Advances in Applied Science Research
ISSN: 0976-8610

Open Access Research Article

Comparative Characterization Study of Fuel Pellets from Rice Husk and Wood Chips

Suthajini Thiruketheeswaranathan*

Department of Technology, Eastern University, Colombo, Sri Lanka

ABSTRACT

Increasing energy demand is unavoidable. In this regard, conventional fuels play a major role of total energy requirement than renewable energy. Conventional energy including fossil fuel, coal creates a lot of environmental problems including air pollution, ecological imbalance and environmental degradation. Generation of hilarious amount of carbon dioxide stimulates the global warming and climate change. The over dependence on fossil fuels can be reduced by using renewable and carbon neutral energy sources in a large amount. Therefore, an eco friendly, cheap energy source has been increasing the attention. Aside being the alternative renewable energy, biomass contributed to climate change mitigation, energy security, maintaining carbon neutral value. In an effort to provide an affordable solid fuel pellet from disparate weight proportion of rice husk and wood chips. The wood chips were collected from timber workshop at Trincomalee and rice husks were collected from paddy ield cultivation area. Wood chips fuel pellet and rice husk fuel pellets were produced by compaction in a mold with 10 mm diameter and 20 mm length at 20 MPa pressure. Wood chips and rice husk were mixed using following proportions; Rise husk: Wood chips, 100:0, 50:50, 25:75, 75:25 and 0:100. Physical and combustion characters were investigated. The heating value increase with wood chip proportion of the pellet. The calori ic value of wood pellet was observed as 17.89 MJ/kg. Based on the water boiling test, wood pellets are the effective domestic solid fuel. Moreover, wood pellet has a high heating potential than rice husk pellet and rice husk pellet potential could be improved by the addition of wood chips.

Keywords: Biomass; Fuel pellet; Rice husk; Wood chips; Physical properties

INTRODUCTION

The heat and power energy sector are one of the most dynamic sectors. There are several renewable options including wind, solar, geothermal, hydro thermal and bioenergy for energy production. Installation of equipment and needed infrastructure make these renewable energies economically unbearable. Nevertheless, solid biofuels can be used as substitute for coal in traditional power plant with the same infrastructure. Aside being the alternative renewable energy, biomass contributed to climate change mitigation, energy security, maintaining carbon neutral value. Forestry, agriculture, livestock and greenery sectors are the major sources of biomass production. Since agricultural waste has been used for various heating process, higher moisture content and lower density make them technically unrealistic

Received:	11-July-2022	**Manuscript No:**	AASRFC-22-13850;
Editor assigned:	13-July-2022	**PreQC No:**	AASRFC-22-13850 (PQ);
Reviewed:	27-July-2022	**QC No:**	AASRFC-22-13850;
Revised:	10-October-2022	**Manuscript No:**	AASRFC-22-13850 (R);
Published:	17-October-2022	**DOI:**	10.36648/0976-8610.13.11.101

Corresponding author Suthajini Thiruketheeswaranathan, Department of Technology, Eastern University, Colombo, Sri Lanka; E-mail: asdsuthajini@gmail.com

Citation Thiruketheeswaranathan S (2022) Comparative Characterization Study of Fuel Pellets from Rice Husk and Wood Chips. Adv Appl Sci Res. 13:101.

for direct combustion and handling problems. In addition, non woody type agro industrial wastes have low density, low calorific value and high ash content. These problems could be reduced by biomass pellets. Through that, volumetric calorific value is increased, thus reduces the transportation, collection and storage cost. Biomass pellet is a plant derivate matter, directly used as fuel or converted into the form of fuel by physical process. It is tradable product popular in Europe and East Asian countries. Based on the final objective, numerous strategies are used to standardize: For example, ask content from woody plant removed by bark removal, the biomass for energy, energy density increased by thermal conversion, bulk density increased by the densification process. Through the application of densification process, briquettes, logs, bales, chips and pellets can be produced and they have the significant role among rural people. Durability is the most important characteristic of pellets which depend on feedstock characters, moisture content, pre processing size reduction, pelletization physical conditions such as die pressure, temperature and feedstock mixers. Wood chips and rise husk are one of the most readily available easily collectable biomass in Sri Lanka which uses commonly as a fuel in rice mills parboiling process, furnace and brick kilns. In addition, it is used as a raw material for sodium silicate, briquettes and molecular sieves. There are several studies have been reported on rice husk fuel pellet as a lignocellulose biomass. However, there are many reasons behind with wood chips for not being utilized effectively, which mainly include, lack awareness, insufficient data, lack environmental concern and lack of technology. This present work is aimed to produce the fuel pellets from wood chips and rice husk with various ratio for household purpose and evaluate the physical properties and combustion characteristics [1-4].

MATERIALS AND METHODS

Raw Material Collection

The wood chips were collected from wood workshop at Trincomalee and rice husks were collected from paddy field cultivation area. It was further grinded into a powdered form and sieved and obtained 1000 micrometer particle density [5].

Fuel Pellet Densification

Wood chips fuel pellet and rice husk fuel pellets were produced by compaction in a mold with the dimension of 10 mm diameter and 20 mm length at 20 MPa pressure. Water is used as a binder and lubricant for densification process. The wood chip and rice husk powderwere mixed with little water before loading in the mold. Wood chips and rice husk were mixed using different proportions (Rise husk: Wood chips, 100:0, 50:50, 25:75, 75:25 and 0:100 [6].

Determination of Ash Content

Ash content was determined by following equation. Pellet samples were placed in a pre weighted crucible. The samples were incinerated in a furnace at 760°C. The crucibles were allowed to cool and weighed [7].

$$\text{Ash Content} = \frac{(W5\text{-}W3)}{(W4 - W3)} \cdot 100$$

Where:

W3=Weight of the crucible,

W4=Weight of the crucible+sample before heating

W5=Weight of the crucible+sample after incineration

Determination of Moisture Content

The moisture content was analyzed by the oven drying method. This was conducted at temperature of 105°C for 1 hour [8].

$$\text{Ash Content} = \frac{(W7 - W6) - (W8 - W6)}{(W5\text{-}W3)} * 100$$

Where:

W6=Weight of empty container

W7=Weight of container+sample before drying

W8=Weight of container+sample after drying

Determination of Porosity Index

The porosity was determined based on the amount of water sample was able to absorb. Pellet sample was immersed in water at room temperature for 1 min. The porosity index was calculated as the ratio of the mass of water absorbed to the mass of the sample immersed in the water [9].

$$\text{Porosity index} = \frac{(W10 - W9) * 100}{W9}$$

Where:

W9=Mass of sample

W10=Mass of sample immersed in water

(W10–W9)=Mass of water absorbed

Determination of Calorific Value

The Net Calorific Values (NCV) was determined by using below equation.

NCV=18.7 (1.0-AC-MC)-(2.5 MC)

Where:

NCV= Net (lower) Calorific Value

AC=Ash Content

MC=Moisture Content

Determination of Burning Rate

Burning rate is the ratio of the mass of the fuel burnt to the total time taken. The combustion was initiated by the addition of a little kerosene and igniting with matches. The temperature of the burning samples was taken by means of thermocouple at every two minute intervals using a stop watch until it was completely burnt [10].

$$\text{Burning rate} = \frac{\text{Mass of fuel burnt}}{\text{Time taken}}$$

Elemental Analysis

Total organic carbon was calculated by following equation using a factor of 1.724. Sample was calculated at 400 degree Celsius for 14 hours [11].

TOC=(((W1-W2*100/W1/1.724

Where,

TOC=Total organic carbon

W1=Mass of dry materials

W2=Mass of incinerated material

Water Boiling Test

Cooking efficiency was compared by measures the time taken for each pellet to boil equal volume of water under similar condition [12].

RESULTS AND DISCUSSION

Fuel pellets prepared from rice husk and wood particles with different weight ration were uniform in structure (shape and diameter). All the pellets have a moisture content less than 3% and total organic carbon fall between (15-17.5%), which synchronize with the results reported in the literature. The solid fuel with high carbon content has a good potential for thermal energy conversion process. The moisture content is increased when the wood portion is increased. Ash level is comparatively high when the pellet has high rice husk portion. High ash content generally a constrain for the thermal conversion application because of the need of ash removal, slagging equipment corrosion and deposit formation in furnace. Therefore, using ash mitigating additives with rice husk pellet is an alternative way to overcome this issue. Significant calorific value was observed and it was high when the wood particles take full portion in the pellet. As the moisture content value increases, calorific value also increases. Reported the contrast result of rice husk fuel pellet production, where heating value increases with decreasing moisture content (**Table 1**) [13].

Table 1: Physical properties of fuel pellet.

Properties	Rice husk: Wood particle (%)				
	100:00:00	75:25:00	50:50:00	25:75	0.069444
Moisture content (%)	1.32	1.74	2.32	2.6	2.78
Ash content (%)	19.8	13.62	9.24	3.12	1.36
Calorific value (MJ/Kg)	14.71	15.78	16.48	17.56	17.89
Total organic carbon (%)	15.69	16.12	16.4	16.71	17.08
Porosity index (%)	22.5	20.6	16.1	12.4	10.3

Porosity index determine the quality of fuel in terms of water penetration resistance. Porosity and water penetration resistance have negative relationship. In this study, fuel pellet only made by rice husk showed the higher porosity index, indicated lower water penetration resistance resulting low combustion efficiency 2012 reported the higher water resistance percentage and concluded the good potential for handling and transportation. On other hand, porosity index would have shown widely disparate value if the compaction pressure would have been varied. Water boiling test explains the suitability of pellets for domestic usage 100 g of each fuel pellet was used to boil 750 ml of water and recorded the time duration taken to reach 100°C. Pellet only has wood portion took less time recorded as 6 minutes to reach 100°C (**Figure 1**).

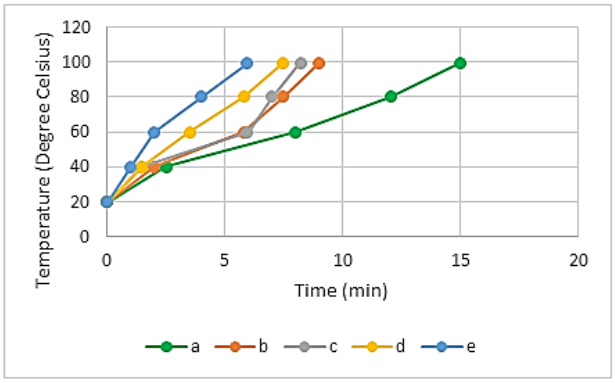

Figure 1: Water boiling test, (R: W), a-100:0, b-75:25, c-50:50, d-25:75, e-0:100.

From the burning test data, wood portion pellet reaches 100°C in 6 minutes and peak temperature in 15 minutes and keeps the temperature above 100°C till first 40 minutes. This means, the useful heat energy could be sustained for 40 minutes. In contrast, rice fuel pellet reaches 100°C in 15 minutes and drops in 40 minutes and sustains only 15 minutes. Therefore, wood pellet has a high heating potential than rice husk pellet and rice husk pellet potential could be improved by the addition of wood chips portion (**Figure 2**).

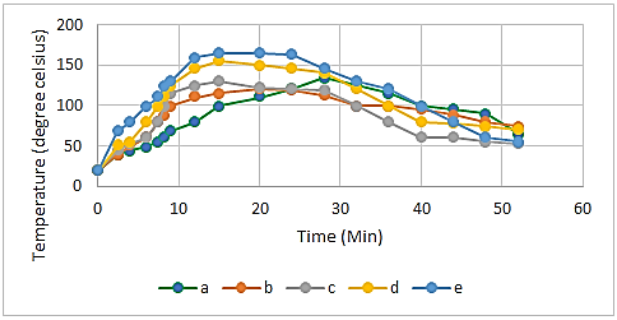

Figure 2: Temperature and time on burning 100 g of fuel pellet (R: W), a-100:0, b-75:25, c-50:50, d-25:75, e-0:100.

CONCLUSION

The study was motivated by the large quantity of rice husk and wood chips waste seen in the paddy field and timber workshop. Solid fuel pellet was formed by different weight ration of rice husk and wood chips. Physical and combustion characters were investigated. The heating value is increased with the incensement of wood portion in the pellet. The calorific value of wood pellet was observed as 17.89 MJ/kg. Based on the water boiling test, wood pellets are the effective domestic solid fuel. Moreover, wood pellet has a high heating potential than rice husk pellet and rice husk pellet potential could be improved by the addition of wood chips.

REFERENCES

1. Bajo PO, Acda MN (2017) Fuel pellets from a mixture of rice husk and wood particles. Bioresour. 12(3): 6618-6628.
2. Djomdi, Fadimatou H, Hamadou B, Nguela LJM, Christophe G, et al. (2021) Improvement of thermo physical quality of biomass pellets produced from rice husks. Energy Convers Manag. 12:100132.
3. Ilari A, Pedretti EF, de Francesco C, Duca D (2021) Pellet production from residual biomass of greenery maintenance in a small scale company to improve sustainability. Resour. 10(12):1-12.
4. James AK, Thring RW, Helle S, Ghuman HS (2012) Ash management review applications of biomass bottom ash. Energies. 5(10):3856-3873.
5. Japhet JA, Tokan A, Muhammad MH (2015) Production and characterization of rice husk pellet. Am J Eng Res. 4(12):112–119.
6. Muazu RI, Stegemann JA (2015) Effects of operating variables on durability of fuel briquettes from rice husks and corn cobs. Fuel Process. Technol. 133:137–145.
7. Pliego-Arreaga R, Regalado C, Amaro-Reyes A, García-Almendarez BE (2013) Valorization of rice husks and bean straws through fuel pellets production: an experimental and modelling approach. Revista Mexicana de Ingeniería Química. 12(3): 505–511.
8. Radacovska L, Holubcik M, Nosek R, Jandacka J (2017) Influence of Bark Content on Ash Melting Temperature. Procedia Eng. 192(1):759-764.
9. Rios-Badran IM, Luzardo-Ocampo I, Garcia-Trejo JF, Santos-Cruz J, Gutierrez-Antonio C (2020) Production and characterization of fuel pellets from rice husk and wheat straw. Renew Energy. 145(1):500–507.
10. Sokhansanj S, Mani S, Bi X, Zaini P, Tabil L (2013). Binder less Pelletization of Biomass. The society for Engineering and Agricultural, food, biological systems. Tampa, Florida.
11. Simonic M, Goricanec D, Urbancl D (2020) Impact of torrefaction on biomass properties depending on temperature and operation time. Sci Total Environ. 740(1):140086.
12. Tokan A, Muhammad MH, Japhet JA, Kyauta EE (2016) Comparative Analysis of the Effectiveness of Rice Husk Pellets and Charcoal AsFuel For Domestic Purpose. IOSR J Mech Civ Eng. 13(05):21–27
13. Widjaya ER, Triwahyudi S, Harsono R (2019) Rice Husk Fuel Pellet: Characterization on Physical and Thermogravimetric (TGA) Combustion Properties. IOP Confer: Earth Environ Sci. 355(1):1–10.