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The Innovation in Chemistry Education in Supporting Green Chemistry Toward The Advanced KalTim 2018

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CHEMISTRY EDUCATION STUDY PROGRAM
DEPARTEMENT OF MATHEMATIC AND NATURAL SCIENCE EDUCATION
FACULTY OF TEACHER TRAINNIG AND EDUCATION
MULAWARMAN UNIVERSITY
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THE INNOVATION IN CHEMISTRY EDUCATION IN SUPPORTING GREEN CHEMISTRY TOWARD THE ADVANCED KALTIM 2018

Held on September 12th, 2015

In Hall of Rector 4th floor FKIP UNIVERSITAS MULAWARMAN

Samarinda Indonesia

CHEMISTRY EDUCATION STUDY PROGRAM

DEPARTMENT OF MATHEMATICS AND NATURAL SCIENCE EDUCATION

FACULTY OF TEACHER TRAINING AND EDUCATION

MULAWARMAN UNIVERSITY

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"The Innovation in Chemistry Education in Supporting Green Chemistry toward the Advanced KalTim 2018"

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PREFACE

International Seminar on Chemistry in 2015 has been carried out on 12 September 2015 in Hall Rector Lt-4 Mulawarman Samarida. Activities of the International Seminar organized by Study Program of Chemistry and fully supported by the Dean of Faculty Teacher and Training Education, Rector Mulawarman University and Forum Cooperation Chemists Eastern Indonesia (FK3TI).

The seminar was attended by a number of participants consisting of: four guest speakers who come from Universitat of Bayreuth Jermany, University of Technology Malaysia, Hasanuddin University Makassar, State University Surabaya, and 36 speakers companion were divided into six groups presenting parallel and six speakers poster of lecturers from various universities in Indonesia and teachers throughout East Kalimantan.

Papers presented in these proceedings is the result of research covering the fields of chemistry, chemistry education, science education and science education. As well as the papers presented in these proceedings has been selected by the Papers evaluation team of the International Seminar of the committee of Chemistry 2015. Efforts publishing these proceedings have been conducted as much as possible and if there are errors and deficiencies in the publication of these proceedings, the criticisms and suggestions are expected in order to improve the The subsequent publication of proceedings.

We as the committee would like to thank all those who have supported and helped the implementation of the International Seminar in 2015 and the publication of these proceedings.

Chairman of the committee

Dr. Usman, M.Sc.

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BIOSORPTION OF CADMIUM (Cd) AT GREEN COCO FIBER (Cocos nucifera) WAS ACTIVATED BY USING ATOMIC ABSORPTION SPECTROPHOTOMETER (AAS) METHOD

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ABSTRACT

Various human activities are potentially produce heavy metal waste. The waste if it is not treated properly will cause environmental pollution and are toxic to organisms living including humans. Biosorbent has several advantages, including relatively low cost and easy to obtain.

The use coco fiber as biosorbent is one good use of waste to reduce environmental pollution. Has conducted research cadmium biosorption (Cd) on biosorbent green coconut coir fiber (Cocos Nucifera) activated NaOH. This study includes the determination of the optimum concentration for activation biosorbent base, determination of optimum pH, determining the optimum time and capacity biosorption by using atomic absorption spectrophotometer (AAS).

The results showed that the highest concentrations of NaOH activation biosorbent is 1.8 M or 11.2310 mg / L. The highest pH used by biosorbent activated is pH 2 or 19.6 mg / L, the highest timing needed to adsorb Cd is 30 minutes ie 14.7941 mg / L, whereas the highest biosorption capacity at a concentration of 70 ppm is 32.2882 mg / L

Keywords: Green coconut husk fiber, cadmium (Cd), biosorbent activated NaOH

BACKGROUND

Activities of human life are very high it turns out has caused various adverse effects to human life and the environment layout. The result will be a shift in the balance in the governance of the environment to a new form that is likely to be worse. This is what causes environmental pollution, whether in water, soil and air. One of the most dangerous pollutants are heavy metals.

Heavy metals are chemicals that are very harmful when present in the human body. Heavy metals in water or waste with concentrations exceeding the threshold can adversely affect normal biological cycle in the environment in both humans and other living things. Among the metal ions harmful environmental pollutants and toxic namely Cadmium (Cd), Lead (Pb), zinc (Zn), Mercury (Hg), Copper (Cu), and iron (Fe). In this regard, the presence of heavy metals in the water and in the environment should be eliminated. Various methods have been developed to reduce the content of metals in the environment,

especially metal cadmium (Cd). One method to do is adsorption. The use sorbent of organic material (biosorbent) lately very much developed. Biosorbent has the advantage to overcome dangerous and toxic metals in the environment because the price is relatively cheap, readily available, renewable and environmentally friendly nature. One is biosorbent derived from coconut fiber green.

Green coconut coir fiber is potentially as biosorbent because it contains a carboxyl group (-COOH) and lignin-containing acid phenolat who had a role in metal binding. cellulose and lignin is a biopolymer that is associated with the separation of heavy metals (Pino, et al, 2005).

Biosorbent with the ability to obtain higher biosorption activation needs to be done using alkaline (Massel, 1996). This activation aims to increase the specific surface area and active sites. Activation treatment using sodium hydroxide (NaOH) causes the impurities contained in green coconut fiber will dissolve so that the pores become more open which allows an increase in specific surface area. Based on the background and the paragraph above, the researchers are interested to study the green coconut fiber to its ability to absorb the metal cadmium (Cd) in contaminated water.

MATERIALS AND METHODS

a. Preparation biosorbent.

Fiber Green Coconut (Cocos nucifera) Objects that were analyzed, namely green coconut coir fiber, coconut peeled old has been prepared and the fiber is separated from the cork. Coconut fibers that have been separated washed clean and rinsed with aquabidest, then dried. The samples were cut into small pieces or blended and then sieved using (+ 40-100) mesh. Coconut fiber is then washed again with aquabidest until clean. The sample was then dried in an oven at 70°C, up to a constant weight is obtained and stored in eksikator

b. Activation biosorbent.

A total of 2 gram biosorbent put into 9 pieces erlenmeyer, then each added 25 mL of NaOH solution with varying concentrations of 0.2; 0.4; 0.6; 0.8; 1.0; 1.2; 1.4; 1.8 and 2.0 M then stirred for 2 hours, the results are filtered and the residue washed with aquabidest to pH neutral (pH 7). Biosorbent then dried in an oven at 70 ° C and stored in eksikator.To obtain optimum NaOH biosorbent activated, each of 0.5 grams of NaOH activated biosorbent put into 9 pieces erlenmeyer and added 25 mL of cadmium (Cd) 20 ppm, then dishaker for 2 hours. The resulting solution is filtered and the filtrate was analyzed by AAS at a wavelength of 228.8 nm.

c. Determination of Optimum pH biosorption.

A total of 0.5 grams of activated biosorbent put into 5 pieces of 250-ml Erlenmeyer, then added 25 mL of 20 ppm Cd, add a few more drops of HCl pa into each solution to obtain a predetermined pH is pH 1, 2, 3, 4 and 5. The mixture is then stirred with a shaker for 2 hours. Furthermore, the resulting solution is filtered and the filtrate is taken

to be analyzed using atomic absorption spectrophotometer (AAS) at a wavelength of 228.8 nm.

d. Determination of Optimum Time biosorption

Into a 250 ml Erlenmeyer each put 0.5 grams biosorbent activated and added to each 25 mL of solution with a concentration of 20 ppm Cd with optimum pH obtained previously. The solution was stirred using a shaker with respectively 10, 20, 30, 40 and 50 minutes. Subsequently, the mixture was filtered and the filtrate is taken to be analyzed using atomic absorption spectrophotometer (AAS) at a wavelength of 228.8 nm.

e. Determination ofCapacitybiosorption

A total of0.5grams ofactivatedbiosorbentput in a250mLErlenmeyer5 piecesand addedwith 25mL ofCdwithvarying concentrationsof 30, 40, 50, 60and70ppm, theninteracting thatduringcontact timeandpHoptimum. Aftertheresulting solutionis filteredand absorbanceis measuredwithatomic absorption spectrophotometer(AAS) at a wavelength of228.8nm.

RESULTS AND DISCUSSION

A. Determination of Activated ConcentrationVariationsUsingBases(NaOH)

Based on theresultsby varying theconcentration ofNaOHactivationin a rowthat is0.2; 0.4; 0.6; 0.8; 1.0; 1.2; 1.4; 1.8and2.0M.The highestuptakewas obtainedin ofthe activation ofa 1.8Mvariation amount of11.2310mg/L. Activationsmallest at0.8Mof7.2724mg/L. Activationabsorptionchartcan be seen inthe graphbelow.

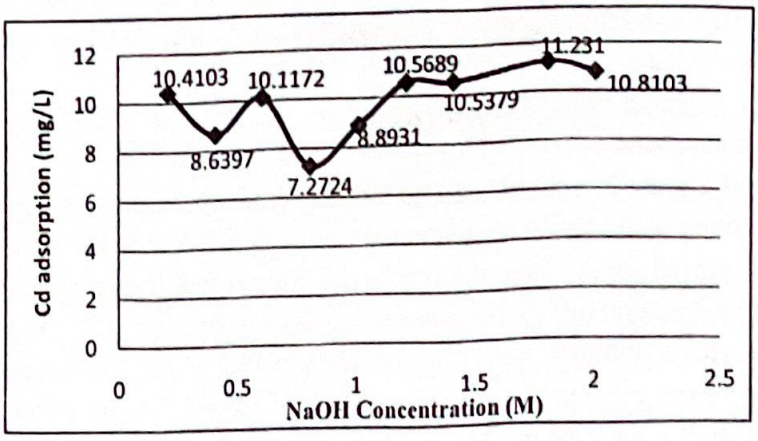

Figure 1. A graph of the variation of contact time biosorbent green coconut fiber on the adsorption capacity of Cd (mg / g).

On the graph 1 shows that the amount of Cd absorbed up and down is not stable due to higher concentrations of NaOH were added, to obtain the highest concentration of 1.8 M. The results obtained by the chart can not show the optimum point, where the results do not fit the theory that increasing the concentration of NaOH, the better process of formation in the active site.

This can occur because the active sites on the surface biosorbent NaOH, pore biosorbent and the active site of NaOH is not functioning properly so it can not absorb Cd perfectly. The use of alkaline activation lead to decreased absorption of ions. This is thought to occur because at the time the addition of NaOH there are some active site of coconut fiber such as lignin experiencing delignification reaction, where the lignin is degraded by NaOH. Lignin is expected to absorb the metals, but lignin did not participate in the process of absorption because it has been unraveled. In addition, the instability of the graph can also be caused because the sample had been contaminated by the air during storage after constant sample weight and possible sample has been contaminated with air so that the samples that had previously been a constant water level is now increased back to affect the weight of the sample.

This causes the active groups of fibers which carboxyl group is bonded to metals should be able to bind well with water so that the resulting reduction in the value of adsorption obtained. On the addition of a greater concentration of NaOH is 2.0 M started to decrease the amount of Cd absorbed. This may indicate that the concentration of NaOH began to decline in forming the active site so that the metal absorbs biosorbent less optimal.

B. Determination ofOptimumpHbybiosorbent(Fiber CoconutGreen)

The determination ofthe optimum pHbiosorbentactivatedcoco fibergreenmadeat a concentration of20ppmCdsolution. PHvariationis 1, 2, 3, 4and5.According tothe Appendix, then the averagemeasurement resultsadsorption capacity ofactivebiosorbentgreencoconut fiberto variations inpH. GraphCduptakebybiosorbentgreencoconut fiber isactivatedat variouspH variationcan be seen inthe graphbelow.

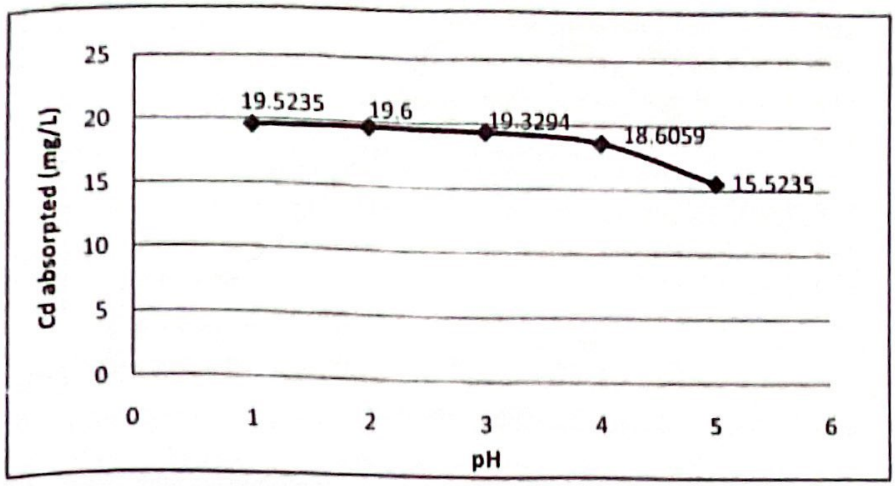

Figure 2. Graph The relationship between variations in pH by adsorption biosorbent green coconut coir fiber to Cd.

On the graph 2 shows that the highest absorption of Cd is at pH 2, with the value of the absorption efficiency is 19.6 mg / L. In the determination of the pH value is absorbed by a very small biosorbent ranged 0.1-0.2 mg / g. The results

obtained have not shown significant changes to the absorption, so that the pH determination there is almost no considerable influence on the absorption of Cd. This can occur due to the acidic pH, ions are subjected to forces repel each other, as presented by Sembiring (2009), at low pH uptake of all low metal ion. This is because on the surface of the adsorbent surrounded by H^+ ions. In acidic conditions also positively charged adsorbent surface, thus causing a repulsion between the adsorbent surface with metal ions, so that the adsorption becomes low.

According to Refilda, et al (2001), at alkaline pH metal ions can form a hydroxide precipitate thus hard to determine absorption efficiency. It can be concluded that the acid and alkaline pH range Cd uptake by coco fiber is less effective. This is why the process is not optimal absorption Based on the theory, in general, increased adsorption in the pH range in which an electrically neutral organic compounds that will bind to ion interaction can occur with either. As the result of research conducted by Ratna Dewi (2012), using straw as biosorbent in the allowance Cd in water to obtain a pH optimum is at pH 7. It can be concluded that in the pH range of acids and bases by the adsorption process of green coconut fiber is less effective.

C. Determination of the optimum time by biosorbent (Green coconut fiber)

The determination of the optimum time biosorbent green coconut fiber is activated to Cd is done by varying the contact time which starts from 10, 20, 30, 40 and 50 minutes with concentrations of Cd metal used is 20 ppm. Measurement of the variation of contact time with the Cd solution using atomic absorption spectrophotometry.

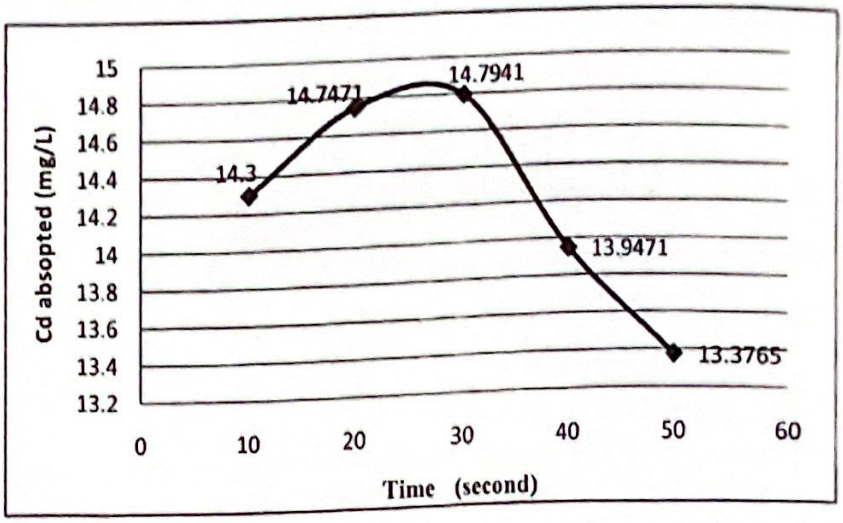

Figure.3. A graph ofthe variationof contact timebiosorbentgreencoconut fiberonthe adsorption capacity ofCd(mg /g).

Based on the graph, the optimum absorption at 30 minutes with the absorption efficiency of 14.7471 mg / L. At the beginning interaction time from 10 minutes to 20 minutes of the adsorbed metal continues to increase until peaking at 30 minutes, but after 40-50 minutes absorbed Cd metal number has decreased. This situation is consistent with the theory that the adsorption process will stop if there

has been a balance in which the adsorbate concentration in the solution and the adsorbent material remains. In this case the active carboxyl groups have experienced equilibrium, so the solution is saturated and no longer able to absorb metal optimally. Time obtained in this study is slightly slower than the research done by Anasthasia, et al (2014), using the dragon fruit skin to absorb the metals Cd in the solution to obtain optimum contact time results faster in the 20th minute.

Similarly, the theory put forward by Sukardjo (1990) that if a solution of two or more substances, substances that one will be absorbed more strongly than other substances. The amount of substance that is absorbed per weight of adsorbent depends on the concentration of solute nevertheless adsorbennya already saturated when the concentration is no longer influential.

Determination of Adsorption capacity by biosorbent (Green coconut fiber)

The determination of the optimum time biosorbent green coconut fiber is activated done by varying the concentration of Cd 30, 40, 50, 60 and 70 ppm. Cd Measurement data can be seen in the following chart.

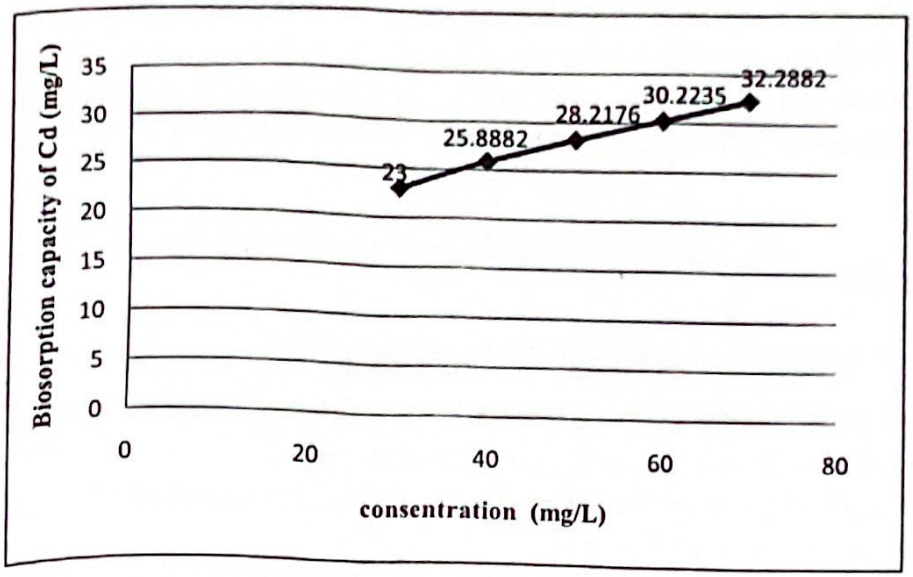

Figure 4. Graph of variations concentration (mg/L) and biosorption capacity (mg/L) /

Based on the graph it can be seen that the results of Cd uptake increased with increasing concentrations of the metal. The highest uptake was obtained at a concentration of 70 ppm is 32.2882 mg / L. While the lowest absorption is obtained at the lowest concentration of 30 ppm at 23 mg / L. Increasing metal ion concentration of Cd in the absorption process, it also increase the adsorption occurs in coconut fiber. the graph of the results obtained have not shown the optimum point but the highest point of absorption, because in this situation has not occurred saturation in which the groups active on the cellulose still able to absorb Cd metal with a higher concentration of Cd. So as Cd metal can still be bound by the cellulose in coconut fiber.It can be seen from the value of accuracy obtained, based on the calculation results R value 0.995. These results indicate that

the higher the R value, the error rate is getting smaller. The following is a reaction mechanism that occurs between the groups contained in the cellulose and the metals Cd.

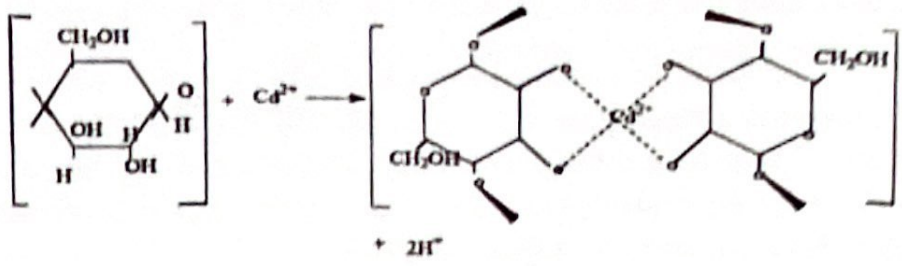

Figure 5. Graph of cellulose and Cd chelation

Uptake mechanism that occurs between -OH group attached to the surface, with a positively charged metal ion is an ion exchange mechanism. The interaction between -OH with metal ions is also possible through the formation mechanism of coordination complex, because the oxygen atom in the -OH group has a lone pair. The bond between Cd^{2+} ions with -OH on cellulose through coordination bond formation, where the lone pair of O in OH would bind to metal ions Cd^{2+} form complexes through covalent bonds.

CONCLUSION

Based on the purpose of research it can be concluded that:

1. Activation highest green coconut fiber (Cocos nucifera) to adsorb metals cd is the activation of a 1.8 M with absorption values 11.2310 mg/ L
2. The highest pH of green coconut fiber (Cocos nucifera) to adsorb metals Cd is at pH 2 with absorption value of 19.6 mg / L
3. The contact time highest of green coconut fiber (Cocos nucifera) to adsorb metals Cd is 30 minutes with the absorption value of 14.7941 mg / L.
4. The capacity biosorption obtained of green coconut fiber (Cocos nucifera) to the highest Cd metal concentration is at a concentration of 70 ppm with a capacity value of 32.2882 mg / L and the lowest absorption occurred at a concentration of 30 ppm with a capacity value of 23 mg / L.

REFERENCES

Achmad, Rukaesih. Kimia Lingkungan. Yogyakarta: ANDI, 2004.

Agustina, Dewi. Kadar Lignin dan Tipe Monomer Penyusun Lignin pada kayu Akasia. Skripsi Fakultas Kehutanan. Bogor: Institut Pertanian Bogor, 2009.

Dananto, Y C. dan Samun T. Pengaruh Aktivasi Karbon Dari Sekam Padi Pada Proses Adsorpsi Logam Cr (VI). EKUILIBRUM. Vol. 7. No. 1. (Januari 2008): h. 13-16. Fakultas Teknik. Surakarta, 2008.

Departemen Agama Republik Indonesia. Al-Quran dan Terjemahannya. Bandung: Diponegoro, 2008.

E. Himmel, Michael et al. Biomass Recalcitrance: Engineering Plants and Enzymes for Biofuels Production. Jurnal Internasional, Vol. 315. SCIENCE,2007.

Hendayana, Rafilda, dkk. Materi Pokok kimia Analitik Instrumen. Universitas Terbuka: Jakarta, 2001.

H. Sugiyarto, Kristian. Kimia Anorganik II . Universitas Negeri Yogyakarta: JICA, 2003.

Khalifah, Susi Nurul. Studi Keseimbangan Adsorpsi Merkuri (II) Pada Biomassa Daun Enceng Gondok (Eichhornia crassipes) yang Diimobilisasi Pada Matriks Polisilikat. Skripsi Fakultas Sains dan Tekhnologi. Malang: UIN Malang, 2007.

Khopkar, S.M. Konsep Dasar Kimia Analitik. Jakarta: UI-Press, 2007.

Krismastuti, dkk, Adsorpsi Ion Logam Cadmium Dengan Silika Modifikasi. Laporan Hasil Penelitian Pusat Penelitian Lembaga Ilmu Pengetahuan Indonesia. Tangerang, 2008.

Kusnandar, Feri. Kimia Pangan. Jakarta: Dian Rakyat, 2010.

Menteri Kesehatan Republik Indonesia. Peraturan Menteri Kesehatan Republik Indonesia Nomor 492/MENKES/PER/IV/2010 Tentang Persyaratan Kualitas Air Minum. (2010). http://www.litbang.depkes.go.id/sites/download/regulasi/permenkes/Permenkes_492-th-2010.pdf, (18 Oktober 2013).

Messel, R.I. Principless of Adsorption and reaction on Solid Surfaces. First Edition, John Willey and Sone. Illionis

Nurahma, Andi. Analisis kandungan zat Besi (Fe) pada Daun Dan Buah kelor Yang ada di Desa Mattajang Kecamatan Dua Boccoe kabupaten Bone. Skripsi. Makassar: UIN Alauddin, 2010.

Okafor, P.C et. al. Adsorption Capacity of Coconut (Cocos nucifera L.) Shell for Lead, Copper, Cadmium and Arsenic from Aqueous Solutions. Department of Chemistry, School of Mathematical and Physical Sciences, North-West University, Int. J. Electrochem. Sci, 7, 2012.

Palar, Heryando. Pencemaran dan Toksisitas Logam Berat. Jakarta: Rineka Cipta, 2004.

Pertiwi, Dini dan Welly Herumurti. Studi pemanfaatan Sabut Kelapa Sebagai Karbon Aktif Untuk Menurunkan Konsentrasi Fenol. Institut Teknologi Sepuluh Nopember, Surabaya, 2009.

Pino, G.H, et. al. Biosorption of Cadmium by Green Coconut Shell Powder. Metallurgi and Material, 225-Gavea. Rio de Janeiro-RJ, Brazil, 2005.

Rahmayanti, Prima Vinka. "Optimasi pH dan Waktu Kontak Biosorpsi Zat Warna RemazolYellow Oleh Biomassa Rhyzopus Oryzae Aktif Dan Terimobilisasi". Skripsi (Jurusan Kimia FMIPA) Surakarta: Universitas Sebelas Maret, 2007.

S. Arbintarso, Ellyawan. Tinjauan Kekuatan Lengkung Papan Serat Sabut Kelapa Sebagai Bahan Teknik. Jurnal Teknologi, Vol. 2, no. 1(Juni 2009): h. 53-60. Institut Sains & Teknologi Akprind Yogyakarta. Yogyakarta, 2009

Samin, Supriyanto C dan Zainul Kamal. "Analisis Cemaran Logam Berat Pb, Cu dan Cd pada Ikan Air Tawar Dengan Metode Spektrometri Nyala Serapan Atom (SSA)". (Seminar Nasional III, Pusat Teknologi Akselerator dan Proses Bahan) Yogyakarta: SDM Teknologi Nuklir, 2007.

Sembiring, Rosdiana. Adsorpsi Logam Cr (VI) oleh Biomassa Chara Fragilis Menggunakan SSA. Universitas Sebelas Maret, Surakarta, 2009.

Sudiarta, I Wayan dan Dwi Ariani Yulihastuti. Biosorbsi Kromium (VI) pada serat Sabut Kelapa Hijau (Cocos nucifera). Jurnal Kimia 4 (2), (2010): h. 158-166. FMIPA, Universitas Uadayana, Bali, 2010.

....., I Wayan dan Emmy Sahara. Biosorpsi Cr (III) Pada Biosorben Serat Sabut Kelapa Teraktivasi Natrium Hidroksida (NaOH). Jurnal Kimia 5 (2). 2011: h. 133-142.FMIPA, Universitas Uadayana, Bali, 2011.

....., I Wayan dan Wahyu Dwijani Sulihingtyas. Biosorpsi Cr(III) Pada Biosorben Serat Sabut Kelapa HijauTeramobilaisasi EDTA. Jurnal Kimia 6 (1), 2012: h. 29-36. FMIPA, Universitas Uadayana, Bali, 2012.

Sukardjo. KimiaFisika. Cet. 3; Jakarta : PT. Rineke Cipta, 1990.

Tyas, Sekar Insani Sumarning. Studi Netralisasi Limbah Serbuk sabut Kelapa (cocopeat) Sebagai Media Tanam. Skripsi Sarjana, Institut Pertanian Bogor, Bogor, 2000.

Wahyudi. Pengaruh Varietas dan Umur Kelapa (Cocos nucifera) Terhadap Tebal, Berat, dan Kadar Serat Nata De Coco. Skripsi.Jurusan Biologi Fakultas MIPA. Malang: Universitas Negri Malang, 2009.

World Health Organization (WHO). WHO Human Health Risk Assessment Toolkit: Chemical Hazards. http://www.who.int/ipcs/publications/methods/harmonization/toolkit.pdf, (18 Oktober 2013).

Widihati, I. A. G, dkk. Karakterisasi Keasaman dan Luas Permukaan Tempurung Kelapa Hijau (Cocos nucifera) dan Pemanfaatannya sebagai Biosorben Ion Cd^{2+}. Jurnal Kimia 4 (1). FMIPA, Universitas Udayana, Bali, 2010.

Widowati, Wahyu, dkk. Efek Toksik Logam. Yogyakarta: ANDI, 2008.

Zulfikar. polisakarida. (20 November 2010), http://www.chem-is-try.org/materi_kimia/kimia-kesehatan/biomolekul/polisakarida/, (19 oktober 2013)