CHARACTERIZATION OF SUGAR INDUSTRY WASTES FOR SOLID STATE BIOCONVERSION

Md. Niamul Bari[1] and Tasrif Ahmed[*1]

[1] *Department of Civil Engineering, Rajshahi University of Engineering & Technology, Rajshahi, Bangladesh*
e-mail: niamulbari@gmail.com

ABSTRACT

Press mud and sugarcane bagasse are two major wastes are producing abundantly in sugar industries every year in Bangladesh. Press mud which is also known as olivar cake or press cake, is a residual output after the filtration of the juice. While bagasse is a fibrous residue of sugarcane stalk that is obtained after crushing and extraction of juice. The study was carried out to determine the characteristics of these wastes for the formation of value added products. The samples were collected from Rajshahi Sugar Mills Ltd., Harian, Rajshahi. The samples were analyzed to determine the unit weight and contents of moisture, cellulose, hemi cellulose, alpha cellulose and residual sugar. The experimental results show the presence of encouraging content of cellulose of 38.33%, hemi cellulose of 22.83% and residual sugar of 6.24 gm/kg in sugarcane bagasse and that of 26.60%, 13.93% and 15.84 gm/kg respectively in press mud. Therefore, it is expected that these wastes materials could be used as raw materials for producing the value added product through solid state bioconversion.

Keywords: *sugarcane bagasse, press mud, residual sugar, cellulose content, bioconversion*

1. INTRODUCTION

Sugar industry plays an important role in the economy of bangladesh by way of farming and creation of employment. The industry is under the bangladesh sugar and food industries corporation (bsfic). By-products of sugar mills have many uses. Molasses, press mud and bagasse are inputs for other industries. Around 425,000 acres of land are under sugarcane cultivation and the annual production is about 7.5 million tons, of which only 2.28 million tons are used in sugar mills and the rest goes to molasses making. Bangladesh now produces about 150,000 tons of sugar, 100,000 tons of molasses, 91200 tons of press mud and 800,000 tons of bagasse per year. There are 15 government sugar industries under bangladesh food and sugar industries corporation. There are also 4 private sugar industries in bangladesh (habibullah and rahman, 2014; hellobangladesh, 2015).

Sugar mills mainly produced two types of waste: bagasse and press mud. Sugarcane bagasse is the fibrous residue of sugarcane (*saccharum officinarum*) which is mainly composed of high content of lignin, cellulose and hemi-cellulose (silva, et al., 2012). The cellulose and hemi-cellulose are also the source of sucrose which is a carbon source for biological conversion. Sugarcane is tall grass having a number of bamboo-like stems, which grows to a height of 4 meters or more. The sugar content in sugarcane is about 10 to 15 percent (partha and sivasubramanian, 2006). Bagasse can be used in composite manufacture; textiles manufacture; pulp and paper manufacture; to produce animal feed; to produce fuel; produce chemicals; produce enzymes and food; produce energy, furfural, polymers; agglomerated boards.

The press mud (also called filter cake) is a solid waste, generated on clarification of cane juice before its concentration and sugar crystallization. It is a soft, spongy, light weight, amorphous, dark brown to black colored material. The chemical composition depends on cane variety, soil condition, nutrients applied in the field, process of clarification adopted and other environmental factors. It also has good proportion of nitrogen (karan, et al., 2010). Press mud can be used as a fuel; production of biogas; production of fertilizer; production of soil conditioner; for wax production.

However, the sugarcane bagasse and press mud can be potential raw material for the value added product through solid state bioconversion because of having good quantity of free residual sugar and cellulose and hemi-cellulose that can be converted to fermentable sugar. The determination of free residual sugar and possible source of fermentable sugar of sugarcane bagasse and press mud is essential to identify the potentiality for their bioconversion to produce bio-product. Therefore, the aim of this study is to determine the characteristic of sugar industry wastes for the proper management through biological conversion.

2. METHODOLOGY

2.1 Sample Collection and Storage

The press mud and bagasse samples were collected from Rajshahi sugar mill Ltd. in Bangladesh. The upper surface of bagasse stupas was removed with the help of scrapers and bagasse was collected from some depth and collected in a polybag. After the collection the bag was tied properly. The press mud was collected in the same way as the bagasse collected and kept in a polybag. After that the polybag was carried to the laboratory. In the laboratory, the samples were packed properly and stored in a refrigerator, maintained at 4ºC, before analysis and other experiments in the laboratory.

2.2 Sample Preparation

The sugarcane bagasse ground and sieved to get particle size smaller than 1 mm (Bari, et al., 2010a). The sieved bagasse particle and press mud are dried at 60 ^{o}C for 48 hours to get constant dry weight for experimental study (Bari et al., 2010a; Alam et al., 2010).

2.3 Experimental procedure

Moisture content and unit weight are determined following standard laboratory procedures. The residual total sugar in sugarcane and press mud is determined by the phenol sulfuric acid method of Dubois et al. (1956) with spectrophotometer at 490 nm. Holocellulose (true cellulose) content was determined according to method developed by Wise et al. (1946). Alphacellulose content was determined according to TAPPI test method T203os-61. The quantity of hemicellulose is calculated by subtracting the quantity of alphacellulose from the quantity of holocellulose.

3. RESULTS AND DISCUSSION

The Characteristics of old and fresh sugarcane bagasse as well as press mud such as moisture content, unit weight, total residual sugar, cellulose content, hemicellulose content are determined. The results are presented in Table 1.

Table 1: Characteristics of, sugarcane bagasse and press mud, the sugar industry wastes

Component	Old Sample		Fresh	
	Bagasse	Press mud	Bagasse	Press mud
Moisture Content (%)	68	59	74	76
Unit weight (kg/m³)	98.08	533.17	124.96	369.12
Residual sugar (gm/kg)	0.032	0.041	6.24	15.84
Cellulose (%)	20.60	11.25	38.33	26.60
Alpha cellulose (%)	14	5.50	16	12.67
Hemi cellulose (%)	6.60	5.75	22.83	13.93

The results show that the moisture contents of fresh sugarcane bagasse and press mud are 74% and 76%, respectively while these are reduced to 68% and 59%, respectively due to the storage for long period of time in open space. On the other hand, the unit weight of press mud is increased to 533 kg/m³ from 369 kg/m³ due to storage while bagasse shows the same trend of reduction as moisture content. The increment of unit weight of press mud is due to the decomposition and reduction of volume for getting compacted though it is becoming a little dried up. However, the degradation of bagasse is usually taken place less compared to press mud due the presence of lignin content in bagasse which is less biodegradable though it is also lost the moisture content (Bari and Islam, 2014).

The experimental analysis of fresh bagasse and press mud show that the content of free residual sugar is of 6.24 gm/kg of dry bagasse and 15.84 gm/kg of dry press mud are readily available. The result of residual total sugar is highly impressive for both fresh bagasse and press mud. Furthemore, the cellulose contents are found to be of 38.33% and 26.60% of bagasse and press mud, respectively those are potential source of carbon for solid state bioconversion. These results indicate that total sugar of about 383 gm/kg of bagasse and 266 gm/kg of press mud can be released through their successful bioconversion.

Usually the cellulosic material is act as a carrier for the growth of microorganisms. For the growth initiation, readily available sugar is essential at the initial stage of microbial growth on solid substrate (Bari, et al., 2009).

Once the microorganisms grown on the substrate, it will secrete cellulase enzymes if the substrate is cellulosic materials. The secreted enzymes will attack the substrate and the cellulose will be hydrolyzed. Finally, sucrose (sugar) will be released as a result of hydrolysis of cellulose. The released sucrose will be consumed by the microorganisms already grown and continue their metabolic activities. Along with the enzymes, organic acid (citric acid) will be produced as a secondary metabolite (Bari, et al., 2010b; Alam, et al., 2010; Bari, et al., 2009).

4. CONCLUSIONS

The fresh sugarcane bagasse and press mud contain readily available residual sugar of 6.24 gm/kg of dried bagasse and of 15.84 gm/kg of dried press mud, respectively which posses a very high content and can be used as substrate for bioconversion. Futhermore, the fresh bagasse and press mud contain 38.33% and 26.60% of cellulose, respectively. These high content of cellulose also proves the potentiality of bagasse and press mud for the bioconversion to produce value added product through solid state bioconversion.

ACKNOWLEDGEMENTS

This study has been carried out with laboratory facilities of the Department of Civil Engineering, RUET and technical support of Rajshahi Sugar Mills Ltd.

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