Comparison of Efficiency of Activated Carbon Between Coffee Grounds, Soybean Straw and Tea Leaves

Comparison of Efficiency of Activated Carbon Between Coffee Grounds, Soybean Straw and Tea Leaves

Paweena Dulyaseree[1]*, Firdaus Mahasae[1], Nufateehah Hayeekueji[1] and Visittapong Yordsri[2]

[1] Physic Program, Faculty of Science Technology and Agriculture, Yala Rajabhat University, Yala, Thailand
[3]National Metal and Materials Technology Center (MTEC), Pathum Thani, Thailand

paweena.y@yru.ac.th

Abstract. Efficiency of activated carbons (ACs) between coffee ground, leaves soybean straw and tea leaves were investigated. All three types of waste can be found widely in the local area. The synthesis of ACs consists of 2 parts. Firstly, preparation of coffee grounds, tea leaves and soybean straw were dried at 100 °C for 24 h, and then carbonized at 560 °C. Second part, the activated carbon was activated with 1 molar of nitric acid (HNO_3) and after that was activated by 1 molar of potassium hydroxide (KOH), washed with DI water to neutralize and dried at 100 °C. Their surface morphology and functional group of the ACs were characterized. The morphology of soybean straw shows the high porosity and increase in oxygenated functional group, implies that easy allow water to seep into surface. These results suggest that can be use filtrate material for filtration system.

1. Introduction

Activated carbons (ACs) are kind of absorbent product which is widely applied to daily life of people in products of medical treatment, electronic and environment [1]. ACs can be produced when the precursor contains large composition of carbon. The synthesis of ACs is mostly from biomass since the carbon content is high in form of cellulose, lignin and hemicellulose. The research and development of ACs with a high specific surface area has become the hot spot of studies by scientific workers along with the development of environmental protection, electronic, medicine, chemistry and military industries [2-4].

Nowadays, the most people be in flavor of drink. A lot of waste derived from making beverages such as tea leaves, coffee grounds and soybean straw. Beverages waste can be synthesis of ACs. However, tea leaves, coffee grounds and soybean straw have high in form of cellulose, lignin and hemicellulose which are important starting materials for synthesis of ACs [5]. The microstructures of ACs largely depend on the raw materials. Normally, the synthesis of ACs consists two processes; carbonization process to converse biomass to carbonaceous structure and activation process to form the pores in carbon network by chemical or physical activation. The benefit of two-process synthesis has been increasing in oxygenated functional group and porosity structure on carbon surface as easy allow water to seep into surface. In this work, we study on efficiency of activated carbon derive from beverage waste such as coffee grounds, soybean straw and tea leaves.

2. Methodology

Fresh coffee grounds, fresh soybean straw and fresh tea leaves were obtained from the local area which dried at 100 °C for overnight. The synthesis of ACs consists of 2 step; carbonization and activation. Firstly, coffee grounds, tea leaves and soybean straw were carbonized at 560 °C for 4h and then were grinded into small piecess by a blender. Second part, the activated carbon was activated with 1 molar of nitric acid (HNO_3) and then washed with DI water to pH 7 and dried at 100 °C for overnight. Next, all samples were activated by 1 molar of potassium hydroxide (KOH), washed with DI water to neutralize and dried at 100 °C for overnight. The ACs derive from coffee grounds, soybean straw and tea leaves are hereafter refferred to as CA, SA and TA, respectively. The all samples were characterized their structures and functional group by transmission electron microscope (TEM) and Fourier transform-infrared spectroscopy (FTIR), respectively. Next, preparation of activated carbon from 3 types was added to water filtration system and were characterized by spectrophotometry to confirm of groundwater quality.

3. Results and Discussion

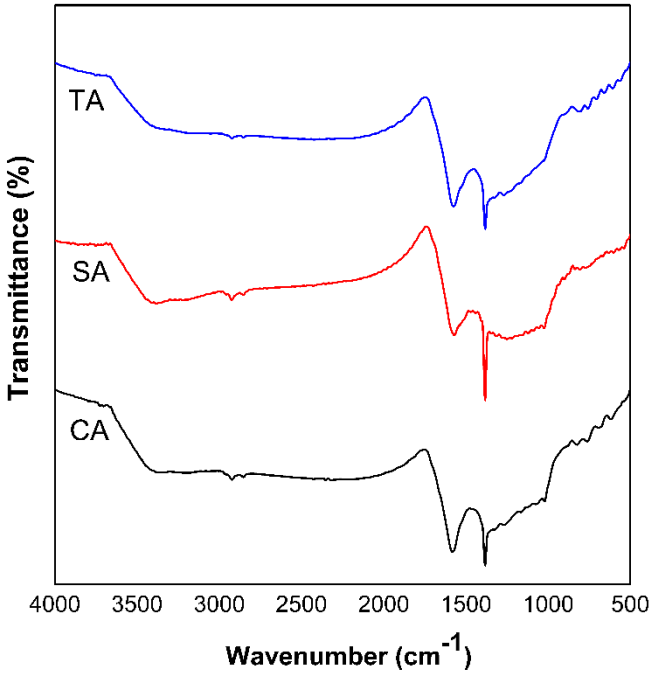

Figure 1. FT-IR spectra all samples.

The FT-IR spectra of CA, SA and TA were shown as Figure 1. The band at ~3420 cm^{-1} is attributed to the stretching vibration of the hydroxyl (OH) group. The OH groups may include absorbed water [6-7]. The absorption bands at ~1583 cm^{-1} is assigned to the stretching vibrations of aromatic rings (C=C) [8]. The peak at ~1384 cm^{-1} was assigned to the bending vibration of C-H. Interestingly, CA and SA show the high functional group of -OH group. A high content of oxygenated functional groups improves the wettability of the carbon surface as relate with a surface porosity which confirmed by TEM. Figure 2 shows TEM images of CA, SA and TA. The morphologies of CA and TA show a smooth surface while SA found high porosity as shown Fig 2b.

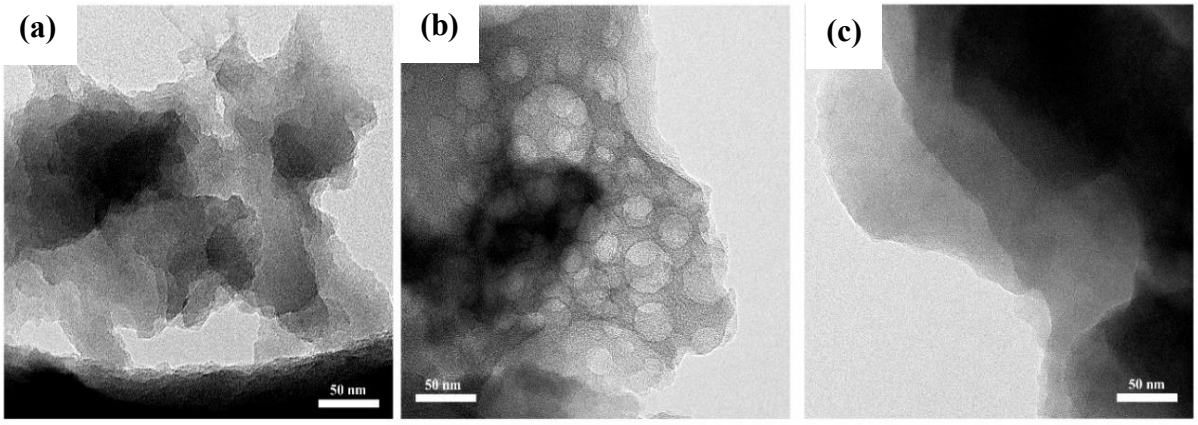

Figure 2. TEM images of (a) CA, (b) SA and (c) TA

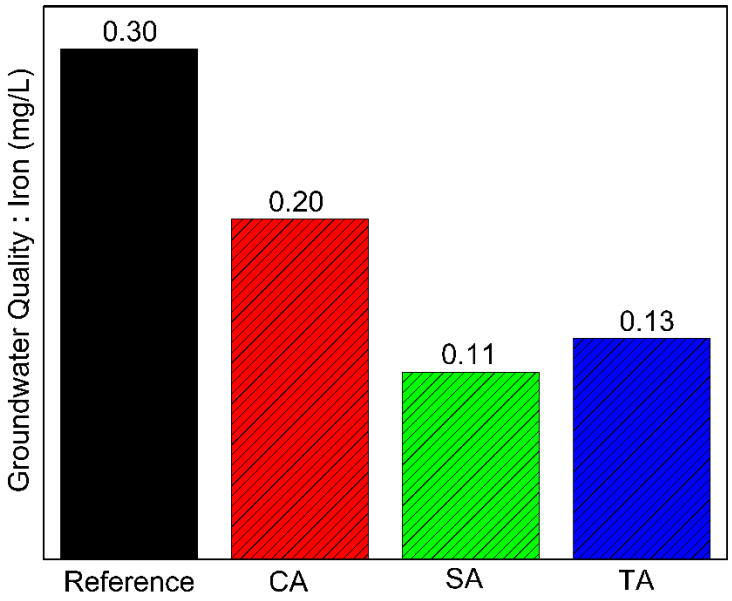

Figure 3. Groundwater quality of all samples

The groundwater quality was characterized by spectrophotometer shown as Figure 3. The adsorption for Fe(II) adsorption capacity for Fe(II) of CA, SA, TA filtrate were 0.20, 0.11, and 0.13 mg/L, respectively when compared with unfiltered water as 0.30 mg/L. Soybean straw shows the best Fe(II) adsorption, resulting in an easy allow water to seep into porosity surface.

4. Conclusion

In summary, soybean straw shows the best efficiency of activated carbon. Soybean straw have porosity structure and the high Fe(II) adsorption. These results suggest that soybean straw can be an easy allow water to seep into porosity surface and can be use filtrate material for filtration system.

References

[1] Zheng Q and Li L 2009 Research progress in activated carbon preparation from crop straw *Journal of Cellulose science and technology* **18(3)** 68-75
[2] Luo J and Pu H 2008 Application of microwave technology in activated carbon preparation

Energy and environment **1** 86-88
[3] Lai Q and Zhu Y 2008 Research progress in activated carbon preparation and regeneration by micowave method *Yunnan college journal* **30(2)** 359-362
[4] Chen C and Li Y 2008 Preparation of bamboo tip carbon by microwave method *Forestry chemistry and industry* **28** 86-90
[5] Khalil H S A, Alwani M S and Omar A K M 2007 Chemical composition, anatomy, lignin distribution, and cell wall structure of Malaysian plant waste fibers. *BioResources* **1(2)** 220-232
[6] Faix O 1991 Classification of lignins from different botanical origins by FT-IR spectroscopy. *Holzforschung* **45** 21-27
[7] Ibrahim M 2002 Preparation of cellulose and cellulose derivative azo compounds *Cellulose* **9** 337-349
[8] Yong-Tae K and Tadaoki M 2006 Competitive effect of carbon nanotubes oxidation on aqueous EDLC performance: Balancing hydrophilicity and conductivity *Journal of Power Sources* **158(2)** 1517