Quality Assessment of Selected Brands of Vegetable Oil Sold at Relief Market Onitsha, Anambra State of Nigeria

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ABSTRACT

This research explores qualities of selected brands of edible vegetable oil namely: PO, LO, KO, MO, and EO sold in the Relief market, Onitsha, Anambra state. These vegetable oils were analyzed for iodine value, peroxide value, acid value, free fatty acid, slip melting point, moisture content, and specific gravity using standard analysis methods. The results obtained show that the acid value and the percentage of free fatty acid contents of the vegetable oil listed above were within the range when compared with the maximum recommended value of 0.6 and 0.3 respectively by Nigeria Industrial Standard (NIS) standard except for EO and PO oils which have higher values. Their iodine value, peroxide value and specific gravity are within the range stipulated by NIS. The percentage moisture content values of LO and KO were within the standard range of 0.05% except for MO and EO which have 0.059% and 0.139% respectively. The slip melting point of PO, LO, KO and MO vegetable oils was within the range of well-fractionated palm olein of 25˚C maximum, except EO which is cloudy with a high slip melting point of 28^{o}C.

INTRODUCTION

Vegetable oil is a term used to describe a variety of fatty acids that can be found in vegetables, legumes, fruits, and grains (Dupont, 2003). Among these are almond oil, argan oil, coconut oil, cocoa butter, corn oil, cottonseed oil, grape-seed oil, lemon oil, flaxseed oil, orange oil, olive oil etc. Not all edible vegetable oils are considered healthful; most are used in animal feed, machinery oil, dyeing equipment, etc (Hammond 2003). The majority of vegetable oils that are suitable for human consumption are liquid at room temperature and are mainly made up of triglycerides, which are made up of three fatty acids bound together by esters and glycerol molecules (Colon, 2023; Nurham, 2016).

Vegetable oils vary in their unique types of fatty acids, which affects their physical, chemical, and nutritional features (Xiang et al., 2024). Compared to animal fats, vegetable oils include a larger ratio of unsaturated fats, which is thought to be good for health. However, during processing, handling, or storage, highly unsaturated oils are prone to quick oxidation and deterioration. Oils with low melting points are highly unsaturated, which makes them susceptible to rancidity (Talbot, 2016). The three processes of oxidation, hydrolysis, and polymerization control how oil quality deteriorates.

Free fatty acids (FFA), mono- and diacylglycerols, and glycerols are produced in greater quantities by hydrolysis in oils compared to oxidation, which produces hydroperoxides and low molecular weight volatile

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compounds such as aldehydes, ketones, carboxylic acids, short-chain alkanes, and alkenes (Eliana and Susana 2022). According to Choe and Min (2006) and Angaye et al. (2013), oil oxidation stability is a critical metric that affects both the amount and duration of oil storage. The primary cause of oil degradation or spoiling is oxidation, which is a result of the oil's fatty acid composition (Nurham, 2016; Gobena et al., 2018).

According to Gobena et al. (2018), the methods utilized to extract the oils from their plant sources impact this quality. Edible oil extracted from different vegetables is sometimes expensive and frequently diluted with inferior oils to make up for the cost of the raw material. This affects not just the genuine product's qualitative attributes but also public health and safety (Ali et al., 2023). Several chemical and physical elements affect the quality of oil. These products' unique advantages are a reflection of the oil's physical and nutritional qualities.

The unique advantages of these products are a reflection of the oil's physical and nutritional qualities. The fundamental factor determining oil quality is the particular values derived from the physicochemical qualities of vegetable oil, such as specific gravity, color, melting point, free fatty acids, peroxide value, and saponification value. Durham (2016). Certain quality indicators can change when oils are exposed to heat, light, or moisture. Temperature, length of exposure, and storage conditions all affect how much the material has changed (spoilage) (Aidos et al., 2002; Fekarurhobo et al., 2009).

One key factor in assessing the quality and shelf life of oils is their oxidation resistance (Choe and Min, 2006). Vegetable oils are commonly exposed to oxidative degradation in most commercial centres due to two typical practices: packing them in transparent containers (plastic bottles and sachets) and displaying them either in direct sunlight or under artificial lighting. Recently, testing for the degree and type of oil oxidation has received a great deal of interest. The quantity of hydroperoxides present in the oil is determined by the peroxide value, which is used to measure primary oxidation products (Maduelosi, et al., 2012).

It is usually expressed in milli-equivalent of oxygen per kg of oil. This research aims to assess the quality of five selected brands of vegetable oils sold at Relief Market, Onitsha, Anambra State through their physicochemical parameters.

MATERIALS AND METHODS

Sample Collection

The five branded vegetable oils such as PO, LO, KO, MO and EO used in this research were purchased from Relief Market, Onitsha, Anambra State.

Determination of peroxide value

50 ml of acetic acid in chloroform was added to a 250 ml conical flask after 5 g of the oil sample had been weighed. Following a gentle swirl to dissolve the oil, 1.0 ml of a freshly produced saturated potassium iodide solution was added to the flask using a pipette. The solution was spun for two minutes and then placed in a dark cabinet away from light for an additional minute. One milliliter of 1% starch solution was then added, and everything was well shaken after adding fifty milliliters of distilled water. When 0.1 N of sodium solution was added to the solution, the endpoint was attained. According to Ifred (2002). The phrase can be used to display the peroxide value (AOCS, 2004).

$$\text{Peroxide Value, } = \frac{(\text{STV}-\text{BTV}) \times \text{N} \times 1000}{\text{W}} \qquad 1.1$$

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Where:

STV = sample Titre Value.

BTV = blank Titre Value.

N = concentration of sodium thiosulphate solution ($Na_2S_2O_2.5H_2O$) in normal or normality of sodium thiosulphate solution (0.1N).

W = weight of the sample in gram.

Determination of acid value and percentage free fatty acid.

10 g of the oil sample was weighed into a conical flask and 50 ml of freshly neutralised ethanol was added. Two or three drops of phenolphthalein indicator were added and swirled. The sample was warmed and titrated with the standard solution of sodium hydroxide until a faint pink colour which lasted for at least 15 seconds was obtained. This marked the endpoint. ((AOCS, 2004).

Acid value = $\frac{5.61 \times V \times N}{W}$ 1.2

Where:

V = the volume in ml of sodium hydroxide solution used in the titration.

N = the concentration of sodium hydroxide in Normal.

W = the weight of the oil sample in grams.

The acidity is frequently expressed based on the most dominant free fatty acid in vegetable oil. Therefore free fatty acid is the half of acid value;

Free fatty acid = 25.6×V×N/M 1.3

Determination of Iodine Value

The oil (0.3 g) was dissolved in 10 ml of carbon tetrachloride in a conical flask.20 ml of wijis solution was added to the mixture and corked this was allowed to stand in the dark for 30 minutes. A blank was also carried out under the same condition.5 ml of 10 % potassium iodide and 100 ml of distilled water were added to each flask and mixed by gentle shaking.1 ml of starch solution was added as an indicator and the content of both flasks was titrated with 0.1 M sodium thiosulphate until the blue-black colour was completely discharged The same experiment was repeated without the test sample for the blank.. The iodine value was calculated using the equation below (AOCS, 2004).

Iodine value = $\frac{(b-a)\ x\ 1.269}{W}$ 1.4

Where a= sample titre value

b= blank titre value

w= weight of sample in gram

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1.269 is a conversion factor

Determination the specific gravity

Method**:** A clean and dry density bottle of 25 ml capacity was weighed, and then filled with the oil, stopper inserted and reweighed. The oil was substituted with water after washing and drying the bottle and weighed. ((AOCS, 2004).) The expression for specific gravity is:

$$\text{Specific Gravity} = \frac{W_3 - W_1}{W_2 - W_1} \qquad 1.5$$

Where:

W_1 = weight of specific gravity of bottle

W_2 = weight specific gravity of bottle + water

$W3$ = weight of specific gravity of bottle + oil

$W_3 - W_1$ = mass of the substance

$W_2 - W_1$ = mass of an equal volume of water.

Determination of percentage moisture content

10 g of the sample was weighed with 50 mil beaker, and allowed to stay in an oven for one hour maintaining at temperature of 100 ºC (AOCS, 2004).

Moisture Content = $W_3 - W_4$

But $W_3 = W_1 + W_2$

$$\% \text{ Moisture content} = \frac{W_3 - W_4}{W_1} \mathbf{x}\ 100\% \qquad 1.6$$

Where:

W_1 = weight of sample.

W_2 = weight of beaker.

W_3 = weight of beaker and oil extracted (before drying)

W_4 = weight of beaker and oil extracted (after drying)

Determination of slip melting point

A pair of capillary tubes were dipped inside the melted oil that had been heated and stirred thoroughly to force in a reasonable amount of oil into the capillary tubes. The capillary tubes were scrubbed on ice to solidify the oil in the capillary tubes and were kept in the freezer for 30 minutes. Use a magnetic stirrer with a hot plate mounted with a thermometer to check at which temperature the oil will slip. The capillary tubes were attached to the thermometer with a thread dipped inside very cold water (<10ºC) in the 1000mil beaker. (AOCS, 2004).

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RESULTS AND DISCUSSIONS

Result of the peroxide value

The term peroxide value of oil refers to the measurement of the degree of primary oxidation that occurs in oils and fats as a result of specific processes involving hydroxyl groups and oxygen molecules to form hydroperoxides (Bustani and Soni, 2023; Kong and. Singh 2011). The greater variations in rancidity are indicated by higher peroxide values, while lower peroxide values indicate higher-quality oil and a good preservation status. The basic idea is that potassium iodide releases iodine when peroxides are present:

$$ROOH + KI \text{ à } ROH + KOH + I_2 \quad 1.7$$

Consuming fried food cooked in rancid oil can have negative health effects on people. Oil samples with a peroxide value greater than 10 meq/kg are deemed rancid and pose several health risks, such as diabetes, obesity, cardiovascular diseases, infertility, Alzheimer's disease, and others (Bustani and Soni, 2023). Table 3.1 shows the result of peroxide values of the 5 vegetable oils. According to the Nigerian Industrial Standard (NIS) and Standard Organisation of Nigeria (SON), (2000), the maximum peroxide value for every Refined Bleached Deodorized vegetable oil must not exceed the l0 milli equivalent of oxygen. From the result in Table 3.1, all the vegetable oils passed the required specifications by NIS and SON agencies. This implies that the amount of peroxide present in the vegetable oils is appropriate which would not lead to the oxidation of the oil causing early rancidity (spoilage) of the oil (Geng et al. 2023).

Table 3.l: Peroxide value of RBD Vegetable oils

Samples	BATCH NO	Weight of standard used (g)	Peroxide value (milliequivalent of Oxygen)
PO	B1-8258	5.20	1.90±0.1
KO	08-2360	5.20	1.92±0.03
MO	08-0157	5.20	3.85±0.05
LO	08-1530	5.20	.3.00±0.1
EO	09-2745	5.2	2.00±0.1
NIS	–	–	10 max

Result of the acid value of vegetable oils

The amount of potassium hydroxide (KOH) milligrams required to neutralize the fatty acids in one gram of the sample is known as the acid value (Spitz, 2016). The amount of free fatty acids in fat or oil is determined by its acid value (AOCS, 1998). An excellent oil should have a low acid value. An increase in the acid value should be interpreted as a sign of oil oxidation, which can cause sludge and gum production.

$$RCOOH + KOH \rightarrow RCOOK + H_2O \quad 1.8$$

The maximum acid value for every edible Refined Bleached Deodorized vegetable oil is 0.6max by NIS. From the result in Table 3.2, the acid values of LO, KO, and MO are within the range of the required specification. The low acid values recorded for LO, KO, and MO the means absence of rancidity (Ogah et al., 2020). In contrast, PO and EO oils are above the required specification and as a result of this, the number of oleic acid(fatty acids) present in PO and EO oils is much and greater than the required specification by NIS. This implies that high consumption of this particular vegetable oil will lead to an increase in the cholesterol level of the consumers (Geng *et al.,* 2023).

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Table 3.2: Acid value of the vegetable oils

Samples	**Batch No**	**Weight of the sample used (g)**	**Acid Value** mg KOH/g fat/oil
PO	B1-8258	10.270	0.765±0.0036
KO	08-2360	10.235	0.274±0.0026
MO	08-0157	10.325	0.326±0.0017
LO	08-1530	10.616	0.262±0.0026
EO	09-2745	10.248	0..821±0.01
NIS standard			0.6 max

Result of the iodine value of the vegetable oils

A fatty acid's degree of unsaturation can be determined using the iodine value. It is the quantity of iodine in grams that will completely saturate 100 grams of fatty acid (Aslan, 2023). Liquid fats at room temperature are known as unsaturated fats. They can be found in fish and plant-based foods including nuts, seeds, and olive oil. It is generally accepted that unsaturated fats reduce LDL (bad) cholesterol levels, which may lessen the chance of developing heart disease (Negash, et al., 2019). Double bonds, which are an unsaturation, react with iodine compounds. According to Mbatchou and Kosoono (2012), the amount of C=C bonds in fat increases with the iodine number. Oils with a higher iodine content, suggest they are probably better for consumption (Negash et al., 2019). Nevertheless, due to their double bonds, highly unsaturated oils undergo oxidative deterioration unless an adequate antioxidant is added (Dziedzic, 1983). Table 3.3 below shows the result of the iodine value of five brands of vegetables. The iodine value for the five brands of vegetable is within the permissible value of 62 max for RBD palm olein, From the result it can be inferred that MO has the highest Iodine value (29.08 gram I_2/100 g oil) followed by LO (23.68 gram I_2/100 g oil) and KO and EO (16. 58 gram I_2/100 g oil, respectively, the least is PO 9.09 gram I_2/100 g oil. This implies that the amount or degree of unsaturation in the form of double bonds which would have reacted with iodine compounds when exposed to air is small (Geng et al., 2023).

Table 3.3: Iodine value of RBD vegetable oils

Samples	**Batch No**	**Weight of the sample used (g)**	**Iodine value** (gram I2/100 g oil)
PO	B1-8258	0.307	9.09 ± 0.231
KO	08-2360	0.374	16.58 ± 1.013
MO	08-0157	0.336	29.08 ± 2.356
LO	08-1530	0.343	23.68 ± 1.978
EO	09-2745	0.374	16.58 ± 1.561
NIS standard			62 max

Result of free fatty acid (FFA) of the vegetable oil

Oil quality is determined by its FFA content. According to Nigerian Industrial Standard, the maximum value for FFA of refined bleached deodorized vegetable oil is 0.3 max. From the result obtained in Table

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3.4, the free fatty acid of KO, MO and LO oils are within the range of required specification while PO and EO oils are above the required specification. High FFA values signifies high decomposition of the oil triglycerides, dullness of the oil and offensive odour. When triglycerides' glycerol backbones are broken down by lipid hydrolysis, which releases free fatty acids (FFAs) into the oil, an elevated amount of FFAs usually signals that the oil is not fresh. It could also have been stored badly. (Frega et al. 1999). Lower FFA content oils typically have longer shelf lives and are more resistant to oxidation. Higher FFA content oils can hasten oxidative rancidity, which can produce off-odours and flavours that detract from the oil's attractiveness and stability. (Daniel et al., 2022).

Table 3.4: Result of the free fatty acid of the vegetable oils

Sample	Batch No.	Weight of the samples (g)	Free fatty acid (meq/g)
PO	B1-8258	10.27	0.349 ± 0.08
KO	08-2360	10.235	0.125 ± 0.0017
MO	08-0157	10.325	0.148 ± 0.0056
LO	08-1530	10.616	0.121 ± 0.001
EO	08-2745	10.248	0.425 ± 0.0052
NIS standard			0.3 max

Result of percentage moisture content of the vegetable oils.

The moisture content of vegetable oil is significant because it can greatly affect the stability and shelf life of the oil. Water in vegetable oils can lead to hydrolytic degradation, resulting in the breakdown of triglycerides into free fatty acids, glycerol, and other compounds, which can deteriorate the oil's quality and result in off-flavours and odours. Elevated moisture content can also promote microbial growth, including moulds, which can produce toxins and further degrade the oil (Smeu, et al. 2022). Moreover, in processes where oils are heated, such as cooking or industrial processes, a high moisture content can lead to splattering and increased oxidation rates, reducing the oil's nutritional value and safety. Therefore, controlling and minimizing the moisture content is essential for maintaining the quality, safety, and consumer acceptability of vegetable oils (Cuvelier & Maillard, 2012) (Arya & Parihar, 1981). The result in Table 3.5 shows the result of the percentage moisture content of the five vegetable oils. The maximum Nigerian Industrial Standard value for the percentage moisture content of Refined Bleached Deodorized vegetable oil is 0.05% max. From the result obtained in Table 3.5, PO, LO, and KO vegetable oils are within the range of specification while MO and EO are above the maximum value. This implies that MO and EO will be prone to early microbial spoilage under the same conditions.

Table 3.5: Moisture content of the vegetable oils

Samples	Batch No	Weight of the sample used (g)	% moisture content
PO	B1-8258	0.005	0.049 ± 0.0021
KO	08-2360	0.005	0.049 ± 0.0019
MO	08-0157	0.006	0.059 ± 0.0020
LO	08-1530	0.001	0.001 ± 0.0013
EO	09-2745	0.014	0.139 ± 0.0010
NIS standard			0.05 max

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Result of slip melting point of the vegetable oils

Vegetable oil's slip point, sometimes referred to as its melting point, is important because it shows the temperature at which the oil transitions from a solid to a liquid condition (Dianika et al., 2021). The slip point is crucial in figuring out how best to handle and store vegetable oil (Cuvelier & Maillard, 2012). Lower slip-point oils stay liquid at room temperature, while higher slip-point oils solidify at room temperature and may need to be warmed before use. Moreover, Saturated fats are solid at room temperature and are present in oils with higher slip points. Compared to unsaturated fats found in oils with lower slip points, these fats have different nutritional ramifications. The selection of oil for various culinary applications might be influenced by the slip point. Table 3.6 shows the results of the slip melting point of the five vegetable oils. According to NIS, the slip melting point of any refined bleached deodourized palm olein should not exceed 25^{o}C. All the vegetable oils are within the specified range except EO (28^{o}C) oil which exceeded the maximum temperature. This implies that, above 25^{o}C, oil starts to congeal due to the presence of stearin which was not fully fractionated to the standard during the production ((Sánchez-Muniz, 2006).

Table 3.6: Slip melting point of the vegetable oils

Samples	Batch No	Weight of the sample used (g)	Slip melting point ^{o}C
PO	B1-8258	0.005	9 ± 1.020
KO	08-2360	0.005	10 ± 1.571
MO	08-0157	0.006	19 ± 2.311
LO	08-1530	0.001	8 ± 1.623
EO	09-2745	0.014	28 ± 2.589
NIS standard			25 max

Result of specific gravity of the vegetable oils

The density of the oil divided by the density of water is called its specific gravity, and it has an impact on how the oil is processed and used. Vegetable oil's specific gravity is important since it is a crucial determinant of its composition and quality. Specific gravity is also a physical indicator of the purity of oil (Ichu, and Nwakanma, 2019). For example, a high specific gravity frequently denotes a decreased oil content (Misra et al., 1993). The NIS specified range for the specific gravity of vegetable oil is 0.900 to 0.920. The five samples of vegetable oils are within the range. This implies that the oil contains no impurities and is of high content.

Table 3.7: Specific gravity of the vegetable oils

	Batch No	Weight of the sample used (g)	Specific gravity
PO	B1-8258	0.005	0.916 ± 0.0231
KO	08-2360	0.005	0.917 ± 0.0125
MO	08-0157	0.006	0.915 ± 0.0210
LO	08-1530	0.001	0.920 ± 0.0493
EO	09-2745	0.014	0.917 ± 0.0325
NIS standard			0.900-0.920 max)

CONCLUSION

The study's findings demonstrate that the five vegetable oils examined adhered to the NIS standards for

peroxide and iodine values, indicating a low susceptibility to oxidative rancidity in typical conditions. LO, KO, and MO oils met the NIS criteria for acid and free fatty acid levels, while EO and PO oils did not satisfy these parameters, suggesting a potential for elevated cholesterol levels in consumers with high consumption of these oils. MO and EO exhibited an increase in moisture content compared to the standard, indicating an increased susceptibility to microbial spoilage. Among the oils assessed, LO and KO exhibited the highest quality, passing all tests successfully, followed by MO, which only failed the moisture content test, and PO, which failed both the acid and FFA value tests. EO performed the poorest among the oils tested, failing three out of seven tests.

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