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FUEL QUALITY PARAMETERS OF FATTY ACID ETHYL ESTER (FAEES) OF CANARIUM SCHWEINFURTHII (Bush Candle Nuts)

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ABSTRACT

With regards to industrial and technological development, the cost of fossil fuels is on the increase, so an alternative source of energy which is bio gradable is needed. The oil quality characteristics of canarium shweinfurthii seed and fuel quality of the corresponding ethyl ester were compared to that of fossil diesel as a standard. The oil was extracted with n-hexane using soxlet extractor and the percentage yield was 39.33%, with 2.20% moisture content,78.52%, iodine value 179.52 meq/kg, saponification value, 32.0 meq/kg, peroxide value. 4.34% free fatty acid and 8.62% acid value. The canarium schweinfurthii oil was transesterified with ethanol and KOH as catalyst and the fuel quality parameters were found as 110.0^{o} c, cloud point 34.0mm, smoke point, 2.70 ^{o} c, pour point, 0.89g/cm3 density. These indicate that the (FAEES) of canarium schweinfurthii can be used as a biodiesel or blend in conventional diesel so as to reduce environmental pollutions as these value are within the American society for testing materials(ASTM) international specification for high quality B100 biodiesel.

Keywords: Biofuel, Biodegradable canarium schweinfurthii, transesterification.

INTRODUCTIONS

The increasing rate of fuel and energy consumption leads to a fast deflection of the world's nonrenewable fossils and has now become a major issue for which many countries are looking for alternative energy source. The environmental impact of fossil fuel has contributed to global warming by transferring sequestered carbon and greenhouse gases into atmosphere (Owen, 1995) the nation that cannot supply their own petroleum needs are forced into unfavourable balances of payment with petroleum importers.

Biofuels offer a partial solution to many of these problems as it improves the quality of the environment with pleasant fruity odour and with less soot generated in the exhaust of vehicle using it (Gerrits, 2000). Economically it reduces importation related logistic and insecurity (Mike, 2001). Biodiesel is an alternative to fossil diesel (petroleum diesel). Its production is easily done and require low energy input, while it can be made from fats, the main stock is vegetable oil which can be obtained from variety of plants. The transesterification of an oil or fat with a monohydric alcohol yields the corresponding mono-alky ester which is the biodiesel (Gerrits, 2000).

The importance of using biodiesel could be seen in the area of reduction in emission of carbon monoxide (CO) by about 50%, and carbon dioxide (CO_2) by 78% on a net life cycle basic because the carbon in biodiesel emission is recycled from carbon that was in the atmosphere from petroleum that was sequestered in the earth crust (Sheenhan, 1998). Furthermore, biodiesel contain fewer aromatic hydrocarbons. Benzofluethane (56% reductions), Benzopyrenes (71% reduction), it reduces the emission of harmful pollutant (manly particulate) form diesel engine (80% less emission), 100% less SO_2 (Gerrits, 2000).

Biodiesel has a higher octane rating fossil diesel which can improve performance and clean up emission compared to fossil diesel (with octane rate lower than 40). The high octane contributes to easy cold starting that is it can easily be ignited at low temperature or low heat requirement during starting of the engine at the combustion chamber. It also extends the life of the engine because of its lubricating ability.

The successful introduction and commercialization of biodiesel in many countries around the world had been accompanied by the development of standard to ensure high product quality and user confidence.

Chemically, transesterification is the process of exchanging the alkyl group (from a hydroxyl functional group) of an ester with another alkyl group from different alcohol, in the case of fatty acid ethyl group ester (FAEES) from the oil of *canarium schweinfurthii* seed, the oil exchanges their alkyl group with ethyl group from an ethoxide which acts as a catalyst resulting in the breakup of the triglyceride esters and joining of the fatty acids with the added ethoxide. The by-product of these reaction is glycerol which can be used in soap and cosmetic industries. The triglyceride first loses one fatty acid group at a second fatty acid to become a monoglycerides, the third fatty acid is finally tripped off leaving free glycerin. Each of the fatty acids inn converted in to biodiesel (ethyl-ester) as they are tripped off. Each step of this reaction occurs by the ethoxide attacking the carbonyl carbon atom of each fatty acid. This is followed by the departure of the biodiesel and leaving behind the oxide anion, which picks up a proton from water to form a hydroxyl group on carbon of the diglyceride, while potassium cation combines with the remaining hydroxyl group from water to regenerate the catalyst.

The plant canarium schweinfurthii otherwise known as bush candle plant belong to the *burseraceae* family, it is a hard woody tree with an average height of 120ft with spreading crown and leaves in turfs at the base of the branches. The diameter above the heavy root swellings can be up to 4.5m bark thick on young tree, fairly smooth, becoming increasing, scaly and fissured with age. The slash is reddish or light brown with turpentine like odour, exuding a heavy, sticky oleoresin that becomes solid, the tree grows slowly from seeds, taking about 30 years to reach maturity. The leaves which are pinnate clustered at the end of the branches is 15-65cm long with 8 -12 pairs of leaflets mostly opposite oblong, correlate at base in lateral nerves on each broad with 12 -24 main lateral nerves on each side of the midrib prominent and pubescent beneath. It starts flowering in November, it's creamy white unisexual flower about lcm long grow inflourescence that stand in the axil of the leaves and may be up to 28cm long. The fruit is a small drupe blackish purple in colour, which is edible fruity starts around April and May, while the nuts are white milky colour oily almond seeds buried ma hard shell *canarium schweinfurthii* is widely grown all over Nigerian, the family is found throughout the tropics especially in

Malaysia, South America and Africa, it is found in hot dry bush field, desert and vast area of the Savannah. The chemical study of canarium schweinfurthii revealed that it contains mostly fatty acid and their glycerides. These consist of oleic acid (36%), linoleic acid (28%), palmitic acid (26%) and stearic acid (7%) (Cliffon, 1987) *canarium schweinfurthii* plant has been used as food, it replaces oil palm as source of edible oil in Northern Nigeria (Sheehan, 1998). Resin exudes from the plant is used in pharmaceutical (Eka,1982). This paper highlights the production of biodiesel from canarium schweinfurthii seed so as to encourage the exploitation of less edible raw material to avoid food crisis and to provide alternative source of energy which is renewable, biogradable, and environmentally friendly fuel.

EXPERIMENTAL

The *canarium schweinfurthii* seeds were obtained at Nasarawa area of Kaduna, the mesocarp was peeled from the endocarp and dried. The automobile gas oil (AGO) otherwise known as diesel oil was obtained from the Kaduna refinery and it served as a control or standard for the entire test The seed oil was extracted using Soxlet Extractor with n- hexane. The moisture content, oil content, saponification value, acid value, peroxide value, free fatty acid value of the canarium seed oil were determined using, the British Standard Institute Method Number 684, 1995. While the iodine value was determined by using Hanus method (Association of Official Analytical Chemist (AOAC), 1975)

PREPARATION OF FATTY ACID ETHYL ESTER

4.5 ml of 95% ethanol was slowly added to 0.15g potassium hydroxide pellet with stirring to form ethoxide solution. The ethoxide solution was slowly added to 30m1 of *canarium schweinfurthii* seed oil with spin stirring overnight. The mixture obtained was separated using separatory funnel and washed with 20m1 warm water, and dried with anhydrous magnesium sulphate, the clean biodiesel was collected in a container. The flash point, cloud point, pour point, smoke point, density, ash content of the biodiesel and diesel fuel were tested using the ASTM D6751 method and Nigerian industrial standard (NIS 149; 2006).

RESULTS AND DISCUSSION

The *canarium schweinfurthii* seed oil was dark brown in colour with a sweet fruity smell while the biodiesel has a light brown colour, slightly chocking smell and less viscous than the oil. The results of the tests are shown in Table 1 below:

The moisture content of the seed oil was found to be 2.20%, this is very low when compared to the acceptable standard value for food moisture content of 8-22% (Frank,1 989). Normally, seed of high moisture content are subjected to rapid deterioration due mould growth, insect damage, heat and sprouting. Since the moisture content is relative low, it means that the oil will have a reasonable shelf life as there will be little or no water for the hydrolysis of the oil. This low moisture content may be due to the long air dried before the determination.

The iodine value, which expresses the degree of carbon in unsaturated fats and oils, is 78.52% which falls below the standard value of 80-100 ASTM (1988). This implies that the oil is a good fuel as it will not give rise to polymerization and oxidation processes. Therefore, there is no tendency of deposit formation in the engine, moreso, the oil has the tendency of producing methyl and ethyl ester (biodiesel).

The high saponification value indicates the presence of high molecular weight long chain fatty acid molecules which means that it can be used as lubricating oil or blend with fossil diesel to improve on its combustion for easy starting and enhances it use as fuel (Pope, 1932)

The peroxide value is higher than that of most edible oil, this may be due to the immediate usage and proper storage after the extraction of the oil. The free fatty acid value is the measure of the extent to which the oil has been subjected to enzymatic hydrolysis in the parent source before extraction, canarium schweinfurthii seed oil has 4.34% free fatty acid value which is higher than the ASTM standard value of 0.5-1.5% (coconut oil is 0.1%). This shows that the oil is not easily subjected to enzymatic hydrolysis.

FATTY ACID ETHYL ESTER (FAEES)

Some specific fuel quality parameters of the fatty acid ethyl ester were compared with the fuel properties of automobile gas oil (fossil diesel) as well as taking into consideration the ASTM standard. The parameters are the flash point which is the lowest temperature corrected to a barometric pressure of 1101.3kpa (760mmHg), at which application of a test flame causes the vapour of a specimen to ignite under specified condition of test. The flash point of the biodiesel obtained from canarium schweinfurthii seed oil was 110^0C which is close to that of automobile gas oil, 97^0C. The flash point is used to assess the overall flammability hazard of fuel, higher value indicates material that is less likely to ignite accidentally (NIS 149, 2006).

The temperature at which a liquid fatty material becomes cloudy due to formation of crystals and solidification of saturated compounds is known as cloud point, thus in an area of low

temperature the FAEES obtained from canarium schweinfurthii will be a better biodiesel because it will not easily freeze as the cloud point is only 9^0C when compared to that of fossil diesel of 2^0C conversely in area where the temperature is always high or during hot season the cloud point of FAEES of canarium schweinfurthii oil can be lower by blending with conventional diesel, additives, or branch chain additives

The biodiesel obtained can be used both in low and high temperature as indicted by it pour point value of 2.70, fossil diesel is 2.00 while the ASTM acceptable standard value is less than 10. The pour point value measures the lowest temperature at which the sample can still flow before it gels

The density of fatty acid ethyl ester obtained from canarium seed oil is almost the same as fossil diesel, hence these could make it to be used as biodiesel if it satisfies other fuel properties.

The biodiesel obtained will be more environmental friendly than fossil diesel as the former has a higher smoke point of 34.0 than the later which has 22.4. This is due to the presence of oxygen which support combustion in the biodiesel but absent in fossil diesel which is mainly hydrocarbon, these are confirmed by the IR spectrum of the canarium schweinfurthii seed oil, the biodiesel, and the fossil diesel as show figure 1,2 and 3. The 1745cm^{-1} absorption band for C = O present in the oil and the biodiesel was absent in the fossil diesel these shows that the biodiesel will be more environmentally friendly due to the presence of oxygen for complete combustion.

CONCLUSION

The presence of high oil content in canarium schweinfurthii seed make it an economically viable source of oil. The fuel quality parameters of the fatty acid ethyl ester (FAEES) reveal that it can serves as a good biodiesel or blend with conventional diesel.

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APPENDICES

TABLE 01: Oil Quality Parameters of *canarium schweinfurthii* seed oil and automobile gas oil (diesel)

S/No.	Quality/Parameters	*canarium schweinfurthii*	Automobile Gas Oil (Diesel)
1	Moisture Content (%)	2.20	-
2	Iodine Value (%)	78.52	8.63
3	Saponification value (meq/kg)	179.52	500.69
4	Peroxide value (meq/kg)	32.00	38.00
5	Free fatty acid	4.34	1.77
6	Acid value (%)	8.62	3.54
7	Colour	Brown	Light Brown/Pink
8	Texture	Viscous	Less viscous
9	Smell	Nutty and Penetrating	Slightly chocking

Table 02: Fuel Quality parameters of fatty acid ethyl ester (FAEES) of *canarium schweinfurthii* seed oil and Automobile gas oil (AGO) or Diesel Oil

S/No.	Fuel Properties	BioFuel from *canarium schweinfurthii Seed Oil*	Automobile Gas Oil (Diesel Oil)	ASTM Standard
1	Flash Point (^{0}C)	110.00	97.00	93.00
2	Cloud Point	010.00	02.00	--
3	Smoke Point (mm)	034.00	22.40	--
4	Pour Point	002.70	02.00	<10
5	Density (g/cm3)	000.89	00.88	0.86