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Biomass: Turning Agricultural Waste to Green Power

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Abstract: People have an essential need of energy to cook. Presently, in developing countries, this requirement is met by directly burning wood derived products in fires and stoves. Many of the developing countries produce huge quantities of agro residues but they are used inefficiently causing extensive pollution to the environment. In rural areas, areca leaves are usually cut and dumped at the bottom of the areca trees or used as temporary roofing material. In order to explore the significance of areca leaf as an alternative for fuel, in this experimental work, areca sheet briquettes were prepared using size of 1700µ and above with sawdust as additives and wheat flour as binder. The various parameters of areca sheet briquettes were established using IS1448-7 for finding the GCV as well as proximate and ultimate analysis using IS 1350. According to the test results of the analysis, briquettes of areca sheet of 1700µ and above with sawdust as additive exhibited gross calorific value of 14.82MJ/kg. The moisture content is 5.37% and the percentage content of ash, volatile matter, and fixed carbon was 13.97%, 78.88%, and 2.48%, respectively. The percentage content of hydrogen, nitrogen, sulphur, and oxygen from the ultimate analysis are 6.67%, 0.52%, 0.60%, and 18.48%, respectively. The results thus obtained were then compared with the commercially available saw dust briquettes and the comparison results were quiet satisfactory. Hence, it can be concluded that briquettes produced from areca sheets of 1700µ and above, with sawdust as additive would make a good biomass briquette.

1. Introduction

In today’s world, energy is necessary for social and economic growth, and to improve the way people live their life, i.e., have good quality lifestyle [1]. However, a contented human life is paid by excessive energy usage in all its forms [2]. For the past four decades, a lot of research activities have been focused on finding an alternative fuel, which would replace the existing fossil fuel resources so as to meet with the ever-growing energy demand and to turn away from the addiction of crude oil [3]. Despite rapid growth of commercial energy, biomass remains the standard energy source in rural and traditional sectors and contributes 33% of India's energy requirements. Therefore, more importance is given to the renewable energy than non-renewable energy. Energy from biomass has emerged as a potential candidate or alternative to the above problem. Biomass is the energy source derived from organic matter such as plant materials, wood from the forest, agricultural process, industrial, and human or animal waste [4].

Biomass in its normal form is extremely difficult to store, transport, handle, and exploit because of factors that can comprise of high moisture content, low bulk density, and unequal shape and sizes. These difficulties can be overcome by means of densification. Densification or briquetting is the process of compacting biomass residue into a uniform solid fuel called briquettes. It has higher density and energy content and less moisture compared to its raw materials. Briquetting of biomass can be done using various techniques, either with or without binder addition [5]. Examples of biomass studies are sawdust [6], waste paper and coconut mixture [7], cotton stalk [8], spear grass [9], cashew nut shell [10], corn cobs and rice husks [11], jatropha seed husks [12], coconut shell, cocoa shell, newspapers [13],and many others.

The main areca nut growing states are Karnataka and Kerala which account for 70 per cent of both area and production in the country. Assam, West Bengal, Meghalaya, Tamil Nadu, Tripura, and Mizoram are other minor areca nut producing states in India. In Karnataka, Chikmagalur district stands first in both area (19.91%) and production (17.38%), followed by Shivamogga and Davanagere district. The top 7 districts, viz., Chikmagalur, Shivamogga, Davangere, Dakshina Kannada, Tumkur, Chitradurga, and Uttar Kannada occupy 89 per cent of area under areca-nut and contribute around 91 per cent of areca produced in the state [14].

There is no set procedure for making biomass briquettes to be used as biomass energy sources. Instead the briquettes are made from available biomass and because of this they change from place to place. This allows for biomass energy generation that does not require much transportation of purchased materials from a distant location [14]. Briquettes made from biomass can be utilized for domestic purposes (cooking, heating, and barbequing) and industrial purposes (agro-industries and food processing) in both rural and urban areas [15]. The main purpose of using briquettes is mainly to find a suitable replacement for coal, which is widely used in industrial process heat applications (steam generation, melting metals, space heating, brick kilns, and tea curing) and power generation through gasification of biomass briquettes. As biomass briquettes are derived from renewable resources, these briquettes have better qualities as well as ecological benefits in contrast to conventional fuels [16].

In order to explore the significance of areca sheet as an alternative for fuel, in this experimental work, areca sheet briquettes were prepared using size of 1700μ and above with sawdust as additives and wheat flour as binder have been prepared.

2. Materials and Methods

In this experimental work, areca sheet as shown in Figure 1 has been employed as a prime raw material for biomass briquetting. In order to prepare the briquettes, areca sheets were collected from nearby farm, cut into small pieces in its green state, before drying them in the sun, the reason being cutting after drying poses some difficulty as, in the period of drying, areca sheets looses much of its moisture and hardens making it difficult to cut. Following the drying process, the sheets were further processed by milling in a hammer mill. During milling, it was converted into powdered form of varying sizes. The milled areca leaves were sieved using ASTM E11 [17] and particle sizes of 1700μ and above were selected for the purpose of briquetting as shown in Figure 2.

Then the required size areca sheet was mixed with water along with sawdust which acted as an additives and wheat flour as binder. The prime objective of these additive agents is to help in enhancing the properties of the formed briquettes. Without employing any binders, the areca sheet briquettes might lose its compactness, and create problems in handling. Here, the raw materials along with additives and binder have been employed in 2:1:1 ratio, i.e., 100gm of biomass raw material, 50gm of additive, and 50gm of binder. The prepared mixture was drenched in water and kept aside in a container for 3 days so as to soften the whole amalgamation.

Figure 2.1: Areca sheet

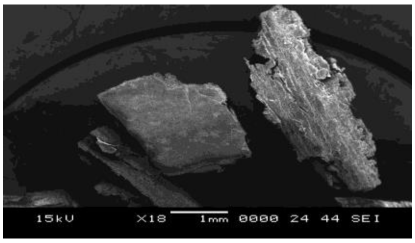

Figure 2.2: 1700μ and above

A piston type briquetting machine was employed for briquette formation. For this, the biomass mixture which had been soaked in water was taken out and filled into the mould of dimension 12x8x10cm, and compressed by a 2ton hydraulic jack at a pressure of 1.28MPa. After the required pressure was applied, the briquettes were ejected from the mould after observing a dwell time of 30 seconds [18]. The briquettes so obtained from the mould were sun dried for a period of 19 days [19].

The briquettes were weighed in their wet and dry conditions and their weights are tabulated in Table 1.

Table1: Wet and Dry Weight of the Areca Sheet Briquette

Sl. No.	Type of briquette	Wet weight (gm)	Dry weight (gm)
Additive used: Sawdust			
i	Areca sheet of 1700μ and above	382.12	212.23

3. Results and Discussion

Employing IS1448-7 [20] for calorific analysis, the gross calorific value of areca sheet briquettes was obtained. Similarly, proximate analysis was done as per IS1350-1 [21] that estimates the moisture content, ash, volatile matter, and fixed carbon. Ultimate analysis was done for estimating the percentage of sulphur, oxygen, nitrogen, and hydrogen in the prepared briquettes.

The following tables depict the physical and fuel characteristics of the briquettes prepared using areca sheet as raw biomass material with sawdust as additive and wheat flour as binder agent.

Table 2: Analysis Result for Areca Sheet Briquettes made from Sizes 1700μ and above, with Sawdust as Additive and Wheat Flour as Binder

Additives	Proximate Analysis				Ultimate Analysis				
	Moisture content %	Ash content %	Volatile matter %	Fixed carbon %	Hydrogen %	Nitrogen %	Sulphur %	Oxygen %	GCV MJ/kg
Areca Sheet	5.37	13.97	78.88	2.48	6.67	0.52	0.60	18.48	14.82

But, for a practical scenario and future objectives, in this work the efficiency of the proposed areca sheet briquette is compared with the commercially available saw dust briquette. Hence, the results of the Table 1, are compared with the commercially available sawdust briquettes to assess the various parameters and to conclude whether the biomass briquette obtained through this experimental work can replace the existing commercial sawdust briquette.

Table 3: Analysis Result for Commercially Available Sawdust Briquette

Sl. No.	Parameters	Sawdust briquette
1	Gross calorific value, MJ/kg	18.63
	Proximate analysis	
1	Moisture content, %	9.44
2	Ash content, %	3.36
3	Volatile matter, %	83.43
4	Fixed carbon, %	3.37
	Ultimate analysis	
1	Hydrogen, %	7.03
2	Nitrogen, %	0.43
3	Sulphur, %	0.58
4	Oxygen, %	21.77

The results obtained from Tables 1 and 2 are plotted as graphs below:

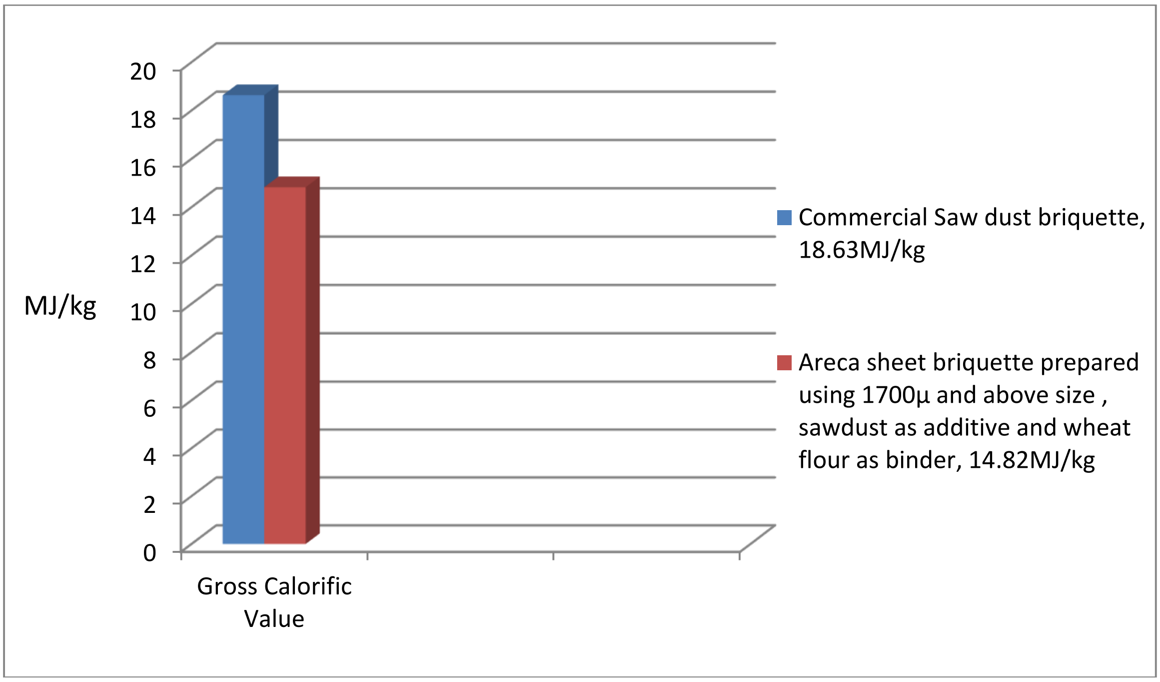

Figure 3.1: Gross Calorific Value of Commercial Sawdust Briquette and Areca sheet briquette prepared using 1700µ and above size

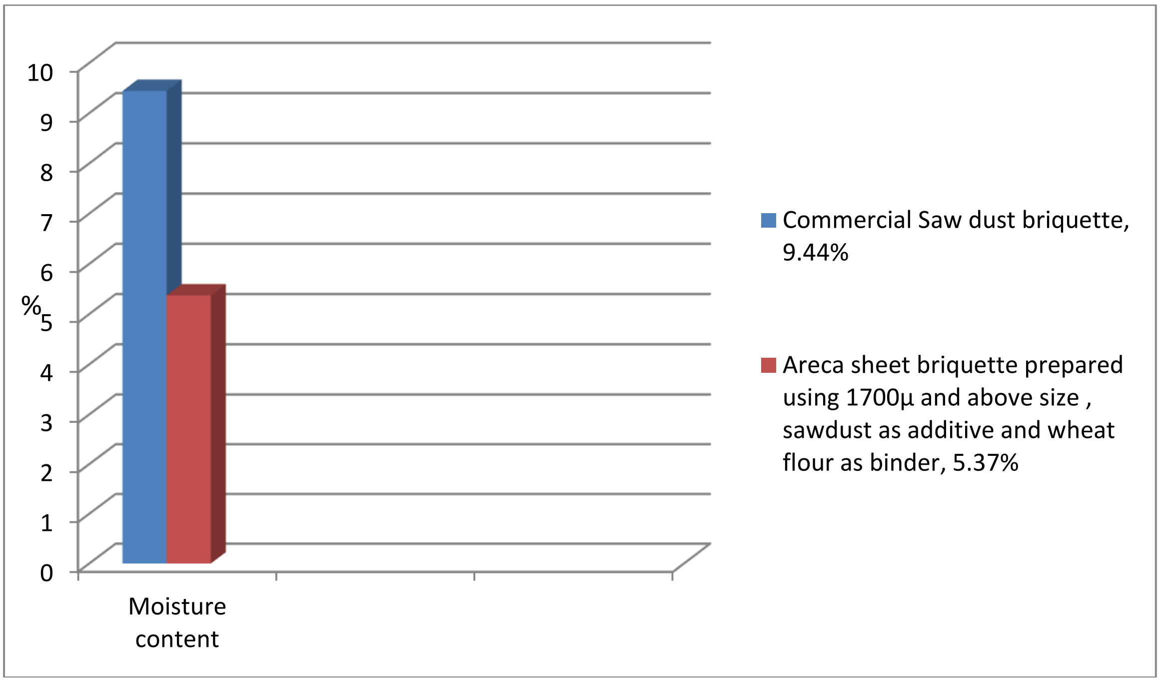

Figure 3.2: Percentage of Moisture Content of Commercial Sawdust Briquette and Areca sheet briquette prepared using 1700µ and above size

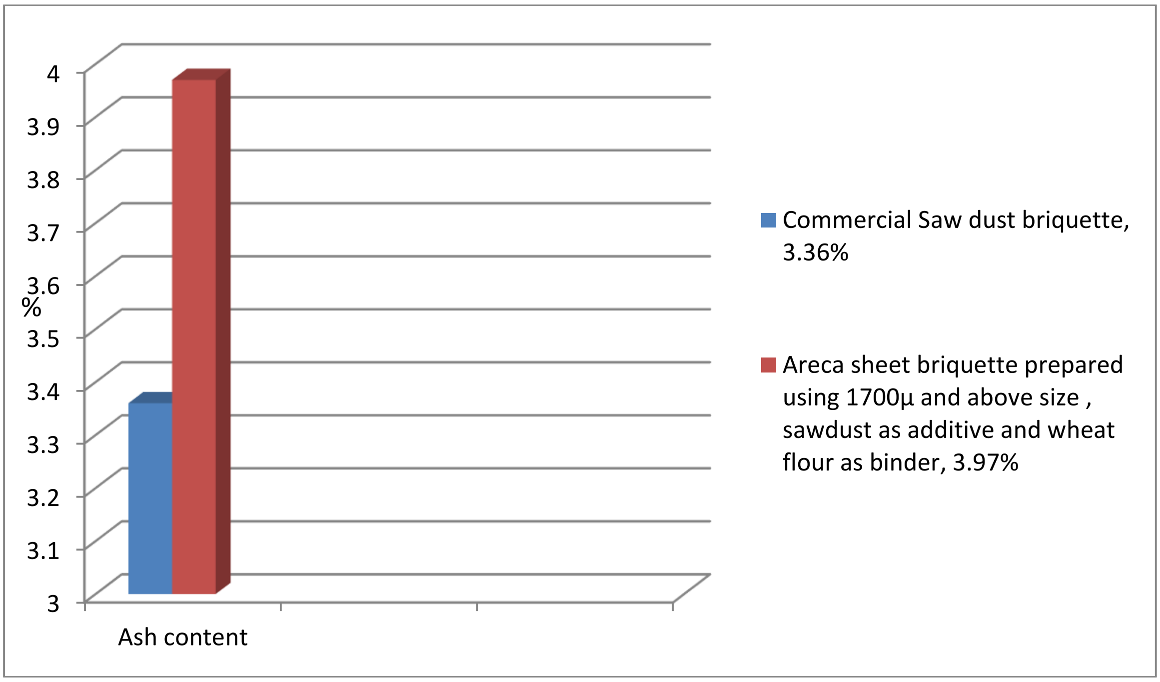

Figure 3.3: Percentage of Ash Content of Commercial Sawdust Briquette and Areca sheet briquette prepared using 1700µ and above size

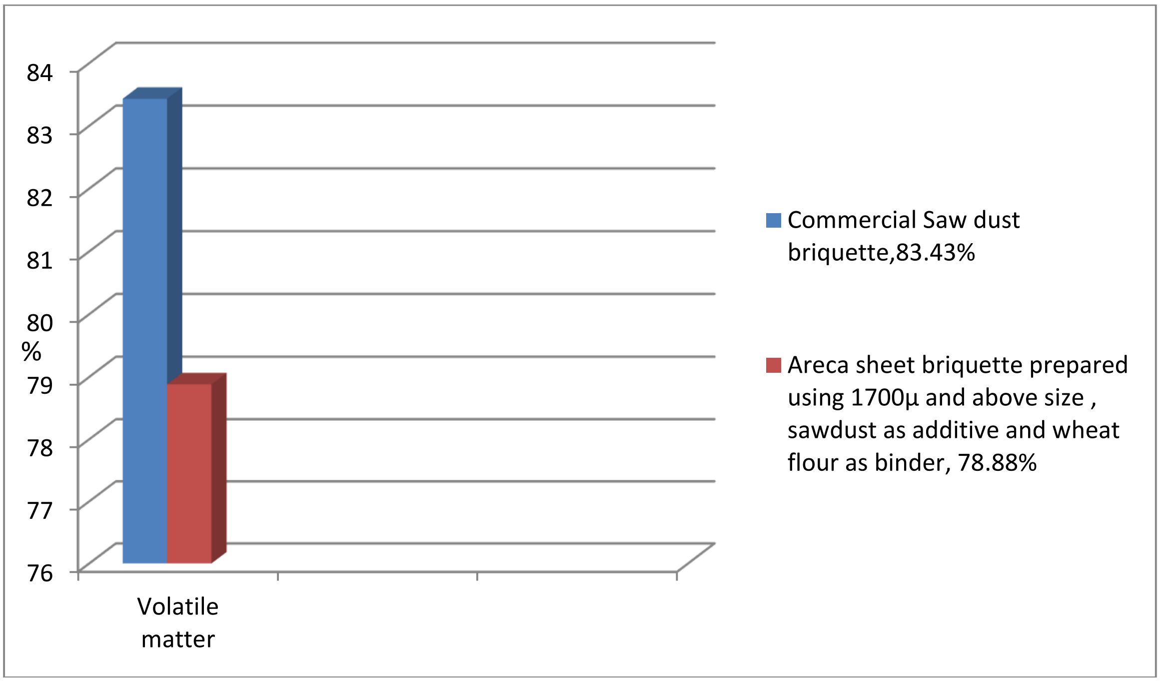

Figure 3.4: Percentage of Volatile Matter of Commercial Sawdust Briquette and Areca sheet briquette prepared using 1700µ and above size

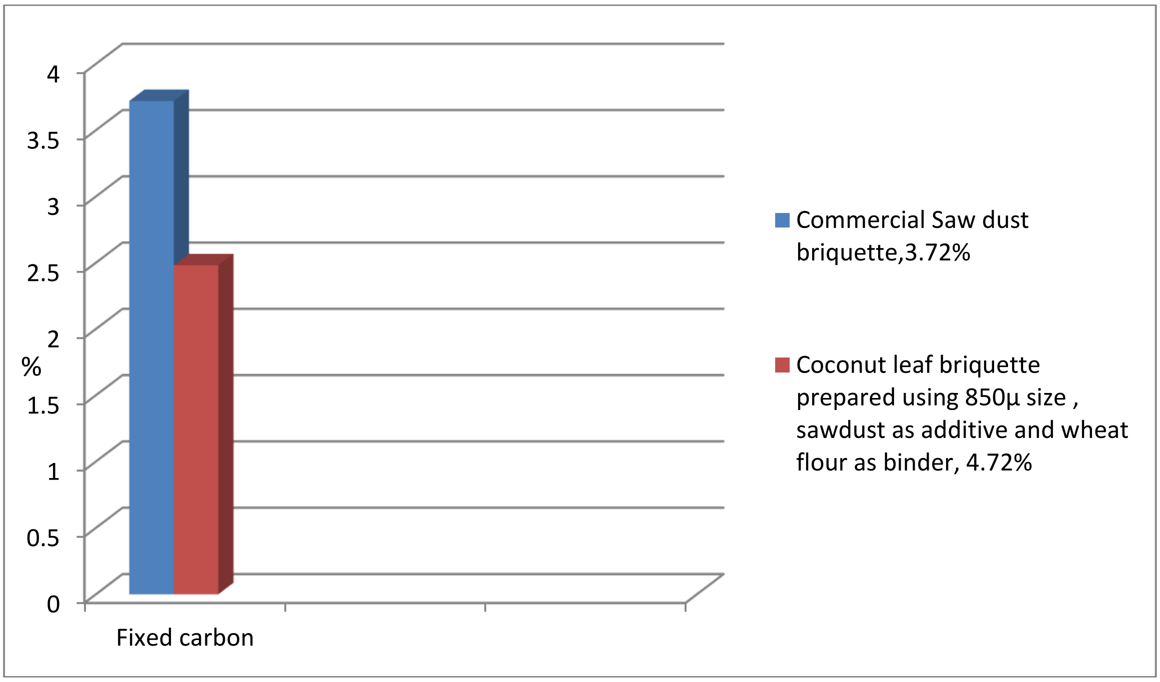

Figure 3.5: Percentage of Fixed Carbon of Commercial Sawdust Briquette and Areca sheet briquette prepared using 1700µ and above size

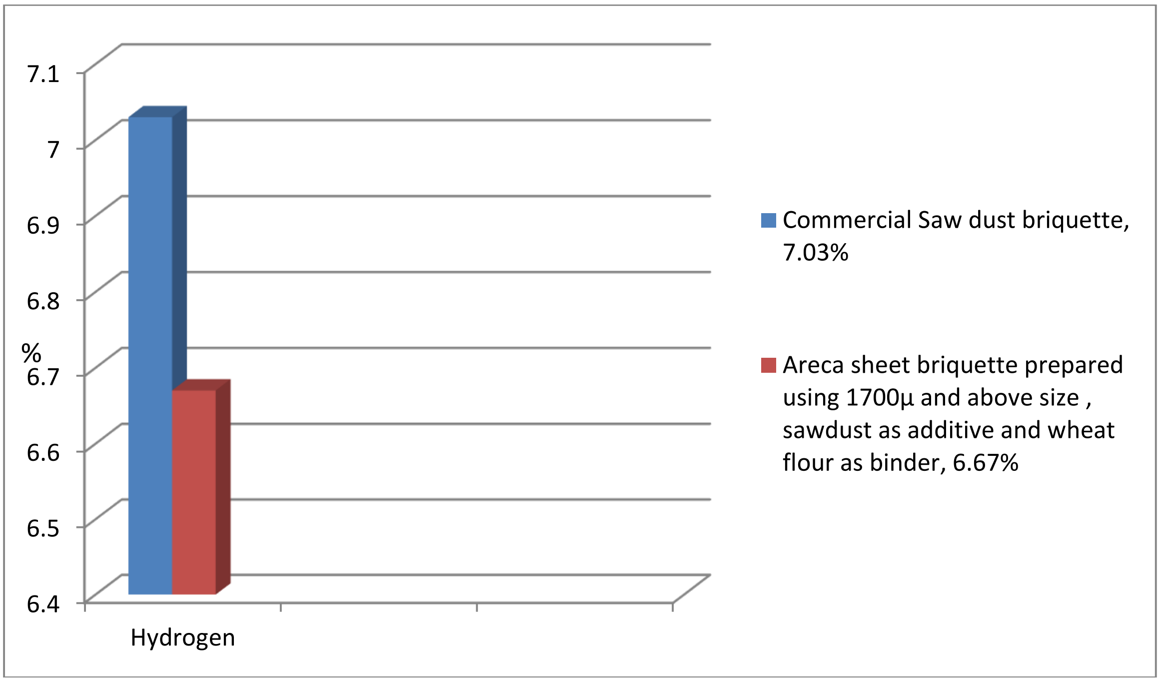

Figure 3.6: Percentage of Hydrogen of Commercial Sawdust Briquette and Areca sheet briquette prepared using 1700µ and above size

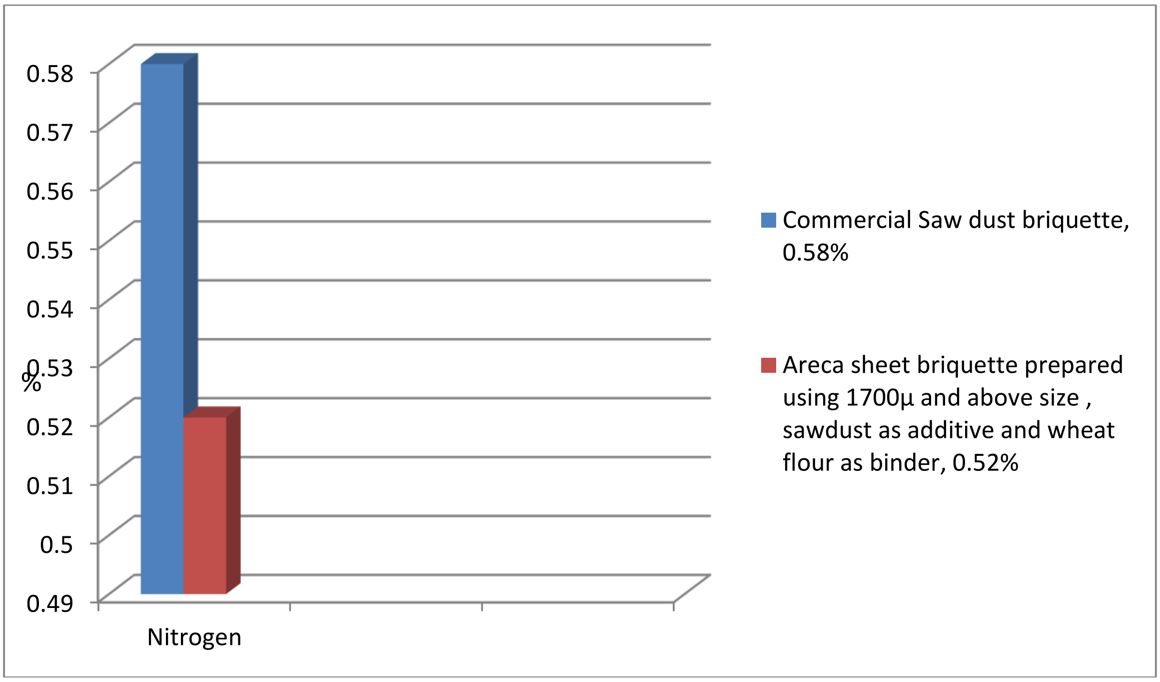

Figure 3.7: Percentage of Nitrogen of Commercial Sawdust Briquette and Areca sheet briquette prepared using 1700µ and above size

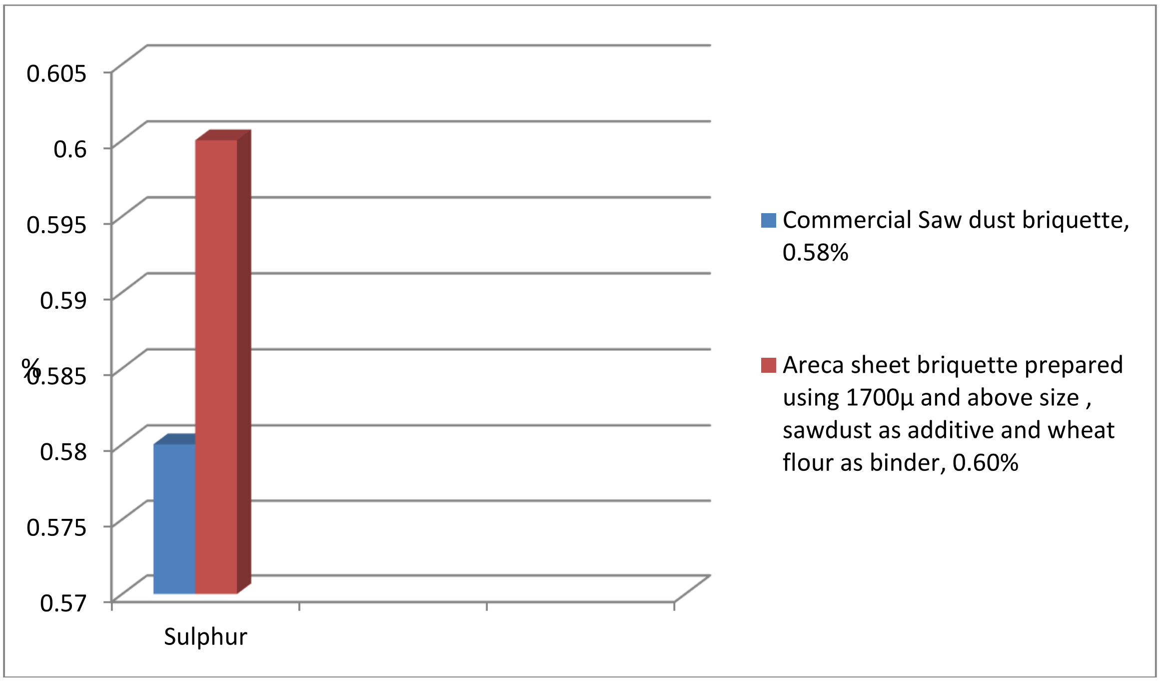

Figure 3.8: Percentage of Sulphur of Commercial Sawdust Briquette and Areca sheet briquette prepared using 1700µ and above size

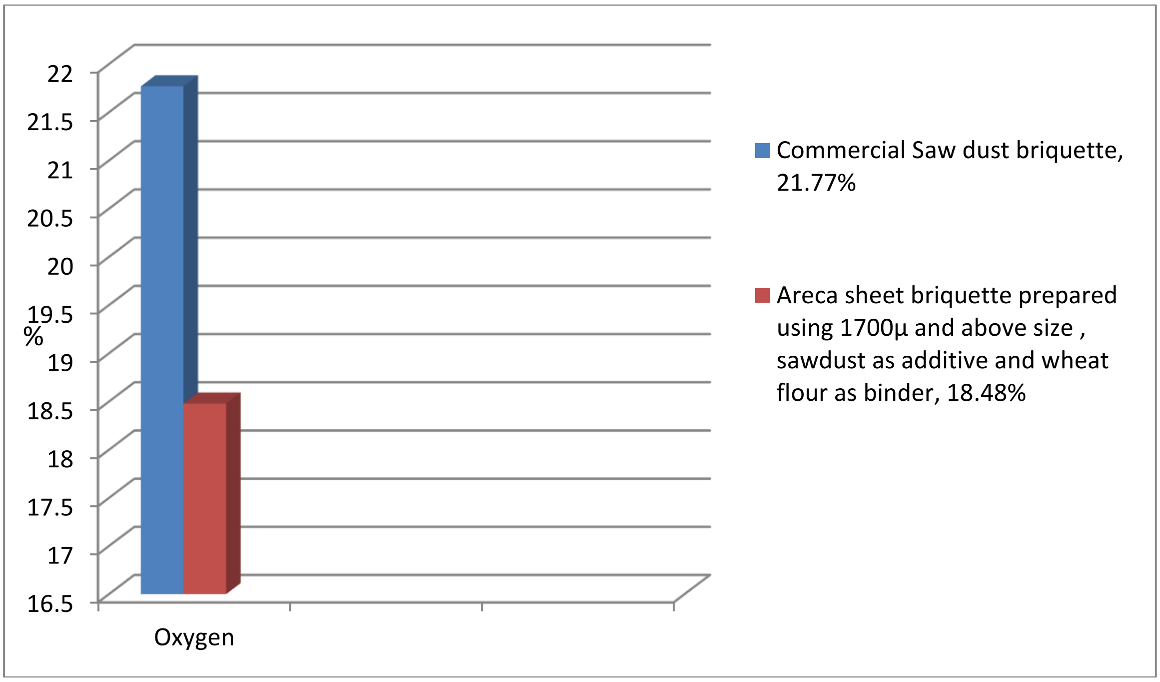

Figure 3.9: Percentage of Oxygen of Commercial Sawdust Briquette and Areca sheet briquette prepared using 1700µ and above size

The results from the graph depict that briquettes made from areca sheets of 1700µ and above with sawdust as additive has a gross calorific value of 14.82MJ/kg, which is good enough to produce the required energy and it can be stated that this energy is sufficient for producing the required heat for domestic and industrial purposes.

The moisture content in the areca sheet briquettes of 1700µ and above is 5.37% and satisfies the limit of 15% recommended for biomass fuels. The percentage content of ash, volatile matter, and fixed carbon was 13.97%, 78.88%, and 2.48%, respectively. The value of volatile matter is good and acceptable, as higher the percentage of volatile matter, faster and complete the combustion. Fewer amount of ash results in a cleaner grate and less space for dumping of ash Therefore, it is desirable to use biomass with lower ash content as fuel. For efficient operation, the ash content of the fuel should be below 10% [22].

The percentage content of hydrogen, nitrogen, sulphur, and oxygen from the ultimate analysis are 6.67%, 0.52%, 0.60%, and 18.48%, respectively. The amount of hydrogen content is satisfactory, as it contributes immensely to the combustibility of any substance in which it is found. Low percentage of sulphur and nitrogen in a briquette means less air pollution, which is a welcome improvement as there will be minimal release of sulphur and nitrogen oxides into the environment.

4. Conclusion

Considering the results obtained and their respective significance, it was found that briquettes prepared from areca sheets of 1700µ and above with sawdust as additive had a calorific value of 14.82MJ/kg, which were satisfactory when compared with commercial sawdust briquette (18.63MJ/kg). The other characteristics, which make up for a good biomass briquette like percentage of oxygen(18.48%), carbon(2.48%), volatile matter(78.88%,), sulphur(0.60%), nitrogen(0.52%),, and moisture(5.37%)were found to be within the permissible limit that enabled this briquette to be employed as an alternative for conventional energy source. Hence, it can be concluded that briquettes produced from areca sheets of 1700µ and above, with sawdust as additive would make a good biomass briquette.

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