To Study the Effect of Pretreatment on Dry Sugarcane Leaves

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Abstract. It is anticipated that oil and natural gas will deplete within next 40-50 years. Moreover, the expected environmental damages such as the global warming, acid rain and urban smog due to the production of emissions from these sources have forced the world to try to reduce carbon emissions by 80% and shift towards utilizing a variety of renewable energy resources which are less environmentally harmful such as solar, wind, biomass etc. in a sustainable way. Biomass is one of the earliest sources of energy with very specific properties and abundantly available. The sources of biomass are forestry, agricultural and municipal waste and residues. The agriculture waste as biomass is either destroyed or burnt inefficiently causing air pollution. The use of agriculture waste for making briquettes to generate power can be an alternative solution to the problems related to their disposal & pollution. Various pretreatment techniques change the physical and chemical structure of the lignocellulosic biomass and improve hydrolysis rates. The present work highlights on pretreating dry sugarcane leaves (biomass) with physical treatment (Mechanical Comminution) by using aggregate impact test apparatus. It was found that effects of number of drops had upgraded the lignin percentage and calorific value and reduces the moisture content and ash content.

Keyword: Dry Sugarcane leaves; Physical Pretreatment; Mechanical Comminution; Lignin.

1. Introduction
In developing countries like India, use of petrol fuels like furnace oil or light diesel oil to meet the thermal energy demands of industries places a heavy burden on the economy [1]. Use of available biomass to meet the energy demand is an attractive alternative instead of oil and natural gas [2, 3]. The examples of biomass are animal waste, agricultural waste, food processing, forestry and municipal wastes which can be used as a source of energy [4]. India produces approximately 320 million tones of agricultural waste. 100 million tones are burned directly in the open field causes environmental pollution. Burning of agriculture waste is loss of energy. Rice husks, wheat straw, rice straw, corn cobs, sugarcane bagasse, and dry sugarcane leaves etc are the main agriculture waste produce [1, 4]. The major content of biomass is cellulose, hemicelluloses and lignin [5]. Energy is liberated upon lignin burning [3]. The sugarcane plant is best example of how nature had provided us with renewable resources to sustain ourselves without depending upon unsustainable and damaging fossil fuels [6, 7]. In India dry sugar cane leaves are burned directly in open field, creating the pollution [8]. World Sugar
cane production is 1877105 thousand metric tons in 2015. Brazil being at top by producing 739267 thousand metric tons of sugar cane and India at second producing 341200 thousand metric tons of sugar cane. The top three sugarcane producing states in India are Uttar Pradesh 132427.6842 thousand metric tons, Maharashtra 69648.0768 thousand metric tons and Karnataka 35732 thousand metric tons [9, 10]. The calorific value of some biomass is listed in Table 1 [11, 12].

| Sr. No. | Raw Material | Calorific values (KJ/Kg) |
|---------|--------------|--------------------------|
| 1       | Sugar Cane   | 16719.26                 |
| 2       | Corn cob     | 16988.63                 |
| 3       | Rice Husk    | 15659.5                  |
| 4       | Bagasse      | 17318.37                 |
| 5       | Saw dust     | 19956.63                 |
| 6       | Sun flower Stalk | 17991.2             |
| 7       | Wheat Straw  | 16988.63                 |
| 8       | Wood         | 18487.59                 |
| 9       | Cotton stalk | 20036.59                 |
| 10      | Cattle Dung  | 15480.8                  |
| 11      | Groundnut Shell | 19355.18             |

The effect of pretreatment on biomass is studied for long time. Pretreatment of biomass is done to increase the hydrolysis, to avoid loss of carbohydrate, to avoid formation of inhibitors, to remove unwanted materials [13]. There are various pretreatment methods like physical, physico-chemical, chemical and biological. To treat the lignin the physical (mechanical comminution, steam explosion), chemical (CO2 explosion, acid) pretreatment are preferred [13, 14]. Lot of study has been made on pretreatment of sugar cane leaves and bagasse pith to convert it into sugars [15]. The mechanical pretreatment is to apply force on the biomass. If force is applied on the biomass the cellulose molecules get rupture. With small pressure, these will be reformed in to a new shape [16]. Mechanical pretreatment reduce the cellulose crystallinity and degree of polymerization of biomass. This pretreatment rupture the complex structure of biomass into simple compound which is used for chemicals and biofuels production. If the purpose of pretreatment is to reduce lignin content it increases the digestibility of biomass and purpose is to increase the lignin content it increase the energy of biomass [3]. The process of compaction of residues into a product of higher density than the original raw material is known as briquetting [17]. Different biomass material like saw dust, mixture of wheat straw, saw dust, dry leaves, mixture of bagasse and leaves, sugar cane waste, municipal solid waste, mixture of rice husk and saw dust, coconut leaves are used for making briquettes [18-22]. The advantageous of briquettes are densified product is easy to transport and store. The process increases the net calorific value per unit volume. The technique helps to solve the problem of residue disposal. The fuel produced is uniform in size and quality [23].

Objective of present work is to study effect of physical pretreatment (mechanical comminution) on dry sugarcane leaves with the help of aggregate impact test apparatus. Emphasis was given towards increasing lignin content and decreasing moisture content and ash content. Attempt was also made to study the effect of impact on calorific value of dry sugarcane leaves.

2. Materials and methods
2.1 Materials
Dry sugar cane leaves (breed 86032) was used as the material, which was taken from agricultural field of western Maharashtra. The sugar cane of breed 8602 is largely cultivated in Maharashtra and India.
2.2 Experimental set-up

Fig. 1 Aggregate impact test apparatus setup

The equipment used for the experiment was aggregate impact test apparatus (Manufacture by Arvind engineering Company, Hyderabad) shown in Fig. 1. It works on the principle of impact. Here the material to be grinded was kept in the pan which was placed below the block. The weight of block was 13.5 kg and height of impact was 0.38 m. Other equipments used were cutting machine and electronic weighing balance.

2.3 Experimental procedure

Dried sugar cane leaves was taken from the agriculture field & kept for sun drying for 24 hours. 100 gm sample was weighted by using electronic weighing balance. The weighted sample was cut into small pieces of around 0.01 m-0.08 m. Sample was then placed in the pan of the aggregate impact test apparatus. Block of weight 13.5 Kg was allowed to fall on the sample from height of 0.38 m. This is called as one drop.

The above procedure is carried for different numbers of drops such as 5, 10, 20, 25, 30, 35 and 40 drops. The crushed sample was removed from pan and subjected for analysis.

2.4 Analysis

The acid soluble lignin and acid insoluble lignin method was used for measuring cellulose, hemicelluloses and lignin percentage. Calorific value of dry sugar cane leaves was measured by bomb calorimeter (Dynamic Engineering, BCA) and loss on drying method was used to calculate percentage moisture content of sample.
3. Results and discussion

3.1 Effect of mechanical comminution on fibers structure of dry sugar cane leave
Scanning Electron Microscope was used to study the surface morphology. Fig. 2 is the image before pretreatment which shows the oval shape fiber like material are parallel and surface appeared smooth [24].

![Fig. 2 SEM micrographs (×500) of the surface of raw dry sugar cane leave before pretreatment](image1)

In SEM image Fig.3, dry sugarcane leaves is characterised. After pretreatment by aggregate impact test apparatus setup on the leaves, the surface of leaves are ruptured and appeared rough and oval shape fibers like material were elongated. This breaking of structure alters the lignin content [24].

![Fig. 3 SEM micrographs (×500) of the surface of dry sugar cane leave after the pretreatment](image2)

3.2 Effect of number of drops on lignin content of dry sugarcane leaves
The experiments were conducted to see the effect of number of drops (Impact) on lignin content of dry sugar cane leaves. Experiments were carried out for different drops like 5, 10, 15, 20, 25, 30, 35 and 40. The lignin content in raw material was 10.8 % and maximum lignin content was found to be 13.408 % at 30 drops as shown in Fig. 4. If force is applied on the dry sugarcane leaves the cellulose
molecules get separated. With small pressure, these will be reformed into a new shape. Sudden impact (Mechanical comminution) reduces the cellulose crystallinity and degree of polymerization of biomass. This pretreatment rupture the complex structure of biomass into simple compound and shows some alteration in lignin percentage [25].

Fig. 4 Lignin percentage vs Number of drops (weight of block is 13.5 kg and height of impact is 0.38 m)

3.3 Effect of number of drops on moisture content of dry sugarcane leaves

The Table 2 shows that the moisture content of raw dry sugarcane leaves before pretreatment and for 30 drops after pretreatment. Decrease in moisture content was due to removal of moisture from sugar cane leaves because of sudden impact during aggregate impact test apparatus. The force applied on solid particles is initially stored in the form of mechanical energy of stress. As extra force is applied to the solids, they are suddenly broken into fragments. During breaking of particles the energy is release in form of energy of stress. In all the size reduction operation the energy is supplied in excess, this excess energy is given out in terms of heat. This heat evolution reduces the moisture content of solid particles [26].

Table 2 Moisture Content of raw material and 30 drops sample

| Sr. No. | Sample         | Moisture (%) |
|---------|----------------|--------------|
| 1       | Raw material   | 4.35         |
| 2       | 30 Drops sample| 3.88         |

3.4 Effect of number of drops on Ash content of dry sugarcane leaves

The ash content of raw dry sugarcane leaves (before pretreatment) and for 30 drops (after pretreatment) was as shown in Table 3. The decrease in ash content was due to removal of dirt particles form dry sugarcane leaves during the aggregate impact test apparatus [27].
Table 3 Ash Content of raw material and 30 drops sample

| Sr. No. | Sample             | Ash (%) |
|---------|--------------------|---------|
| 1       | Raw material       | 11.35   |
| 2       | 30 Drops sample    | 7.27    |

3.5 Effect of number of drops on gross calorific value of dry sugar cane leaves

The change in gross calorific values of dry sugarcane leaves before and after pretreatment was as shown in Table 4. This change is due to increase in lignin content shown in Fig. 4, because lignin on burning generates energy [3]. The increase in the calorific value was due to reduction in moisture content and ash content after pretreatment of dry sugarcane leaves [27]. The energy required to pretreat 0.1 Kg dry sugarcane leaves for 30 drops was 1.5097 KJ.

Table 4 Calorific Value of raw material and 30 drops sample

| Sr. No. | Sample             | Calorific value (KJ/Kg) |
|---------|--------------------|-------------------------|
| 1       | Raw material       | 14736.05                |
| 2       | 30 Drops sample    | 15493.35                |

4. Conclusions

The present work shows that physical pretreatment (Mechanical Commination) by aggregate impact test apparatus effects lignin content, moisture content, ash content and gross calorific value of dry sugarcane leaves. There was increase in lignin content to 13.408 % and gross calorific value 15493.35 KJ/Kg and decrease in moisture content to 3.88 % and ash content to 7.27 %.

From above discussion it can be concluded that Mechanical comminution pretreatment methods does not shows significant changes in lignin content, calorific content, but shows significant changes in moisture content and ash content.

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