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THE CALORIFIC VALUE EXPERIMENT ON COCONUT SHELL, BAMBOO AND MIXED CHARCOAL BRIQUETTE

Phoummixay Siharath[1], Metkham Chanthakhoun[2], Soulyphan Kannitha[3], Chankhachone Sonemanivong[4], Somchay Vilaychaleun[5], Khampasith Thammathevo[6], Phaiphana Siharath[7], Bounmy Phommakone[8], Kalaphath Kounlaxay[9], Pathana Inthaphouthone[10], Youlananh Leuanglith[11]

[1,2,3,4,5,6,7]National University of Laos, Lao PDR; [8]Small Grants Programme, UNDP; [9]Souphanouvong University, Lao PDR; [10,11]Savannakhet University, Lao PDR
phoummixay2011@gmail.com

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Abstract

The utilization of biomass waste to produce energy is an alternative to get rid of wastes and also save the environment, charcoal briquette is a significant energy and potential choice to use in households, restaurants, markets and other cooking activities, because, it is very easy and convenient to use. The objective of this study is to research on calorific value of charcoal briquettes in various different material. Therefore, according to the experiments found that, the calorific value results of coconut shell briquettes (CBr1), bamboo charcoal briquette (CBr2), mixed charcoal briquette (CBr3) are 6,682 MJ/kg ,4,880 MJ/kg and 5,433 MJ/kg, and remaining ashes are 77 g, 100 g and 250 g, respectively. Apparently, the coconut shell briquette is more preferable and less remaining ashes on environment than other materials.

Keywords: Bamboo, Coconut Shell, Calorific Value, Mixed Charcoal

INTRODUCTION

Currently, the energy is a vital and necessary factor for human being (Dalimunthe et al., 2021), nevertheless, clean energy and eco-friendly with environment are the most important to mitigate greenhouse gases emissions (Somchay et al., 2023), less ash, sulfur and nitrogen will be less pollution on environment (Suttibak & Loengbudnark, 2018), as be seen from the waste production of an agricultural activities, plantations harvesting and other wastes are generated the biomass wastes (Suluh, Sampelawang, & Sirande, 2019) , these wastes are become one of potential energy sources to promote and support waste to energy as circular economy (Purwanta, Augustine, Octivia, Fani, & Rifai, 2022) and these waste should be converted into clean and high heat intensity energy (Sabo, Aji, Yaumi, Mustafa, & Research, 2022), based on the research, there are some studies on the calorific values of coconut shell and bamboo and mixed charcoal found that 18.60 MJ/kg, 12.45 MJ/kg and 16.40 MJ/kg(Hasan, Jahiding, Ilmawati, Wati, & Sudiana, 2017; Sadiku, Oluyege, & Sadiku, 2016; Tanko, Ahmadu, Sadiq, & Muazu, 2021), respectively.

METHODS

Biomass materials sources

The study used three types of biomass waste materials to experiment on calorific value such as: coconut shell(a), bamboo(b) and mixed charcoal(c) to make to solid fuels as briquette as indicated in Figure1, coconut shells were brought from market where is the disposal area, bamboos took from the local people that they were cut and mixed charcoal were brought from restaurant.

Coconut shell(a) Bamboo(b) Mixed charcoal(c)

Figure1: Biomass materials used in the experiments

Material composition

The charcoal briquette preparation, the coconut shells and bamboos need to be carbonized by the pyrosis stove, except the mixed charcoal and then all materials must be very fine by grinding machine as indicated in Figure 3 (d) and Figure3 (e) and then they were mixed and ratios as shown in table1.

Table 1: Material composition of charcoal briquette

No	Materials	Coconut shell	Bamboo	Mixed charcoal	Remark
1	Charcoal powder(g)	1,000	1,000	1,000	Very fine
2	Cassava powder(g)	70	50	60	Very fine
3	Water(ml)	800	600	700	Fresh water

Formulas and Equations

The study were used some formulas as below (Yuliah, Kartawidjaja, Suryaningsih, & Ulfi, 2017)

Material density: of samples before and after heat treatment was intended

$$\rho = \frac{m}{V} \quad \text{(i)}$$

Where: ρ : Material density, $(g \cdot cm^{-3})$

M: Mass of dried briquette, (g)

V: Volume of dried briquette, (cm^{-3})

Volume of the cylinder: $V = S * h$ (ii)

Where V: Volume of the cylinder (cm^3)

S: Surface area of the cylinder (cm^2)

h: Height of the cylinder (cm)

Moisture content: it was measured by weighing the charcoal briquettes sample, then drying The dried samples were then cooled in a desiccator and weighed again.

$$\mathbf{MC}=\frac{W1-W0}{W0}\mathbf{x100\%} \quad \text{(iii)}$$

Where: w1: air dry weight(g)

w0: oven dry weight(g)

Low Heating value: the lower heating value (also known as net calorific value) of a fuel is defined as the amount of heat released by combusting a specified quantity(Asmara et al., 2023; Badri, Arief, & Kurniawan, 2022)

$$\mathbf{LHV}=\frac{[\mathbf{Mw}\times\mathbf{Cpw}(\mathbf{Twf}-\mathbf{Twt})+\mathbf{Mwe}\times\mathbf{Hfg}]}{\mathbf{Mf}\times\boldsymbol{\eta}}\times\mathbf{100} \quad \text{(iv)}$$

Where: η : Stove efficiency 13-23.5%

Mw: initial water mass (g)

Mwe: evaporated water mass (g)

Mf: mass (g)

Cpw: specific heat capacity of water (4.186J/g)

Twf: final temperature of water (℃)

Twt: Initial temperature of water (℃)

Hfg: Heat of vaporization (2,260J/g)

LHV: Low Heating value (J/g(dry) or MJ/kg)

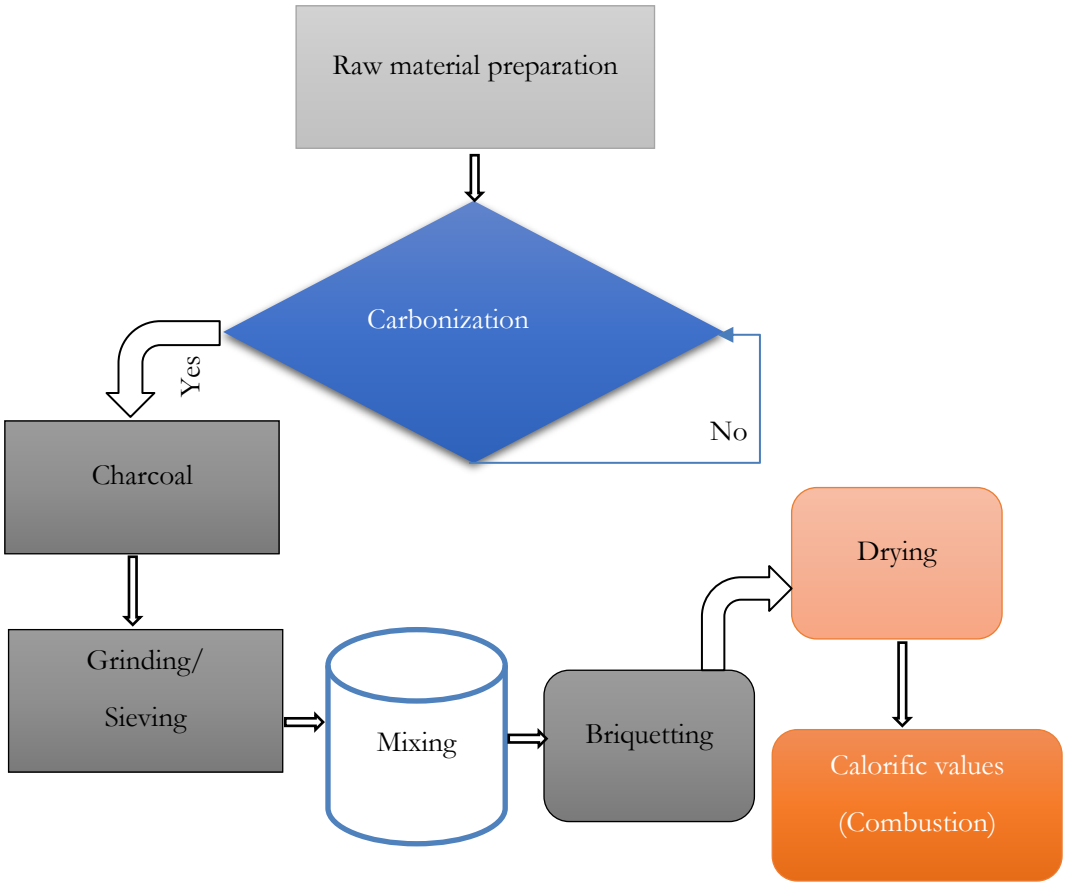

Figure2: Process of charcoal briquette preparation.

Figure3: Biomass charcoal briquette making in laboratory

RESULTS AND DISCUSSION

The coconut shell bamboo and mixed briquettes were conducted and experimented in order to find out the material density, moisture, caloric value and remaining ashes as indicated in table2 and table3 (Jamradloedluk & Wiriyaumpaiwong, 2007; Kongprasert, Wangphanich, & Jutilarptavorn, 2019; Mulindwa, Egesa, Osinde, & Nyanzi, 2021).

Material density

The coconut shell, bamboo and mixed briquettes were calculated to figure out the material density, therefore, the densities are: 2.079 g/cm^3, 2.079 g/cm^3 and 0.849 g/cm^3, respectively. Hence, one piece of the coconut shell, bamboo charcoal briquette with dimension of 7mm(height), 4mm(width) and 1mm (inner diameter) and the mixed charcoal briquette with dimension of 10mm(height), 4mm(width) and 1mm (inner diameter), mass of coconut and bamboo charcoal briquettes are 80 g/piece and mixed charcoal briquette is 100 g/ piece as shown in Figure4.

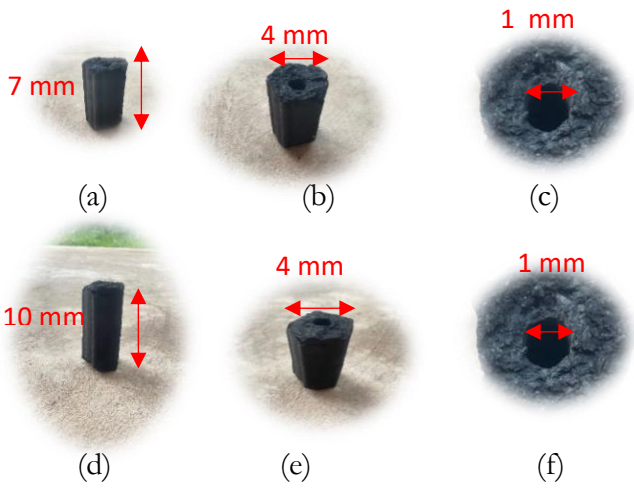

Figure4: Sample of the coconut shell, bamboo (a,b,c) and mixed briquettes(d,e,f)

Moisture Content

The moisture content of the coconut shell, bamboo and mixed briquettes were measured by digital moisture content meter as indicated in Figure 5; therefore, the moisture contents are: 9.7 %,9.8% and 9.0%, respectively as indicated in table2.

(a) (b) (c)

Figure5: Moisture content of the coconut shell, bamboo and mixed briquettes(a,b,c)

Calorific value

The mixed charcoal contains the calorific value of 5,433 MJ/kg, bamboo charcoal briquette contains the calorific value of 4,880 MJ/kg, and the calorific value of coconut shell charcoal briquette is 6,682 MJ/kg as illustrated in table2.

Catching fire and combustion

The mixed, bamboo and coconut shell charcoal briquettes was caught fired after 5 mn, the experiment was used 2,000 ml of water to boil, later on, with saturated boiling time at 17 mn(coconut shell),18 mn(bamboo) and 20 mn(mixed charcoal) of each charcoal briquette, the combustion was kept to burn out and took time: 3h 30 mn, 3h 15 mn and 3 h 00 mn, respectively, as shown in table3.

Remaining ashes

The remaining ashes after burning out of the mixed charcoal briquette was 250 g, bamboo charcoal briquette was 100 g, and coconut shell charcoal briquette was 77 g. and temperature in the stoves were 742 °C, 790 °C and 861.2 °C, respectively.

Figure6. Coconut shell briquette experiment

Table2. Moisture, density, calorific value and temperature

Types	Moisture %	Density (g/cm^3)	Temperature in the stove °C	Water volume, (ml)	Heat value (MJ/kg)	Remaining Ashes(g)
CBr1	9.7	2.079	861.2	2,000	6,682	77
CBr2	9.8	2.079	790	2,000	4,880	100
CBr3	9	0.849	742	2,000	5,433	250

Table3.Experiment results and comparison

Types	Mass g	Time (minutes)				Used time
		Catching fired	Boiling point	Initial collapse	Final collapse	
CBr1	1,000	5	17	65	95	3 h 30 mn
CBr2	1,000	5	18	52	89	3 h 15 mn
CBr3	1,000	5	20	50	85	3 h 00 mn

CONCLUSION

In summary, this study found that mixed charcoal briquette contains a calorific value of 5,433 MJ/kg, bamboo charcoal briquettes contain a calorific value of 4,880 MJ/kg, and the calorific value of coconut shell charcoal is 6,682 MJ/kg, the remaining ashes are 77

g, 100 g and 250 g respectively. Consequently, it can conclude that charcoal briquette that be made by coconut shell obtains more heating energy value than other charcoals and less remaining ashes, it means that, the coconut shell charcoal briquette can save environment due to less ash pollution from combustion.

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REFERENCES

Asmara, S., et al. (2023). Production and Characterization of Bio-Briquettes from the Cassava Stems and Bamboo Charcoal Bonded with Organic Adhesive. *18*(2), 407-413.

Badri, M., et al. (2022). Effects of oil palm trunk (opt), peat and coconut shell charcoal on the characteristics of biomass pellet. *66*(1), 1-7.

Dalimunthe, Y. K., et al. (2021). Making briquettes from waste of coconut shell and peanut shell. 196-209.

Hasan, E. S., et al. (2017). *Proximate and the calorific value analysis of brown coal for high-calorie hybrid briquette application.* Paper presented at the Journal of Physics: Conference Series.

Jamradloedluk, J.Wiriyaumpaiwong, S. (2007). Production and characterization of rice husk based charcoal briquettes. *34*(4), 391-398.

Kongprasert, N., et al. (2019). Charcoal briquettes from Madan wood waste as an alternative energy in Thailand. *30*, 128-135.

Mulindwa, P., et al. (2021). Production of fuel briquettes from bamboo and agricultural residue as an alternative to charcoal. *11*(3), 105-117.

Purwanta, W., et al. (2022). *Study of circular economy potential in the Bantargebang waste-to-energy plant.* Paper presented at the IOP Conference Series: Earth and Environmental Science.

Sabo, M. N., et al. (2022). Preparation and Characterization of Biomass Briquettes Produced from Coconut Shell and Corncobs. *1*(1), 47-54.

Sadiku, N. A., et al. (2016). Analysis of the calorific and fuel value index of bamboo as a source of renewable biomass feedstock for energy generation in Nigeria. *5*(1), 34-49.

Somchay, V., et al. (2023). The Calorific Value Experiment of Refuse Derived Fuel by Utilizing Residual Waste to Produce Energy. *International Journal of Science and Society, 5*(1). doi:10.54783/ijsoc.v5i1.660

Suluh, S., et al. (2019). *An analysis of the use of local bamboo as an alternative energy source.* Paper presented at the IOP Conference Series: Materials Science and Engineering.

Suttibak, S.Loengbudnark, W. (2018). *Production of charcoal briquettes from biomass for community use.* Paper presented at the IOP Conference Series: Materials Science and Engineering.

Tanko, J., et al. (2021). Characterization of rice husk and coconut shell briquette as an alternative solid fuel. 1-12.

Yuliah, Y., et al. (2017). *Fabrication and characterization of rice husk and coconut shell charcoal based bio-briquettes as alternative energy source.* Paper presented at the IOP Conference Series: Earth and Environmental Science.