UTILIZATION OF BANANA BUNCHES BIO-CHAR AS AN ADSORBENT TO REDUCE PHOSPHATE LEVELS IN HAND WASHING WASTE WATER DURING THE COVID-19 PANDEMIC

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Abstract

Coronavirus disease is a global health problem that is being faced today. One of the efforts that can be done to prevent its spread is to wash your hands with soap and water. This increase in handwashing activities with soap and water creates a waste problem for the environment. So, steps are needed to treat this waste, namely using biochar. Biochar is a carbon-rich solid material from the conversion of organic waste to agricultural or plantation biomass. One example of organic waste is banana bunches. This study aims to determine the quality of hand washing wastewater in terms of phosphate levels, before and after treatment with the addition of biochar with adsorption times of 1 day, 3 days, and 5 days. Phosphate levels of handwashing wastewater without biochar were 15.63 mg/L, and phosphate levels of handwashing wastewater at adsorption times of 1 day, 3 days, and 5 days were 9.64; 9.87; and 15.32 mg/L. The results showed that there was a decrease in phosphate levels with the application of biochar and the effective adsorption time was 1 day.

Keywords: biochar, banana bunches, adsorbent, phospate levels

Introduction

December 2019 marked the start of Coronavirus Disease's, also known as Covid-19's spread which plunged the world into a global health crisis. The main clinical symptoms experienced by infected individuals include fever, cough, fatigue, and acute respiratory disorders (Elya et al, 2020).

As of the fourth of August 2021, the Government of the Republic of Indonesia has reported 3,532,567 confirmed cases of COVID-19 and 100,636 deaths (CFR: 2.8%) (Annisa, 2021). To counter this problem, the World Health Organization (WHO) has called for the implementation of health protocols along with other efforts to quell the spread of Covid-19.

One way to prevent contracting Covid-19 is by washing your hands with soap under running water. Washing your hands with soap breaks the chain of microorganisms such as Covid-19 that may be present on your hands. This is done as hands can potentially act as an agent, carrying microorganisms that were transferred by direct contact from one person to another, or by indirect contact through an object's surface (Hasanah and Dwi, 2020).

The reason for using soap during hand washing relates to the structure of the Coronavirus itself. Coronavirus belongs to the family of enveloped viruses. This virus has a lipid bilayer with proteins covering a core which is composed of complex of nucleic acids and proteins (Poon et al, 2020). Soap is composed of carbon chains of C12 to C16 which are amphiphilic because there are non-polar hydrophobic groups and polar hydrophilic groups. The hydrophobic group will bind with fat molecules and impurities on the hand's surface, while the hydrophilic group will bind with water-soluble molecules. The presence of this hydrophobic group plays a role in binding the lipid bilayer of the Coronavirus.

The widespread habit of washing hands with soap is currently not only done in the household, but also in offices, shopping centers, and schools. An increase in the frequency of hand washing using soap causes an increase in the production of hand washing water waste. This waste water is alkaline in nature having a pH above 7 and containing surfactants and phosphates. In bodies of water, excessive phosphate content may cause eutrophication. The high pH of hand washing waste water will also affect the survival of organisms in the water body.
In an effort to treat hand washing water waste, researchers applied the adsorption method by using bio-char from unused banana bunches. Banana bunches contain cellulose, and hemi cellulose which are the raw materials used in making bio-char (Sari et al, 2017).

The purpose of this research is stated as follows. This research aims to examine the quality of hand washing waste water, in terms of phosphate levels after adsorption by banana bunch bio-char for 1, 3, and 5 days.

Research Methodology

Banana Bunches Bio-Char Preparation

The samples of banana bunches were washed, cut to a size of ± 5 cm, dried in the sun and carbonized using a simply made improvised pyrolysis device in the form of a drum

tube (Matheus *et al*, 2017). The kiln drum used comes from used drums with air holes at the top. After carbonization, the yielded carbon was cooled. For uniformity, all the samples were mixed homogeneously using a stirring rod, then crushed using a mortar and pestle. The finely ground carbon powder was then sieved through a 100 mesh sieve to obtain a homogeneous particle size.

Bio-Char Application in Hand Washing Wastewater

The hand washing waste water was obtained from the sink pipe at Doremi Excellent School. 3 grams of the bio-char sample was put into a glass container and then 200 mL of hand washing wastewater was added, the mixture is then stirred until homogeneous and tightly closed. The adsorption time varies with 1 day, 3 days, and 5 days of adsorption. After adsorption, the samples were then filtered using filter paper and analyzed for quality in terms of phosphate levels.

Determination of Phosphate Levels

25.0 ml of the sample is pipetted into a 100 mL Erlenmeyer then 2.5 mL of ammonium molybdate-sulfuric acid solution and a tip of a spoon of ascorbic acid crystals is added. The solution was then boiled until a perfect blue color is formed. The solution was then cooled and shaken until homogeneous. The absorbance of the solution was then measured at a wavelength of 630 nm.

Research Design

Our research will make use of real experiments with the application of the one-group pretest- posttest design such as what is shown on the table below.

Table 1 – Research Design

Sample	*Pretest*	Treatment	*Posttest*
Experiment	O_1	X	O_2

Legend:

O_1 : *Pretest*

X : Treatment

O_2 : *Posttest*

Determination of Data Source

The sample of banana bunches were acquired from a few vendors in Pasar Buah Batukandik, Jalan Cargo, Denpasar. The aforementioned samples were then processed into bio-char. The second sample which is the hand washing waste water was collected from Doremi Excellent School's sink pipe.

Research Variables

There were three variables applied in this research which were, (1) the independent variable, which is deliberately changed in an experiment. In our case this means changing the adsorption time which were 1 day,3 days and 5 days. (2) The dependent variable which changes due to changes of the independent variable, in our case this would be the phosphate levels of hand washing waste water after adsorption. (3) The controlled variable, which is the variable that is kept constant throughout an experiment which in our case is the mass of the banana bunch derived bio-charcoal (3 grams) and volume of hand washing waste water (200ml).

Data analysis

All the data obtained are described clearly. In the next stage, the analysis of differences in phosphate levels in the experimental group in the pretest and posttest was carried out with the following steps:

a. Data selection includes editing, coding, and tabulation with the SPSS version 25.0 for Windows program to determine whether there is an effect between before and after treatment.
b. Analysis of normality of phosphate levels in each group was analyzed using the Shapiro-Wilk test (because the number of samples were < 30) with a significance level of = 0.05; the data is categorized as normally distributed if sig> 0.05.
c. The homogeneity test of variance was analyzed using the Levene test to determine whether the variation in each group was homogeneous. Variations between groups were homogeneous when p> 0.05. The ANOVA requirement is that the data is normally distributed and homogeneous and/or normally distributed only.
d. To determine the effect of bio-charcoal on phosphate levels from each treatment group to the control group and to determine the interaction between treatments which will be

analyzed using One Way ANOVA at a significance level of = 0.05.

Result and Analysis

Production of Banana Bunch Bio-Char

Banana bunches that have been carbonized with a simple pyrolysis apparatus produces 500 grams of bio-charcoal or 25% from the total mass of the sample of banana bunches. Banana Bunches have a high amount of lignocellulose which is more than 85 wt% of their dry weight along with higher levels of holocellulose, hemicellulose, and lignin (Putra et al, 2020). Lignocellulose materials offer a renewable and inexhaustible supply of carbon materials provided suitable methods for production are developed. Waste material like banana bunches have little or no economic value and often pose great disposal problems. Thus, these waste materials are used in treated and untreated forms for the removal of various contaminants (Patel, 2018).

Phosphate Levels of Hand Washing Waste Water

The sample of waste water from hand washing was treated with the addition of three grams of banana bunch bio-char and tested for their quality by measuring the phosphate levels present.

Phosphate is one of the nutrients used by plants which also supports the fertility of water. Its presence has many benefits for bodies of water such as the increase in the population of phytoplankton and fish (Astuti et al, 2019). However, high phosphate levels may have negative effects on affected water bodies such as triggering eutrophication which causes a severe reduction in water quality, the depletion of the water's oxygen levels, decrease in biodiversity and an increase in the probability of the emergence and reproduction of a particularly dangerous species of phytoplankton (Astuti et al, 2019).

Based on our research findings, Table 2 below shows the phosphate levels in the samples after one day, two days and three days of adsorption by our banana bunch bio-char.

Table 2 – Phosphate Level Test Results

Time of adsorption (Days)	Phosphate levels (mg/L)
Control	15,63 ± 0,015
1	9,64 ± 0,011
3	9,87 ± 0,011
5	15,32 ± 0,015

The data above has been tested through the use of the *SPSS ver.25.0* app through three test stages. The normality test, homogeneity test and One Way Anova test. The results of the normality test are displayed below on Table 3.

Table 3 – Normality Test Results

	Time of adsorption	Significance value
Phospate Level	Control	1.000
	1 day	0.637
	3 days	1.000
	5 days	0.637

Based on data on the significance value which is more than 0.05 with a confidence interval of 95%, the data above is considered to have a normal distribution therefore tests can continue to the next stage which is the homogeneity test. Results for the homogeneity test are shown below on Table 4.

Table 4 – Homogeneity Test Results

		Levene statistic	df1	df2	Significance value
Phospate Level	Based on Mean	.485	3	8	.702
	Based on Median	.167	.3	8	.916
	Based on Median and with adjusted df	.167	3	6.400	.915
	Based on trimmed mean	.460	3	8	.718

Based on data shown on Table 4, the significance value is larger than 0.05 therefore it can be concluded that the data

is homogeneous. After fulfilling the criteria put forward by both normality and homogeneity tests, we then continue by conducting the OneWay Anova test. Results of the OneWay Anova test are shown below on Table 5.

Table 5 - OneWay Anova Test Results

	Phospate Level				
	Sum of squares	df	Mean square	F	Significance value
Between groups	98.492	3	32.831	196984.733	.000
Within groups	.001	8	.000		
Total	98.494	11			

On Table 5, the significance value 0.000 is smaller than 0.05 therefore it can be concluded that there is a significant difference in the data. This result shows that the application of banana bunch derived bio-char effects the phosphate levels in hand washing waste water after 1, 3 and 5 days of adsorption.

Adsorption is an economical and effective treatment method for removal of impurities or pollutants. Adsorption is termed as a surface phenomenon, but the entire mechanism does not occur at the surface, it also involves the area between the pore space of the adsorbent. (Patel, 2018). Based on the data gathered, the application of banana bunch bio-char is able to decrease phosphate levels in hand washing waste water due to the presence of pores and its large surface area which can potentially adsorb impurities within the sample. Bio-char adsorption is considered a potential process to remove contaminants that are non-polar, of low solubility, or of high molecular weight (Patel, 2018). Upon observation of Table 2, it can be seen that the optimal length of time for bio-char adsorption in descending order of effectivity 1 day, 3 days and lastly 5 days. This could be caused by the decreasing capacity of the bio-char to adsorb phosphate as time goes on.

Conclusion

Upon completion of our study, we can draw the conclusion that phosphate levels in hand washing waste water prior to banana bunch bio-char treatment is 15,63 mg/L and phosphate levels of hand washing waste water after continual adsorption through the addition of banana bunch derived bio-char for 1 day, 3 days and 5 days respectively are 9,64; 9,87; and 15,32 mg/L. This shows that there is a decrease in the phosphate levels of hand washing waste water after the application of banana bunch bio-char with one day being the optimal time of adsorption. Due to our current resource and time constraints, we were not able to conduct our study to its maximum effectiveness. In the future we would like to conduct this study on a larger scale to see if we would be able to further decrease the phosphate levels of waste hand washing water to at least 1 mg/L of phosphate as per Government Regulation No. 82 of 2001, concerning the management of water quality and control of water pollution which is to be used for irrigation. This will be done by the larger scale production or banana bunch bio-char through the acquisition of larger scale pyrolysis apparatuses for more efficient bio-char production which will allow us to use more banana bunch bio-char in our experiment and allow the treated hand washing waste water to be used in agricultural activities such as irrigation.

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References

[1] Elya. Windi Indah Fajar Ningsih. Eliza. Andi Eka Yunianto. Emy Yuliantini. Miratul Haya dan Ahmad Faridi. (2020). Kebiasaan Cuci Tangan, Berjemur, dan Media Informasi pada Masyarakat Sumatra Selatan Selama Masa Pandemi Covid-19. Jurnal Medika Kesehatan, 59-66, 13(2).

[2] Annisa, D. 2021. “Situasi Terkini Perkembangan Coronavirus Disease (COVID-19) 4 Agustus 2021.”

Kementrerian Kesehatan. https://infeksiemerging.kemkes.go.id/situasi-infeksi-emerging/situasi-terkini-perkembangan-coronavirus-disease-Covid-19-4-agustus-2021. Accesed on 6 Agustus 2021.

[3] Hasanah, U and Dwi Rizki Mahardika. (2020). Edukasi Prilaku Cuci Tangan Pakai Sabun pada Anak Usia Dini untuk Pencegahan Transmisi Penyakit. Seminar Nasional Pengabdian Masyarakat LPPM UMJ.

[4] Poon, W.C.K., Aidan T. Brown, Susana O. L. Direito, Daniel J. M. Hodgson, Lucas Le Nagard, Alex Lips, Cait E. MacPhee, Davide Marenduzzo, John R. Royer , Andreia F. Silva , Job H. J. Thijssen, and Simon Titmuss. (2020). Soft matter science and the COVID-19 pandemic. Journal Soft Matter,16(1), 8310-8324. doi: 10.1039/d0sm01223h.

[5] Sari, H.M., Noor Hindryawati. and R.R. Dirgarini N. (2017). Pembuatan Karbon Aktif dari Tandan Kosong Pisang Kepok (Musa paradisiaca L.) dengan Bantuan Gelombang Ultrasonik. Prosiding Seminar Nasional Kimia, 97-100.

[6] Matheus, R. M. Basri. Mika S. Rompon and Nimrod Neonufa. (2017). Strategi Pengelolaan Pertanian Lahan Kering dalam Meningkatkan Ketahanan Pangan di Nusa Tenggara Timur. Partner, 529-541, 22(2). doi:10.35726/jp.v22i2.246.

[7] Putra, A.E.E., Novriany Amaliyah, Shinfuku Nomura, and Ismail Rahim. (2020). Plasma generation for hydrogen production from banana waste. Biomass Conversion and Biorefinery, Biomass Conversion and Biorefinery. Springer. doi:10.1007/s13399-020-00765-3

[8] Patel, H. (2018). Charcoal as An Adsorbent for Textile Wastewater Treatment. Separation Science and Technology, 2797-2812, 53(17). doi:10.1080/01496395.2018.1473880.

[9] Astuti, W., Luluk Siti Zulaechah, and Lian Kristian. (2019). Teak Leaf-Based Activated Carbon for Phospate Removal. Jurnal Bahan Alam Terbarukan, 52-58, 8(1). doi: 10.15294/jbat.v8il.20169.

Peraturan Pemerintah Republik Indonesia Nomor 82. 2001. Pengelolaan Kualitas Air dan Pengendalian Pencemaran Air.