

# Examination of Chemical Properties of Ethanol Product of *Brachystegia eurichoma* Wood

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## Abstract

This work covers the process of making Ethanol from wood biomass instead of starchy biomass. The saw dust of *Brachystegia eurichoma* was collected in a saw mill in Ore, Ondo State, Nigeria and it was used to produce ethanol by hydrolysis and fermentation processes. The density of the wood species was 750 kg/cm<sup>3</sup>. The density of the ethanol produced was gotten to be 0.8033 g/cm<sup>3</sup>. The ionic constituents of the ethanol from the wood biomass was analyzed using Fourier Transform Infrared Spectrometric Analyzer (FTIR) and Atomic Absorption Spectrometric Analyzer (AAS). The AAS result shows that the ethanol obtained from the three wood species contains transition metals like Copper (Cu), Zinc (Zn), Cadmium (Cd) and Chromium (Cr) while the FTIR results show the presence of ethanol functional groups such as OH, Carbon to carbon single bond which are normal components of ethanol in the conventional ethanol.

**Keywords:** Ethanol; Hemicellulose; Lignin; Caustic soda; Tetraoxosulphate (Vi) acid; Sugar; Filtration

## Introduction

For several decades, the major source of power in Nigeria apart from the irregular hydroelectric power source as well as the solar power source is the petroleum. The Crude oil is refined to obtain fractions like petroleum gas, petrol, kerosene, diesel etc. [1] in refineries which are not functional in Nigeria. These petroleum fractions are used in driving engines, lighting of lamps and cooking gargets such as stoves, gas cookers etc.

The petroleum fractions whose sources are from Nigeria and some other countries, are too costly due to high cost of exportation of the crude oil resource for refining in foreign countries and high cost of importation of the refined oil.

Apart from the high cost of the crude oil fractions, incomplete combustion of the fractions of petroleum in engines brings about the release of a poisonous gas called carbon monoxide to the atmosphere. Inhalation of carbon monoxide by man and animals causes serious respiratory problems which cause drastic increase in the mortality rate of living organisms in the environment [1,2]. The petroleum fractions obtained from some other countries contain lead dust and sulphure impurities that are also injurious to man [1]. In order to check the adverse effects of petroleum fractions on lives, scientists discovered the use of ethanol, which burns completely with smokeless flame and without carbon monoxide, emission as fuel alternative [3-8].

As the production of ethanol increased, the effect of biofuel on agricultural markets and the environment became increasingly an important topic. The evolution of new biofuel production technologies could help alleviate some of the concerns regarding the use of food for fuel by facilitating the use of non-feedstock [9-15]. It could also alleviate some of the environmental concerns associated with grain ethanol production. In particular, ethanol produced from wood species is believed to hold great promise in this regard. Hence there is the need for the development of an alternative means of ethanol derivation that reduces the competition between starch consumers and ethanol biofuel makers and in order to put an end to the use of hazardous and costly petroleum fractions.

This research therefore reveals a cost effective method of ethanol production from (*Brachystegia eurichoma*), the yield and the chemical

composition of the ethanol produced from the saw dust of the wood dust (*Brachystegia eurichoma*) in comparison with that of conventional ethanol.

## Materials and Methods

### Hydrolysis of lignocellulosic material

*Brachystegia eurichoma* wood was turned to dust with the aid of a sanding machine. The dust was sieved to create uniformity of particles with the aid of sieve with the mesh size of 200 picometre (pm). The saw dust samples were then air dried for 12 hours to remove moisture. Air drying was preferably used to avoid massive escape of minerals to the atmosphere due to volatilization. A conical flask was filled with 100 g of dry sawdust of *Brachystegia eurichoma* and 300 ml of 18 M H<sub>2</sub>SO<sub>4</sub> (sawdust to acid (w/v) ratio is 1:3) was added to each of them at standard conditions. In 1000 ml beaker, 200 ml of distilled water was added and the acid solution was poured and stirred thoroughly [16-18].

### Neutralization of acidified sugar solutions

8.5 M NaOH (caustic soda/sodium hydroxide) solution was prepared and added to the acidified sugar solution obtained. This is done to increase the pH of the resulting hydrolyzed cellulosic paste to about pH of 5-6 which is the suitable pH for the growth of *Saccharomyces* (Yeast cell) needed for fermentation.

### Filtration of hydrolyzed solution

The neutralized solution was poured on the open flat surface of Buchner funnel whose protruding end was placed in a conical flask

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[19-25]. By so doing, the lignin component of the solution in form of black solid residue remained in the funnel, from where it was disposed while liquid filtrate of fermentable sugar solution was collected in the conical flask.

### Fermentation and purification

About 10 g of potato dextrose Agar (PDA) was dissolved completely in 250 ml of water in a conical flask. The mixture was covered with cotton wool and foil paper and then sterilized in an autoclave at 121°C for 5 minutes. On removal, it was allowed to cool and then poured into Petri dishes and set aside so as to solidify. The *Saccharomyces cerevisiae* cells were then introduced into the Petri dishes with the aid of a sterilized inoculating loop. The Petri dishes were sealed and kept in an incubator for 48 hours at a temperature of 250°C.

The culture of *Saccharomyces cerevisiae* in the agar slant tube was dissolved in 10 ml of distilled water containing a drop of tween80 oil (an oil whose presence aids the growth of yeast according to Tran et al.) in a separate conical flask [26-35]. 10 ml of the solution was then added to the filtrate samples to ferment them. Ethanol fermentation was performed in a shaker incubator at 150 rpm (revolution per minute) for 72 hours at 36°C to allow it to ferment completely. The Ethanol solution was distilled using a distillation bath at 78°C as water distilled at 100°C. A pure ethanol was then obtained.

### Chemical analysis of ethanol product of the wood

The authenticity of the ethanol was ascertained by determining its density according to Ababio and compared with that of conventional ethanol which is made from petroleum (hydrocarbon).

Ethanol derived from the wood dust of *Brachystegia eurichoma* was tested for the concentration of Cadmium (Cd), Copper (Cu), Zinc (Zn), Chromium (Cr) as it was passed through Atomic Absorption Spectrometer. In the process, the ethanol was aspirated into an air-acetylene flame, which caused evaporation of the solvent and vaporization of the free metal atoms; a process known as atomization [36-45]. The concentration in part per million (PPM) of each of the metals present in the ethanol was measured with a conventional UV-visible dispersive spectrometer with photomultiplier detector.

The various functional groups that constitute the molecular structure of ethanol was also tested for by passing the sample of the ethanol derived from the wood dust of *Brachystegia eurichoma* through Fourier Transform Infrared Spectroscopy (FTIR) analyzer. The FTIR analysis was performed on a Thermo Scientific-Nicolet 6700 FTIR spectrometer in attenuated total reflection infrared mode. The spectra were recorded in the wave number range of 4000 to 400  $\text{cm}^{-1}$  in the transmittance mode at a resolution of 4  $\text{cm}^{-1}$ , with 64 scans per specimen.

### Results and Discussion

The concentration in part per million [PPM] of Cadmium (Cd), Copper (Cu), Zinc (Zn) and Chromium (Cr) ion in the ethanol produced from the wood dust of *Brachystegia eurichoma* is  $0.072 \pm 0.0012$ ,  $0.587 \pm 0.0009$ ,  $0.955 \pm 0.0055$ ,  $0.104 \pm 0.0003$  respectively. The above chart clearly shows that Zinc (Zn) has the highest concentration in the ethanol product of *Brachystegia eurichoma* [46-50]. The metallic ion having the least concentration is the Cadmium ion (Cd). The metallic ion with the next highest concentration after Zinc ion (Zn) ion is the Copper ion (Cu) ion. The concentration of Chromate ion (Cr) is lower than that of Zinc (Zn) and Copper (Cu) ion but higher than that of Cadmium (Cd) in the ethanol made from the wood of *Brachystegia eurichoma* (Figure 1).

The FT-IR of Ethanol produced from the wood of *Brachystegia eurichoma* as illustrated in Figure 2 above, shows the following peaks of wave numbers: 3336  $\text{cm}^{-1}$ , 2091  $\text{cm}^{-1}$ , 1643.45  $\text{cm}^{-1}$ , 1259.06  $\text{cm}^{-1}$ , 415.54  $\text{cm}^{-1}$ . The Wave number 3336  $\text{cm}^{-1}$  shows the presence of OH compound like Ethanol, Xylitol, Alcoholic Lignin, Sugars from Cellulose and Hemicellulose [51-55]. The Wave number 2091  $\text{cm}^{-1}$  shows the presence of compounds with carbon to hydrogen bond (C-H) as in ethanol, Lignin, Cellulose and Hemicellulose sugars. The wave number 1643.28  $\text{cm}^{-1}$  Shows the presence of compound that contain carbon to carbon double bond (C=C). This is common to phenolic compound like Lignin sub unit. The wave number 1259.06  $\text{cm}^{-1}$  shows the presence of Phenolic OH group like Lignin. These are in agreement with the specification made by Bodirlău and Teacă [56-60].

### Conclusion

Waste wood biomass in form of saw dust can serve as the source of green house free ethanol fuel as a good alternative to petroleum products whose cost of production is higher and also pollutes the air as it burns with smoky flames as well as a good alternative to ethanol produced from starchy Agricultural food stuffs which has been competing with man's food availability [61-65].

The ethanol from the wood biomass contains the following metallic ions:  $\text{Cu}^{2+}$ ,  $\text{Cd}^{2+}$ ,  $\text{Zn}^{2+}$  and  $\text{Cr}^{2+}$ . The ethanol from the wood biomass contains the following functional groups: -OH, C-C, C-H by which it is actually confirmed to be a real organic compound and the presence

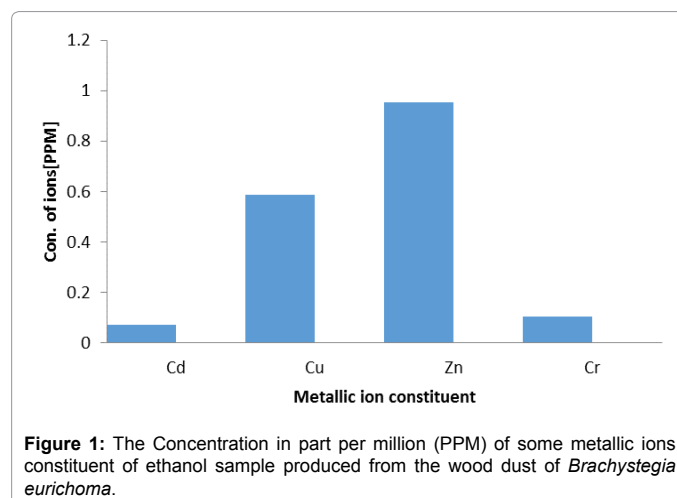


Figure 1: The Concentration in part per million (PPM) of some metallic ions constituent of ethanol sample produced from the wood dust of *Brachystegia eurichoma*.

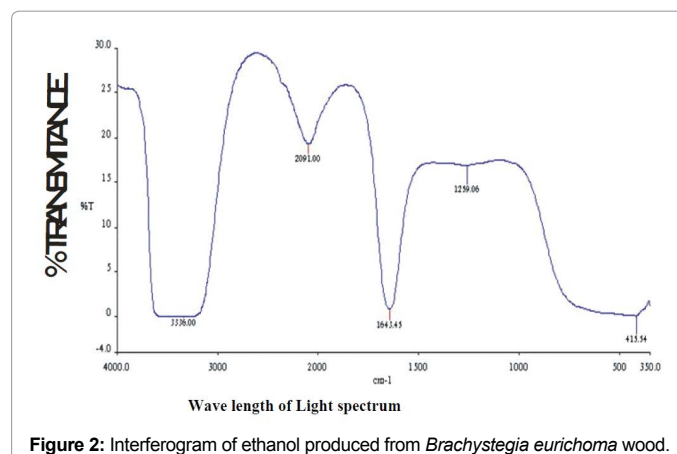


Figure 2: Interferogram of ethanol produced from *Brachystegia eurichoma* wood.

of OH group confirms that it is an organic compound that belongs to the same homologous series as ethanol [66-69]. The density of the ethanol produced from *Brachystegia eurichoma* sawdust is 0.8033 g/cm<sup>3</sup> and with this unique density the ethanol from the wood species is confirmed to be ethanol.

## Recommendation

Petroleum economy is enviable but has a lot of terrible associated problems. Nations that rely solely on petroleum economy often slum into unforeseen fatal problems. Agro based Economy is therefore recommended because of its lasting effects, particularly for the African nations that are agrarians.

The wood biomass (*Brachystegia eurichoma*) is recommended for ethanol production due to the priceless availability of its saw dust instead of depending on feed stock raw materials in order to save them for food security and continuity and instead of depending on very expensively produced fossil fuels called petroleum whose combustion releases poisonous exhaust to the environment.

The density of ethanol is the same as 0.8033 g/cm<sup>3</sup>, no matter the type of raw material from which the ethanol is produced. Transition metals like Cu, Cd, Cr, Zn play important roles in binding enzymes to substrate sugars during the production of ethanol. They are readily present in the wood biomass of *Brachystegia eurichoma*. For more efficient production of ethanol, the addition of transition metals to the substrate or the use of the sawdust of any of the three wood species like *Brachystegia eurichoma* is therefore recommended. Ethanol from wood biomass is therefore recommended as a good fuel alternative to costly and smoky petroleum fuel.

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