Available online www.jocpr.com

Journal of Chemical and Pharmaceutical Research, 2015, 7(6):192-197

Research Article

ISSN : 0975-7384
CODEN(USA) : JCPRC5

Biomaterials supported with titania as photocatalyst in peat water purification

Hermansyah Aziz[1]*, Admin Alif[1], Ririn Ariani[1], Lidya Trisna[1], Agna Wahyuni[1] and Edison Munaf[2]

[1]Laboratory of Physical Chemistry, Department of Chemistry, Faculty of Mathematics and Natural Sciences, Andalas University, Padang, Indonesia
[2]Laboratory of Environmental and Toxicological Chemistry, Department of Chemistry, Faculty of Mathematics and Natural Sciences, Andalas University, Padang, Indonesia

---

ABSTRACT

A new photocatalyst supports based on biomaterials surface is proposed to apply for titania semiconductor. Biomaterials such as Talang Bamboo, Coconut Shell, and Surian Wood was prepared as TiO_2 / Biomaterials reactor in peat water purification. Peat water was irradiated using sunlight in TiO_2 / Biomaterials photochemical reactor in order to determine the capability of photochemical reactor to purifythe peat water and also to measure the stability of the reactor. As the result of irradiation in 10 hours the organic component was decreased about 66% respectively for all 3 kinds of biomaterials. Found that the pH was increased until 6.50 and Fe ions content was also decreased.

Keywords: TiO_2. Biomaterials. Photocatalyst. Peat water.

INTRODUCTION

Water is a natural resource that has a very important function for the life of humans.Water is an essential requirement for survival, human life and other living creatures. Water that would be required to meet the quality and quantity [1].

Peat water is a surface peat swamp water wich can be characterize as maroon colored, acidic, smells, and have a very high organic content. This type of water can not be used directly as drinking, bathing, and washing because the quality factor. The water must be purified before in order to be utilized according to its poor quality [1].

Peat water is an heterogeneous mixture of organiccompounds which vary in terms of molecular weight (MW), chemical structure and functional groups. Peat water is often fractioned on the basis of hydrophobicity and molecular size [2-3] and therefore includes a set of hydrophilic substances, particularly aliphatic carbon and nitrogenous compounds (sugars, carbohydrates, amino acids etc.), [2-4] and a set of hydrophobic substances, consisting principally of humic compounds (humic and fulvic acids), noted for their aromaticity and carboxylicand phenolic acid functionality.

At present, there are several methods used toremove humic acid as main component from peat water, such as coagulation-flocculation [3, 5-8] electro coagulationprocesses [9,10], oxidation [5], photocatalysis [11]and membrane technology [3, 7, 12, 13]. All of these alternative processes, however, are of high operational cost and none of them therefore, is considered by industries to be commercially viable because economically unrealistic.

The coating of TiO_2 photocatalyst on the surface of the support such as ceramic, glass, plastic, PVC, paper with a thin coating of various techniques have been able to overcome the shortage of TiO_2 suspension system. Many researchers are optimistthat this technology economically viable, because it can take an advantage of a thin layer TiO_2 photocatalyst and low-energy UV light, as well as a thin layer TiO_2 photocatalyst can besimply regenerated. From the existing literature, the degradation of humic compounds in water, especially humic acid in peat water that has not been much enough to apply the TiO_2coated photocatalytic reactors [14].

In this study used biomaterials such as talang bamboo *(Schizostachyum brachycladum Kurz)*, coconut shell (*Cocos nucifera lin*) and surian wood (*Toona sinensis*) asphotocatalyst support in the process of peat water purification. Biomaterials are used because it is easy to come by, simple, effective, environmentally friendly so it can be applied to society.

EXPERIMENTAL SECTION

Preparation of biomaterials support

Bamboo used is a talang bamboo*(Schizostachyum brachycladum Kurz)*. Bamboo measuring as 30 cm (1 segment) is split into two parts using cutting tools. Bamboo was cleaned using a damp cloth. Coconut shell (*Cocos nucifera lin*) with a diameter of 10 cm was cut using a cutting tool with sandpaper and cleaned. Surian wood (*Toona sinensis*) beam shaped cut with cutlery, hollowed rectangular measuring 12 cm x 10 cm with a thickness of 5 cm. The surface sanded until smooth. Biomaterials support driedat a temperature of 60 ^{o}C for 1 h.

Peat water purification process

1.5 gof agar powder weighed and put into a 100 mL beaker. Then 25 mL of distilled water was added, stirred until homogeneous using a magnetic stirrer. After that, put 3 gr of TiO_2 powder, stirred again until homogenous. Pasta of TiO_2wascoated on biomaterials as much as 5 times coating evenly to cover the surface of biomaterials. Then a layer of wind dried ± 10 minutes. Put 50 mL of peat water was added to the coated biomaterials container (batch photochemical reactor). Then irradiated with sunlight with irradiation time variations of 2, 4, 6, 8, and 10 hours at 11.00 to 13.00 for 5 days with a light intensity of 204.800 lux. Every 2 hours irradiation pH and absorbance were measured, respectively.Feions contentafter10hours ofexposurewas measuredusing Atomic Absorption Spectrometry detection at wavelength 248.3 nm.

Testthe stability of TiO_2 coating on biomaterials support

Measurement of peat water absorption spectrum done by means of UV-Vis Spectrophotometer in the 200-800 nm region. The absorbance of each fresh sample was measured every 2 hours irradiation with 4 times repetitions using TiO_2 /biomaterial. Ech sample (fresh peat water) was replaced every 2 hours irradiadion.

RESULTS AND DISCUSSION

Irradiation of peat water in titania coated biomaterial photoreactors

Semiconductor coated biomaterials are used as photocatalytic reactor in peat-water purification with the sunlight as irradiation source. The biomaterials such as talang bamboo, coconut shell and surian wood are porous materials with a large surface area. TiO_2 was coated into biomaterials using an adhesive in order to build a photochemical batch reactor. As shown in Fig. 1.

Biomaterials coated with TiO_2 as much as 5 times coating with the aim of getting a thick layer of TiO_2, as the more energy of absorbed photons. As a result, more and more reduced content of organic compounds in the peat water. TiO_2 coating thickness may affect the utilization of photon energy to excite the charge carriers from the valence band to the conducting band [9].

Determinan of UV-Vis spectra

Peat water absorption spectra done by means of UV-Vis spectrophotometer in the 200-800 nm region. Measurement of absorption spectrum aims to determine humic acid reduction contained in the peat water. Clear peat water will have a low absorbance values. This is due to the low concentration of organic substances contained in peat water. In the method, the predetermined maximum wavelength for measuring the peat water. The resuls can be shown at Fig. 2.

The spectrum does not show the maximum absorption of peat water in visible light region, but an increase in the UV absorption. It can be said that the peat water absorption is in the UV. The optimum conditions of peat water degradation is obtained by performing benchmark in the exploration wavelength UV region. Taken one point as a benchmark to measure the uptake of peat water is at a wavelength 265 nm.

Photocatalytic degradation of humic acid (peat water)

With the purification using TiO_2 coated biomaterials as much as 5 times coating, the absorption spectrum of peat water into decline. UV-Vis spectrum can be observed decrease in absorbance at water purification results. Figure 3 shows the effect of Irradiation of peat water inside TiO_2 / biomaterials reactor with sunlight

The longer the exposure time, the lower the absorption spectrum absorbance on the amount of organic compounds contained therein will be smaller. This is because when the photocatalyst TiO_2 is exposed to UV light with a wavelength below 400 nm, the electrons will be excited from the valence band across the band gap into the conduction band, producing a hole in the valence band and electrons in the conduction band. TiO_2 hole in the valence band react with water molecules or OH- ions and produce hydroxyl radicals (OH•) which is a strong oxidizing compounds. The hydroxyl radical will decompose the organic pollutants such as humic acid in a liquid into a gas that subsequently evaporates or into other substances that are not harmful [9].

pH measurement

Measurement of peat water before purification was obtained as 4.87. This result indicate that water containing some organic compounds such as humic acid, fulvic acid, and humin [2]. After irradiation with sunlight using TiO_2 coated biomaterials shown an increasing in pH. It can be seen from the curve of Fig. 4.

From the curve in Fig. 4, its appears that the increase in pH during irradiation of peat water with sunlight utilizing three types of biomaterials. After 10 hours of exposure an increase in the pH to 6.07; 6.50 and 6.26, respectively on talang bamboo, coconut shell and surian wood. This is because the longer the peat water is irradiated with sunlight, there will be an oxidation reaction that is triggered by the presence of TiO_2 photocatalyst material in the reaction resulting in a decrease in the content of organic pollutants such as humic acid and can improve water quality. The longer the peat water, the more illuminated OH radicals are formed so that the reduction in humic acid resulting in increasing pH [9].

Test the stability of TiO_2 coating on biomaterials support

Measurement of absorption spectrum of water in the peat layer of TiO_2 endurance test aims to determine the resistance of TiO_2 layers with an irradiation continously every 2 hours with the use of repetition as much as 4x same container. Irradiation is done in ranges 11:00 to 13:00 o'clock for 4 days. Irradiation is done by replacing samples (peat water) every 2 hours, and measured the absorbance of each. This is done to determine the stability of the TiO_2 layer against water degradation. As shown in the graph below

From the curve in Fig. 5 above, it appears that the stability of TiO_2 layer on the biomaterial surface decrease slowly during the application of the reactor as well as the degradation of peat water due to the fluctuation of the value of the absorbance. This is because a part of TiO_2 layer is beginning to damage.

Analysis of Fe(III) ion

Atomic absorption spectrum measurement is done by using Atomic absorption spectrophotometric detection. This measurement is intended to determine the content of ions – metals ions in peat water. The measurement of Fe metal ions present in the peat water before and after irradiation can be seen from the Table 1 below.

Table 1. Concentration Fe(III) ions before and after purification

Biomaterials	Peat water (mg/L)	Peat water illuminated 10 hours (mg/L)
Talang Bamboo	3.354	0.354
Coconut shell	3.354	0.376
Surian wood	3.354	0.536

From the Table 1 it can be seen that, after purification using TiO_2 coating on biomaterials he concentration of Fe(III)ions in the peat water was decrease gradually. This is because the electrons in the conduction band will reduce the heavy metals adsorbed on the surface of the catalyst.

A B C

Fig. 1. Photocatalytic process using biomaterials :
(A) Talang bamboo *(Schizostachyum brachycladum Kurz)*; (B) Coconut shell (*Cocos nucifera lin*) and (c) Surian wood (*Toona sinensis*)

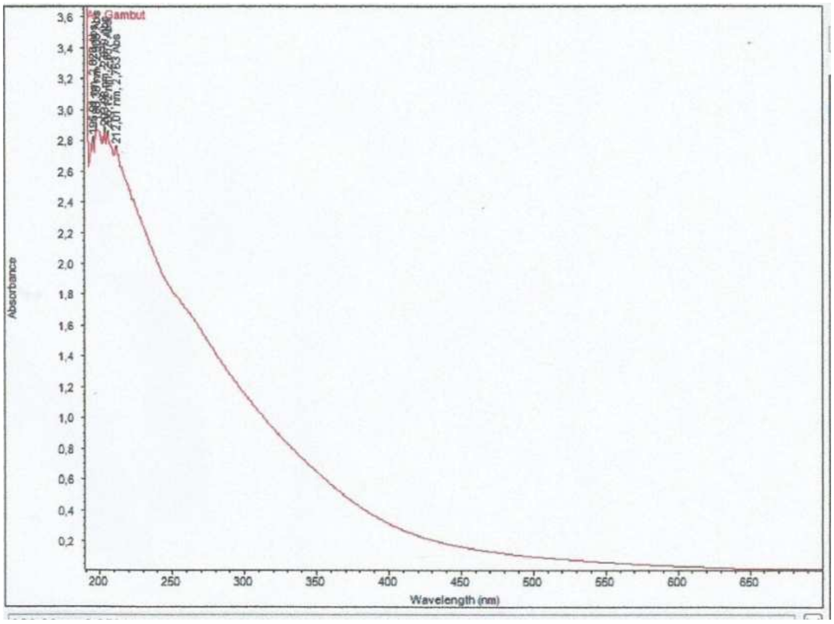

Fig. 2. UV-Vis Spectra of peat water

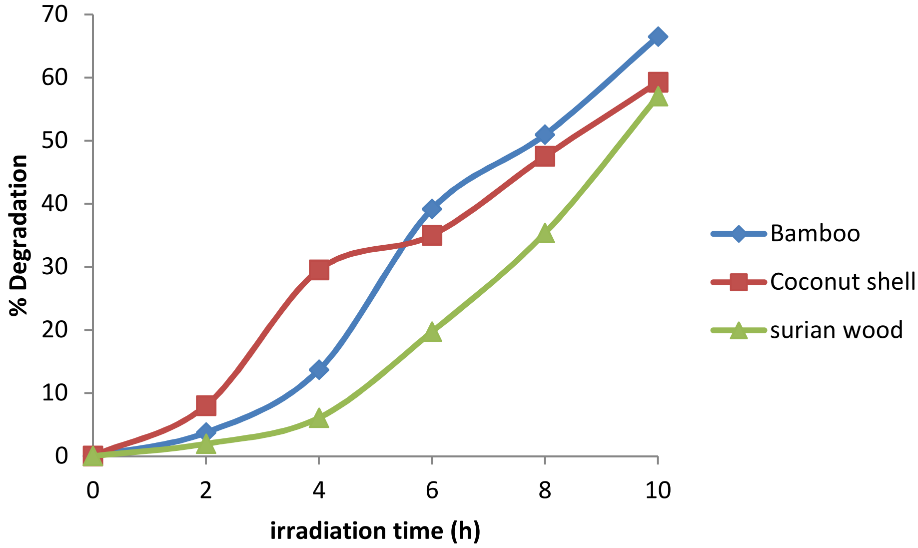

Figure 3. Irradiation of peat water inside TiO_2/biomaterials reactor with sunlight

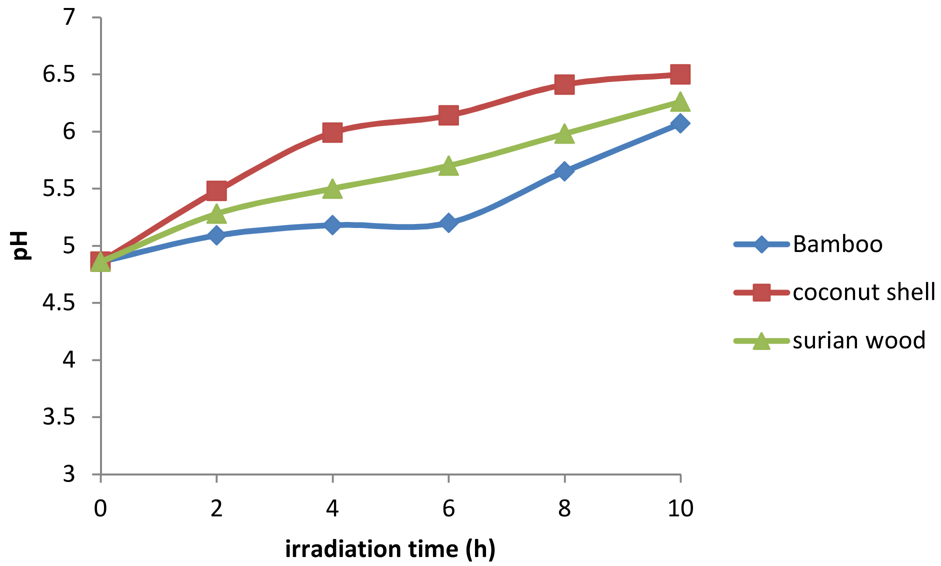

Fig. 4. Evolution of pH during irradiation of peat water inside the reactor TiO_2/biomaterials with sunlight

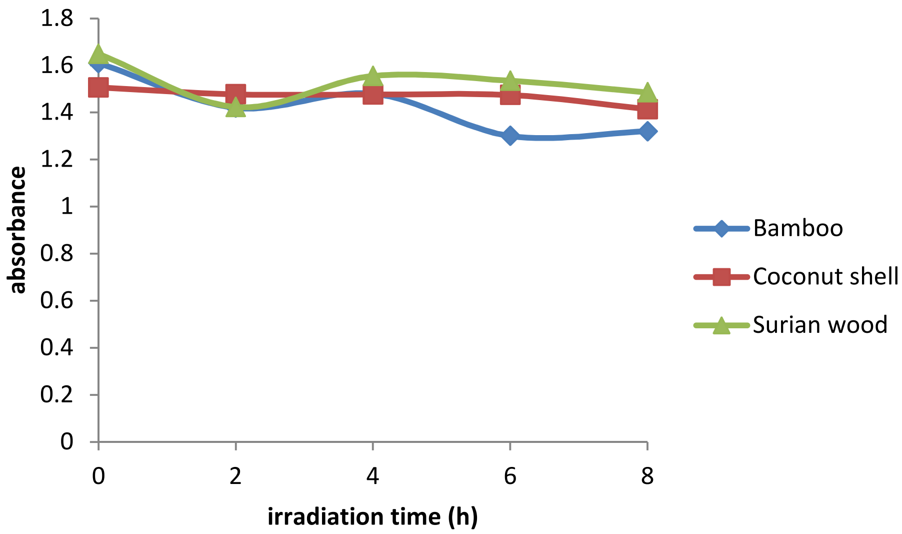

Fig. 5. Irradiation peat water inside the reactor TiO_2/biomaterials with sunlight

CONCLUSION

TiO_2 coating/biomaterials can be used as a photocatalytic reactor in the peat water purification process. So as to raise the pH to 6.07; 6.50; 6.26, reduce the content of organic compounds such as humic acid peat to 66.46 %, 59.2 % and 28.80 %, for talang bamboo, coconut shell and surian wood, respectively. Fe(III) metal ions content in each biomaterials decreased after 10 hours of exposure. While the TiO_2 coating is less good stability when used repeatedly.

REFERENCES

[1] D. Novrian, H. Aziz and Syukri, *Media Sains*,**2013**, 5(1). 66-74.
[2] A. Abate, J.C. Masini, *Colloids Surf*, A, **2003**, 226, 25-34.
[3] JC. Rojas, J. Pérez, G. Garralón, F. Plaza, B. Moreno, MA. Gómez,*Desalination*, **2011**, 128- 133.
[4] CN. Albers, GT.Banta, PE. Hansen, OS. Jacobsen, *Environ. Sci. Technol*., **2008**, 42, 8687-8691.
[5] CS. Uygunera, SA. Suphandaga, A. Kercb, M, Bekbolet, *Desalination*, **2007**, 210, 183-193.
[6] B. Libecki, J. Dziejowski, *Polish J. Environ. Studies*, **2008**, 17(3), 397-403.
[7] S. Park, T. Yoon, *Desalination*, 239, 146-158,
[8] C. Sun, Q. Yue, B. Gao, R. Mu, J. Liu, Y. Zhao,Z. Yang, W. Xu, **2011**
[9] D. Ghernaout, B. Ghernaout,A. Saibaa, A. Boucherita, A. Kellil, *Desalination*, 281, 243-247, **2009**

[10] J. Wang, X. Han, Y. Ma, Y. Ji, L, Bi, *Chem. Eng. J*, **2011**,173, 171-177.
[11] D. Sonea, R. Pode, F. Manea, C. Ratiu, C. Lazau, I. Grozescu, *Chem.Bul. of Politehnica* **2010**, 55 (69) 148-151.
[12] KS. Katsoufidou, DC. Sioutopoulos, SG. Yiantsios, AJ. Karabelas, *Desalination*, 210, 264, 220- 227.
[13] NAA. Hamid, AF. Ismail, T. Matsura, AW. Zularisam, WJ. Lau, E. Yuliwati, MS. Abdullah, *Desalination*, **2011**, 273, 85- 92.
[14] Gusfiyesi, A. Alif, H. Aziz, S. Arief, E. Munaf. *J. Pharm. Biol. Chem Sci*, **2014**, 5(4), 918-930.