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GRAIN/RICE HUSK AND GRAIN/RICE HUSK ASH UTILIZATION IN THE WASTEWATER TREATMENT

Abstract: In Indonesia, the grain-dry-grain production of grain was about 54.60 million tons in 2019, however, it became ± 64% rice and ± 36% by-product. The rice husk is estimated to reach ± 10.92 million tonnes in 2019. In fact, the use of by-products from the rice mill process is still limited and sometimes becomes waste and pollutes the environment. Agriculture waste is one of the largest renewable resources in the world and is available in huge quantities. In this perspective, rice husk (RH) and rice husk ash (RHA), which is agriculture waste, are a potentially and invaluable source for use in wastewater treatment. RH and RHA have properties that provide excellent adsorption and coagulation ability due to the presence of carboxyl and silanol groups. The RH and RHA are potential as a material for treatment oily content in the wastewater. The industrial process such as palm oil, olive oil, sunflower oil etc. generates a lot of oily contents to wastewater, forming pollution. The RH and RHA as a potential adsorbent and coagulant would be as a potential solution for mitigation of pollution. It gives a good base to compare the removable effectiveness with other grain derives.

Keywords: agriculture waste, oily content, rice husk, rice husk ash.

1. INTRODUCTION

Indonesia is the fourth-largest rice producer in the world with rice production reaching 34 million metric tons in 2019/2020 (Foreign Agricultural Service, 2020). In Indonesia, the grain-dry-grain production of grain was about 54.60 million tons in 2019, however, it became ± 64% rice and ± 36% by-product. The by-product from rice mill processes such as rice husk (RH) (15-20%), bran (8-12%), and rice groat (±5%) (Central Bureau of Statistics of Indonesia, 2018). Thus, the estimation of rice husk in 2019 reaches ±10.92 million tons. The utilization of agriculture waste such as rice husk from the rice mill process is still limited, sometimes becomes waste and pollutes the environment (Central Bureau of Statistics of Indonesia, 2018).

Agriculture waste is one of the foremost abundant renewable resources in the world and available in a huge amount (Adegoke and Bello, 2015), becoming a source of porous materials that is rich in active functional groups (da Rocha et al., 2020). Today, research about material from a natural resource for wastewater treatment is still under development, one of the potential resources is agriculture waste. Agriculture waste could become new material for wastewater treatment which is low-cost, efficient, and environmentally friendly.

The RH is an agriculture waste that could be utilized in wastewater treatment. RH is insoluble in water, having a granular structure, advanced mechanical quality, and chemical stability, making it a potential material for wastewater treatment. RH and rice husk ash (RHA) have properties that provide excellent adsorption and coagulation ability due to the presence of carboxyl and silanol groups (Ahmaruzzaman and Gupta, 2011). The RH is burnt ∼20 wt% to produce the ash, RHA has more than 95 wt% of silica with advanced porosity and a huge surface range since it retains a cellular structure skeleton (Ahmaruzzaman and Gupta, 2011).

The industrial process such as palm oil, olive oil, sunflower oil, etc. generates a lot of oily contents to wastewater, forming pollution. Oily content is a harmful waste that is discharged into the environment. The concentration and physical nature of the oily content and the droplet sizes affect the removal of oily in wastewater (Coca-Prados and Gutiérrez-Cervelló, 2010). The wastewater treatment methods for the oil industry among others are biological, chemical, or a combination of both (Kontos et al., 2014). For instance, the advanced treatment of palm oil mill effluent (POME) includes advanced oxidation process (AOP)-photocatalysis, coagulation-flocculation (CF), membrane filtration, and adsorption (Yashni et al., 2020).

The adsorption is a wastewater treatment method with a simple design and lower processing cost (Cai et al., 2019), and also an excellent approach for the removal of organic pollutants (de Tuesta et al., 2018). Adsorption uses organic materials (Martini et al., 2020) as a wastewater treatment method which is environmentally friendly. Coagulation is a simple and effective treatment method that could be used in industrial wastewater (dos Santos et al., 2018). The coagulation process has an essential function in wastewater treatment for reclamation or removed pollutants (Ang and Mohammad, 2020). The natural coagulant is an environmentally friendly green product, unlike chemical coagulants that could affect human health and the environment (Othmani et al., 2020).

The number of researches RH and RHA for wastewater treatment is still limited. RH and RHA as a potential adsorbent and coagulant would be a potential solution for mitigation of pollution. This study aimed to find out the removable effectiveness of RH and RHA in the wastewater and compare it with other grain derives.

2. LITERATURE REVIEW

The use of RH and RHA as a bio-adsorbent for wastewater has been done in some previous researches. In the research by (Elham et al., 2010) the RH utilization in the dairy wastewater for adsorption of Pb (II) and Zn (II) ions. The result shows that removing Pb (II) and Zn (II) was achieved at 96.8% and 70%, respectively. Besides, in a study by (Sharma et al., 2010) RH and RHA use for adsorption of methylene blue in aqueous waste. The higher capacities for removal of methylene blue by adjusting pH around 7, time of 30 minutes, and temperature setting of $323^{o}K$.

The modification of RH or RHA was conducted by (Phan et al., 2019) Triamine-activated rice husk ash (TRI-ARHA) is a potential bio-adsorbent for nitrate and other anions removal. The TRI-ARHA shows a nitrate adsorption capacity (>160 $mgNO_3^-/g$) compared to the anion exchange resin akulite A420 (~80 $mgNO_3^-/g$), with 10 cycles of adsorption-desorption. In the research conducted by (Mor et al., 2016) using the activated rice husk ash (ARHA) for removal of phosphate in wastewater and water. The ARHA would enhance of adsorption capacity for phosphate with maximum removal of 89% with pH 7, 2 g/L dose, and time of 120 minutes.

Besides, in an investigation of (Wongjunda and Saueprasearsit, 2010) the rice husk ash (RHA) and modified rice husk ash (MRHA) using for adsorption of Cr (VI). The result shows adsorption ability of RHA and MRHA of 59.12% and 81.39% at pH 2 with room temperature, contact time is 180 minutes, adsorbent size 250-500 μm, speed of agitation is 120 rpm, dosage of adsorbent is 40 g/L and concentration of Cr (VI) is 10 mg/L also, the adsorption capacity of RHA and MRHA was 0.49 mg/g and 0.84 mg/g, respectively.

The several bio-adsorbent from natural resource has been studied for removed pollutants in wastewater. For instance, a study was conducted by (Bellahsen et al., 2020) using bio-adsorbent from the banana peel, compost, bark, wheat husk, wheat bran, sugar beet pulp and pomegranate peel for adsorption of ammonium. The result shows pomegranate peel powder (PPP) could remove ammonium of 97% at a dosage of adsorbent is 400 mg, pH 4 and the speed of stirring is 100 rpm, however, other materials showed a negative and low adsorption ability.

Other than that, bio-coagulant from RH/RHA or other grains has been studied in some previous researches. In the research (Huzir et al., 2019) RHA as a potential bio-coagulant for palm oil mill effluent (POME) treatment with optimum conditions was pH 3.6, 6.0 g with a time of 57 minutes. The results show RHA could remove the total suspended solids (TSS) and chemical oxygen demand (COD) up to 83.88% and 52.38%, respectively.

A research was conducted by (Jagaba et al., 2020) using *Moringa oleifera* as a bio-coagulant to compare with a chemical coagulant. The result shows the dosage optimum of *Moringa oleifera* obtained 2000 mg/L for removing turbidity, oil & grease, TSS, COD, Colour, and NH_3-N. (Ahmad et al., 2015) reported the pre-treatment for POME using *Moringa oleifera* and chitosan as a bio-coagulant combined with the integrated membrane. The result shows percentage of recovery for turbidity value 20 NTU obtained 78%. Other than that, a study by (Nikam et al., 2012) shows the effectivity of *Moringa oleifera* as a bio-coagulant for reduction turbidity in wastewater. The percentage of reduction of turbidity obtained 32.52% with an optimum dosage of 10 mg/L.

Furthermore, in the research by (Kim et al., 2020) *Trigonella foenum-graecum* (fenugreek) as a bio-coagulant and *Hibiscus esculentusas* (okra) as a bio-flocculant for treatment of POME. The optimum conditions of removal percentages for TSS, COD, and turbidity were found in a dosage of fenugreek is 4.6 g/L, a dosage of okra is 40 ml/500 ml POME, pH 4, and speed of mixing is 155 rpm. The results from fourier transform infrared (FTIR) spectroscopy show fenugreek and okra have properties that provide excellent coagulation-flocculation ability due to the presence of polysaccharides groups.

Besides, in a study by (Shak and Wu, 2015) *Cassia obtusifolia* seed gum as a bio-coagulant with alum application for treatment of POME. The optimum conditions using response surface methodology (RSM) were found in a dosage of alum is 1.15 g/L, a dosage of *Cassia obtusifolia* seed gum is 2.47 g/L, and settling time of 35.16 minutes. The removal percentages for COD and TSS up to 48.22% and 81.58%, respectively.

3. CONCLUSION

The RH and RHA are potential materials for use in wastewater treatment. The previous study showed RH and RHA as an alternative of bio-adsorbent and bio-coagulant has effectiveness for removing pollutants in the wastewater. RH and RHA could be compared with other grains as a base study for further research in the future.

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