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Determination of the elemental contents of lignocellulosic residues coming from biodiesel production

Determinação dos teores elementares de resíduos lignocelulósicos provenientes da produção do Biodiesel

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ABSTRACT:

Forest biomass along with the use of solid residues has aroused interest from energy purposes due to the great potential of energy generation. However, in order that such kinds of residues can be used as possible energy sources, it is necessary to know the physicochemical and thermal properties of this sort of material. Before the exposed, the aim of this work was to determine the elemental contents of four agricultural residues (peanuts shell, castor hulls, macaw palm and physic nut shells), all of them coming from the making of biodiesel, aiming at the production of bioenergy. To begin the works, five fractions of each residue were sampled, ground in a Willey-type Miller and classified, the fraction which past through a 200 mesh sieve being utilized. Soon after, its elemental content (ET) was determined in an Elementar Vário Micro Cube analyzer. The results demonstrated that the peanut and macaw palm shells presented greater contents of carbon (C%) and hydrogen (H%) as compared with the castor hulls and physic nut shells. These elements demonstrate direct relationship with the caloric value (higher heating value) of the material; hence the highest content of

RESUMO:

A biomassa florestal junto ao aproveitamento de resíduos sólidos tem despertado interesse para fins energéticos, devido a seu grande potencial de geração de energia. Entretanto, para que se possam utilizar tais tipos de resíduos como possíveis fontes de energia, é necessário conhecer as propriedades físico-químicas e térmicas desse tipo de material. Diante do exposto, o objetivo deste trabalho foi determinar os teores elementares de quatro resíduos agrícolas (casca de amendoim, mamona, macaúba e pinhão-manso), todos provenientes da fabricação do biodiesel, visando à produção de bioenergia. Para iniciar os trabalhos, cinco frações de cada resíduo foram amostradas, moídas em moinho tipo Willey e classificadas, sendo utilizado a fração que passou através da uma peneira de 200 mesh. Logo após foi determinado seu teor elementar (TE) em analisador Elementar Vário Micro Cube. Os resultados demonstram que as cascas de amendoim e macaúba apresentaram maiores teores em carbono (C%) e hidrogênio (H%) comparadas as cascas de mamona e pinhão manso. Estes elementos demonstram relação direta com o valor calórico (poder calorífico

these elements makes the material more interesting from the energy standpoint. On the contrary of the carbon and nitrogen content, the oxygen content (O%) presents inverse relationship with the higher heating power. By indirect via, the greatest content of this element is less interesting to energy production. Therefore, the peanut shells and the macaw palm fruit shells present higher quality for energy generation as compared with the other residues.
Keywords: Bioenergy, Co-products, Heating power.

superior) do material, logo o maior teor destes elementos torna o material mais interessante do ponto de vista energético. Ao contrário do teor de carbono e hidrogênio, o teor de oxigênio (O%) apresenta relação inversa com o poder calorífico superior. Por via reflexa, o maior teor deste elemento é menos interessante para a geração de energia. Portanto, as cascas do Amendoim e do fruto da Macaúba apresentam maior qualidade para geração de energia comparada aos demais resíduos avaliados.
Palavras chave: Bioenergia, Co-produtos, Poder Calorífico.

1. Introduction

It is of fundamental importance to stand out that renewable sources stretch out to the utilization of energy coming from clean sources such as the Sun and wind, in their works GABRIEL FILHO (2008; 2010; 2012), CREMASCO (2009), have been comparing the real importance of its use, in addition, they have been seeking its optimization to improve its output, GABRIEL FILHO (2011).

In that context of clean and renewable energy, one cannot forget that the production of biofuels is a part of this picture too (CASTELLANELLI & CUNHA, 2015). And in the search for alternative energies, expressive results and technologies perfectly applicable to several segments of the society have demonstrated expressive highlights as it is the case of biodiesel, a fuel originated by means of the reaction between oils or fats in the presence of catalyzer (ESTEVES & PEREIRA, 2016). Its production on an industrial scale gives rise to a great amount of biological residues which can release energy in the form of heat made it possible by the direct combustion process.

For the classification of a material destined to the energy generation by combustion, a number of analytical procedures are necessary to characterize the same one and infer about its energy quality. From among these analyses, the determination of the elemental contents in carbon, hydrogen, sulfur and oxygen is accomplished, which present significant relationship with the calorific value or calorific power of the material (PROTÁSIO et al., 2010; DOURADO 2015).

Before the exposed, the aim of this work was determining the elemental contents of four agricultural residues ("peanut shell, macaw palm shell, castor hull and physic nut shell), these ones being coming from the making of biodiesel, aiming at the bioenergy production.

2. Materials and methods

In this work, the coats of four agricultural cultivars destined to the production of biodiesel were utilized, these ones being: peanuts, macaw palm, castor oil plant and physic nut. The material was originated from experimental plantings at the Universidade Federal de Lavras (UFLA) (Federal University of Lavras), in Lavras, Minas Gerais.

Through the elemental analysis, the contents of Carbon, Nitrogen, Hydrogen, and Sulfur were determined and by difference, we have the Oxygen of the material analyzed.

The coats of each one were individually sieved and he aliquot utilized was the one which past through the 200 mesh sieves. After the sieving, the materials were dried in a conventional oven at the temperature of (105±2°C) for 24 hours.

At first, by utilizing a scale with 0.005 mg precision, approximately 2 mg of residue were weighted in a tin sample holder. Next, 2mg of tungsten oxide (neutralizer of halogen) was added to the material, the set (residue + sample holder) was placed onto the equipment carousel (Elemental Vario Micro Cube) illustrated in Figure 1A. The analysis was conducted in a sample at a time, with four treatments and five replicates. The gases necessary for the operation were helium, which is the carrier gas and oxygen, ignition gas. The combustion pipe temperature, localized in the equipment interior at the moment of fall of the sample of the carousel was of 1.150°C. Soon after combustion, the gases were carried by carrying to the reducing pipe and from it; they followed to the detection column. The elements were determined by means of a thermoconductivity detector, in which each element did its interaction and had its specific peak. The computer which was coupled with the equipment did the calculation of that integration and the values of the elements in percentage were obtained.

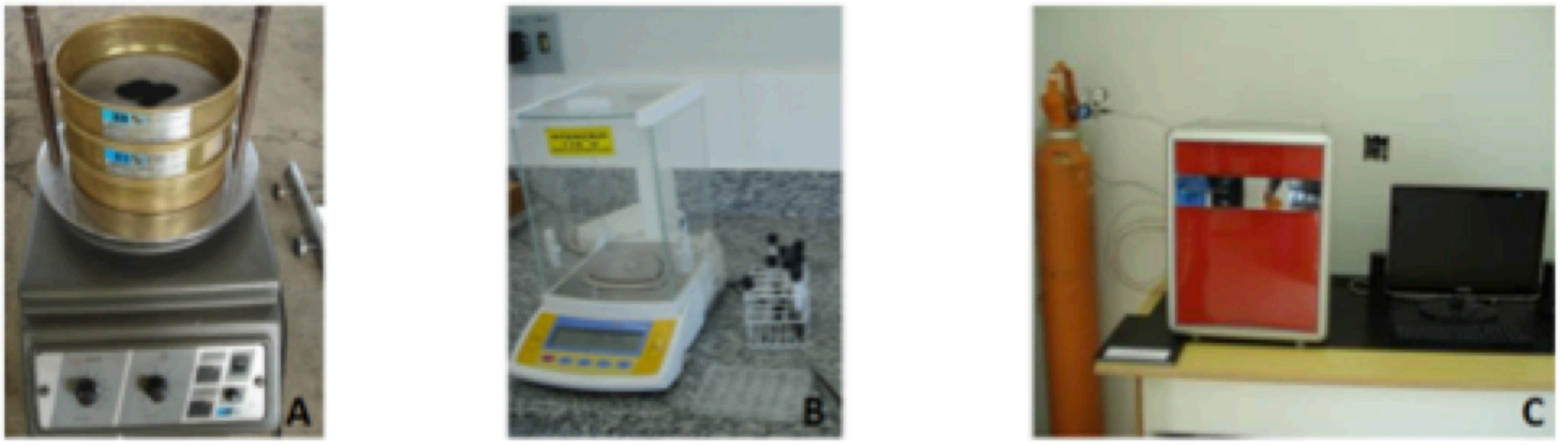

Figure 1. A: vibrating table with a set of sieves; B: precision scale; C: Elemental Analyser Vario Micro Cube.

The statistical dign utilized was the completely randomized (DIC) with four treatments and five replications. The analysis of variance was done and the means were compared by means of the Tukey test with the aid of the statistical software SISVAR.

3. Results and discussion

Table 1 presents the summary of the analysis of variance of the elemental values of the residues. It is found that the residues present statistical difference at 5% of probability in all the elemental contents. The low values of the coefficients of experimental variation with the exception only of the sulfur (S%) were found. Such a result allows us to infer that the experiment presents high precision (PIMENTEL-GOMES, 2005)

Table 1: Summary of the analysis of variance of the elemental values of the residues.

FV	GL			QM		
		C%	H%	N%	S%	O%
Residues	3	70.2*	0.51*	2.44*	0.03*	74.79*
Error	16	1.312	0.033	0.001	0.005	1.826
	CV(%)	2.66	3.3	2.49	29.58	2.71

FV: Source of variation, GL: degrees of freedom, QM: mean square,
C%: Carbon content, H%: Hydrogen content, N%: Nitrogen content,
S%: Sulfur Content, O%: Oxygen Content, CV(%): Coefficient of experimental variation,
e*: Significant values at 5% of probability by the F test.

Table 2 presents the means of the elemental contents and means test conducted. Great elemental variability among the residues is noticed, seeing that the values ranged from 39.01 to 46.42, 5.18 to 5.83, 0.41 to 1.99, 0.17 to 0.34 and 46.08 to 54.34 for the contents of C, H, N, S and O, respectively.

Table 2: Means of the elemental contents and classification of them according to the Tukey test at 5% of probability.

Residues	Elemental Contents				
	C(%)	H(%)	N(%)	S(%)	O(%)
Peanuts	46.14A	5.83A	1.71B	0.22A	46.08A
Macaw palm	46.42A	5.77A	0.41D	0.17A	47.21B
Castor plant	40.75B	5.18B	1.99A	0.34B	51.72C
Physic nut	39.01B	5.34B	1.11C	0.17A	54.34D

Means followed by the same letter do not differ statistically at 5% of probability by the F test.

Both the peanut and macaw palm shells presented higher contents of carbon (C%) and hydrogen (H%) compared with the castor shells and physic nut shells. These elements present direct relationship with the caloric value (higher heating power) of the material, so the higher content of these ones makes the material more interesting from the energy standpoint. According to Vale et al. (2000) working on *Eucalyptus grandis* under different fertilizations found an average PCS of 4,650 cal/g, a value close to the superior caloric power of the macaw palm shell and castor hull. Protásio et al. (2010), found average values of 4,606 and 4,515 cal/g for the residues of the processing of coffee beans and corn harvest, respectively. On the contrary of both carbon and hydrogen, the nitrogen content (O%) presents an inverse relationship with the higher heating power. Following the same reasoning, the highest content of this element is less interesting to energy generation. Protásio et al. (2010) evaluating the relationship between the elemental components and the higher heating power of the plant coal of *Eucalyptus* sp., found a positive correlation between carbon content and higher heating power and inverse considering the oxygen content.

The highest average values in O% were found for castor hull and physic nut shell, denounced that they release less energy during their combustion.

The low sulfur contents (S%) are a beneficial characteristic when the objective is energy generation, since the release of this element in the atmosphere causes undesirable environmental impacts as fro example rain water acidification (BRITO & BARRICHELO 1978).

It is found that both the peanut shell and castor hull presented higher contents of nitrogen, 1.71 and 1.99%, respectively. That result points out that such residues doe not present a high potential of application in bioenergy production.

4. Conclusions

The peanut and macaw palm fruit shells presented percent higher values of Carbon (C%) and Hydrogen (H%) and lower of Oxygen (O%) which, comparatively to the other sorts of residues studied, make these residues of higher quality for energy generation.

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