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Method of Drying Mixed Briquettes (Cassava Skin, Corn Weevil, Rice Straw) Using Microwave

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Abstract: Microwaves (microwave) have a function to increase temperature by means of friction on material particles. The drying method of agricultural waste briquettes using microwave heating is considered faster and can be measured. Briquettes from agricultural waste are an alternative to fossil fuels. The purpose of this study was to determine the moisture content, ash content, flame duration, and calorific value of the briquettes using the microwave drying method. In addition, the purpose of this research is one of the outputs of applied research funded by the Research and Technology Directorate through the 2020 DPRM. The basic ingredient of briquettes is a mixture of coconut shell, soybean shell, peanut shell, corncob, rice straw, and cassava skin. The results showed that the lowest water content was found in specimen 2 with a composition of 40% corn cobs, 50% straw, 10% cassava husk, the lowest ash content in specimen 2 with a composition of 40% corn cobs, 50% straw, 10% cassava skin, Long flame time of specimen 1 with a composition of 50% corncob, 20% straw, 30% cassava husk, the highest calorific value in specimen 1 with a composition of 50% corn cobs, 20% straw, 30% cassava skin. Overall, the test of agricultural waste material that has the highest value is coconut shell.
Keywords: Mircowave, Agricultural waste, Drying briquettes.

I. INTRODUCTION

Agriculture in Indonesia plays an important role in supporting the community's economy, especially the people of Ponorogo district, whose main income is from the agricultural sector. Agriculture also produces waste. Agricultural waste is the residual material of agricultural production such as ketala skin, corn cobs and straw. Waste generated from agriculture is generally characterized by a high protein, carbohydrate and low starch content [1]. Post-harvest waste is divided into waste before processing and waste after processing / agricultural industrial waste. The use of agricultural waste as alternative fuels will increase the selling value of the waste.

In agriculture and animal husbandry, certain types of biomass waste can be processed into organic fertilizer [1] and animal feed [2]. In addition, biomass waste can also be processed into biogas [5], biofuel [7], and biomass briquettes [7], [8] as an alternative energy source. By using today's technology, peanut shells and rice husks can be processed and used as substitutes for other fossil fuels [10].

Cassava skin is one of the ingredients that can be used for the manufacture of briquettes. Besides that, cassava skin can also be used for cow feed with a crude protein content of 8.11%; Crude fiber 15.20%; and TDN (Total Digestible Nutrient) 74.73%. The calorific value of briquettes made from cassava peels is 3785 cal / g so that it can be used as a source of heat energy [9].

Corn cobs were also used for this study because of the abundance of numbers and their not optimal utilization. Corn cobs have a Lignin content of 23.74%; Cellulose 65.96%; Hemicellulose 10.82%. The adhesive material has an effect on the quality of corn cobs charcoal briquettes. In this study, the results showed that 10% corncob charcoal briquettes with starch adhesive had the lowest water content and ash content and the highest calorific value was 5484.54 kcal / kg [10].

Rice straw is a potential food crop waste. Rice straw is agricultural waste from the rest of the rice plants that have been harvested, namely, in the form of stems, leaves that are still green or have turned yellow.

Some researchers have shown that making briquettes from biomass using microwave technology is more effective [11] - [15]. The combustion process using microwave technology has been reported to be more effective than conventional methods. By using this technology, heat and combustion time can be controlled precisely so as to produce a homogeneous biochar product. The combustion process is carried out at low temperatures between 200oC - 300oC which is known as the to refaction method [7], [16].

The drying method using a microwave is a method of flowing microwaves on the particles that cause friction, the friction of these particles causes heat to the material that is subjected to it. The use of microwave heating to dry wet materials does not damage the structure of the material, and has a high carbon value [17], [18]. From this explanation, the researchers were interested in examining more deeply about the drying of briquettes with agricultural waste as the basic ingredients, namely: corncob, rice straw, and cassava skin.

II. BASIC THEORY

The test results showed that the value of good water content was found in a mixture of 70% peanut shell and 30% rice husk at 14.225%, a good ash content value was found in a mixture of 70% peanut shell and 30% rice husk at 13.873%, Good evaporation is found in a mixture of 30% peanut shell and 70% rice husk of 36.712%, a good value of bound carbon content is found in a mixture of 30% peanut shell and 70% rice husk of 27.028%, a good calorific value in the peanut shell mixture 70% soil and 30% husk of 5834.60% [19]

Drying the briquettes that have been printed using a microwave heater with a power of 450 watts [16], [20]. The time needed for drying is 120 minutes, with temperatures reaching 200 ^{o}C.

III. METHODOLOGY

The materials used are agricultural waste: 1) soybean husks, 2) peanut shells, 3) corncobs, 4) rice straw, 5) cassava shells, and 6) coconut shells. These materials are no longer used by farmers, so they have a low selling price. The adhesive used was tapioca flour with a percentage of 10% [21].

Equipment for use includes: 1) Microwave heating model ME731K, power consumption 150-800 W, input voltage 240V - 50Hz, 2) digital scale with a capacity of 10,000 grams with an accuracy level of 1gr, 3) dismill with mesh 60, 4) mixer, 5) briquette molding device with a cylinder model.

The test tools used include: 1) thermometer gun measuring capacity of -50 to 370 degrees Celsius, 2) PAAR brand 1241 EF bomb calorimeter, 3) moisture, 4) digital scale with 0.1 gram accuracy.

Preparation for making briquettes is drying the raw materials, namely agricultural waste, then charcoal by minimizing oxygen, the materials that have become charcoal are crushed and mashed with 60 mesh, then mixed with 10% tapioca flour adhesive and a little water. The evenly mixed material is then printed with a pressure of 250 psi with a cylinder model.

IV. RESULT AND DISCUSSION

The test results and measurements of briquettes are presented in the table below:

Material specimens	Initial Weight(gr)	Calorific Value(Cal/gram)	Ash Weight(gr)	Water content (%)
50% BJ 20% JR 30% KT	0.50	7398.10632	0.069	7.48
40% BJ 50% JR 10% KT	0.50	3581.017547	0.0148	7.01
10% BJ 40% JR 50% KT	0.50	3652.223254	0.175	8.10

Information:
BJ: Corn Weevil
JR: Straw
KT: Cassava Skin

Water content

The effect of water content in briquettes is very large on the resulting calorific value. The lower the water content, the higher the resulting calorific value. Calculation of the water content value aims to determine how much the charcoal briquettes absorb water during the adhesive mixing process.

Specimens	Testing 1	Testing 2	Testing 3	Average
Specimens1 50% BJ 20% JR 30% KT	7.26	7.39	7.8	7.48
Specimens2 40% BJ 50% JR 10% KT	6.61	6.87	7.57	7.01
Specimens3 10% BJ 40% JR 50% KT	7.47	9.21	7.63	8.10

It is known from the table above that material 1 with a mixture composition of 50% corn cobs, 20% straw, and 30% cassava husk has the highest moisture content in test 2 with a value of 7.39% and the lowest value in test 3 with a value of 7.8%. while the average value of material 1 was 7.48%.
In the second material with a mixture composition of 40% corncob, 50% straw, and 10% cassava skin, the highest moisture content value was in test 3 with a value of 7.57% and the lowest value was in the first test with a value of 6.61%. while the average value of the second ingredient was 7.01%. In the third ingredient with a mixture composition of 10% corncob, 40% straw, and 50% cassava skin, the highest water content value was in test 2 with a value of 9.21% and the lowest value of 7.47%. while the average value of the 3rd ingredient was 8.10%.

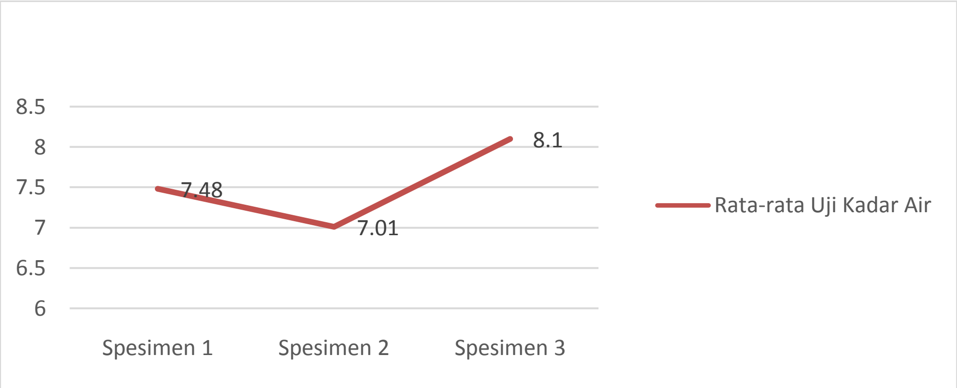

Figure 1. Water Content Test

From Figure 1, it can be seen that the highest water content value in the 3rd specimen with a composition of 10% corn cobs, 40% straw, and 50% sweet potato skins with a moisture content value of 8.10% and the lowest value in the second specimen with 40% corn cobs, 50% Straw, 10% Cassava skin with a moisture content of 7.01%. The best water content value is the second specimen with a composition of 40% corn cobs, 50% straw, 10% cassava skin with a moisture content of 7.01%, while the standard value of water content in Indonesia is 8%. The chemical composition of corn cobs contains a moisture content of 7.5% [22].

Calorific Value

Specimens	Average Calorific Value Test
Specimens1 50% BJ 20% JR 30% KT	7398.10632
Specimens2 40% BJ 50% JR 10% KT	3581.017547

Specimens 3 10% BJ 40% JR 50% KT	3652.223254

It is known from the table that the test results of the calorific value above on specimen 1 with a composition of 50% corncob, 20% straw, and 30% cassava husk produce an average calorific value of 7398.10632 Cal / gram. In specimen 2 with a composition of 40% corncob, 50% straw, and 10% cassava husk yielded an average calorific value of 3581.017547 Cal / gram. In specimen 3 with a composition of 10% corncob, 40% straw, and 50% cassava husk yielded a calorific value of 3652.223254 Cal / gram.

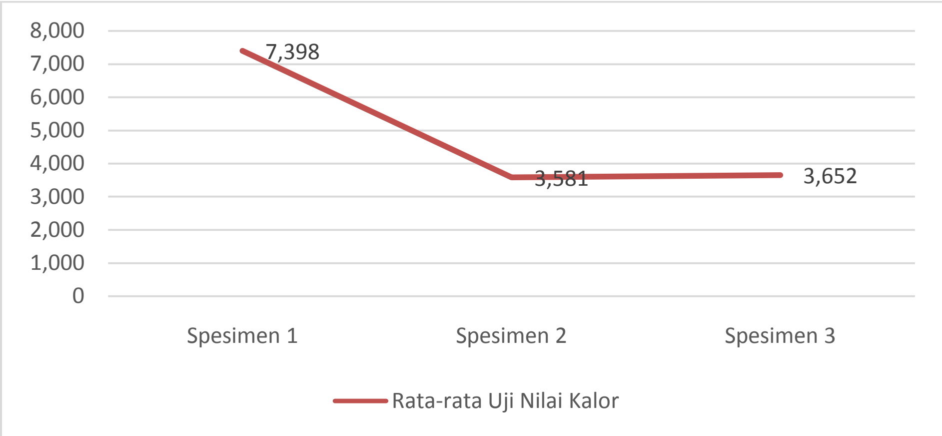

Figure 2. Heat Test Value

From Figure 2 it can be seen that the highest calorific value in specimen 1 with a composition of 50% corn cobs, 20% straw, 30% cassava skin with an average calorific value of 7398.10632 Cal / gram. While the lowest value was in specimen 2 with a composition of 40% corncob, 50% straw, 10% cassava skin with an average calorific value of 3581.017547 Cal / gram. While the standard calorific value in Indonesia is 5000 cal / gram. It can be seen from the graph above that specimen 2 has not met the standard heating value, and material 1 and material 3 have met the calorific value standard in Indonesia. Many factors affect the heating value, such as moisture content, ash content, and the mixing process. From these factors can affect the high and low calorific value produced by briquettes. The calorific value of briquettes made from cassava skin is 3785 cal / g so that it can be used as a source of heat energy [9].

Ash content

Specimens	**Sample Initial Weight (gr)**	**Ash Weight(gr)**
Specimens 1 50% BJ 20% JR 30% KT	0,5 gr	0,069 gr
Specimens 2 40% BJ 50% JR 10% KT	0,5 gr	0,0148 gr
Specimens 3 10% BJ 40% JR 50% KT	0,5 gr	0,175 gr

From the results of the above calculations, it can be seen that in specimen 1 with a composition of 50% corn cobs. 20% straw, and 30% cassava peel yields an ash content value of 0.138%. In specimen 2 with a composition of 40% corncob, 50% straw, and 30% cassava husk resulted in an ash content value of 0.0296%. In specimen 3 with a composition of 10% corncob, 40% straw, and 50% cassava husk resulted in an ash content value of 0.058%. The Indonesian standard value of ash content is 0.35%. It can be ascertained that the ash content value has met the ash content standard value in Indonesia.

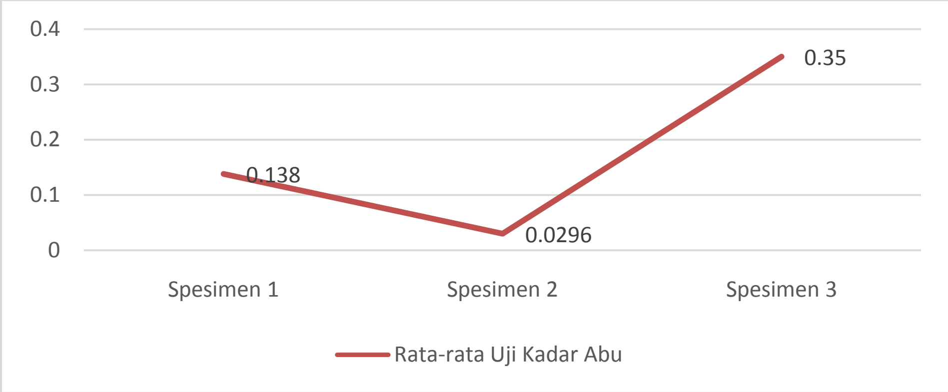

Figure 3. Ash Content Test

From Figure 3 it can be seen that the value of the highest ash content in specimen 3 with a composition of 10% corn cobs, 40% straw, and 50% cassava husk with an ash content value of 0.35%. While the lowest ash content value in specimen 2 with a composition of 40% corn cobs, 50% straw, and 10% cassava husk resulted in an ash content value of 0.0296%. The Indonesian standard value of ash content is 8%. It can be ascertained that the value of the ash content of all specimens has met the standard value of the ash content in Indonesia. The best ash content value is ingredient 2 with a composition of 40% corn cobs, 50% straw, and 10% cassava husk resulting in an ash content value of 0.0296%. The lower the ash content, the better heat the briquettes will produce. According to journals cited in Chapter II, corn cob charcoal briquettes with starch adhesive of 10% have the lowest water content and ash content and the highest calorific value, namely 5484.54 kcal / kg [10].

Briquette Burning Heat Test

Heat test / 3 minutes	**Microwave drying**		
	Specimens 1 50%,BJ 20% JR,30% KT	**Specimens 2 40%,BJ,50% JR,10% KT**	**Specimens 3 10%BJ,40% JR,50% KT**
1.	109	147	246
2.	273	257	114
3.	266	233	201
4.	263	246	248
5.	357	285	250
6.	295	340	231
7.	338	319	310
8.	321	333	318
9.	314	301	296
10.	342	292	206
11.	299	105	280
12.	153	124	190
13.	210	137	113
14.	171	103	
AVERAGE	**265,071^{0}C**	**230,1429^{0}C**	**231^{0}C**

Testing the heat of the briquettes using a thermometer gun with a hot firing interval of 3 minutes until the material runs out, it can be seen that specimen 1 with a composition of 50% corncob, 20% straw, and 30%

cassava shell produces an average briquette burning heat test of 265.0710C . In specimen 2 with a composition of 40% corncob, 50% straw, and 10% cassava husk produced an average heat value of 230.14290C. In specimen 3 with a composition of 10% corncob, 40% straw, and 10% cassava husk produced an average briquette burning heat value of 231^{o}C.

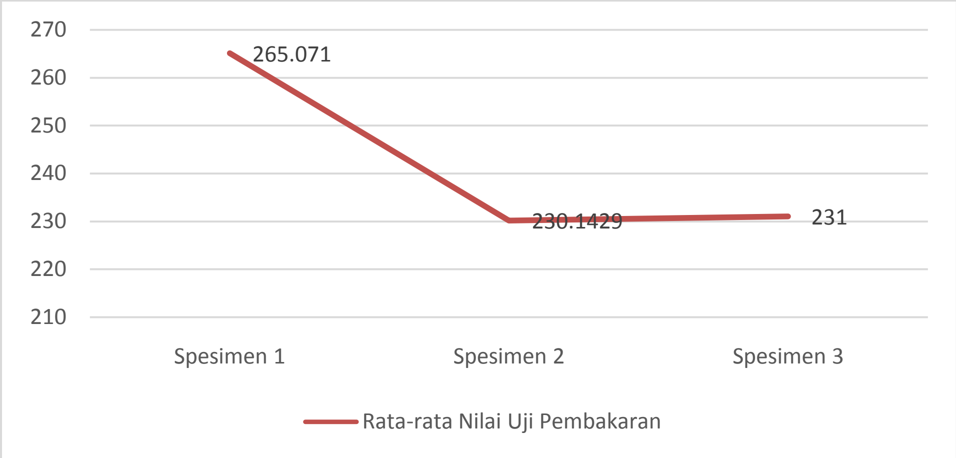

Figure 4. The Value of Burning Heat of Briquettes

From Figure 4 it can be seen that specimen 1 with a composition of 50% corncob, 20% straw, and 30% cassava husk produces a high heat burning test value of 265.0710C. While the lowest value in specimen 2 with a composition of 40% corncob, 50% straw, and 10% cassava husk resulted in an average heat value of 230.14290C. From the test, the combustion heat of briquettes has a high heat. The effect in this combustion heat test, namely silica (the combustion residue attached to the briquette), maximizes the heat testing and unstable weather (cloudy). One of the factors that influence the combustion process of solid fuel is that it is small in size, so that a solid fuel burns faster [23].

V. CONCLUSION

From the results of the research data and discussion that has been done, the following conclusions can be drawn:

1. The results of the briquette test showed a good moisture content in specimen 2 with a composition of 40% corn cobs, 50% straw, 10% cassava husks yielded an average moisture content value of 7.10%. Good calorific value levels are found in specimen 1 with a composition of 50% corn cobs, 20% straw, 30% cassava skin with a calorific value of 7398,10632Cal / gram. Good value of ash content in specimen 2 with a composition of 40% corn cobs, 50% straw, 10% cassava skin with an ash content value of 0.0296%. The test value of good briquette combustion on specimen 1 with a composition of 50% corn cobs, 20% straw, 30% cassava skin with a burning test value of 265.0710C with a burning time of 1 hour 13 minutes 04 seconds. Good calorific value levels are found in specimen 1 with a composition of 50% corn cobs, 20% straw, 30% cassava skin with a calorific value of 7398,10632Cal / gram.
2. Good briquette test results are found in specimen 1 with a composition of 50% corn cobs, 20% straw, 30% cassava skin with a heating value of 7398.10632Cal / gram. The test value of good briquette combustion on specimen 1 with a composition of 50% corn cobs, 20% straw, 30% cassava skin with a burning test value of 265.0710C with a burning time of 1 hour 13 minutes 04 seconds.

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