



Determination of Physico-chemical Properties, Cholesterol and Vitamin A Levels of Vegetable Oils commonly Sold in Ado Ekiti Metropolis

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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

Edible vegetable oils are very important resource that are in high demand globally, and used in a variety of ways as they are considered a concentrated source of energy for human beings and carriers of oil-soluble vitamins which supply the essential fatty acids that are required for a wide range of biological and physiological functions. This work was aimed at evaluating the physicochemical properties, cholesterol content and analyzes the vitamin A contents of commonly sold vegetable oils in Ado Ekiti metropolis. The physicochemical parameters such as density, acid value, iodine value, peroxide value and saponin value, cholesterol content as well as Vitamin A content were all analyzed using standard analytical methods. Results of the physicochemical analysis showed that there was no significant difference ($p>0.05$) in the densities of the oil samples, It was observed that sample 4 oil showed maximum (1.58 mgKOH/g) and sample 6 showed minimum (1.38 mg KOH/g) acid values. Highest iodine values were observed in sample 8 (68.13 g/I2/100g) and lowest in sample 4 (56.38 g/I2/100g). Peroxide value was found to range from 2.18 meq O₂/kg to 2.67 meq O₂/kg, while saponin value was highest in sample 6 (130.3 mg KOH/g) and lowest in sample 8 (122.4 mg KOH/g). All the oil samples were found to contain cholesterol which ranged from 1.21±0.04 mg/dl (sample 1) to 4.58±0.01 mg/dl (sample 4), while

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the vitamin A content ranged from 674.80 ± 10.26 IU/g (sample 2) to 877.97 ± 20.52 IU/g (sample 8). Findings from this research showed that the researched oils meet the acceptable physicochemical standard. However, the cholesterol levels were against the inscriptions of cholesterol free on the labels.

Keywords: Vegetable oil; cholesterol; vitamin; nutrition; human health.

1. INTRODUCTION

Oil is generally used in generic sense as substances that are greasy or oily fluid at ambient temperature. Vegetable oils are gotten from the seed of plants which are cultivated in many parts of the world [1]. Oilseed plants are the main source of lipids for human nutrition as well as for many 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 includes groundnut, soybean, palm kernel, cotton seed, olive, sunflower seed, rapeseed, sesame seed, linseed and safflower seed [2]. These oil seed plants are major sources of lipids for human. In animals, oil is found in various parts of the body such as liver. Vegetable oils have found applications in a variety of ways which includes food texturing, baking, and frying and also used industrially, in the production of soap, detergent, cosmetics and oil paints [3].

Nutritionally, vegetable oils are usually preferred to animal fat because of the unsaturated fatty acids they contain as well as their molecular weight [1].

Vegetable oil obtained from various sources thrives and are sold under different brand names in the society. The importance of vegetable oils has made a significant 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 [4]. There has been an increase in the world production of oil seeds over the last thirty years [5]. 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 assess the compositional quality of oils [6,7]. These physicochemical parameters include density, saponification value (SV), iodine value (IV), acid value (AV), and peroxide value (PV). Repeated

frying has been reported to cause several oxidative and thermal reactions which results in change in the physicochemical, nutritional and sensory properties of the oil. 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 subsequently harmful to human health [8]. Therefore, it is important to monitor the quality of oil so as to safeguard the health of its consumers.

In Nigeria, the demand for vegetable oil is increasing daily, 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 [9]. 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), Codex Alimentarius Commission, International Standards Organization (ISO) sets standard parameters for edible oils. It is therefore, very crucial that the quality and oxidative stabilities of commercially available vegetable oils be determined to ascertain their suitability for consumption. This study therefore investigates the physicochemical properties and quality of vitamin A in vegetable oils commonly sold in Ado Ekiti, Ekiti State Nigeria.

2. MATERIALS AND METHODS

2.1 Materials

Eight different brands of vegetable oils were purchased from Ado Ekiti markets and were analysed as bought.

2.2 Methods

2.2.1 Determination of chemical properties of the oil

2.2.1.1 Determination of acid value

Acid Value of the oil was carried out using the method of AOAC [10]. The acid value of an oil or

fat is the number of mg of potassium hydroxide required to neutralize the free fatty acid in 1.0 g of the sample. Twenty five (25) ml diethyl ether with 25 ml ethanol was mixed and warmed on hot plate for few minutes to remove the dissolved gases in the mixture. About 1.0g of the oil was dissolved in the neutralized solvent mixture and also warmed on hot plate for few minutes and removed. Two drops of phenolphthalein indicator was added to the solution and the solution was titrated against standardized 0.1 M potassium hydroxide. The yellow colour of the oil solution became milky immediately the indicator was added and this later turned pink at the end-point.

Calculation

$$\text{Acidvalue} = \frac{56.1 \times \text{titre value (ml)} \times \text{Molarity of base}}{\text{Weight of sample used}}$$

2.2.1.2 Determination of saponification value

The content of saponin in the oil sample was determined using the method of AOAC [10]. About 1.0 g of the oil was weighed into a flask and 25 ml of alcoholic potassium hydroxide solution was pipetted into it. Reflux condenser was attached and heated on a boiling water bath for one hour with occasional shaking. The inside of the condenser was washed with little distilled water to ensure that all the potassium hydroxide was in the flask. The entire content was titrated while still warm with standard 0.5 M HCl using phenolphthalein as indicator. The blank was prepared by titrating 25 ml aliquots of the standardized alcoholic potassium hydroxide with standard 0.5 M HCl.

Calculation

$$\text{Saponification value} = \frac{(b - a) \times 28.05}{\text{Weight of sample used}}$$

Where,

b = volume of HCl used for blank
 a = Volume of HCl used for sample
 28.05 = Value of ½ of molar mass of KOH.

(Since 0.5 M KOH) was used).

2.2.1.3 Determination of iodine value (Wij's method)

The iodine value of the oil sample was determined using the method of AOAC [10]. The

iodine value of oil or fat is the weight of iodine absorbed by 100 parts by weight of the sample. A solution of about 0.63 g of iodine and 10 g of potassium iodide was prepared in a 25 cm using distilled water and this solution was kept in a cool place. About 0.5 g of the oil was weighed into a glass-stopper bottle of about 250 ml capacity. Ten (10) ml carbon tetrachloride was added and dissolved. Exactly 20 ml of wij's solution was also added and then a stopper been moistened with potassium iodide solution was inserted. The mixture was mixed and allowed to stand in the dark for 30 min, 15 ml potassium iodide solution and 100 ml of water was added. Then 25 ml of 0.1 M standard sodium thiosulphate was mixed and introduced into the burette and titrated against the mixture. This was done until the titrant had a straw colour and at this point the starch indicator was added and the titration continues to a colourless end point. It was repeated in duplicate and the mean value was determined.

Calculation

$$\text{Iodine value} = \frac{(b - a) \times 1.269 \times M}{\text{Weight in gram of sample used}}$$

Where

b = titre value of blank
 a = titre value of the sample
 M = molarity of Na₂S₂O₃

2.2.1.4 Determination of peroxide value

The peroxide value of the oil sample was determined using the method of AOAC [10]. The concentration of peroxide in oil gives an indication of the extent of spoilage. The oil is mixed with potassium iodide in an organic solvent and the peroxide liberates the iodine from potassium iodide. About 1.0 g of the oil was weighed into clean conical flask and placed on boiling water bath. 1 g powdered potassium iodide and 20 ml of the solvent mixture of acetic acid and chloroform (3:1) was added. The contents was poured into a titration flask which contained 20 ml potassium iodide solution and the tube was washed with 25 ml portion of water and added to the titration flask which was then titrated with 0.002 M sodium thiosulphate using starch as indicator. The procedure was repeated for the blank.

Calculation

$$\text{Peroxide value} = \frac{0.002 M \times (\text{sample titre} - \text{blank titre}) \times 1000}{\text{Weight of sample used}}$$

Where 0.002M = concentration of $\text{Na}_2\text{S}_2\text{O}_3$

2.2.2 Determination of cholesterol

2.2.2.1 Procedure

Standard (10 μl) and plasma (10 μl) were pipetted into labeled test tubes. Working reagent containing (1000 μl) was added into all the tubes. The reaction mixtures were shaken thoroughly and incubated for 10 min at room temperature. The absorbance of the sample was taken at 500 nm against the reagent blank.

2.3 Determination of Vitamin A

2.3.1 Determination of vitamin A

Calorimetric method of AOAC [10] was used for vitamin A determination. This method measures the unstable color at the absorbance of 620 nm that result from the reaction between Vitamin A and SbCl_3 . Pyrogallo (antioxidant) were added to 2 g of the sample prior to saponification with 200 ml of alcohol potassium hydroxide. The saponification took place in water bath for 30 minutes. The solution was transferred to a separating funnel where water was added. The solution was extracted with 1.5 ml of hexane. The extract was washed with equal amount of water and filtered through filter paper containing 5 g anhydrous Na_2SO_4 into volumetric flask. The filter paper was rinsed with hexane. Then, hexane was evaporated from the solution and blank, this was followed by the addition of 1 ml chloroform and SbCl_3 solution to the oil and blank. The reading of the solution and blank was taken from the colorimeter adjusted to zero absorbance or 100 %.

Calculation:

Vitamin A (mg) = $A_{620\text{ nm}} \times \text{SLX (v/wt)}$.
 Where $A_{620\text{ nm}}$ = absorbance at 620nm
 SLX = slope of standard curve.
 V = final volume in colorimeter tube
 Wt = weight of sample.

3. RESULTS

The results of this study is presented in Tables 1 to 3.

4. DISCUSSION

The quality of vegetable oils was analyzed by evaluating their physico-chemical properties such as; density, acid value, peroxide, iodine and saponification value (as shown in Table 1). These parameters are very crucial in order to assess the quality and improved process of vegetable oils. The densities of the oils have values that are closely related to the standard range of 0.900-0.913g/cm³ approved by Nigeria Industrial Standards (NIS) [11]. There was no significant different ($p > 0.05$) among the samples 1 - 8 respectively. This is consistent with the findings of Badmos *et al.* [12] who reported a density value of 0.92 g/ml for vegetable oils commonly sold in Minna, Niger state. The result in this findings showed that the oil samples were less dense than water and therefore, could be useful in the manufacture of creams and related products as it will make the oil flow and spread easily on the skin. Oyeleke *et al.* [13] had earlier made similar assertion. 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 [14].

The acid values obtained for all samples were higher than the maximum value of 0.6 mg KOH/g max recommended by NIS [11] for edible oils. The result of our findings is comparably lower than the reported 8.20 mg KOH/g for edible oil sold in Niger state [12]. Acid value gives an indication of the quality of fatty acids in oils. Acid values for the samples are significantly different ($p < 0.05$) from one another with sample 4 having the highest value (1.58) and the lowest value (1.38) was recorded for sample 6. 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 [5]. Low acid value has been linked to be 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 [9]. Increase in 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 [9,15].

Table 1. Physicochemical properties of oil samples

Sample	Colour	Viscosity @ 40°C	Density (g/ml)	Acid value (mg KOH/g)	FFA	Iodine value (g I ₂ /100 g oil)	Peroxide value (meq O ₂ /kg)	Saponin value (mg KOH/g)
1	Yellow	43.6	0.8965	1.52	0.76	64.83	2.42	128.4
2	Yellow	41.8	0.8917	1.46	0.73	58.41	2.63	124.5
3	Yellow	42.7	0.9012	1.54	0.77	62.67	2.18	130.2
4	Yellow	41.3	0.8964	1.58	0.79	56.38	2.33	126.8
5	Yellow	44.6	0.8873	1.41	0.71	67.42	2.67	128.6
6	Yellow	40.9	0.8968	1.38	0.69	58.86	2.54	130.3
7	Yellow	43.4	0.9058	1.42	0.71	56.46	2.46	124.5
8	yellow	43.2	0.8896	1.46	0.73	68.13	2.28	122.4

Table 2. Cholesterol levels of oil samples

Sample	Cholesterol (mg/dl)
1	1.21±0.04
2	1.61±0.02
3	1.46±0.04
4	4.58±0.01
5	2.34±0.01
6	2.46±0.02
7	2.29±0.01
8	2.65±0.04

Values are means ± standard deviation

Table 3. Vitamin A levels of oil samples

Sample	Vitamin A (IU/g)
1	703.83±10.26
2	674.80±10.26
3	682.06±0.00
4	747.36±10.26
5	765.50±5.13
6	848.95±0.00
7	794.53±5.13
8	877.97±20.52

Values are means ± standard deviation

The iodine value obtained for the samples ranged from 56.38 g I₂/100g to 68.13 g I₂/100 g (oil). This is significantly higher than the reported 7.23 g I₂/100g for edible oils sold in Minna Niger state [12]. 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. Oils with iodine value less than 100 gI₂/100 g of oil are non-drying oils. It was reported by Aremu *et al.* [5] 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 found useful as raw materials in the manufacture of vegetable oil based ice cream [16].

Peroxide values obtained for the oil samples are within the range of 10 meq O₂/kg for any particular oil as specified by NIS [11]. 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 [17]. The peroxide value is the most common indicator of lipid oxidation. The results of this study showed the peroxide value to be ranged from 2.18 meqO₂/kg to 2.67 meqO₂/kg. High peroxide value is indication of high levels of oxidative rancidity of the oils and also suggests absence or low levels of antioxidant. Certain antioxidants maybe used to reduce rancidity such as propylgaldlate and butyl hydroxyl anisole [18].

The saponification values for the oil samples were lower than the stipulated range 245-255 mg KOH/g by NIS [11]. 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 [19]. Oil with high saponification value have been reported to contain high proportion of lower fatty acids [20].

Different varieties of vegetable oil brands in are being sold in the markets nowadays and all of them claimed to be cholesterol free. Cholesterol has been known as the 'oily killer' for decades, especially when several works have shown that it is the main cause of atherosclerotic lesions which are the major causes of coronary heart

disease [21,22]. As awareness of the health implications of high cholesterol in diets keeps increasing, most people now prefer to purchase cholesterol-free vegetable oils [23,24]. People consume different varieties of vegetable oils directly or as their food ingredients. From this study, it was evident that the vegetable oils had different cholesterol levels (table 2). The cholesterol levels of the vegetable oils in this study ranged from 1.21 ± 0.04 mg/dl to 2.65 ± 0.04 mg/dl. This value is considerably lower to 14.96 ± 0.39 mg/dl reported by Zelalem *et al* [25]. Dimberu *et al.* [26] reported that rapeseed oil contained significantly the highest cholesterol concentration (257.1 ± 0.42 mg/L) while branded palm oil has the least concentration (88.8 ± 0.85 mg/L) of cholesterol. The values obtained in the present investigations except for nigger seed oil (NG) are lower than the earlier reported values [26]. This finding contradicts the label claim by most of the producers of these vegetable oils. It is pertinent that oil producers and marketers should label their products correctly with the quantity of their cholesterol in the oil brand no matter how minute the quantity therein.

The vitamin composition of the vegetable oils is represented in table 3. From the result, it is shown that the vegetable oils are good sources of Vitamin A. Thus, they could provide adequate amounts of many vitamins for humans. The content of vitamin A in the sample ranged from 674.80 ± 10.26 IU/g to 877.97 ± 20.52 IU/g. Vitamin A is a fat-soluble vitamin and also comprises of a group of unsaturated nutritional organic compound. They have long been known to play a critical role in vision [27], gene expression [28], growth and immune function by its maintenance of epithelial cell functions [29]. Its deficiency has led to a wide variety of diseased conditions which ranges from xerophthalmia [30], conjunctiva xerosis [31] and keratomalacia [32].

5. CONCLUSION

This study has shown different physicochemical parameters, cholesterol and vitamin A content of edible vegetable oils commonly sold in Ado Ekiti metropolis. Some of the samples are not in line with the standards recommended by regulatory agencies. The result of cholesterol showed that most of the vegetable oils contained considerable quantity of cholesterol as against their label. Regulatory agencies are therefore called upon to ensure that they visit the manufacturers of these oils to ensure compliance

to regulations so as to avoid sales of products that will be detrimental to consumers' health.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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