WOOD RESEARCH
64 (3): 2019
549-556

RESEARCHES ON GRAPE HUSK WASTE OBTAINED FROM THE WINERY AND ITS USE AS PELLETS FOR COMBUSTION

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(Received May 2018)

ABSTRACT

Nowadays, there is a tendency to find new sources of biomass and to efficiently use old sources, especially to find renewable fuels. The paper aims to use grape husks resulting from the preparation of wine as pellets for combustion. Oven dry grape husk were used to be crushed and graded with the sieve of 1×1 mm in order to obtain dust for pelletizing. The pellets obtained from grape husk winery have a good density of 979 kg·m^{-3}; a good ash content of 4.53% and a better high and low calorific value of 20.150 MJ·kg^{-1} and 19.850 MJ·kg^{-1}, respectively. All over, the obtained results showed that this kind of raw material (pellets) can be use successfully when they are pelletized.

KEYWORDS: Ash content, calorific value, density, grape husk, pellets.

INTRODUCTION

The wine and winemaking industry is a particularly complex field, where, although many people seem to understand, there are always new issues less researched or developed. In this field, there are lots of waste and biomass (Kažimírová et al. 2013, Lakó et al. 2008, Kuhlman et al. 2013, Okello et al. 2013). Within the vineyard industry, there have always been concerns about the use of vine ropes husk (Yeniocak et al. 2009) as lignocellulosic material in combustion (Toscano et al. 2013). Getting these ropes is made in springtime when they are cut and cleaned by dry sediments from vineyard. Drying of these ropes is made naturally by placing them under open and well-ventilated sheds. The direct use a fuel of these ropes isn't effective because they burn quite quickly, they are thin, they have a low density and they have a soft core (Jehlickova and Morris 2007). The problem of rapid and direct burning of these ropes can be disadvantageous due to the fact that in time of combustion a very much heat is lost on the chimney (Aebiom 2013, EC 1997).

The seeds resulted from mashing the grapes have multiple uses, one of them being the production of sugar, obtaining approximately 6.4% sugar from the total of raw material and 5.7% ash content. Until now, there haven't been constant preoccupations of using the peel resulted after mashing the grapes (Demirbas 2001). The main use of these remains is as fertilizer in agriculture, especially because of their sugar content. The grapes remains, named husks of grapes - pomace, represent a large quantity and look as it may be noticed in Fig. 1 (GH 2018).

Fig. 1: Grape husks (GH 2018)

Other research (Mitsui et al. 2016) evaluated the antioxidant properties of the seed husk of grapes from a winery. Pomace is the technical name of the kind of grape waste. Pomace would be processed into a lot of other products such as: cream, distilled in spirits, ground into powdered tannin extract and can be used as colorant. Grape seeds can be separately processed and transformed in oil. These dry remains are easy and small and their use in combustion might be out of the questions because of the quick burning and because they can't be burnt on usual burners. From the economical point of view for waste use it can specify that a great benefit can be obtained when is obtained a certain processed product. For instance, in the case of animal fat feedstock only the oleic acid can be considered the major component and economic use (Kasteren and Nisworo 2006).

The paper has as objective the using in combustion pellets of the grape pomace; the remains resulted after mashing the grapes and making them wine. Within this general objective other activities have been carried out, such as transforming the gross remains in sawdust, pelletizing, determine the density, the ash content and caloric power of these pellets.

MATERIALS AND METHOD

The used raw material is represented by the peels resulted after mashing the grapes within a vineyard. These peels have been naturally dried out from other liquids by keeping them on a sieve, after that being dried in a laboratory oven at a temperature of 105°C until a moisture content of 10% was reached (Fig. 2).

Fig. 2: Raw material.

This raw material has been firstly mashed in a laboratory hammer mill, obtaining a fine dust similar to the wood sawdust. Density of pellets depends greatly on granulometry of particles: when particles are smaller the density of pellets will be higher. During this stage the sizes of the dried raw material and the gravimetric grading of the grained material have been determined, using the 3.15; 2.0; 1.25; 0.8; 0.5 and 0.4 mm sieves. Then, in order not to change this moisture content, the raw material was kept in polyethylene foils. There have been obtained stable pellets by using a manual lab press. Process of pelletisation is very important and must use a temperature about 90-100°C and a great pressure in order to obtain a stable and compacted pellets.

The main 3 properties of the pellets and of the milled grape husks have been determined, such as: pellets density, ash content and calorific power. The pellets density was determined as a ratio between their weight and volume, taking into consideration that the volume of a pellet is equivalent to the volume of a straight circular cylinder (Kers et al. 2013), with the following Eq. 1:

$$\rho = \frac{4 \cdot m}{\pi \cdot d^2 \cdot l} \qquad (\mathrm{kg \cdot m^{-3}}) \qquad (1)$$

where: m - pellet weight (g),
d - pellet diameter (mm),
l - pellet length (mm).

In order to obtain a correct value of the pellet diameter, two perpendicular diameters were determined and its arithmetic mean was calculated (Demirbas and Demirbas 2004). There were used 20 pellets in order to obtain an average value with a large precision. In order to determine the ash content of the grapes remains, the general method of standardized determination was used (ASTM D2866-11 2012, Verna et al. 2009). According to this method, the milled and dried material until 0% moisture content is calcined at a temperature of 650°C in a lab oven, during 3 hours at least (Fig. 3).

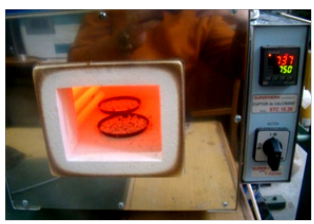

Fig. 3: Laboratory oven for determining the ash content.

The advanced calcined operation is made on a metallic crucible resistant to high temperature, and the weighting was made on an analytical balance with a 3 decimal precision.

When determining the ash content, it will be taken into consideration that the sample is completely dried and the cleaned and empty melting pot weight.

$$A_c = \frac{m_{a+c} - m_c}{m_{s+c} - m_c} \cdot 100 \qquad (\%) \qquad (2)$$

where: m_{a+c} - mass of ash plus crucible,
m_{s+c} - mass of sample plus crucible,
m_c - mass of empty crucible.

When determining the calorific power a calorimeter with explosive burning was used, at an oxygen pressure of 30 bars (ISO 1928 2009). The pellet sample with a weight of 0.6-0.8 g has been dried in a lab stove at 105°C, during 2 hours for a complete dryness. At the end of the tested period of time, it was obtaining a high calorific power as well as a low one (DIN 51900-1 2000).

There were used 6-8 replicas of the same type of raw material (ASTM D3865-12 2000). The installation used to determine the calorific value of wood biomass was the XRY-1C explosive type burner produced by Shanghai Changji Geological Institute in China (Fig. 4).

Fig. 4: Bomb calorimeter used to determine the caloric power.

The calorific power represents the quantity of energy resulted while a unit of fuel mass is burnt. Before performing the proper determination, the calibration of the calorimetric bomb is made with benzoic acid, in order to determine the caloric coefficient of the calorimeter. The procedure to determine the caloric power refers firstly to the preparing the raw material (pellets) and the installation preparation. Then, the proper determination of the calorific power and finally obtaining the results are processed. The sample is put in a metallic crucible and is introduced in a laboratory oven, in order to be dried at a temperature of 103 ± 2°C. The final result of burning lignocellulosic pellets is expressed by the calorific power, notion through which one understands the heat quantity obtained by burning a mass unit. The proper test contains a 3 distinct periods, respectively: fore, main and after. Finally the high calorific value and low calorific value are obtained.

RESULTS AND DISCUSSION

The quality of pellets doesn't depend only on the used raw material but on its grading, because larger size lead to a better compacting but a smaller density and the small sizes lead to a low compacting-adhesion, but a higher density (Rahman et al. 1989). The plane sizes (length, width or diameter) of the gross raw material were varied from 2 mm to 20 mm. The participating percentage of different plane sizes is observed (Fig. 5), which highlights the average size of

10 mm. The sizes of the milled raw material are hard to be determined, reason for which the method of sorting and weighting each fraction of material remaining above the sieve has been used (Fig. 6). It is clearly noticed that the average dimensional variation is within 0.4-0.8 mm range of milled material, and the remaining of approximately 40% shows that the most part of the material is under the size of 0.4 mm of sieve meshes.

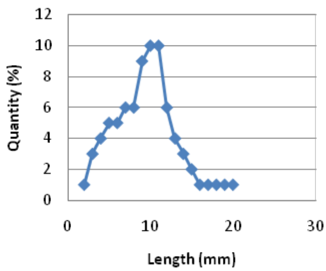

Fig. 5: Statistic distribution of the plane size of the raw material.

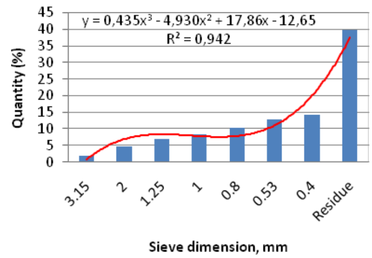

Fig. 6: Mass percentage of sorting with sieves of milled material.

The effective density of pellets was of 979 kg·m^{-3} with a standard deflection of 34.7 kg·m^{-3}. It is representing a percentage of 3.4%. It is noticed that the density of the pellets is just a bit over the one of beech wood sawdust (Mitchual et al. 2013, Hansen et al. 2013) meaning that this material is compacted well enough.

The ash content of the grape remains within a vineyard was of 4.4% - 4.7%, with an average of 4.53% (Fig. 7) and is higher than many of the most wood species, but a bit less than some barks of wooden species or wheat straws (Boutin et al. 2007, Griu and Lunguleasa 2014).

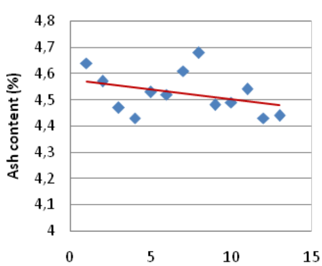

Fig. 7: Ash content tendency.

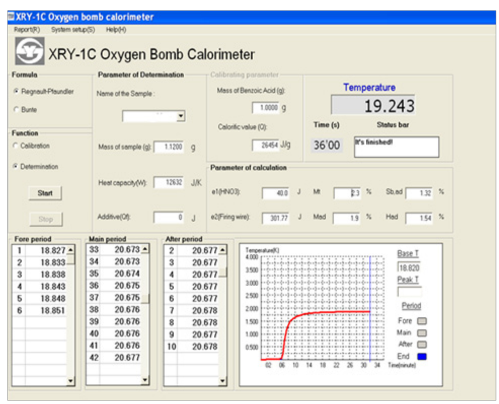

Fig. 8: The image of the computer software for explosive burning calorimeter.

The calorific value of the grapes remains was of 20.150 MJ·kg^{-1} (high calorific value) and of 19.850 MJ·kg^{-1} (low calorific value), comparable with the one of fire wood (EPC 2013) and a little bit less than the inferior coals (Fig. 8) (Garcia et al. 2004). As other researchers stated before (Prado et al. 2014) the more sugar the higher calorific value will be.

CONCLUSIONS

Grape husk (pomace) obtained from a winery in native state can't be used efficiently due to its size, biodegradability and low weight. It is recommended to diminish the dimensions of the raw material until the level of the sieve of 0.4 mm, in order to obtain the compact pellets and higher density of them. The grape raw materials has a very good caloric power, comparable with the one of fire wood and pellets obtained from beech or resinous sawdust. Even if the ash content has just some percentage higher than the fire wood, the general conclusion of the paper expresses the possibility of obtaining some pellets of good quality from this raw material, especially inside the vineyards, where an enormous quantity of raw material is obtained each year.

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