Preparation of Active Carbon from Rice Straw to Reduce TSS Levels and pH Value of Tofu Waste

Mery Napitupulu
Department of Science Education
Tadulako University
Palu, Indonesia
merytn@gmail.com

Siti Nukra
Department of Science Education
Tadulako University
Palu, Indonesia
sitinukra704@gmail.com

Daud K Walanda
Department of Science Education
Tadulako University
Palu, Indonesia
walanda@gmail.com

***Abstract*— This research aims to utilize waste agriculture rice straw as a source to produce carbon active and can be used to reduce the levels of TSS and pH value of activated carbon. The feasibility of TSS levels in tofu waste is seen from SNI 06-6989-3-2004. The yield of activated carbon from rice straw was obtained by 37%, water content of 3.5%, and ash content of 1.13%. The optimum time for activated carbon to adsorb TSS levels is 8 hours, with a decrease in TSS levels to 10 mg /L, with a pH value of 4. While the optimum weight for activated carbon to adsorb TSS levels is 1.5 grams, with a decrease in TSS levels to 8 mg /L with a pH value of 4.**

Keywords*— *Activated Carbon, TSS, pH, Adsorption

I. INTRODUCTION

Using straw rice as a raw material for making activated carbon is one of the efforts to utilize waste to become carbon active. Rice farming produces a large amount of garbage that has not been used optimally. Straw Rice is generally left to rot on agricultural land, although some are used as fodder for livestock. At the same time, these wastes can be processed into activated carbon and have the potential to be produced industrially and provide economic value and environmental health [1].

The activated carbon manufacturing industry in Indonesia has progressed quite rapidly. This is due to the increasing market demand, both domestically and for export abroad. The rising number of applications of activated carbon for industry and various human aids causes the growing need for activated carbon. Activated carbon can be used for multiple industries, including medicine, food, beverage, and water treatment (water purification). Nearly 70% of activated carbon products are used for refining in the coconut oil, pharmaceutical, and chemical sectors [2].

Biomass in agricultural residues, which is used as raw material for the manufacture of activated carbon, plays a role in the utilization of activated carbon as an adsorbent in the treatment of tofu wastewater.

Wastewater not managed correctly can also become a breeding ground for disease vectors such as mosquitoes, flies, cockroaches, and others [3]. The characteristics of tofu liquid waste are that the temperature exceeds the average temperature of the receiving water body (60-80 ℃), the color of the waste is yellowish white and cloudy, pH < 7, COD (Chemical Oxygen Demand) 1534 mg/L, BOD (Biochemical Oxygen Demand) 950 mg/L, TSS (Total Suspended Solid) 304 mg/L [4]. The solids are partly in the form of soybean skin, mucous membranes, proteins, fats, and carbohydrates. This liquid waste in water can potentially cause a foul odor due to anaerobic processes in the breakdown of proteins, fats, and carbohydrates by microorganisms. It also adds to the burden of water pollution [5].

Suspended solids (Total Suspended Solid) are all solid substances or particles suspended in water. They can be living (biotic) components such as phytoplankton, zooplankton, and fungal bacteria or dead (abiotic) parts such as residues and inorganic particles. The impact of TSS on water quality can lead to a decrease in water quality. This condition can cause disturbance, damage, and danger to all living things that depend on water resources. TSS causes turbidity and reduces the light that can enter the water. Therefore, the benefits of water can be diminished, and organisms that need light will die. The death of these organisms will disrupt the aquatic ecosystem. If this amount of suspended matter settles, then the formation of mud can significantly disrupt the flow in the channel, and silting quickly occurs, meaning that the effect on health will be indirect [6].

II. METHODS

A. *Activated Carbon Preparation*

The activated carbon was prepared from rice straws, dried, then carbonized in a furnace for an hour and 250^{o}C. Charcoal from rice straw is used to make actuated carbon since it contains biomass such as lignin, and cellulose is picked from the old and yellow stems and dried in the sun. The wind-dried tests were weighed and pounded employing a blender, at that point, put in an electric counter, warmed at 250°C for 1 hour, cooled for 24 hours, and weighed the charcoal. The powder was sifted with a pass estimate of 80 work. The calculation of the water and ash substance is displayed in Table 1. The water content and ash content were calculated before the Pore analysis was performed using SEM (Scanning Electron Microscope) to determine the pore size of the activated carbon and by EDS to find out the element's content.

Before the SEM-EDS was performed, the filtered powder was activated by physical means, soaking the filtered charcoal powder with $ZnCl_2$ for 24 hours, then washed with cold water and filtered/drained. The product is dried in a desiccator

F. Zahra et al. (eds.), *Proceedings of the 2nd International Interdisciplinary Conference on Environmental Sciences and Sustainable Developments Education and Green Economy (IICESSD-EGE 2022)*, Advances in Social Science, Education and Humanities Research 794,
https://doi.org/10.2991/978-2-38476-172-2_56

B. Measuring the Influence of Carbon on TSS and pH

The study to reduce the TSS level and pH value of tofu waste by activated carbon from rice straw were conducted with variations in contact time and mass weight of the carbon.

III. RESULT AND DISCUSSION

TABLE I. DATA ANALYSIS OF BIOCHAR FROM RICE STRAW

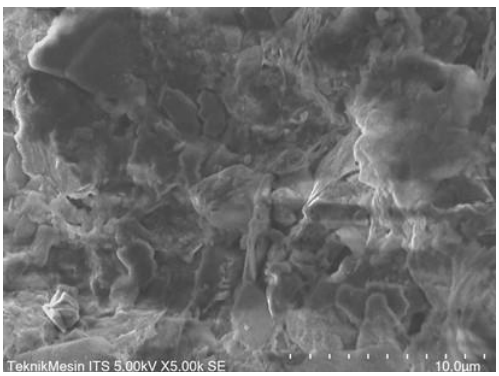
Sample	Pyrolysis Temperature	Yield (%)	Water content (%)	Ash content (%)
Cacao leaf	250	37	3.5	1.13

The yield of rice straw is 37%. The percentage yield of rice straw is relatively low. This is due to the difference in the particle size of the sample. The result of activated carbon has particles with a small size. It will produce less yield than carbon, having a larger particle size [8].

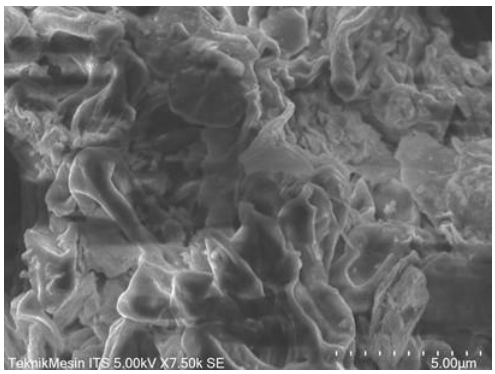
The analyses indicated that the water content of activated carbon in rice straw was 3.5%. This is caused by drying the raw materials under the sun for five days before being made into activated carbon. The raw material has been dehydrated, so the amount of water in the activated carbon is small. According to the Indonesian National Standard (SNI) 1995, good-quality activated charcoal has a maximum water content of 15%. At the same time, the ash content showed that the ash content of the rice straw's active carbon was 1.13% higher. When asked in a kiln with ashing temperature and time, activated carbon from rice straw becomes ash faster, producing more ash content. Where the ash content produced depends on the composition of the raw materials and the method of ashing used. According to the Indonesian National Standard (SNI) 1995, good quality activated charcoal has a maximum ash content of 10%.

A. SEM-EDS Analysis

Scanning Electron Microscope (SEM) -EDS analysis aims to determine the surface of the pores of a material. In this case, the material analyzed is activated carbon from rice straw. Scanning Electron Microscopy (SEM) was carried out with magnifications of 2500 and 5000 times. SEM is to determine the difference in the shape of the pore surface of calcined pyrolysis-activated carbon at 250°C for 1 hour. The results are shown in the following image (a) with 5000x magnification and (b) with 7500x magnification.



(a)



(b)

Figure 1. Pore surface structure analysis was performed using a scanning electron microscope (SEM)

Figure 2 shows that the activated carbon test appears that the molecule measure from the SEM is 20 m and 10 m, demonstrating that activated carbon is classified as microporous. The littler the pore breadth of the carbon and the bigger the pore volume, the more noteworthy the surface region and retention of the carbon. Shaped like lumps of rock and irregular, after analysis, it shows the formation of pores whose surfaces also tend to be partitioned, and the number of pores some of them are closed unevenly because some of the pores are open and the adsorption surface area becomes large. Also there are white powders that stick to the surface of the pores. Where it can be seen that the pores formed are not evenly distributed but have irregular pore shapes.

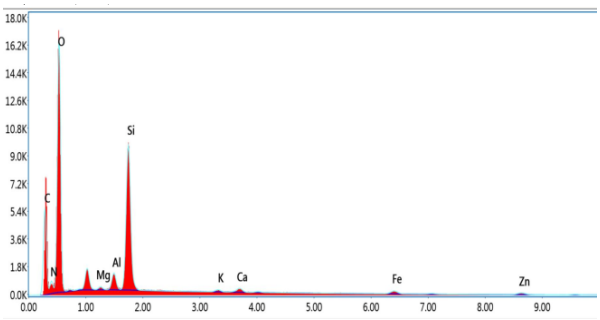


Figure 2. EDS analysis shows the distribution of carbon and other elements in activated charcoal of rice straw

TABLE II. ELEMENT CONTENT IN ACTIVATED CARBON

Element	Weight (%)	Atoms (%)
C	24.91	34,12
N	4.77	5.60
O	47,68	49,04
Mg	0.30	0.20
Al	1.67	1.02
Si	13,48	7.89
K	0.45	0.19
Fe	1.99	0.59
Zn	3.80	0.96

Activated carbon of rice straw has elements, including Carbon 24.91%, Nitrogen 4.77%, Oxygen 47.68%, Magnesium 0.30%, Aluminum 1.67%, Silicon 13.48%, Calcium 0, 45%, Calcium 0.97%, Iron 1.99%, and Zinc 0.96%. Dispersive X-Ray Spectroscopy (EDS) obtained carbon content in activated carbon of rice straw below 50%.

The low temperature causes this during pyrolysis. The researcher found that the optimal temperature for carbonization is 500◦C because temperatures above 500◦C can cause changes in the solid carbon content to turn into ash so that the stable carbon content will decrease [7]. This is because more and more material is burned, and the amount of carbon content remains dependent on the amount of moisture, ash, and volatile matter. The lower the value of water, ash, and volatile matter content, the greater the value of solid carbon content.

B. Measurement of TSS and pH Value in Tofu Wastewater

TSS testing on wastewater within the field employments the Gravimetric strategy was concurring with the reference, specifically the reference to SNI 06-6989.3-2004.

The water execution changed with the treatment of blending enacted carbon from rice straw out into the three tried water tests. The quality of the tofu wastewater examined experienced a diminish within the TSS esteem indeed in spite of the fact that it did not meet the measures (Table III) since there was still eight mg/L TSS within the water indeed even though the time utilized had come to 8 hours with 1 gram of enacted carbon.

TABLE III. TSS AND PH MEASUREMENT IN TOFU WASTE BASED ON CONTACT TIME VARIATIONS

Carbon Weight (gr)	Time (hours)	TSS (mg/L)	pH
0	0	16	4.43
1	1	16	4.74
1	4	14	4.77
1	8	10	4.82

TABLE IV. TSS AND PH MEASUREMENT IN TOFU WASTEWATER BASED ON WEIGHT VARIATION

Carbon Weight (gr)	Time (hours)	TSS (mg/L)	pH
0	0	16	4.43
O.5	24	12	4.73
1	24	10	4.77
1.5	24	8	4.80

According to Table III. The results obtained from variations in contact time on TSS levels and pH values were at the time of immersion for 1 hour with a weight of 1 gram of activated carbon, activated carbon of rice straw obtained TSS levels of 16 mg/L with a pH value of 4.74. In immersion for 4 hours with a weight of 1 gram of activated carbon, the activated carbon of rice straw obtained a TSS content of 14 mg/L with a pH value of 4.77. And in immersion for 8 hours with a weight of 1 gram of activated carbon, the activated carbon of rice straw obtained a TSS content of 10 mg/L with a pH of 4.82.

Based on the description above, it can be seen that the decrease in TSS levels by varying the contact time did not decrease in immersion for 1 hour but decreased at 4 and 8 hours of immersion. TSS levels are still high due to the high organic matter in tofu liquid waste that has not been entirely absorbed by activated carbon and the immersion time is not long enough [9].

While the acidity test (pH) on tofu waste for its acidity, has a pH of 4, where there is no increase in the pH value. The increase in pH occurs due to the absorption of hydrogen ions (H^+) from a series of adsorption processes by activated carbon [10].

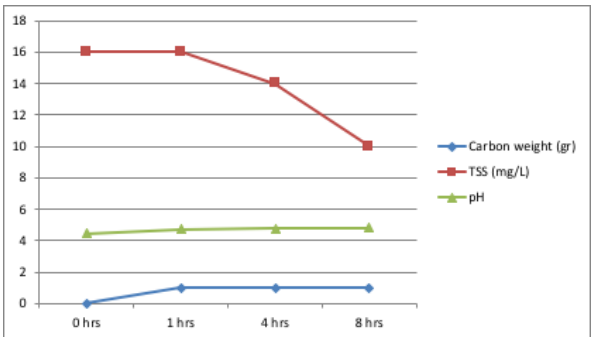


Figure 3. Results of measurements of TSS levels and pH values of tofu wastewater based on contact time variations

Table IV shown that the results obtained from weight variation carried out by soaking activated carbon-activated rice straw obtained TSS levels of 12 mg/L with a pH of 4.73. Soaking rice straw-activated carbon received a TSS content of 10mg/L with a pH of 4.77. Soaked rice straw-activated carbon obtained a TSS content of 8 mg/L with a pH of 4.80. It can be seen from the table that the decrease in TSS levels by varying the weight has decreased immersion as much as 0.5 g - 1.5 g. The complete absorption of TSS levels causes low TSS levels by activated carbon and the long soaking time. Based on the acidity test (pH) on tofu waste for its acidity, it has a pH of 4, where there is no increase in the pH value. The increase in pH occurs due to the absorption of hydrogen ions (H^+) from activated carbon's adsorption processes.

IV. CONCLUSION

The results of the characteristics of activated carbon 37% for rice straw. The moisture content of activated carbon from rice straw was 3.5%. Meanwhile, the ash content obtained for rice straw was 1.13%. In the variation of contact time, TSS levels and pH values were obtained, namely when soaking for 1 hour with a weight of 1 gram of activated carbon, activated carbon of rice straw received TSS levels of 16 mg/L with a pH value of 4.74. In immersion for 4 hours with a weight of 1 gram of activated carbon, the activated carbon of rice straw obtained a TSS content of 14 mg/L with a pH value of 4.77. And in immersion for 8 hours with a weight of 1 gram of activated carbon, the activated carbon of rice straw obtained a TSS content of 10 mg/L with a pH of 4.82. In the weight variation, TSS levels and pH values were obtained; namely, when soaking activated carbon in rice straw, TSS levels were obtained at 12 mg/L with a pH of 4.73. Soaking rice straw-activated carbon brought a TSS content of 10mg/L with a pH of 4.77. Soaking rice straw-activated carbon received a TSS content of 8 mg/L with a pH of 4.80.

ACKNOWLEDGMENT

The author(s) is grateful to the Chemistry Education study program Lab Assistants, who helped a lot during the research. The research grant from the Faculty of Post Graduate is highly appreciated.

REFERENCES

[1] Khoshnood Motlagh E, Asasian-Kolur N, Sharifian S and Ebrahimian Pirbazari A 2021 Sustainable rice straw conversion into activated carbon and nano-silica using carbonization-extraction process Biomass and Bioenergy 144 105917

[2] Anshary A and Napitupulu M 2022 Surface Performance of Biochar from Young Coconut Shells (Cocos Nucifera) for Cd2+ Ion Adsorption International Journal on Advanced Science, Engineering and Information Technology 12 774

[3] Walanda D K, Anshary A, Napitupulu M and Walanda R M 2022 The Utilization of Corn Stalks as Biochar to Adsorb BOD and COD in Hospital Wastewater IJDNE 17 113–8

[4] Chua J-Y and Liu S-Q 2019 Soy whey: More than just wastewater from tofu and soy protein isolate industry Trends in Food Science & Technology 91 24–32

[5] Dianursanti, Rizkytata B T, Gumelar M T and Abdullah T H 2014 Industrial Tofu Wastewater as a Cultivation Medium of Microalgae Chlorella vulgaris Energy Procedia 47 56–61

[6] Chen W, Wang J, Cao X, Ran H, Teng D, Chen J, He X and Zheng X 2021 Possibility of using multiscale normalized difference vegetation index data for the assessment of total suspended solids (TSS) concentrations in surface water: A specific case of scale issues in remote sensing Environmental Research 194 110636

[7] Wang S, Zhang H, Huang H, Xiao R, Li R and Zhang Z 2020 Influence of temperature and residence time on characteristics of biochars derived from agricultural residues: A comprehensive evaluation Process Safety and Environmental Protection 139 218–29

[8] Yi M, Cheng Y, Wang Z, Wang C, Hu B and He X 2020 Effect of particle size and adsorption equilibrium time on pore structure characterization in low pressure N2 adsorption of coal: An experimental study Advanced Powder Technology 31 4275–81

[9] Irfan M, Butt T, Imtiaz N, Abbas N, Khan R A and Shafique A 2017 The removal of COD, TSS and colour of black liquor by coagulation–flocculation process at optimized pH, settling and dosing rate Arabian Journal of Chemistry 10 S2307–18

[10] He Y, Yao T, Tan S, Yu B, Liu K, Hu L, Luo K, Liu M, Liu X and Bai L 2019 Effects of pH and gallic acid on the adsorption of two ionizable organic contaminants to rice straw-derived biochar-amended soils Ecotoxicology and Environmental Safety 184 109656