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BIOMASS BASED POTENTIAL UTILIZATION OF AGRICULTURAL WASTE MANAGEMENT: A CASE STUDY OF SUSTAINABLE DEVELOPMENT IN FUTURE

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Abstract: The restrained primary human energy source is biomass. The agricultural waste constitutes have the most potential portion of which include numeral economic crops like paddy, maize, sugarcane *etc.* The sustainable development and ever–increasing fuel demand requirement has recognized as agricultural residues and the biomass ashes of lower energy density which can be exploited into many commercial waste products. They have an average bulk density (0.61 to 1.21 gcm^{-3}) with high porosity (80 %) but low molar conductivity Λ_m ($S\,cm^2\,mol^{-1}$). In the present paper, the pyrolysis of biomass residues from two agricultural waste sources namely rice husk and sawdust were carried out. Both the residues have an elemental composition of C, H, S and O was confirmed by elemental analysis (Ultimate Analysis) and also the highest water absorbing property of rice husk ashes is due to the presence of Silica as a main component in it. The Thermal decomposition starts at 219.43°C. Thermogram of these samples has three key decompositions responsible for hemicelluloses (273.38°C), cellulose (401.15°C) and lignin (479.18°C). From SEM pictographs, both the residues have regular morphology with homogeneous phase separation. From this study, these biomass ashes are more effectual when applying to the environmental management applications.

Key words: Sustainable development, Biomass ashes, Elemental, Thermochemical, SEM.

INTRODUCTION

Biomass fuels as renewable form of energy are gifted alternative to fossil fuels. They proffer numerous environmental compensation which turn into more and more attention since they are imperative in extenuating global warming and securing fuel supply. The combustion of biomass turns out considerably a smaller amount of oxides of nitrogen and sulphur and is CO_2 –neutral. Besides the agriculture area is emergent quickly and shown the way to profusion of agricultural waste. Yearly, about million tones of agricultural wastes are produced which are used as raw materials for energy production. The mainly used agricultural residues are rice husk, sawdust, straw, bagasse, sugarcane trash, groundnut shells and coir pith. The Rice husk is in the form of hull which is the outer cover of rice (Umamaheswaran *et al.,* 2008). Thermal conversions of agricultural waste have attractive industrial applications (Purevsuren *et al.,* 2003). When the moisture content is around 8–10%, the calorific value which is in the range of 12–16 MJ/kg for all the biomass is identical since they have similar CHNO composition on an ash free basis, apart from the non–combustible mineral content. The lower end belongs to rice husk and the higher end belongs to saw dust. At temperature 300–600°C, the biomass evolves volatile material leaving fixed carbon. In this exothermic process CO_2 and water vapor are formed along with production of energy which can protract pyrolysis and combustion incessantly at about the temperature 1200–1400 °C, consequently thermal energy is converted into chemical energy (Das *et al.,* 1997).

The establishment of physical and chemical properties of biomass residues from agricultural waste sources has been executed in several countries (Nordin, 1994). In industry, thermal conversion of solid agricultural waste occupies an essential part (Purevsuren *et al.*, 2003). Biomass ashes have been concentrating applications to not only to carbon storages but also to farming field as fertilizer (Glaser *et al.*, 2002). The present paper aims to characterize rice husk and sawdust biomass ashes physico–chemically.

EXPERIMENTAL

Materials and Reagents

Rice husk and Saw dust from local mills (Kalady, Kerala) were preferred for this study. The biomass ashes were obtained by pyrolysis of the above said biomass materials after drying at around 110°C for one day, powered and sieved to 2–3 mm sizes.

Instrumentation

Micro analytical data (Ultimate Analysis) were performed on Elementar Vario EL III CHNS analyzer. Molar conductance of the mixed ligand complexes (1×10^{-3} M) was measured using an Elico CM 180 conductivity bridge by using 0.01 M KCl solution as calibrant. Thermal stabilities of the complexes were recorded in dynamic nitrogen atmosphere (flow rate 20 ml/min) with a heating rate of 10°C /min using a Perkin Elmer (TGS–2 model) thermal analyzer. Scanning Electron Micrography with Energy Dispersive Spectrometry associated (SEM/EDS) using JSM–5610 scanning electron microscope was used for morphological evaıuation.

RESULTS AND DISCUSSION

Table 1 shows the proximate analytical data with calorific value of the biomass samples which were taken from references (Wan Ab Karim Ghani *et al.*, 2010). Table 2 explains the composition of elements such as carbon, hydrogen, nitrogen and oxygen with molar conductivity of biomass ashes. The carbon and hydrogen provide a positive and oxygen provides a negative contribution to the calorific value for the samples. Table 3 shows some physical properties which were taken from the literature (Wan Ab Karim Ghani *et al.*, 2010).

Chemical Composition

The results obtained from Table 4 describes SiO_2 is one of the prime components in rice husk sample except saw dust also there are some other

Table 1. Proximate analysis with Calorific values of Biomass Samples[a]

Samples	Volatile Matter (%)	Fixed Carbon (%)	Ash Content (%)	Calorific value (MJ/Kg)
Rice husk	60.68	15.02	24.30	13.51
Saw dust	51.39	14.29	22.67	18.30

[a= Taken from literature data]

Table 2. Elemental Analysis (Ultimate Analysis) of Biomass Samples with Molar Conductivity of Biomass ashes

Samples	Carbon (%)	Hydrogen (%)	Nitrogen (%)	Oxygen (%)	Sulphur (%)	Λ_m ($S\,cm^2\,mol^{-1}$)
Rice husk	33.88	4.93	0.11	61.08	–	1.53
Saw dust	54.01	6.91	3.07	36.01	–	8.77

Table 3. Physical Properties of Biomass Ashes[b]

Samples	Bulk Density (gcm^{-3})	Apparent porosity (%)	Water Absorption (%)
Rice husk Ash	0.61	79.71	37.41
Saw dust Ash	0.98	33.72	20.30

[b= Taken from literature data]

Table 4. Chemical Composition of Biomass Ashes[c]

Chemical Composition (%)	Rice husk ash	Saw dust ash
SiO_2	89.79	8.78
Al_2O_3	1.32	13.89
Fe_2O_3	1.43	2.35
P_2O_5	1.04	19.32
CaO	0.77	2.72
TiO_2	1.01	35.72
MgO	0.76	0.35
Na_2O	1.15	1.04
K_2O	1.65	1.93
Cl	1.30	0.07
C	–	13.83

compounds like P, Mg, Al, Ca, Fe and K which are responsible for ash melting, deposition, formation, emission and corrosion. The lesser content of Silicon and iron make the ash inherent (Bridgeman *et al.,* 2007).

Thermal Analysis

Thermogravimetric analysis (TGA/DTA) has been studied in the temperature ranges from 40 to 1100°C. The Thermal decomposition starts at 219.43°C. Thermogram of these samples has three key decompositions responsible for hemicelluloses (273.38°C), cellulose (401.15°C) and lignin (479.18°C) (Bridgeman *et al.,* 2007)., it is also known from the Thermogram of rice husk biomass sample (Figure 1). The loss of physically bound water molecules occur at 107.74°C. The DTA of the biomass samples were represented as peak height and peak temperature, shown in Figure 2 for both the

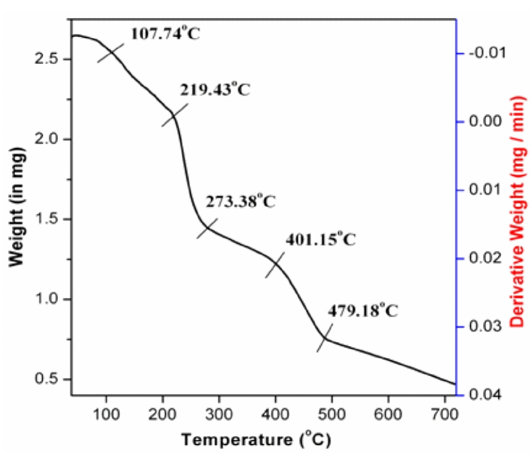

Fig. 1. Thermogram of Rice husk Sample

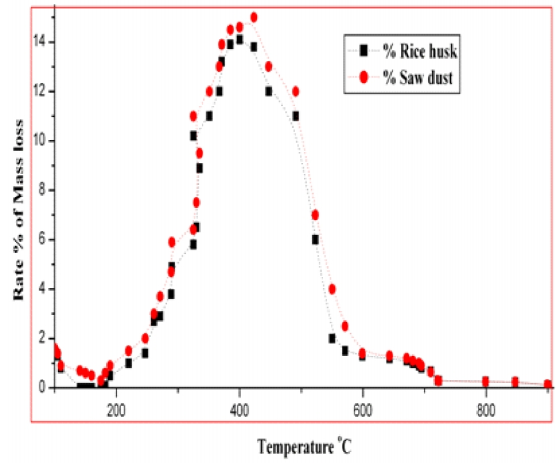

Fig. 2. Differential Thermogram of Pyrolysis of Rice husk and Saw dust Samples

samples at constant heating rate of 10°C/min with nitrogen atmosphere (120mL/min). From this study, the higher potential for energy production could be suggested for pyrolysis and gasification (Vamvuka *et al.,* 2003).

Morphological Analysis

Figure 3 illustrates the Scanning Electron Microscope (SEM) which describes an elementary structure for both the biomass samples. An aligned honey comb like carbonaceous structure is observed for rice husk sample. Broken stone pieces similar capillary structure is obtained for saw dust sample. This proves that in the regular size and arrangement of plant cells, the macro–pore size distributions are composed discrete groups (Cozzani *et al.,* 1995).

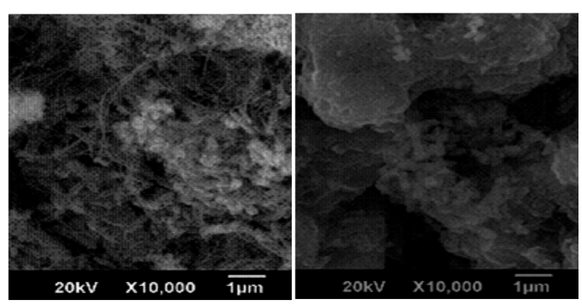

Fig. 3. SEM Pictogram for a) Rice husk ash and b) Saw dust ash

Significant Applications of Biomass Ashes

The biomass ashes can be recycled for the production of structural ceramics, ceramic insulators, filters and adsorbent materials due to their porosity, low conductivity, immobilized toxic metals and high water absorption. They improve the soil functions such as aeration, hydrology, water holding and adsorption capacity (Bridgwater, 2003). The unburnt carbon in the biomass is responsible for their adsorbing tendency. In addition, they are commonly used in food processing industries. Recent times, these biomass ashes can be used to alleviate CO_2 like green house gases from atmosphere and power plants.

CONCLUSIONS

The biomass samples were physico–chemically characterized with high moisture and ash content but low calorific values which indirectly depend on high water absorption and low conductivity. TGA/DTA analysis revealed the weight loss is in the range of 290 to 600°C. The SEM reports confirm their irregular and porous structure. The properties of biomass ashes make them to play a chief role in environmental management applications.

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