International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Chicken Feather Activated Carbon as an Adsorbent and It's Application in Chemistry Learning

***Siti Zulaiha*[1], *Nurul Adawiyah*[2], *Pangoloan Soleman Ritonga*[3]**

[1]Faculty of Animal Science and Agriculture, Universitas Islam Negeri Sultan Syarif Kasim Riau
[2]MAN 1 Indragiri Hilir
[3]Faculty of Teacher Training and Education,Universitas Islam Negeri Sultan Syarif Kasim Riau
✉Email: siti.zulaiha@uin-suska.ac.id

ABSTRACT

Chicken feathers are a waste product with keratin protein that can be utilized as an adsorbent for the filtration of drilled well water. This study aims to see if activated carbon from chicken feathers may reduce Fe levels in drilled well water, as well as to see how students respond to a questionnaire. The research design of this study was experimental research combined with the purposive sampling strategy. The water volume was varied, specifically 5, 10, 15, 20, and 25 ml with 1 gram of activated carbon and a 30 minutes contact time. The Atomic Absorption Spectrophotometer (AAS) was used to determine the concentration of Fe metal. The results showed that the largest decrease in Fe metal concentration occurred at a volume of 5 ml, precisely 0.2078 ppm with a 95.09% absorption percentage. The total score on the questionnaire for students' understanding and interest in research was 98.70 percent, which is a very good result.

Keywords: chicken feathers, activated carbon, drilled well water, AAS

1 Introduction

Water is the most vital component of life. Groundwater, a natural resource that plays a role in delivering water supplies for various purposes [1] is one of the water sources used by people. The majority of the groundwater used comes from community wells. Drilled well water was discovered in the Indragiri Hilir Regency, specifically in the Tembilahan Hulu District. The physical appearance of the drilled well water utilized by the community in that location is brownish yellow, which could be caused by the presence of micronutrients such metallic iron (Fe).

Fe levels that exceed the quality standard established by PP No. 82 of 2001 (0.3 mg/L) for Water Quality Management and Water Pollution Control [2] can result in smelly water, yellow-brown color, or traces of crust on clothes, bathroom tub walls, porcelain and other appliances a few moment after air contact. Fe can potentially cause a variety of health issues, including digestive difficulties and Fe poisoning [3]. To overcome this, drilled well water treatment is required to meet the requirements for clean water quality, which include clear, colorless, tasteless and odorless water [4], such as purifying water using coagulation, filtration and adsorption techniques.

The adsorption method is commonly utilized since it is eco-friendly, cost-effective and does not cause allergies. Organic pollutant adsorbents are used in the adsorption process. The adsorbent activated charcoal or activated carbon, which has a high absorption/adsorption capacity for materials in the form of solutions or vapors, is often applied in the treatment of clean water (as well as wastewater). The absorption of activated carbon is quite high, ranging from 25 to 100 percent [5]. Activated carbon can be generated from organic or inorganic carbon-containing materials.

Chicken feathers are one of the materials that may be utilized to make activated carbon because they include keratin fibers that can form tubes. When keratin fibers are heated, carbon nanotubes develop [6]. The use of chicken feathers is also intended to reduce environmental pollution by accumulated waste such as environmental sanitation disturbances, unpleasant odors and a source of disease spread as a result of decreasing air quality. In addition, chicken feather waste also causes a decrease in soil quality because it is difficult to degrade due to the presence of keratin or fibrous protein in the form of fiber [7].

Bagaskoro et al. [8] found that the larger the bulk of the chicken feather adsorbent, the more Fe was absorbed. Chicken feathers with a mass of 0.5 g are the optimum point for Fe absorption. Meanwhile, Rojikhi [9] stated that the results of the Fe ion test with chicken feather activated carbon were 93.59%. Thus, the researcher believes that activated carbon derived from chicken feathers can be utilized to purify drilled well water, which is a concern in the Tembilahan Hulu District.

Water purification using activated carbon from chicken feathers can be presented in chemistry classes at schools/madrasah equivalents, specifically in colloid materials, sub-materials are colloid properties (adsorption), and one of them is water purification. According to the findings of an interview with one of the chemistry teachers at MAN Tembilahan, students at the madrasah were slow to understand the subject matter and were susceptible to losing

theory without real-life examples. Students are less interested in the subject, as shown by the number of students who are focused in conversation with their peers while the teacher explains. It is expected that having an explanation that connects the subject to everyday life and being around them will boost student interest and support them to understand the topic more faster than only presenting a theoretical explanation, as is generally done by teachers.

Based on the description on the background, the researchers conducted this research which aims to determine the ability of chicken feather activated carbon in reducing Fe metal concentrations in drilled well water and determine the students' understanding and interest.

2 Material and Methods

To collect drilled wellwater samples with high Fe potential, this study used a descriptive experimental method combined with a purposive sampling methodology. This research involved several stages, including the production of activated carbon from chicken feathers, the purification of drilled well water and its application in chemistry classes. The procedure for implementing research on chemistry learning is carried out on a colloidal subject (adsorption). A video illustrating the process of producing activated carbon and purifying drilled well water was used to introduce the material to the students. The students are then asked to complete a questionnaire that includes the material that has been presented.

To carry out the research steps, an AAS, analytical balance, orbital shaker, furnace, desiccator, porcelain cup, spatula, mortar and a set of laboratory glassware are needed. Meanwhile, the materials used included standard solutions of Fe, HCl pa., NaOH pa., formic acid pa., aquades, drilled well water, Whatman filter paper no. 1 and chicken broiler feathers.

The research data were collected from the results of the AAS measurements and questionnaires. The data obtained from the concentration of Fe metal is described descriptively, while the data obtained from the questionnaire is analyzed for each alternative answer with the formula P = $\frac{F}{N}$x 100% where P= percentage, F = frequency and N = number of frequency/number of respondents.

3 Results and discussion

3.1 Chicken feathers activated carbon

Feathers are the most common waste product of the chicken slaughterhouse. As the chicken farming industry grows, so does the chicken slaughter industry, which has a direct impact on the increase in chicken feather waste [8]. In this study, chicken feather waste was used as a raw material for the production of Fe metal adsorbent in the purification of drilledwell water. The potential of chicken feathers as an adsorbent is due to the content of keratin in the form of fiber. Activated carbon of chicken feathers is made through a process of dehydration, carbonization and activation as shown in Figure 1.

The dehydration process aims to reduce the moisture content of chicken feathers before the carbonization stage. The carbonization process was carried out at a temperature of 400oC for 1 hour causing all organic compounds contained in chicken feathers to be degraded [9]. Because surface area is such an important role in the adsorption process, chicken feathers are smoothed after carbonization. The ability of an adsorbent to absorb is related to its surface area. As a result, it's expected that the activated carbon in chicken feathers will absorb the most Fe metal in the drilled wellwater. This carbonization process produces 13.40 g of activated carbon from 40.10 g of burnt chicken feathers. So that it can produce a 32.59% yield.

Chicken feathers, which are utilized as raw materials for the production of activated carbon, contain a sulfur and cysteine-rich protein called keratin (fiber protein). Cysteine is an amino acid with side chains including carboxylate, amine and sulfhydryl functional groups [10]. Following the carbonization process, chicken feathers with the keratin functional group are activated in order to enlarge the pores by breaking hydrocarbon bonds or oxidizing surface molecules, causing the carbon to undergo physical and chemical changes. The surface area rises, which impacts the adsorption strength.

An acid solution (HCl 0.5 M) is added to the carbon, which denatures the proteins. Then, to strengthen the keratin group, formic acid was added [11]. Formic acid can open keratin's active site, allowing more Fe to be absorbed. Carbon is neutralized by the addition of a NaOH solution. The mixture was then agitated for 24 hours, allowing polyelectrolyte properties to form, causing it to perform as an ion exchanger and an adsorbent for Fe metal [12]. The activation process is completed by filtering the mixture of solution and carbon residue, resulting in marinated chicken feathers that are dried in a 105°C oven for 3 hours after soaking to remove moisture. The chicken feather activated carbon was then chilled for 30 minutes in a desiccator before being used.

3.2 Purification of drilled wellwater

Purification of drilled wellwater is accomplished by combining 1 g of chicken feather activated carbon with 5, 10, 15, 20 and 25 ml of drilled wellwater. The presence of Fe dissolved in the water gives the drilled wellwater a brownish yellow color. The metal content of Fe is estimated to come directly from the water source used. The metal content of Fe is unlikely to come from the well water equipment itself, because the pipe used is a paralon pipe, which has very little corrosive effect, and the pipe is also unlikely to alter the metal content of Fe.

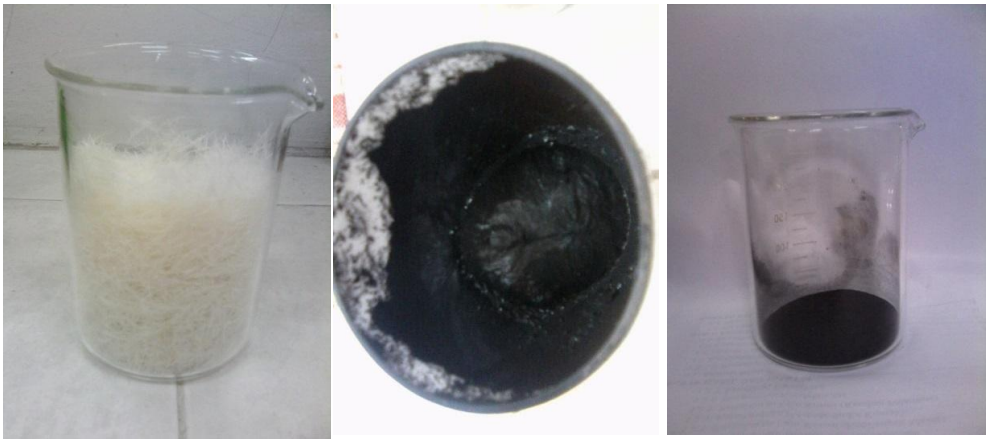

Figure 1. (Left to Right) Stages of Dehydration, Carbonization and Activation

Excessive Fe concentrations can degrade the aesthetic value of clothing, porcelain and other household goods, causing yellow spots to appear on them. Iron can be found in water as dissolved Fe(II) and Fe(III) [13]. The activated carbon of chicken feathers is a polyelectrolyte, while the metal in water is a positively charged particle. With the difference in charge between the adsorbent and metal, an electrostatic force arises so that metal ions will stick to the activated carbon of chicken feathers. The electrostatic interaction between metal ions and activated carbon of chicken feathers is thought to be due to the Van Der Waals force [14].

Drilled well water which has a brownish yellow color is also influenced by the presence of dissolved organic substances (humus material), especially in the form of humic acid, including humic acid and fulvic acid derived from peat soil. These acids can also be adsorbed onto the activated carbon surface. Keratin is a group of amino acids that are both acidic and basic. The presence of an NH group on the basic nature of chicken feather keratin is expected to react with acidic humus compounds in drilled well water. Because the activated carbon groups of chicken feathers were not examined in this work, it is unknown which groups will react or bind to Fe metal and humic acids present in the drilled water.

3.3 Measurement of Fe Concentration

Table 1 and the curve in Figure 2 show the Fe concentration before and after being treated with chicken feathers activated carbon. The high content of Fe in drilled well water, which is 4.2396 ppm, is shown in the table. Fe concentration in the drilled well waterwas measured after treatment and found to be lower. In other words, metals are absorbed by chicken feather activated carbon. The greatest decrease in Fe concentration was found in the volume of 5 ml drilled well waterwith an absorption percentage of 95.09%. A 5 ml sample of drilled well waterproduces clear water with a Fe metal content of 0.2078 ppm.

Based on Table 1, there is a decrease in absorption capacity along with the volume of drilled well water. Maximum absorption occurs at a volume of 5 ml, explaining that the conditions are in equilibrium time [15]. After this condition the activated carbon began to saturate, resulting in a decrease in absorption because it had passed the maximum absorption limit as in the volumes of 10, 15, 20 and 25 ml. The concentration of Fe in drilled well waterwith this volume variation exceeds the quality standard for Fe content for clean water. According to the measurements, 1 g of chicken feathers activated carbon can be used in 5 ml and 10 ml of drilled well waterbecause it passes clean water standards. However, at a volume of 5 ml of drilled well water, the best absorption is achieved.

The first and second repetitions of the 5 ml and 10 ml drilled well watervolumes indicated a significant difference in the results of the drilled well waterpurification process as evaluated by AAS. The repetition findings for volumes 15, 20 and 25 ml were not significantly different. This is due to the activated carbon of chicken feathers not maintaining homogeneous particle size due to refining without employing a mesh size filter. As a result, the adsorption power of activated carbon in chicken feathers is expected to change as the well drill's water volume changes. Furthermore, the presence of factors beyond the researcher's control, such as temperature and pH, is assumed to be a contributing factor to the lengthy repetition value.

Table 1. Fe Absorption by Chicken Feather Activated Carbon in Drilled Well Water

Volume (ml)	**Fe Concentration (ppm)**	**Adsorption (%)**
5 (control)	4,2396	0
5	0,2078	95,09
10	0,5069	88,04
15	2,0102	52,59
20	2,4574	42,04
25	2,6486	37,52

Values are means

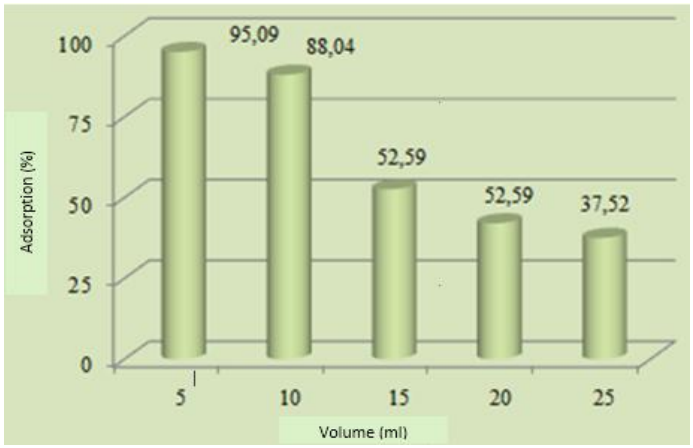

Figure 2. Graph of Fe Metal Absorption Percentage

3.4 Implementation of chicken feather activated carbon in chemistry learning

The objective of the questionnaire is to find out how well students know deep down about colloid adsorption. The procedure of collecting data for this questionnaire begins with an explanation of the basics of colloid adsorption, followed by a discussion of one of its applications: water purification. When explaining this, the researcher reflected on previous teachings on the basis of colloid adsorption, and it was clear that many students had forgotten or misunderstood the subject of adsorption properties.

A video about the research on the use of activated carbon from chicken feathers as an adsorbent in the purification of drilled well water was shown to the students before the questionnaire was handed out. Students will pay close attention until the video is done and then ask about anything they didn't understand during the video's exposure.

The findings of the questionnaire responses to students' understanding and interest were outstanding, with a percentage of 98.70%. As a result, utilizing activated carbon from chicken feathers as an adsorbent in the purification of drilled well water can improve students' understanding and interest in the subject of colloid adsorption properties.

4. Conclusions

The use of chicken feathers activated carbon as an adsorbent can lower the concentration of Fe metal in drilled well water, according to the findings of this study, with the highest absorption of 95.09% at a ratio of 1:5 (g/ml) of activated carbon and drilled well water. The decrease in concentration has met the quality standard for Fe metal content according to the Minister of Health of Republic Indonesia No. 416 of 1990 which is 1.0 ppm for clean water. The results of the questionnaire responses of students' understanding and interest were very good, with a percentage of 98.70 percent, indicating that students better understand and are interested in the material of colloid adsorption properties.

REFERENCES

[1] B. Prastistho, P. Pratiknyo, A. Rodhi, C. Prasetyadi, R. M. Massora, and Y. K. Munandar, *Hubungan Struktur Geologi dan Sistem Air Tanah*, 1st ed. Perpustakaan Nasional Katalog Dalam Terbitan, 2018.

[2] Presiden RI, "Peraturan Pemerintah Republik Indonesia Nomor 82 Tahun 2001 tentang Pengelolaan Kualitas Air dan Pengendalian Pencemaran Air," Jakarta, 2001.

[3] D. R. Indah, P. P. Kimia, I. Mataram, and J. P. No, "Upaya Menurunkan Kadar Ion Logam Besi Pada Air Sumur Dengan Memanfaatkan Arang Ampas Tebu," *Hydrog. J. Kependidikan Kim.*, vol. 5, no. 2, 2017.

[4] Menteri Kesehatan RI, "Peraturan Menteri Kesehatan Nomor: 416 / MEN . KES / PER / IX / 1990 Tentang Syarat-syarat Dan Pengawasan Kualitas Air," Jakarta, 1990.

[5] R. Dewi, C. Dari, and K. Aktif, "Aktivasi Karbon dari Kulit Pinang dengan Menggunakan Aktivator Kimia KOH," *J. Teknol. Kim. Unimal*, vol. 2, no. Nopember, pp. 12–22, 2020.

[6] A. Alhamidi *et al.*, "Karakterisasi Karbon Aktif dari Bulu Ayam untuk Aplikasi Penyimpan Gas Hidrogen (Hydrogen Storage)," *Rotasi*, vol. 21, no. 1, pp. 16–22, 2019.

[7] D. S. Mulia, R. T. Yuliningsih, H. Maryanto, and C. Purbomartono, "Pemanfaatan Limbah Bulu Ayam Menjadi Bahan Pakan Ikan dengan Fermentasi Bacillus subtilis," *J. Mns. dan Lingkung.*, vol. 23, no. 1, pp. 49–57, 2016.

[8] A. P. Bagaskoro *et al.*, "Pemanfaatan Bulu Ayam Sebagai Adsorben Logam Fe dalam Air Tanah," *J. Chem. Process Eng.*, vol. 01, no. 01, pp. 1–8, 2020.

[9] Rojikhi, "Pemanfaatan Hasil Pirolisis Bulu Ayam Sebagai Adsorben Ion Na dan Fe Dalam Larutan Simulasi," UIN Syarif Hidayatullah, 2011.

[10] F. Nor, "NaOH / Na 2 SO 3 Sebagai Penurun Kadar Logam," Universitas Negeri Malang, 2013.

[11] N. Sa'adah, R. Hastuti, and N. B. A. Prasetra, "Pengaruh Asam Formiat pada Bulu Ayam sebagai Adsorben Terhadap Penurunan Kadar

Larutan Zat Warna Tekstil Remazol Golden Yellow RNL," *Chem Info*, vol. 1, no. 1, pp. 202–209, 2013.
[12] D. N. Hidayat, "Pemanfaatan Biomassa Bulu Ayam Sebagai Adsorben Logam Ion Seng (Zn2+)," Universitas Hasanuddin, 2018.
[13] R. Apriani *et al.*, "Pengaruh Konsentrasi Aktivator Kalium Hidroksida (KOH) terhadap Kualitas Karbon Aktif Kulit Durian sebagai Adsorben Logam Fe pada Air Gambut," *Prism. Fis.*, vol. I, no. 2, pp. 82–86, 2013.
[14] L. H. Rahayu and S. Purnavita, "Pengaruh Suhu dan Waktu Adsorpsi Terhadap Sifat Kimia-Fisika Minyak Goreng Bekas Hasil Pemurnian Menggunakan Adsorben Ampas Pati Aren dan Bentonit," *Momentum*, vol. 10, no. 2, pp. 35–41, 2014.
[15] I. Syauqiah, M. Amalia, and H. A. Kartini, "Analisis Variasi Waktu dan Kecepatan Pengaduk pada Proses Adsorpsi Limbah Logam Berat dengan Arang Aktif," *Info Tek.*, vol. 12, no. 1, pp. 11–20, 2011.