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ORIGINAL ARTICLE

Physico-Chemical Properties of Biopellet from Coffee Shell

Rusdianto, A. S.
1Department of Agro industrial Technology, Faculty of Agricultural Technology, University of Jember, Indonesia
*Corresponding e-mail: andrew.ftp@unej.ac.id

ABSTRACT
Coffee shell is a waste from coffee industry that is usually used as fertilizer, feed and biogas. Coffee shell contains carbon element that stored in stored incellulose, hemicelluloses andlignin which is potential to be developedinto alternative fuels. The purpose of this study was to determine the composition of the skin biopellet manufacture of coffee and getting coffee skin biopellet physicochemical characters. Research coffee shell biopellet consists of the manufacturing process and analysis of physicochemical biopellet. Analysis of physic-chemical properties biopellet consists of analyzing physical and chemical properties. Coffee shell biopellet has the characteristics an average diameter 10.93 mm, an average length 62.86 mm with a color is dark brown. Making biopellet without adhesives produce a whole by 66 %, while the use of adhesive 1 % (w/w)to 5 %(w/w)) can produce a whole of 80 % to 90 %. The best treatment is biopellet with adhesive 5%(w/w); where the highest heating value of 17979.73J/g, most low odor levels, the lowest moisture content as well as the highest levels of fixed carbon.
Keywords: coffee shell; biopellet; physicochemical characteristic

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INTRODUCTION

Coffee shell is a waste from coffee industry that is usually used as fertilizer, feed and biogas. Coffee shell contains carbon element that stored in stored in cellulose, hemicelluloses and lignin which is potential to be developed into alternative fuels. Coffee skin has a high calorific value, low water content and low sulfur content [1-3]. Biopellet (biomass pellets)as fuel, can be an alternative to coffee shell processing into value-added products to be used as fuel at remote area. Biopellet from coffee shell can be commercialized to increase the income of farmer groups of coffee plantation. The purpose of this study was to determine the composition of the biopellet manufacture of coffee skin and getting physicochemical characters.

MATERIALS AND METHODS

Tools and Materials

This study uses the main ingredient in the form of waste of coffee shell. Other study materials include tapioca flour which is used as an adhesive biopellet and chemicals for analysis. The equipment used in this study includes a hammer mill, pellet maker (diameter 1.5 cm), 40-mesh sieve, balance and glassware for analysis.

Biopellet Production [4]

Coffee shell mashed to reduce the particle size and sieved (40-mesh) and mixed with tapioca (percentage 1%(w/w), 3% (w/w) and 5%(w/w)). Biopellet dough is then shaped using a pellet maker and then dried.

Physico-Chemical Characterisation of Coffe Shell Biopellet

Analysis of physicochemical biopellet consists of physical and chemical properties. Analysis of physical properties includes dimensional analysis (diameter and length) and the density biopellet. Analysis of chemical properties include moisture content, heating value, volatile matter content, ash content and fix carbon content [3].

Research Design

The experimental design used was completely randomized factorial design consisting of a single factor, namely the composition of starch (T)) with three replications. Factor composition consisting of tapioca flour 1 % (w/w)(T1), tapioca flour 3 % (w/w)(T2), and tapioca starch 5 % (w/w)(T3). Fisher further test carried out to determine the effect of treatment of parameters [6].

Factorial design:
T1 = coffee shell (99%w/w) :tapioca flour (1% w/w)
T2 = coffee shell (97%w/w) : tapioca flour (3% w/w)
T3 = coffee shell (95%w/w) : tapioca flour (5% w/w)
Control = coffee shell (100%w/w)

RESULT AND DISCUSSION

Physic Characterisation of Coffe Shell Biopellet

Biopellet is the result of physical transformation of biomass (bark coffee) where the use is as fuel. Physical changes on the shell of the coffee into biopellet has the advantage that more space-saving storage and easy to carry anywhere. Coffee shell biopellet has the characteristics an average diameter 10.93 mm, an average length 62.86 mm with a color is dark brown. The size of the diameter of a coffee shell biopellet 1 mm longer than the standard biopellet based ÖNorm M7135 Austria due to adjust the biomass stove is used. The stove requires a minimum diameter of 1 cm to obtain good combustion. Biopellet diameter of less than 1 cm can lead to the combustion process becomes less than perfect due to the lack of air circulation between stacks biopellet in the furnace. Characteristics of physical properties of the shell biopellet coffee are presented in Table 1.

Table 1. Physical Characterization of Coffee Shell Biopellet

TREATMENT	LENGTH(mm)	DIAMETER (mm)	COLOUR
Without Adhesive	61,59 ± 5,00	10,84 ± 0,25	Dark Chocolate
Adhesive 1%(w/w)	63,67 ± 3,36	11,04 ± 0,19	Dark Chocolate
Adhesive 3%(w/w)	60,59 ± 9,24	10,84 ± 0,26	Dark Chocolate
Adhesive 5%(w/w)	65,60 ± 7,33	10,99 ± 0,13	Dark Chocolate
ÖNorm M7135 Austria[12]	5xD[1]	4-10	-

(1) not morethan20% biopellet measuring 7.5xdiameter

Adhesives are added to the biopellet process to keep the shape of biopellet that is not easily destroyed. Types of adhesives are added to this study is the organic adhesive; tapioca flour with percentage are 1%(w/w), 3 %(w/w) and 5 %(w/w). The result of biopellet fractionation showed that the use of adhesives can reduce product that was broken during the production process and drying biopellet. Making biopellet without adhesives produce a whole by 66 %, while the use of adhesive 1 % (w/w) to 5 %(w/w)) can produce a whole of 80 % to 90 %. Table 2 shows that the shell coffee biopellet can be made without the use of adhesives, but the possibility of product destroyed after the production process is quite high, reaching 24 %.

Table 2.Fractination of Coffee Shell Biopellet

TREATMENT	FRACTINATION (%)		
	GOOD	**BROKEN**	**RESIDUAL (AT MACHINE)**
Without Adhesive	66.1	23.8	10.1
Adhesive 1%(w/w)	82.7	0.7	16.6
Adhesive 3%(w/w)	91.7	4.0	4.3
Adhesive 5%(w/w)	80.9	5.6	13.5

Based on the observed physical parameter, the manufacture biopellet without the use of adhesives is not recommended for treatment while giving adhesive 1%(w/w), 3%(w/w)and5% (w/w) is still recommended. Making biopellet without using adhesive will produce the most widely biopellet destroyed when process and dried so that indicated that more products are broke during the process of packaging and distribution.

Chemical Characterisation of Coffe Shell Biopellet

Chemical parameters were observed from biopellet include moisture content, volatile matter content, ash content, fixed carbon and heating value. Value proximate analysis results coffee shell biopellet are presented in Table 3.

Table 3.Chemical Characterisation of Coffe Shell Biopellet

TREATMENT	MOISTURE (%)	VOLATILE MATTER (%)	ASH (%)	FIXED CARBON (%)	HEATING VALUE (J/g)
Without Adhesive	6,46 ± 0,06^{ab}	57,93 ± 0,03^{c}	12,88 ± 0,04^{a}	22,73 ± 0,05^{a}	16.121,41 ± 137,49^{c}
Adhesive 1%(w/w)	6,31 ± 0,07^{bc}	58,60 ± 0,02^{b}	12,33 ± 0,08^{b}	22,77 ± 0,17^{a}	16.521,62 ± 121,85^{c}
Adhesive 3%(w/w)	6,59 ± 0,00^{a}	58,77 ± 0,07^{b}	11,76 ± 0,08^{c}	22,88 ± 0,15^{a}	17.130,81 ± 158,77^{b}
Adhesive 5%(w/w)	6,17 ± 0,07^{c}	59,08 ± 0,04^{a}	11,71 ± 0,04^{c}	23,03 ± 0,15^{a}	17.979,73 ± 112,15^{a}
Standard	<12[4]	-	<1,5[4]	-	17.000-19.000
Biomass Wood *Gmelinaarborrea*	6,56[2]	68,59[2]	1,41[2]	23,44[2]	18.340[2]
Cane	9,7[7]	78,0[7]	6,6[7]	-	12.146[7]
Golden Bamboo	6,7[7]	75,3[7]	3,4[7]	-	19,919[7]
Sawlog residual	7,5[7]	76,7[7]	1.0[7]	-	16,807[7]

Table 3 showed that coffee shell biopellet contains less than 10% water which ranges from 6.1% to 6.6%, while the standard requires biopellet moisture content below 12%. The higher water content of biopellet can impact the combustion power is poor. The higher the water content will reduce the heating value and complicates the initial flame. Biopellet moisture content is too high will invite the organisms such as fungi, beetles because biopoellet raw materials derived from biomass (coffee shell). Moisture content biopellet coffee skin has a value that is approximately equal to some other biopellet research results (Table 3) which ranges from a value of 6.5% to 9.7%.

Volatile matter content of the coffee shell biopellet coffee, for all treatment, has a lower value than the biopellet of wood biomass *Gmelin aarborrea*, cane, golden bamboo and sawlog residual. The greater the volatile matter indicates more particles that fly when the combustion process. The more particles that fly when burning will cause more smoke arising. The more smoke released during the combustion process can lower the selling points of biopellet itself because if used for cooking, the smoke that comes out can litter the cookware.

Residue burning unwanted of biopellet (in addition to the smoke) is ash because it will accumulate in the furnace. Ash caused the mineral content in the raw materials. The ash content coffee shell biopellet is high enough to indicate that the ash left over after burning more than biopellet such as sugarcane and golden bamboo, while biopellet made of sawlog residual and biomass wood *Gmelin aarborrea* has small ash content according to the standard that is moreless than 1.5%. The ash content coffee shell biopellet is quite probably due to the mineral content of the raw materials is high; the mineral content in the coffee shell is 7.3% [5].

The heating value coffee shell biopellet using adhesives as much as5%(w/w) has the highest heating value compared to the other treatment that is equal to 17979.73J/g. The heating value coffee shell biopellet with an adhesive 5%(w/w) when compared with the value of the standard DIN51731is still in the value range of 17,000 to 19,000J/g. Coffee shell biopellet without adhesives and adhesive addition of 1% (w/w) has acalorific value of magnitude below the standard DIN51731is in the range 16.000J/g. Biomass feedstock that produces the highest heating value was derived from golden bamboo, while for biopellet of wood and sawlog residual brother has a value nearly equal to biopellet coffee skin is in the rangeof 17,000to 18,000J/g.

In general, the most excellent treatment is coffee shell biopellet with addition of adhesive as much as 5%(w/w). Coffee shell biopellet with addition of adhesive 5%(w/w) has better chemical characteristic than other treatment such as the smallest moisture content, the smallest ash content, the higher value of carbon content and especially the heating value of the most high (significantly different statistically).

CONCLUSION

Based on the research that has been done, itcan take several conclusions, among others:

1. Biopellet can be made of raw materials coffee shell that has been reduced in size and given adhesive tapioca starch.
2. The best treatment is biopellet with adhesive 5%(w/w); where the highest heating value of 17979.73J/g, most low odor levels, the lowest moisture content as well as the highest levels of fixed carbon.

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