ISSN : 0974 - 7451 Volume 12 Issue 6

Environmental Science
An Indian Journal
Critical Review

ESAIJ, 12(6), 2016 [227-231]

Evaluation of yield characteristics cum determinant factors in earth mound method of charcoal production using billet of *Acacia nilotica*

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ABSTRACT

Tree residues are generated in large quantity in our environment. Nowadays, adding value to these residues could make them become item of economic importance. The aim of this study is to adapt a traditional method of charcoal production (Earth Mound) in order to add value to the tree residues generated in University of Ibadan with a view to enhance the benefit derived from them. The billets of *Acacia nilotica* were converted from both wet and dry wood samples. The billets were then grouped into six different parts. Moisture content to some extent has a great influence on the use of charcoal produced from traditional method as the billets of wood with a high moisture content of about 22.5% have the highest yield of 22kg of the total input of 9.83×10^{-4} m^3. Nature of covering material also contributes to the charcoal yield for wet billets covered with grasses and asbestos (W_{GA}) has the highest charcoal yield of 22kg followed by dry billets covered with grasses and asbestos (D_{GA}) with 4kg yield and the least is the dry billets covered with only grasses (D_G) of 0.13kg yield. The study was able to detect that duration of burning has a great influence on the yield of charcoal produced from traditional method with W_{GA-} (Wet billets covered with grasses and asbestos) having the lowest duration of burning of 8days but produced the highest charcoal yield of 22kg, D_{GA} (Dry billets covered with grasses and asbestos) burnt for 12days with 4kg charcoal yield while D_G (Dry billets covered with grasses only) has the highest burning duration of 13days with the lowest charcoal yield of 0.13kg. The result of the experimental test shows that the charcoal produced from traditional method is a very good source of fuel for cooking for every household but the total recovery or yield of the traditional method is considerably moderate which is about 60-89%, hence an improved mother kilning methods is recommended to compliment the traditional method.

KEYWORDS

Tree residues generation;
Moisture content influence;
Nature of covering material
Duration of burning.

INTRODUCTION

Fuel is among the basic needs of man while charcoal, gas, briquette, firewood, fossil oil; among others are various sources of fuel. All these different fuels enjoy patronage and at different rate. Charcoal appears to be gaining more popularity in the recent time and perhaps because of its unique properties. The patronage of charcoal as household fuel in developing countries have been reported to be due to its suitability as a relative clean fuel for urban environments and low cost to the end-users[2]. According to the data provided in Okimori, *et al*.[8], , from *Acacia mangium* plantations in South Sumatra 23.39% of total above ground biomass becomes wood residue (56.4t/ha from 241.1t/ha) after taking out materials for pulp. Those residues are abandoned in the field. It will decompose and can be the source of CO_2 emission. At a pulp mills, although wood bark is utilized as fuel for a generator, large amount is still abandoned[8].

In Nigeria, logging operations and related activities in natural forests, plantation and open field are generating various types of wood residue and large amount of such residue are left unused. In University of Ibadan for instance, most of the wood residue generated by such activities are often abandoned, dumped or at most sold as fire wood. Recycling them has been an important issue. Values may be added to the abundance wood residue via several methods. Producing compost can be a good way to return nutrients in wood residue to the soil. This method, however, is still not common because fermentation of wood residue is difficult. Wood residue could also be used for firewood but has great influence on environmental pollution. It could be subjected to further processing which in most cases does not work out as result of availability required raw-materials. One of the countermeasures for recycling those residues is production of charcoal for fuel, soil conditioner, water purification and other purposes, and at the same time, contributing to carbon sequestration or CO_2 emission reductions[4,8,10].

Due to advancement in technology, scarcity and tremendous increase in other fuel products, high wastage rate of forest products, human population leading to increasing demand and wide usage of charcoal in recent years, had informed the collaboration between this researcher and the University of Ibadan Campus Tree Management Committee (CTMC) to investigate the possibility of adapting local method of charcoal production to add value to abundant wood residues generated in her campus and part of this study was extended to investigate some yield parameters.

METHODOLOGY

This study was carried out in the Department Agricultural and Environmental Engineering, Faculty of Technology, University of Ibadan, Ibadan, Oyo State, Nigeria. It was aim at compiling information on yield factor parameters. The billets of *Acacia nilotis* were divided into six (6) different experimental plots. These were also divided into two (2) parts and the first part was made up of dry billets denoted by A_{dry}, wet billets denoted by B_{wet} and mixture of both dry and wet billets denoted by C_{dw}. The second part was made up of dry billets denoted by A_{dry}, wet billets denoted by B_{wet} and mixture of both dry and wet billets denoted by C_{dw}. First part was covered with grass only while the second part was covered with both grass and asbestos. The billets in each plots was about 60ft^3 (9.83x10^{-4}m^3) in volume.

Arrangement process begun with under-lay billets of about 4-6ft in length with appreciable space in between them following the subsequent arrangement of the remaining billets from one level to another until a height of about 3ft was attained with each layer or level perpendicular to under-lay and they were arranged side by side and air- tight spaces in between the billets in each experimental plots to allow easy transfer of heat from one billet to another and to allow slight passage of air for the incomplete combustion (pyrolysis) to take place. Covering of the arranged billets was achieved with the use of a dried elephant grasses to cover the surface of the billets to about 1ft thick at each of the four (4) sides and about 1.5ft thick on the upper part of the arranged billets. The surrounding ground was then wetted with water to soften the ground and was left for 24hours for easy penetration of water into the soil and for easy digging. The wetted earth or soil was used to cover the whole surface making an earth mound and a small lightning faces were then exposed at the leg sides of each heaps through which they were later lighted and a small protruding hole was then made at the bottom of the burning mound which is very important, for release of tar or moisture, etc. and in order to allow slight passage of air for incomplete combustion (pyrolysis) to take place. Ignition of the earth mounds were achieved by lightning small fire wood after which fire was transferred to the earth mound via opened face regarded as the leg of the mound and later covered after some part of the billet had been ignited. The ignited earth mounds were monitored day and night in order to observe the rate of burning and to salvage the mounds incase of exposure which can lead to a complete combustion instead of incomplete combustion (pyrolisis). The charcoals produced were harvested after six (6) days and allow cooling, following the massive picking and packaging of the charcoal into very portable transparent sacks.

The harvesting of the burnt billets was achieved by stopping the burning fire with about 125litres of water for each of the earth mound after they have been left for about six (6) days to burn. Small holes were made on the earth mound through which water was poured to stop the burning process. The volumes of each earth mounds were determined using the formula;

$V_p = L \times B \times H$

Where,

V_p = Plot volume (m^3)

L = Length of the plot (m)

B = Breadth of the plot (m)

H = Height of the arranged billets (m)

Moisture Content was also calculated using the formula;

$$\% \text{ M.C} = \frac{\text{Wet weight - Dry weight}}{\text{Dry weight}} \times 100$$

RESULTS AND DISCUSSIONS

The results of the yield for the six sample plots of 9.83x10-4m^3 each in volume were presented in TABLE 1. A further analysis of the results were presented in Figure1

From TABLE 1 above it was observed it that the plot labeled W_{GA} has the highest yield with value 22.0kg followed by D_{GA} with value 4.0 kg while the least is C_G with value 0.13kg. According to FAO[3], the variation in the yield shows that to some extent the presence of moisture has positive influence on productivity. Mok and Antal, also speculate that this is due to the moisture's role as a catalyst in charcoal formation. It was also observed that, plot tagged W_{GA} has the lowest burning duration of 8days followed by D_{GA} of 12days while D_G being the highest with 13days. The variation in the duration of burning agrees with FAO[3] submission that

TABLE 1 : Summary of effect of moisture content and nature of covering material on charcoal yield

Plots	Volume of input (m^3)	Output Weight (Kg)	%M.C	Duration of burning (Days)
W_G	$9.83\text{x}10^{-4}$	0.15	22.5	12
W_{GA}	$9.83\text{x}10^{-4}$	22.0	22.5	8
D_G	$9.83\text{x}10^{-4}$	0.13	4	13
D_{GA}	$9.83\text{x}10^{-4}$	4.0	4	12
C_G	$9.83\text{x}10^{-4}$	0.5	13.3	12
C_{GA}	$9.83\text{x}10^{-4}$	0.14	13.3	13

Keys: W_G = Wet billets covered with grasses; W_{GA} = Wet billets covered with grasses and asbestos; D_G = Dry billets covered with grasses; D_{GA} = Dry billets covered with grasses and asbestos; C_G = Mixture of dry and wet billets covered with grasses; C_{GA} = Mixture of dry and wet billets covered with grasses and asbestos

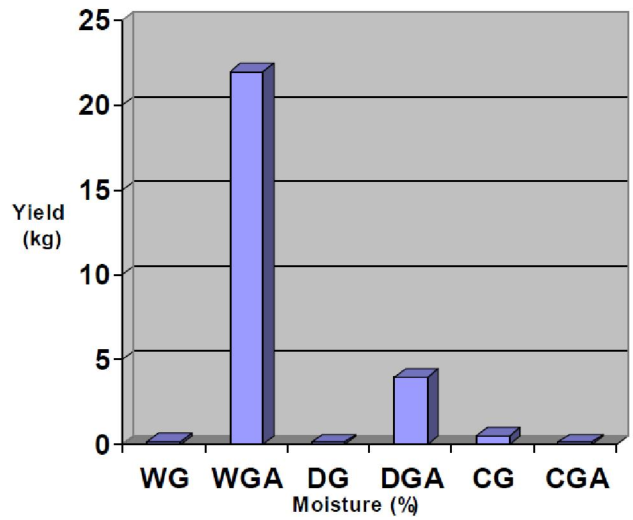

Figure 1 : Yield vs moisture content

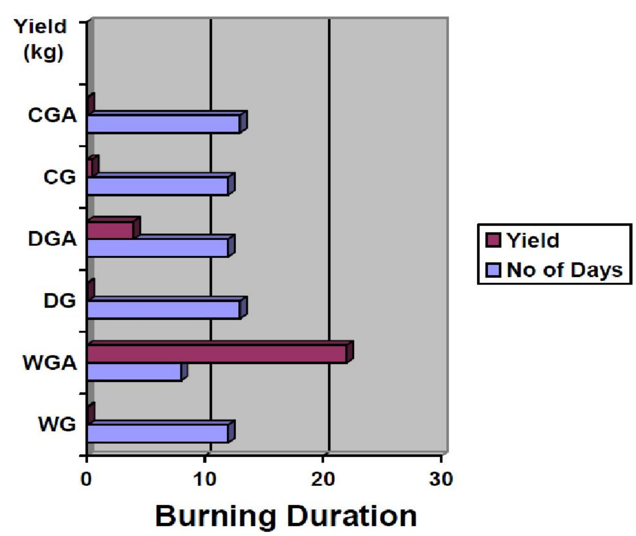

Figure 2 : Yield vs burning duration

Plate 1 : Arranged billets of wood

Plate 2 : Covering of billets

Plate 3 : Samples of a packaged charcoal

Plate 4 : Samples of collected fragmented charcoal

the presence of moisture has a negative influence on duration of burning because heating of water and its evaporation takes time and that the drying always comes with cost.

Furthermore, it was observed that the plot covered with grasses and asbestos has more yield than the plots with only grasses with W_{GA} being the highest 22.0kg, followed by D_{GA} 4.0kg and the least is C_G 0.13kg.

The figure shows that W_G (22kg) has the highest yield followed by D_{GA} (4kg) while the least is D_G (0.13).

The figure shows that W-$_{GA}$ has the lowest burning duration (8days) with highest charcoal yield (22kg) followed by D_{GA} (12days) with 4kg yield while D_G being the highest (13days) with lowest charcoal yields (0.13).

Sir! Plates showing the following are needed: clearing of site; covering of arranged billets; igniting the earth mound; harvesting of the formed charcoal and lastly the samples as below.

CONCLUSIONS

This study confirmed that commonest of all the traditional method in use in places visited is earth mound and is easy to adapt and transfer. Earth mound also involved a lot of drudgery; this is reason while the charcoal making is practice mainly for men. It takes between 4 to 5 days for the pyrolysis to go to completion especially with partially dried wood. It was also established that the use of concrete slab improves the yield. The study further confirmed that moisture content, nature of covering materials and duration of burning to a large extent has a great influence on the yield of charcoal produced from tradition method.

RECOMMENDATIONS

It is however recommended that wet and denser wood should be used in charcoal produced from traditional method. Burning site should be well monitored to control and salvage earth mound when need arises. Also used building material such as used asbestos can employed while covering the earth mound. Afforestation program should be embarked on in order to replace any tree felled for charcoal production which will also enhanced the availability of raw-material for charcoal production and other uses.

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