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Determination of Some Physical Properties of Selected Edible Oils in Nigeria

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Abstract: ***Edible oils are commonplace in table food, snacks and industrial food products. This inclined the study in this research work which is aimed at investigating the physical properties of the oils and their varying effect on their electrical conductivity, to determine their edible viability and shelf –life. The effect of increased temperature on the viscosity of the oil was studied. Also the electrical conductivity versus power supply through the oil and also the cooling property of the oil were studied using calorimetry experiment. The results show a typical trend of variation in the electrical conductivity and viscosity (dependent variables) and temperature and power supply (independent variables). The electrical conductivity of the oils was found to be increasing with temperature and the viscosity was decreasing with temperature. This is in agreement with earlier postulation. I therefore recommend that it is better to keep edible oils at temperature below 40^{o}C so as to maintain acceptable rate of spoilage and thereby elongated shelf-life.***

Keywords: Electrical conductivity, Cooling curve, Viscosity, Edible vegetable oils, Nigeria.

1. Introduction

Vegetable oils are substances widely used in our daily life. The term “vegetable oil” can be narrowly defined as referring only to substances that are liquid at room temperature [1].

They are among the three main food sources for human beings making important supplies to our energy daily consumption. They also play fundamental role in industry, especially in snack industry. Vegetable oils may or may not be edible. Some of these vegetable oils are used for domestic (edible) and industrial purposes [2]. Inedible vegetable oils include processed linseed oil and castor oil used in lubricants, paints, cosmetics and other industrial applications. Most of the edible oils and fats produced are derived from plant sources such as soya beans, melon, groundnut, corn, oil palm, shea butter and coconut. Edible oil in Nigeria are produced locally and also imported, an indication of the important roles it plays [3].Edible oils have made an important contribution to the diet of people in many countries serving as a good source of protein, lipid and fatty acids for human nutrition including the repair of worn out tissues, new cell formation as well as useful source of energy[4]. They also play important functional and sensory roles in food products and they acts as carriers of fat soluble vitamins A,D,E and K[5].

They also provide energy and essential linoleic and linolenic acids responsible for growth [6,7] and they are one of the main ingredients used to manufacture soaps, cosmetics, and pharmaceutical products [8,9].

There are various physical properties of vegetable oils that can be observed. Three out of these properties that would be looked into are the electrical conductivity, viscosity and cooling curve.

Electrical conductivity is a measure of the ability of a solution to carry a current. It is the reciprocal of electrical resistivity, and measures a material's ability to conduct an electric current.

Viscosity is the quantity that describes a fluid’s resistance to flow [10]. In everyday terms (and for fluids only), viscosity is "thickness" or "internal friction". Thus, water is "thin", having a lower viscosity, while honey is "thick", having a higher viscosity. Simply, the less viscous the fluid is, the greater its ease of movement otherwise called fluidity[11].

It has been well established that temperature has a strong influence on the viscosity of fluid products with viscosity generally decreasing with increase in temperature [12].

Newton’s law of cooling states that for a small difference of temperature between a body and the surroundings, the rate of gain or loss of heat by the body is proportional to the difference in temperature between the body and the surroundings [13].

The rate of loss of heat by a body is directly proportional to the temperature difference between the body and the surroundings, provided the difference is not very large.

2. Materials and Methods

2.1 Materials

Nine (9) different types of Nigeria edible oil samples were studied which include: Palm kernel oil (sample A) (Elaeis guineensis), groundnut oil (sample B) (Arachis hypogaea), Shea butter oil (sample C) (Vitellaria paradoxa), coconut oil (sample D) (Cocos nucifera), olive oil (sample E) (Olea europaea), melon oil (sample F) (Citrullus colocynthis L.), soyabean oil (sample G) (Glycine max), palm olein oil (sample H) (Elaeis guineensis), and palm oil (sample I) (Elaeis guineensis). The different samples of the edible oils were collected randomly from Bodija market in Ibadan.

2.2 Methodology

The following materials were used during the experimental procedure to determine the conductivity of the different samples of the edible oils collected from the market randomly: Thermometer (liquid -in- glass 0^0C – 100^0C), calorimeter and its accessories, connecting wires, switch, DC power supply (0-32V), voltmeter (0–20V), ammeter (0–100μA), multimeter (digital), stirrer and stopwatch (analogue).

For the electrical conductivity experiment, the dependent variable is the electrical conductivity of the fluid and the independent variable is the fluid used. The apparatus was set up according to the diagramin Fig 1, the oil was poured inside the calorimeter and the thermometer dipped inside it. The ammeter, voltmeter, switch, dc power supply and rheostat were connected to the calorimeter using connecting wires. The electrical conductivity of the oils was determined by pressing the switch to take the readings from the ammeter and voltmeter as the dc power supply was varied. This experimental procedure was carried out on all the nine samples of oils.

To derive the electrical conductivity of the oils, the following equations were used:

$$\sigma = \frac{1}{\rho} \qquad (2.1)$$

Where σ is the electrical conductivity and σ is the resistivity.

$$\rho = \frac{RA}{L} \qquad (2.2)$$

Where R is the resistance, A is the cross sectional area and L is the length between the two electrodes (L= 0.0191m).

Then from ohm's law, V = IR where V is the voltage and I is the current. Making R the subject of the formula for each oil, we have:

$$R=\frac{V}{I} \qquad (2.3)$$

The cross sectional area of a cylinder is:

$$A = 2\pi r^2 + 2\pi rh \qquad (2.4)$$

Where r is the radius of the cylinder and h is the height of the cylinder (d =0.0523m, r = 0.0262m, h = 0.0767m, A = $0.0169m^2$).

For the cooling curve experiment, a copper calorimeter was half filled with the liquid and heated to 30^0C above room temperature. With the aid of a stopwatch and a thermometer, the temperature of the liquid was taken at regular intervals of 5minutes. The liquid was kept well stirred during the period of cooling until it gets back to the room temperature. The experimental method was carried out on all the nine samples of oil collected.

For the viscosity experiment, the independent variable is the fluid used (vegetable oil) and temperature. The dependent variable is the viscosity of the fluid. This was simply determined by using a separating funnel and stop watch to measure the flow rate. The viscosity can then be determined by calculating the inverse of the flow rate for each of the oil sample. The constants (control variables) are the size of the hole of the funnel and its volume. The oil was kept at different temperature while the funnel was opened gently and the oil was allowed to flow. A stopwatch was used to time the flow from the funnel into a beaker and the time taken for the oil to empty into the beaker was recorded. The procedure was repeated 3 times for the same temperature and the average time was calculated. The experimental method was carried out on all the nine samples collected for different temperatures between 20^0C and 60^0C.

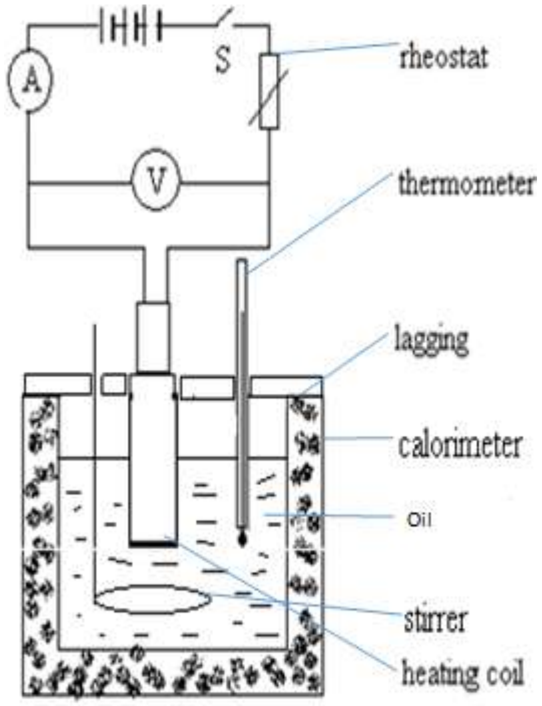

Figure 1: Diagram for the Determination of Electrical Conductivity

3. Results and Discussions

3.1 Electrical conductivity

Having performed the experiment on the samples of the oil, the electrical conductivities of the oils were calculated using the equations 2.1 – 2.4 and the result of the experiment is presented in Fig 2.

A close observation of the Fig 2 shows the same level of electrical conductivity for all the oils above 25Watt supply (i.e. around 0.32). Also, the initial conductivity of the oils varies, some decreases rapidly, while we observe mild decrease in others within 0-15W power supply, however above 15Watt the same characteristic curve is observed in all the oils though steepness varies but they all settle at the same conductivity level of about $0.32(M\Omega m)^{-1}$.

Referencing Lakrari in his work [14], electrical resistivity of some oils (Argan, sunflower and Rapeseed) are plotted against Temperature, and the observation was a decline in resistivity with temperature. The result and observation of our experiment align with his work as the conductivity i.e. the reciprocal of resistivity increases with power supply above 15Watt, we can infer that the current flow above 15Watt causes increase in temperature and thus increase in conductivity of the oil. Since he measured resistivity against temperature, which shows an inverse relation; our measurement of conductivity with power supply (i.e. increase in temperature due to current) will consequently show a direct relation to depict the same trend.

3.2 Cooling curves

For the cooling curve, the experiment was stopped where the temperature was constant irrespective of the time above 70 minutes. The comprehensive graph for all the oils is shown in Fig 3.

From the comprehensive graph of all the nine oils (Fig 3), it was observed that all the oil samples started their cooling from almost the same point, diverged at the middle due to the little differences in the properties of each oil and then settles at almost the same temperature of about 32^0C and 33^0C.

3.3 Viscosities

Studying the graph (Fig 4), for all other oil, the rate of reduction in viscosity tends to reduce and almost stayed at constant from 40^0C temperature value. On the contrary, Shea butter's viscosity tend to increase in its rate of reduction after 40^0C temperature value and also shows a rate of reduction at 50^0C. It can then be seen that for all the oils studied, the viscosity property changes at 40^0C and the viscosity is reducing as the temperature is increasing.

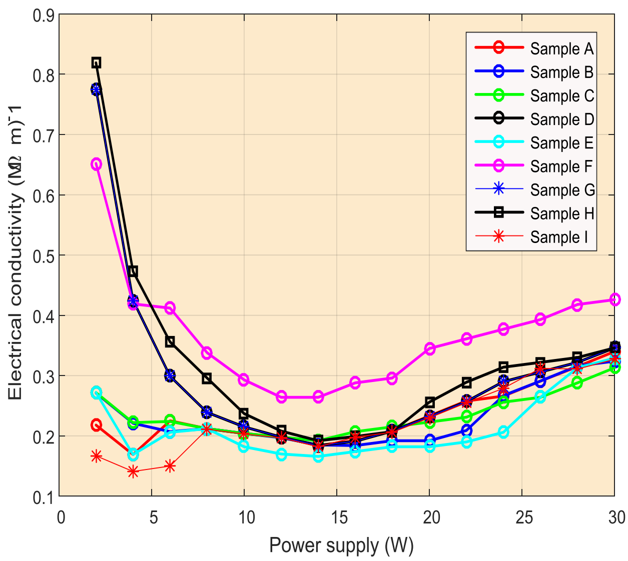

Figure 2: Graph presenting electrical conductivity of oil samples

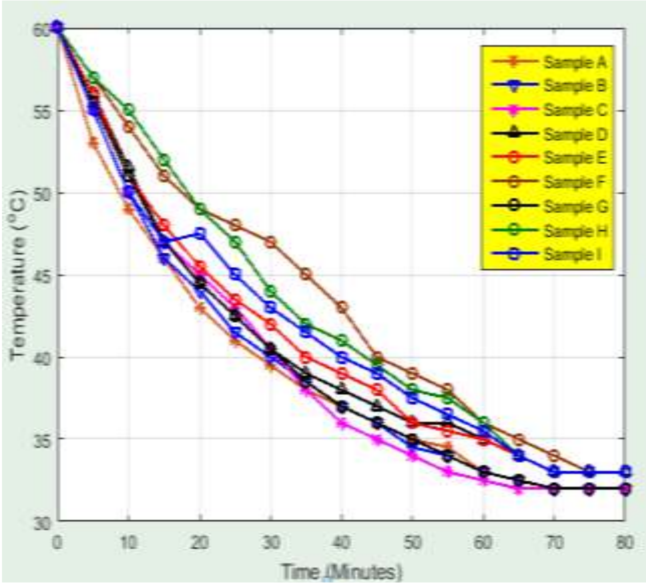

Figure 3: Cooling Curve For All The Nine Oil Samples

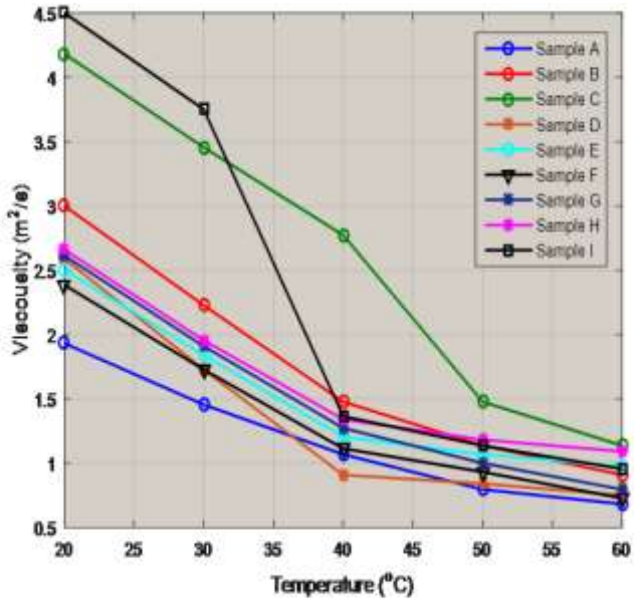

Figure 4: Viscosity for all the nine oil samples

4. Conclusion

Electrical conductivity of edible oils has been observed in this research work to increase with temperature while the viscosity is decreasing with temperature.

The increase in the electrical conductivity of the oils is observed in this study to vary in direct proportion to temperature. In convers the viscosity of the oil varies indirectly with temperature. It is also established by literature that this electrical characteristics of the studied oils is a strong indicator to the deteriorating food quality of oils.

With respect to human consumption, it is established that increased electrical conductivity of oils increases the rate of spoilage[14], thus can be inferred that when oil is exposed to high temperature, the rate at which it spoils increase thus reduce its shelf-life as edible food product to humans.

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