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EARLY STUDY OF BIOCHARCOAL QUALITY FROM POULTRY LIVESTOCK WASTE

Dwi A. Anggorowati[1*], Faidliyah N. Minah[2], Anis Artiyani[3], Lalu Mustiadi[4]
[1,2]Department of Chemical Engineering, Faculty of Industrial Technology Industri, Institut Teknologi Nasional, Malang, Indonesia
[3]Department of Environmental Engineering, Institut Teknologi Nasional, Malang, Indonesia
[4]Department of Mechanical Engineering, Institut Teknologi Nasional, Malang, Indonesia

***Corresponding Email: ana_anggorowati@lecturer.itn.ac.id**

ABSTRACT: Bio charcoal is one type of fuel in the form of charcoal made from various kinds of biological or biomass material, which includes agricultural waste, forestry waste, agro-industrial waste, animal waste from livestock waste. Bio charcoal is produced from the carbonization process or the charcoal process of materials containing carbon (biomass). One of the biomasses that has the potential to be used as raw material for bio charcoal is poultry manure originating from poultry livestock waste. The composition of poultry livestock waste (chicken manure) is crude protein by 9.97-12.67% and crude fiber by 30.36-32.65. This study aims to determine the optimal carbonization temperature and particle size in the carbonization process so that optimal Fixed Carbon level can be obtained by using variations in the size of Chicken Manure Particles, namely: 30 mesh, 40 mesh, 50 mesh, and Charcoal temperature: 200° C, 225° C, 250° C, 275° C and 300° C. Stages of the process carried out is drying chicken manure to the weight of constant chicken manure (water content < 10%) and then mashed and sieved to sizes of 30, 40, and 50 mesh and the last stage is the charcoal process of chicken manure with variations in temperature of 200° C, 225° C, 250° C, 275° C, and 300° C until the perfect charcoal process. From this study, the best parameter is obtained at 350° C and 50 mesh particle size with 45% Fixed Carbon content, 3.26% moisture content, 41% ash content, and volatile matter content 22%.

Keywords: Bio charcoal, Fixed Carbon, Carbonization Process

1. Introduction

Livestock waste causes various environmental problems, pollutant generated from livestock is caused by decomposition of livestock manure, namely BOD and COD (Biological/Chemical Oxygen Demand), pathogenic bacteria, water pollution, dust, and odor pollution [1]. Chickenmanure wastes contain ammonia gas and flammable H_2S. From a livestock, a broiler chicken can produce 0.15 kg of manure. Based on BPS data, the population of broilers in East Java in 2017 amounted to 1,698,368,741 so that the potential to produce chicken manure was 254,755.31 tons of chicken manure. In the process of forming carbon, chicken manure must go through a charcoal process (carbonization) [2].

The contents of compounds in chicken manure are as follows: 6% Phosphorus, 17% Nitrogen, 0.58% Calcium, 9.97-12.67% Crude Protein and 30.36-32.65 5 Crude fiber [2].

According to Cheresmisinoff (1993) in Dahlan (2013) Carbonization or charcoal is the process of heating organic materials with a certain temperature with a limited amount of oxygen [3]. This process causes the decomposition of several organic compounds such as constituents of materials such as methanol, acetic acid vapors, tartar, and hydrocarbons. The remaining material after carbonization is carbon with narrow pores.

Previous studies by Setiawati et al. [4] with the title Effect of Activator on Making Active Carbon of Coconut Shell with fixed variable of drying coconut shell under the sunlight to 10% water content, the most optimal result used 20% NaCl activator, 4.88% water content, 3.54% ash content, 14.63% volatile matter, and 761.07 mg/g iodine absorption [4].

A study conducted by Sumangat and Broto with the title Technical and Economical Study of Jatropha Seed Processing as a Furnace Raw Material with a particle size of a 40 mesh jatropha seed [5]. The most optimal result has 7.25% moisture content, 6% ash content, 23.75% oil content, and 4117 calories/gram calorific value. Similar to the research conducted by Asroni et al. [6] with the title Effect of Charcoal

Formation from Variation Dimensions of Chicken Feces Particles. By determining the mass of chicken feces particles with a mass of 1000 grams, at the charcoal temperature 1255C, and the rotating drum rotation 25 rpm, for variations in the dimensions of chicken feces particles at (0.323, 0.392, 0.989, 1.634) mm2, resulting in curing time (42,781; 32,086; 25,346; 15,821) s, with the rate of mass formation of charcoal (23,375; 31,166; 39,454; 63,207) grams/s. Increased lau mass formation of charcoal, caused by the surface area of particles in the heat absorption of charcoal, so that the dimensions of chicken feces particles have a clear influence on the rate of mass formation of charcoal.

In the study of Saparudin et al. [7] with the title Effect of Pyrolysis Temperature Variation on the Result Level and Calorific Value of the Mixed Briquette of Rice Husk-Chicken Manure with varying charcoal temperatures of 225° C, 275° C, 325° C, and 375° C. The most optimal is charcoal at 275° C with a calorific value of 4252.67 cal/gram, a moisture content of 1.504%, a Char content of 51.12%.

Some studies above discussed several topics, especially regarding chicken manure, but it still needs improvement on the most optimal process in the initial stages of the study of the process of carbonization of chicken manure so that the study aims to find out the most optimal process in the process of chicken manure carbonization. Furthermore, it can be applied to several study topics.

2. Methodology

2.1 Bio Charcoal

Charcoal is black residue containing impure carbon produced by imperfect heating/burning to remove water content and volatile components from animals or plants. Charcoal is black, light, easily destroyed, and resembles coal consisting of 85% to 98% carbon, the rest is ash and other chemical elements [7].

Bio charcoal can be made from faeces of all types of livestock, even according to Setiawan [8], the energy produced from burning wood is 3,300 kcal/kg while the energy produced from burning bio charcoal can reach 5,000 kcal/kg.

Table 1 Charcoal quality requirements based SNI 01-6235-2000

Parameter	Score
Water Content	Max. 8%
The missing part in heating of 950° C	Max. 15%
Ash Content	Max. 8%

2.2 Experimental

The study was conducted at the Chemical Engineering Research Laboratory of S1 ITN Malang. The permanent variable used in this study was the mass of dried chicken manure = 100 grams, the water content in chicken manure was less than 10%. Meanwhile, the changeable variable used was the Charcoal Temperature by 200° C, 225° C, 250° C, 275° C, and 300° C and the size of chicken manure particle by 30, 40, and 50 mesh.

2.3 The Materials and Equipment

Material used in this study was chicken manure and equipment used for the study were gloves, burners (furnaces), digital scales, porcelain cups, 30, 40, and 50 mesh sieves, stirrers.

2.4 Study Procedure

The stages of the process carried out in the charcoal process are drying chicken manure that has been taken from the previous cage until the weight of the dried chicken manure becomes constant (water content < 10%) then smoothing chicken manure by pounding it then sifting in sizes of 30, 40, and 50 mesh and the last stage is the process of chicken manure charcoal with temperature variations of 200°C, 225°C, 250°C, 275°C, and 300° C with the size of chicken manure particle: 30, 40, and 50 mesh to the perfect charcoal process.

3. Results and Discussion

3.1 Charcoal Yield

A yield analysis is carried out to determine the results of the charcoal obtained after the carbonization process. The following is a graph

of the relationship between charcoal yield and charcoal temperature:

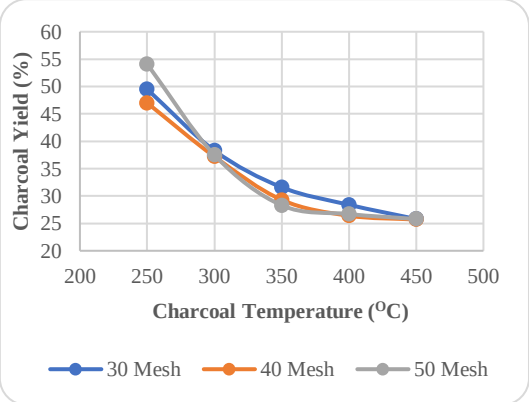


Figure 1 The Relationship Between Charcoal Temperature and Particle Size Towards Charcoal Yield

It can be seen in Figure 1that there was a decrease in the Charcoal Yield in chicken manure with variations in temperature of 250°C, 300°C, 350°C, 400°C, and 450° C and sizes of 30, 40, 50 mesh. From the picture above, the higher the carbonization temperature and the smaller the particle size, the yield will decrease.

From the chart above, the best Charcoal Yield is at 250° C and a size of 50 mesh with the result of 54.1%. According to Sukiran et al. [9] the higher the carbonization temperature, the more substances contained in the material will be decomposed so that the charcoal formed will be less. The yield of charcoal is also influenced by the particle size of chicken manure, according to Asroni et al. [10] from the results of his research the increased rate of mass formation of charcoal, caused by the surface area of the particles in the heat absorption of charcoal.

So are yield is also influenced by ash content, the more ash content, the less yield will be. The higher the carbonization temperature and the smaller the particle size, the more material is burned so that the ash produced will increase and the yield will decrease.

3.2Water Content

Analysis of Water Content is carried out to find out the water content in carbon. If the water content is getting bigger, the carbon quality will decrease because it will reduce the level of bound carbon or fixed carbon. The following is a chart of the relationship between water content and charcoal temperature:

From Figure 2., there was a decrease in water content in charcoal with temperature variations of 250° C, 300° C, 350° C, 400° C, and 450° C and sizes of 30, 40, 50 mesh. From the picture above, the higher the carbonization temperature and the smaller the particle size, the water content produced will decrease. The lowest water content results obtained at a temperature of 450° C and sizes of 30, 40, and 50 mesh with a moisture content of 1%. The highest water content results obtained at a temperature of 250° C and sizes of 30, 40 mesh with a moisture content of 4.95%. All variables are in accordance with SNI 01-6235-2000 for water content which is a maximum of 8%.

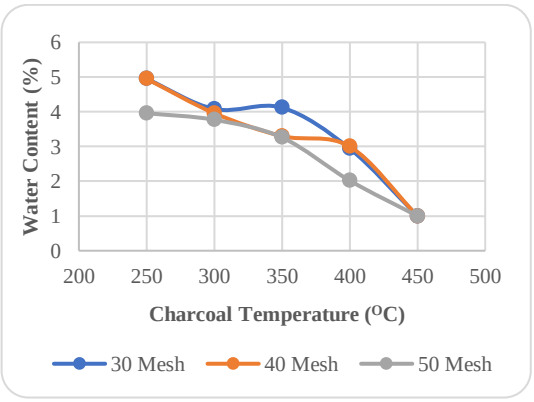


Figure 2 The Relationship between Charcoal Temperature and Particle Size Towards Water Content

The higher the temperature and the smaller the mesh size, the more perfect the combustion process will be so that more water will be evaporated. According to Martunis [11], the smaller the particle size, the lower the water content. This is because the smaller the particle size, the wider the surface area so that the porosity of the material will be higher, and the evaporation of water will be greater.

3.3Ash Content

Ash content is a parameter used to determine ash quality. If the ash content is low, the quality of charcoal will be higher. The following is the results of the analysis of ash content:

Based on Figure 3, there was a decrease in ash content in charcoal with temperature variations of 250° C, 300° C, 350° C, 400° C, and 450° C and sizes of 30, 40, and 50 mesh. From the chart above, the higher the carbonization temperature and the smaller the particle size, the higher the ash content produced. From the analysis results of the lowest ash

content is at the carbonization temperature of 250° C at the size of 30 mesh with 20% ash content, the highest ash content is at the carbonization temperature of 450° C at the sizes of 30, 50 mesh with 52% ash content. All variables do not comply with SNI 01-6235-2000 for ash content which is a maximum of 8%.

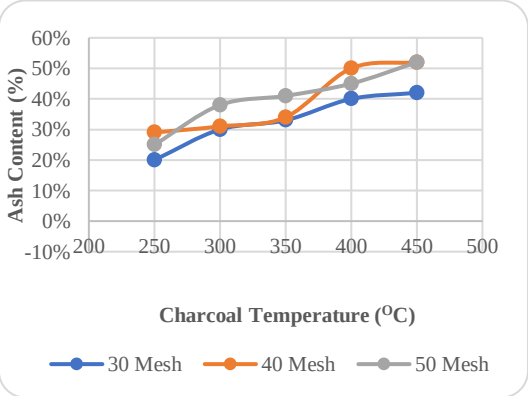


Figure 3. The Relationship Between Charcoal Temperature and Particle Size Towards Ash Content

From the Figure 3 above, the higher the temperature and the smaller the particle size, the ash content will increase. This is because when the carbonization temperature is higher, the combustion process of the material will be more perfect so that the more ash is formed. Ash is the remaining part of the combustion process in which the main constituent is silica minerals [12]. If the impurity in the material is higher, the ash content will be higher especially the mineral content which cannot be burned or oxidized by oxygen such as SiO2, Al_2O_3, Fe_2O_3, CaO, and alkali. According to Sulistyanto [13] the smaller the particle, the faster the material will be burnt because the porosity and surface area of the material is getting bigger.

3.4Volatile Matter Content (Flying Substance Level)

Volatile Matter or Flying substance level is a substance that can evaporate as a result of the decomposition of compounds that still exist in charcoal other than water such as CO, CO_2, CH_4, and H_2. Volatile Matter is also a parameter used to determine the quality of charcoal. The lower the Volatile Matter content, the better the quality of charcoal. The following is the results of the content analysis of Volatile Matter:

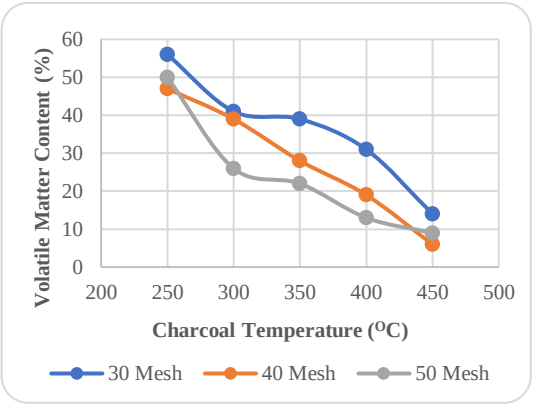


Figure 4. The Relationship Between Charcoal Temperature and Particle Size Towards Volatile Matter Content

From the analysis result above, in general, the higher the temperature and the smaller the particle size, the Volatile Matter Content will decrease. The lowest result was obtained at 450° C and the size of 40 mesh with a Volatile Matter Content of 6%. The highest result is obtained at a temperature of 250° C and the size of 30 mesh with a Volatile Matter Content of 56%. Volatile Matter Content according to SNI 01-6235-2000 is at a temperature of 400° C with a particle size of 60 mesh and at a temperature of 450° C with particle sizes of 30, 40, 60 mesh. Everything is in accordance with SNI, no more than 15%.

If the carbonization temperature is higher, the more materials will be evaporated so that the Volatile Matter will decrease. The height of volatile matter content is caused by the low temperature of decomposition of non-carbon compounds such as CO, CO_2, CH_4, and H_2 are not perfect, causing many non-carbon compounds left in the material [14].

High evaporated substance content will cause a lot of smokes during the combustion process, especially high-value CO gas so it is not good for health and the environment.

3.5Fixed Carbon Content

Fixed Carbon is the most important parameter used to determine the quality of charcoal. Fixed Carbon is obtained from the accumulation of yield, water content, ash content, and Volatile Matter. The following is a Fixed Carbon analysis in this study:

The best Fixed Carbon content is at 350° C and the size of 50 mesh. Fixed Carbon is influenced by factors of water content, ash content, and Volatile Matter. If the water content,

ash, Volatile Matter are getting smaller, the quality of charcoal will be better.

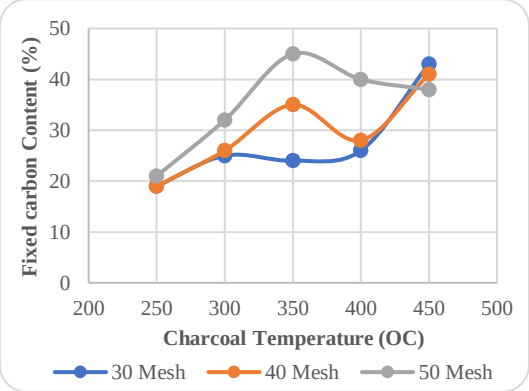
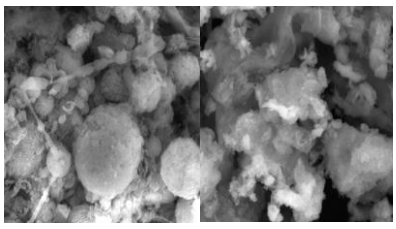


Figure 5. The Relationship Between Charcoal Temperature and Particle Size Towards Fixed Carbon Content

The magnitude of Fixed Carbon is strongly influenced by the amount of ash, water content, and Volatile Matter content [15]. If the ash content, moisture content, and Volatile Matter content are high then Fixed Carbon will be smaller. Conversely, if the ash content, water content, and Volatile Matter content are low, then Fixed Carbon will be higher.

3.6Image of Surface Structure Morphology (SEM)

One of the characteristics that can describe the surface morphology of chicken manure particles is by using Scanning Electron Microscopy (SEM). The surface structure morphology describes the surface shape, texture, and porosity of the surface. This characterization uses 2 samples, namely chicken manure with and without charcoal process. The difference from the characteristics of the chicken manure particles will be clearly seen.



a. b.

Figure 6. Comparison of the SEM result of Chicken Manure (a) before the charcoal process (b) after the charcoal process

SEM images after the charcoal process were taken from samples that have the best carbon fix levels, namely the charcoal temperature at 350 °C and 50 mesh particle size. From the picture it can be seen that after the charcoal process the carbon particles have a very rough surface which confirms that it belongs to the amorphous group.

4. Conclusions

Based on the study, the best result is the chicken manure charcoal carbon fixed content of 45% at 350° C and 50 mesh particle size with 3.26% moisture content, 41% ash content, and 22% volatile matter content.

Suggestions

When the charcoal comes out of the furnace or after the carbonization process is completed, it must be cooled immediately because if it is in contact too long with air, the charcoal will convert into ash.

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