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EVALUATION OF THE INDUSTIAL POTENTIAL OF *PENTACHLETRA MYCROPHYLLA* SEED

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ABSTRACT: *The fruit of Pentachletra Mycrophylla, a* woody *plant of the West African rain forest zone was analyzed and found to contain about 22.0% fats and oil. The Thermophysical and chemical characteristics of the oil compared well with both industrial and edible oil in Nigeria. The oil has a density of 875.6-kg^{3}, viscosity of 16.4 x 10^2 Nsm and a saponification number of 198. About 0.22 kg (250cm^3) oil was extracted per kg seed of the P. Mycrophylla fruit. An exponential function given by $\log$ = $\log_e^{b}$ 2.302bT described the viscosity variation of the oil with temperature. This is significant of the lubricity index. Its thermophysical properties present it as a commercially exploitable industrial coolant in Nigeria.*

KEY WORDS: P. Mycrophylla, industrial coolant, drying oil.

INTRODUCTION

Whereas this nation is endowed with abundant natural raw materials, the industrial utilization of these materials is extremely low, and our industries depend on Europe for supply of chemical raw materials. The increases productivity of renewable resources holds the key to future economic stability and the general-well-being of the human race. New technology as well as resource inputs constitute the major elements of national productivity.

In an earlier report (Taiwo and Ogunbodede, 1995)[1] It was highlighted that there is increasing awareness of the direct utilization of forest trees as valuable raw materials in chemical industries.

One of such awareness is the identification of the woody plant *Pentachletra Mycrophylla* in the rain forest outliers of the West Africa. The plant occur mainly in the rain forest zones of Ghana and Nigeria. It is a perennial wood, fruiting between September and October. The seed which is encased in one seed coat is soft and cream coloured when fresh, but hard and black coloured when dry (Keay et. al. 1964).

It is a fact that the fossil-based resources which are non-renewable are being rapidly depicted. Vegetable oils, renewable byproducts of agricultural processes could be reliable source of energy.[2] Presently, most of the industrial utilization of forest based oil had been in soap

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RODUCTION

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It is a fact that the fossil-based resources which are non-renewable are being rapidly depleted. Vegetable oils, renewable byproducts of agricultural processes could be reliable source of energy. Presently, most of the industrial utilization of forest based oil had been in soap and detergents, thus, attempts need to be intensified to steamline the overdependency on petroleum based raw materials. This study investigates the quality and industrial potentials of the oil of *P. mycrophylla's* (oil bean) seed. The properties indicative of effective performance of coolants is informed by high boiling point, low dynamic viscosity, high thermal conductivity and high specific heat capacity (Utah et. al., 1989). Milne et al. (1990) showed that plant oil is characterized by a high selectivity for aromatic hydrocarbon in the liquid phase. The lubricity of oil depends on various factors. More importantly on the viscosity of the oil and the structure of the hydrocarbon molecule of various classes (Marcheva et. al. 1984), and the thermooxidative stability of the oil (Chepurova et. al. 1984).

The major thrust of this study is to evaluate the thermophysical properties of the oil to asses its operability in the areas of cooling and lubrication of machinery.

MATERIALS AND METHODS

Samples of *P. Mycrophylla* seeds employed in this work were obtained from the wild at Ijebu-Igbo in the South Western region of Nigeria. All the reagents used were supplied by British Drug House, London and were of Analar grade. The proximate analysis of the seed was determined by the methods earlier reported (Okegibile and Taiwo. 1990). Extraction of the oil of *P. Mycrophylla* seed was carried out by solvent extraction using petroleum ether, while the physical peoperties of the oil such as density, viscosit, surface tension and boiling point were determined using standard method (AOAC. 1984). The moisture content of the oil was determined by heating a known weight of the oil to weight constancy at 105°C in an oven. The weight loss was recorded in percentage as moisture content.

Bomb calorimetric method using well lagged Aluminium calorimeter was employed in the determination of the specific heat capacity (Furman et. al., 1984). The thermal conductivities of the oil were determined by the modified Lee's disc method of ASTM (1978).

The significance of P mycrophylla's oil as drying oil was examined by mixing it in varying proportion with ethylene glycol and linseed oil and then stirred thoroughly to homogenize. The mix was applied as thin film (0.5 mm) on glass plates and allowed to air dry (Igwe and Ibemesi, 1989). Ten glass plates films of each proportion were experimented and the drying level examined at an hourly interval after initial time of ten hours. The results were compared with existing literature data for some synthetic oils of varying interests.

RESULTS AND DISCUSSION

The proximate analysis of the *Pentachletra mycrophylla* seed (table 1) revealed that the seed contains oil and protein to the value of 22.0 and 18.3 percent respectively. The results in Table 2 show the physical properties of the oil compared with those of other industrial oils.

Table 1: Proximate analysis of P.mycrophylla fruit

Nutrient	Percentage
MoistureContent	14.2±0.40
Ash	4.1±0.13
Crude fat/oil	22.5±0.54
Crude protein	18.3±0.95
Crude fibre	18.o±2.10
Vitamin C (mg/100g)	55.0±5.41

The physical properties of *P. mycrophylla* oil is in same order of magnitude with those oils reported in the literature (Shekher et. al. 1978). The density, surface tension, thermal conductivities and specific heat capacity are of the same order of magnitude. However, the viscosity of the forest-based oil is lower than that of the engine oil, but higher than that of the transformer oil.

Lubricating esters in the oil could have accounted for the considerable density value of 875.2-kg m^{-3}.

This will enhance the lub. city of the oil. Alternatively the excess density of the experimental oil over the engine oil could result from the massive in-organic which might be deleterious to its performance at higher moisture content. However, the moisture content of 0.35 percent serves as advantage. Water, which is a contaminant in oils, affects the quality as well as the condition and wear of engines in course of use. Due to high polarity, it is expected to influence greatly the physical state of the oil and interact chemically with the oil components (e.g. additives) and partake actively in the surface-phnomena of the parts being lubricated. The performance of lubricating oil have been shown to be unaffected by moisture up to 1.5 percent (Echin et. al., 1983). Thus corrosion induced wear which might result into adverse effect on antiscouring properties, thereby limiting the operability of oil will be mininial with

Table 2: Physical properties of the *P. mycrophylla* oil compared with some other fossil* and vegetable⁺ oil at 27°C

Property	*P. mycrophylla*	Engine oil	Transformer oil	Palm kernel oil
Density ($Kg\ m^{-3}$)	875.6	865.2	815.6	921.2
Viscosity ($10^{-2}\ Ns\ m$)	46.4	104.8	9.8	21.5
Surface tension ($10^{-2}\ N\ m^{-1}$)	2.0	1.9	2.4	1.9
Specific heat ($KJ\ Kg^{-1}\ K^{-1}$)	2.84	2.92	2.62	3.31
Thermal conductivity ($Wm^{-1}\ K^{-1}$)	0.120	0.199	0.159	0.226
Boiling point (°C)	288.0	350.0	261.0	334.0

* Mercheva et al 1984
⁺ Utah et al 1989

Table 3: Physico-chemical properties of the compared with standard values

Parameters	*P. mycrophylla*	*Standard**
Refractive index	1.452	1.450 - 1.456
Colour (absorbance)	0.745	-
Acid value	12.9	12.0
Saponifiction number	198	196 - 206
Ester number	187	185 - 194
Iodine number	56	52 - 58
Unsaponifiable matter (%)	6	-
Moisture content (%)	0.35	<1.50

. Eminov 1977

the use of oil *P. mycrophylla.*

Another deleterious effect of in-organic content in oil is the possibility of enhancement of reactions such as hydrogenation, isomerization and reforming identified by Katikaneni et. al., (1997). However, Chen et. al. (1989) reported the essential need for steam as medium for most of these reactions in the presence of in-organics which in most cases serve as catalysts. Close proximity of the properties of *P. Mycrophylla* oil to that of transformer oil suggests that it can serve as coolant. Moreso that its properties compared well with standard values (table 3). The thermal conductivities and specific heat of both oil were comparable. The higher conductivities of the engine oil and transformer oil as well as the NKM-40 of Siberia (Marcheva et. al., 1984) could be explained by the presence of activated complexes introduced to enhanced their lubricity. The thought in the direction of industrial cooling application of the oil of *P. mycrophylla* stemmed from the fact that it has high specific heat, moderately high boiling point, average thermal conductivity and low dynamic viscosity. These properties enhance adequate withdrawal of heat from the machinery and when coupled with good lubricity index reduces the heat generation at friction surfaces.

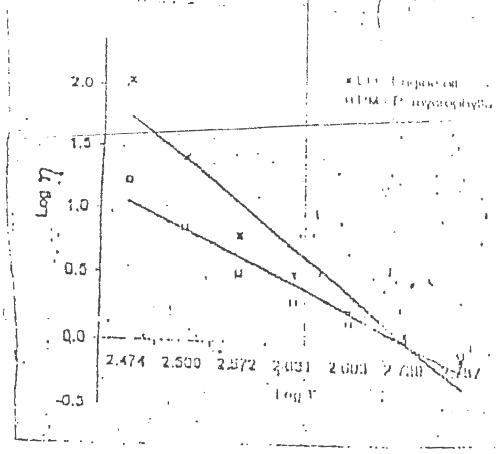

Fig 1: Effect of varying temperature on viscosity of the oil

Further assessment of its lubricating effect is its viscosity behaviour over a range of temperature between atmospheric and close to boiling point. A behaviour similar to that of the engine oil (figure 1) suggests its possible effectiveness as coolant and lubricant. A decrease in viscosity of the oil with increasing temperature is in agreement with the correlation reported in the literature (Kaye and Laby, 1975) for liquids of its type.

This is: Log η = log η₀ − 2.302 l

$\text{Log}_9 = \text{log}_{9 - 2.302bT}$ ....(1).

where ç is viscosity of oil at any given temperature, ç° is viscosity of oil at 0°C. T is temperature in°K and b is a constant. For this experimental oil, 5.82 x $10^{-4} \leq b \leq 8.46 \times 10^{-4}$ was established. This value is lower than those quoted for palm

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