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EVERYTHING MAIZE: FOOD, FEED, OR ENERGY

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Abstract. *Maize is one of the most widely used cereal crops that attract global interest in ensuring food security; with an annual production of over 1 billion metric tonnes, it covers over one-fifth of the global calories. 56% of the total grain production is used for animal feed, and only 13% is used for human food. Its production is associated with the generation of different by-products (leaves, stalk, husk, and cobs), some of which are used as animal feed, and others are left or burned in the field. The by-products were proven to have high energy value and therefore considered promising feedstocks for biofuel production.*
Keywords*: corn, green energy, biofuels, residual biomass, sustainable waste management.*

Introduction

Maize, also called corn (*Zea mays*), is a universal crop with versatile functions within and around the world [1] that significantly attracts global interest in ensuring food security [2, 3]. Its global annual production of over 1 billion metric tonnes makes it a world-leading staple cereal [4]. It contributes more than 20% to global calories [5]. Its production is associated with the generation of different by-products during and after harvest. Some of these by-products end up in lagoons, and drainage channels, causing serious environmental problems [6], especially in the rural areas of developing countries.

The shoot, which is the harvestable part, comprises the stalk, leaf, cobs, and husk enclosing the grains [6]. Their production usually increases with an increasing planting density, aimed at improving productivity [1].

Maize is globally considered a good and widely used feedstock for feed production and an important food crop in Latin America and sub-Saharan Africa. 56% of the total grain production is used for feed and only 13% as food and food products. The remaining goes to post-harvest losses, retained as seed and other non-food uses [1, 5].

The grain, which is mainly used for food or feed, is sometimes infested during harvest or storage, making it non-viable for food or feed production. Such grains are the alternative feedstocks for biofuel production [1]. Bioethanol can therefore be produced without compromising the legislation that prohibits using food crops for energy purposes, as there will be no competition in any way. A coproduct that can be used as animal feed is obtained from bioethanol production, with a slight decrease in the quantity of maize used. After bioethanol production, 1 t of the distiller's grain is generated from every 1.2 t of maize grain [7]. Therefore, the grains intended for feed production can be used for integrated feed and energy production.

Maize stover, consisting of straw, leaves, husk, and cobs, constitutes about 73% of the total maize plant weight, mostly left on the field after harvest, and is a valuable forage source for feeding livestock. The by-products have a production rate of 24-31 $MJ.ha^{-1}$, depending on the maize variety [8]. Unlike the leaves, stalks, and husks, which are mostly grazed by livestock, the cobs are nonedible and are usually left or burned on the field.

Methodology

The analytical sample was prepared by milling each of the by-products using the laboratory knife mill Grindomix GM 100 and sieving the samples through a 1 mm screen fraction in accordance with BS EN 14780:2011 [9] standard methodology.

The gross calorific value was measured by LAGET MS-10A bomb calorimeter and calculated with equation (1) [10], according to the provision of EN ISO 18125:2017.

$$GCV = \frac{dTk * Tk - c}{m} \quad (J.g^{-1}) \tag{1}$$

where: GCV – gross calorific value ($J.g^{-1}$); dTk – temperature jump (℃); Tk – mean value of the effective heat capacity of the calorimeter as determined in the calibrations (9,161 $J.℃^{-1}$); c – total repair (repair on burning spark fine wire) (J); m – the weight of the material sample (g).
The moisture content of tested samples was 7.56 %.

Result and Discussion

The energy potential of agricultural by-products obtained from maize production, namely, maize cobs, maize leaves, and maize husk, were measured for possible utilization as feedstock for biofuel production (Table 1).

Table 1: Energy value of Maize by-products (as received)

By-product	Calorific value (MJ.kg-1)
Maize cobs	17.76
Maize leaves	17.88
Maize husk	16.89

All the by-products were proven to have good calorific value for energy utilization. Judging by their calorific value, all of them fulfilled the standard requirement of the best-graded non-woody briquette (A) [11]. The result is similar to what was reported by some researchers [12, 13] on maize cobs.

These agro-resudies' integration into energy will help in managing waste and overcoming the emissions resulting from open burning. Instead of direct combustion, as the usual practice in rural areas, the by-product can be transformed into solid biofuel (briquettes and pellets). This will improve combustion efficiency, reduces storage capacity, and eases the handling and transportation of the by-products.

This is a preliminary result of ongoing research, which will be published upon completion.

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