Extraction and Physicochemical Characterization of Walnut (*Juglansregia*. L) Seed Oil for Biodiesel Production.

G.B. Folaranmi[1]; C.U. Ibeji[2]*; and N. Oji[1]

[1]Department of Chemistry, Federal University, Ndufu, Alike, Ikwo, Nigeria.
[2]Department of Pure and Industrial Chemistry, University of Nigeria, Nsukka, Enugu, Nigeria.

E-mail: ugohukwu.ibeji@unn.edu.ng*
Telephone: +2348063653002

ABSTRACT

The physicochemical characterization of the oil extracted from walnut seed was carried out in this work. The oil was analyzed for density at 25^{o}C, acid value, saponification value, iodine value, peroxide value, ester value, and kinematic viscosity. The acid value was 0.84mg KOH/g. The total acidity expressed as acid value gave the index of the amount of free fatty acids present in the oil and hence, it measures the extent of rancidity in a stored oil sample. The fatty acid and saponification value were 0.423 and 308mg KOH/g. The high value of the oil reveals the high molecular weight of the fatty acid of the triglycerides present in the walnut seed oil.

The values of the physicochemical analysis fall within the range of the standard set by ASTM and EN for walnut (*Juglansregia. L*) seed oil. The values of the parameters obtained showed that the oil can be used in biodiesel production.

(Keywords: walnut seed, physicochemical parameters)

INTRODUCTION

Biofuel is a form of fuel gotten synthetically from biomass (a source of renewable energy from living matters, i.e., plants, microbes, etc.) as opposed to fossil fuel. Developing nations like Nigeria find solace in the monopolistic use of fossil fuel which sometimes may be ecologically unfriendly. Walnut has many medicinal advantages and in addition, can be used in the production of biodiesel. Biodiesel production is quite chemically oriented and it is useful mainly in the aviation Industry (Liu*et al*., 2010).

The process of producing biofuel, biodiesel, is through a chemical esterification and trans-esterification reaction. This involves the reaction of animal fat or oil with short chains alcohols typically methanol or ethanol (Dermirbas, 2010).

The patent work is dated back to Duffy and Patrick in 1853 where vegetable oil was first trans-esterified. A great amount of research had been done since its discovery and the first test flight was performed by a Czech jet aircraft powered on biodiesel (Liu et al., 2010).

So many feed stocks have been used in biodiesel production. Straight vegetable oil has several advantages which include low sulfur and aromatic content with high viscosity. Currently, more than 95% of world biodiesel is produced from edible oils (soybean, rapeseed, and palm kernel oil) which are easily available (Gui *et al.,* 2008). Animal fats such as chicken fat, beef and sheep tallow, etc. are another group of viable feedstock for biodiesel production. In comparison to vegetable oils, fat possesses low free fatty acids but the limitation is the availability of the material to meet the world demand (Basiron, 2007).

The advantages of biodiesel over fossil fuel cannot be over emphasized. It is biodegradable, with higher lubricity and flash point (Dermirbas, 2007) and is environmentally friendly. The chief side effect to this advent of science is the replacement of feedstock for human production to make biofuel.

MATERIALS AND METHODOLOGY

All reagents used in this work are analar grade chemicals from Sigma Aldrich and Fluka. They were used as purchased without any purification.

Memmert and Fisher ISOTEMP 100 SERIES oven were used for all drying purposes. All glasswares used were either PYREX or BOROSILICATE.

i. Seed Processing

Walnut seeds were removed from their endocarp mechanically and the bad ones were sorted out. The clean seeds were then dried to remove any moisture. Thereafter, they were ground in a machine to increase the surface area for solvent penetration during extraction.

ii. Oil Extraction

Oil extraction was conducted in batches using n-hexane as the extracting solvent and a soxhlet apparatus. In a typical extraction, ground seeds were weighed into the soxhlet thimble connected to a 500mL capacity flat bottom flask containing n-hexane and then, the condenser was inserted and extraction began. Extraction was conducted at 60oC for 6hrs after which the set up was dissembled and the solvent was redistilled off from the miscella (n-hexane mixture) to obtain the crude walnut seed oil.

The percentage oil content of the seed was calculated thus:

% Oil yield =

$$\left(\text{weight of the oil} \middle/ \text{weight of the seeds}\right) * 100$$

iii. **Oil Characterization**

The extracted oil was characterized for the following physicochemical properties:

Percentage free fatty acids (%FFAs), Acid free value in mg KOH/g of oil (%FFA * 1.99), Iodine value, Saponification value, Peroxide value, Kinematic viscosity, Ester value (SV-AV) and Relative density.

RESULTS AND DISCUSSION

The physicochemical characteristics of the extracted oil from walnut seeds are presentable in Table 1. The density was determined at 25^{o}C acid value was 0.845mg KOH/g. The total acidity expressed as acid value gave the index of the amount of free fatty acids present in the oil and hence, it measures the extent of rancidity in a stored oil sample. Rancidity in a long run could affect the yield of biodiesel because a significant amount of triglycerides would have been converted to free fatty acid thereby necessitating a pretreatment mechanism before trans-esterification reaction. The acid value conforms well to that of the ASTM D1639-1690(1994) and ASTM D1962-1967(1979) which is mg KOH/g.

The value of relative density obtained was 0.873. The value was close when compared to the soybean and sunflower seed oils in the range of 0.915-0.923 (Pearson, 1976). The iodine value is often a useful index, which gives an idea of the drying character of oils and helps in the classification of oils into drying and semi drying categories. The iodine value of 76.05 Wij obtained classify the oil as non-drying oil. The value conforms favorably well with the recommended international codex standards and ASTM for edible oils.

High peroxide value is associated with the development of rancidity in fat and oil which eventually limits there use in food industry. Rancid taste is noticeable with the peroxide value ranges between 20 and 40mg/g of oil (Oderinde *et al.,* 1998; Ajayi *et al.,* 2002). The peroxide value of the oil was 56mL/g of oil which is equivalent to 5.6mg KOH/g. The value is well below 10mg peroxide Oxygen/kg of oil hence, suitable as edible oil. The high value shows that walnut has low resistance to oxidation. The peroxide value according to Europe Standard EN 14214(2003) and ASTM D6751 (2002) is less than or equal to 5.0.

The fatty acid and saponification value of the oil are 0.423 and 306mg KOH/g. The ester value of the oil is 307.154 which reveal the high tendency of the oil towards the suitability for biodiesel production. The kinematic viscosity of the oil is 34.5 this shows the resistance of the fluid to flow under specific conditions. It can be inferred from the kinematic viscosity value that the flash point would be low. The flash point gotten was 156^{o}C which conforms to the standard EN 14214 (2003) and ASTM D6751 (2002) (130^{o}C). This shows that the flammability hazard of the oil is low.

Table1: Physicochemical Properties of Walnut (*juglansregia L*) Oil**.**

Parameters	Walnut (*Juglansregia* L) oil
Yield (%)	26
Relative Density (Kg/l)	0.873
Flash Point (°C)	156
Iodine Value (Wij)	75.05
Acid Value (Mg KOH/g)	0.846
Saponification Value (Mg KOH/g)	308
Peroxide Value	56
Free Fatty Acid (Mg KOH/g)	0.423
Ester Value	307.577
Color	Golden yellow
Kinematic viscosity (mm^2/s)	34.5

CONCLUSION

The research work presented in this paper proved the suitability of walnut seed oil for biodiesel production having met the necessary conditions of the Europe and ASTM standards.

REFERENCES

1. ASTM D 6751. 2007. *Biodiesel Stock specification (B100).*
2. Basiron, Y. 2007. "Palm Oil Production through Sustainable Plantations". *European Journal Lipid Science Technology*.109: 289-295.
3. Dermirbas, A. and H. Kara. 2006. "New Options for Conversation of Vegetable Oils to Alternative Fuels".
4. Dermirbas, A. 2003."Biodiesel Fuels from Vegetable Oils via Catalytic and Non-Catalytic Supercritical Alcohol Trans-Esterification and other Methods. A Survey". *Energy Convention Management*. 44(13):2093-2109.
5. Guo, Y. 2005. "Alkaline-Catalyzed Production of Biodiesel Fuel from Virgin Canola Oil and Recycled Waste Oils". Department of Mechanical Engineering, The University of Hong Kong: Hong Kong, China. 184.
6. Liu, X. and Y. Wang. 2008. "Trans-Esterification of Soybean Oil to Biodiesel using CaO as a Solid Base Catalyst". *Energy Fuel.* 87:216-221.
7. Oderinde, R.A. and I.A. Ajayi. 1998. "Metal and Oil Characterization of Seed and Seed Oil of Huracrepitins and Kinetics of the Degradation of the Oil during Heating". *EJEAF Chem*, 8(3): 201-208.
8. Pearson, D. 1976. *The Chemical Analysis of Foods.* Churchill-Livingstone: London, UK. 488-496.

ABOUT THE AUTHORS

G.B. Folaranmi, BSc., MSc. Affiliation: Lecturer, Federal University Ndufu Alike Ikwo. Postal Address: Department of Chemistry, Federal University Ndufu Alike Ikwo, Ikwo, Ebonyi State. Email :gbenro6@yahoo.com

C.U. Ibeji, B.Sc., MSc., PhD. Affiliation: Lecturer, University of Nigeria (Nsukka). Postal Address: Department of Pure and Industrial Chemistry, University of Nigeria, Nsukka, Enugu State. Email: ugochukwu.ibeji@unn.edu.ng

N. Oji, B.Sc., M.Sc. Affiliation: Lecturer, Federal University Ndufu Alike Ikwo. Postal Address: Department of Chemistry, Federal University Ndufu Alike Ikwo.Ikwo.Ebonyi State. Email: nkiruoji@yahoo.com

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