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Study on Briquetting and Optimizing Organic Composition of Ramie (*Boehmeria nivea* (L). Gaud) Biomass

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ABSTRACT

Rami (*Boehmeria nivea* (L.) Gaud.) was one of the potential natural plant fibers to use as a raw material for converting them into briquette. The study conducted to obtain the exact composition of the ramie-decorticated residue (R) and utilization of corncobs (CC) and manure (M) from agricultural waste in Garut, West Java Indonesia. Carbonized the biomass was then performed size reduction to 60 mesh size. The study was conducted by using descriptive method to analysis of chemical characters proximate of the bio briquette. The results showed that the optimum condition for composition of ramie briquette was R30 % + CC70 % + Ad2 % generating highest calorific value 6,200 cal/g. Optimizations of the level adhesive were carried out by altering concentration of starch 2% and 4%. Short ignition time was observed at 17 sec for composition R70 % + CC30 % + Ad4 %, while the longer flame time was 211 min derived from the composition of R30 % + CC70 % + Ad4 %. These results indicated that briquetting of ramie potential to be developed as sustainable bio energy.
KEYWORDS— ramie, corncob, manure cow, bio briquette, carbonization.

INTRODUCTION

Indonesia as a developing country had kinds of agro-products and consequently produced abundant residues; however they used uneconomically causing problems to the environment. A lot of research had done on the use of organic residues as bio briquette. Briquette was a process of densification of biomass to produce homogeneous, uniformly sized solid pieces of high bulk density which easily be used as fuel [1]. Biomass component containing cellulose, hemicelluloses, and lignin had a potential as raw material to produce bio briquette [2].

Ramie was a plant to generate fiber through decortication by separating fiber from stem. This process produced ramie-waste chip in huge quantity. Chip of ramie had 6.0 - 7.8%, silicate 1.9-2.9%, lignin 30.7-31.1 %, alpha cellulose 33.8 – 36.0%, holocellulose 63.0- to 63.8%, pentosan 17.4 - 18.1 % [3]. It recognized that the calorific value of briquettes from biomass did not vary significantly; to increase the calorific value of ramie briquettes needed other options composition organic such as corncobs and cow manure.

Referring to the potency of corncob in Indonesia, a huge amount of this biomass had not widely use. A non carbonization corncob had a heating value of 3,500- 4,500 cal/g [4]. The use of corncob combining with other organic mass increased calorific value of briquette [5], [6]. Variations in the composition of ramie and corncobs expected produce bio briquette with good quality.

Researches on the combination of different kinds of biomass into briquettes had carried out, including a utilize rice husk, straw, and coconut shell. The best briquette contained in the composition of cow manure: farm waste was 1 : 3 with a calorific value of 4527.22 cal/g [7]. Waste products of metabolism proceeded cow feed as cow manure contains as much water content 3: 06%, 43.7% vaporized substances, 36.6 % crude fiber, ash 22.1%, 23% cellulose, 18.3% hemicelluloses, lignin 10.2%, total organic carbon 34.7 % [8]. After the constituent raw materials bio briquette combination of cow manure and coconut shell charcoal with a composition 20%: 80%, then the resulting briquette with a higher calorific value was 6593.4 kcal/kg with a density value of 0.7 g/cm 3, a strong press 35.4 kg/cm^2, the ash content of 10.9 %, and 67.9 % bound carbon content [9].

Since both corncob and cow manure were organic biomass products used as briquette, those combination with organic waste also can be used. This was one of the ways of reducing the trouble constitute by these wastes. Mixing ramie-waste chip with both of organic could lead to better briquette performance. This leads to the investigation of the effect of composition organic matter on the calorific value of briquettes. The quality of briquettes was generally determined based on the physical and chemical properties, bonded carbon content and calorific value, and influenced by levels of adhesive. Starch from tapioca powder was one of the popular binders used in briquetting. Giving more adhesive levels would be increasing levels of substance evaporates and easier to burn, however levels of adhesives tapioca flour need to know for efficiency composition in ramie briquette with not more than 5% [10].

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METHODS

A. Materials

The required materials of the bio briquette were residual ramie chip from Central of Ramie, in Wanaradja, Garut; cow manure was from PT. Citra Buana Agro Industry, in Mekarsarih, Garut ; corncob obtained from Sumedang West Java. Adhesive starch was used from tapioca flour.

B. Densification

Densification of the biomass ramie, corncob, and cow manure achieved by method of pyrolysis densification using a binder with processes involving:

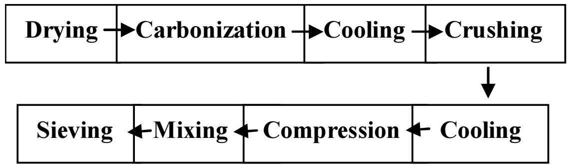

Figure 1. Densification process of biomass ramie, corncob, and manure

Carbonization of biomass was reacted one at a time in the cylindrical furnace belong to Development Center for Mineral and Coal Technology (TEKMIRA) in Paliman, Cirebon, West Java. Source of fire coming from the gasification stove, with gasify fuel ignited using corncobs and coal in the ratio (3:1). Create a constant flame pyrolysis takes place effectively. Air holes in the bottom of the drum set to air flow during the combustion. Carbonization was done until the end of combustion, characterized by thinning out the smoke Ramie, corncob, and manure charcoal were then milled to a powder and they were sieved into 60 mesh size. The charcoals were weighed according to the composition of the expected level of variation. Starch adhesive made in various 2% and 4 % of the total weight 30 g diluted with water (1:10).

C. Procedure

Study on ramie bio briquetting was done by comparing quality of briquette using single organic or composition of corncob and manure with the ramie chip (3:7) using 5% of starch in purpose to selective best quality of briquette.

The best selected composition briquette then studied by determination composition of starch. The study was conducted with composition of ramie chip and corncob (R -30%:CC-70%), (R70%:CC30%) each adhesive composition was added levels (2% and 4%). Based on chemical properties can be determined of bio briquette quality from analysis proximate (water, ash , volatile matter content , solid carbon, and calorific value according to standard analysis in TEKMIRA. Furthermore, ignition characteristic of briquette was analyzed to measure time of flash point and starting of ignition until the briquettes turn to ashes as a whole.

RESULTS AND DISCUSSION

A. Proximate Analysis

To evaluate chemical characteristic of the briquette we analysis of proximate parameters as shown in Fig. 1 to 5, all the parameters are expressed in percentage or cal per unit mass for calorific value.

1. Water Content

The results of analysis of water content on any biomass that had carbonized and briquetting shown in Fig. 2. Briquette from manure showed low water content only 6.76%, instead of the corncob briquette showed the highest water content 10.98%. Charcoal combination of ramie with manure or corncob tended to reduce the water content in the briquettes. The water content in the organic composition of the briquettes except the corncob showed that convene with the standards bio briquette in Indonesia or Japan.

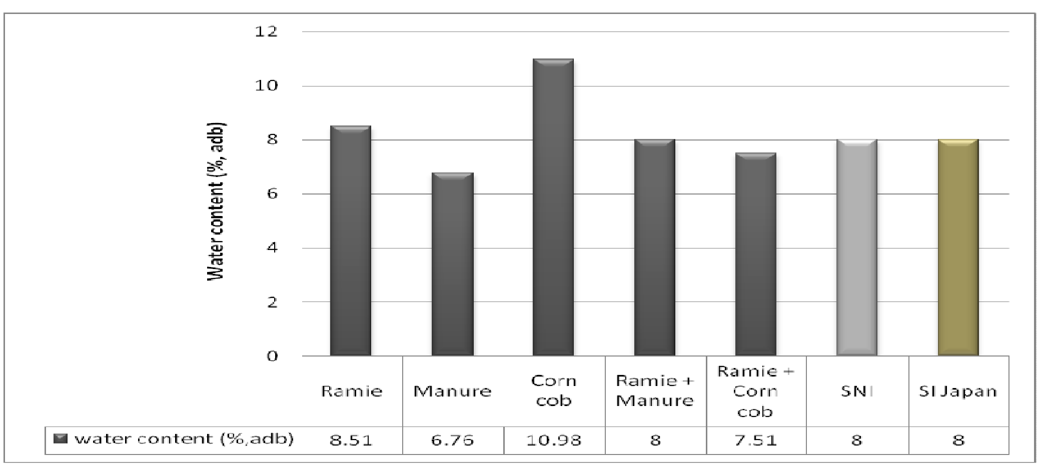

Figure 2. Water content of ramie, manure, and corn cob briquette comparing to SNI and SI Japan

2. Ash Content

Ash briquette influenced by the type of raw materials. High content of the as in briquette reduced calorific value and caused crust to stove or equipment. Fig. 2 showed that briquetting of carbonized corncob had a high ash content 10,98% , comparing to ash of briquette manure which only had 6.76%. Combination of ramie and corncob showed ash content accordance with the briquette standard ≤ 8 % .

3. Volatile Matter

Fig. 3 showed highest levels of volatile compounds contained in the briquette manure. Addition of ramie had reduced ash content of the briquette manure, on the other hand increased ash of the cob. However, a combination of ramie and corncob still provided the levels of substances that meet the standards bio briquette.

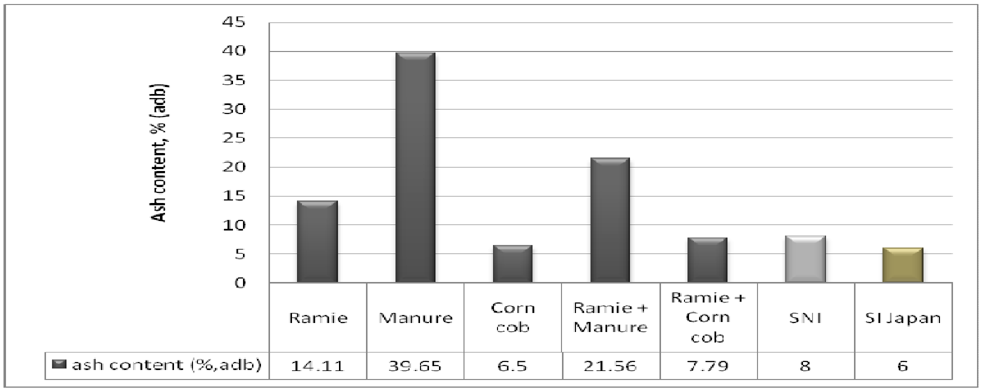

Figure 3. The ash content of ramie, manure, and corn cob briquette comparing to SNI and SI Japan

Fig. 4 showed that the briquettes had high percentage of volatile matter that would be made available for combusting. Since the volatile matter level of all the briquette did not meet the national standard briquettes, referring to a standard Japanese, the values of volatile matter were good and acceptable (Fig. 4).

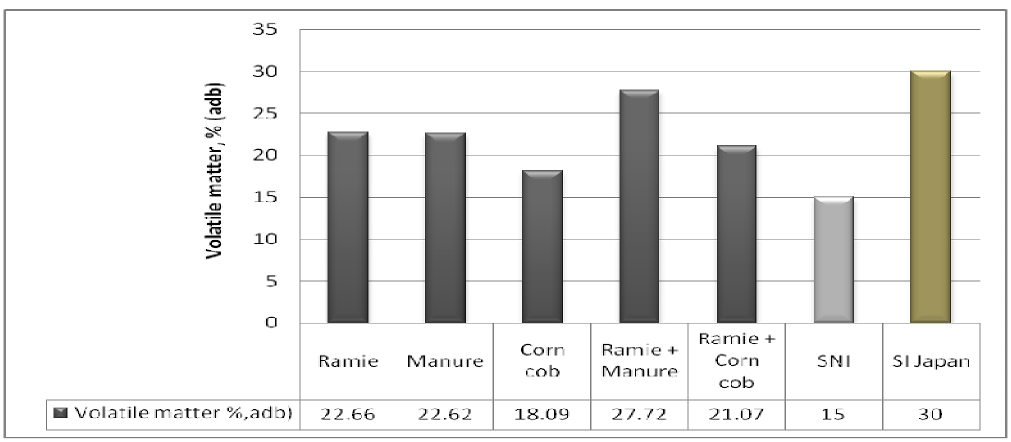

Figure 4. Level of volatile matter of ramie, manure, and corncob briquette comparing to SNI and SI Japan

4. Fixed Carbon

Fixed carbon in the briquette influenced by levels of substance bound to evaporate and ash content. It affected the carbon content and calorific value to time flame. Carbon content increased if the maximum temperature or extended duration of carbonization process [11]. Fig. 5 showed single organic mass manure had low content of fixed carbon. Ramie with addition of corncob charcoal increased the carbon content of the carbon to approach the quality standards.

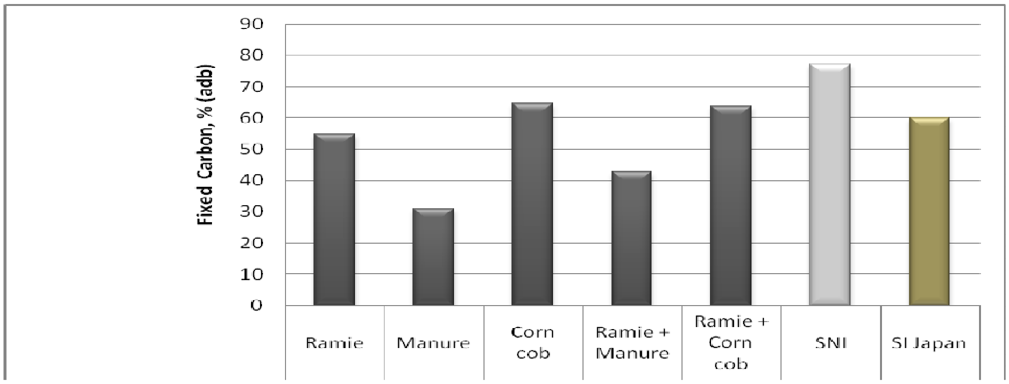

Figure 5. Percentage of fixed carbon of ramie, manure, and corncob briquette comparing to SNI and SI Japan

5. Calorific Value

Calorific values expressed as proportional to the heating value of the fixed carbon to generate greater calorific value. This was due to the oxidation reaction that can produce heat. Carbonization process and raw materials affected the calorific value of the briquettes, the more perfect the carbonization process bound carbon content and calorific value even higher [12].

Analysis showed that the calorific value of manure bio briquette have very low calorific value is 3449 cal / g , this value was quite far from the standard. The use of briquettes with the composition only manure seemed inefficient. Mixture of corncobs and ramie showed highest calorific value up to 6,200 cal / g.

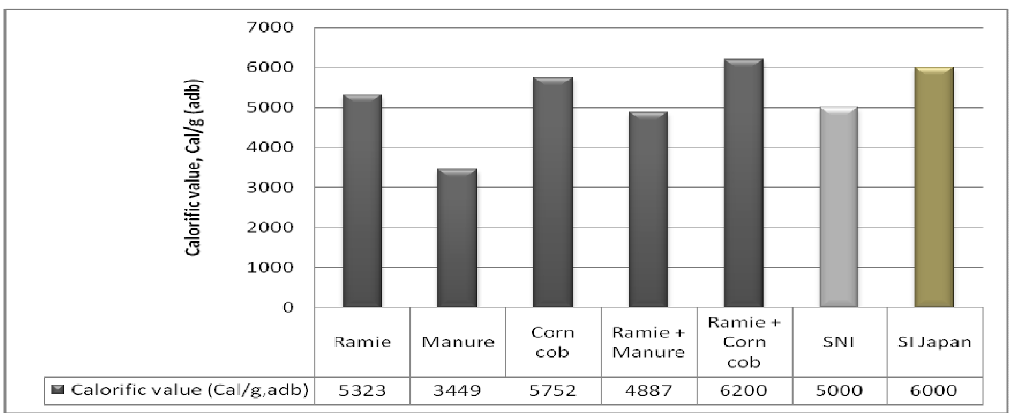

Figure 6. Calorific value of the briquette of ramie, manure, and corncob comparing to SNI and SI Japan

B. Adhesive Effect for Ramie Bio briquette

Table 1 was show the effect of variations of starch as adhesive with variations briquette ramie and corncob.

Effect of adhesive on the chip bio briquette of ramie and corncobs observed in the composition of the A and C and compared to treatment B and D, with contains starch 2% and 4%. It discovered that the composition of ramie and corncob at difference concentration of starch have little or no significant effect on all the parameters.

Table 1 Composition of bio briquette with level of adhesive to variation of ramie and corn cob of adhesive

Parameters	SNI No.1 /6235/2000	Composition of bio briquette			
		A	B	C	D
Water content (%)	≤ 8	7.51	7.63	7.86	7.97
Ash content (%)	≤ 8	7.79	7.81	11.78	12.18
Solid carbon (%)	≥ 77	63.63	62.89	59.16	56.8
Volatile matter (%)	≤ 15	21.07	21.67	21.2	23.05
Calorific value (Cal/g)	≥ 5000	6200	6177	5707	5640

Composition of biobriquette
(R = ramie, CC=corncob; and Ad=adhesive)
A). R 30 % + CC 70% + Ad 2%
B). R 30 % + CC 70% + Ad 4%
C). R 70 % + CC 30% + Ad 2%
D). R 70 % + CC 30% + Ad 4%

Comparison of the composition of A and B to C and D as an effect of composition of ramie and corncob with different level of adhesive showed an increase in the percentage of ramie from 30% to 70%. Increased biomass ramie tended to slightly increase the value of water, ash content, and volatile matter. The composition of ramie as main bio briquette showed significant effect on the calorific value as well as on the on the solid carbon. However, the calorific value, ash and the fixed carbon content were altered by the addition of ramie and so also the calorific value of the briquettes. As the percentage of ramie increased from 30% to 70% both the solid carbon and the calorific values decreased. This had shown that corncob, used to improve the performance of ramie briquettes. Hence, mixing ramie waste with corncob briquettes adding with adhesive could lead to better briquettes performance.

C. Biomass Ignition and Flame Time

Ignition time was time of the entry of fuel until the flame formed at a temperature of ignition, and the composition of ramie chip in bio-briquettes influence time of ignition and flame time as shown in Table 2.

Combustion analysis of the briquettes showed that the composition of ramie and corncob (3 : 7) gave flame time 211 min with a burning flame 26 sec, while most rapid flame coal exhausted the manure briquette with only 71 min with ignition time 37 sec. The ignition and flame time affected by structure of material, fixed carbon and level of material hardness. The ignition could be affected by water content and levels of volatile matter. The lower moisture, the less time it took to restart bio briquette. Bio briquette which had high levels of volatile matter will burn faster and higher burning speeds anyway [13].

Addition manure as a mixture of biomass ramie reduced ignition time of the briquette.

Table 2 Ignition time and flame time for each biomass content

No.	Composition	Volatile matter (%)	Ignition time (sec)	Flame time (min)
1	Ramie	22.66	15	83
2	Manure	22.62	37	71
3	Ramie + manure (30%:70%)	27.2	28	77
4	Ramie + corn cob (30%:70%)	21.07	26	211

Manure with the percentage of volatile matter was higher than the other briquettes, showed the highest burning speed, so as to have a flame just 71 minutes. Even it had slow flame time about 37 seconds. This possibility affected by moisture content and levels of volatile substances. The lower water had less time to restart bio briquette. [13] Bio briquette had high levels of volatile substances optimum would burn faster and had higher burning speeds anyway. Addition cow dung as a mixture of biomass ramie briquettes could shorten the time of ignition of bio-briquettes.

CONCLUSION

Biomass of corncob was the best organic composition for ramie briquetting with formulation 30% ramie : 70% corncob, and addition of 2 % starch generated calorific value 6,200 cal/g. From this study, ignition and combustion quality shown that ramie briquettes might be developed as a potential biomass energy.

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