RESEARCH FRONT

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PRODUCTION AND EVALUATION OF BRIQUETTES MADE FROM DRY LEAVES, WHEAT STRAW, SAW DUST USING PAPER PULP AND COW DUNG AS BINDER

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ABSTRACT

Every year millions of tons of agricultural waste are generated which are either destroyed or burnt inefficiently in loose form causing air pollution. The use of agricultural and agro-industrial waste as biomass fuel for power generation like briquettes can be an alternative solution to the problems related at their disposal & pollution. Briquettes produced from lignocellulosic waste, through a simple process and low cost are an excellent source of energy and environmentally benign, ideal for replacing fossil fuels in this day. In the present research, an experimental study was undertaken for production and quality analysis of different briquettes using dry leaves, wheat straw & saw dust as the feed stocks & paper pulp, cow dung as binder. These briquettes were analysed by using proximate analysis. The results were then compared with a commercially available cow dung briquettes. Results showed that briquettes produced by using these feed stocks and cow dung as a binder had a calorific value of 5920.40kCal/kg, which was higher than other briquettes used paper pulp (5874.12kCal/kg) as a binder and also higher than the commercially available cow dung briquettes (3452.34kCal/kg). Other properties like percentage of ash content, sulphur content & chloride content were less and also there was an increased percentage of volatile matter when compared to traditional cow dung briquettes. Thus produced biomass briquettes can be used as a replacement for the commercially available cow dung briquettes.

Key words: Biomass, Briquetting, Briquettes, Agro waste residues, Manual press technology,

INTRODUCTION

The more comfortable human life is paid by excessive energy increase in all its form. The reserves of non-renewable energy source (coal, oil, natural gas) are not limit less and they are gradually getting exhausted for that their price continually increase [1]. Over the recent years the problem of environment is pollution, sustainability and safety which insist for the development of power generation systems which are techno economically viable, sustainable and safe. In this context researches has been carried out on alternative fuel resource including nuclear, solar, geothermal, wind, tidal and biomass based [2, 3]. Biomass can be defined as "all renewable organic matter including plant material, whether grown on land or water, animal products and manure, food processing and forestry by-product; and

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urban wastes" [4]. Biomass residues have great potential in most developing countries, since they are able to replace energy sources such as fire wood, coal [5]. In many developing countries with the increasing population the amount of agricultural waste is also increased. So the amount of solid waste generated is one of the most debatable environmental issues. The same condition is also a major concern for India, an agriculture based country. In India large amount of agricultural waste is produced like rice straw, wheat straw, cotton stalks, coir pith, groundnut shell, coffee stalks etc. A large portion of crop residues are burnt in situ, so the smoke of these residues cause huge air pollution in environment. In order to overcome this issue biomass briquetting is an alternative way of managing waste beside incineration process.

A briquette is a block of compressed coal, biomass or charcoal dust that is used as fuel [6]. Briquetting is a high pressure process which can be done at elevated temperature [7], or at ambient temperature [8, 9] depending on the technology one applies. In some briquetting techniques, the materials are compressed with or without addition of adhesive [10, 11].

Generally briquetting are done where charcoal is used as one of the major feed stocks, but the use of charcoal in briquettes brings many problems, one of them is the emission of greenhouse gases like CO_2, SO_X, NO_X, CH_4 [12, 13]. To mitigate all these problems biomass briquetting is a better option; it mainly includes rice husk, wheat straw, cotton stalk, bagasse, jute stick etc. Apart from agro wastes the dried leaves are disposed off by burning them in open field, which is a huge loss of potential heat energy. Biomass briquetting has advantages of large accumulation of ash and higher thermal efficiency than loose biomass burning [14]. On the other hand it has higher density and energy content, less moist compared to its raw materials. Apart from these advantages it can be used in domestic purpose (cooking, heating, barbequing), industrial purposes (agro industries, food processing) in both rural and urban areas [15, 16]. Those are renewable source of energy and they avoid adding fossil carbon to atmosphere. So being derived from renewable resources biomass briquettes has superior qualities than coal fuels.

Many works have been reported on the production of briquettes from many agro residues with coal dust and charcoal dust. But no observation is made on the production of briquettes with different ratio of agro wastes, dried leaves and binders. So production of briquettes with different agro residues and ecological wastes is an attractive solution to mitigate the problem of environmental pollution and can be a potential source of alternate energy. Hence the present study aims towards:

- Production of low cost briquettes from different feed stocks (wheat straw and dry leaves) using different binders in different ratios.
- Characterisation of different briquettes produced by manual press method.

MATERIALS & METHOD

This experimental study was carried out Department of Biofuel, CSIR-CMERI, Ludhiana. This study is patterned from the methods of study by ***Lockard*** on how to make biomass briquettes with manual press technology.

Pre-processing of different Feed Stocks & Binders

The required feed stocks for this experiment were dry leaves, wheat straw and saw dust. Dry leaves were taken from the premises of CSIR CMERI, Ludhiana. After collecting

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they were fed into a grinder machine for reduction in the size. Wheat straw was collected from normal agricultural field of Ludhiana City, Punjab. After collecting they were dried out in the open sun for two days to remove as much moisture as possible. After the wheat straw has been dried they were also fed into the grinder machine to make into smaller size and Saw dust were collected from nearby carpentry shop.

In this research work paper pulp and cow dung were used as binder. Strips of waste newspapers were (weighing 100gm) cut and soaked into 1 litre of waste water for 2 days. On the second day, the soaked newspaper strips were crushed into grinder until only the fibers of the newspaper were seen. This mixture served as the binder for the biomass briquettes which is termed as paper pulp. This was a binder used in this research and was collected from storage area of biogas plant in CSIR-CMERI, Ludhiana.

Production of Biomass Briquettes

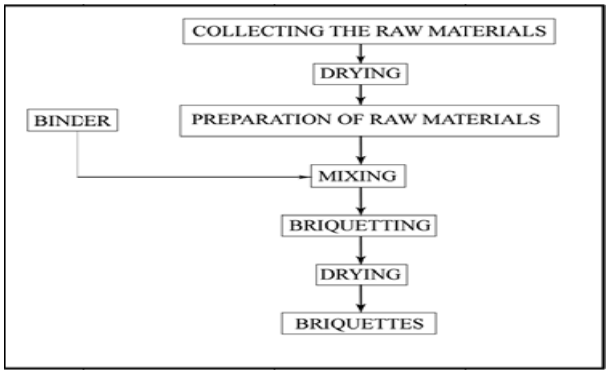

Figure 1: Flow chart of Briquetting Process

Initially 50 briquettes were made with different ratios of raw materials and binders manually with arbitrary pressure. Each briquette was of approximate 40 gm in weight. Then the briquettes were dried out in open sun for 7 days and calorific value was measured for each briquette. This study was done just for feasibility study of production of briquettes with different ratios of feed stocks and binders by assessing its cohesiveness (physical) and calorific value. Calorific values of all these briquettes were determined by Bomb Calorimeter, and out of 50 briquettes 14 briquettes were selected based on their calorific value and binding characteristic (cohesiveness by physical appearance). There after best 14 briquettes, having the composition as stated below (weighing approximate 200gm) were made in iron mould to give it a proper shape and then compressed manually to drain out the visible water. After the production of those briquettes, they were sun dried for 15 days before analysis. After that different parameters like calorific value, moisture content, ash content, volatile matter, fixed carbon, density, ignition time, burning time, sulphur content and chloride content were analysed using standard method. After that 6 briquettes from those 14 briquettes were chosen having highest calorific value and lowest ash content and performance was evaluated of those best quality briquettes in a Conventional Household Tandoor. The amount of feed stocks in different briquettes is presented in Table 1.

Sample	Dry leaves (gm)	Wheat straw (gm)	Saw dust (gm)	Amount of binders (gm)	Binder used
A_1	10	10	00	180	Paper Pulp

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A_2	00	05	05	190	Paper Pulp
A_3	05	00	15	180	Paper Pulp
A_4	15	00	05	180	Paper Pulp
A_5	00	25	25	150	Paper Pulp
A_6	12.5	37.5	00	135	Paper Pulp
B_1	05	05	00	190	Cow Dung
B_2	20	30	00	150	Cow Dung
B_3	30	20	05	150	Cow Dung
B_4	00	05	05	190	Cow Dung
B_5	15	00	05	180	Cow Dung
B_6	27	00	23	150	Cow Dung
AB_1	20	80	00	100	PP & CD
AB_2	25	25	00	150	PP & CD

Table 1: Amount of different Feed Stocks & Binders in Biomass Briquettes

NOTE: CD = Cow dung, **PP** = Paper pulp

Figure 2: Produced Briquettes with different Feed stocks (dry leaves, wheat straw & saw dust) & Binders (paper pulp & cow dung)

RESULTS & DISCUSSION

The results of proximate analyses of the biomass briquettes were shown in Table 2. From the results, it is clearly shown that the briquettes where cow dung was used as binder have highest calorific value (5920.40kCal/kg) as compared to the briquettes where paper pulp was used as binder whereas control has calorific value lower than all briquettes. But in case of briquettes where paper pulp was used as binder wheat straw plays a major role for increasing the calorific value rather than dry leaves and saw dust. On the other hand, briquettes having cow dung as binder, dry leaves are responsible for enhancing the calorific

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value of briquettes. In this table it was also observed that with increasing volatile matter the ash content is decreasing and it is also applicable for control. But when the binder is changed from paper pulp to cow dung the average volatile matter was 70%, 63%, 70% respectively for paper pulp, cow dung and both of them. Similarly, the briquettes with paper pulp as binder was found to have lower ash content as compared to the other binders. Across the composition of briquettes, it was observed that the samples where wheat straw was used in higher amount the resulting briquettes have higher volatile matter and lower ash content. So from this Table 2, it can be concluded that wheat straw is a major contributor for increasing the volatile matter and decreasing the ash content. But here contradictory result was observed i.e. when dry leaves were used in higher amounts than wheat straw and saw dust; it produces briquettes having higher volatile matter and lower ash content. So from this it can be concluded that dry leaves play a major role in increasing the volatile matter when cow dung was used as binder and wheat straw is responsible for enhancing the volatile matter when paper pulp was used as binder.

Briquettes	Calorific Value (Kcal/Kg)	Volatile Matter (%)	Ash Content (%)	Fixed Carbon (%)
CONTROL	3452.34	50	25	10.0
A1	5780.88	78	5.5	16.0
A2	5524.44	65	15	18.5
A3	5221.47	65	10	18.4
A4	5421.88	65	10	18.2
A5	5687.64	70	10	18.0
A6	5874.12	80	05	13.8
B1	5454.54	60	15	20
B2	5920.40	68	12	14
B3	5687.64	74	10	12
B4	5520.40	65	15	15
B5	5361.63	55	15	25
B6	5309.78	60	15	20
AB1	5874.10	65	20	10
AB2	5221.44	75	15	05

Table 2: Calorific Value, Volatile Matter, Ash Content, Fixed Carbon of different Briquettes

Moisture content is very important property and can greatly affect the burning characteristics of the briquettes. In case of briquettes with increasing moisture content the calorific value was found to be decreasing. From Table 3, it was observed that among the binders like paper pulp and cow dung, paper pulp is better for decreasing the moisture content whereas control has highest moisture content among all briquettes. For paper pulp briquettes when wheat straw was used in higher proportion then moisture content was showing decreasing trend, but in case of cow dung briquettes having higher portion of dry leaves decreased the moisture content. In Table 3 it was observed that density of the briquettes is increasing with increasing moisture content, and when dry leaves were used in higher proportion resulting briquettes were showing higher burning time.

BRIQUETTES	**MOISTURE CONTENT (%)**	**DENSITY (gm/cm^3)**
Control	15	0.50
A_1	0.5	0.22

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A_2	1.5	0.28
A_3	6.6	0.24
A_4	6.8	0.29
A_5	2.0	0.25
A_6	1.2	0.23
B_1	05	0.42
B_2	06	0.49
B_3	04	0.46
B_4	05	0.50
B_5	05	0.49
B_6	05	0.43
AB_1	10	0.32
AB_2	05	0.47

Table 3: Moisture Content, Density of different Briquettes

From Figure 3 it was observed that when dry leaves were used in higher proportion with cow dung as binder then it showed highest burning efficiency whereas when wheat straw was used in higher proportion with paper pulp as binder it was responsible for higher burning time of briquettes and it had been seen that control has higher burning time than briquettes where paper pulp was used as binder. In this context it was observed that cow dung has better burning efficiency than paper pulp.

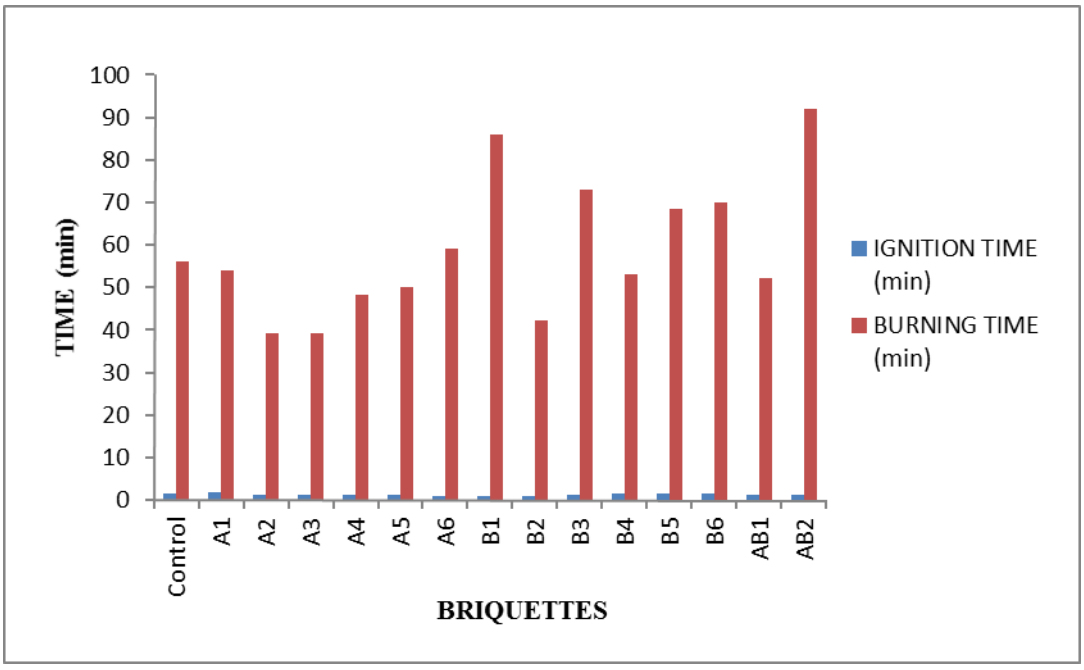

Figure 3: Ignition Time & Burning Time of different Briquettes

Sulphur and chloride cause several harmful effects on environment. So when the ash of briquettes is disposed to soil & water body, it pollutes the ecological environment. So lower the amount of chlorine & sulphur in ash of the briquettes better will be the quality of briquettes with respect to pollution. Based on Figure 4, percentage of chloride varied from 0.02% to 0.09% where paper pulp was used as binder, and it was also observed that higher the amount of dry leaves and wheat straw lower the amount of chloride content in the ash of briquettes. Similar trend was also seen for sulphur content and percentage varied from 0.3% to 0.7%. On the other hand, a contradictory result was observed i.e. when dry leaves & wheat

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straw were used in higher amounts than saw dust in cow dung briquettes showing lower level of sulphur and chloride. In briquettes where cow dung was used as binder, percentage of sulphur & chlorine ranged from 0.4% to 0.5% & 0.1% to 0.18% respectively.

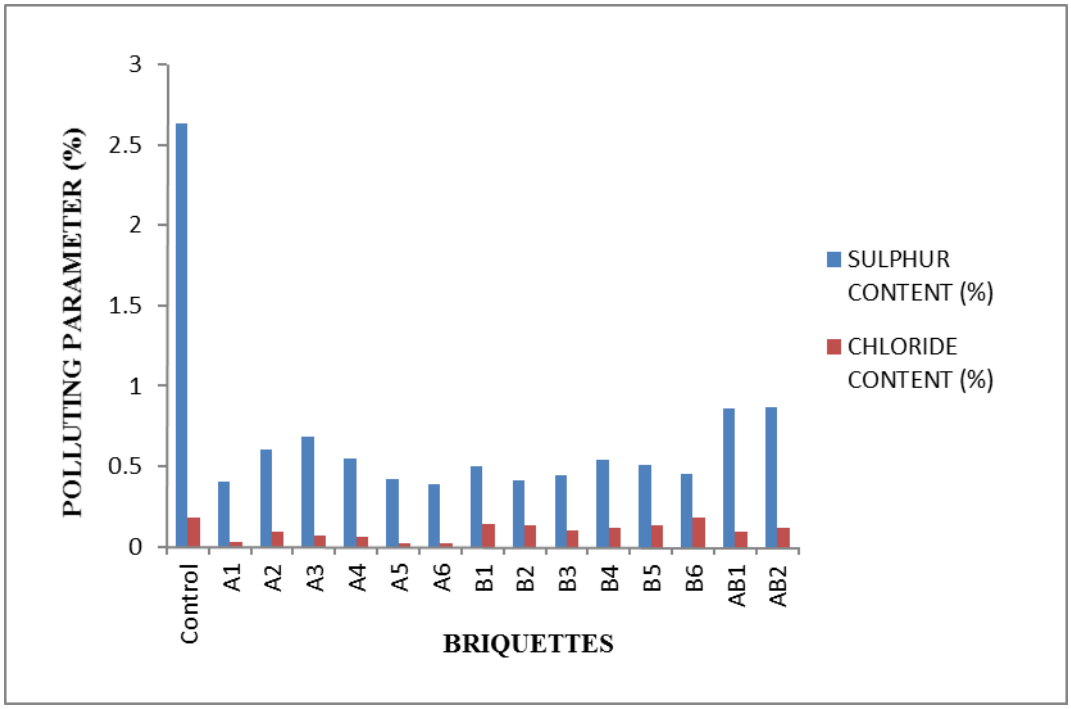

Figure 4: Sulphur Content & Chloride Content of different Briquettes

CONCLUSION

It can be concluded that that waste material like dry leaves, wheat straw & saw dust are potential feed stocks & paper pulp is better binder for biomass briquetting. Among the combination of feed stocks and binders it can be suggested that the combination of paper pulp and wheat straw is better one rather than combination of cow dung and dry leaves. Generally dry leaves and wheat straw are burnt to reduce the waste which causes severe pollution to environment, but if wisely handled these waste then could be a better option for briquetting. Hence for an agrarian country like India that produces huge amount agriculture waste every year, use of these wastes as briquettes can be an economically viable, sustainable and environment friendly solution.

RECOMMENDATIONS

- Exploration of other waste materials as feed stocks and binder.
- Optimisation of shapes of biomass briquettes.
- Optimisation of pressure required for compactness of briquettes.
- Optimisation of particle size of different feed stocks

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