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Characterisation of Biodiesel Produced Using Domestic Waste Ash as Catalyst in the Transesterification Stage

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Abstract- *Domestic wastes ash of unripe plantain peels, palm fruit husks and kola nut pods were used in place of inorganic potassium and sodium in biodiesel production. Analysis of fuel parameters such as Density, Viscosity, Cloud, Pour and Flash points were carried out on the produced biodiesel using the American Standard for Testing Materials ASTM D6751. Quantitative analysis with Atomic Absorption Spectroscopy was done to determine the presence of metals on the 3 ash samples. The result of fuel parameters of Density (mm²/s), Viscosity (mm²/s), Cloud (°C), Pour (°C) and Flash (°C) points gave 0.890±0.007, 5.046±0, 9.0±0.28, 6.5±0.35, 168±1.41 respectively for unripe plantain sample; 0.890±0.01, 5.196±0.00, 9.0±0.56, 6.0±0.14, 168±8.48 for palm fruit husk; 0.895±0.01, 5.912±0.00, 10.25±0.14, 8.0±0.70, 172±2.82 for kola nut pods and 0.886±0.00, 4.813±0.01, 6±0.28, 3±0.00, 165±2.12 for the control sample. Quantitative analysis of the ash samples for metals showed the presence of these metals in the following order K > Na > Pb; Na > K > Pb and K > Na > Pb respectively. The samples studied were found to be rich sources of alkali which can be utilized as alternative to conventional alkali in industries.*

***Key words**: Alkali, Biodiesel, Domestic Wastes, Transesterification.*
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1. Introduction

Modern biofuels have been reported as a promising long-term renewable energy source which has potential to address both environmental impacts and security concerns posed by current dependence on fossil fuels [1, 2, 3]. Biofuels are a wide range of fuels which are derived from biomass. The term covers solid biomass, liquid fuels and various biogases [4]. Biodiesel refers to a vegetable oil or animal fat- based diesel consisting of long- chain alkyl (methyl, propyl or ethyl) esters. Biodiesel is typically produced by chemical reaction between lipids (vegetable oil or animal fat) and an alcohol producing fatty acid esters. It is a completely natural, renewable fuel applicable in any situation where conventional petroleum diesel is used. This environment-friendly fuel reduces tailpipe emissions, visible smoke and obnoxious odors. It can also be used in blends with conventional/ petroleum diesel while still achieving substantial reductions in emissions. It is meant to be used in standard diesel engines and is distinct from the vegetable and waste oils used to power diesel engines. The technical name of biodiesel is mono- alkyl ester of fatty acids [5].

Biodiesel Fuel Quality- For biodiesel to be sold in the market, the fuel must meet certain quality specifications. In the United States, biodiesel must meet the American Society for Testing and Materials (ASTM) requirements for biodiesel fuel in its D 6751 standard. The standard in Europe is defined by EN14214. These properties include density, viscosity, pour point, cloud point, flash point, and cetane number.

In this study, production of biodiesel by the base catalyzed transesterification process using a combined alkali regime (sodium and potassium) got from ash of domestic wastes was carried out. The biodiesel produced was characterised based on the American Society for Testing and Materials Standard for fuel quality.

2. Materials and Methods

2.1 Materials

The palm kernel oil used as the biodiesel feedstock was purchased at the Eke ukwu market, Owerri. The domestic wastes materials of unripe plantain peels, palm fruit husks and kola nut pods were got from AIFCE Staff Quarters, Owerri, Nigeria. All other chemicals were of analytical grade.

2.2 Synthesis of Biodiesel

The protocol described by Ojolo *et al.,* [6] was used.

2.3 Quantitative Determination of Some Elements in the Ash

The method described by_Babayemi and Adewuyi [7] was used with slight modifications. The elements were Na^{2+}, K^{2+} and Pb^{2+}.

2.4 Determination of Specific Gravity

This was done according to ASTM standard D1298.

2.5 Determination of Viscosity

This was done according to ASTM standard D445.

2.6 Determination of Cloud Point

This was done according to ASTM standard D25100-8.

2.7 Determination of Pour Point

This was done according to ASTM standard D97.

2.8 Determination of Flash Point

This was done according to ASTM standard D56.

3. Results

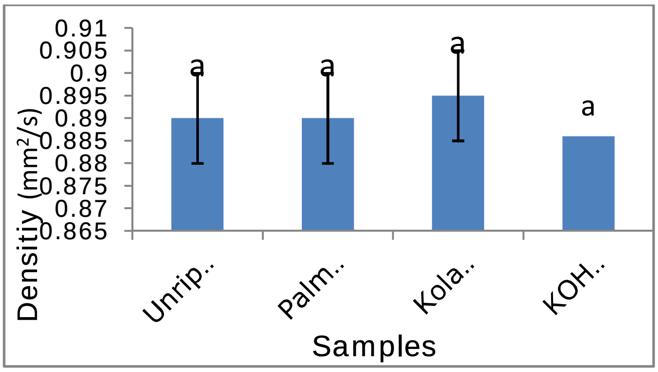

Figure 1 showing result of fuel characteristics: density.
a= significant.
***Values are mean ±SD of triplicate determinations.**

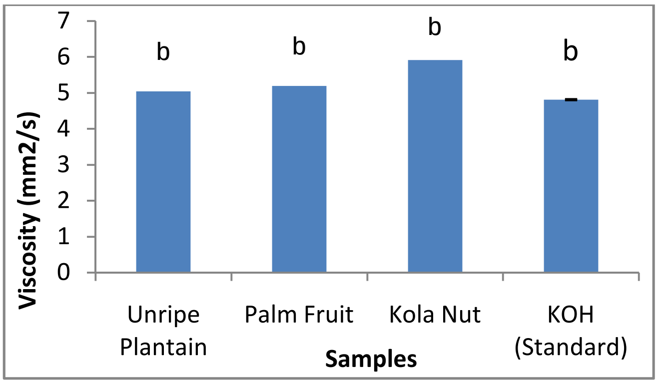

Figure 2 showing result of fuel characteristics: viscosity.
b= not significant.
***Values are mean ±SD of triplicate determinations.**

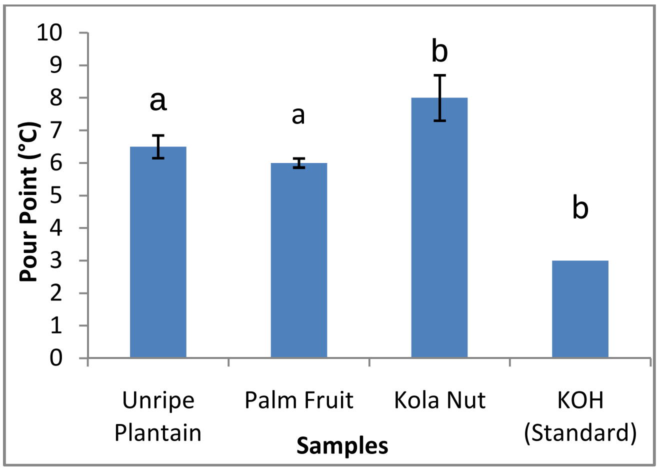

Figure 3 showing result of fuel characteristics: pour point.
a= significant; b= not significant.
***Values are mean ±SD of triplicate determinations.**

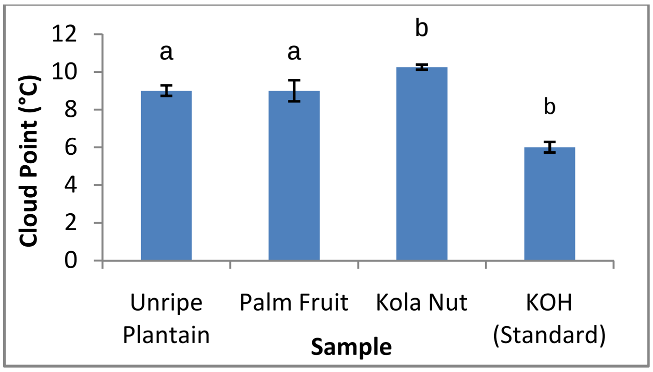

Table 4 showing result of fuel characteristics: cloud point.
a= significant; b= not significant.
***Values are mean ±SD of triplicate determinations.**

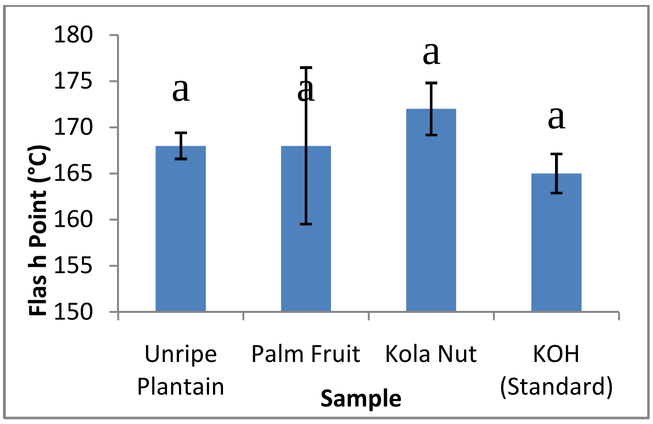

Table 5 showing result of fuel characteristics: flash point.
a= significant.
***Values are mean ±SD of triplicate determinations.**

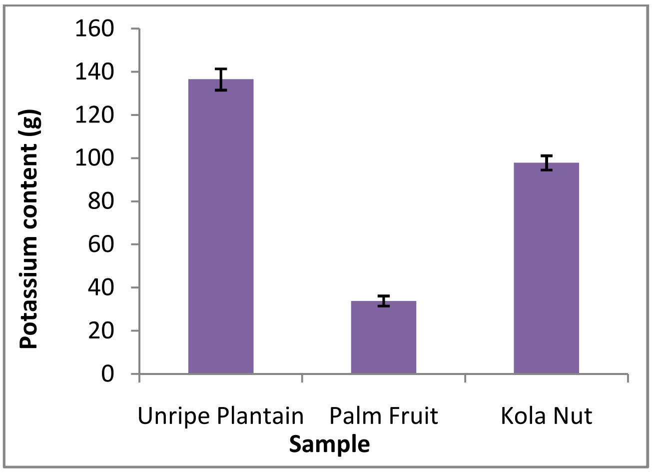

Fig. 6 Potassium content of domestic wastes ash samples.
***Values are mean ±SD of triplicate determinations.**

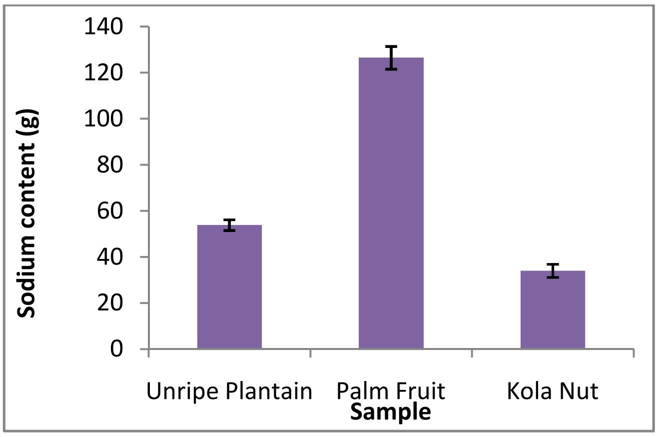

Fig. 7 Sodium content of domestic wastes ash samples.
***Values are mean ±SD of triplicate determinations.**

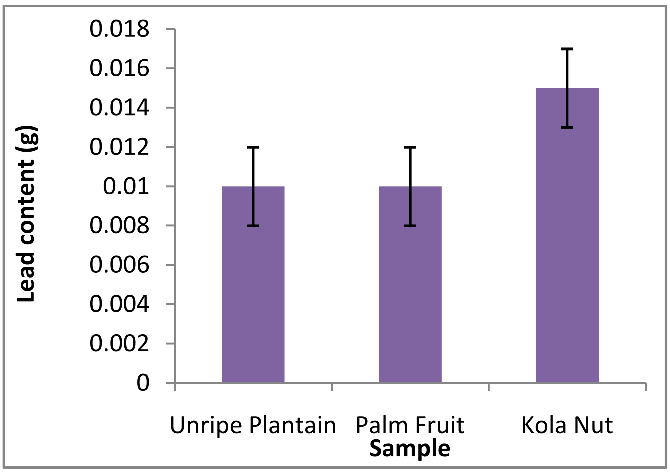

Figure 8 Lead content of domestic wastes ash samples.
***Values are mean ±SD of triplicate determinations.**

4. Discussions

The results presented above show ample concentrations of K and Na contained in aqueous extract of ashes all the samples of the domestic wastes while the concentration of Pb was insignificant. The result confirms that potash or soda ashes extracted from ashes are not only salts of K and Na but other compounds of other metals that are highly soluble in water. This implies that heavy metals that have a reduced solubility in water do not dissolve easily. The modified process which involved subjecting the dried palm bunch husk and plantain peels respectively to total combustion, soaking, filtering and recrystallizing the ash-residue to obtain a colourless filtrate and pure extract of the alkali has proved an effective way of getting a pure alkali extract devoid of heavy metals which invariably are not soluble in water. The result is in agreement with the works done by Babayemi *et al.,* [8], Akunna *et al*., [9] and Onyegbado [10]. The use of these ashes as alternative to inorganic KOH or NaOH in the transesterification stage of biodiesel synthesis will not in any way lead to Pb emission in the atmosphere; its maximum contaminants level being 0.3 mg/kg CEC [11]. The low level of Pb is attributable to its poor solubility in water. Also, it can be seen that the alkali used in the transesterification process is a mixed alkali regime as the 3 samples contain both Na and K in appreciable quantities, thus enhancing the efficiency of the ash samples.

Specific gravity got for the biodiesel samples were higher than the values for petroleum diesel. This is expected because of the nature of the feedstock for biodiesel. The results showed the biodiesel as good alternative to diesel fuel.

Viscosity values for the biodiesel got were higher than viscosity for petro diesel. Abigor *et al.,* [12] reported a viscosity of 32.40 mm^2s for Nigerian palm kernel oil. The transesterification of the palm kernel oil of which the catalyst plays a major role has thus achieved a reduction of its viscosity in the PKO biodiesel. The catalyst used in this work did not have a negative effect on the viscosity reduction process; rather it gave results similar to works done by Alamu *et al.,* [13] and Abigor *et al.,* [12] with similar catalysts. This makes the transesterification process a beneficial mechanism as it can enhance the fluidity of this fatty acid methyl ester in diesel engines.

The cloud and pour points are a measure of biodiesel's cold weather characteristics. The cloud and pour points were higher than that of petro diesel. The cloud point is the temperature of the fuel at which small, solid crystals can be observed as the fuel cools or the temperature at which heavier components of the biodiesel solidify, resulting to cloud of crystals. While pour point is the temperature at which wax becomes visible when the fuel is cooled. The presence of particles and impurities and their type grossly increases the cloud point values. Some ash particles which were the source of alkali for the transesterification stage must have passed the filtration point to the biodiesel sample. Subsequent washing with water may not effectively remove them owing to the lipophilic nature of the biodiesel as they can be dispersed in the solution and settle when allowed to stand. Hence, the higher level of cloud point. This invariably also affected the pour point. The values from this study were significantly higher than that reported by Alamu *et al.,* [13] using of same feedstock but catalysed by inorganic KOH. However, the values showed that the ash got from the samples can be very efficient and can alternate the standard alkali in industries.

The flash point is not directly related to engine performance. It is, however, of importance in connection with legal requirements and safety precautions involved in fuel handling and storage. The flash points of the diesel samples were within the standard range, and therefore generally accepted.

Conclusions

This research reveals the possibility of synthesis of biodiesel as an alternative diesel fuel from PKO using base catalysed transesterification process and a bio-inorganic source of alkali as catalyst. These bio-inorganic alkalis which were sourced from unripe plantain peels, kola nut pods and palm fruit husks are readily available within our society. They can be easily sourced and harnessed for commercial production of biodiesel. The fuel characteristics of the biodiesel produced are comparable to that of standard fuel, which suggests that it can be used as an alternative to normal fuel.

References

[1] Batidzirai, B, Faaij, A. P. C and Smeets, E., 2006. Biomass and Bioenergy Supply from Mozambique. *Energy for Sustainable Development*, 10(1): 54-81

[2] Alamu, O.J, Waheed, M. A, Jekayinfa, S. O and Akintola, T. A., 2007. "Optimal transesterification duration for biodiesel production from Nigerian palm kernel oil". Agricultural Engineering International: *the CIGR Ejournal Manuscript EE 07018*. Vol. IX.

[3] Gupta, P. K, Kumar, R, Panesar, B. S and Thapar, V. K., 2007. Parametric studies on biodiesel prepared from rice bran oil. *Agricultural Engineering International: The CIGR Journal of Scientific Research and Development* 9: 06-07.

[4] Demirbas, A., 2009. "Political, economic, and environmental impacts of biofuels: a review". *Applied Energy* 86: 108–117.

[5] American Standard for Testing Materials ASTM, 2009. Standard Specification for Biodiesel Fuel (B100) Blend Stock for Distillate Fuels.1131-1136.

[6] Ojolo, S. J, Adelaja, A. O, Sobamowo,. G M., 2012. Production of Biodiesel from Palm Kernel and Groundnut Oils. *Advanced Materials Research,* 367: 501- 506.

[7] Babayemi, J. O and Adewuyi, G. O., 2010. Assessment of Combustion and Potash Production as Options for Management of Wood Wastes. *Journal of Applied Sciences and Environmental Management,* 14 (1): 73- 75

[8] Babayemi, J. O, Dauda, K. L, Kayode, A. A. A, Nwude, D. O, Ajiboye, J. A, Essien, E. R and Abiona, O. O., 2010. Determination of Potash Alkali and Metal Contents of Ashes Obtained from Peels of Some Varieties of Nigerian Grown Musa Species. *BioResourses,* 5(3):1384- 1392.

[9] Akunna, T. O, Ahaotu, E. O, Osuji, C. N and Ibeh, C. C., 2013. Production of soap using palm bunch ash. *International Journal of Applied Science and Engineering*, 1(2): 79-82.

[10] Onyegbado, C. O, Iyagba, E. T and Offor, O. J., 2002. Solid soap production using plantain peels ash as source of alkali. *Journal* of *Applied Science and Environmental Management,* 6(1): 73-77.

[11] Commission of the European Communities CEC. 2008. Setting maximum levels for certain contaminants (amending regulation (EC) no 1881/2006) *Journal of European Union*.

[12] Abigor, R.D, Vadia, P.O, Foglia, T.A, Haas, M. J, Jones, K.C., Okpefa, E., Obibuzur, J. U, Bafor, M. E., 2000. Lipase-catalyzed production of biodiesel fuel from some Nigerian lauric oils. *Biochemical Society Transactions,* 28(6): 979 – 981.

[13] Alamu, O. J, Akintola, T. A, Enweremadu, C. C and Adeleke, A. E., 2008. "Characterization of Palm-Kernel Oil Biodiesel Produced Through NaOH-Catalyzed Transesterification Process*". Scientific Research and Essay,* 3(7): 308-311.