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Synthesis and Characterization of Biocomposite Super Absorbent Polymer (SAP) Based on Aren Fiber (*Arenga pinnata* Merr) and Polyacrylamida (PAM) for Dry Land

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Abstract: The biocomposite which is both cellulose in waste of aren fiber (*Arenga pinnata* Merr) and Polyacrilamida (PAM) can be used to synthesis Superabsorbent Polymer (SAP). The characterization of SAP was studies. It includes determination of functional group by FTIR (Fourier Transfer Infra Red) spectrophotometer, the ability water absorption (swelling factor). The effectiveness of a fraction transplants (grafting) and endurance SAP in store water. The method compromises cellulose preparation with hydrolysis, using of electron beam machine to SAP production and SAP purification. The FTIR spectrophotometer result shows which the dominant functional groups are O-H, C-H and C=O. Meanwhile, the levels of cellulose, grafting factor and swelling ratio are 66.90, 64.20 and 899.83%, respectively. In addition depreciation factor SAP can keep the 50% for 2 days and 20% for 2 weeks.

Key words: Aren fiber, superabsorbent polymer, cellulose levels, grafting factor, swelling factor, depreciation factor

INTRODUCTION

Dry land caused by climate change effect in several area decreases fertile soil. It reduces plantation such as agricultural production and green spaces in the residence. In this study, Superabsorbent Polymer (SAP) has been synthesized from waste of aren fibers in order to return fertile soil. The aren fibers waste was collected in Tulung district, Daleman village, Klaten regency, Central Java province, Indonesia. The characterization of SAP has been conducted to understand functional group, cellulose level, grafting factor and swelling factor. In the previous research, cellulose on SAP has been accomplished (Andriyanti and Ngasifudin, 2011; Kiatkamjornwong *et al*., 2002; Swantomo *et al*., 2008). Polymerization process using ion radiation to synthesis is more feasible than conventional process because no need additional chemical material (Dutkiewicz, 2002).

MATERIALS AND METHODS

Figure 1 shows the stage of flow diagram how to synthesis and characterize SAP.

Equipment and substance: This study needed glass beaker, funnel, saucer, filtered paper, pH paper, centrifuge, magnetic stirrer, oven, water batch, analytic scale, electron beam machine 350 keV/10 mA. Meanwhile, the substances

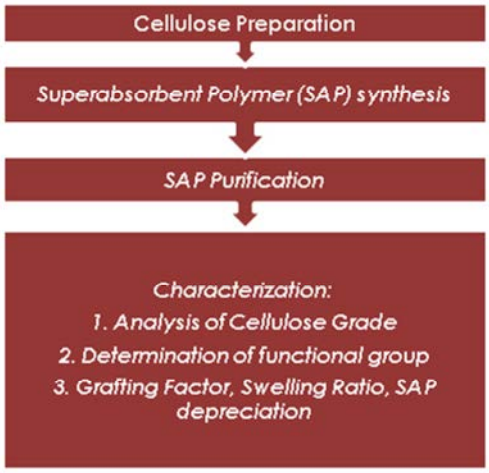

Fig. 1: Block flow diagram of the research work

comprise of aren fibers, aquadest, NaOH Merck, HCl Merck 0,1M, H_2SO_4 Merck 1N, H_2SO_4 Merck 72% and Polyacrilamida (PAM) Aldrich.

Synthesis

Cellulose preparation: Washing 1 kg aren fiber with aquadest and sun-dried for 12 h. Then, oven dried aren fiber at 85°C for 16 h. Furthermore,. making powder of aren fiber with blender and drying of aren fibers in the oven at 110°C for 6 h.

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Mixing 20 g aren fiber powder and 1000 mL NaOH 15% in the beaker glass and heating the mixture at 110°C for 4 h. Then, the sludge filtering, washing with aquadest and drying at 100°C for 6 h. Then, using of beaker glass to hydrolyze the sludge with 200 mL HCl 0.1 M at 105°C for 1 h (ratio 1:10). After that, washing of the cellulose sludge with aquadest until neutral pH.

Superabsorbent Polymer (SAP) synthesis: Weighing both cellulose powder and PAM in the ratio 1:12.5 or (0.008:1 g). Glass beaker mix both cellulose and 3 mL aquadest. Putting of PAM and heating at 90°C for 1 h. Thin layer mixture is made by the box of electron beam machine. Then SAP radiation with 50 kGy.

SAP purification: Washing result of SAP synthesis phase with water and drying in the oven at 85°C for 24 h. Then making powder SAP. Using of centrifuge for 14 h to separate between unreacted SAP (liquid at top layer) and reacted SAP (solid at bottom layer). Washing reacted SAP to characterize.

Characterization: To characterize the SAP, this study used double calculation. It is for determination of functional groups, grafting factor, swelling ratio, SAP depreciation. Double calculation did not represent the fiber age because it was difficult to separate fiber waste from source based on the fiber age.

Analysis of cellulose grade: The 1 g dry cellulose (W_A) is mixed with 150 mL aquadest and it refluxes at 100°C for 2 h with water batch using. Filtering and washing for residue with 300 mL hot water. Then, oven dries the residue drying in order to get constant Weigh (W_B). Mix residue and 150 mL H_2SO_4 1 N to. Using of water batch to reflux of mixture at 100°C for 2 h. Filtering and washing for residue with aquadest to neutral pH and residue drying to get constant weigh (W_C). Immerse dried residue into 100 mL H_2SO_4 72% at standard temperature for 4 h. Then, addition of 150 mL H_2SO_4 72% and the mixture was refluxed in the water batch at 100°C for 2 h. Filtering and washing of residue with aquadest to neutral pH. Then oven heats at 105°C in order to get constant weigh (W_D). Cellulose grade is estimated by Eq. 1:

$$\text{Cellulose grade} = \frac{W_C - W_D}{W_A} \times 100\% \quad (1)$$

Determination of functional group with Spectrophotometer FTIR: Oven dries SAP from electron beam machine at 120°C for 1 h. Make SAP powder to analyze functional groups.

Grafting factor: Oven dries SAP at 60°C until constant weigh (W_0) and washing and stirring of SAP for 5 h. Centrifuge process is conducted at 2000 rpm for 15 min. It results two layers where bottom layer is dried and weighing at constant temperature until constant weigh (W_1). Grafting factor was calculated by Eq. 2:

$$\text{Graphing factor} = \frac{W_1}{W_0} \times 100\% \quad (2)$$

Swelling ratio: Oven dries SAP at 60°C until weigh constant (W_0). SAP immersion to aquadest for 48 h. SAP cleaning with tissue and SAP weighing (W_s). Equation 3 calculates swelling ratio:

$$\text{Swelling ratio} = \frac{W_s - W_0}{W_0} \times 100\% \quad (3)$$

SAP depreciation: Using of analytical scale to weighing regularly SAP form swelling ratio for 15 days (W_d). Equation 4 evaluates SAP depreciation:

$$\text{Depriciation} = \frac{W_d - W_0}{W_0} \times 100\% \quad (4)$$

RESULTS AND DISCUSSION

Cellulose of aren fibers: This study has 66.90% cellulose grade whereas other vita and another study has 85.27% (Mahmuda and Savetlana, 2013).

Determination functional groups: Figure 2 and 3 show the functional groups from FTIR. Both of figure illustrates before and after using of electron beam machine. Figure 2 detects O-H, C-H,C=O,C-C while Fig. 3 finds O-H,C-H,C=O,C-N and C-C. This study detects some functional group in SAP for O-H, C=C and C-H. The study proposed that functional group is hydrophilic group and It is suitable with other study (Andriyanti and Ngasifudin, 2011).

Swelling ratio: Swelling ratios is showed by Table 1. It with immersion time 24 and 96 h are 960 and 977%, respectively. Meanwhile, second sample 850% (24 h) and 812% (96 h). SAP has ability to absorb water (Chang *et al*., 1999).

Grafting factor: Grafting factor shows the efficiency process for synthesis SAP in Table 2. It depends on raw material which is cellulose and PAM and irradiation exposure. In another study the cellulose grade, grafting

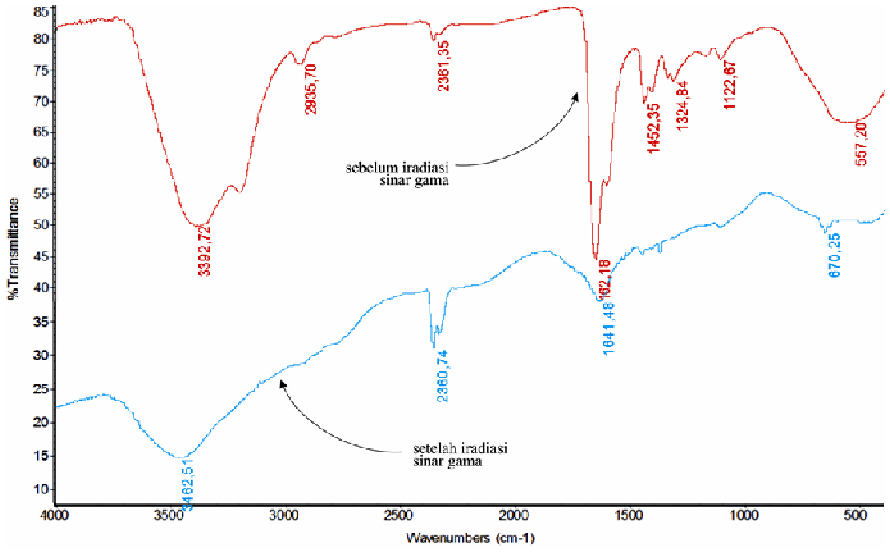

Fig. 2: The functional groups for first sample

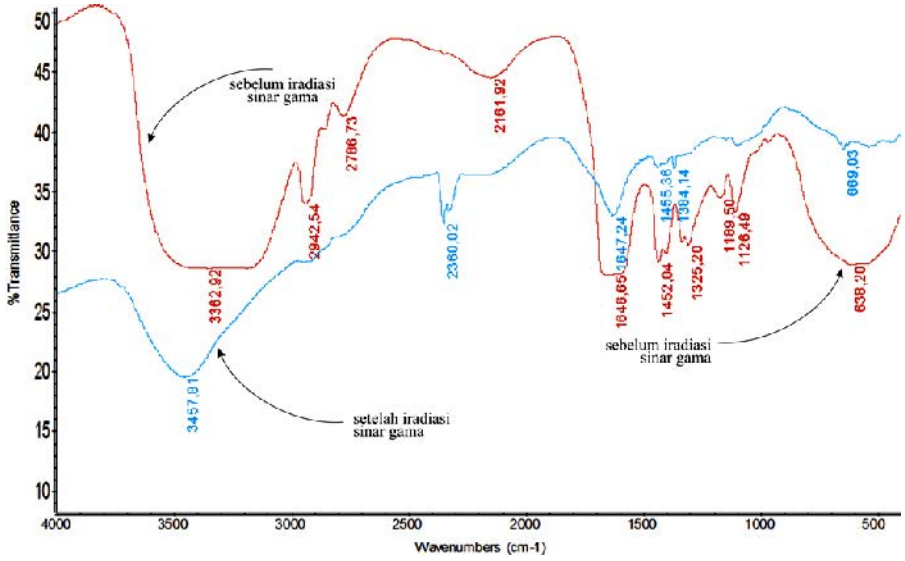

Fig. 3: The functional groups for second sample

factor and ratio swelling can achieve to 95, 96.15 and 500%, respectively (Andriyanti and Ngasifudin, 2011). Meanwhile, other study the grafting ratio and swelling ratio can be 97.827 and 115.9% in that order (Swantomo *et al*., 2008).

Depreciation factor: Figure 4 shows the depreciation factor for two samples where on 2nd day SAP have decreased up to 50-60% and it will increase to about 90% for >2 weeks. In this study, SAP can store half accumulated water and it will keep 20% water until a half-month.

Table 1: Swelling ratio

	Swelling ration (%)	
Sample	Immersed time 24 h	Immersed time 96 h
1	960	977.0
2	850	812.0
Average	905	894.5

Table 2: Grafting factor

Sample	Grafting factor (%)
1	72.25
2	56.15
Average	64.20

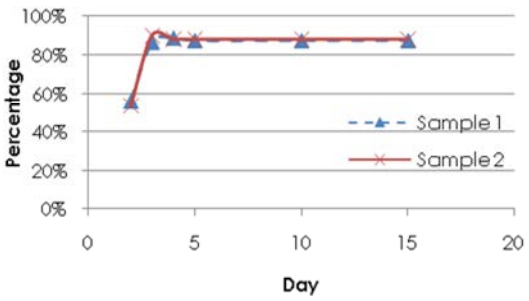

Fig. 4: Depreciation factor

CONCLUSION

This study synthesis biocomposite SAP based on aren fibers and PAM. The dominant functional group has detected for O-H, C-H and C = O. The levels of cellulose, grafting factor and swelling ratio are 66.90, 64.20 and 899.83, respectively. Depreciation factor for SAP achieve 50% for 2 day and 20% for 2 week. According this finding, SAP synthesis needs to find other materials to improve the ability of SAP and SAP characterization have to add ability to absorb salt liquid for high salinity in the soil.

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