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Physicochemical Characterization Of The Tropical Biomass: Methodological Study And Analysis

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Abstract— The biomass in general occupies a place of choice in the satisfaction of the world energetic needs, and the countries in the process of development in particular. Its development knows a significant progression in the energetic balance of almost all the countries. In Benin, it represents 59 % of the total energetic consumption into 2005. However its exploitation at energetics ends requires the knowledge of the physicochemical characteristics which will make it possible to determine the modes of energetic valorization adapted to ensure an optimal output of conversion. This article is interested mainly in the experimental study of the physico-chemical characteristics of some plentiful biomasses of the countries in the process of development which influence their energetic valorization. Lastly, thorough analyses of these data were carried out and of the correlations between the energetic content and their elementary composition were proposed.

Key words— biomass, physicochemical characteristics, energetic valorization, and energetic content, elementary composition.
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1 Introduction

ENERGY is an important lever for the developing process of any country, especially developing countries. Indeed, it counts a lot in the fight against poverty as well as in the country's development.

Developing countries give increasing importance to:

- electricity bills that add constraints
- weakened competitiveness witnessed by producing enterprises due to a lack of electric power and to the high cost of electricity;
- great consumption of energy stemming from the biomass compared to other forms of energy
- insufficient electrification in urban as well as rural settings;
- weak energy efficiency which impacts conside ably on the environment (deforestation, air pollution, etc.).

Furthermore, the latest development in the world's markets, especially the prolonged hike that faces society converting the biomass. If developed countries have made in-depth studies on their own biomass, the developing nations are content with using these data stemming from their analysis, which in fact can diminish the efficiency of conversion analysis.

The main objective of this study is to analyze in an experimental fashion the physicochemical characteristics that have an influence on energy valorization, of certain important bio-

in the price of a barrel of oil, and the food scarcity have increased these countries' difficulties in the field of energy supply. Indeed they are, for the most part, entirely dependent upon outside sources for their overall oil consumption. With this situation in mind, it is urgent to explore various ways and means of developing, like other countries are doing, new and renewable sources of energy.

Among these new energy sources, biomass comes out among the first due to its availability and the easiness with which it can be converted into usable energy. For example in Benin, the biomass consumption represents 59% in 2005 of energy consumption. However, its operation requires precise knowledge of the physicochemical features that will allow us to understand the utilization procedures that are linked to the superior

mass sources due to their availability, and their quality from developing countries, especially tropical countries. This study is meant to carry out an in-depth analysis of these data and to finally propose correlations between their energy content and their chemical composition.

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2 The Choice of Biomass Sources and Their Physicochemical Features

In most developing countries, agriculture is based on economic development; it gives work to more than 50% of the population and contributes to more than 70% of their gross domestic product. Agriculture casts out a lot of residues that are not used most often and moreover, through their accumulation, create environmental pollution that is truly responsible for climate change.

Consequently, agricultural waste constitutes a good part of the waste these countries produce and will therefore be the main biomass sources we have chosen for this study.

The sources of crop chosen are common to these countries. They are the following:

- Cotton waste (cotton stems) ;
- Corn waste (corn stalks and stems)
- Sorghum waste (stalks and straw)
- Oil palm waste (husk and fibre).

The selected physicochemical features are those that have a trusted influence on the energy valorization of these types of waste and they are the following: relative humidity, cinder content, nitrogen content, carbon content, lignin cellulose and hemicelluloses content, sulphur content, and heating value.

3 Methods of Analysis and Experimental Results

3.1 **Methods of Analysis**

Humidity was determined by passing through the incubator at 110°C during approximately two hours [2], the rate of cinders by incinerating in the furnace respectively at 200°C for 15 minutes, 400°C for 45 minutes and 600°C for one hour, and finally at 700°C for 5 minutes [2]. Carbon proportioning was done with the ANNE method [5], and nitrogen proportioning with the modified KJELDAHL method [5]. The cellulose was proportioned by the WEENDE [2] method and the lignin by the GUILLEMET method [2]. The superior heating value was measured by using a calorimetric bomb that allows at the same time the sulphur content to be graded through an appropriate chemical method [6].

3.2 *Experimental Results*

The following chart summarizes the results obtained for each source of biomass studied (average of tests).

Table 1: Physicochemical results

Biomass	Carbon	Nitrogen	Sulphur	Ashes	Humidity (%)	PCS (kcal/kg)
Cotton Stems	36	1,12	_	13,2	6,45	_
Corn Stems	42,40	0,63	7,93	8,23	4,19	2765
Corn Stalks	66,44	0,47	3,27	3,69	7,27	4688
Sorghum Stems	61	0,91	_	9,16	4,29	_
Sorghum Straw	68,70	0,56	_	4,85	4,13	5036
Oil Palm Fibre	67,40	1,37	4,39	7,07	8,03	5032
Palm Oil Husk	63,7	0,47	_	3,81	7,57	4178
Stalks of Palm Clusters	51,80	1,91	3,42	12,7	4,64	4100

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4 Results Analysis

The results obtained confirm the strong link between the carbon content and the superior heating value which is the main feature in the energy valorization of the biomass.

Indeed according to TILLMAN [1], heating value and carbon content are linked by the following formula:

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PCS= 0,4373C- 0,3059 (MJ/kg) (1).

Besides, the humidity content of these types of biomass is not high (less than 12%). Therefore they can be valued by thermo-chemical methods with good energy results. The same observations can be made on the percentage of ashes with the exception of the stalks of palm clusters and cotton stems.

In conclusion, it is to be noticed that the quantity of organic matter present in these sources of biomass is greater than 85% and, in some cases, reaches 90%, which allows one to conclude that these sources of biomass are fit for any type of energy valorization. The availability will allow comparison in energy efficiency according to the evaluation procedure and the choice of optimum valorization.

5 THE RELATION BETWEEN HEATING VALUE AND CARBON CONTENT

From the results obtained, we have established the correlation between superior heating value and carbon content for the biomass studied by linear regression.

The equation obtained is the following:

PCS = 75,924 C – 256,85 (kcal/kg) (2).

The following curve shows the variance between this theoretical straight line and the experimental dots and gives way to a good correlation, differences between theoretical and experimental values being minimal (chart 2).

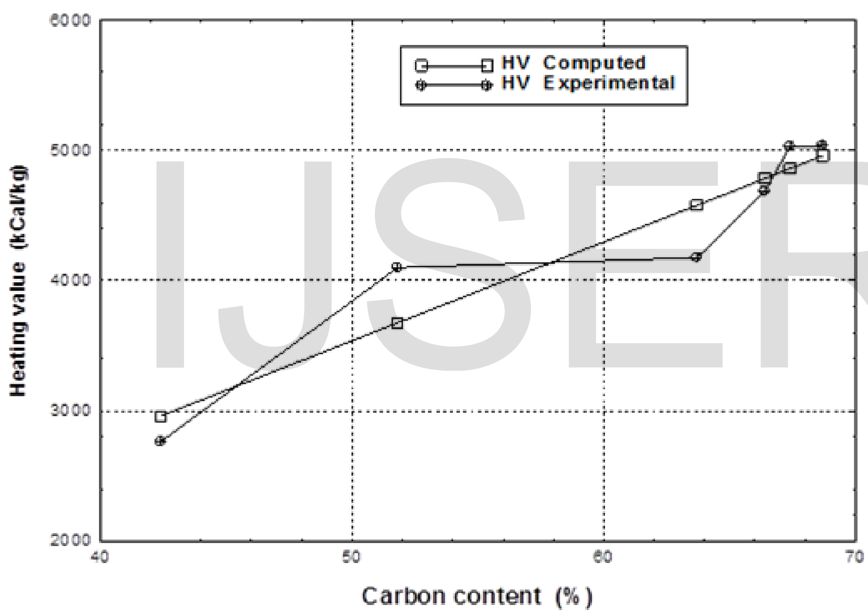

Fig 1: Heating Value (kcal/kg) according to Carbon Content

However, this equation is different from the one proposed by TILLMAN [1] on the biomass sources from the temperate zones, mainly wood residues, rice wastes, city wastes, which is the following:

PCS = 0,4373C- 0,3059 (MJ/kg). The chart above sums up the comparisons between theoretical values, those obtained by the TILLMAN equation, and those calculated by the equation proposed in the present study.

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Table 2: Comparative Table of Results

Biomass	Carbon Content	PCS (kcal /kg) Experimental	PCS (kcal/kg) TILLMAN	Ratio % Tillman	PCS(kcal / kg) Proposed Equation	Ratio % Present equation
Oil Palm Fibre	67,40	5032	6978	-38,67	4860	3,42
Stalks of Palm Clusters	51,80	4100	5345	-30,37	3676	10,34
Palm Oil Husk	63,70	4178	6590	-57,73	4579	-9,60
Sorghum Straw	68,70	5036	7114	-41,26	4959	1,53
Corn Stems	42,40	2765	4362	-57,76	2962	-7,12
Corn Stalks	66,40	4688	6873	-46,61	4784	-2,05

By analyzing the data summarized in this chart, it can be concluded that the relation proposed by TILLMAN cannot apply to tropical biomass sources on account of the important variances found.

We consequently propose the relation stemming from this study; they simulate fairly well the relations between carbon content and heating value for agricultural biomass sources in tropical countries.

6 Conclusion

The present study is a contribution to the determination of physical and chemical characteristics of tropical biomass which is not taken into account in many Scientifics publications. The present study shows that the Tillman formula concerning the evaluation of heating value of biomass in function of their carbon content cannot be used for tropical biomass in this state. So, it proposed another formula which seems to be adapted to the tropical biomass. This formula will permit to appreciate better the energy content of such biomass and.

to evaluate with more precision the conversion yield and at last to choose the best way of its energetic valorization.

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