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Variation in Lipid Composition of the Seed Oil *Parinari polyandra* Benth.

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ABSTRACT

Parinari polyandra Benth. fruit also known as maranthes *Parinari polyandra* Benth. fruit of the family Rosasceae has a yellowish-white endosperm with a thick seed coat containing oily mass and subsequent by-product meal. The oil seeds harvested from the same *Parinari polyandra* Benth. tree in April and November 2008 was evaluated in the present study to check the variations in the composition of the seed oil. Successive extraction from *Parinari polyandra* Benth. seeds harvested in April (AHS) and November (NHS) gave 31.6 and 59.4% yields respectively. The major constituents of *Parinari polyandra* Benth. seed oil was analyzed by using GC-MS. n-hexadecanoic acid (46.3%), 9,12-octadecadienoic acid (18.10%), phytol (26.%) for AHS while n-hexadecanoic acid (4.69%), 9,12 Octadecadieonic acid (8.31%), arachidonic acid (43.38%), stigmasterol (13.41%) for NHS. Due to the variation (which may be as a result of climate influences) in the compositions found in *Parinari polyandra* Benth. seed oil, the study suggests that the oil extracted from AHS may be appropriate for biodiesel production while that of NHS will be good raw material for alkyd resin production.

Key words: *Parinari polyandra* Benth., biodiesel, alkyd, extraction

INTRODUCTION

There has been a surge in research interest aimed at harnessing various vegetable seed oils for use in the chemical industry. The need is as a result of the ever increasing world demand for oil and the challenge to expand the existing supplies of oil for both domestic and industrial use (Gunstone, 1996).

Vegetable oil is one important environment-friendly raw material used in the productions of oil-modified alkyd resins (Akpan *et al*., 2006; Hill, 2000; Aigbodion and Okieimen, 2001; Ogunniyi and Odetoye, 2008; Ogunniyi and Njikang, 2000) and biodiesel (Veljkovic *et al*., 2006; Berchmans and Hirata, 2008; Abreu *et al*., 2004; Zacher and Grasas, 1990; Crabbe *et al*., 2001; Canakci, 2007).

Soy beans oil, Linseed oil, Castor seed oil, Rapeseed oil, Tobacco seed oil etc. are the popular seed oils used in oleochemical industry. However, in Nigeria, there abound a vast number of seeds produced from tropical plants with no competing food uses, this characteristic turn attention to *Parinari polyandra* Benth. that is grown in the North, North-central and Western parts of Nigeria.

Parinari polyandra plant is made up of 115 genera and with about 3200 species (e.g., *Parinarium capense, Parinarium laurim, Parinarium rudolphic* etc.). The tree is about 8 m high with a gnarled and twisted bole. The branches are slightly hairy and covered with pale

lenticels. It has dark glossy green leathery leaves with a very shot tip. *Parinari polyandra* Benth. flowers between January and August and produces fruit between March and October with red to blackish purple, broad ellipsoid smooth fruit (Dalziel, 1937). Although, the fruit is scarcely edible, the leaves are said to be chewed like kola. The endosperm has a yellowish white appearance with thick seed coat containing oily mass.

Oil content, fatty acid composition and protein content were investigated (Olatunji *et al*., 1996; Uzzan, 1961) while the seed oil is considered not edible because of its high content of free fatty acids value and relatively high concentration of eleostearic acid, poly unsaturated fatty acid with a significant drying property (Olatunji *et al*., 1996).

Vegetable oils common raw material in the coating industry especially for alkyd resins and also can serve as a renewable and potentially inexhaustible resources for biodiesel production. In this area of application the *Parinari polyandra* Benth. seed oil can find some uses.

In this study, we report the variation in oil content, physicochemical properties, fatty acid compositions of AHS and NHS *Parinari polyandra* Benth. seed oil. The physico-chemical characterization of *Parinari polyandra* Benth. seed oil was investigated in this study and its properties were compared to other vegetable oil used in alkyd and biodiesel productions.

MATERIALS AND METHODS

Collection and dehulling of seeds: *Parinari polyandra* Benth. seeds were first collected in April, 2008 (AHS) from a tree planted at Oke-Odo, Ilorin, Kwara State Nigeria. The seeds were dehulled, sundried and crushed to increase the surface area for maximum oil extraction. This procedure was repeated in November, 2008 (NHS).

Extraction of oil from the seeds: Two hundred gram of the crushed seed was weighed and extracted for 4 h using soxhlet extractor and n-hexane as solvent. The extract was concentrated using rotatory vacuum evaporator dried at 60°C and weighed. Yield was calculated on dry weighed basis (Papageorgiou *et al*., 1996).

Physicochemical properties of *Parinari polyandra* Benth. seed oil: The oil was analyzed for both physical and chemical properties (using ASTM methods). The properties determined were density, specific gravity, refractive index, kinematic viscosity, acid value, flash point, iodine value, saponification value, ash content (Gunstone, 1996; Olatunji *et al*., 1996).

***Parinari polyandra* Benth. fatty acid composition:** Fatty acid composition of *Parinari polyandra* Benth. seed oil was determined by GC-MS analysis. Agilent 6890 N model gas chromatography with an agilent 122-5532 type column 30 m long and split-splitless injector, was used. The inside diameter was 0.25 mm and film thickness was 0.25 μm. The detector was a mass selective detector 5973 N model. An automate sampler was attached to the agilent 6890 GC to automatic sample introduction. The sample (*Parinari polyandra* Benth. seed oil) amount injected was 1 μL. The temperature of GC injector was 250°C. Helium was used as a carrier gas. The mass selective detector temperature was 250°C. the oven temperature was kept at 100°C for 5 min. After that, the oven was heated with heat ratio 4.0°C min^{-1} to 230°C. The oven temperature was constant for 30 min. The final temperature was 230°C. The fatty acids of *Parinari polyandra* Benth. seed oil were identified by comparing its retention time to the retention time of standard fatty acids.

RESULTS AND DISCUSSION

The yield of *Parinari polyandra* Benth. seed oil ranged from 28.4 to 34.8% (average x_1 = 31.6%) for AHS and 58.1 to 60.7 (x_2 = 59.4%) for NHS on dry weight basis. These values indicate that *Parinari polyandra* Benth. seed are rich in oil compared with other oil bearing seeds. Table 1 presents the oil yield of some oil-bearing seeds (% dry weight) used in alkyd and biodiesel productions compared with parinari polyandra seed oil. From Table 1 the oil yield for *Parinari polyandra* Benth. AHS has a lower yield of about 34.8% compared to *Parinari polyandra* Benth. NHS which has a yield of 60.4%.

Physicochemical properties of *Parinari polyandra* Benth. seed oil are shown in Table 2 while the summary of physicochemical and fuel-related properties of *Parinari polyandra* Benth. seed oil (soxhlet column hexane extracted) and other seed oils used for biodiesel production (Srivastana and Prasad, 1999), as well as European requirements for automotive diesel fuel (Stournas *et al*., 1997) are listed in Table 3.

Table 1: Oil yield of some oil-bearing seeds (Gunstone, 1996; Olatunji *et al*., 1996) compared with *Parinari polyandra* Benth. seed oil

Oil seed plant	Oil yield (%)
Babassu	60-65
Copra	65-68
Soybeans	18-20
Tobacco seed	32-42
Palm fruit	45-50
Rape seed	40-45
Groundnut	45-50
Parinari polyandra Benth. (AHS)	28.4-34.8
Parinari polyandra Benth. (NHS)	58.1-60.7
Parinari polyandra (Olatunji *et al*., 1996)	31-60

Table 2: Physicochemical properties of *Parinari polyandra* Benth. seed oil

Properties	AHS oil	NHS oil
Colour	Light yellow	Golden yellow
Kinematic viscosity at 40°C cSt	225.740	46.850
Refractive index at 25°C	1.464	1.425
Specific gravity at 32°C	0.839	0.897
Iodine value (g I_2/100 g oil)	80.710	168.480
Acid value (mg KOH g^{-1} oil)	2.620	2.244
Saponification value (mg KOH g^{-1} oil)	118.200	246.132

Table 3: Physicochemical and fuel related properties of *Parinari polyandra* Benth. seed oil and other vegetable oils used for biodiesel production

Vegetables	Kinematic viscosity at 40°C(cSt)	Flash point (°C) (ASTM, 1995a)	Specific gravity (ASTM, 1995c)	Iodine value (mg KOH g^{-1}) (AOAC, 1993)	Saponification value (mg KOH g^{-1}) (AOAC, 1997)	Acid value (mg KOH g^{-1})	Ash content (%) (ASTM, 1995b)
Soybeans	32.60	254	0.9138	112.5	189-195	-	<0.010
Tobacco	27.70	220	0.9175	135.0	193	-	0.008
Rapeseed	37.00	246	0.9115	130.0	168-181	-	0.054
Parinari (AHS)	25.74	228	0.8390	80.7	118	2.620	0.006
Parinari (NHS)	46.85	234	0.8970	168.5	246	2.244	0.038
European standard for automotive diesel fuel	2-4.50	56 (min)	0.820-0.845	120.0	-	/	0.010 (max)

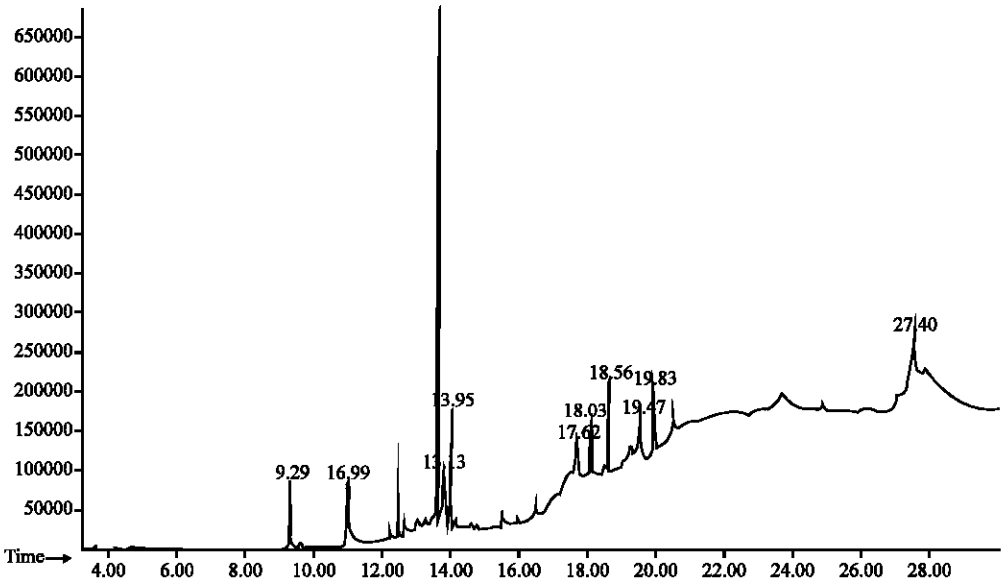

Fig. 1: Gas chromatogram of crude parinari oil (NHS)

From Table 3 a comparison of the physicochemical properties of both the *Parinari polyandra* Benth. AHS and *Parinari polyandra* Benth. NHS were reported. It was discovered that the Saponification value of *Parinari polyandra* Benth. AHS is lower than *Parinari polyandra* Benth. NHS. This suggests that *Parinari polyandra* Benth. NHS has a much longer chain of fatty acid present in it compared to *Parinari polyandra* Benth. AHS.

The iodine value of *Parinari polyandra* Benth. AHS is lower than that of *Parinari polyandra* Benth. NHS suggesting that *Parinari polyandra* Benth. NHS has a higher iodine number.

Acid value measures of the number of carboxylic group present in the fatty acid from the above table *Parinari polyandra* Benth. AHS has a high number of carboxylic group.

Most of the values obtained for *Parinari polyandra* Benth. seed oil compares well with other popular vegetable oil used for biodiesel production and falls within European standard for automotive fuels as shown in the Table 3.

Figure 1 and 2 represents the GC chromatograph of *Parinari polyandra* Benth. oil obtained from AHS and NHS, respectively, while its percentage composition were compared with values reported by Olatunji *et al.* (1996) in Table 4. It was discovered that there were variations in the % composition of chemical content due to the season in which the seeds were collected and analyzed, compared to the study reported by Olatunji *et al.* (1996) but the percentage composition of 9,12-Octadecadienoic acid were similar to the one reported in this study.

The total saturated and unsaturated fatty acid compositions of AHS *Parinari polyandra* Benth. oil were 46.25 and 20.65%, respectively, while that of NHS oil were 4.69 and 58.69%, respectively. The n-hexadecanoic acid (16:0) is the most abundant saturated fatty acid for AHS *Parinari polyandra* Benth. oil while that of NHS *Parinari polyandra* Benth. oil is 5,8,11,14-Eicosate traenoic acid (all z) (arachidonic acid) is the most abundant unsaturated fatty acid.

From the fatty acid composition, it can be observed that AHS parinari oil would be classified as palmitic oil while that of NHS parinari oil would be classified as an Arachidonic oil.

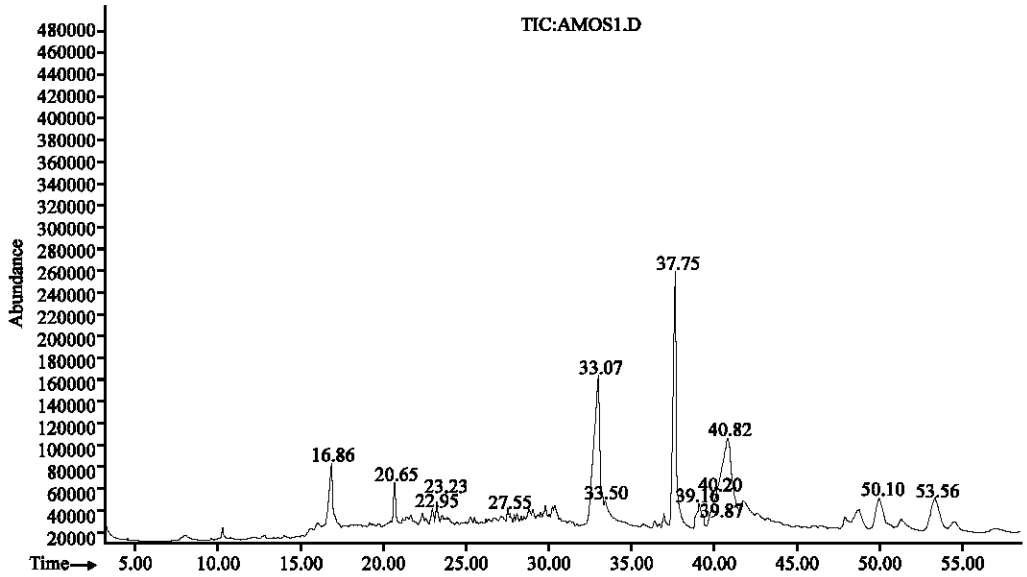

Fig. 2: Gas chromatogram of crude parinari oil (AHS)

Table 4: Percentage composition of *Parinari polyandra* Benth. seed oil

Components	Cn:m	AHS oil (%)	NHS oil (%)	Olatunji *et al.* (1996) (%)
1,4,8-dodecatriene, (E,E,E)	C12:3	-	7.55	-
n-hexadecanoic acid	C16:0	46.25	4.69	17.05
Trans-2-hexadecanoic acid	C16:1	0.49	-	-
9-Octadecanoic acid	C18:1	0.12	-	-
9,12-Octadecadienoic acid	C18:2	18.10	8.31	18.27
12,15-Octadecadienoic acid	C18:2	1.62	-	-
2,5-Octadecadienoic acid	C18:2	0.32	-	-
Eleostearic acid (z,z,z,)	C18:3	-	7.45	15.13
Arachidonic acid	C20:4	-	43.38	1.43
Phytol	-	26.80	-	-
Alpha-tocopherol	-	6.30	4.72	
Beta-tocopherol	-	-	5.36	-
Stigmasterol	-	-	13.41	-

The high degree of unsaturation of the NHS *Parinari polyandra* Benth. oil could render the oil to be susceptible to autoxidation and polymerization resulting in cross-linked and tough films upon exposure to air. Hence, the oil could find some uses in alkyd resin production.

The variations in fatty acid composition may be as a result of climatic condition, rainfall and temperature effects on the biosynthesis of fatty acid in the seed bearing plant (De-Bussy, 1975).

CONCLUSIONS

- *Parinari polyandra* Benth. seed was found to be rich in oil when compared to other vegetable oils.
- The physicochemical and fuel related properties of parinari polyandra oil obtained in the present research compared well with other vegetable oils

- Variations in composition of parinari oil obtained from AHS and NHS may be as a result of climatic condition, rainfall and temperature effect
- AHS parinari oil can serve as a potential renewable raw material for biodiesel production while that of NHS parinari oil can be useful in Alkyd resin production

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