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JATROPHA CURCAS – ANALYSIS OF GROSS CALORIFIC VALUE

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Abstract

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In recent years biofuels have obtained a considerable interest, due to the implementation of ruling and gradual replacement of fossil fuels. One of production steps at gaining the oil is a pressing process. Wastes come into being from this process. These wastes are used as feed, fertilizer prospectively as fuel. A contemporary scientific literature pays attention namely to one of prospective produces which is a produce of the tropical and subtropical zones *Jatropa curcas*. Tests were performed at *Jatropha Curcas* seeds of a brown colour (that means gnaw). The aim of a research is an analysis of *Jatropa curcas* seed from the utilization point of view of the gross calorific value. The basic instrument to evaluate the gross calorific value of each variant of the experiment was a calorimeter PARR 6200 and digital scales for accurate laboratory weighing.

Keywords: biofuels, jatropha curcas, gross calorific value

INTRODUCTION

In the tropical belt countries there are several dozens of prospective oil plants as oil palm, coconut, cotton, soya, Jatropha curcas and others. A significant percentage of oil of these plants crops is used in the food-industry. Currently the Jatropha curcas oil is not used in the food-processing industry. Although, there is effort in the improvement area to remove this limits. The Jatropha curcas oil is used for several centuries as a fuel and it is also used in the pharmaceutical industry (Kabutey *et al*., 2011; Herák *et al*., 2013). From the ecological point of view vegetable oil-based biofuels are in many aspects better than fossil fuels, such as in the agricultural machinery area (Pexa *et al.,* 2013; Ales *et al*., 2012).

Sustainability in the energy consumption area is inextricably linked with the search of new alternatives. That is one of the options which is currently preferred by the "green energy", "renewable energy sources" and others. The reason is the limited amount of fossil fuels. Another problem is the use of petroleum derivatives in the production area of polymeric materials. The availability of petroleum is limited due to the dynamical increase of energy consumption.

In terms of analysis Jatropha curcas is one of the prospective crop in the area of tropical and subtropical belt (Herák *et al.,* 2013; Petrů *et al*., 2012). The products obtained from the processing of Jatropha curcas have been traditionally used in various industries – energetics, pharmaceutics, cosmetics, natural fertilizers, etc.).

The basic technologic process to obtain the oil from crops is pressing. Pressing is a complex process and a number of authors deal with this process in the papers. Detailed understanding of the process of oil pressing is important factor that can help to find the system with maximum ratio of energy: output versus input (Herák *et al*., 2013; Kabutey *et al*., 2012; Petrů *et al*., 2012).

The aim of the research is the analysis of Jatropha curcas seeds in terms of weight ratio of the subcomponents, as a seed coat, seed kernel. Another aim is to determine the gross calorific value of these components and compare the values with the gross calorific values of pressed oil.

METHOD

Gross calorific value evaluation of Jatropha curcas was performed with the brown coloured seeds that are overripe (Fig. 1). In the measurements there were used the samples of seeds which were crushed.

The gross calorific values were measured for seed coat, whole seed (kernel with seed coat) and unrefined seed oil. The refining is a cleaning process during which undesirable ingredients from the oil are removed. Before the evaluation process of gross calorific value there were determined the shares of the individual seed parts, as seed, seed coat and seed kernel.

Individual parts of the seed were separated mechanically by hand and with using a special knife. Emphasis was placed on minimal contamination of the parts.

The pressing was in progress on the machine ZDM5t (500kN) with a software TIRAtest (Fig. 2). A deformation speed was 10 mm.min^{-1}. The pressing equipment was of a cylindrical shape (60 mm). A dump was till the height 80 mm.

The basic instrument to evaluate the gross calorific value of each variant of the experiment was calorimeter PARR 6200 and digital scales for accurate laboratory weighing. Experiments were performed in accordance with the standard CSN EN 14 918 (2010).

To evaluate the gross calorific value for each variations of the experiment material was prepared and weighed at intervals of 1 to 3 g. The spacemen was inserted into the test container where was placed the wick (the wick is to ignite the spacemen). Than the container was closed and there was created air overpressure which is necessary for combustion process. The second container was filled with two litres of distilled water, which is used for cooling. The container with the spacemen was placed into the container with distilled water and subsequently was placed into the test area of calorimeter. The container shell (located test spacemen) is measured by sensors and another sensor measures the water temperature depending on time.

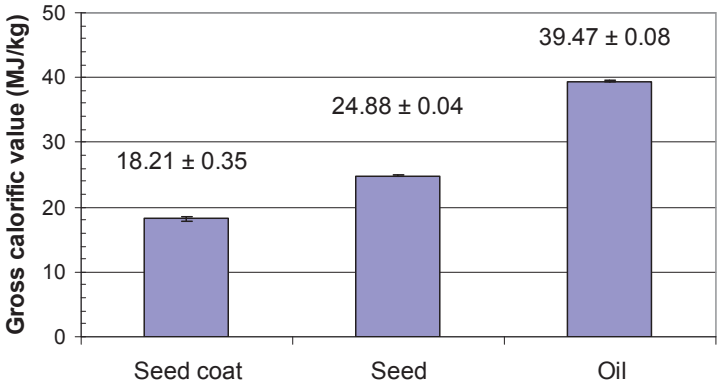
2: *Pressing equipment and evaluation machine*

RESULTS OF RESEARCH

To determine the variation in weight of 200 tested seeds and respective amount of the seed coat and seed kernel coefficient of variation was used. The coefficient of variation is defined as a ratio of the standard deviation and the arithmetical average, in the case of seed the value was determined 16.08%, for seed coat 11.87%. The seed coat mass was 0.24 ± 0.03 g. The seed mass was 0.64 ± 0.10 g.

Graphical exemplification of the gross calorific value results was Fig. 3.

1: *Jatropha curcas seed with coat*



3: *Gross calorific value of particular Jatropha curcas product*

The Tukey's HSD test was used for the statistical comparison of mean values. In the Tab. I, there is shown single means in the statistically homogeneous groups.

The difference among the tested series is clear in the comparing of the average data set values of gross calorific value and inconsumable residues. In the light of statistic there is not homogeneity among the tested series. The gross calorific value of the oil from Jatropha curcas is higher than in the case of natural gas. The gross calorific value of testing variants exceeded the gross calorific value of wood (Ružbarský *et al*., 2013). Solid fuels made from woody biomass reach following gross calorific values: forest wood chips 18.74 MJ.kg^{-1}, polar pellets 18.2 MJ.kg^{-1}, energy sorrel spruce pellets 16.54 MJ. kg^{-1}, lucerne pellets 16.61 MJ.kg^{-1}, knotweed pellets 17.62 MJ.kg^{-1} and oats grain 17.17 MJ.kg^{-1} (Malaťák & Passian, 2011).

I: *Statistical comparison of mean values – Tukey's HSD test*

Designation	Calorific value	Agreement		
	MJ/kg	1	2	3
Seed coat	18.2078	****		
Seed	24.8785		****	
Oil	39.4671			****

CONCLUSION

In recent years biofuels have obtained considerable interest, due to the implementation of ruling and gradual replacement of fossil fuels. World research is focused mainly on searching of new and effective sources of biofuels. Potential place to obtain these biofuels is primarily in tropical and subtropical areas where are facilities for the harvest a few times per year and yield maximization. However in these areas there is problematic infrastructure and availability of efficient technologies very often event.

In this paper Jatropha curcas seed is analysed from the view of the volume and gross calorific value of the subcomponents:

- Absence of the consensus is obvious from the statistical evaluation of homogeneity of the calorific value.
- From the gross calorific value point of view the highest values in the test are reached according to an assumption at the oil.
- The gross calorific value is of 36.90% lower in the case of energy utilization of the seed with seed coat against to oil obtained by pressing.
- The gross calorific value is of 53.87% lower in the case of energy utilization of the seed coat against to oil obtained by pressing.

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