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Garden Waste To Fuel Briquettes

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Abstract – *The current study focused at manufacturing energy-fuel briquettes from garden waste. After being subjected to open sun drying green garden waste yielded approximately 10 to 20 % dry matter. The dried mass was then pulverized and combined with sawdust in various ratios, and subsequently molded into briquettes without the addition of any external binding agents. The resulting briquettes exhibited good quality, with bulk densities 10 to 15 times higher than that of the material in its dry loose form. The calorific values of the four different types of briquettes produced from gardenwasteandsawdustrangedfrom15.2 to 16.3 MJ/kg of dry matter.*

Keywords- ***Garden waste (GW), Sawdust (SD), briquettes, volatile matter, Calorific value***

I- INTRODUCTION

Energy and fuels are crucial for civilization and human development. The challenges associated with fossil fuel use such as demand-supply gaps, rising prices, global warming, and environmental concerns have prompted the exploration of alternative energy sources like solar, wind, ocean, and biomass [1]. Biomass energy, in particular, is rapidly gaining attention due to the abundant availability of agricultural, garden, and forest residues.

In India, biomass waste is generated from various sources, including gardens, agriculture, municipal areas, forests, and food processing industries. Municipal solid waste landfills and open dumping sites often serve as major disposal locations for garden waste, leading to significant environmental pollution and health hazards due to improper waste management.

Numerous studies have investigated the conversion of solid wastes, including banana peels, garden waste (such as beans and carrots), aquatic weeds like water hyacinth, sugar mill press mud, and fruit and vegetable processing residues [2]. Accumulation or decomposition of garden waste can result in serious environmental issues, making the drying and briquetting of these materials a promising solution to mitigate pollution.

Briquetting technology offers several advantages, including improved storage and transportation, and serves as an effective method for waste-to-energy conversion. This process involves densifying materials to enhance their calorific value and handling characteristics. In this study, various garden wastes—such as Neem leaves, grass, mango leaves, hibiscus leaves, and Ficus religiosa leaves—were utilized to produce briquettes.

The focus of this study is the thermochemical conversion of garden waste into environmentally friendly and cost-effective biofuel. High-quality briquettes were produced from dried garden waste without the need for external binders. These briquettes can serve as fuel for domestic cook stoves, boilers, and gasifiers, offering a sustainable solution for energy needs while addressing waste management challenges.

II-METHODOLOGY

Preparation method of composite briquette

Raw green garden wastes, including Neem leaves, grass, mango leaves, hibiscus leaves, and Ficus religiosa leaves, were collected from the college garden, while sawdust was purchased. The preparation method for creating composite briquettes from these garden wastes and sawdust is illustrated in Figure 1. The feedstock materials were weighed according to the required proportions and mixed with sawdust, which acts as a binding agent.

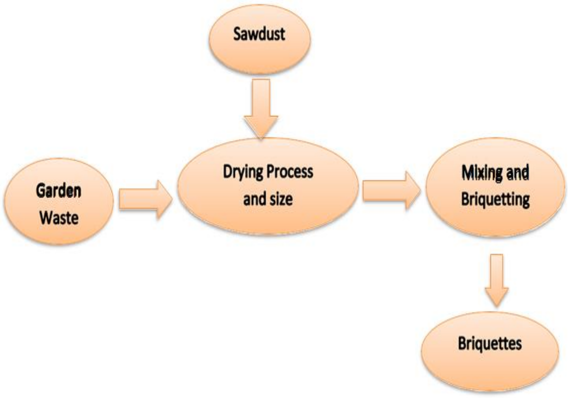

Fig. 1: Preparation Method of Composite Briquette from Garden Wastes and Sawdust

Data Analysis

Moisture Content: The moisture content was calculated based on the difference between the dry and wet weights of the briquette using the formula [3] moisture content (%) = (A-B)/A*100 whereA is 2g (weight of pulverized briquette sample) and B is the weight obtained after oven drying at 110℃-120℃ for 2hrs.

B. Volatile Matter Content (VMC): To calculate the percentage of volatile matter content, a 2g sample of the briquette was pulverized, oven-dried, and then subjected to a temperature of 550°C for 10 minutes in a furnace [4]. The weight was recorded, and the VMC was calculated using the formula: VMC (%) = (B-C) /B*100 where, B is the oven driedweight and C is the weight of oven dried sample after 10 min in the heat treatment furnaceat 550℃.

C. Calorific Value: The higher heating value (HHV) of each briquette sample was estimated using a bomb calorimeter.

III – RESULT AND DISCUSSION

The proximate analysis of the fuel briquettes was conducted to determine moisture content (MC), volatile matter content (VMC), and calorific value, with the results presented in Table1.

Table 1. The proximate analysis of the fuel briquettes

Sr. No.	Material	Moisture content (MC) %	Volatile matter Content (VMC) %	Calorific value (MJ/KG)
1	Garden waste + saw Dust(100:0)	4.2	73.22	15.2
2	Garden waste + SawDust (75:25)	4.5	74.8	15.8
3	Garden waste + saw Dust(50:50)	4.8	79.2	16.2
4	Garden waste + saw Dust(25:75)	4.9	83.1	16.3

The moisture content of the briquettes was calculated based on the difference between the dry and wet weights. It ranged from 4.2% to 4.9%, as shown in Table 1, for composition ratios from 100:0 (garden waste to sawdust) to 25:75. The lowest moisture content (4.2%) was observed for the 100:0 ratio, while the highest (4.9%) occurred at the 25:75 ratio. This trend indicates that as the percentage of sawdust increases, the moisture content in the briquettes also rises, likely due to the hydrophilic nature of sawdust, which may enhance both the moisture content and porosity of the briquettes.

Compared to briquettes made from other biomass materials—such as water hyacinth and empty fruit bunch (9.3%) [5], palm oil mill sludge (10.42%) [6], and rice husk and starch (7.9%)[7] and sawdust charcoal briquette (5.7%)[8]—the produced briquettes exhibited lower moisture content. Maintaining a low moisture content is crucial, as high moisture levels can adversely affect combustion characteristics, requiring more energy for drying.

Biomass typically has high volatile matter content, ranging from 70% to 86%, making it a highly reactive fuel compared to low-grade fuels like coal, which often release significant smoke and toxic gases due to lower volatile content. The volatile matter content in the garden waste-sawdust briquettes was between 73.22% and 83.1%, indicating good ignition properties and flame length. The pure garden waste briquette had the least volatile matter content (73.22%), while the highest (83.1%) was observed in the 25:75 GW-SD briquette. This suggests that increasing sawdust content raises the volatile matter percentage.

The volatile matter content of the GW-SD briquettes surpassed that of common biomass briquettes, such as rice husk and starch (34.38%) and rice straw with sugar cane leaves (74.67%), and was comparable to firewood (75–80%). It was also greater than conventional fuel sources like lignite (43.5%), bituminous coal (25.95%), and coal (20–35%). The volatile matter content of GW SD briquette was higher than common biomass briquettes such as rice husk and starch (34.38%) [7], rice straw with sugarcane leaves (74.67%) [9] and sawdust charcoal briquette (71%) [8].

The higher heating value (HHV) of each briquette sample was estimated using a bomb calorimeter. The calorific values for the different ratios of GW-SD briquettes were 15.2 MJ/kg (100:0), 15.8 MJ/kg (75:25), 16.2 MJ/kg (50:50), and 16.3 MJ/kg (25:75). This indicates that the calorific value of the composite fuel briquettes increased as the mass percentage of sawdust increased.

IV - CONCLUSION

The combustion properties, particularly the calorific value, of the garden waste (GW) briquettes were significantly enhanced through the incorporation of sawdust. The highest heating value was observed in the composite briquette with a ratio of 25:75 (GW to sawdust). Additionally, the volatile matter content, which plays a crucial role in the combustion of densified solid fuels, reached a maximum of 83.1% for this same composition, outperforming briquettes made solely from garden waste.

The briquetting technique effectively converts garden waste into a valuable energy source, presenting a viable solution for waste management by transforming potential waste into usable fuel rather than allowing it to accumulate in dumpsites. This approach not only enhances energy recovery but also helps address environmental pollution issues significantly.

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