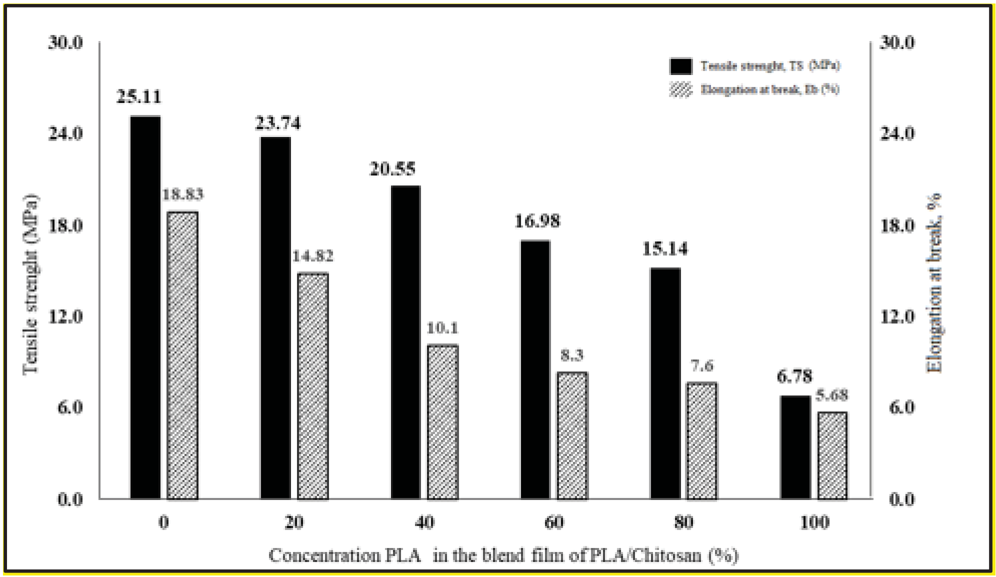

FIGURE 2. Mechanical properties of chitosan-PLA blend film Tensile strength (MPa); b) Elongation at break (%)

Total amount of polymer and number of solid dissolved significantly affected to the blend film thickness [18]. More solid dissolved into blend film solution thicker film will obtained. Table 2 shows there is no thickness changing from the film. It caused by the total of chitosan particle used in the solution are in the same level.

Tensile strength is the ability of blend film to resist the rupture when the forces are submitted to each unit are of film. On the other hand, the percentage of elongation at break is defined as the ability of blend film to resist the distorting effect. The elongation at break is measured through the extension traction [19]. From the Fig. 2 it clearly show the best value of tensile strength and percentage of elongation at break for chitosan-PLA are 23.74 MPa and 14.82% at the ratio of chitosan : PLA (2:0.4).

Chemical Properties of Blend Film

The function groups of chitosan and chitosan-PLA blend film using glycerol as plasticizer were investigated by FT-IR spectrometry. From the FT-IR spectrometry shown in fig 2A, the wave number of 3267 cm^{-1} confirm that OH function is in the blend film matrix. It is also apparent wave number of 2881 and 2835 cm^{-1} indicate C-H bound of CH_2 and CH_3. Fig 2A also show the wave number of 1656; 1559; 1411; and 1378 cm^{-1} which represent the C=O, N-H, CH-OH, and CH_2-OH in the blend film.

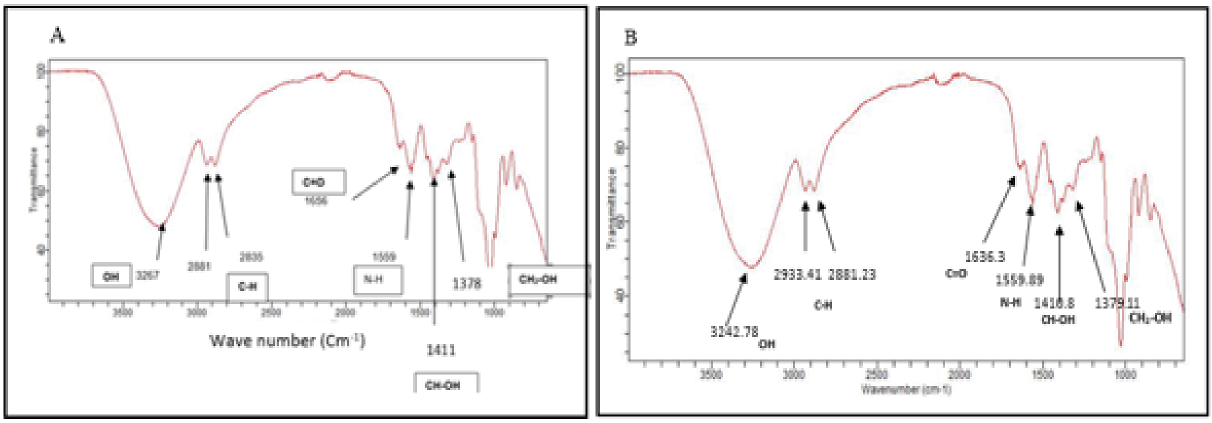

FIGURE 3. FT-IR spectra of chitosan and chitosan-PLA blend film A (2/0); B (20/04)

From the FT-IR spectrometry shown in fig 2B, the wave number of 3242,78; 2933,41; 2881,23; 1636,3; 1559,89; 1410,8; 1379,11 cm^{-1}. Each wave number confirm that O-H, C-H, bound of CH_2 and CH_3, C=O, N-H, CH-OH and function group of CH_2=OH. Comparison of FT-IR spectra of chitosan and chitosan-PLA blend film A (2/0); B (20/04) are presented in table 1.

TABLE 1. Comparison of FT-IR spectra of chitosan and chitosan-PLA blend film A (2/0); B (20/04)

	Wave number (cm^{-1})	
Function	**Chitosan**	**Chitosan/PLA**
OH	3267	3242,78
CH	2881	2933,41
C=O	1656	1636,3
N-H	1559	1559,89
CH-OH	1411	1410,8
CH_2-OH	1378	1379,11

Table 1 exhibits that the peak of each function group chitosan and chitosan-PLA blend film are located in closely wave number. It occur because the usage of chitosan is greater than PLA, so it lead the chitosan-PLA has almost similar function groups to chitosan blend film. Therefore, chitosan and chitosan-PLA blend film decrease the transmittance value. From the result it is shown the transmittance value for chitosan blend film decreased about 47,98% and 47.73% for chitosan-PLA.

Morphology of chitosan and chitosan-PLA blend film were analysis using *Scanning Electron Microscope* (SEM). Fig 3 present the morphology of chitosan and chitosan-PLA blend film.

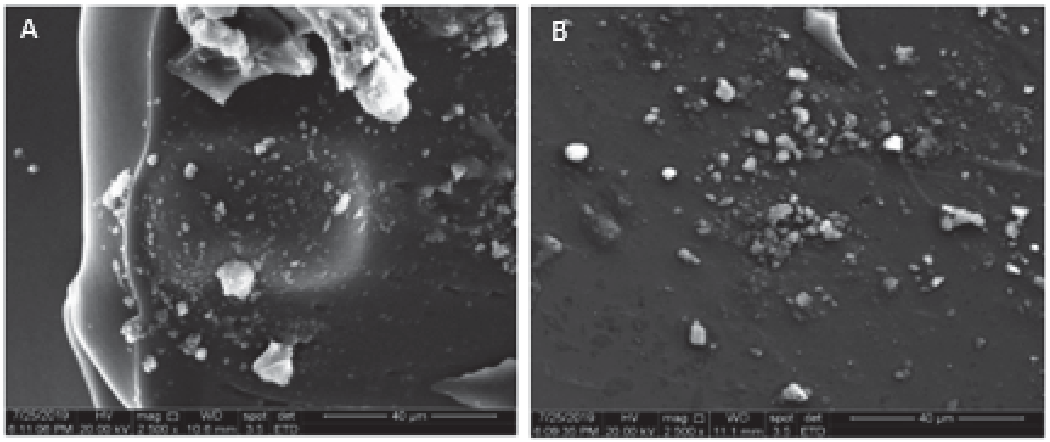

FIGURE 4. Morphology of blend film (A) chitosan and (B) chitosan-PLA

It appear from the Fig. 3 that, chitosan particle dispersion of on blend film is not distribute perfectly. Imperfect of chitosan particle distribution is caused by solubility of chitosan particle into acetic acid solution.

CONCLUSION

Chitosan-PLA blend film is a biodegradable and biocompatible matrix. PLA addition not effect to the blend film thickness but can decrease the tensile strength and percentage of elongation at breaks. The best value of tensile strength and percentage of elongation at break for chitosan-PLA are 23.74 MPa and 14.82% at the ratio of chitosan : PLA (2:0.4).

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