

Briquettes from Tobacco Stems as the New Alternative Energy

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ARTICLE INFO	Abstract
<p>Article history:</p> <p><i>Received date : 28 November 2017</i></p> <p><i>Revised date : 19 December 2017</i></p> <p><i>Accepted date: 20 December 2017</i></p> <p>Available online at : http://inajac.lipi.go.id</p>	<p><i>Tobacco briquettes is the new alternative energy developed in PT Perkebunan Nusantara X (PTPN X). The tobacco briquettes research is important for PTPN X because of three reasons: high availability of the raw material, it can be used as substitution for coal briquettes, and expected for industrial scale. Currently, many researches have been conducted for biomass-briquettes but only few who used tobacco. PTPN X have been cultivated tobacco only for its leaves which latter used for cigar and the rests were thrown as waste. By conducting the tobacco briquettes research, many forms of utilization are expected. For short term, the aim of this research is generating a diversification of added value - product from tobacco. For middle term, PTPN X is expected to be the role model for the tobacco growers. For long term, PTPN XI's goal is to decrease coal briquettes usage and break the negative stigma of tobacco. Briquetting process was conducted in Physical Laboratory of Tobacco Research of Jember and the observation located in Tobacco Processing Barn of Ajong Gayasan PTPN X. Analysis of proximate test showed that the moisture content of tobacco briquettes with cassava starch as adhesive was 8.00 to 8.97%, the volatile matter was 49.60 to 41.13%, the ash content was 9.93 to 7.89%, the fixed carbon was 32.47% to 42.01%, the sulphur content was 1.02 to 0.49%, the bulk density was from 0.35% to 0.41%, the calorific value was from 4,285 to 4,586 cal/gr, and flammable duration was from 592 to 697 minutes. The briquetting process did not affect the taste of leaves as cigar material.</i></p>
<p>Keywords:</p> <p><i>product diversification, waste recycling, substitute coal briquettes usage</i></p>	

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1. INTRODUCTION

PTPN X is a stated-owned enterprise plantation where one of its business is in tobacco sector. Tobacco is produced by three plantations of PTPN X, including Ajong Gayasan Plantation, Kertosari Plantation, and Klaten Plantation. Their products are shade grown. Ajong Gayasan and Kertosari Plantation are the producer of Besuki Na-Oogst Tobacco, whereas Klaten Plantation is the producer of Vorstenlanden Tobacco. Both of the plantations are oriented to fulfill cigar raw material for export-scale.

Because of shade grown planting, the plants subjected to etiolation which is associated to the longer and higher stem of the tobacco to more than three meters height.

After cultivation and harvesting, the grower only took the leaves and left the stem as a waste.

Table 1. Tobacco Stem Waste in PTPN X

No.	Plantation	Land area (ha)	Stem waste (tons)
1	Ajong Gayasan	327.400	13,096
2	Kertosari	350.500	14,020
3	Klaten	200.500	8,020
Total		878.400	35,136

Source: Data PTPN X (2017)

As described on Table 1, PTPN X has tobacco cultivation of 878.4 hectares. If a hectare contains 25,000 trees and the average weight of stem is 1.6 kg/tree, the total population in three plantations will be 21.96 million trees with total weight 35,136 tons. It means that there are 35,136 tons stem waste unutilized in the environment. Whereas, stem waste can be processed into briquette, pellet, nicotine, pottery, rice husk substitutor, handicraft, and so on.

In other cases, tobacco plantation of PTPN X needs at least 186 ton coal briquettes every year for fermented process of leaves in processing barn. Therefore, the author selected to process the stem waste as briquette for the research focus. The aim of this study is to substitute coal briquette with tobacco briquette which lead to the reduction of solid waste in the environment.

2. EXPERIMENTAL SECTION

2.1. Materials

The main material used in this research are tobacco stems. The tools and supporting materials needed for briquetting were as follows: cassava starch as adhesive, disk mill, and manual press. Rasio for adhesive to tobacco stem powder is 1:9. Tobacco stem, disk mill, and manual press are shown in Figure 1 - 3.

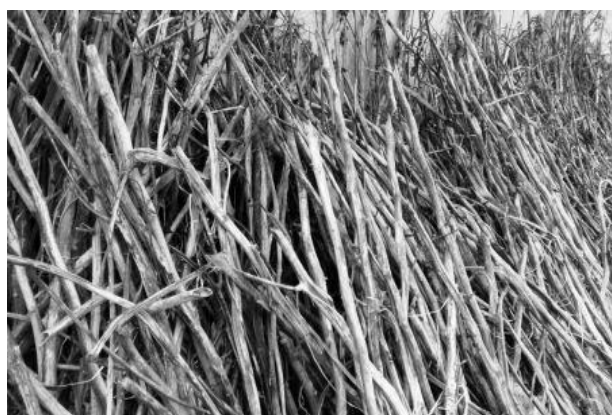


Fig. 1. Tobacco Stem



Fig. 2. Disk Mill



Fig. 3. Manual Press

The tobacco stem was air-dried for two weeks. Latter, it was ground using disk mill to 1 mm or less. Raw material for briquetting was processed manually. Briquettes were prepared by adding cassava starch which was acted as adhesive with the ratio of 1:9 (cassava starch: tobacco stem). Figure 4 presented the final product of tobacco briquettes.



Fig. 4. The Tobacco Briquettes

2.2. Methods

2.2.1. Percentage Moisture Content

The moisture content percentage (PMC) of biomass was measured using oven-dried (gravimetry) method. Sample with the known weight was kept in oven at 105 °C for one hour. Then the oven-dried sample was weighed (ASTM D-3173) [1]. The moisture content of sample was calculated using following Equation 1:

$$MC = \frac{W_2 - W_3}{W_2 - W_1} \times 100\% \dots\dots\dots \text{Eq. 1}$$

where;

W_1 = weight of crucible (gr)

W_2 = weight of crucible + sample (gr)

W_3 = weight of crucible + sample, after drying (gr).

2.2.2. Percentage Volatile Matter

The percentage of volatile matter (PVM) was determined by pulverising 2 g of the briquette sample in a crucible and placing it in an oven until a constant weight was obtained. The briquettes were then kept in a furnace at a temperature of 550 °C for 10 minutes and weighed after cooling it in a dessicator (ASTM D 3175-11) [2]. The PVM was calculated using Equation 2:

$$PVM = \frac{A - B}{A} \times 100\% \dots\dots\dots \text{Eq. 2}$$

Where;

A = weight of the oven-dried sample (gr)

B = weight of sample after 10 minutes in the furnace at 550 °C (gr).

2.2.3. Percentage Ash Content.

To calculate the percentage of ash content (PAC), bio-briquettes were heated in the furnace at temperature 800 °C for three hours, then the furnace was turned off. Wait until the temperature below 400 °C before removing it from the furnace. Samples will be weighed if it is really cold (ASTM D 3174-12) [3]. The calculating was conducted using Equation 3:

$$PAC = \frac{(m_5 - m_1)}{(m_2 - m_1)} \times 100 \dots\dots\dots \text{Eq. 3}$$

where;

m_1 = weight of empty cup,

m_2 = weight of empty cup + sample taken from stage (II),

m_5 = weight of empty cup + ash left in the cup

2.2.4. Percentage Fixed Carbon

The percentage of fixed carbon (PFC) was calculated by subtracting the sum of PMC, PVM, PAC from 100 as mentioned in Equation 4 based on (ASTM D-3172) [4]:

$$PFC = 100\% - (PMC + PVM + PAC) \dots\dots\dots \text{Eq. 4}$$

2.2.5. Sulphur Content.

The different samples of the briquettes was pulverized, 1 g of the finely powdered samples was mixed with 5 g of Na_2NO_3 and 0.2 g of NaNO_3 in a crucible. The mixture was preheated at 400 °C for 30 minutes in an electric muffle furnace and then fused at 950 °C. After fusion, the crucible was allowed to cool and was placed in a 150 cm³ beaker. HCl was added to neutralize the Na_2CO_3 . Latter, the mixture was boiled with BaCl_2 to precipitate excess of sulphate. Drops of HF and H_2SO_4 was added to the precipitate, ignited and weighed again (ASTM D-3177) [5]. Total sulphur was determined by following equation [9]

$$\% \text{ sulphur} = \frac{\text{BaSO}_4 \text{ (g)} \times 13.7 \times 100}{\text{Weight of sample}} \dots\dots\dots \text{Eq. 4}$$

2.2.2 Bulk Density

The bulk density of material was determined by the standard procedure. A cylindrically shaped container of 1000 mL (1000 cm³) volume was used for determination. The empty container was weighed to determine its mass and then it was filled with the sample and weighed once again. The bulk density was determined by dividing the mass of the material by the volume of the container. The bulk density was calculated by using Equation 6:

$$\text{Bulk Density} = \frac{\text{Mass of biomass sample (gr)}}{\text{Vol of cylinder (cm}^3\text{)}} \dots\dots\dots \text{Eq. 6}$$

2.2.3 Calorific Value

The gross calorific value of the samples was determined in accordance with (ASTM D5865-13) [6]. The analysis was conducted using IKA C2000 bomb calorimeter. About 0.4 g of each sample was burnt in the bomb calorimeter until complete combustion was reached. The difference between the maximum and minimum temperatures was used to calculate the gross calorific values of the biomass materials according to the following equation:

Heat released sample,

$$Q = \frac{\text{G.meter deflection} \times \text{calib.}}{\text{Original weight of sample}} \dots\dots \text{Eq. 7}$$

This is equal to:

$$Q = \frac{(\Theta_3 - \Theta_1)Y}{\dots\dots} \text{ kcal/gr}$$

3. RESULT AND DISCUSSION

The tobacco briquettes was analyzed and compared to SNI 1-6235-2000 [7]. The results and discussion for each analysis as follows:

3.1. Moisture Content

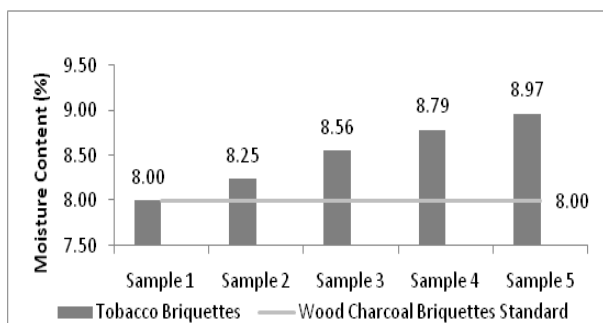


Fig. 5. Moisture Content of Tobacco Briquettes

Moisture content is a very important property and can greatly affect the burning characteristics of the briquettes [15]. The moisture content of tobacco briquettes started from 8.00 to 8.97 %. Standard of moisture content reached maximum at 8.00 % (Figure 5). It means that no samples meet the standard. It might be caused by many factors, including hygroscopic and porosity of substance (tobacco stem), carbonization time and also drying time after briquetting [13].

3.2. Volatile Matter

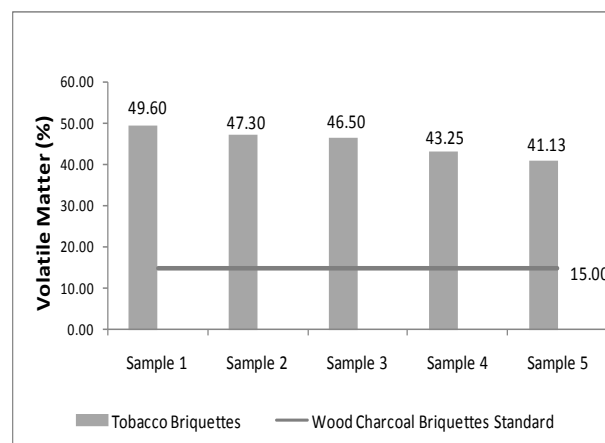


Fig. 6. Volatile Matter of Tobacco Briquettes

Figure 6 showed that the interval volatile matter of tobacco briquettes was in the range of 49.60 % to 41.13 %, whereas the maximum standard was 15 %. Volatile matter was usually released in the form of CO, CO₂, CH₄, and H₂. High point of volatile matter means that the briquettes have good combustion rate [10]. It can be concluded that tobacco briquettes have high level in flammable and burning, also released a great amount of smokes.

3.3. Ash Content

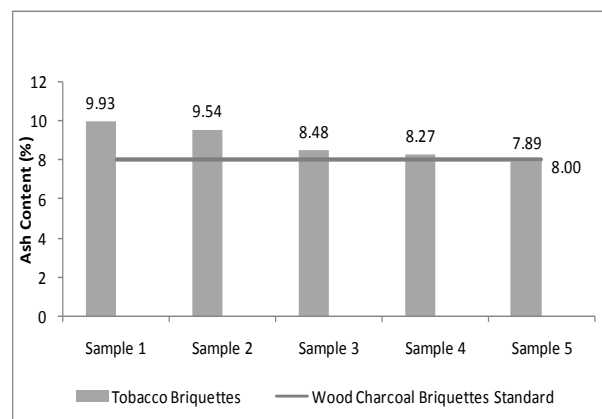


Fig 7. Ash Content of Tobacco Briquettes

Ash content of tobacco briquette was in the range of 9.93 % to 7.89 %. Meanwhile maximum ash content standard of wood charcoal briquette was 8 % (Figure 7). It can be concluded that ash content of tobacco briquette was worse than wood charcoal briquette standard. Higher ash content generally affects the level of impurities, cause of worn out and corossion of the equipment. A briquette with high ash content is very unfavorable as it will form crust [14].

3.4. Fixed Carbon

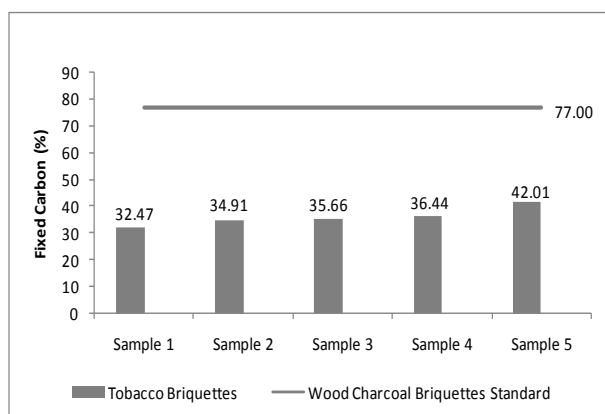


Fig. 8. Fixed Carbon of Tobacco Briquettes

Fixed carbon is a measure of the solid combustible material in solid fuel after the expulsion of volatile matter. Its content is used as an estimate of the amount of coke that will be obtained on carbonization [8]. Fixed carbon of tobacco briquette started from 32.47 % to 42.01 %, whereas the maximum fixed carbon standard is 77 % or more (Figure 8). It means that all samples have lower fixed carbon than standard. Fixed carbon content is linear to calorific value, because every oxidation reaction from carbon substance will generate sums of calories [12].

3.5. Sulphur Content

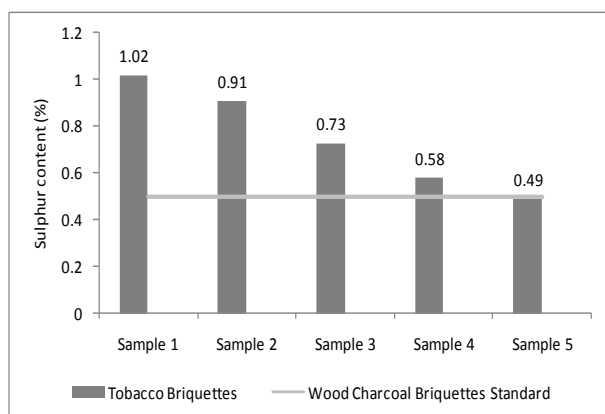


Fig 9. Sulphur Content of Tobacco Briquettes

Sulphur is the major cause for the formation of harmful emission and contributor for the forming of ash [11]. The sulphur content of tobacco briquettes varied from 0.49 % to 1.02 %. In other cases, the sulphur content standard of wood coal briquettes is no more than 0.5 % (Figure 9). It means that the majority samples of tobacco

briquettes (80 %) still have worse sulphur content than wood charcoal briquettes.

3.6. Bulk Density

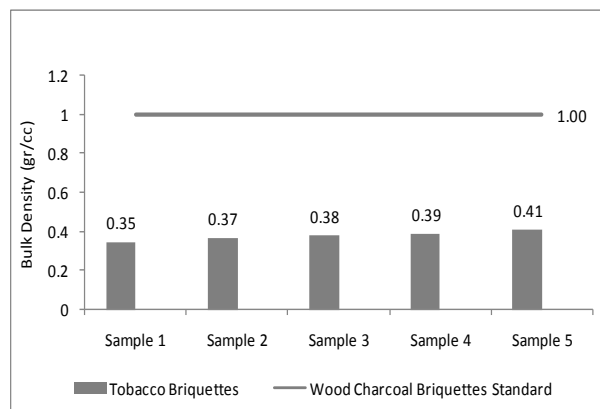


Fig. 10. Bulk Density of Tobacco Briquettes

Tobacco briquettes are lighter than coal briquettes. It was observed from the bulk density number. The wood charcoal briquettes standard have 1.00 gr/cc for each bulk density. However, the value of the bulk density for tobacco briquettes was only 0.35 to 0.41 gr/cc for each bulk density (Figure 10). This low value might be caused by manual pressing process when briquetting. Pressing process will affect not only density, but also calorific value and porosity.

3.7. Calorific Value

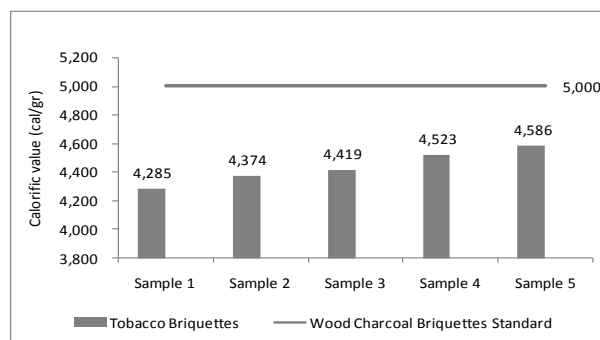


Fig. 11. Calorific Value of Tobacco Briquettes

Figure 11 described the calorific value between wood charcoal briquette and tobacco briquette. The calorific value of tobacco briquette was in the range of 4,285 to 4,586 cal/gr, with the average of 4,437 cal/gr. Meanwhile, wood charcoal briquette standard has calorific value of 5,000 cal/gr. There are two future works which can be conducted in order to reach the similar or even exceed the calorific value of wood briquette, including

increasing density and adding ratio binder to tobacco stem on briquetting.

3.8. Flammable Duration

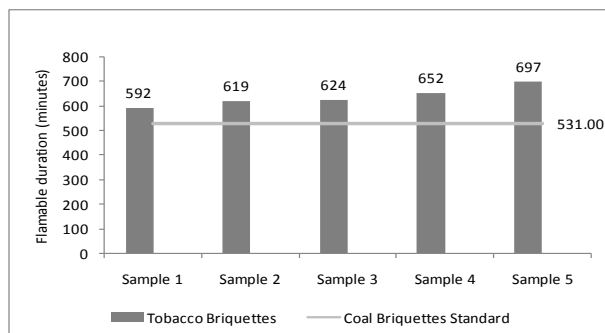


Fig 12. Flammable Duration of Tobacco Briquettes

One of this study goals is to substitute the utilization of coal to tobacco as briquette. Therefore, the flammable duration should be observed. To compare flammable duration between two kinds of briquettes, each sample prepared on 10 kg weight and burn in the same starting time until the briquette's ember appeared. From the result, it was observed that flammable duration of tobacco briquettes started from 592 minutes to 697 minutes or 9 hours to 11 hours. Meanwhile, coal briquettes reached flammable duration on 531 minutes or 8 hours 51 minutes. It can be concluded that tobacco briquettes have better flammable duration than coal briquettes. It is an important aspect for to reduce the cost effectively and efficiently.

3.9. Nicotine Content

Table 2. Nicotine Content

No.	Parameter	Tobacco stem (wet based)	Tobacco stem (dry based)	Tobacco briquette
		a	b	c
1	Nicotine content (%)	0.25	0.11	0.07
2	Nicotine content reduction than a (%)	-	56	72
3	Nicotine content reduction than b (%)	-	-	36

Source: Nicotine Content Analysis Result of Tobacco PTPN X (2017)

One of chemical compounds contained in tobacco is nicotine. Table 2 describes the nicotine content from raw tobacco until final product. Tobacco stem (wet-based) as the raw material contained 0.25 % nicotine.

However, dry-based tobacco stem has only 0.11 % nicotine. After proceed into tobacco briquette (final product), nicotine content decreased to 0.07 %. The decrease of nicotine content from tobacco stem (wet based) to tobacco stem (dry based) was 56 % and decrease even more to 72 % (tobacco briquette). In other cases, the decrease of the nicotine content from tobacco stem (dry based) to tobacco briquette was 36 %.

An observation was conducted in Ajong Gayasan plantation's processing barn to compare the performance tobacco briquettes and coal briquettes. The appearance and overall quality of dry leaves did not change although temperature and humidity in processing barn was adjusted and replaced by ember of tobacco briquettes.

3.10. Future Works

Regarding to the results of the research, the author proposed several future works, as follows: 1) further treatments and trials are needed to decrease sulphur content and also to increase both bulk density and calorific value; 2) The trial could be adding the variation of binder/adhesive, tobacco waste, and ratio adhesive:char; 3) The alternative adhesives that could be used except cassava starch, are molasses, vinasse, and stilage; 4) The variation of tobacco waste used as raw material except stem are tobacco roots, tobacco stalks, and tobacco seeds; 5) finding the best combination of raw material and adhesive to release high quality tobacco briquettes; 6) Currently, the biomass from tobacco are proceed directly into briquettes (first generation/G1 process). In the future, lignin and cellulose from the tobacco could also be considered for bioethanol production or other biomolecular products. Latter, the waste from bioethanol production can be processed into briquettes or another useful and economical products (second generation/G2); 7) A comparison between inlet energy used for briquetting and energy result of briquettes should be conducted; 8) Tobacco stem has high nicotine content (0.25 %) which was then reduces to 0.07 % for tobacco briquettes. Therefore, there should be an increase in safety procedure to

minimize emission of volatile matter, especially nicotine from combustion in briquetting process and ember in processing barn; 9) in order to reduce nicotine effect and also to use the nicotine as other new product, while briquetting, the smoke can be trapped and later proceeds as smoke liquid; and 10) Waste management should use zero waste method and optimize the waste recycling concepts.

4. CONCLUSIONS

According to the analysis, tobacco briquettes need further treatment to fulfill the accepted standard. Regarding the nicotine content analysis, combustion in briquetting process from tobacco stem (raw material) into tobacco briquettes can reduce nicotine content to 72%. Based on observation in processing barn, tobacco briquettes provided the similar results with coal briquettes, including no sparkling and it had no effect to the taste of dry leaves as cigar material. Tobacco briquettes have longer flammable duration than coal briquettes. Therefore, it can be concluded that the tobacco briquette from Processing Barn Tobacco Plantation of PTPN X can be used as substitute for coal briquette usage.

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