Conformability of Five Brands of Vegetable Oil Sold in Roban Stores Awka, Nigeria to NAFDAC Set Standards

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ABSTRACT

The study investigated the conformability of five brands of vegetable oil sold in Roban stores Awka to NAFDAC set standards. The oil brands used were; Sunchi soya oil (CBI), Carlini pure canola oil (ABI), Lassa vegetable oil (NEI), Golden penny pure soya oil (NMN), and Activa pure vegetable oil (JGO). The result obtained for the physical properties of the oils differed significantly ($p \leq 0.05$) and ranged from 0.65-0.92, 1.33-1.54 and 50.55-80.44 mPa・s for specific gravity, refractive index, and viscosity respectively and were below the standard set by NAFDAC for oils (0.91-0.92, 1.46-1.48) except for sample CBI with a specific gravity of 0.92 and refractive index of 1.46. However, all oil samples analyzed met the standard of ≥ 0.2 set by NAFDAC for viscosity. Furthermore, the values obtained for Saponification number, Iodine value, and Peroxide value differed significantly ($p \leq 0.05$) and ranged between 145-190 mg KOH/g, 0.90-8.86 mgI2/g and 1.70-7.48 meq/kg respectively. They complied with NAFDAC standards (190-209 mg KOH/g, 50-55 (Wijs) and ≤ 10 meq/kg). Other chemical properties analyzed were Free fatty acid, pH, Base value and impurity level. The standards of these parameters were not set by NAFDAC. Their values ranged from 3.40-6.31 mg/g KOH, 8.4-12, 8.4-12, and 0.13-0.60 respectively. The values of all parameters analyzed were within the NAFDAC recommended standard for edible oil. Thus, indicating that the oil samples studied were of good quality and suitable for consumption.

INTRODUCTION

Vegetable oils are produced from the seeds of plants that are cultivated throughout the world (Otunola *et al*., 2009). Oilseed plants, such as peanut, soybean, palm kernel, cotton, olive, sunflower, rapeseed, sesame, linseed, and safflower seeds, are important sources of lipids for human nutrition as well as for several industrial uses (Ajala and Adeleke, 2014). Vegetable oils are utilized in many different applications, including food texturizing, baking, and frying as well as in processed foods like cream and chocolate (Endo, 2017). Moreover, they are employed industrially in the production of oil paints, soap, detergent, and cosmetics (AminMir *et al*., 2014). Due to their high molecular weight and presence of unsaturated fatty acids, vegetable oils are typically favored to animal fat in terms of nutrition (Otunola *et al*., 2009).

Differences in plant sources, processing methods, physical and chemical characteristics, are some factors that may affect oil quality among brands and must be carefully considered since they can have an impact on the quality of oil-based foods (Ogah *et al*., 2020, Ceriani, *et al*., 2008; Mousavi *et al*., 2012). Colour, specific gravity, refractive index, melting point, congeal point, smoke point, flash point, fire point, and viscosity are among the physical characteristics of edible fats and oils, while their chemical properties include acid value, saponification value, iodine value, fatty acid composition, trans isomers, triacylglycerol composition, unsaponifiable matters (sterols, tocopherols), and minor components like phospholipids, chlorophyl Indexes of the deterioration of edible fats and oils include peroxide value, p-anisidine value, carbonyl value, polar molecules and polymerized triacylglycerols (Endo, 2017).

A set of standard values, guidelines and codes of practice, referred to as the "Food Code" has been adopted by the Codex Alimentarius Commission (CAC). CAC is an international food standard body established jointly by Food and Agriculture Organization (FAO) and World Health Organization (WHO) to protect the health of consumers by ensuring food safety and fair practices in food trade (Ogah *et al*., 2020). It is a statutory obligation for food commodities in international trade to comply with these regulatory standards. In Nigeria, the National Agency for Food and Drug Administration and Control (NAFDAC) and Standard Organization of Nigeria (SON) set the

standards for measuring these parameters in edible oils. So, in order to assess if commercially sold vegetable oils are suitable for consumption in accordance with these established standards, it is crucial to determine their quality and oxidative stabilities. The aim of this study was to determine the conformability of five brands of vegetable oil sold in Roban stores Awka to NAFDAC set standards.

Materials and Methods

Source of raw materials

Vegetable oil samples were purchased from Roban stores in Awka, Awka south local government of Anambra state, Nigeria.

Experimental Design

The experiment was a completely randomized design. The samples were collected in no order.

Determination of Physical Properties

The physical parameters (specific gravity, relative viscosity, colour) were carried out on the oil samples according to the method of AOCS (2016).

Determination of refractive index (RI)

The temperature of refractometer was adjusted to 40℃ using circulating hot water. The Prisms were cleaned and dried. Few drops of the well mixed sample were placed on the prism, closed, and allowed to stand for 1 min. The instrument and lighting were adjusted to obtain the most distinct reading. Each sample was treated two times and average Refractive Index was recorded.

Determination of relative viscosity (RV)

Carbon dioxide from oil samples was removed by shaking gently at first and then vigorously. Temperature of the sample was kept at 30℃ by using SETA KV-8 viscometer water bath. The suspending material in the oil was removed by passing the sample through a filter paper. Appropriate volume of sample was added to the kinematic viscometer which was held in a water bath at 30℃. The suction was used to draw the sample above the upper mark of kinematic viscometer and then allowed to fall. The time for the sample to pass through the upper and lower of the viscometer was measured. The analysis was carried out in duplicate to obtain the mean value of RV.

$$RV = CT \quad (1)$$

Where, T = time for flow of oil sample, C = Constant of the viscometer

Determination of specific gravity (SG)

The hydrometer was cleaned and dried. Appropriate amount of the well mixed sample was placed on suitable beaker. The hydrometer, which reads directly the specific gravity, was immersed in the beaker, and allowed to stand for 2 min. Each measurement was done in duplicates.

Determination of Chemical Parameters

Determination of iodine value (IV)

Iodine Value was determined following AOCS (2016) method. Approximately 0.25 g of the oil was measured into a 500 mL conical flask with glass stopper, to which 25 mL of carbon tetrachloride have been added. The content was mixed well. 25 mL of Wijs solution was added to the mix. The flask was covered with stopper to prevent loss of halogen by evaporation. The flask was gently swirled and stored in the dark for one hour. 20 mL of the potassium iodide solution and 150 mL of water was added. The flask was shaken and the content was titrated with standardized 0.1N Sodium thiosulphate solution, using starch as indicator. Formation of a blue colour, which disappeared after through shaking marked the end of the reaction. Blank determination was conducted in the same manner as test sample but without the oil.

$$IV = (12.69 (B – S) N) / W \quad (2)$$

Where, B = volume in mL of standard sodium thiosulphate solution required for the blank, S = volume in mL of standard sodium thiosulphate solution required for the sample, N = normality of the standard sodium thiosulphate solution, W = weight in g of the sample.

Determination of acid value (AV) and free fatty acids (FFAs) contents

Acid Value was determined following AOCS (2016) method. Approximately 5 g of the oil sample was weighed into a 250 mL conical flasks and 150 mL of freshly prepared equal amount of (v/v) diethyl ether and ethanol 95% v/v were added. About 1 mL of phenolphthalein indicator solution was added. The mixture was boiled for about five minutes and was titrated while hot against standard 0.1N KOH with vigorous shaking during the titration until the end point.

FFAs as oleic acid percent by weight = 28.2VN / W (3)

AV = percent fatty acid (as oleic) x 1.99

Where V = Volume in mL of standard KOH solution, N = normality of the KOH solution, W = weight of the sample in g.

Determination of peroxide value (PV)

Peroxide Value was determined following AOCS (2016) method. Approximately 2 g of oil sample was measured accurately in 250 mL conical flask. 30 mL of solvent (20 mL acetic acid in 10 mL chloroform solution) was added and swirled to dissolve the sample. 1 mL of KI solution was added and the flask was allowed to stand for 1 min with gentle shaking. 30 mL of distilled water and few drops of starch indicator were added. Appearance of blue colour on addition of starch indicates presence of free iodine. The liberated iodine was titrated with 0.1N Sodium thiosulphate until the blue colour just vanished.

PV ($meqO_2/Kg$) = N x Vx1000/W (4)

Where; N = normality of sodium thiosulphate, V= volume of sodium thiosulphate consumed by sample in mL, W = weight of sample in g.

Determination of saponification value (SV)

Saponification value, which is the number of milligrams of potassium hydroxide required for the saponification of one gram of the test portion, was determined following AOCS (2016) method. A test portion of approximately 2 g was measured accurately in 250 mL conical flask. Exactly 25 mL of ethanolic potassium hydroxide solution was added by using burette. The flask was connected to a condenser and refluxed for one hour. The soap solution was titrated with 0.5 N HCl in the presence of phenolphthalein while it was warm. A blank determination was carried out by refluxing and titrating under the same conditions.

SV = 56.1 (B - S) N / W (5)

Where, N = normality of Hydrochloric acid, B= volume of Hydrochloric acid consumed by Blank in mL, S = volume of Hydrochloric acid consumed by sample in mL, W = weight of sample in g.

Determination of insoluble impurities (IIM)

Insoluble impurities, which are the dirt and other foreign matter, expressed as a percentage by mass, which are insoluble in n-hexane or light petroleum under the conditions specified, was determined following AOCS (2016) method. Approximately 20 g of sample was measured accurately in 250 mL conical flask. The test portion was dissolved by adding 20 mL of n-hexane in to the flask and was shaken. The solution was left for about 30 min at 30℃. Then the solution was filtered through ashless filter paper which was dried previously at 103℃ and weighed. The remaining residue on the filter paper was washed with the same solvent. The solvent remaining in it was allowed to evaporate in the open air and the evaporation was completed in the oven at 103℃. The filter paper with its vessel was removed from the oven and cooled in desiccator. The filter paper with its dried sample were measured. Two parallel determinations for each sample were carried out simultaneously to ensure that the difference between the two samples did not exceed 0.05 g of insoluble impurities per 100 g of sample.

IIM (percent by mass) = (M1 – M2) / Mo) X 100 (6)

Where, Mo = weight of test portion, M1= weight of filter paper containing dry residue, M2 = weight of filter paper.

Statistical Analysis

Results obtained from each determination are presented as mean ± SE (standard error). Tests for significance in variations was conducted by SPSS version 23.0 using Analysis of variance (ANOVA). Variations were considered significant at $p \leq 0.05$.

RESULTS AND DISCUSSION

Physical properties of the oils

The physical properties of the oil samples investigated are shown on Table 1. From the data obtained, significant differences ($p < 0.05$) were observed in refractive index, viscosity, and specific gravity values of the oil brands. The values obtained for refractive index ranged between 1.33-1.54, with sample JGO having the least value and sample ABI having the highest value. The values obtained were lower than the 1.45-1.46 set by NAFDAC and 1.44-1.47 set by JOCS. Only sample CBI with refractive index of 1.46 met the set standard. Endo (2017) reported that the refractive index of oils depends on the fats and oils variety. Palm oil has a refractive index of 1.44-1.45, while other vegetable oils have a refractive index of 1.47 at 25℃. The differences observed in the refractive index of the oils studied could be related to the source of the oil.

The values obtained for specific gravity of the oils ranged between 0.65-0.92, with sample NMN having the least value and sample CBI having the highest value. These values were below the standard set by NAFDAC for oils (0.91-0.92), except for sample CBI with a specific gravity of 0.92. The specific gravity of edible fats and oils such as corn, olive and soybean oils are in the range of 0.90-0.92 at 25℃, although palm oil and the related oil had slightly lower specific gravity 0.89-0.90）at 25℃ (Endo, 2017).

In addition, viscosity which is an index used to determine the extent of oxidation and thermal deterioration of oils was measured, and the values obtained ranged between 50.55-80.44, which were all above the standard set by NAFDAC (≥ 0.2%) and JOCS (6-10 mPa・s) at 98.9℃.

Table 1: Physical properties of investigated Oil brands

Oil brands	Refractive index	Specific gravity	Viscosity (mPa・s)
NEI	$1.43^{b}\pm0.03$	$0.70^{b}\pm0.26$	$50.55^{e}\pm0.26$
NMN	$1.44^{b}\pm0.01$	$0.65^{c}\pm0.26$	$60.45^{d}\pm0.26$
ABI	$1.54^{a}\pm0.03$	$0.83^{a}\pm0.03$	$70.65^{b}\pm0.03$
JGO	$1.33^{c}\pm0.03$	$0.73^{b}\pm0.03$	$80.44^{a}\pm0.01$
CBI	$1.46^{b}\pm0.01$	$0.92^{a}\pm0.03$	$70.23^{c}\pm0.01$
NAFDAC	1.45-1.46	0.91-0.92	≥0.2%

Results are expressed as mean ± SD. Values with the same superscript on the same column do not differ significantly at ($p \leq 0.05$). Pure canola oil= ABI; Sunchi Soya Oil= CBI; Pure vegetable Oil=JGO; Lassa vegetable oil=NEI; Golden penny oil = NMN

Chemical properties of the oils

The data obtained for the chemical properties of the oils are shown on Table.2. Significant differences ($p < 0.05$) were observed in all the parameters analyzed. The saponification values (SV) which means the average molecular weight of triacylglycerols in oils investigated in this study ranged from 145-190 mg KOH/g. The lowest and highest values were found in ABI and NEI, respectively. Only sample ABI with saponification value of 190 mg KOH/g was within the standard set by NAFDAC (190-209 mg KOH/g). Differences in the saponification values of all the samples investigated were significant at level ($p < 0.05$). The saponification values were in the order ABI>NMN>CBI>JGO>NEI. A higher SV is a measure of low-molecular weight triacylglycerols of edible fats and oils. Most vegetable oils such as corn, olive, rapeseed, and soybean oils have an SV of about 190, whereas the SV of palm oil and coconut oil, rich in palmitic acid（16:0, myristic acid（14:0）and lauric acid（12:0）is more than 200 (Endo, 2017).

Saponification value (SV) shows the extent of usefulness of the oil in soap making. It is an indication of the milligrams of KOH necessary to saponify 1g of oil sample (Odoom and Edusei, 2015). The values obtained for saponification value in this study were within the range of 5.58 - 249.90 mg KOH/g reported by Aremu *et al.* (2015) in some Nigeria oil seeds and 179.04 ± 1.60 mg KOH/g reported by Muibat *et al.* (2008) in their work on seed oil of *Telfairia occidentalis*. The result for SV showed that most of the oils studied could be used in soap making (Amoo *et al.*, 2004).

Also, a wide variation in the iodine value among the various samples of oils was observed. CBI recorded the lowest iodine value (0.90 mgI2/g) while NEI (8.86 mgI2/g) had the highest iodine value. Iodine value gives the extent of unsaturation in oil sample. It is the amount of iodine (in grams) that is required to bring about the complete saturation of 100 g of oil sample (Sanders, 2003). The iodine values of JGO (4.84 mgI2/g), NMN (4.13 mgI2/g) and ABI (4.21 mgI2/g) in this study were lower than the range of 50-55 mgI2/g set by NAFDAC and 16-23 mgI2/g reported in AOCS (2006) for palm kernel oil. The iodine values of all the oil brands investigated were lower when compared to the result reported by Muibat *et al.* (2008) in their study of seed oil of *Telfairia occidentalis* and 132.7 mgI2/g reported for soya beans oil by Aremu *et al.* (2015). The value obtained was also lower when compared to 49.10 mg I2/100g obtained in melon seed by Abdulhamid (2014). The iodine value of oil is an index for assessing the level of unsaturation and ease with which the oil can go rancid (Amoo *et al.*, 2004).

Furthermore, from Table 2, the peroxide values of the various samples analyzed ranged from 1.70 - 7.48 meq/kg and were in line with the ≤ 10 meq/kg set by NAFDAC, but lower than the 30 meq/kg set by JOCS. The highest value was found in the ABI oil while CBI oil had the least value. The peroxide value of all the oil brands tested showed significant differences ($p < 0.05$). The values were also lower than 290.00 meqO2/kg reported by Aremu *et al*. (2015), but higher than 2.26 meq/kg of seed oil of *Telfairia occidentalis* reported by Muibat *et al*. (2008). The peroxide value is used as an indicator of deterioration of oils (Endo, 2017).

In addition, the Free fatty acid (FFA), which is the percentage by weight of a specified fatty acid (Nielsen, 2014) was also measured. The edible oils had varied FFA content. This could be attributed to the variation in the refining and deodorization processes used and the moisture contents of the samples (Ong *et al*., 2009). The highest value was obtained in ABI (6.31 mg/g-KOH) and the lowest in CBI (3.40 mg/g-KOH). Free Fatty Acid values were lower for all oils and were below the standard set by NAFDAC (6.3-7.8 mg/g-KOH) for edible oils, except for sample ABI which had an FFA value of 6.31 mg/g-KOH. High levels of free fatty acids especially linoleic acids are undesirable in finished oils because they can cause off-flavours and shorten the shelf life of oils (Aremu and Amos, 2010).

The pH which is the hydrogen ion concentration of the various oils also differed significantly ($p < 0.05$) among the samples and ranged between 8.4-12. The order of increase in pH value was; CBI>JGO>NEI>ABI>NMN. The impurity level of all the oil sample were significantly different ($p < 0.05$). The base value of the oil samples (NEI, CBI and JGO) were significantly different ($p < 0.05$), while oil samples (ABI and NMN) were not significantly different ($p > 0.05$).

Table 2: Chemical properties of investigated oil brands

Properties	NEI	NMN	ABI	JGO	CBI	NAFDAC
Iodine Value (mgI2/g)	8.86^{a}±0.26	4.13^{d}±0.26	4.21^{c}±0.26	4.84^{b}±0.26	0.90^{e}±0.26	50-55
Saponification Value (mg KOH/g)	145^{d}±1.00	180^{b}±1.00	190^{a}±2.65	170^{c}±2.65	180^{b}±2.65	190-209
Peroxide Value (meq/kg)	2.66^{d}±0.26	3.24^{c}±0.26	7.48^{a}±0.02	4.18^{b}±0.01	1.70^{e}±0.26	<10 mL
Impurity Level	0.56^{b}±0.03	0.60^{a}±0.03	0.50^{c}±0.03	0.45^{d}±0.01	0.13^{e}±0.01	-
Base Value	10^{c}±0.49	8.4^{d}±0.10	8.9^{d}±0.10	11.0^{b}±2.65	12.0^{b}±2.65	-
Free fatty acid value	4.25^{d}±0.01	5.36^{b}±0.01	6.31^{a}±0.03	4.53^{c}±0.26	3.40^{e}±0.26	6.3-7.8
pH Value	9.9^{c}±0.10	8.4^{d}±0.10	8.9^{d}±0.10	11.0^{b}±2.65	12.0^{b}±2.65	6.3-8.6

Results are expressed as mean ± SD. Values with the same superscript on the same column do not differ significantly at ($p \leq 0.05$).
Pure canola oil= ABI; Sunchi Soya Oil= CBI; Pure vegetable Oil=JGO; Lassa vegetable oil=NEI; Golden penny oil = NMN

CONCLUSION

In the present study, different physicochemical parameters have been examined for five edible oil samples sold and consumed within Awka Metropolis. The physical properties of the various brands of oils investigated in this study did differ significantly ($p \leq 0.05$). The wide variations among their chemical properties account for the differences in their compositions. Their physicochemical properties as obtained in this study showed that they are all suitable for consumption as they are within the permissible ranges set by NAFDAC.

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