Original Research Article

COMPARATIVE STUDY OF PHYSIOCHEMICAL PROPERTIES OF DIFFERENT BRANDS OF VEGETABLE OIL SOLD IN IHIALA MARKET OF ANAMBRA STATE

ABSTRACT

Objective: To compare the physicochemical properties of four brands of vegetable oil sold in Ihiala market.**Method:** 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. **Result:**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.eLahda 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 $P < 0.05$.**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.

Keyword: *Vegetable oil, physiochemical properties. saponification value, iodine value, free fatty acid.*

1.0 Introduction

Vegetable oils are extracted from nuts and seeds of various plants and are made up of mainly triacylglycerols. They comprise a major part of the human diet as a source of energy, fat-soluble vitamins and essential fatty acids [1].Vegetable oils have wide application in foods where they are used in frying, cooking, salad dressing, shortening of pasty etc. The quality of vegetable oils may be affected by several factors, from the choice of raw material to the methods of processing, refining, bottling and storage. Therefore, appropriate control throughout the production chain is important to ensure the quality of vegetable oils delivered to food industries and final consumers.The quality of any oil is a function of some physico-chemical properties, such as peroxide value, saponification value, iodine value, unsaponifiable value,color appearance, free fatty acidetc.Heat, light or moisture can alter some of the quality indicators of oil;the level of alteration depends on the extent of exposure, temperature and condition of storage[2][3]. The stability of oils to oxidation is an essentialsign indetermining oil quality and shelf-life [4].Various brands of vegetable oils are sold in markets; some are manufactured in the country while some are imported [5].Edible oils are mainly vegetable oils which have been made to pass through several processes to remove unwanted constituents. In order to make them appropriate for human utilization, most edible oils are subjected to refining processes, such as neutralization, bleaching and deodorization [6]. In this present study, we have determined and compared the physico-chemical properties of different vegetable oil sold in Ihiala market of Anambra State.

2.0 MATERIALS AND METHODS

Sample Collection and Preparation:

The samples used for this study areLahda soya oil®, Palm kernel oil, Power oil® and Devon king's refined palm olein vegetable oil®, they were bought fromIhiala 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.

2.1 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 capacity 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;

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

2.2 Determination of Peroxide Value:

Five (5) grams of each sample was weighed into different 250 ml stoppered conical flask. Then 10 ml of chloroform was added to dissolve the oil. This was followed by the addition of 1 ml 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;

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

Where,

V = Titre of sample.

V_1 = Titre of blank.

2.3 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;

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

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

2.4 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= **a**ml)**.** A blank titration was carried out at the same time starting with 10 ml carbon tetrachloride (titration = **b** ml)[10].

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Calculation;

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

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.

2.5 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;

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

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.

2.6 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]

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

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

combing both equations (1) and (2),

AV/56.1 = FFA% /28.2 Or**AV= 1.99FFA %**

%FFA = AV/1.99 = AV × 0.503

2.7 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)

2.8 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]

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

% Glycerol = 0.0547 × EV

2.9 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.

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).

3.0 RESULTS AND DISCUSSION

Table 1.1 Result of physicochemical properties of four different brands of vegetable oil sold in Ihiala market.

Physicochemical Properties of oil	**Lahda oil**	**Devon kings**	**Palm kernel oil**	**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.*

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, wereanalyzed by evaluating physiochemical properties such as peroxide value, iodine value, saponification value, acid value, FFA, ester value, refractive index, glycerol and specific gravity. The specific gravity of the different brands of vegetable oils have values that are closely related to the standard range of 0.898-0.912 approved by Standard Organization of Nigerian,[14]except for the lahda and palm kernel oil which has values of 0.01 ± 0.01. This decrease might be due to the increasing temperature of the oil and hence resulting in continuous break down of the oil structure.

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 1.1 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. The high saponification value is an indication 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 1.1 than the stipulated standard range of 0.3max.[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].

Iodine value measures the degree of unsaturation in a fat or vegetable oil. It determines the stability of oil to oxidation, and allows the overall unsaturation of the fat to be determined qualitatively [17][18]. It was observed that measured iodine values of four brands of vegetable oil were about 0.2g 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]. These low iodine value may have contributed to its greater oxidative storage stability. The oxidative and chemical changes in oils during storage are characterized by an increase in FFA contents and a decrease in total unsaturation of oils.[19].

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 oil. The peroxide value in this study was found to increase with the storage time, temperature and contact with air of the oil samples. 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 high FFA. These high FFA have the tendency to increase the risk of coronary heart disease by raising cholesterol level.[20].

CONCLUSION

The exposure of vegetable oil to light and heat result in their degradation affecting their physicochemical properties. This is of interest to scientists because the products of such degradation reactions are linked to the cardiovascular diseases. The effect is more on the oil sold in the open market than those sold in supermarket. This may be attributed to the harsh storage/ display conditions of the products in the open markets. The findings from the research show that some of the vegetable oil sold in the markets is substandard. It also reveals that oil with low free fatty acids tends to have low peroxide value which is good quality attributes of ideal vegetable oil.

RECOMMENDATION

Vegetable oil should be stored in lacquered cans or sachets and not clear jars or plastic bottles often used which allows ultraviolet radiation to damage the oil. Since there is degradation in the physicochemical properties of vegetable oil that was analyzed, we should avoid using these oil at least not more than two times during frying process because of the changes in the physicochemical properties of the oil which affects the quality of the oil for human consumption. Oil not suitable for human consumption would be suitable for alternate uses including biodiesel production.

COMPETING INTERESTS DISCLAIMER:

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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