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Biochar Briquette from Jackfruit Crust: Production, Mechanical and Proximate Properties

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Abstract*—In present work, biochar briquettes are produced from jackfruit crust. The briquettes have diameter of 30 mm and height of 40 mm. The work aim to investigate effect of particle size on mechanical and proximate properties of the briquettes and to obtain jackfruit briquette that meet SNI Standard (Standard Nasional Indonesia). Particle size variation of jackfruit char are 40 mesh, 60 mesh, and 80 mesh. The result shows the briquettes made from 80 mesh jackfruit char has the best quality in present work and meet the SNI Standard. Its heating value, fixed carbon, volatile matter, water content, and ah content are 5864 cal/gr, 58.401%, 25.065%, 7.981%, and 8.553%, respectively. However, maximum compressive stress of 0.68 N/mm2 is observed in briquette with particle size of 60 mesh.*

***Keywords*—** *Biochar, jackfruit, compressive stress, proximate.*

I. INTRODUCTION

Based on Indonesia Energy Outlook [1], Indonesia has biomass energy potential about 434.000 GW. The biomass energy potential mainly comes from waste of agriculture and forestry. The potential can be utilized as energy source for substitution of fossil fuel. Many biomass wastes have been used as raw material of biomass briquettes. Rice husk has been used as briquette by [2] and [3]. Different binders are used in [3]. Rice husk briquette was also used in blending with corn cob as briquettes by [4]. Ristianingsih et al. 2012 [5] made biochar briquette from organic waste and Ketapang leaves. Other works on production of briquette from fly ash and husk of coffee bean was performed by [6] and agro-residue briquette was investigated by [7] as feedstock of gasifier.

Important parameters in biomass briquette are proximate properties. Ash content, volatile matter, fixed carbon, and heating value of the briquettes have to meet the Indonesia Standard SNI. Regarding with biomass briquettes production, *Standard Nasional Indonesia (SNI)* No.1/66235/2000 [8] as shown in Table I. The table also presents proximate results from aforementioned works. In this work, biochar briquettes of jackfruit crust are produced using extrusion method. The briquettes are made with different size of jackfruit char, i.e. 40 mesh, 60 mesh, and 80 mesh. The work aims to investigate compressive stress and proximate properties of the briquettes and to obtain briquettes which meet SNI Standard No.1/66235/2000. No previous works have used jackfruit crust as a raw material of biochar briquettes, thus present work is different from previous work in terms of raw material used.

II. MATERIAL AND METHOD

A. Briquette Production

Biochar briquettes of jackfruit crust are made from jackfruit char by means of extrusion method. Production of the briquettes is started with pyrolysis of jack fruit crust into biochar. The crust is blend with rice husk (2:1 by mass) prior to pyrolysis. After 20 hours, jackfruit char and rice husk ash are obtained. The char is separated from rice husk ask and dried under sunlight. The next step is making a dough of the briquette. The char is mixed with a binder of tapioca flour with ratio of the char to the flour is 20:1 by mass. The dough is extruded with extrusion machine to produce the cylindrical briquettes. The briquettes have a diameter of 30 mm and height of 40 mm. Three models briquettes are made with variation in char particle size, i.e. 40 mesh, 60 mesh, and 80 mesh. Figure 1 shows production process of the jackfruit biochar briquettes.

B. Testing of Mechanical and Proximate Properties

To figure out quality of the briquettes, compressive test and ultimate analysis are conducted. Water content, volatile matter, ash, and fixed carbon obtained from proximate analysis are compared with SNI standard and other previous works. The compressive test is performed at Laboratory of Material Testing - *Institut Sains & Teknologi AKPRIND* and the proximate test is conducted at PAU (*Pusat Antar Universitas) Universitas Gadjah Mada.*

TABLE I. *Standar SNI No.1/66235/2000* and proximate results from various works.

Proximate	SNI Standard	Saputra et al.	Ristianingsih et al.	Elfiano, et al. [9]	Gunawan et al.	Widarti et al.
Water content (%)	8	7.916	2.045	2.305	N/A	N/A
Volatile matter (%)	N/A	89.11	40.12	30.54	N/A	N/A
Ash (%)	8	1.415	0.37	5.865	N/A	N/A
Fixed Carbon (%)	77	34.64	41.44	N/A	N/A	N/A
Heating value (cal/gr)	5000	4270	6024	4604	2498	6078

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(a) pyrolisis (b) extrusion (c) biochar briquettes

Fig. 1. Briquettes production.

III. Result and Discussion

A. Compressive Stress

Figure 2 shows compressive stress of the briquettes with variation in particle size. The highest compressive stress of the briquettes is obtained with particle size of 60 mesh. Compressive stresses of the briquette are 0.51 N/mm2, 0.68 N/mm2, and 0.35 N/mm2 for particle size of 40 mesh, 60 mesh, and 80 mesh, respectively. For particle size 60 mesh, the binding effect of the binder is less effective hence lower briquette's compressive stress. Meanwhile, porosity of the briquettes is too high when using 80 mesh. High porosity reduces compressive stress of the briquettes.

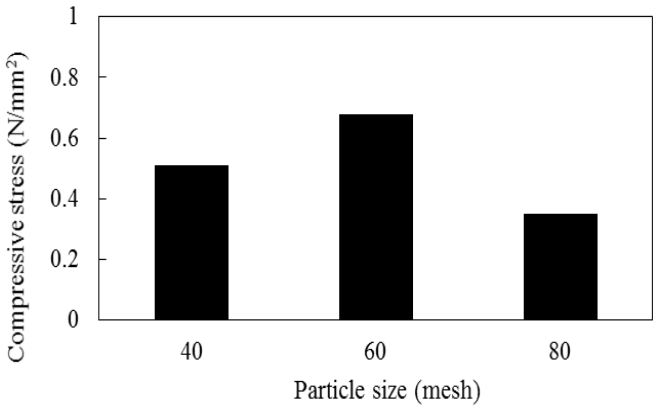

Fig. 2. Compressive stress.

B. Proximate Properties

Figure 3 displays water content in present biochar briquettes, SNI standard, and other works. It is observed that water content of present briquettes of 40 mesh and 60 mesh are higher than SNI Standard, Saputra et al, Ristianingsih et al., as well as Elfiano et al. However, briquettes of 80 mesh has lower water content, thus fulfill the SNI Standard. The 80 mesh briquettes have water content of 7.981% whereas the maximum water content in SNI Standard is 8%.

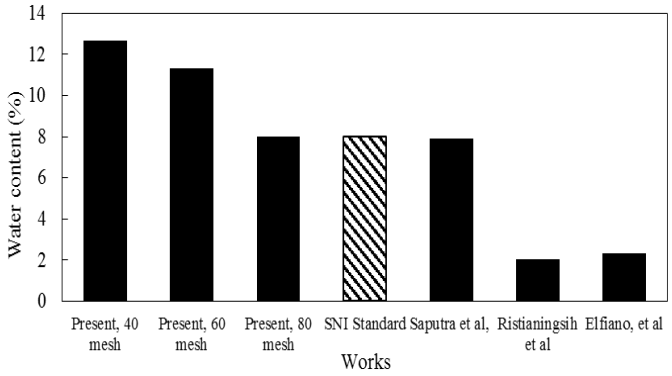

Fig. 3. Water content.

Figure 4 presents comparison of volatile matter in present work and other results including ESDM standard. Volatile matter plays important rule during briquettes combustion. High volatile in briquettes produces more smoke during combustion. Volatile matter in briquettes is affected by raw material of the briquettes. Allowed maximum volatile matter in biochar briquettes is 15% as stated in Regulation of Minister of ESDM No. 047/2006 [10] In present work, 40 mesh briquettes has volatile matter of 14.193 % which fulfill the ESDM standard.

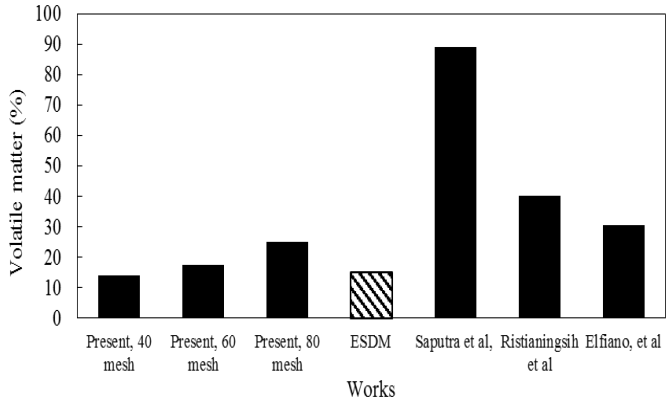

Fig. 4. Volatile matter.

Combustion characteristic of briquettes can be observed from ash content. High ash content after combustion effects low heating value of the briquettes. High heating value indicates good thermal quality of the briquettes. Figure 5 and Figure 6 show ash content and fixed carbon of the present briquettes and also from others. Ash content in the present briquettes do not fulfill the SNI standard. The ash contents are higher than SNI Standard. Higher ash content reduces fixed carbon of the briquette. Fixed carbon in present briquettes of 40 mesh, 60 mesh, and 60 mesh are lower than SNI standard. It is due to higher ash content in the present briquettes.

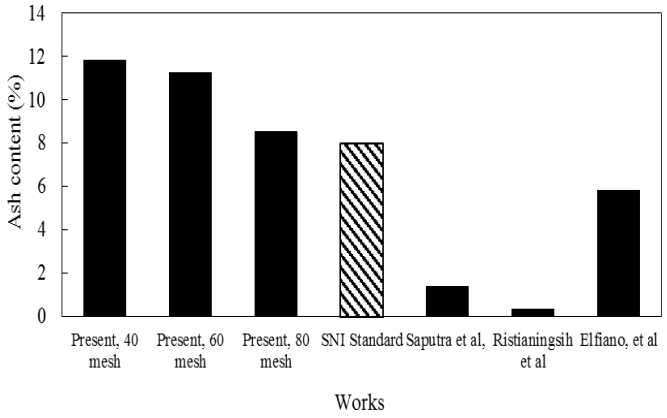

Fig. 5. Ash content.

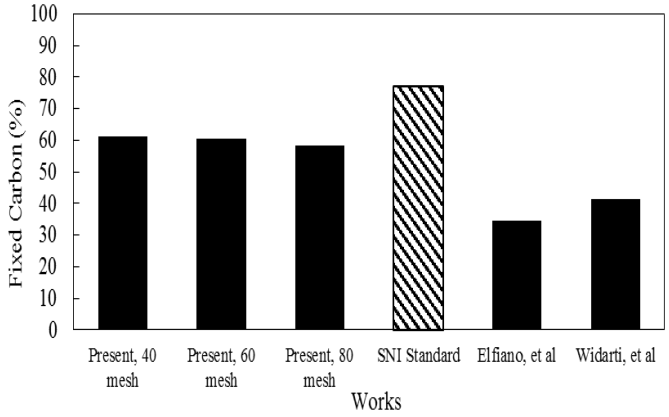

Fig. 6. Fixed carbon.

Meanwhile, heating value of the briquettes meet the SNI Standard. The lowest limit of heating value in SNI standard is 5000 cal/gram, since the heating value are 5370. 4 cal/gram, 5386.97 cal/gram, and 5864 cal/gram for briquettes of 40 mesh, 60 mesh, and 80 mesh, respectively as given in Figure 7.

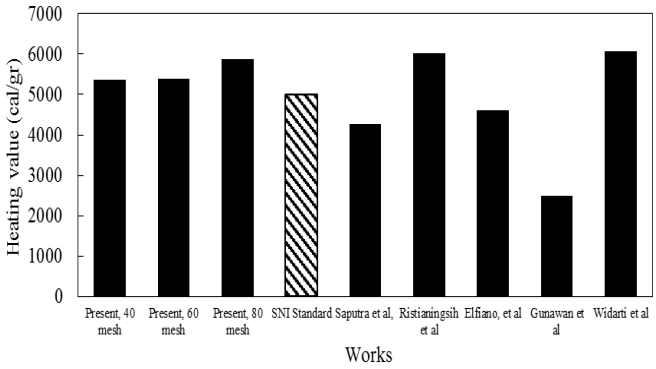

Fig. 7. Heating value.

IV. CONCLUSION

The highest compressive stress is obtained in 60 mesh briquette. Ash content and fixed carbon do not meet the SNI Standard No.1/66235/2000. However, all three briquettes of 40 mesh, 60 mesh, and 80 mesh satisfy the SNI Standard in term of heating value. Thus, it can be concluded that jackfruit biochar briquette with particle size of 80 mesh is the best in present work and meet the SNI standard.

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