DETERMINATION OF SOME PHYSICO-CHEMICAL PARAMETERS OF THREE VEGETABLE OILS SOLD IN BOSSO MARKET, MINNA, NIGERIA

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Abstract
Three samples of selected vegetable oils namely; (X1), (X2) and (X3) sold in Bosso market Minna, Niger State, Nigeria were investigated for some physicochemical parameters. Density, acid value, iodine value, peroxide value and saponification values were determined for each oil sample using standard methods of analysis to evaluate the compositional quality of oils and compare the results with some standards. The result obtained shows that there were no significant differences (p > 0.05) in the density of the selected vegetable oils. It was observed that X3 oil showed maximum (8.20 0.14 mgKOH/g) and X2 showed minimum (1.68 0.04) acid values. Highest peroxide values were observed in X1 (4.25 0.074 meq O_2/kg) and lowest in X3 (0.50 meq O_2/kg). Iodine value was found to be 7.23 0.21, 4.95 0.14 *and 5.46 0.13 g/I_2/100g in X1, X2 and X3 respectively. On the contrary, highest saponification value was observed in X3 (100.98 3.21) and lowest in X1 (14.03 0.40 mgKOH/g). Findings from the present investigation shows that two of the vegetable oil samples (X1 and X2) meet the recommended standards. Thus, these can serve as a guide for nutritionist in selecting better edible oil.*

Keywords: Physicochemical Parameters, Vegetable Oils, Acid value, and NIS Standards

Introduction
The term oil is used in generic sense as substances that are greasy or oily fluid at ambient temperature (Buba,2005). Vegetable oils are derived from the seed of plants which are grown in many different parts of the world (Otunola *et al.*, 2009). Oilseed plants are major sources of lipids for human nutrition as well as for several industrial purposes. Oil seeds are defined as those seeds that contain considerably significant amounts of oil. Several hundred varieties of plants known to have oil bearing seeds (conventional oil seeds) which includes groundnut, soybean, palm kernel, cotton seed, olive, sunflower seed, rapeseed, sesame seed, linseed and safflower seed (Ajala & Adeleke, 2014). These oil seed plants are major sources of lipids for human. In animals, oil is found in various parts of the body e.g. liver. Vegetable oils are used in a variety of ways such as food texturing, baking, and frying and also used industrially, in the manufacture of soap, detergent, cosmetics and oil paints (Amin Mir*et al.*, 2014). Nutritionally, vegetable oils are usually preferred to animal fat because of the unsaturated fatty acids they contain and their molecular weight (Otunola *et al.*, 2009). Vegetable oil obtained from various sources thrives and are sold under different brand names in the society.

The importance of vegetable oils has made avital contribution to the balanced diet in many countries, serving as a good source of proteins, lipids and fatty acids for human nutrition including repair of worn-out tissues, new cells formation, as well as, a useful source of energy (Aremu & Amos, 2013). There has been an increase in the world production of oil seeds over the last thirty years (Aremu*et al.*, 2015). This is because vegetable oil is always at a higher price per ton than the cake, which is as a result of higher demand for oil than their cake.

Different physical and chemical parameters of vegetable oil are used to monitor the compositional quality of oils (Ceriani, *et al.*, 2008, Mousavi *et al.*, 2012). These physicochemical parameters include density, saponification value (SV), iodine value (IV), acid value (AV), and peroxide value (PV). Repeated frying have been reported to cause several oxidative and thermal reactions which results in change in the physicochemical, nutritional and sensory properties of the oil (Cheman & Jasvir, 2000). Atmospheric oxygen reacts instantly with lipid and other organic compounds of the oil to cause structural degradation in the oil which leads to loss of quality of food and harmful to human health (Bhattacharya *et al.*, 2008). Therefore, it is essential to monitor the quality of oil to avoid the use of abused oil due to the health consequences of consuming foods fried in degraded oil, and to maintain the quality of fried foods.

In Nigeria, the demand for vegetable oil has ever been widening as industrialist rely mostly on the popular vegetable oil such as groundnut, palm and soybean, cotton seed oil and coconut seed oil for preparation of various products (Aremu*et al.*, 2006). In order to safe guard the health of consumers, regulatory bodies, such as Standards Organization of Nigeria (SON), National Agency for Food and Drug Administration and Control (NAFDAC) (at the National levels) and at international level, the Codex Alimentarious Commission, International Standards Organization (ISO)sets standard parameters for edible oils.

The sources and characteristics of a large number of edible oils are not known. It is therefore, very important that the quality and oxidative stabilities of commercially available vegetable oils need to be determined to ascertain their suitability for consumption. This study investigates the physicochemical properties of3 vegetable oils sold in Bosso market, Minna Niger State.

Materials and Methods

Materials

Three different vegetable oil samples were purchased at Bosso market in Minna, Nigeria, under different brand names and coded as X1, X2, and X3, respectively. They were bought as packaged in one litre food grade plastic containers and stored at room temperature in the laboratory, Department of Chemistry Federal University of Technology, Minna until required for analysis. All reagents used were of analytical grade.

Methods

Density Determination

Relative Density bottle (50cm^3) was used to measure the densities of oil samples according to standard method (AOAC, 1993). Density was calculated as:

$$\text{Density} \quad \frac{\text{Weight of the oil sample(W}}{\text{Volume of the R. D bottles(V}} \quad /cm^3$$

Acid Value

The acid value of oils was determined titrimetrically using Association of Official Analytical Chemists (AOAC, 1993). Briefly, 5g of each oil was taken in a 250 cm^3 conical flask and 25 cm^3 of ethyl alcohol was added and heated on water bath. Phenolphthalein indicator solution was added in few cm^3(2 drops) then the solution was titrated while hot against standard potassium hydroxide solution with continuous shaking until a faint permanent pink colour that persisted for 30 seconds appeared at the end point (Ekwu & Nwagu,2004). Acid value was calculated as:

$$\text{Acid Value} \quad \frac{\text{A} \quad \text{M} \quad 56.1}{\text{W}}$$

$$\text{A} \quad \text{Volume of standard NaOH solution} \quad cm^3$$

M = Molarity of standard NaOH solution ($Moldm^{3}$
W = Weight of oil sample (g

Iodine Value

The iodine values of each oil sample was determined using the method of American Oil Chemist Society (2016). About 1g of each oil sample was taken in a conical flask and dissolved in 15 cm^3 CCl_4. Then 10 $cm^3$of Wij's solution (Iodine monochloride solution) was added and the mixture was allowed to stand for 30min in dark with vigorous shaking. Accurately, 10 cm^3 of 10% KI solution and 50cm^3 distilled water was added to the mixture and washed down any free iodine. The iodine was titrated with standardized $Na_2S_2O_3$ solution which was added gradually with constant shaking until the yellow solution turned almost colourless. Few drops of starch indicator were added and titration continued until blue colour disappeared. Bottle was shaken violently so that any iodine remaining in $CHCl_3$solution might be taken up by the KI solution. The volume of $Na_2S_2O_3$ solution used for the experiment was recorded. A blank experiment was conducted along with the sample. Percentage weight of iodine absorbed by the oil sample was calculated as:

$$\text{Iodine Value} = \frac{(B \quad A \quad M \quad 0.127 \quad 100}{W}$$

B = Volume of 0.1M Na S O_3 required by blank (cm^3
A = Volume of 0.1M Na S O_3 required by oil sample (cm^3
M = Molarity of Na S O_3($Moldm^{3}$
W = weight of oil sample (g

Saponification Value

Saponification value was determined by taking 1.0 g of oil sample in a conical flask and25$cm^3$of 0.5$Moldm^{-3}$alcoholic KOH was added and heated under a reserved condenser for 30min to ensure that the sample was fully dissolved. After cooling the sample, 1cm^3phenolphthalein indicator was added and titrated with 0.5$Moldm^{-3}$HCl until a pink end point was reached. A blank was determined under the same conditions (AOAC, 1993).

$$\text{Saponification Value} = \frac{(B \quad A \quad M \quad 56.1}{W}$$

B = Volume of Hcl required by blank (cm^3
A = Volume of Hcl required by oil sample (cm^3
M = Molarity of HCl ($Moldm^{3}$
W = weight of oil sample in (g

Peroxide Value

The peroxide value is a measure of the concentration of substances that oxidize KI to I_2. 1g of each oil sample was dissolved in CH_3COOH then CCl_4 (ratio 2:1) and saturated KI mixture was added. The amount of iodine liberated from KI by the oxidative action of peroxides present in the oil was determined by titrating with 0.2$Moldm^{-3}$$Na_2S_2O_3$ using starch solution as an indicator. Titration was also performed for blank (Marinova *et al.*, 2012)

$$\text{Peroxide Value(meq O /kg oil} = \frac{(A \quad B \quad M}{W}$$

A = Volume of Na S O_3 consumed by oil sample(cm^3
B = Volume of Na S O_3 used for blank(cm^3
W = weight of oil sample (g
M = Molarity of sodium thiosulphate($Moldm^{3}$

Results and Discussion

The quality of vegetable oils was analysed by evaluating their physic-chemical properties such as; density, acid value, peroxide, iodine and saponification value (as shown in Table 1). In order to access quality and improved process these properties are very important

parameters. The density of the three oils have values that are closely related to the standard range of 0.900-0.913g/cm^3 approved by Nigeria Industrial Standards (1992), except for the X1 which has 0.92g/cm^3. There was no significant different ($p > 0.05$) among the sampleX1, X2, and X3 respectively. The result showed that the oil samples were less dense than water and hence, they may be useful in manufacture of creams and related products as it will make the oil flow and spread easily on the skin (Oyeleke *et al.*, 2012). The density of vegetable oils is dependent on their fatty acid composition, minor components and temperature. However, the difference in density of vegetable oil samples may possibly be due to the refined quality of the oils (Fakhri & Qadir, 2011). Consequently, lower density values of oils are highly appreciable to consumers.

Table 1: Physicochemical properties of three vegetable oils available in Bosso market, Minna Nigeria

Parameter	X1		X2		X3		NIS standards
Density (g/ml)	0.92	0.02^a	0.91	0.02^a	0.91	0.02^a	0.900-0.913
Acid Value (mg KOH/g)	4.32	0.10^b	1.68	0.04^c	8.20	0.14^a	0.6 max
Peroxide Value (meq O_2/kg)	4.25	0.074^a	1.50	0.002^b	0.50	0.002^c	10 max
Iodine Value (g I_2/100 g oil)	7.23	0.21^a	4.95	0.14^c	5.46	0.13^b	7-10
Saponification Value (mg KOH/g)	14.03	0.40^c	36.47	0.84^b	100.98	3.21^a	245-255

X1 = brand, X2 = brand 2 and X3 = brand 3

Mean values with different superscripts along the same rows are significantly different ($p< 0.05$).

The acid values obtained for all three samples were higher than the maximum value of 0.6mg KOH/g max recommended by NIS (NIS, 1992) for edible oils. Acid value gives an indication of the quality of fatty acids in oils. Acid values for the three samples are significantly different ($p < 0.05$) from one another with sample X3 having the highest value (8.2±0.14) and the lowest value (1.68±0.04) was recorded for X2. However, these values accounted for the presence of free fatty acids in the oils and it's an indicator of the extent of hydrolysis by lipolytic enzymes and oxidation (Aremu *et al.*, 2015). Low acid value is an indication of stability of oils over a long period of time, as well as, protection against rancidity and peroxidation. Acid value is also used as an indicator for edibility of an oil and suitability for use in the paint and soap industries (Aremu *et al.*, 2006). Increase of acid value of an oil showed that the oil may not be suitable for use in cooking (edibility) but may be useful for manufacturing of paints, liquid soap and shampoos (Aremu *et al.*, 2006; Akintayo, 2004).

Peroxide values obtained for the three oil samples are within the range for any particular oil as specified by (NIS, 1992). Peroxide value is used as a measure of the extent to which rancidity reactions have occurred during storage. It could be used as an indication of the quality and stability of fats and oils (Ekwu & Nwagu,2004). The peroxide value is the most common indicator of lipid oxidation. In this study, peroxide value ranges from 0.50 0.002 to 4.25 0.074 meqO_2/kg for X3 and X1, respectively. These values are significantly lower compared to the standard value of 10 meqO_2/kg specified by (NIS, 1992). High peroxide value is indication of high levels of oxidative rancidity of the oils and also suggest absence or low levels of antioxidant. Certain antioxidants maybe used to reduce rancidity such as propygadlate and butyl hydroxyl anisole (Kyari, 2008).

The iodine value obtained for all the samples were less than l0g I_2/100 g of oil recommended by NIS (1992) for edible oils, except for the oil sample X1. The iodine value is a measure of the degree of unsaturation. Moreover, this could be used to quantify the amount of double bond present in the oil which reflects the susceptibility of the oil to oxidation. For the oil samples, iodine value was recorded to be 7.23 0.21, 4.95 0.14 and 5.46 0.13 for X1, X2 and X3, respectively. The lower iodine value of the samples may have contributed to its greater oxidative storage stability. Oils with iodine value less than 100gI_2/100g of oil are non-drying oils. It was reported by Aremu *et al.,* (2015) that the lower the iodine value the lesser the number of unsaturated bonds thus, the lower the susceptibility of such oil to oxidative rancidity. Therefore, non-drying oils are not suitable for ink and paint production due to their non-drying characteristics but may be useful in manufacturing of soaps. High iodine value is an indication of high percentage of unsaturated fatty acids in vegetable oils; as such amount of iodine that will be absorbed by the unsaturated acids would be find useful as raw materials in the manufacture of vegetable oil-based ice cream (Oderinde *et al*., 2009).

The saponification values for the three oil samples were lower than the stipulated range 245-255mg KOH/g by NIS (1992). Saponification value (SV) is an index of average molecular mass of fatty acid in the oil samples. The lower value of saponification values suggests that the mean molecular weight of fatty acids is lower or that the number of ester bonds is less. This might imply that fat molecules did not interact with each other (Denniston *et al*., 2004). Oil with high saponification value contains high proportion of lower fatty acids. Therefore, the low saponification value of oils under review indicates that they might contain high proportion of higher fatty acid and can be regarded as non-edible oils (Akinoso & Ekaette, 2012).

Conclusion

In the present study, different physicochemical parameters have been examined for three edible oil samples. Some of the samples are not in line with the standards recommended by regulatory agencies. The result shows that sample X1 and X2 fulfil most parameters accepted by NIS to be used for consumption. On the contrary, sample X3 is characterized by extremely high acid values which makes the oil to be more susceptible to oxidative rancidity, thereby, affecting the quality of the oil. This may be attributed to decomposition, poor extraction techniques, use of damaged seeds and incorrect or lengthy storage that can be accelerated by temperature and sunlight. Hence, companies should take appropriate measures to enhance the quality of vegetable oils and also give public awareness not to expose edible oils to oxygen and light for long time.

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