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Comparative Study of Physiochemical Properties of Different Brands of Vegetable Oil Sold in Ihiala Market of Anambra State

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Objective: To compare the physicochemical properties of four brands of vegetable oil sold in Ihiala market.
Methods: The samples were brought from different super stores in Ihiala market and standard methods were used to analyze the physicochemical properties of the various samples.
Results: The analysis showed that the peroxide value, saponification values, acid value, ester value and glycerol of palm kernel oil (43.91 ± 0.01, 1234.20 ± 0.01, 74.14 ± 0.01, 38.56 ± 0.02, 1195.60 ± 0.01 and 65.40 ± 0.02) is significantly higher than Lahda, Devon King's and Power vegetable oil $P < 0.05$. While the iodine value, refractive index and specific gravity of Power oil and Devon King's oil (56.53 ± 0.10, 0.26 ± 0.01 and 0.91 ± 0.01) brought from Ihiala market were significantly higher than the other brands of vegetable oil i.e Lahda and Palm Kernel oil at $P < 0.05$. There is no significant difference in the refractive index and specific gravity of Palm kernel and Lahda oil (0.01 ± 0.01 and 0.01 ± 0.01) at $P < 0.05$.

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Conclusion: The difference in the values of iodine, peroxide, saponification, acid value, FFA, ester value and glycerol level in the samples could be attributed to differences in the sources of the oil and in processing. However, the nutritional composition of the vegetable brands is still adequate for human consumption except that of Palm Kernel oil which has the highest values from the above analysis.

Keywords: Vegetable oil; physiochemical properties; saponification value; iodine value; free fatty acid.

1. INTRODUCTION

"Vegetable oils are extracted from the seeds and nuts of various plants and are composed mainly of triacylglycerols. It forms the main part of the human diet as a source of energy, fat-soluble vitamins and essential fatty acids" [1]. Vegetable oils are widely used in the food industry, where they are used in frying, cooking, dressings for salads, etc. The quality of vegetable oils can be affected by several factors, from the selection of raw materials to the methods of processing, cleaning, bottling and storage, thus quality is guaranteed of vegetable oils supplied to the food industry and final consumers. It is important to have good controls throughout the production chain. Oil quality is a function of physicochemical properties such as peroxide content. saponification value, iodine number, undeter-mined value, color appearance, free fatty acids, etc. heat, light or moisture can change some of our oil quality indicators; the rate of change depends on the degree of exposure, temperature and storage conditions [2,3]. Oxidative stability of oil is an important parameter in determining oil quality and durability [4]. Different brands of vegetable oil are sold in the market; some are produced domestically and some are imported [5]. Vegetable oil is basically oil that has gone through some process to remove unwanted substances. In order to be suitable for human consumption, most vegetable oils undergo a processing process such as neutralization, bleaching and deodorization [6]. In this study, we determined and compared the physicochemical properties of different vegetable oils sold in Ihiala market, Anambra State Nigeria.

2. MATERIALS AND METHODS

2.1 Sample Collection and Preparation

The samples used for this study are Lahda soya oil®, Palm kernel oil, Power oil® and Devon king's refined palm olein vegetable oil®, they were bought from Ihiala village market in Anambra State, Nigeria and were kept in the refrigerator until it was ready to use for the analysis. While the chemicals used for the study are of analytical grade.

2.2 Determination of Specific Gravity Using Density Bottle

The specific gravity of the samples were determined following the method of [7], a clean and dry empty density bottle of 25 ml was weighed (W_1) g. The density bottle was filled with distilled water, stoppered and weighed at 20°C (W_2) g. The same density bottle was substituted with sample and weighed at 20°C (W_3) g**.** The Specific gravity at 20 °C was the calculated using the following.

Calculation;

$$\textbf{Specific gravity at } 20℃ = \frac{\mathbf{W3 - W1}}{\mathbf{W_2 - W1}}$$

2.3 Determination of Peroxide Value

Five (5) grams of each sample was weighed into different 250 ml conical flask. Then 10 ml of chloroform was added to dissolve the oil. This was followed by the addition of 1 ml of fresh saturated KI solution. The flask was stoppered for a minute and allowed to stand in the dark for 15 minutes. Seventy five (75) ml of water was added and mixed. The mixture was then titrated against 0.01 M sodium thiosulphate solution using soluble starch as indicator [8].

Calculation;

$$\textbf{Peroxide value} = \frac{(\mathbf{V - V2}) \times \mathbf{10^3\ mEq/kg}}{\mathbf{Weight\ of\ sample\ (g)}}$$

Where,

V = Titre of sample.
V_1 = Titre of blank.

2.4 Determination of Saponification Value

The samples were thoroughly mixed and 1.5 g of each of the dry sample was weighed into different 250 ml Erlenmeyer flask. About 25 ml of

alcoholic potassium hydroxide solution was pipette into the flasks. A blank determination along with the sample was conducted. A reflux condenser was attached and heated in water for 1 hr, 1 ml of phenolphthalein solution was added to the hot mixture with excess alkali and titrated against 0.5 M HCl. The titre value represents ***a***. Blank titration was carried out and called ***b*** [9].

Calculation;

$$\textbf{Saponification} = \frac{(\mathbf{b} - \mathbf{a}) \times \mathbf{28.05\ mgKOH/g}}{\textbf{wt of sample (g)}}$$

Where,

b = Volume in ml of standard hydrochloric acid required for the blank.
a = Volume in ml of standard hydrochloric acid required for the sample

2.5 Determination of Iodine Value

"The samples (0.2 g) were weighed into different conical flasks, 10 ml of carbon tetrachloride and 20 ml of the Wijs solution were added to the flasks and the solutions were kept in dark for 30 mins at room temperature, 15 ml of 10 per cent potassium iodide solution with 100 ml of distilled water were added to the flask. The resulting solution was titrated against 0.1 M sodium thiosulphate ($Na_2S_2O_3$), using starch as indicator just before the end point where the blue black coloration becomes colorless (titration= aml). A blank titration was carried out at the same time starting with 10 ml carbon tetrachloride (titration = **b** ml)" [10].

Calculation;

$$\textbf{Iodine value} = \frac{(\mathbf{b} - \mathbf{a}) \times \mathbf{1.269}}{\textbf{Weight of sample (g)}}$$

Where,

b = Volume in ml of standard hydrochloric acid required for the blank.
a = Volume in ml of standard hydrochloric acid required for the sample.

2.6 Determination of Acid Value (Acid Number)

Five hundred milligrams (500 mg) of the oil samples were taken into different conical flasks and dissolved by the addition of 50 ml of distilled alcohol, warmed gently. After which they were titrated against 0.1 N KOH using 1 ml of 1 % phenolphthalein as indicator until a slight pink colour persist for 15 seconds was obtained [11].

Calculation;

$$\textbf{Acid value} = \frac{\mathbf{V} \times \mathbf{N} \times \mathbf{56}}{\mathbf{W}}$$

Where,

V is the volume of alkali added in ml,

N is the normality of KOH and W is the weight of the oil sample taken in grams.

56 is the equivalent mass of KOH.

2.7 Determination of Percentage Free Fatty Acid (%FFA) from Acid Value

The percentage of free fatty acid was calculated in terms of oleic acid, 1000 g of sample contains 282 g of oleic acid. The relationship between AV and FFA % can be obtained by resolving the following equations: [12]

$$AV/56.1 = (V - B) \times N / W \quad (1)$$

$$FFA\% /28.2 = (V - B) \times N / W \quad (2)$$

combing both equations (1) and (2),

AV/56.1 = FFA% /28.2 Or AV= 1.99FFA %
%FFA = AV/1.99 = AV × 0.503

2.8 Determination of Ester Value

The ester value is defined as the mg of KOH required to react with glycerin (glycerol / or glycerin) after one gram of fat is saponified. Ester Value is calculated from the saponification value *(SV)* and the acid Value (AV): [12]

Ester Value (EV) = Saponification Value (SV) – Acid Value (AV)

2.9 Determination of Percentage Glycerol from Ester Value

It has been established that 168 mg of KOH generates 92 mg of glycerol (George, 2012). However, this was calculated from the following equation: [12]

$$\% \textbf{ Glycerol} = \frac{\textbf{92} \times \textbf{100} \times \textbf{Ester Value (EV)}}{\textbf{168} \times \textbf{1000}}$$

% Glycerol = 0.0547 × EV

2.10 Determination of Refractive Index

"The Abbe's refractometer was resetted with a light compensator (water at 20 ^{0}C). The oil samples were smeared on the lower prism of the instrument and closed. A light passed by means of the angled mirror, the reflected light appeared in form of a dark background. Using the fine adjustment, the telescope tubes was moved until the black shadow appears central in the cross wire indicator. The refractive index was observed and read" [13].

Calculation;

$$\textbf{Refractive index} = 1.4643 - 0.0000665 - \frac{0.0096A}{S + 0.0001171I}$$

Where;

S = Saponification value.
A = Acid value.
I = Iodine value.

2.11 Method of Data Analysis

All data collected were subjected to Descriptive and ANOVA (Analysis of Variance) test using Statistical Package for Social Sciences (SPSS) Version 16 software. All data were represented in mean ± standard deviation (m ± s.d) of triplicate values and the confident level of determination (P = 0.05).

3. RESULTS AND DISCUSSION

The quality of four brands of vegetable oil (Lahda oil, Devon Kings, Power oil and Palm Kernel oil) gotten from Ihiala in Anambra State Nigeria, were analyzed by evaluating physiochemical properties such as peroxide value, iodine value, saponification value, acid value, free fatty acids (FFA), ester value, refractive index, glycerol and specific gravity. The specific gravity of the various brands of oils have values that are closely connected to the standard range of 0.898-0.912 approved by Standard Organization of Nigerian, (SON) [14] apart from the lahda and palm kernel oil which has values of 0.01 ± 0.01. This reduction may be due to the increasing temperature of the oil, which results in a continuous disruption of the oil structure.

The saponification value is a measure of oxidation during storage and also indicates deterioration of the oils. Saponification values obtained for lahda, devon kings and power oil are lower than the range for any particular oil as specified [14,15]. Table 1 showed characteristics of palm kernel oil, having saponification value of 1234.20 ± 0.01 which is higher than the standard range of 245-255mgKOH/g. A high saponification value indicates that the oil will be most suitable for industrial use.

The percentage free fatty acid (FFA) of four brands of vegetable oil analyzed measured to be higher Table 1 than the stipulated standard range of 0.3 max [14]. "The deviation in the values maybe attributed to the high temperature attained by the oil or that the extent of hydrolytic rancidity in this oil is appreciable" [16].

The iodine number measures the degree of unsaturation in a fat or oil. It determines the stability of the oil against oxidation and enables a qualitative determination of the total unsaturation of the fat [17,18]. "It was observed that measured iodine values of four brands of vegetable oil were about 0.2 g respectively. These vegetable oils tend to have low related values to that of the standard range of 7-10 depending on the oil" [14,15]. "This low iodine number, may have contributed to its greater oxidative stability during storage. Oxidative and chemical changes in oils during storage are characterized by an increase in FFA content and a decrease in total unsaturation of oils" [19].

The peroxide number is used to evaluate the level to which rancidity has occurred during storage, it could be used as a pointer of the quality and stability of fats and oils. The peroxide value in this study was found to increase with storage time, temperature and exposure of oil samples to air. It was observed also that the peroxide value of power oil is within the standard range of 10max [15] while lahda oil 15.93 ± 0.01, devon kings 27.89 ± 0.01 and palm kernel oil 43.91 ± 0.01 exhibited significant deviation from the standard. The deviations from the standard value could be as a result of continuous exposure of the oil to light, high temperature and atmospheric oxygen, which reacts with the oil to form peroxide.

"Acid value of vegetable oil brands exhibited significant deviation higher from the standard range of 0.6mgKOHg^{-1} max for refined oil for human consumption, [15] especially the palm kernel oil with the range of 77.14 ± 0.01. Studies have shown that high acid values translate to

Table 1. Result of physicochemical properties of four different brands of vegetable oil sold in Ihiala market

	Physicochemical			
Properties of oil	**Lahda oil**	**Devon kings oil**	**Palm kernel**	**Power oil**
Iodine value	38.07 ± 0.02[c]	55.84 ± 0.04[b]	25.36 ± 0.02[d]	56.53 ± 0.10[a]
Peroxide value	15.93 ± 0.01[c]	27.89 ± 0.01[b]	43.91 ± 0.01[a]	1.98 ± 0.01[d]
Saponification value	140.23 ± 0.02[b]	41.24 ± 0.01[c]	1234.20 ± 0.01[a]	5.55 ± 0.01[d]
Acid value	5.50 ± 0.01[c]	21.45 ± 0.01[b]	77.14 ± 0.01[a]	2.76 ± 0.01[d]
FFA %	2.75 ± 0.02[c]	10.78 ± 0.02[b]	38.56 ± 0.02[a]	1.38 ± 0.01[d]
Ester value	137.50 ± 0.01[b]	30.47 ± 0.02[c]	1195.60 ± 0.01[a]	4.17 ± 0.01[d]
Glycerol %	7.53 ± 0.01[b]	1.66 ± 0.02[c]	65.40 ± 0.02[a]	0.23 ± 0.01[d]
Refractive Index	0.01 ± 0.01[c]	0.03 ± 0.01[b]	0.01± 0.01[c]	0.26 ± 0.01[a]
Specific gravity	0.01 ± 0.01[b]	0.91 ± 0.01[a]	0.01 ± 0.01[b]	0.91 ± 0.01[a]

•*Values are mean ± standard deviation. Values within the same row bearing the same superscript letters are not significantly different at P < 0.05.*

high free fatty acid. These high free fatty acids have the tendency to increase the risk of coronary heart disease by raising cholesterol level" [20].

4. CONCLUSION

Exposure of oil to heat and light leads to their degradation, however affecting their physico-chemical properties. This is of importance to scientists since the products of such degradation are linked to cardiovascular disease. The effect is seen to be greater in oil sold in the open market than for oil sold in the supermarket. This can be ascribed to the harsh storage/display conditions of the products in the open markets. Findings of this study show that some vegetable oils sold in the markets are substandard, which could be as a result of storage system or continuous exposure of the vegetable oil to conditions such as heat and light. It also reveals that an oil low in free fatty acids tends to have a low peroxide value, which is a good quality of an ideal vegetable oil.

5. RECOMMENDATION

Vegetable oil should be stored in lacquered cans or bags, not in the clear jars or plastic bottles that are often used, which allow the oil to be damaged by ultraviolet radiation. Since the physico-chemical properties of the vegetable oil that has been analyzed are degraded, we should avoid using this oil at least no more than twice during the frying process due to changes in the physico-chemical properties of the oil that affect the quality of the oil. Oil that is not suitable for human consumption would be suitable for alternative uses, including biodiesel production.

COMPETING INTERESTS

Authors have declared that they have no known competing financial interests or non-financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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