Improved Thermochemical Properties by Roasting Residual Biomass and Its Applicability for Developing Biobriquettes

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1. Introduction

In Peru, farming, agribusiness and the wood industry are an important source of dry waste biomass which annually generate more than 11'600,000 metric tons/year of residuesintegrated mainly by 440,000 MT of rice husk, 90,000 MT of sawdust , 200,000 MT of wood chipand 55,000 MT of coffee husk. Biomass residues possess on average 13,000 kJ / kg.

The waste biomass material due their low density, high degree of dispersion, high moisture content and heterogeneity are not used that is why high volumes accumulate near the centers of generation (fields or processing plants) with the problems of pests and soil mineralization so they are burned or thrown into rivers to eliminate generating pollution.

The densification work we have done with biomass waste residues in their virgin state, at moderate pressure with organic binder, represent an interesting alternative for energy use and easy replicability because it not require a sophisticated technology. Densified products developed called "briquettes" can be used as fuel for cooking processes, water heating and house heating.

However, the main disadvantage of the briquettes developed is the smoke generation during their combustion by the high content of moisture and volatile matter; biodegradation and low combustion efficiency for the moisture present. Additionally, the calorific value appears to be similar to or lower than the raw material, or even less according to the binder used.

In order to provide a densified product with improved characteristics has been incorporated in the conditioning step of the raw material a thermochemical roasting process which is a slow heating of the residual biomass, in an atmosphere with a limited presence of oxygen at a temperature near 270 ° C for 30 minutes. This process is carried out in a cylindrical reactor.

In this research work 3 residues were chosenone from the agricultural sector - coffee husk, one from the wood industry –wood chip - and other from the food and beverage sector - barley husk.

The roasting process gave the barley husks, coffee husks and wood chips the possibility to improve their properties with an increase in calorific value 13.6 %, 16 % and 18.7 %. The volatile content was reduced by 38.7 %, 27.4 % and 28.7% respectively. In addition, the raw material toast used to make briquettes showed a greater homogeneity and a greater friability which facilitated the process of size reduction (grinding).

The biomasses toasts were used in the preparation of briquettes with cornstarch gel as a binder. Under this procedure, the briquettes showed an average density of 700 kg/m^3 , increased resistance to biodegradation , and improved performance in combustion processes.

2. Experimental

The selected biomasses: barley husks, coffee husks and wood chips were applied the inmediate analysis, elemental analysis. Heating value and apparent density was determined. The results are shown in Tables I, II and III.

Table I. BiomassProximate analysis and heating value - Dry Basis

		Barley husk	Coffee husk	Wood chip
Volatile matter	%	87.42	82.37	88.41
Ash	%	4.21	1.51	0.91
Fixed carbon	%	8.38	16.12	10.68
Gross Calorific value	kcal/kg	5,127	4,653	4,865

Table II. Biomass Elemental Analysis - Dry Basis

		Barley husk	Coffee husk	Wood chip
Carbon	%	51.11	49.03	51.72
Hydrogen	%	6.78	5.95	6.03
Sulfur	%	0.03	0.05	0.05
Nitrogen	%	3.68	0.49	0.13
Chloride	%	0.02	0.01	0.01

Tabla III. Bulk density (kg/m^3)

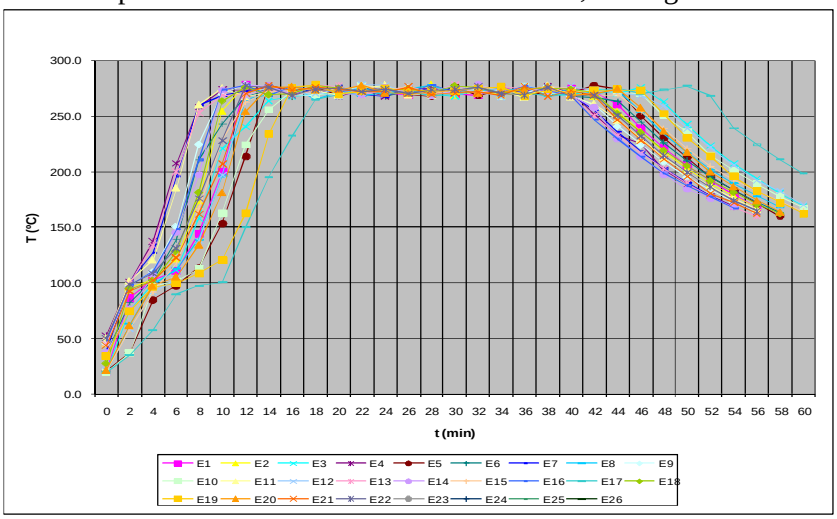
Barley husk	Coffee husk	Wood chip
130	210	70

The biomass selected were sun dried to remove the surface moisture, after that they were toasted. The roasting was performed in a horizontal cylindrical reactor, batch loading, see Figure 1. The temperature was recorded using a set of k-type thermocouples and the weight of the material was recorded using electronic balance.
Proximate analysis was applied to the toasted products and heating value was also determined, see Figure 2. The results are showed in Table IV.

Figure 1. Reactor

Figure 2. Toasted Biomass

Roasting process comprised of three steps: step of heating the biomass at a rate of 16.5 ° C / minute, roasting stage is performed in 30minutes at a temperature close to 270 ° C and cooling stage which lasts 15 minutes. Toast biomass are removed when the tempearture in the reactor is below 150 ° C, see Figure 3.



The toast biomass are ground up Mesh N° 100 using a hammer mill, after that the material is mixed with gelatinized cornstarch. Then the mixture is densified by mechanical compression in a hand press. The densified product is then dried by sun or in a electric oven. Table V shows the results obtained.

Table V Briquettes characteristics

	Barley huskbriquette	Coffee husk briquette	Wood chip briquette
Diameter (mm)	35.4	35.4	35.4
Length (mm)	30.2	30.2	30.2
Hole diameter (mm)	11.5	11.5	11.5
Density (kg/m^3)	782	687	721

Figure 4 Grinding**Figure 5** Pressed **Figure 6** Briquette

3. Results

After being roasted the biomass residuesit was observed a reduction in the volatile matter of 38.74%, 27.4% and 28.76% in the barley husks, coffee husks and wood chips. Also the calorific value increased by 13.63%, 16.05% and 18.73% respectively.

4. Conclusions

1. Roasting improves the properties of the biomass increasing its calorific value, reducing the percentage of volatile matter and increasing the resistance to biodegradation.
2. Smoke emission reduction during combustion of the briquettes made from roasted material is due to the reduction of volatile matter.
3.The increase of friability simplifies the grinding process which results in energy and time saving and also less utilization of the equipment is needed.
4. The briquettes produced using toasted biomass show a density 2 times higher than the briquettes made from virgin material.

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