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ESTIMATION OF THE PHYSICAL CHARACTERISTICS OF SOME LOCALLY AND IMPORTED EDIBLE VEGETABLE OILS SAMPLES IN NIGERIA

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ABSTRACT

Vegetable oils can be obtained from different plant seeds and constitutes important source of fat in food and cosmetics. Although it can be marketed both locally and internationally, the need arises to know the physical properties that help in the extraction and the utilization of vegetable oil and to verify the standardization. Five different samples each of imported and locally produced edible vegetable oils were put to test to know their specific heat capacities (SHC) and viscosities (μ) through the electrical method and flow rate method respectively. Experimental results show that the various selected samples fall within the stipulated World Health Organization (WHO) standard which implies that it poses no health hazard to consumers. The Specific heat capacities values were within the value which is 2.200 $Jg^{-1}{}^{\circ}C^{-1}$ while the viscosity values fall between the 25 and 84 millipascal seconds repectively for a range of temperature from 20^{o}C to 40^{o}C. It is therefore necessary to draw a conclusion that adequate attention should always be paid to the locally produced ones as it would help reduce the reliance on imported ones thereby boosting the economy of the nation and also providing job opportunities.

Key words: ***Specific Heat Capacity, Viscosities, Locally, Imported, Edible Vegetable Oils, Nigeria.***

INTRODUCTION

Worldwide, natural vegetable oils and fats are increasingly becoming important in nutrition and commerce because they are sources of dietary energy, antioxidant, bio-fuels and raw materials for the manufacture of industrial products and over 100 million tonnes are produced annually (Fasin and Colley, 2008) and are used in foods, cosmetics, pharmaceutical & chemical industries.

Vegetable oils account for 80% of the world's natural oils and fat supply (FAO, 2007). Vegetable oils may or may not be edible. Inedible vegetable oils include processed linseed oil and castor oil used in lubricants, paints, cosmetics and other industrial applications. About 79% of the over 100 million tonnes of edible oils and fats produced worldwide annually are derived from plant sources. 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 (Fasin and Colley, 2008). They similarly provide energy and essential linoleic and linolenic acids responsible for growth and they are one of the main ingredients used to manufacture soaps, cosmetics and pharmaceutical products.

Edible oil in Nigeria are produced locally and also imported, an indication of the important roles it plays. Vegetable oils are mostly used for cooking and frying of foods and snacks. In these applications, the oils are heated in the temperature range of 35^{0}C to 180^{0}C. Although many plant parts may yield oil but in commercial practice, oil is extracted primarily from seeds and the major raw materials for extraction and production of vegetable oil are sunflower, palm, soya bean and cotton seeds, with the increasing awareness of the importance of vegetable oils in the food, pharmaceutical and cosmetic industries. There is need to focus on indigenous plant species to meet the increasing demand of vegetable usage.

The minor components of edible fats and oils are formed of mono and diethyl-glycerol, free fatty acids, phosphatides, sterols, fat-soluble vitamins, tocopherol, pigments, waxes and fatty alcohol (Salunkhe et. al 1998). Normally, oils are liquids whereas fats are solids at room temperature. For example, the seeds of Sacha inchi are of great interest

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in Colombia because of their high oil content (35-60%) with Linolenic and linoleic acid that make it great potential for application in the food and pharmaceutical industries. It also contains 45% of the total fatty acids. Fatty acids play an important role in the life and death of cardiac cells because they are essential fuels for mechanical and electrical activities of the heart. The modern way of processing vegetable oils is done through chemical extraction and the use of solvent extracts, a process that produces higher yields of less expensive oils in a short time. Physical extraction, a method that does not use a solvent, is another way of processing vegetable oils through traditional mechanical extraction. Oil seed presses are commonly used in developing countries, among people for whom other extraction methods would be prohibitively expensive (Bockish, 1988). The refinement of oils means the removal of natural colour, smell, odour and free fatty acids. The final product of refinement is transparent cooking oil. It involves chilling plant (to remove the wax content the crude oil), neutralization (to remove soap); bleaching (to remove colour), Filtration (use wax filter and use pressure leaf filter), and cooling.

With the increasing global demand of vegetable oil, characterization of physio-chemical properties of vegetable oil originating from Nigeria is essential and thermo-physical properties of the major ingredients involved in these processed must be known. Two of the thermo-physical properties that would be looked at are specific heat capacity and viscosity because of the limitation of Laboratory accessories. Specific heat capacity of a solid or liquid is the heat required to raise the unit mass of substance by one degree of temperature while Viscosity is the quantity that describes a fluid's resistance to flow as described by Barnes (2000). Viscosity is a measure of the resistance of a fluid which is being deformed by either shear stress or tensile stress. 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 (Holman, 2002). With the exception of super fluids, all real fluids have some resistance to stress and therefore are viscous. A fluid which has no resistance to shear stress is known as an ideal fluid or inviscid fluid. The study of flowing matter is known as rheology, which includes viscosity and related concepts (Symon, 1971).

AIM AND OBJECTIVES

The aim of this study is to determine the viscosities and the specific heat capacities of the different samples of edible vegetable oils (imported and local ones) for the sake of scientific education to the public and then compare their values with World Health Organization Standard for the information on their safety for consumption or otherwise. This is because the stability or shelf-life of edible oil is important, especially in developing countries where the storage condition for the edible oils is not ideal.

JUSTIFICATION FOR THE PRESENT WORK

The study is to justify that physical properties like viscosity and specific heat capacity (SHC) have essential and important role they play in the extraction of good consumable vegetable oils which help in the life and death of cardiac cells because they are essential fuels for mechanical and electrical activities of the heart (Follegatti-Romero et al, 2009). This therefore motivated the current investigation to also know whether it is in consonance with the international standard values particularly as the oils are used food supplements.

MATERIALS AND METHOD

I. MATERIALS

Ten (10) different types of edible vegetable oil samples were studied comprising Five (5) local and five (5) imported for the study. The Authors however kept the samples' names to avoid socio-political and/or trade conflicts since the study was purely for scientific education and information particularly for regulating Agencies on Food and Agriculture. However, the manufacturers' stipulated use and other information on their products and details are as tabulated in Table 1.

II. METHODOLOGY

The following materials were used during the experimental procedure to determine the specific heat capacities of the different samples of the vegetable oils collected from the markets randomly from both Ogun and Lagos states after strict identification.

- Thermometer
- Calorimeter and its accessories
- Resistance wire
- Cork

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- Nickel knife cell batteries
- Rheostat
- Voltmeter

Fig. 1 depicts the Experimental set up for the determination of the specific heat capacities of the samples.

Table 1: Description of Samples studied for investigation

SAMPLE NUMBER	CATEGORY	COUNTRY OF PRODUCTION	MANUFACTURER STIPULATED USE	ADDITIONAL INFORMATION PROVIDED
SAMPLE 1	LOCAL	NIGERIA	Ideal for Cooking	Produced from Finest Selected Seeds
SAMPLE 2	IMPORTED	BENIN	Deep and shallow frying, Baking, Salad dressing	Pure Cotton Seed oil, Double refined and Deodourised
SAMPLE 3	LOCAL	NIGERIA	Frying and Dressing	
SAMPLE 4	LOCAL	NIGERIA	Frying and Dressing	
SAMPLE 5	LOCAL	NIGERIA	Frying and Dressing	
SAMPLE 6	IMPORTED	MALAYSIA	Roasting, Baking, Frying	Made from Pure Palm Olein
SAMPLE 7	IMPORTED	INDONESIA	Baking, frying and multipurpose Oil use	100% Vegetable Oils which contains Omega-9
SAMPLE 8	IMPORTED	HONG KONG	For all Culinary uses (frying and baking)	Refined, Bleached and Deodourised Palm Olein
SAMPLE 9	LOCAL	NIGERIA	Frying and Dressing	
SAMPLE 10	IMPORTED	EGYPT	Multipurpose Vegetable oil ideal for cooking & frying	Specially refined Palm Olein fraction packed under nitrogen blacket

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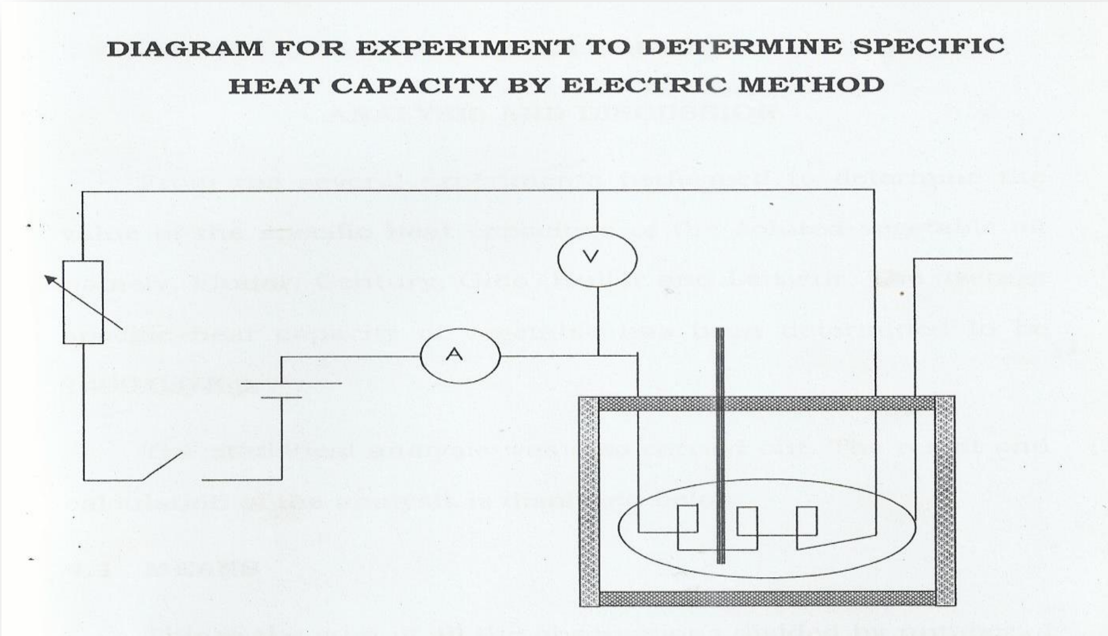

Figure 1: The Experimental Electrical Method Set up where the symbols have the usual meanings

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 known volume of metal measuring cylinders and stopwatch to measure the flow rate. The constants (control variables) are the size of the hole in the metal cylinders and the volume of the cylinders. A 1.00mm electric drill was used to make a small hole at the bottom of one of the two metal cylinders. The oil was kept at 20°C while the metal cylinder with a hole was placed over the second metal cylinder without a hole. The upper cylinder was then filled with the oil sample at a fixed temperature with one finger on the hole blocking any possible flow. After the cylinder was filled up and the finger released with a stopwatch started to time the flow from the upper cylinder to the lower cylinder. The time taken for the oil to empty into the lower cylinder was recorded. The procedure was repeated 5 times for the same temperature and the average time was calculated. The experimental method was carried out on all the ten samples collected for different temperatures between 20^{o}C and 40^{o}C.

It should be stated that the following precautions were observed during the experimentation

(i) The experiment was performed under the natural laboratory temperature

(ii) It was ensured that all fans were switched off

(iii) Error of parallax was noted

(iv) The zero error of measuring devices was observed and finally

(v) It was ensured that all the connecting wires were firmly done to avoid contact resistance.

RESULTS AND DISCUSSION

The usual equation as in equation 1 was used to calculate the specific heat capacity for each oil sample.

$$C_{o}=\frac{1}{M_o}\left(\frac{IVT}{\Delta\theta}-M_cC_c\right) \quad (1)$$

where I = Current, V=Voltage, T = Time, $\Delta\theta$ = Change in temperature (Final oil temperature ^{0}f - Initial oil temperature ^{0}i), M_o = (M_2- M_c) Mass of Oil, M_c = Mass of Calorimeter, $'_2$ = Mass of Calorimeter + oil, C_c = Specific heat capacity of calorimeter.

The results of the vegetable oil samples are as tabulated in Tables 2 and 3 for the respective imported and local oils.

The viscosity estimated by timing the flow of a known volume of edible vegetable oil samples is otherwise called kinematics viscosity and the formula used was as explained by Timms (1985), Valeri and Meirelles (1997)

It would be observed from the Tables 2 and 3 that the determined specific heat capacities C_o of the various samples of the vegetable oils are below the World Standard which is 2.200 $Jg^{-1}°C^{-1}$ [Specific heat capacity table, 2012]. Our values similarly agree with the work of Noor et al (2000) who estimated the liquid specific heat capapcity of vegetable oils based on their fatty acid composition while the viscosity ranges from 25.9millipascal second to 44.4millipascal seconds. These values still fall within the World Standard values of between 25 and 84 millipascal seconds at different temperatures (Glenn, 2010 and Viscosity Chart, 2012). The determined values of our samples are very low when compared to the viscosity of Sacha Inchi Oil (SIO) obtained by solid phase extraction which was calculated to be 35.4 millipascal seconds (Gutiérrez et al, 2011) which was attributed to high content of unsaturated fatty acids. Kinematics viscosity is an important oil property that represents the flow characteristics of oil. According to Knothe et al (2003), kinematic viscosity increases with fatty acid chain length and with increasing degree of saturation of the fatty acid.

It should be stated that different factors can affect the results particularly temperature, oil thickness, light and storage but the specific heat capacity and viscosity are parts of the determining factors of how good or bad a vegetable oil is known. The values of the specific heat capacities are very consistent with the determined values of Thermal and flow properties of oils from salmon head as reported by Sathievel (2005). It also agrees with the recommendations of Tochilani and Fujimoto (2001). The present study however verified experimentally that all the samples are good for human consumption since they fall within the International standard values.

The relative viscosity for cooking is known to increase due to insoluble materials, oxidation, overheating, air contamination, coolant contamination, and water contamination and temperature (Santos et al, 2005) but our observations show that the vegetable oil samples are less contaminated by the values of the determined viscosities as depicted in Tables 4 and 5. This implies less insoluble materials and means faster flow of the oils. The viscosity value falls as the temperature increases as it could be seen in Fig. 2a and 2b which agrees with the observations of water viscosities whose values varies from 1.79 cP s to 0.28cP s in the temperature range from 0^{o}C to 100^{o}C (Raymond, 1996; Serway and Jewett, 2004).

It is therefore essential to carry out more analysis on various grades of vegetable oils as this would help in improving the quality of oils produced locally to encourage National producers to be in tune with the Millennium Development Goals (MDGs). Aside from this, it shall provide employment opportunities for vast majority of youths who are churned out of the tertiary institutions to move nearer the objectives of vision 20, 20:20.

CONCULSION AND RECOMMENDATION

Specific heat capacity and Viscosity form part of the determining factors of how good or acceptable a vegetable oil is for human consumption. It could be concluded that all the selected oil samples are good enough for the human health. It should be stated that temperature, storage and availability of equipment had effect(s) on the results determined in this study

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but within the experimental limitation, the results are consistent and tolerable.

It is hereby recommended that both the Federal and State Governments should pay adequate attention to the locally produced vegetable oils and to ensure compliance with the World Health Organization. The farmer planting the raw materials should be motivated and assisted to boost the economic empowerment of farmers and to encourage entrepreneurship scheme locally through less reliance on imported ones and job creations and opportunities.

Table 2: The results of the Specific Heat Capacity of the imported vegetable oil samples.

SAMPLE	C_o (Jg^{-1}°C^{-1})
2	1.231
6	2.228
7	2.981
8	3.314
10	3.263

Table 3: The results of the Specific Heat Capacity of the local vegetable oil samples.

SAMPLE	C (Jg^{-1}°C^{-1})
1	1.4613
3	1.6984
4	1.9462
5	2.1164
9	2.188

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Table 4**:** The results of the viscosity values of the imported vegetable oil samples.

SAMPLE	**VISCOSITY AND FLOW RATE OF VEGETABLE OIL AT DIFFERENT TEMPERATURES (MILLIPASCAL SECONDS)**				
	20°C	**25°C**	**30°C**	**35°C**	**40°C**
SAMPLE 2	55.8	30.9	20.8	13.3	10.5
SAMPLE 6	52.3	30.8	22.7	15.7	10.1
SAMPLE 7	69.8	43.5	20.4	12.7	10.2
SAMPLE 8	64.8	48.3	25.6	17.2	14.5
SAMPLE 10	59.8	38.4	28.5	16.3	11.8

Table 5: The results of the viscosity values of the locally made vegetable oil samples.

SAMPLE	**VISCOSITY AND FLOW RATE OF VEGETABLE OIL AT DIFFERENT TEMPERATURES (MILLIPASCAL SECONDS)**				
	20°C	**25°C**	**30°C**	**35°C**	**40°C**
SAMPLE 1	87.7	49.7	33.5	28.5	22.5
SAMPLE 3	76.8	42.9	28.3	19.4	12.1
SAMPLE 4	50.2	30.8	28.7	20.6	13.6
SAMPLE 5	57.7	50.0	29.6	19.6	16.7
SAMPLE 9	55.6	31.8	22.8	15.4	11.2

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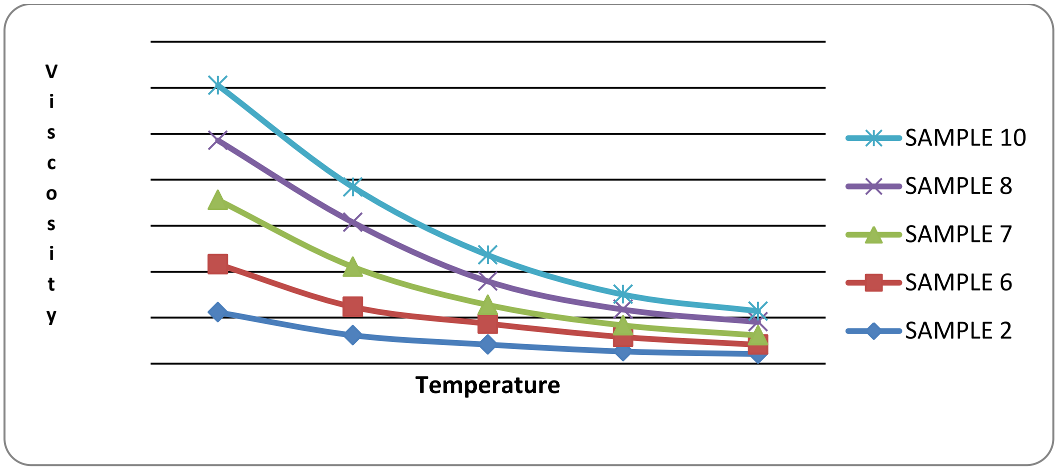

Fig. 2a: Graphical plot of viscosity value against Temperature for Imported Vegetable Oils

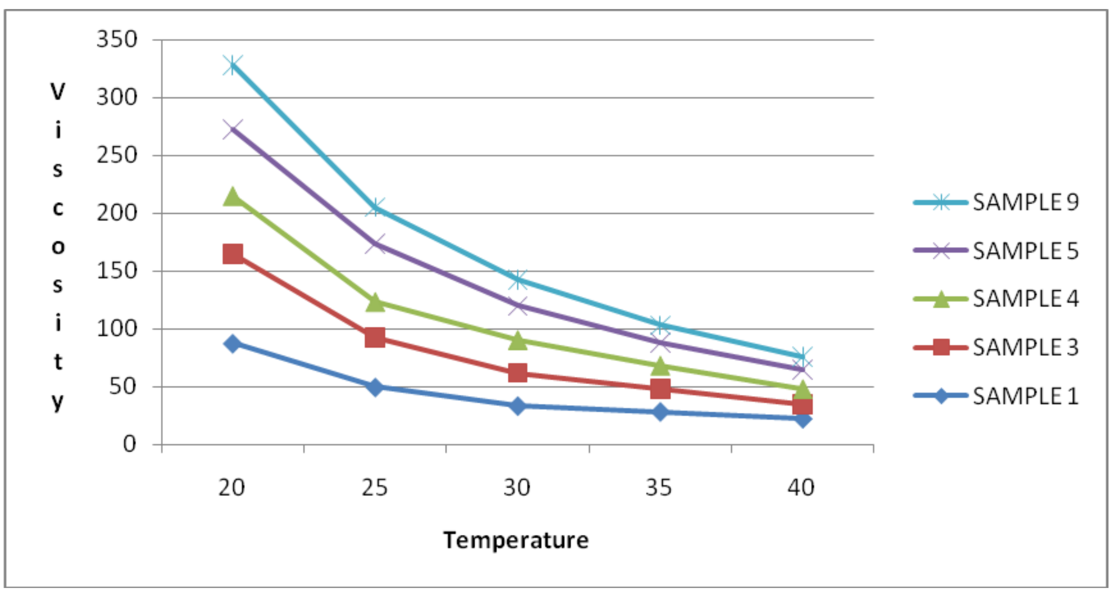

Fig. 2b: Graphical plot of viscosity value against Temperature for Local Vegetable Oils

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