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ASSESSMENT OF BIOMASS QUALITY OF SOME TREE'S SPECIES FOR BIOENERGY PRODUCTION

Abstract
In view of the finite reserves of fossil fuels, and the impact of their utilization on the environment, there is a growing interest to exploit an alternative energy resources, including biomass for energy production, and reduce the net carbon emission as environmentally friendly. The increasing demand for biomass in energy production requires to be grown specifically for energy purposes. The energy plantation schemes not only for biomass production but also can improve both the livelihoods of communities and environment state and they mean more efficient land use management. Biomass feedstock is varying, and their chemical composition is highly depended on the plant species. Therefore, the most suitable plant species to be selected for energy plantation. In Our research we evaluate the biomass quality of some trees species to fill the knowledge gaps for unfamiliar species in term of bioenergy production. Our goal to address the issues of variability in biomass composition and select the most promising species as efficient feedstock for biomass-based energy production.

Keywords. *biomass quality, energy plantation, efficient feedstock, bioenergy production*.

1. Introduction

Biomass is currently the most widespread form of environmentally friendly energy and its exploitation is further increasing due to the concerns over the devastative impacts of fossil fuel utilization, on the climate and their negative impacts on human health (Galik *et al.*, 2009, Sántha *et al.*, 2020, Quyen *et al.*, 2020). Obligations of EU countries with respect to their national renewable action plans mobilized substantial amounts of forest biomass for production of wood chips and pellets (Pelkonen *et al.*, 2014). Furthermore, Africa also anticipating extending the energy tree plantation to satisfy the future increasing demands for biomass. The biomass is likely to become most common energy source worldwide in the future (Mononen *et al.*, 2016). In Hungary the annual energy consumption can be estimated 1000-1100 PJ of which the contribution of biomass is 405-540 PJ which can cover about the half of the annual needs (Vágvölgy, 2013). Another example Sudan, where the estimated woody biomass stock is 278 million m^3 and the total consumption averages 16.9 million m3 (FAO, 2012). Although the demand for biomass is increasing in the two countries, there are problems with the species of energy plantation. For example, in Hungary Vágvölgy *et al* (2012) shows how the insects pests' effect on biomass production such as the red poplar leaf beetle (*Chrysomela populi L.*). Or we can mention that there is currently no mature technology for harvesting black locust trees for energy purposes. Due to their high density and hardness, less energy is required than poplar and willow and the plantations can be harvested in one go **(**Deák *et al.,* 2017). According to Omer (2018), one of the biggest challenges in biomass utilisation in Sudan is the sustainable supply of wood fuels. Their volume is declining while the demand for renewable energy sources is constantly increasing. A reasonable approach to tackle this issue could be to present new native species with high growth performance, high biomass production and easy harvesting method to expand energy tree plantation spatially especially in marginal sites is necessary. Before proceeding to select the most suitable trees species for energy plantages, it is important must be taken into consideration the following. Firstly, there is a growing body of literature that recognises the importance of trees species selection (Gonçalves et al., 2018, Neves et al., 2011), as source of biomass and their affect to the different characteristics of fuel, furthermore to the variation within each species or types of biomass due to biological variation. And secondly, an assessing biomass quality is therefore vital to decide on its feasibility for conversion (Thomas, 2014), because some combustion technologies can accept a wide range of biomass feedstock, others require much more homogenous feedstock to operate. Identification criteria to measure biomass quality is importance for identifying the chemical and physical properties of the final product then defining the ideal use of the biomass (Da silva *et al.,* 2019). With increasing pressure on natural forests, alternative sustainable approaches are needed to keep pace with the growing demand for bioenergy (FAO, 2005). There are knowledge gaps in terms of investigating their suitability as feedstock in energy production and, there is the need for the most suitable plant species must be identified before the potential biomass production. Further research needed into the combustion characteristic of many plant species which can serve as potential feedstock in the bioenergy production.

2. Objectives

The sustainable supplies of wood fuels are declining while the need for these fuels continues to increase. Evidence suggests that correct biomass selection is among the most important factors for energy yield optimization (Da silva *et al.,* 2019). The research to date has tended to focus on biomass production rather than quality. Therefore, this study attempt to address the knowledge gaps for unfamiliar species in term of bioenergy production, throughout biomass quality evaluation of some trees species and define approach to select the most promising species as efficient feedstock for biomass-based energy. The goal is low emission of unwanted elements that cause environmental problems. Specifically, the project objectives are,

1. To select a multi-purpose trees species with high initial growth rate and naturally distributed.
2. To test the variation in biomass properties among the species that identified as candidates for evaluation.
3. To identify the variation within selected species for energy yield and suitability of them to the various bioenergetic conversion techniques.
4. To identify the main elements that impacted on environment as result of solid biofuel combustion.
5. To develop a list of the most promising species in term of biomass quality for energy production.

3. Materials and methods

3.1. Description of the study area

This research intends to develop procedures for trees species selection for bioenergy production. Since there are different type of biomass produced from various sources. Energy contained in each of the biomass materials is not the same; they vary in type and geographical zone (Thomas, 2014). Therefore, different geographical zones will be selected to compare the biomass quality and their energy content. The study will be conducted in Hungary, a landlocked country in Central Europe. Located between the 44 and 48 north latitudes and the 16 and 22 east longitudes. The climate of Hungary is continental, with the western oceanic and the southern Mediterranean climate also having an impact. With the Two main zonal vegetation types appear in Hungary: the zone of deciduous forests, which is dominated by oak and beech (especially in hilly and mountainous areas). The other zonal vegetation is the forest steppe on lowland areas, which includes different sand and loess forest steppes, and herbaceous associations (eugo.gov.hu, 2020). While the other geographical zone located in the northeast Africa continent which is Sudan, lies between 15 N, north latitudes 30 E east longitudes. The climate ranges from hyper-arid in the north to tropical wet-and-dry in the far southwest. With the various vegetation types from desert in the northern zone to closed high forest in the most southern part of the country. The central part of the country with rainfall confined to the rainy season (3-5 month) is dominated by deciduous drought tolerant tree species (En.wikipedia.org, 2020).

3.2. **Data collection**

The study will be started with tree species selection. A combination of qualitative and quantitative data collection methods will be used to gather both primary and secondary data. Prior to the laboratory analysis, a review and analysis of secondary sources will be conducted to gain general insight into the case study area and issues related to energy trees species and biomass conversion process into energy in the selected regions. Key informant structured interviews will be conducted, including experts and individuals who have information about tree species for selecting appropriate species for the evaluation process. The structured interviews will cover different issues related to the biological characteristics of native species such as high initial growth rate; high regeneration potential; formation of coppice sprouts.

3.3. Laboratory procedure

To decide the potential of biomass on energy production and their suitability for various conversion technique, and environmental impact as result of their use, the following analysis methods are necessary:

3.3.2. Proximate analysis

Many researchers have utilised proximate analysis to measure the most important characteristics of biomass fuel (Domalski *et al.,* 1986). From selected species each species will be sampled with diameter outside the bark at breast height of diameter classes 10,15, 20 and 25 cm. A disc of about 1-inch thickness will be cut from the trunk wood of freshly cut trees of each of the species. The trunk wood samples and freshly removed trunk bark besides, twigs of diameter varying from 1 to 5 cm and mature leaves of the trees will collected and used for the determination of various biomass fuel properties. The moisture content of plant parts will be determined according to the method described in ASTM D1762 methods. the sample will be weighed when wet, dried at 103 ºC for at least 24 h and weighed again when dry. And then calculated according to equation 1 (Thomas, 2014).

$$CM = \frac{m-m_0}{m} x100\% \qquad 1$$

where, m = mass of wet wood***;*** m0 = oven dry mass.

To determine the ash content, oven dry samples will be placed in a ceramic crucible and the weight of each crucible and the biomass is noted. The crucibles were then be placed and in the furnace at a temperature of 575 ºC for 3 h according to EN 14775 methods. the resulting weights of ash and moisture level in the sample are used to calculate the percentage ash present at 525ºC on a moisture-free sample basis by the relationship shown in equation 2 (Thomas, 2014).

$$Ash\ (\%) = \frac{\mathrm{mA} \times 100}{m_0} \quad (2)$$

Where, mA = mass of ash**,** m0 = mass of oven dry sample.

For bioenergy purposes the bulk density of chips is determined via shock impact BS EN 15103. A cylindrical vessel with known volume will be filled to the rim with chips and shock exposed (dropped from a certain height) to compact the chips. The vessel will then either be refilled to maximum level or the surplus material will be removed. The basic bulk density of the wet chips is then given by equation 3 (Thomas, 2014).

$$BDw = (m_2 - m_1) / V \quad (3)$$

Where, m_1: weight of vessel, m_2: weight of vessel + biomass, V = inner volume of vessel.

To determine the volatile content, oven dry samples will be placed in a ceramic crucible and the weight of each crucible and the biomass will be noted. The crucibles will then be placed and in the furnace at a temperature of 900 ºC for 7 min (ASTM E872-82). After cooling, the volatile content is calculated according to equation 4 (Thomas, 2014).

$$Volatile\ (\%) = \frac{100x(m_2 - m_3)}{m_2 - m_1} \quad (4)$$

Where, m_1 = mass of crucible, m_2 = mass of oven dry sample and crucible, m_3 = mass of contents and crucible after heating.

3.3.3. Elemental analysis

One of the most well-known methods for assessing unwanted elements that cause environmental problems is elemental analysis. Solid biomass samples will be weighed in tin containers and loaded into an automatic sampler. The tin cups will then be dropped in a tube where in the presence of external oxygen flask combustion occurs at a temperature of 1800 °C. The gaseous combustion products N2, NOx, H2O, SO2, O2 and CO2 will be carried by the helium as carrier gas through a column filled with copper oxide and from there to a Cu-column where nitrogen oxides will be reduced to elementary nitrogen, and O2 to CuO. Water will be absorbed in another column. The remaining gasses will be introduced into a TPD (Temperature Programmed Desorption) column where N2 goes right through it and the other gases are bound to the column. With a programmed temperature raise in the column the gases are released separately. They flow along a thermal conductivity detector (TCD) which produces an electrical signal proportional to the concentration of nitrogen, carbon, hydrogen, and sulphur (CN elemental analyser, 2020).

3.4. Data analysis

To determine differences between selected species and by type of wood of geographical zones, the analysis of variance will be carried out followed by a comparison of means with the method of minimum significant difference. The details of the final ranking of species and subsequent laboratory trials will be the subject of this research.

4. Expected outcomes

This study will establish baseline data on the native tree species for energy production. This point is very important on the grounds that the native tree species is more resistant to the natural enemies than exotic species accordingly they can address the issue related with pest effect on the some current energetic plantation species in the study area. Moreover, it will contribute to the knowledge on the importance of biomass quality assessment for energy production and make it as basis for selecting energy plantation species on one side and on the other side to inform the beneficiaries and stockholders about suitability of selected tree species as feedstock for various energy conversion processes. Furthermore, will help us to identify the energy content of biomass raw material for different geographical zone and possibility of exploiting them locally and globally based on their energetic properties. And restore a large area of marginal site that need long-term of solution with tree species that have favourable growing characteristics. This will ensure a sustainable and efficient biomass feedstock supply to meet the future energy need and conserve the biodiversity.

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