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Research Article

DETERMINATION OF BIOLUBRICANT CHARACTERISTICS OF LOCALLY PRODUCED MORINGA SEED OIL TO ENCOURAGE LOCAL PRODUCTION FOR SUSTAINABLE DEVELOPMENT

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Abstract

This study assessed the characteristics of Moringa seed oil as a Lubricant. Moringa oil was obtained by the local extraction process. The viscosity of Moringa oil was obtained using the absolute measurement apparatus. The specific heat capacity of the oil was obtained by the electrical method and the conductivity of the oil was obtained by using the mini conductivity meter. The viscosity was 0.180NSM^{-2} comparable to that of coolant (0.370NSM^{-2}), but higher than that of transformer oil (0.038 NSM^{-2}). The specific heat capacity was 2716.3JKg^{-1}K^{-1} which is close to that of transformer oils (2616.5JKg^{-1}K^{-1}) and coolant (2200JKg^{-1}K^{-1}). Its density was 940KgM^{-3} at 26^{0}C which almost conforms to that of transformer oil (920KgM^{-3} at 20^{0}C) and coolants (876KgM^{-3} at 40^{0}C). The electrical conductivity was found to be 1.5μ ΩM^{-1} at 25^{0}C. From the results obtained the physical properties (Specific heat capacity, density, boiling point, electrical conductivity) of moringa oil are similar to that of transformer oil. Therefore, the oil could be used as transformer oil if its viscosity can be reduced. The results also show that Moringa oil has similarities in properties (Viscosity, Density, Specific heat capacity, High boiling point) with lubricants. Thus, its characteristics make it a good candidate for usein machines, as an alternative bio-lubricant different from mineral oil lubricant, asit is prepared from non-conventional energy resources and is non-toxic, biodegradable, and eco-friendly. This can, in the long run, lead to national and sustainable development.

Keywords: Moringa oil, Viscosity, Conductivity, Density, Specific heat capacity.

INTRODUCTION

Moringa, native to parts of Africa and Indonesia, is the sole genius in flowering plant family *Moringacae* and of various species. It can grow to about 5 meters in height, and its seeds contain oil. The oil is greasy –like to feel, brownish-yellow, or golden-yellow, and tasteless. The oil serves as food, lubricant for watches, clocks, and aircraft, as hair care products, and as machine oil. Industrial liquids include various kinds of liquid products such as mineral oils, animal fats, and vegetable oils, synthetic oil, water-based fluids, etc., and also gases. The oils have various uses in different areas of machine parts, engines, and transformers. Some of these properties (viscosity, specific heat capacity, and thermal conductivity) determine whether or not a particular oil could be used as a lubricant, engine oil, and/ or transformer oil [1]. Several reports are available in the literature on the extraction and characterization of Moringaoleifer aseed oil. Extraction methods reported included mechanical press [2] [3] solvent extraction [4] [5] [2] and enzymatic extraction [5] [6] the yield and physicochemical properties of the oil vary with the method of extraction. There has been growing interest in the use of vegetable oils as lubricants and hydraulic fluids due to the toxicity and environmental issues arising from conventional petroleum-based fluids. Biolubricant is an alternative lubricant different from mineral oil lubricant asit is prepared from non-conventional energy resources and is non-toxic, biodegradable, and eco-friendly. Several vegetable oils have been applied asbio-lubricants and additives including canola, rapeseed, castor, and palm [7]. Vegetable oils with high oleic contents are considered to be the best alternative to substitute conventional mineral oil-based lubricating oils and synthetic esters [8]. It is given this backdrop that we set up this investigation to characterize the physical properties of moringa oil which is a renewable source of energy, to see the possibility of substituting it for some of the industrial oils already in use.

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Viscosity

Viscosity kind of internal friction which offers a resistance to the motion of one layer of liquid over the other and this develops viscous force. The viscosities of most fluids have temperature dependence; those of liquids decrease with increasing temperature while those of gases increase with an increase in temperature [9].

The viscous force is given by

$$F = \eta A \frac{dv}{dy} \qquad (1)$$

Where η is the viscosity. The unit of η is NSM^{-2} = KgM^{-1}S^{-1}

A. Specific Heat Capacity

The specific heat capacity of a substance is defined as the ratio of the heat energy, dQ, to the product of the mass of the body and temperature change, dT.

$$C = \frac{dQ}{MdT} \qquad (2)$$

B. Electrical Conductivity

In the presence of electric and magnetic fields, most liquids conduct electricity. Electrical Conductivity in liquids is characterized by the movement of ions. In such instances, the field act on both electrons and ionized atoms to produce a dynamical effect, which may include the bulk motion of the medium itself [10].

METHODOLOGY

A. Extraction of Moringa oil

The Moringa seeds were collected. About 500gof dried seeds were shelled. The shelled seeds were then grounded and the powder mixed with a little water enough to turn itinto a paste. The paste was then processed, collecting the oil in a container. It was then allowed to settle, then decanted leaving the sediments behind. Pure cold-pressed moringa oil was obtained

B. Measurement of Viscosity of moringa oil

The viscosity of Moringa oil was measured by using the apparatus in Fig1 connecting one end of a capillary tube, T to a constant pressure apparatus, A, which provides a steady flow of a liquid using a beaker, B, and a stopped clock, the volume of liquid per second flowing through the tube was measured. The viscosity was calculated using Poiseuilles Formula.

$$\eta = \frac{\pi p a^4 t}{8VL} \qquad (3)$$

Where ŋ = Coefficient of Viscosity,
t = time of flow of liquid,
v = volume of liquid,
p = hydrostatic pressure
L = length of capillary tube,
a = radius of capillary tube

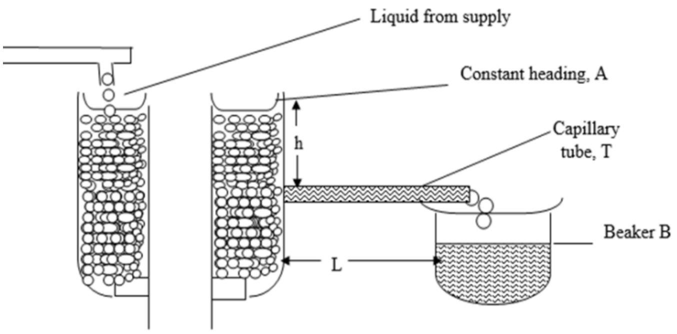

Fig. 1. Apparatus for absolute measurement of Viscosity [11]

C. Measurement of Specific Heat Capacity

The specific heat capacity of moringaoil was measured using the apparatus in Fig2.The mass of the calorimeter and the stirrer was found (m1). Then it was filled with moringa oil to cover the heating coil and reweighted (m2), to be able to get the mass of the oil. The thermometer and the heating coil were immersed in the oil inside a large heat-insulating calorimeter. The ammeter reading was kept constant by adjusting the rheostat when necessary. The oil was allowed to heat for 8minutes when the temperature (θ2) was taken and the key opened to stop the power supply at the same time. The specific heat capacity was calculated using the formula

$$VIt = MC\Delta\theta \text{ ie } C = \frac{VIt}{M\Delta\theta} \qquad (4)$$

Where M = Mass of the oil used

C = Specific heat capacity of the oil
Δθ = Change in temperature
I = Current supplied
t = time taken
V = Voltage supplied

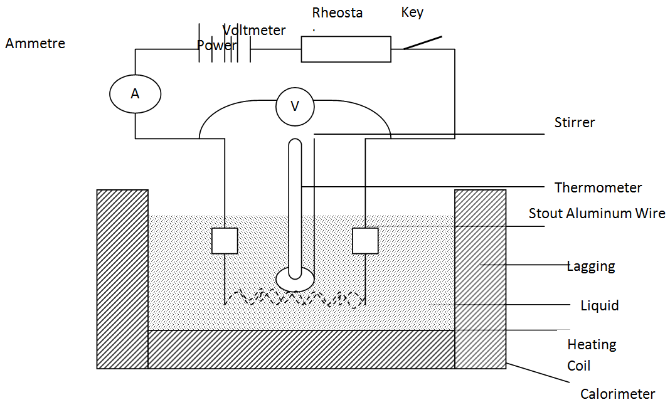

Fig. 2. Apparatus for determining specific heat capacity of a liquid by electrical method [12]

D. Measurement of Conductivity of Moringa Oil

The mini conductivity meter (Fig3) was used to take direct measurements of the oil when its probe was immersed in the oil. It measures conductivity directly. The instrument is graduated in micro-ohm per centimeter and has temperature variation from 10°C to 50°Cwhich is inbuilt. This meter can measure conductivities as low/small as 0.1Necm^{-1} at room temperature.

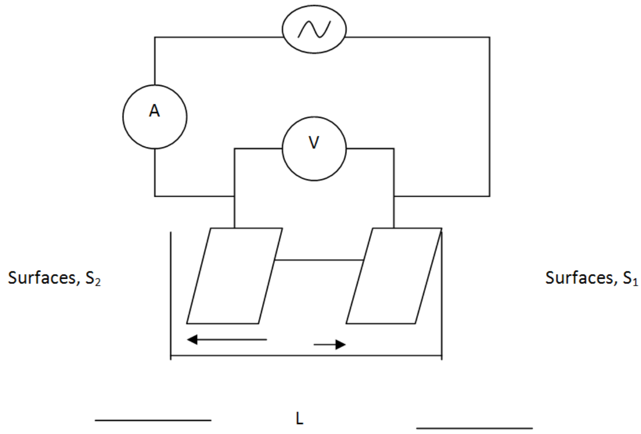

Fig.3. Mini Conductivity Meter

RESULTS

Results for Viscosity Measurement

The measurement of viscosity performed experimentally using the constant pressure method to measure the volume per second flow through a capillary tube is displayed in Table 1 and illustrated in Fig3 below.

Height of tank (pressure head) h = 0.064m
Length of capillary tube L = 0.19m
Radius of capillary tube a = 0.00032m
The slope of the graph, $S = \frac{\Delta V}{\Delta t} = 1.1333\ X\ 10^{-7} m^3 s^{-1}$

Table 1. Volume per Second flow for Moringa Oil at 210C Temperature

T (s)	Volume 1^{st}	(CM^3) 2^{nd}	Average	Volume $M^3 \times 10^{-6}$	$^{v}/t \times 10^{-7}$ $M^3 s^{-1}$
20.00	23.10	23.30	23.20	2.3	11.60
30.00	33.00	35.00	34.00	3.4	11.33
40.00	43.50	46.50	45.00	4.5	11.25
50/00	55.00	57.50	56.25	5.6	11.26
60.00	66.00	69.00	67.50	6.8	11.34

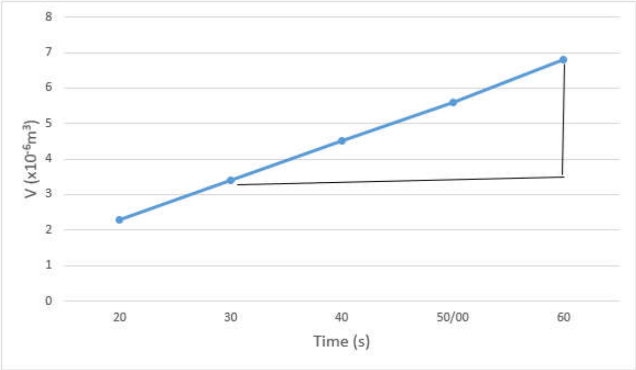

Fig. 4. Graph of Volume against Time

Using Poiseuilles Formula (equation 2), the Viscosity was calculated and found to be0.17981 NSM^{-2} at 21^{0}Cand $0.180NM^{-1}$ at 26^{0}C.

Results for Specific Heat Capacity: The result of the specific heat capacity by the electrical method was determined using equation 3and it was found to be 2716.3 $Jkg^{-1}k^{-}$

Results for Conductivity

The probe of the instrument was dipped into the liquid and its deflection read on the meter. The results are as in Table 2.

Table 2. Electrical Conductivity of Moringa oil at Selected Temperatures

Temperature (°C)	Electrical conductivity (μΩ m^{-1})
10	13
15	9
20	5
25	1.5

Table 3. General Results

Liquid	Specific Heat Capacity ($JKg^{-1}K^{-1}$)	Viscosity (NMS^{-2})	Density (KgM^{-3})	Conductivity ($WM^{-1}K^{-1}$)
Moringa oil	2716.3	0.180	940 at 26°C	1.5
Transformer oil	2616.5	0.038	920 at 20°C	0.136
Coolant	2200	0.370	-	-
Engine oil	-	0.820	865 at 20°C	0.145
Palm oil	1625	1.22	915 at 31°C	-

DISCUSSION

The viscosity, specific heat capacity, and electrical conductivity of the oil were evaluated as described above. The results are here compared with those quoted by [13] and [14]. These are shown in Table 3. From Table 3, moringa oil has a specific heat capacity of 2716.3 $JKg^{-1}K^{-1}$ which is not far from the [14] of about 2200 $JKg^{-1}K^{-1}$. The high boiling point of about 551K (278^{0}c) and viscosity of $0.180NM^{-1}$ at 26^{0}C of moringa oil is in agreement with that of [13]. Moringa oil has a specific heat capacity and density close to that of transformer oil. Its high boiling point shows that it will have a high resistance to gas evolution. Therefore, moringa oil may be used as transformer oil if we can add some additives to bring its viscosity down close to 0.038 NSM^{2}. The density of lubricants reduces by about $13Kg^{-3}$ for every 20°C rise in temperature, thus it will serve as a good lubricant provided the change in density as temperature rises are within the stipulated range. Also, the high boiling point of moringa oil makes it good for engines.

CONCLUSION

From the results obtained the physical properties **(**Specific heat capacity, density, boiling point, electrical conductivity) of moringa oil are similar to that of transformer oil. Therefore, the oil could be used as transformer oil if its viscosity can be reduced. The results also show that Moringa oil also has similarities in properties (Viscosity, Density, Specific heat capacity, High boiling point) with lubricants, thus it can be used as a lubricant in machines. In this era of economic hardship, it is justified that efforts are made towards exploring the properties of commonly available natural resources such as moringa oil, to see the possibility of substituting them for some of the oils already in use as insulators, lubricant, engine oil, and transformer oil. This is more so when the synthetic and petrol chemical oils used as lubricants, coolants, and engine oils are usually very costly thereby constituting an economic drain on our lean earnings. Also, the finite and whole oil reserve can be exhausted at any moment, since it is not a renewable resource, it becomes necessary to look for an alternative source, of which Moringa oil is one of such alternative sources. As a recommendation on this paper, the following can be noted.

1. Certain additives or enrichment process (nano-particles, liquid detergent,etc) can be done to reduce the high viscosity of moringa oil to serve as an alternative to industrial oil.
2. The test for variation of viscosity as a function of temperature can be carried out.

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