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Bioenergy 2019- High-Energy Fuel Pellets- Michael Ioelovich- Celdesigner Ltd, Israel

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Abstract
The purpose of this study was to improve main features of fuel pellets made from plant biomass. To increase energetic potential, strength and density of the pellet, as well as to reduce their hydrophility and the production cost, it is proposed to introduce into biomass (BM) the waste rubber or polyolefin as a polymer binder (PB). Calorific value (Q) and energy density (ED) of the improved pellets can be calculated by the equations: Q= Σ[(1-WPB) QBM + WPB QPB], ED=d Q, where QBM and WPB is calorific value of BM and PB, respectively; WPB is weight fraction of PB; d is density of pellets. Since QPB is more two times higher than QBM, additive of PB increases both calorific value and energy density of final pellets. It has been found that improved fuel pellets consisting of plant biomass and additive of PB are the most promising solid fuels, since they provide a higher calorific value, energy density and strength, as well as the lower hydrophility and cost than the biomass only. Moreover, the energetic features of the improved fuel pellets are close of those of solid fossil fuels such as coals (see image).

Keywords: Biomass, Polymer binder, Fuel pellets, Calorific value, Density of thermal energy

Introduction
As is known, the main solid fuel is fossil coal, which provides 28-30% of annual energy consumption in the world, about 160-180 EJ [1]. To generate such energy, more than 6 billion tons of coal are burned each year. However, this fossil source of energy is not reproduced in nature, and therefore its reserves are permanently depleted. Besides, the burning of coals is accompanied by emission of the greenhouse gas - carbon dioxide, in the huge volume of 1700-1800 m3 from each ton, which can exacerbate the problem of global warming [2]. An alternative to coal can be solid fuel based on plant biomass, which in contrast to fossil fuel, is reproduced in nature; in addition, it is considered neutral in relation to the CO2-emission. However, the plant biomass is a heterogeneous material of low bulk density, which consists of pieces of different shapes, sizes and compositions. These negative features of the plant biomass leads to deterioration in fuel properties, in particular density of thermal energy [3]. To increase the energetic density, the loose biomass is converted into dense pellets. Currently, fuel pellets are made mainly from softwoods. The first problem is that this biomass is expensive and its sources are limited, and as a result, the cost of the fuel pellets is quite high. The second problem is that fuel properties of the pellets are lower than solid fossil fuels such as coals. The third problem is that the pellets are hydrophilic, and therefore their contact with moist air during transportation and storage leads to a deterioration in their properties. The purpose of this study was to improve the fuel and other characteristics of pellets made from plant biomass.

Materials and Methods
Two types of biomass were used: (1) common feedstock such as chips of mixed softwood (SW) and (2) alternative feedstock, namely olive pomace (OP). The biomass samples were cut, knife-milled and screened through a sieve to obtain the fraction of 1 mm and then conditioned to moisture content of 10%. Polymer binder (PB), such as waste rubber or polyolefin, was also used for pelletization.

Pelletization
The milled biomass samples were heated to 100oC, compacted under pressure of 150 MPa and then cooled.

Coating
Part of the pellets was coated with a melt of PB and then cooled.

Characterization
The following characteristics of the pellet were studied: Calorific value (Q), Density of thermal energy (ED), Bulk density (d), Water vapor sorption (S) and Durability (D).

Results and Discussion
Study of fuel characteristics of pellets obtaining from plant biomass without PB additive showed that SW pellets had Q=20.1 MJ/kg and ED=12.1 GJ/m3, while OP pellets had Q= 22.7 MJ/kg and ED=13.6 GJ/m3. Significant shortcoming of these fuel pellets is their hydrophility. Therefore, after storage of the pellets in humid atmosphere (RH=85%), there is an appreciable decrease in fuel characteristics (fall on 10-16%) and durability (fall on 15-20%).

To prevent sorption of water vapor, and enhance the durability and fuel properties of solid biofuel, the pellets were additionally coated with melt of hydrophobic PB. The result was a significant improvement in fuel properties. For OP pellets coated with PB, Q value increased from 22.7 to 27.5 MJ/kg, while ED value increased from 13.6 to 19.2 GJ/m3. Thus, the energetic features of these pellets become comparable with those of fossil coal (Figure 1).

This work is partly presented at 14th Global Summit and Expo on Biomass and Bioenergy on August 26-27, 2019 at Vienna, Austria

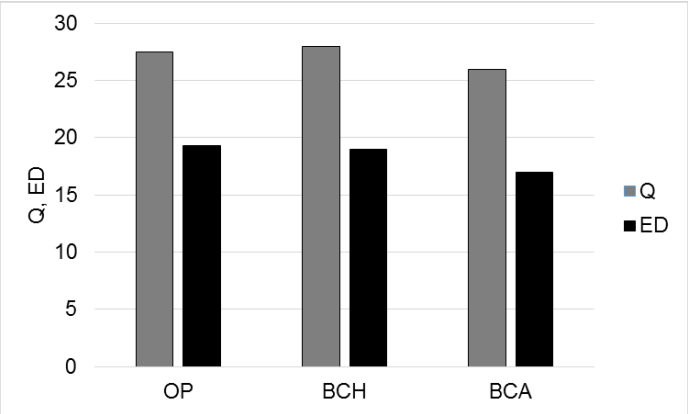

Figure 1. Fuel characteristics of OP pellets coated with PB (OP) in comparison with bituminous coal of high quality (BCH) and average quality (BCA)

Moreover, after keeping in the humid atmosphere, durability and fuel properties of the PB-coated OP pellets remained unchanged.

Conclusions

It was found that olive pomace (OP) can be a promising alternative natural source for the production of high-quality fuel pellets. However, these fuel pellets have an increased hydrophility. As a result, after storage of OP pellets in the humid atmosphere, there is an appreciable decrease in fuel characteristics and durability was observed. To significantly increase various features of the solid biofuel, a core-shell architecture for especial OP pellets having were proposed, where the core contains compacted biomass, whereas the shell consists of hydrophobic and high-energy polymer binder (PB), such as rubber or polyolefin. As a result, the hydrophobity and durability of the PB-coated pellets increases, whereas energetic features of these solid biofuels become comparable to those of fossil coals.

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