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# PREDICTING THE NUTRITIONAL HEALTH STATUS OF LOCALLY PRODUCED PALM OIL USING SOME PHYSICAL PARAMETERS

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## ABSTRACT

*Three physical properties of locally produced palm oil – viscosity, thermal conductivity and density for varying temperatures were determined. The values obtained were compared with corresponding internationally stipulated standard values using statistics of mean and graphs. The purpose of the comparison was to predict the nutritional health status of palm oil. Results show that the obtained mean values were (18.50 ± 5.35) Pa.s, (0.1429 ± 0.0042) W/m $^oC$ and (898.1 ± 0.28 kgm$^{-3}$) for the locally produced palm oil as against (20.47 ± 5.68) Pa.s, (0.1677 ± 0.0006) W/m $^oC$ and (849.6 ± 5.47) kgm$^{-3}$ for the standard. These represent respective errors of 10, 15 and 5 %. Results also show that the slopes of the respective relationships of these parameters with temperature at $\theta = 25\ ^oC$ (RT) for instance are – 0.266 Pa.s/ $^oC$ , 0 and – 0.022 kgm/m$^3$ $^oC$ for the locally produced while the values obtained using standard data are – 0.242 Pa.s/ $^oC$, - 0.0008 W/m $^oC$ and – 0.442 kg/m$^{3o}$C. The associated percentage errors are 7, 100 and 95. These pronounced errors give an indication that from the standpoint of the examined physical properties, the studied locally processed palm oil may not be as nutritionally healthy as the standard oil. Proper monitoring of the local palm oil mills by the relevant agency is therefore recommended.*

**Key words:** Predict, Status, Locally produced, Palm oil, physical properties, nutritional health.

## INTRODUCTION

Palm oil is usually obtained from the mesocarp of the oil palm fruit, *Elaeis guineensis*, jaq (Trappist the monk, 2016). It has been defined as 'an important and versatile vegetable oil and presents an essential raw material in food and non-food industries. As a result of its unique features, it has become not only globally accepted but also widely applicable (Wikipedia, 2015) and as such accounts for 35% of world edible vegetable oil production (United States Department of Agriculture USDA, 2013). For instance, it is used for cooking, frying, shortening and the production of margarine/confectionary fats in food industry. It is also used in the production of non-diary creamers and ice-cream (Schuster Institute for Investigative Journalism SIFIJ, 2014).

In the non food sector, it has not only maintained its traditional use in the production of soaps, detergents, greases, lubricants, candles, pharmaceutical products and cosmetics but is now used as feedstock for the production of biodiesel. It is also used in the production of bactericides and water treatment products. In human medicine, it has been reported to be capable of causing a reduction of 13 % of total cholesterol in hypercholesterolemics (Qureshi, 1995)

These wide applications notwithstanding, it has been observed that improper production and use could result in health issues.

Specifically, it could cause increase in the risk of cardiovascular disease. This could be due to its fat content. Fat can raisecholesterol. It is difficult to digest, and also reduces the ability of the blood to clot thus leading to excessive bleeding. These must have informed the USDA's recommendation that consumption of saturated fat should not exceed 10% of a person's total daily fat intake (USDA, 2015).

Nutritional health is an important aspect of healthcare. This work then examines the suitability (health implication/ nutritional health status) of locally produced palm oil by comparing some of its physical properties with the corresponding standard properties available in the literature. Specifically the physical properties examined include viscosity, thermal conductivity and density.

## MATERIALS AND METHODS

Locally produced palm oil was obtained from a mill located at Obinomba in Ukwuani Local Government Area of Delta State. Three specific physical properties of this oil were investigated. They include viscosity Ƞ, thermal conductivity K and density ρ.

Ƞ was determined for varying temperatures (20-150 °C) using a Brookfield Low Dial Reading viscometer- Brookfield LV shown in Figure 1. The oil contained in a beaker was heated to varying temperatures. At each desired temperature the spindle of the viscometer was quickly and carefully lowered into the oil. The torque required for the spindle to maintain a constant rotation of 20 revolutions per min (rpm) was converted to the viscosity reading and displayed on the dial. To obtain viscosity values at temperatures below 27 °C (RT), the beaker containing the oil was placed on ice cube. The viscometer was carefully cleaned using tissue paper, detergent and water after each reading. Specific heat $c_l$ of the palm oil was determined using the cooling method (Figure 2). In relation to the specific heat $c_w$ of water, the former was calculated from the relationship:

$$c_l = \frac{(m_w c_w + m_s c_s)\left(\frac{d\theta}{dt}\right)_w - m_s c_s\left(\frac{d\theta}{dt}\right)_l}{m_l\left(\frac{d\theta}{dt}\right)_l} \qquad (1)$$

$m_w c_w$ , $m_l c_l$ and $m_s c_s$ represent the heat capacities of water, palm oil and stirrer respectively. The quantity of heat $Q$ absorbed by any mass of oil at a particular temperature was then determined using the simple relationship:

$$Q = m_l c_l \Delta\theta \qquad (2)$$

$\Delta\theta = \theta_i - 27$ is the change in temperature from RT. The thermal conductivity K of the palm oil sample at the particular temperature was consequently obtained from the relation (Ramesh et al; 2014):

$$K = \frac{QH}{\Delta t\, A \Delta\theta} \qquad (3)$$

$H$ is the height of the palm oil column of cross sectional area $A$ and $\Delta t$ the change in time interval.

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Density ρ of the oil sample was determined for varying temperatures by noting the volume of a given mass of it obtained by subtracting the empty mass of the measuring beaker from the mass of the beaker containing oil and then applying the simple relationship:

$$\rho(\theta) = \left(\frac{M}{V}\right)_{\theta} \qquad (4)$$

Measurements above RT was achieved by heating using a heater while lower temperature measurements were made by placing the beaker containing the oil on ice block. In each of the three measurements the upper limit temperature of 150 °C since from the literature, the smoke point of palm oil ranges from 235 to 300 °C (Mutt, 2016 and Aguilar, 2015)

The values of the physical parameters so determined for this locally produced palm oil were then compared with their corresponding values for the standard palm oil available in literature (Chempro.in, 2015) using statistics of mean and graphs. Inferences were subsequently made regarding the nutritional health status of this studied locally produced palm oil on the basis of the observed comparison.

## RESULTS AND DISCUSSIONS

The obtained values for η of the locally produced palm oil at varying temperatures as well as standard values available in the literature are presented in Table 1 while the relationship between this parameter and temperature is predicted in Figure 3 using both set of values. The mean for the locally produced is 18.50 ± 5.35 as against 20.47 ± 5.68 for the standard. This represents an error of 10 %. From Figure 3, the relationship between viscosity and temperature for the standard palm oil is $\eta_S$ = 21803 $\theta^{-1.75}$ while that of the locally produced is $\eta_L$ = 21396 $\theta^{-1.77}$. Their respective slopes at RT for instance are – 0.266 and - 0. 242. This indicates an error of 7 %. This error of 7 % in the slope and that of as much as 10 % in the mean suggests that the locally produced palm oil may not be nutritionally as healthy as the standard from the standpoint of viscosity.

The corresponding K values and the graphical estimation of the relationship with temperature are presented in Table 2 and Figure 4 respectively. The mean K for the locally produced oil is 0.1429 ± 0.0042 and that of the standard 0.1677 ± 0.0006. The error is 15 %. From Figure 4, the predicted relationship between K and Θ is
$K_L$ = - 0.0000 Θ + 0.184 and

$K_S$ = - 0.0008 Θ + 0.173 for the locally produced oil and the standard respectively. From these two linear relationships a 100 % error in the slopes is observed. This remarkably high value as well as the error of 15 % obtained in the values of the mean further add credence to the fact that this studied locally processed palm oil may not be as healthy as the standard palm oil nutritionally specifically from the standpoint of this physical parameter K.

From Figure 5, the relationship between density and temperature for palm oil is obtained as $\rho_L$= - 0.022 Θ + 900.5 and $\rho_S$ = - 0.442 Θ + 897.3 for the locally processed and standard palm oil respectively. This represents an error in slope of 95 %. Meanwhile data from Table 3 show that while the mean density value is 898.1 ± 0.28 $kgm^{-3}$ for the local that of the standard is 849.6 ± 5.47 $kgm^{-3}$ such that the error in the mean values is 5 %. This 5 % error in the mean values notwithstanding, the quite significant error of 95 % in the slopes of density curves tends to indicate non compliance of this locally processed oil with the standard as far as the physical parameter of density is concerned. By implication then, it can be inferred that with respect to the physical property density, the examined locally processed palm oil does not satisfy nutritional health requirements as the standard oil.

The failure of this studied palm oil to be nutritionally healthy from the standpoint of the three examined physical properties may be as a result of the quality of the raw material-oil palm fruit. It may also be attributable to the processing procedure adopted during milling as well as the level of hygiene maintained. It is expected too that the standard oil may have undergone some refining processes.

**Table 1:** Obtained Viscosity values and corresponding standard values

| Temperature (˚C) | Viscosity (Pa.S) | |
|---|---|---|
| | Local palm oil | Standard Value[a] |
| 20 | 102.40 | 106.80 |
| 30 | 50.45 | 57.85 |
| 35 | 40.62 | 44.68 |
| 40 | 33.46 | 35.41 |
| 45 | 25.75 | 28.68 |
| 50 | 20.76 | 23.68 |
| 55 | 17.86 | 19.88 |
| 60 | 15.74 | 16.93 |
| 65 | 13.46 | 14.61 |
| 70 | 10.68 | 12.75 |
| 75 | 9.68 | 11.23 |
| 80 | 8.53 | 9.99 |
| 85 | 7.61 | 8.96 |
| 90 | 6.01 | 8.09 |
| 95 | 5.09 | 7.35 |
| 100 | 5.06 | 6.72 |
| 105 | 5.03 | 6.18 |
| 110 | 4.97 | 5.71 |
| 115 | 4.86 | 5.30 |
| 120 | 4.62 | 4.94 |
| 130 | 4.16 | 4.34 |
| 135 | 4.00 | 4.08 |
| 140 | 3.43 | 3.86 |
| 145 | 3.26 | 3.65 |
| 150 | 3.16 | 3.45 |
| Mean | 18.50 ± 5.35 | 20.47±5.68 |
| STDEV | 23.94 | 25.43 |

(a: Chempro.in, 2015)

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**Table 2:** Obtained Thermal Conductivity and corresponding standard values

| Temperature (˚C) | Thermal Conductivity (W/m°C) | |
|---|---|---|
| | Local palm oil | Standard Value[a] |
| 25 | 0.1742 | 0.1721 |
| 30 | 0.1692 | 0.1717 |
| 40 | 0.1645 | 0.1708 |
| 50 | 0.1600 | 0.1699 |
| 60 | 0.1558 | 0.1691 |
| 65 | 0.1518 | 0.1687 |
| 70 | 0.1480 | 0.1683 |
| 75 | 0.1444 | 0.1679 |
| 80 | 0.1410 | 0.1675 |
| 85 | 0.1377 | 0.1671 |
| 90 | 0.1346 | 0.1668 |
| 95 | 0.1316 | 0.1664 |
| 100 | 0.1287 | 0.1660 |
| 110 | 0.1260 | 0.1653 |
| 120 | 0.1234 | 0.1646 |
| 130 | 0.1209 | 0.1636 |
| 140 | 0.1184 | 0.1633 |
| Mean | 0.1429 ± 0.0042 | 0.1677 ± 0.0006 |
| STDEV | 0.0175 | 0.0026 |

(a: Chempro.in, 2015)

**Table 3:** Obtained Density values and corresponding standard values

| Temperature (˚C) | Density (kg/m$^3$) | |
|---|---|---|
| | Local palm oil | Standard Value[a] |
| 25 | 900.0 | 887.5 |
| 30 | 899.9 | 885.0 |
| 40 | 899.7 | 882.5 |
| 50 | 899.6 | 877.5 |
| 60 | 899.2 | 872.6 |
| 65 | 899.2 | 867.8 |
| 70 | 899.0 | 865.4 |
| 80 | 898.8 | 860.7 |
| 90 | 898.6 | 856.1 |
| 100 | 898.3 | 851.6 |
| 110 | 898.1 | 847.1 |
| 120 | 897.9 | 842.7 |
| 130 | 897.6 | 837.1 |
| 140 | 897.4 | 834.2 |
| Mean | 898.1 ± 0.28 | 849.6 ± 5.47 |
| STDEV | 1.2583 | 24.4961 |

(a: Chempro.in, 2015)


Fig. 1: Rotational viscometer

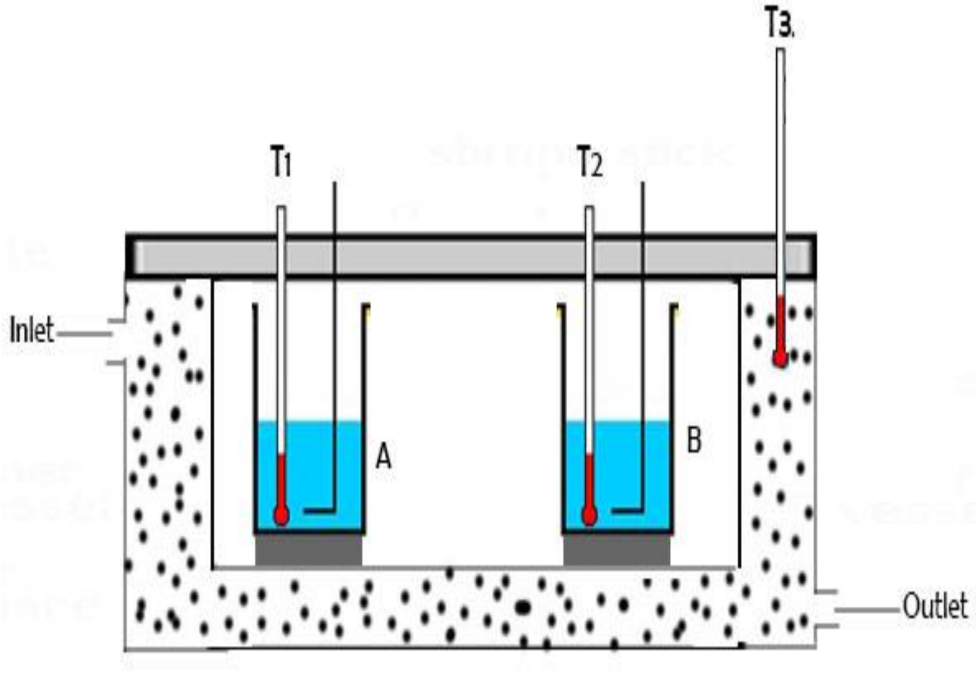


Fig. 2: Experimental setup of specific heat capacity of liquid by the method of cooling (Kullabs.com, 2015)

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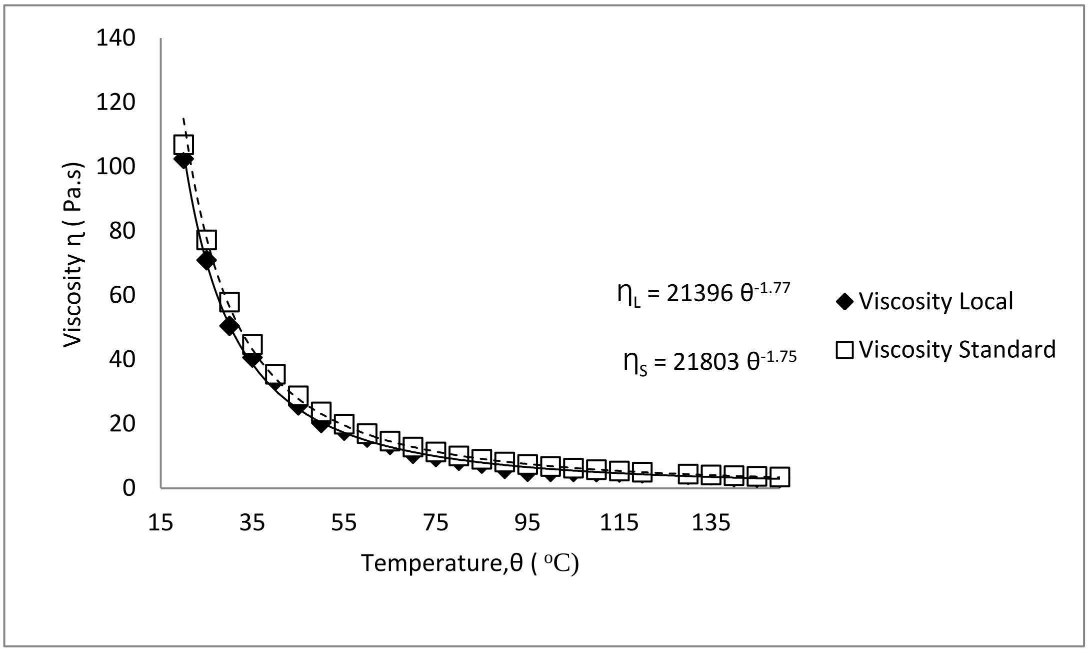


Fig. 3: Graph showing the relationship between viscosity and temperature

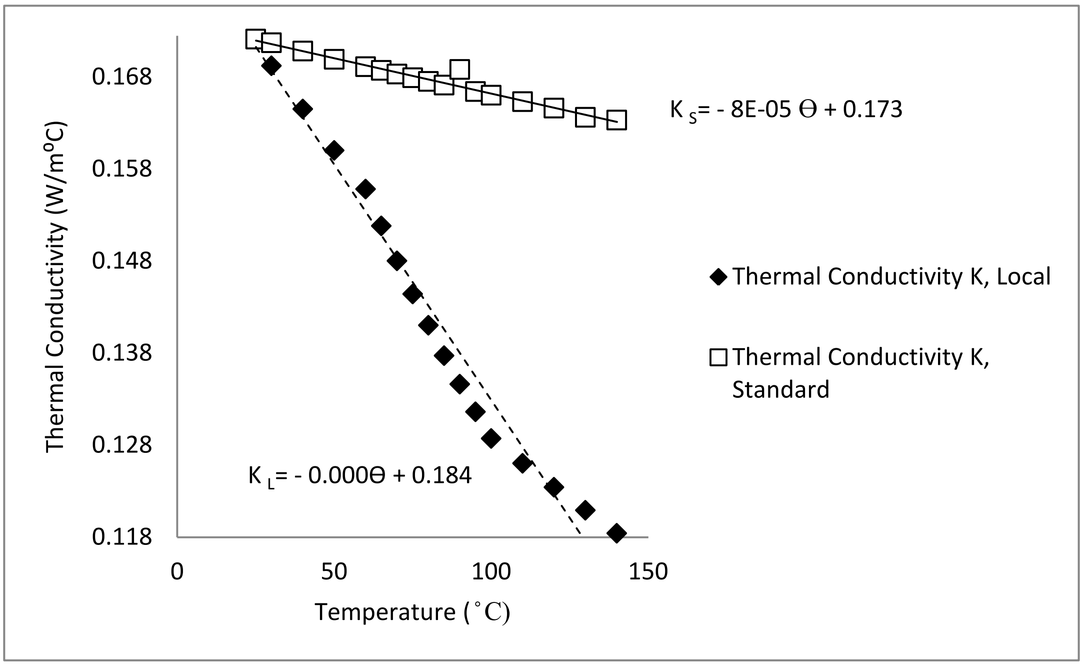


Fig. 4: Graph of Thermal conductivity against Temperature

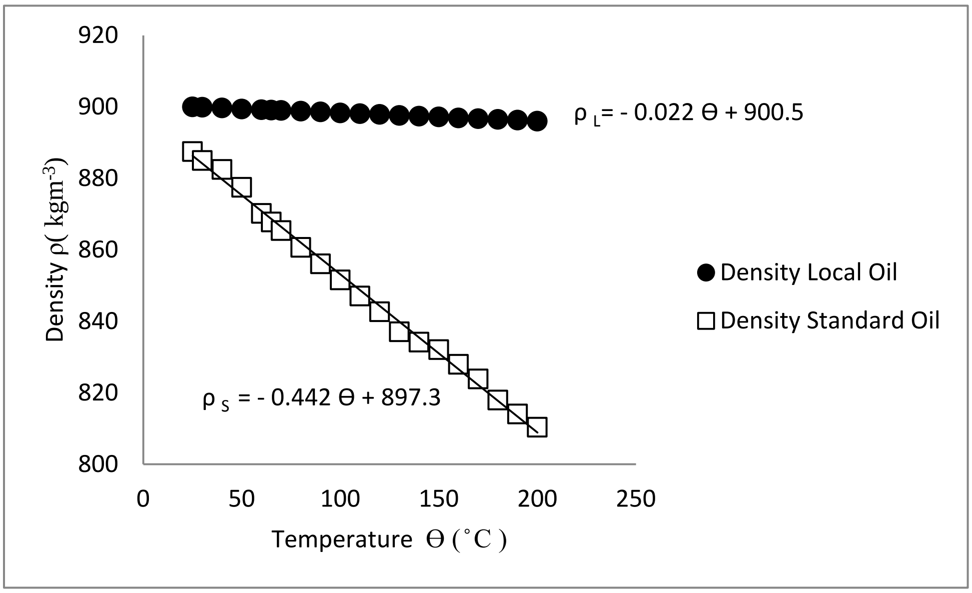


Fig. 5: Graph of Density against Temperature

Since the errors observed in the physical properties of the studied locally produced palm oil in relation to similar properties of referenced/standard oil are significant, it is therefore concluded that this locally processed oil may not be as nutritionally fit/healthy.

In view of the above conclusion, it is suggested that the Standard Organisation of Nigeria SON or whatever appropriate body should monitor the operations of the local palm oil mills so as to ensure that their delivery is in line with the standard stipulations and so nutritionally healthy.

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