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An Assessment of Fatty Acids Ethyl Esters [FAEES] from *Canarium schweinfurthii* Engl. Seeds Oil

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Abstract

The Canarium schweinfurthii Engl. seed oil has been trans esterified to ethyl ester and the fuel properties of the corresponding esters of Canarium schweinfurthii Engl. seed oil and the diesel oil [D2] were determined. The Oil yield of 60g mesocarp of Canarium schweinfurthii Engl. seed was found to be 38% which yield 26% ethyl esters (biodiesel) with 86.96% conversion of straight vegetable oil (SVO) to fatty acids ethyl esters (FAEES). The fuel quality parameters of the mesocarp Ethyl Ester was found to be 0.86 specific gravity, 150°C flash point, 10°C cloud point, 2.0 pour point, 98.60mm^{2}s^{-1} viscosity, 0.89gm^{-1} density and 13120.02KJ calorific value. Also, fuel properties for SVO and D2 was found to be 0.37 and 0.88 specific gravity, 125°C and 140°C flash point, 19°C and 2°C cloud point, 3.0 and -2.0 pour point, 82.10 mm^{2}s^{-1} and 240.22 mm^{2}s^{-1} viscosity, 0.98 gm^{-1} and 0.88 gm^{-1} density, respectively and 2246.70KJ calorific value for D2. These values were compared to ASTM standard specifications for fuel.

Key words: *Canarium schweinfurthii* Engl. seeds, oil extraction, Fuel quality parameters, ethyl esters and Biodiesel yields.

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Introduction

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The greenhouse effect, fuel and energy crises of the late 1970's and early 1980's as well as accompanying concerns about the depletion of the world's non-renewable resources provided the incentives to seek alternatives to conventional problem

based fuels (Knothe, Dunn, and Bagby, 2002). This has led to the search for alternative sources of energy and increased awareness of the environment issues resulting from the extensive consumption of fossil fuel. Therefore, the need for an alternative source of energy and power which is renewable, biodegradable and environmentally friendly than fossil fuel is necessary. Biodiesel is a clean, renewable, environmentally friendly and domestically produced diesel fuel, promising alternative energy source that is becoming accepted in a growing number of countries around the world (Gerrits, 2000). The uses of vegetable oil as fuel for diesel engines now occupy a prominent position in the development of other alternative fuels. Hundreds of scientific articles and various other reports from round the world dealing with vegetable oil-based alternative diesel fuel (biodiesel) have appeared in print (Bailey, 1945). Furthermore, other sources studied include animal fats, waste cooking oils and recent studies using a species of algae with up to 50% oil content (Gerrits, 2000). Most of pure biodiesel (B100) fuel manufactured in the US has been produced using Soybean oil feedstock (Weiksner, Stephen, and Thomas, 2006).

The previous study examined the oil quality parameters of *Canrium schweinfurthii* Engl. seed oil (Magashi and Abayeh, 2012). Iodine value [IV] of 13.50mg/g which equally falls within the class of non-drying oils [IV< 125mg/g], that have the tendency of producing both methyl and ethyl esters biodiesel, therefore *Canrium schweinfurthii* Engl. seed oil holds a lot of potential in biodiesel development (Magashi and Abayeh, 2012). Present study continues with production of biodiesel from the seed. This study is restricted to the production of ethyl esters of *Canrium schweinfurthii* Engl. seed oil (FAEES) and its fuel properties, which will then be compared to that of the conventional diesel as a control.

Material and Methods

Chemicals: All chemicals used were of analytical grade and were products of Riedel-de Haen, Chemical Ltd, Germany, unless otherwise stated.

Collection and preparation of seeds sample

Canarium schweinfurthii Engl. fruits used for this study were obtained from Mangu area in Plateau State, Nigeria. The sample was identified in the Biology Programme

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of Abubakar Tafawa Balewa University, Bauchi. The fruits were sampled by random sampling techniques. The freshly harvested fruits were collected in

polyethene bags. The mesocarp was manually peeled from the fruits and oil was immediately extracted from the seeds.

Oil Extraction: oil from mesocarp (50±10)g of *Canarium schweinfurthii Engl.* was extracted by continuous extraction in Soxhlet extractor for 8hrs, using petroleum ether (60-80^{o}C) as a solvent, according to method 28.002 described by AOAC (1984). At the end of the extraction, the residual solvent was evaporated in Gallenkamp forced air oven at 105^{o}C to constant weight. The extracted oil was stored in air tight and moisture proof containers at room temperature, for further analysis.

The Fuel Properties: Fuels are characterized by evaluating the parameters required in ASTM D1975. The standard specifications for diesel fuel oils include: flash point, viscosity, pour point, smoke point, cetane number, cloud point, oxidative stability, specific gravity, heat of combustion, lubricity are among others (Sharp, 1994).

Preparation of Fatty Acids Ethyl Esters (FAEES): It was prepared according to methods 28.058 and 28.059 of AOAC (1984).

***GC-MS Analysis* of Fatty Acids Ethyl Esters (FAEES):** Fatty acids ethyl esters analysis was carried out on GCMS-QP2010 Plus-Shimadzu, Japan. The temperature of the column was programmed as follows: it was first held at 60°C for 5mins, then increased to 120°C at a rate of 10°Cmin^{-1} and held at 200°C for 2mins at rate of 8°Cmin^{-1}. MS was operated in ACQ mode with a scan range of 20-600m/z started at 3.00mins and ends at 44.00mins and scan speed of 1250m/s. Data acquisition and analysis were performed using the NIST, 2005 library software.

Results and Discussions

The oil yield determines the economic value of the oilseed. The percentage oil yield was found to be 38% (Table 1). This range is in line with earlier study reported as 30-50% oil content of *Canarium schweinfurthii Engl.* in fruits pulp (Obame *et al*, 2007). This value (38%) make the *Canarium schweinfurthii Engl.* seed economically viable when compared with other known oilseeds like G. nut oil 46.5% and cotton seed 16-17% (Oyenuga, 1968). In the previous work the oil content of its pulp varies between 36 and 58% depending on the agro-ecological origin and it was shown that

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the fruits, even when damaged can be used in small scale oil production. However, oil yield vary due to climatic condition, soil composition, botanical variety and the stages of maturity of the *Canarium schweinfurthii Engl.* seed (AFTD, 2008).

The extracted oil was transesterified with ethanol and the fuel analysis of SVO and its FAEES of *Canarium schweinfurthii Engl.* mesocarp was presented in (Table 2). 60g of mesocarp of the seed yield 38% oil (SVO), in which 28.6g oil (SVO) yields 26% biodiesel (FAEES) with mass of 1059g, assuming the triglyceride composed of three moieties of Oleic acids (1013g). Moreover, the actual yield of biodiesel 26.0% was comparable to the theoretical yield 29.898%. The results showed that there was a significance conversion of SVO to FAEES, 86.96% (Table 1).

The chromatogram in (Figure 1), 9 peaks were identified with their respective fatty acids. These fatty acids represent the fatty acids compositions in the FAEES sample. The mesocarp oil of *Canarium schweinfurthii* Engl. composed of short and medium fatty acid with low degree of unsaturation (Magashi and Abayeh, 2012). The results from GC-MS analysis carried out on FAEES showed that the predominant fatty acids are saturated and unsaturated carbon chains with an even number of carbon atoms and a single carboxyl group such as C14, C16, C18:1, C18:2, C20 & C22. (Table 2) present fuel analysis of straight vegetable Oil (SVO) and its fatty acid ethyl esters (FAEES) of *Canrium schweinfurthii* Engl. seed oil compared to diesel (D2) as a standard. The specific gravity of the *Canrium schweinfurthii* Engl. seed oil (SVO), 0.37 does not fall within the ASTM specification range of 0.82 minimum. However, for biodiesel (FAEES), 0.86 and D2 control diesel, 0.88; all are within the ASTM standard range. The flash point of FAEES, 150°C was also promising, as minimum requirement by ASTM was 100°C. The flash point is used to assess the overall flammability hazards of a material and the higher values indicate materials that are less likely to ignite accidently (Mittlebach, Tritthart, and Junck, 1985). The value was closely related to that of D2, 140°C and SVO, 125°C (Table 2) and biodiesel would be considered significantly safer with a flash point between 128 - 174°CVellguth, G. (1983). The cloud points varied significantly, as ASTM specification required -5.0; SVO was 19 and FAEES, 10. Using a product below its cloud point may reduce the level of the fuel properties, the cloud point of FAEES can be reduced by blending with the conventional diesel, additives, branched-chain esters and winterization (Holbrook, 2000). The pour point is a temperature at which the fuel is observed flow before it gel. Higher pour point indicates difficulty of use of such oil in the areas with low temperature. The viscosity, density and calorific values for biodiesel was found to be 98.60 mm^2s^{-1}, 0.89 gml^{-1} and 1320.02 KJ

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respectively (Table 2). The values can be modified to fall within the acceptable range; hence the FAEES satisfy other properties.

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Table1: Fuel Analysis of SVO and Its FAEES of *Canarium schweinfurthii* Engl. mesocarp, on dry matter basis.

Physical Properties of *Canarium schweinfurthii* Engl mesocarp oil				
Mesocarp Weight (g)	Oil Yield (%)	FAEES (Biodiesel) Yield (%)	% Conversion of SVO to FAEES	Theoretical yield (as Oleic acid) %
60	38	26	86.96	29.898

Table 2: Fuel Analysis of Straight Vegetable Oil (SVO) and Its Fatty Acid Ethyl Esters (FAEES) of *Canrium schweinfurthii* Engl. Seed Oil and Diesel (D2).

Fuel Properties	**SVO**	**FAEES**	**Diesel (D2)**	**ASTM Standard**
Specific gravity	0.37	0.86	0.88	0.82 min.
Flash point (°C)	125	150	140	100 min.
Cloud point(°C)	19	10	2.0	-5.0
Pour point(°C)	3.0	3.0	-2.0	-3.0
Viscosity (mm^2s^{-1})	82.10	98.60	240.22	1.9 – 6.0
Density (gml^{-1})	0.98	0.89	0.88	0.86
Calorific value (KJ)	-	1320.02	2246.70	-

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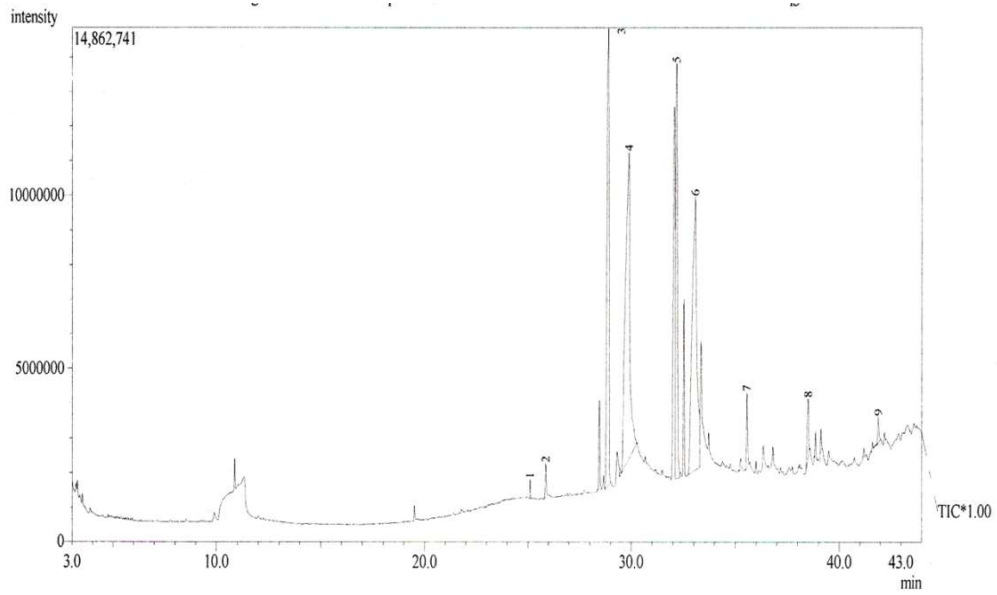

Figure 1: Chromatogram of fatty acids ethyl ester of *Canarium schweinfurthii* Engl. seed oil.

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Conclusion

The fuel properties of the FAEES determined indicates its fitness as a biodiesel, as most of the fuel properties, specifications were closed to that of diesel D2 that was used as a standard.

Recommendations

1. The *Canarium schweinfurthii* Engl. seeds are viable feedstock for biodiesel production.
2. *Canarium schweinfurthii* Engl. seeds are also a viable source for edible oil.

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