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Assessment and Characterization of Agricultural Residues

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Abstract

This paper deals with the estimation of availability of agricultural residues in Karnataka state and experimental characteristic analysis of these residues. Estimation of agricultural residues in Karnataka state shows that three agricultural residues chilli stalk, redgram stalk and soyabean stalk are major contributors, generating residues about 10 lakh tonnes per year. The characteristic analysis includes elemental analysis (CHNSO) and Thermo Gravimetric Analysis (TGA). These agricultural residues having the moisture 4 to 7% which is within range of gasification and carbon 46 to 49% gives better energy. The lower nitrogen 3% and negligible sulfur content will reduce the pollution.

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1. Introduction

The biomass is an organic matter from the plant or animal seminary. The biomass concerned to the agriculture crops is the part which remains after grain separation, which is called agriculture or crop residue. The biomass fulfils the various needs of human being in the form of food, energy and shelter from the ancient days. Later days the use of fossil fuels becomes more popular than the biomass because of convenience and lower price. Presently the use of fossil fuels increased many folds causing the two serious problems to mankind. The first is the deflation of limited source of fossil fuels and the second is the increase in environmental pollution which is a serious concern [1]. The

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alternative energy sources should be considered and can be used for the energy needs; particularly those are locally available, renewable and environmental friendly by contributing to CO_2 balance [2]. Biomass is a potential carbon neutral and domestic fuel, therefore increasing interest is being paid to these alternative and renewable sources of energy and their raw materials [3]. Biomass consumption is continues to increase worldwide for the provision of heat and electricity [4]. As per the report of the National Council for Applied Economic Research [5] biomass fuel contributed 90% energy in the rural areas and over 40% in the urban areas.

The biomass is available from the different sources like forest, energy plants, agro-industrial wastes and agriculture residues. The agriculture residues are the better sources of energy, as these are available surplus and its utilization for energy will lead to economic residue management [6]. The biomass in the form of agricultural residues is suitable for supplying the energy in the rural areas for agriculture and domestic need. The estimation of availability residues can be done by using the residue to product ratio for the particular region. If the sufficient quantity of agriculture residue is available in the region then the appropriate method of energy conversion can be designed and used to convert it to useful form of energy. Before designing the suitable system for the energy conversion for agriculture residues it is essential to estimate the availability of the residues in the region [7]. Ministry of New and Renewable Energy, Government of India was estimated that about 500-540 MT/year of crops residue is generating in India [8].The crops residue generated in Karnataka state is about 29.9575 MT/year and in the Belgaum district is about 4.4341 MT/year [9]. The Karnataka is the fifth largest agriculture residue generating state in India [10]. As major share of energy is consumed by agriculture sector in Karnataka about 35 %, it is necessary to develop a system to supply the required energy and which also uses the agriculture residues [11]. The Belgaum district is the one of the major agriculture residue generating district in Karnataka [12].

For the effective utilisation of biomass fuel and selecting the optimum energy conversion technology, the knowledge of characteristics of biomass are very essential [13]. Proximate and ultimate analyses are used for characterization of biomass. The moisture content and other characteristics of individual agriculture residues are greatly influence on energy content [14]. The thermo gravimetric analysis (TGA) is the quick and suitable method for the biomass characterization [15]. The common and efficient biomass conversion technologies are densification, pyrolysis and gasification. The agriculture residues can be economically gasified as compared to woody biomass [13].

2. Materials and Methods

2.1. Assessment of agricultural residues

The estimation of availability of agricultural residues involves some approximations as the production of crop residues depends upon the number of factors. The survey has been carried out by interviewing formers of Karnataka state for estimation of three agriculture crop residues.

2.2 Characterization of agricultural residues

The three agriculture crop residues chilli stalk, redgram stalk and soyabean stalk for Kharif season were collected from the accessible fields of the Belgaum district. The crop residues were air dried, grinded to powdered form and sieved to 850μm for its required homogeneity for analysis.

The proximate analysis using PerkinElmer apparatus and ultimate (CHNSO) analysis using ThermoFinnigan apparatus for prepared crop residues were carried out at Sophisticated Analytical Instrument Facility (SAIF), Indian Institute of Technology, Bombay.

3. Results and Discussion

3.1 Assessment of agricultural residues

The estimation of the crops yield was first obtained, and then quantities of crop residues were calculated by using residue to product ratio as show in below Table 1.

Table 1. Crops yield

Production of three crops in Karnataka state			
Crop name	Area lakh hectares	Yield kg/hectare	Production lakh tonnes
Chilli	1.14	1191	1.29
Redgram	8.91	625	5.29
Soyabean	1.68	923	1.47

[State agriculture profile Karnataka October 2013]

The estimation of the agriculture crop residue production is carried out using the relation, Residue production (tonne/year) = Grain production (tonne/year) x RPR (residue to product ratio). Residue to product ratio can be estimated by direct measurements in the fields during harvesting. Air dried residue to product ratio and residue generated for three crops are tabulated in table 2.

Table 2. Residue generation

Residue available for 1 kg of crop in 2011-12			
Crop name	Residue name	Amount in kg or RPR [14]	Residue estimated lakh tonnes
Chilli	Stalks	1.5	2.03661
Redgram	Stalks	1.1	6.19375
Soyabean	Stalks	1.7	1.55064

3.2 Characterization of agriculture crop residues

3.2.1 Proximate analysis

The proximate analysis of the samples was carried out as per the ASTM standards using PerkinElmer thermal analyzer. The samples were analyzed by thermogravimetric analyzer under nitrogen (inert) atmosphere. The heating rate for the analysis was of 20^0C/min up to 940^0C.The first stage of weight loss starts from 30^0C up to 200^0C for giving off moisture. The second stage is from 200^0C to around 400 ^{0}C for volatile matter, the major weight loss is in this stage. In the third stage only ash and fixed carbon remains. Typical TGA curve is shown in Fig.1.

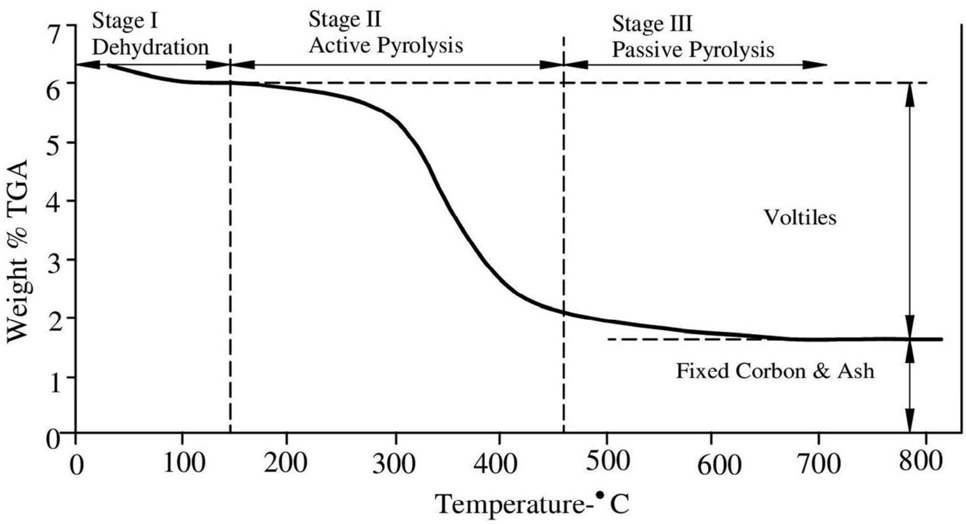

Fig. 1. Typical TGA curve

The results of the proximate analysis and calorific value for three agriculture crops residues are given in the table 3. The values obtained are plotted in the Fig.2 which gives the all properties are having closer values for three crop residues.

Table 3. Proximate analysis (Weight %)

Crop residue/Properties	Chilli stalk	Redgram stalk	Soyabean stalk
Moisture	7.013	4.204	7.469
Volatile matter	79.379	82.84	85.831
Fixed carbon	8.018	8.94	4.03
Ash	5.5	4.016	2.67
Heating value MJ/kg	18.73	19.82	18.24

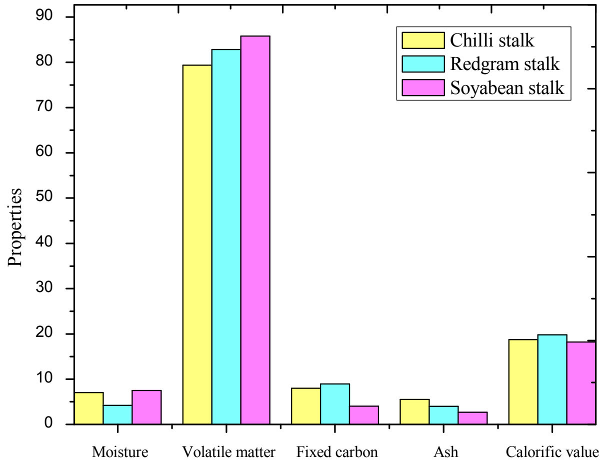

Fig. 2. Proximate analysis

3.2.2 *Ultimate analysis*

Table 4 Ultimate analysis

Crop residue	C %	H %	N %	O%
Chilli stalk	46.974	5.583	3.2	28.937
Redgram stalk	49.231	5.949	3.789	30.030
Soyabean stalk	47.83	5.122	3.13	29.634

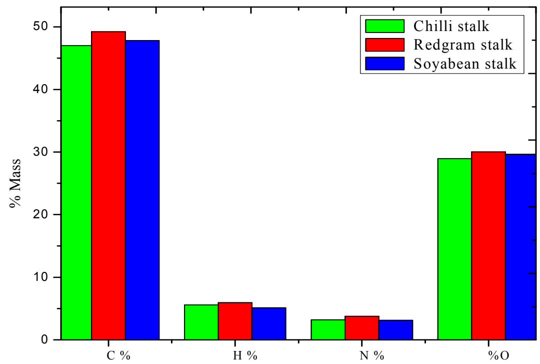

Fig. 3. Ultimate analysis

The ultimate analysis was done to determine the percentages of carbon, hydrogen, nitrogen and oxygen. The all three biomasses have the negligible amount of sulfur. The results of the ultimate analysis for three agriculture crops residues are given in the table 4 and results are plotted in the Fig.3 which shows variation in results of each parameter is less.

The three agriculture crops residues are having similar characteristics as according to Fig.2 and Fig.3. The analysis shows that these three crops residues can be used in the single energy conversion process.

4. Conclusion

The availability of the three different crops residues chilli stalk, redgram stalk and soyabean stalk (biomass) in the region were assessed. The study shows the 6 lakh tonnes of redgram stalk, 2 lakh tonnes of chilli stalk and 1.5 lakh tonnes of soyabean stalk are producing in Karnataka per year. Thus the three agriculture crops residues will be potential energy sources in the region.

The characterization of the crops residues was carried out and it has been observed that three crops residues possessing the similar properties in terms of proximate and ultimate analysis. The moisture is of 4% to 7%, volatile matter 79% to 85%, fixed carbon 4% to 8%, ash is of 2% to 6% and the heating value about 19MJkg^{-1}. The carbon is 46 to 49 %, hydrogen 5 to 6% and nitrogen about 3% with negligible sulfur content. These crops residues are having higher carbon content and could be energy efficient feedstock.

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