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QUALITY EVALUATION OF SOME LABELED AND UNLABELED VEGETABLE OILS MARKETED IN UMUAHIA CITY, ABIA STATE, NIGERIA

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ABSTRACT

Due to higher market prices for labeled vegetable oils, many consumers are compelled to make do with unlabeled vegetable oils without any details about the manufacturers, where such oils are sourced or the oil quality. The aim of this study was to determine the quality of some labeled and unlabeled vegetable oils marketed in Umuahia and its environs. Vegetable oils used for this study were procured from Orie-Ugba market, Ahiaeke market and Market Square shopping mall, all in Umuahia, Abia State. All the oils were analyzed using standard methods. The physical properties of the oils showed significant ($p<0.05$) differences in the labeled and unlabeled oils results. The chemical results indicated the ranges of free fatty acid (0.28 - 1.42%), saponification value (188.53 - 261.11 mgKOH/g), acid value (0.57 - 2.83 mg KOH/g), iodine value (49.62 - 98.61gI/100g) and peroxide value (6.43 - 12.68mEq/kg). Significant ($p<0.05$) differences existed in the calcium, iron, vitamin A, vitamin E and cholesterol contents of the oils. The results of the physical, chemical, minerals and vitamins contents of the vegetable oils were inside of the regulators standards and so are nutritionally satisfactory. This study disproves the producers' and marketers' claim that the oil they produced is cholesterol-free with the exception of sunflower oil, soya oil, laziz oil, olive oil and activa oil.

Key words: Labeled vegetable oil, unlabeled vegetable oil, cholesterol-free, chemical properties, physical properties
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INTRODUCTION

Vegetable oils are oils extracted from seeds of plant or from other parts of fruits like palm oil, olive oil, soybean oil, canola oil, pumpkin oil, peanut oil, sesame oil, sunflower oil, etc. (Thomas, 2002). Vegetable oil refers exclusively to vegetable fats which are liquid at room temperature (Saroj *et al*., 2007). This oil is widely used for cooking of all kinds of food worldwide with general acceptability. Vegetable oil is estimated to have saturated fat of 14g, polyunsaturated fat of 33g, monounsaturated fat of 48g which is common in diet (Yanai *et al.,* 2015) and can undergo fortification to meet nutritional requirement which might have been lost during processing.

Vegetable oil functions as a heat transfer medium and contributes flavor and texture to food. Vegetable oils are composed of naturally occurring phytochemicals such as polyphenol, plant

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sterols and vitamin E which collectively affect color, flavor, aroma and nutrient value. The repeated use of cooking oil, changes its physical appearance, increases viscosity and darkens in color which alters the fatty acid composition (Kalogeropoulos *et al.,* 2007). Heating causes oil to undergo a series of chemical reactions like oxidation, hydrolysis and polymerization. Unlike the popular olive oil and coconut oil extraction method of cold pressing the ingredients to create the final product (Gunstone *et al.,* 2001), the process of production involves various techniques and stages depending on the oil type and desired properties. This diversity underscores the complexity and versatility of oil production in meeting diverse culinary and industrial needs. Vegetable oil is also an ingredient used in desserts, salad dressing kits, vegetarian and vegan-friendly foods, ready-to-go meals, and fried food recipes.

Some processing methods used by vegetable oil manufacturers can influence the characteristic of the commodity. Also, vegetable oil retailers frequently bare them to thermal energy, light and oxygen in the shops and marketplaces, and such inappropriate storage conditions causes rancidity and reduction of the quality. To hinder the beginning of rancidity and uphold greater stability, vegetable oils must be correctly packaged and stored in a cool dry place, safe from heat, light and oxygen. Displaying vegetable oils to the whims of weather makes them vulnerable to oxidation which can give grounds for the formation of oxidation products such as lipid peroxides and hydroperoxides (Ramachandra, 2000), thus making vegetable oils rich in polyunsaturated fatty acids to have a restricted storage life (Nataliya *et al.,* 2008).

Second to this is the deterioration of vitamin A, a micronutrient required in vegetable oils fortification program. Vitamin A plays an extremely important function in supporting healthy vision, neurological functions, reproduction, healthy skin, and must be taken in required quantities in order to meet the recommended daily intake. Vitamin A is also needed to increase the absorption of zinc and iron to meet the physiological necessities of the body. Vegetable oil components such as vitamins A and E, act as antioxidants which are capable of hindering some oxidative stress-related diseases (Oguntibeju *et al.,* 2010) and improving immunity.

In Umuahia City and its metropolis, vegetable oils are left uncovered to erratic weather conditions which make them susceptible to oxidation and spoilage. Furthermore, this exposure can lead to degradation of vitamin A which is a micronutrient that has been made compulsory in the vegetable oil fortification program. This research work will help to educate marketers of vegetable oil on the best methods of storing their products to maintain the quality of the products and prevent oxidation and spoilage. The result of this research will equally enlighten the people on the best oil to consume and the quality attributes of oils marketed in Umuahia city. The result will also show the extent to which the labeled and unlabeled vegetable oils sold in Umuahia City meet the vitamin A and E standards of the regulatory bodies (NAFDAC, SON, etc.). The objective of this study is to evaluate the quality of some labeled and unlabeled vegetable oils marketed in Umuahia city.

MATERIALS AND METHODS

SOURCES OF RAW MATERIALS

Vegetable oils (Activa oil, Laziz soya oil, Golden penny soya oil, Mamador oil, Casa De Campo refined sunflower oil, Chatura Valley 100% Olive oil, unbranded oil 1 and unbranded oil 2) used in the project work were procured from Orie-Ugba market, Ahiaeke market and

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Market Square shopping mall in Umuahia, Abia State. Sample analysis was carried out at Biochemistry Laboratory and Biotechnology Laboratory of National Root Crop Research Institute, Umudike.

Determination of Physical Properties of the Vegetable Oils

Refractive index: The method described by Onwuka (2018) was used. The refractometer (Laxco Handheld Analog, Thomas Scientific, USA) was adjusted with a light compensator. The oil sample was smeared on the lower prism of the instrument, closed, and illumination in the visible light range was passed by means of the angled mirror. The reflected light appeared in form of a dark background. Using the adjustment, the telescope tubes were moved in the cross-wire indicator and the refractive index read off.

pH: The process described by Onwuka (2018) was used to determine the pH of the oil. Ten gram (10g) of each oil was placed in a beaker and mixed thoroughly in a warring micro – blender. The pH was measured with INE-PHSJ-3F pH meter.

Specific gravity: The method described by Onwuka (2018) was used for the determination of specific gravity. Specific gravity is a dimensionless quantity that is defined as the ratio between the density of an object and a reference substance.

A 50ml pycnometer was thoroughly washed with detergent, water and petroleum ether, dried and weighed, then the bottle filled with water and weighed. After drying the bottle it was then filled with the oil sample and weighed.

$$\text{Specific gravity} = \frac{weight\ of\ Xml\ of\ oil}{weight\ of\ Xml\ in\ water}$$

Smoke point: The smoke point determination was done using the method reported by Onwuka (2018). A 10 ml of the oil sample was poured into an evaporating dish. A thermometer was then suspended at the centre of the dish ensuring that the bulb just dips inside the oil without touching the bottom of the dish, after which the temperature of the oil was raised gradually using a stove. The temperature in degree Celsius at which the oil sample gave off a thin bluish smoke continuously was noted as the smoke point.

Melting point: The melting point was done using Fisher-John melting apparatus as reported by Onwuka (2018). A little frozen oil was smeared on the heating plate of the Fisher-John melting apparatus and covered with the observation lens. The apparatus was switched on and the temperatures were observed at which the fat began to melt and when the little smear completely melts through an inserted thermometer.

Determination of Chemical Properties

Free fatty acid: The method described by Onwuka (2018) was used to determine the free fatty acid in oil. A mixture of 25ml diethyl ether with 25ml alcohol, 1ml phenolphthalein solution (1%) was carefully neutralized with 0.1m NaOH in a conical flask with 1g of the oil in the mixed neutral solvent and titrated with aqueous 0.1m NaOH and constantly shaken until a pink colour which persisted for 15 seconds was obtained.

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Acid value = $\frac{Titre(ml)\times 5.61}{weight\ of\ sample}$

Peroxide value: The method described by Onwuka (2018) was used to determine the peroxide value of the vegetable oils. A 1g sample of oil was weighed into a clean dry boiling tube and while still liquid one gram (1g) powder of potassium iodide was added to 20ml of solvent mixture (2 vol. glacial acetic acid + 1 vol. chloroform) and the tube was placed in boiling water and the liquid was allowed to boil vigorously for 30 seconds. The content was poured quickly into a flask containing 20ml of potassium iodide solution (50%). The tube was washed twice with 25ml water and titrated with 0.002M sodium thiosulphate solution using starch indicator, with the blank titration performed at the same time.

Peroxide value = $\frac{(b-a)\times 0.002x1000}{wt\ (g)of\ sample}$

Where: a = titre value, b = blank, 0.002 = normality of acid used

Iodine value: The method described by Onwuka (2018) was used to determine iodine value of the vegetable oils. A 2ml portion of oil was poured into a small beaker, 10ml of carbon tetrachloride was added to the oil and 20ml of Wij's solution. A stopper (previously moistened with potassium iodide solution) was inserted and allowed to stand in the dark for 30 minutes. A 15ml solution of potassium iodide (10%) and 100ml of water were added, thoroughly mixed, and titrated with 0.1M sodium thiosulphate solution using starch as indicator. A blank was carried out at the same time.

Iodine value = $\frac{(b-a)\times Nx12.69}{weight\ of\ sample}$

Where: a = titre value, b = blank, N = normality

Acid value: The method described by Nzelu *et al*. (2012) was used to determine the acid value. A 25ml of diethyl ether with 25ml of alcohol potassium hydroxide (KOH) and 1ml of phenolphthalein solution were mixed in a conical flask and neutralized with 0.1M NaOH. Then, 2g of the oil sample was dissolved in the mixed neutral solvent and titrated with aqueous NaOH and the warm mixture shaken constantly until a permanent pink colour which persisted for 15 seconds was obtained. The acid value was calculated as;

Acid value = $\frac{Titration\ (ml)x5.61}{Weight\ of\ sample}$

Saponification value: The Method described by Uzodinma *et al*. (2018) was used. Here, 2g of the oil was weighed into a 250ml conical flask and 25ml of 0.5M alcohol potassium hydroxide solution was added, and the flask heated in boiling water for 1h, and shaken frequently. A little volume (1ml) of phenolphthalein was added and the excess alkali titrated with 0.5N hydrochloric acid. The blank titration was carried out at the same time, and the saponification value was calculated as:

Saponification value = $\frac{b-a\times NX56.1}{wt(g)of\ sample}$

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Where: a = titre value, b = blank, N = normality

Determination of Vitamins

Vitamin A: The AOAC (2010) method using the colorimeter was adopted. This measures the unstable colour at the absorbance of 620nm that result from the reaction between vitamin A and SbL_3. Pyrogallol (antioxidant) was added to 2g sample prior to saponification with 200ml alcoholic KOH. 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 – 2.5ml of hexane. The extraction was washed with equal volume of water. The extract was filtered through filter paper containing 5g anhydrous Na_2SO_4 into volumetric flask. The filter paper was rinsed with hexane and made up to volume. The hexane was evaporated from the solution and blank. About 1ml chloroform and SbL_3 solution were added to the extract and blank. The reading of the solution and blank was taken from the colorimeter adjusted to zero absorbance or 100%.

Vitamin A = A620nm x SL x (V/Wt) Mg

Where: A620nm = absorbance at 620nm, SL = Slope of standard curve (Vit. A conc) + A620 reading, V = Final volume in colorimeter tube, Wt = Weight of sample

Vitamin E: Vitamin E was determined using the method described by Pearson (1976). One gram of the sample was weighed into a 100ml flask; 10ml of absolute alcohol and 20mls of M alcoholic tetraoxosulphate VI acid (H_2SO_4) were added. Ten milliliters of the clear solution was pipetted into a test tube and heated in a water bath at 90ºC for 3mins. This was allowed to cool. The absorbance was read in a spectrophotometer at 470nm wavelength.

$$\text{Vitamin E in Mg/100g} = \frac{a - b \times c}{s - b\ w}$$

Where: a = absorbance of test sample, b = absorbance of the standard solution, c = concentration of standard in mg/100g, w = weight of the sample used

Determination of Minerals

Iron: The iron content of the sample was determined by spectrophotometric method of Onwuka (2018). Five grams of the sample was first digested with 20 ml of acids mixture (650 ml concentrated HNO_3, 80 ml perchlonic acid and 20 ml concentrated H_2SO_4). The digest was diluted by making up to 100 ml with water. Two grams (2 g) of the sample solution was pipetted inside a flask before 3 ml buffer solution, 2 ml hydroquine solution and 2 ml bipyridyl solution were added. The absorbance reading was taken at wavelength of 520 nm and the blank was used to zero the instrument. Also, a standard solution of iron was prepared by dissolving 3.512 g of Fe $(NH_4)_2.$ (SO_4) $6H_2O$ in water and two drops of 0.5 N HCL were added and diluted to 500 ml with distilled water. The iron standard was further prepared at different concentration at 2 ppm to 10 ppm by diluting with distilled water. Three milliliters (3 ml) of buffer solution, 2 ml of hydroquinone solution and 2 ml of bipyridtyl solution were added. Absorbance reading was taken at 520 nm. The readings were used to plot a standard iron curve for extrapolation.

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Calcium: Calcium content of the vegetable oil samples were determined by the complexiometric titration method of Onwuka (2018). Twenty milliliters of each oil sample was dispersed into conical flask and treated with pinches of the masking agents (hydroxylamine hydrochloride, sodium cyanide and potassium ferrocyanide). The flask was shaken, and the mixture dissolved. A 10 % NaOH was added to it to raise the pH to 10.00. The mixture was titrated against 0.02N EDTA solution using solechrome dark blue indicator. A reagent blank was also titrated and titration in each case was done from deep red to a permanent blue end point. Total calcium content was calculated using the formula:

$$\mathrm{Ca} = \frac{100}{\mathrm{W}} \mathrm{x} \frac{\mathrm{T} - \mathrm{B}\ (\mathrm{N}\ \mathrm{x}\mathrm{Ca})}{\mathrm{Va}} \mathrm{x} \frac{\mathrm{Vf}}{1}$$

Where: W=Weight of sample, T = Titre value of sample, B = Titre value of blank, Ca = Calcium equivalence, Va = Volume of extract titrated, Vf = Total volume of extract, N=Normality of titrant (0.02N EDTA).

Test for Cholesterol Content

The method described by Ojiako and Akubugwo (1997) was employed. Approximately 0.1 ml of each oil sample and standard cholesterol dissolved in chloroform in ratio 1:10 was evaporated to dryness in a water bath at 50^0C. Glacial acetic acid (3.0ml) and 3.0ml of colour reagent (a solution of ferric chloride/glacial acetic acid/sulphuric acid), was added to each sample and the standard, then shaken vigorously to dissolve the oil. Blank contained 2.oml of chloroform, 3.0ml glacial acetic acid and 3.0ml of colour reagent. After cooling for 30 min at room temperature, absorbance of standard and samples were read at 560nm. Cholesterol content was estimated with the formula:

Cholesterol mg100mL = AB/AS x CS

Where: AB = Absorbance of oil sample, AS = Absorbance of Standard cholesterol, CS = Concentration of Standard cholesterol.

Statistical Analysis

The experimental design used in this work was Completely Randomized Design (CRD). The data obtained were subjected to Analysis of Variance (ANOVA) using SPSS (Statistical Package for Social Sciences) Version 22.0. Treatment means were separated using Duncan multiple range test at 95% confidence level.

RESULTS AND DISCUSSION

Physical Properties of the Vegetable Oils

The result of the physical properties of the labeled (branded) and unlabeled (unbranded) vegetable oil samples is presented in Table 1 and they showed significant ($p<0.05$) differences. The pH of the vegetable oils ranged from 6.39 to 6.68 with the highest value (6.68) recorded

for laziz soya and olive oil, while the lowest value (6.39) was recorded for mamador oil. There were no significant (P>0.05) differences in pH of laziz soya oil and olive oil as well as between mamador oil and unbranded oil 1. The values of pH observed in this study were slightly higher than the values (4.63 to 5.17) for olive oil stored at room temperature (Ashokkumar *et al*., 2018). The differences in values could be attributed to the differences in treatment meted on them. The pH is a measure of the degree of acidity or alkalinity on a logarithmic scale (Karastogianni *et al*., 2016). The oil samples were weakly acidic, which suggests that they contained low quantities of free fatty acids. High quantity of free fatty acids is undesirable in vegetable oils because they can reduce the palatability and shelf life of the oil (Nkafamiya *et al*., 2010). The pH is also useful in evaluating the stability of vitamin A in oil, because vitamin A can be quite unstable at pH value less than 4.5.

Refractive density of the vegetable oil samples ranged between 0.90 and 0.93. There was no significant difference (P>0.05) between sunflower oil, laziz oil, unbranded oil 2 and olive oil and also between soya oil and activa oil. The values obtained in this study correspond to the previous studies by Sahasrabudhe *et al*. (2017) who reported the density of soybean oil at room temperature as 0.9157 and Tulcan *et al*. (2008) who reported values of 0.922 and 0.920 as the refractive density of soybean oil at 15°C and 20°C respectively. Refractive density is an important factor that influences oil absorption.

The refractive indices of the various vegetable oils vary between 0.89 and 0.93. The refractive index values obtained in this study were lower than values (1.453 to 1.478) earlier reported by Wazed *et al*. (2023) for edible oils at room temperature and after heating at high temperature. The variation could be due to the varietal differences. The values obtained for refractive index of the oil sample in this study were good as high refractive index increases the degree of unsaturation (Bello *et al*., 2012). Refractive index is an indicator of the degree of purity of the oil. It is a parameter that relates to molecular weight, fatty acid chain length and degrees of unsaturation and conjugation (Yousefi *et al*., 2013). The refractive index of fats and oils is sensitive to their composition and it is an excellent spot test for uniformity of compositions of oils and fats (Fakhri and Qadir, 2011).

The melting point ranged from 0.00 – 26.25°C and was lower than (32.65 - 36.50°C) and (36.7 to 48.3°C) reported respectively by Ndife *et al*. (2019) and Norizzah *et al*. (2014) on melting point of palm oil samples and different palm oil fractions after interesterification respectively. The melting point was also lower than 41 to 48°C reported by Akinola *et al*. (2010) on palm oil from different palm oil local factories in Nigeria. Changes in melting characteristics of oils are generally due to redistribution of the fatty acid chains within the 1,2,3-propantriol molecules (Bannie and Choo, 2000). However, among all the oil samples analyzed melting point were detected only in mamador oil and unbranded oil 1.

There was significant (P<0.05) difference in the smoke point of oil samples which ranged between 126.25°C and 273.25°C. The values recorded in this study were higher than (118.55 – 129.35 °C) reported by Ndife *et al*. (2019) on smoke point of palm oil samples. The highest smoke point (273.25°C) was recorded for soya oil, while the least (126.25°C) was found in unbranded oil 1. The smoke point is the temperature at which a fat or oil produces a continuous

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wisp of smoke when heated. According to Sarwar *et al*. (2016), the smoke point of cooking oil must be at least 170^{o}C, while SON (2000) gave the maximum standard for frying temperature at 200^{o}C. This suggests that all the oil samples analyzed in the present study were above this value with the exception of the unbranded oil 1 which had a smoke point < 170^{o}C. The high smoke point of the vegetable oil samples indicates that the oils were properly refined, can resist ignition at high temperatures and are suitable for deep fat-frying. The smoke point gives an indication of the thermal stability of the free fatty acids in oils.

Fire point of the oil samples ranged from 185.65 to 305.55°C. There was significant (P<0.05) difference in all the oil samples. The highest value (305.55°C) was observed in soya oil sample, while the least value (185.65°C) observed in unbranded oil 1 sample. The values obtained in this study were higher than the value (220.55^{o}C) reported by Ndife *et al*. (2019) for the fire point of palm oil. This could be attributed to the varietal differences.

Chemical Characteristics of the Oil Samples

The result of the chemical characteristics of the vegetable oil samples is presented in Table 2 and they exhibited significant (p<0.05) differences. The free fatty acid (FFA) content of the vegetable oil samples in this study ranged from 0.28 to 1.42% with the highest value (1.42%) recorded for unbranded oil 1, while soya oil and olive oil had the least value of 0.29% respectively. No significant (p>0.05) difference existed between soya oil and olive oil. The values for free fatty acid observed in this study compare favorably with the values (0.28 to 0.29%) reported by Eke-Ejiofor *et al*. (2021) for free fatty acids of soybean oil from four varieties. Free fatty acids are one of the impurities in crude oils which shorten their shelf life by stimulating oxidative rancidity and also darkening of the oils (Chompoo *et al*., 2019). The values obtained are lower than the maximum allowable limit of 0.6% stipulated by Codex (1999). The values shows that all the vegetable oils except the unbranded oil 1, mamador oil and active oil were within the maximum allowable limit, as oils with lower content of free fatty acids are less prone to hydrolytic rancidity (Eke-Ejiofor *et al*., 2021). Deterioration of fat leads to the liberation of free fatty acids (FFA) from triglycerides. The amount of free fatty acid (FFA) in a fat or oil is indicative of its level of spoilage (Ekwenye, 2006).

Acid value (AV) of the samples ranged from 0.57 to 2.83 mg KOH/g. It was observed that the unbranded oil 1 had the highest acid value (2.83 mg KOH/g) among all the oil samples and unbranded oil 2 had the lowest value (0.57 mg KOH/g). There was no significant (P>0.05) difference in acid value between soya oil and olive oil. Higher acid value recorded for unbranded oil1 implies the lower quality of the oil, and its vulnerability to go rancid (Quader *et al*., 2018). Acid value represents the mg KOH required to neutralize the free fatty acid in 1 g of oil. Therefore, the acid value is a good indicator of oil degradation caused by hydrolysis or enzymes (Othman and Ngaasapa, 2010). The distinction of acid value in our study could be due to variance in moisture contents as well as the alteration in the refining and deodorization technologies (Wazed *et al*., 2023). Acid value is used as an indicator for edibility of oil and suitability for use in the paint industry (Akubugwo *et al*., 2008).

The iodine values (IV) obtained for the oil samples ranged from 49.62 to 98.61 mg/100g. There was significant (P<0.05) difference in iodine values of the samples. The highest value

(98.611mg/100g) was recorded in unbranded oil 1, while sunflower had the least value of 49.621mg/100g. These values were within allowable limit of 45g/100g recommended for oil by Codex (2011). Oils and fats do not contain iodine, but iodine value measures the amount of iodine that can be absorbed by unsaturated fatty acids. The higher the iodine value of oil, the greater its degree of unsaturation (Potter and Hotchkiss, 1995). Iodine value is a measure of the degree of unsaturation of the oils (Chuayjuljit *et al*., 2017). The iodine value is a therefore, a measure of fat stability and resistance to oxidation (Onimawo and Akubor, 2012).

There was significant ($P<0.05$) difference in the saponification value (SV) of the oil samples which ranged from 188.53 to 261.11 mgKOH/g. Unbranded oil 1 recorded the highest SV (261.11 mgKOH/g) while soya oil had the lowest (188.53 mgKOH/g). The saponification value of oil increases with reduction in the average molecular weight of the oil (Akinola *et al*., 2010). Saponification value of oils is the measurement of the number of mg of KOH needed to saponify one gram of the oil (Onwuka, 2018). Saponification value is an indication of the molecular weights of triglycerides of oils. High saponification value indicates high proportion of low fatty acids, since saponification value is inversely proportional to the average molecular weight or length of fatty acids (Muhammad *et al*., 2011). The saponification value gives information with regard to the solubility in water and soap formation (Akinola *et al*., 2010). Unbranded oil 1 has a relatively high saponification value due to its high content of short and medium chain triglycerides (Gopala *et al*., 2010). All the oils had SV which compared well with CODEX (2011) standard of 248 to 265 mgKOH/g of oil.

The peroxide value (PV) of the oil samples recorded significant ($P<0.05$) differences and they ranged from 6.43 to 12.68mEq/kg. The unbranded oil 1 had the highest value of 12.68mEq/kg, while unbranded oil 2 had the least value of 6.43mEq/kg. Peroxide value (PV) is the most common indicator of lipid oxidation, rancidity level of fats and oils and is also used for the prediction of the quality and stability of oils (Nangbes *et al*., 2013).. It is a measure of the peroxides contained in oil. High peroxide value suggests low level of antioxidants in the oil and progressive oxidative rancidity (Aremu *et al*., 2015). Oxidative rancidity is associated with the degradation of fats/oils by oxygen in the air via a free radical process, in which the double bonds of an unsaturated fatty acid can undergo cleavage, releasing volatile aldehydes. It can be suppressed by the exclusion of oxygen or by the addition of antioxidants (Nzewi and Uzomba, 2011). Fresh oils have peroxide values lower than 10 mEq/kg, and before oil becomes rancid, its peroxide value must be between 20 and 40 mEq/kg (Akubugwo and Ugbogu, 2007). The lower values of peroxide recorded for unbranded oil 2, sunflower oil, active oil, laziz oil and soya oil implied that they are less susceptible to rancidity (Brien, 2004). The results revealed that unbranded oil 1 is not a good oil, since its peroxide value is above the standard limit of 10 mEq/kg.

Mineral, Vitamin and Cholesterol Content of the Oil Samples

The mineral, vitamin and cholesterol composition of the oils are shown in Table 3 below. The results demonstrated that significant differences ($P<0.05$) existed between the samples in all the parameters.

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The results obtained for calcium of the oil samples ranged from 0.36 – 1.61mg/100g. It was observed that soya oil had the highest calcium value of 1.61mg/100g, while mamador oil had the least calcium value of 0.36mg/100g. The values in this present study differ from the previous values (5.33 to 6.47mg/100g) reported by Aladekoyi *et al*. (2019). The variations observed in these results could be as a result of the varietal differences in the oils. Calcium is needed for the formation and maintenance of bones, the development of teeth and healthy gums. It has a natural calming and tranquilizing effect and is necessary for maintaining a regular heartbeat and the transmission of nerve impulses. It is necessary for blood clotting, stabilizes many body functions and is thought to assist in preventing bowel cancer (Attieh, 1999).

The results obtained for iron of the oil samples ranged from 0.15 to 1.32mg/100g. It was observed that soya oil had the highest iron value of 1.32mg/100g, while unbranded oil 1 had the least iron value of 0.15mg/100g. The values in this present study were slightly higher compared to the previous values (0.07 to 0.15mg/100g) reported by Ndife *et al*. (2019) for calcium content of palm oil samples. The variation in these results could be as a result of the different varieties and processing methods. The disadvantage of the presence of the metals in oil is that they could catalyse rancidity reactions (Ndife *et al*., 2019). However adequate Fe and Zn in the diet are very essential for abasing disease conditions (Wardlaw, 2004).

There were significant ($P<0.05$) differences in the vitamin content of the oil samples. Vitamin A levels were in the range of 0.04 – 0.23µg/g and these values were lower compared to the range of values (49.61 – 60.21mg/100g) earlier reported by Ndife *et al*. (2019) for vitamin content of palm oil samples. It was observed that vitamin A content of the unbranded oil1 and mamador oil was significantly ($P<0.05$) higher compared to the other oil samples analyzed. There was no significant ($P>0.05$) difference in vitamin A level of soya oil and laziz oil, and also between the unbranded oil1 and mamador oil. Vitamin A promotes skeletal growth, normal tooth structure, healthy membrane, healthy skin, eyes and hair, it is also crucial for night vision (Rakhi and Punia 2013). Studies have shown that over 34 - 69% of childhood blindness in Nigeria is caused by corneal opacity, which results mainly from an interplay of vitamin A deficiency, measles and harmful traditional eye practices (Rabiu and Kyari, 2002). However, vitamin A deficiency which manifests in the eye as xerophthalmia is the dominant problem in these children (Rabiu and Kyari, 2002).

The results obtained for vitamin E of the oil samples ranged from 0.27 to 1.23mg/100g. It was observed that soya oil had the highest vitamin E value of 1.23mg/100g, while unbranded oil 1 had the least vitamin E. There was no significant ($P>0.05$) difference in vitamin E content of sunflower and olive oil. The values in this present study were lower compared to the values (13.82 to 16.22mg/100g) reported by Ndife *et al*. (2019) for vitamin E content of palm oil samples. Vitamin E helps in the protection from oxidation by free radicals (Ndife, 2016).

The results obtained for cholesterol level of the oil samples ranged from 0.00 to 3.96 mg/L. It was observed that unbranded oil1 had the highest cholesterol level of 3.96mg/100g followed by unbranded oil 2 with a cholesterol level of 0.27mg/100g. No cholesterol was detected in sunflower, soya oil, laziz oil, olive oil and activa oil. Higher values of cholesterol (66.187 to

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330.340 mg/L) were reported by Bereket *et al*. (2017) for cholesterol content of some selected edible oils. The values obtained in this present study were also lower than the values (88.8 to 257.1mg/L) reported earlier by Dimberu *et al*. (2011). Cholesterol has been known as the 'oily killer' since the early-mid 60s, especially since several works showed that it is the main cause of atherosclerotic lesions which are the major causes of coronary heart disease (Okpuzor *et al*., 2009). Due to increasing awareness of the health implications of high cholesterol in our diets, most people now prefer to purchase cholesterol-free vegetable oils (Attarde *et al*., 2010).

CONCLUSION

The quality of some labeled (branded) and unlabeled (unbranded) vegetable oils marketed in Umuahia city, Abia State, Nigeria, have been analyzed and compared. The values obtained for the physical, chemical, minerals, vitamins and cholesterol contents of the different oil samples met the regulators standards and are therefore nutritionally satisfactory. The vegetable oils pose no significant health risks to the consumers. This study shows that the branded oils analyzed (sunflower, soya, laziz, olive and activa) are cholesterol-free, while the unbranded 1 and unbranded 2 oils contain little cholesterol. This study provides supportive information for quality monitoring of edible vegetable oils that are used for foodstuff. Furthermore, the high saponification value and low iodine value in the oils show that the oils are of good nutritional value, have good quality and could be recommended as suitable for cooking and for industrial applications. Further studies should be carried out on the effects of natural and artificial preservatives, storage conditions and packaging materials on the shelf stability of the oils.

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Table 1: Physical Properties of the Vegetable Oils

Sample	pH	Refractive Density	Refractive Index	Melting Point (°C)	Smoke Point (°C)	Fire Point (°C)
Sunflower Oil	6.53^{c}±0.02	0.93^{a}±0.00	1.45^{c}±0.00	0.00^{c}±0.00	261.85^{d}±0.07	284.30^{f}±0.28
Soya Oil	6.63^{b}±0.01	0.92^{b}±0.00	1.47^{a}±0.00	0.00^{c}±0.00	273.25^{a}±0.21	305.55^{a}±0.21
Laziz Soya Oil	6.68^{a}±0.01	0.93^{a}±0.00	1.47^{a}±0.01	0.00^{c}±0.00	270.35^{b}±0.21	302.65^{b}±0.21
Unbranded Oil 2	6.51^{cd}±0.01	0.93^{a}±0.00	1.47^{a}±0.00	0.00^{c}±0.00	236.25^{f}±0.21	285.35^{e}±0.35
Olive Oil	6.68^{a}±0.01	0.93^{a}±0.00	1.47^{a}±0.00	0.00^{c}±0.00	267.20^{c}±0.14	298.30^{d}±0.14
Activa Oil	6.49^{d}±0.00	0.92^{b}±0.00	1.46^{b}±0.00	0.00^{c}±0.00	256.25^{e}±0.21	300.40^{c}±0.41
Mamador Oil	6.39^{e}±0.01	0.89^{d}±0.00	1.46^{b}±0.00	22.25^{b}±0.21	192.20^{g}±0.14	201.30^{g}±0.28
Unbranded Oil 1	6.41^{e}±0.01	0.90^{c}±0.00	1.45^{c}±0.00	26.25^{a}±0.07	126.65^{h}±0.21	185.65^{h}±0.07

Values are means of duplicate determination ±SD. Means having the same letter within a column are not significantly different ($p< 0.05$).

Table 2: Chemical Properties of the Oil Samples

Sample	FFA (%)	AV (mgKOH/g)	IV (mg/100g)	SV (mgKOH/g)	PV (mEq/kg)
Sunflower Oil	0.35^{d}±0.01	0.71^{d}±0.01	49.62^{h}±0.02	197.83^{d}±0.03	6.97^{g}±0.01
Soya Oil	0.29^{ef}±0.00	0.59^{ef}±0.01	89.11^{e}±0.01	188.53^{h}±0.02	8.38^{c}±0.01
Laziz Soya Oil	0.31^{e}±0.01	0.61^{e}±0.01	90.45^{d}±0.02	189.12^{g}±0.03	67.82^{e}±0.02
Unbranded Oil 2	0.28^{f}±0.00	0.57^{f}±0.01	53.21^{g}±0.01	197.62^{e}±0.02	6.43^{h}±0.03
Olive Oil	0.29^{ef}±0.00	0.58^{ef}±0.01	91.65^{c}±0.02	192.83^{f}±0.02	8.23^{d}±0.03
Activa Oil	0.71^{c}±0.01	1.41^{c}±0.01	54.14^{f}±0.02	198.63^{c}±0.03	7.13^{f}±0.01
Mamador Oil	0.99^{e}±0.01	1.97^{b}±0.01	94.82^{b}±0.02	259.72^{b}±0.03	10.13^{b}±0.02
Unbranded Oil 1	1.42^{a}±0.02	2.83^{a}±0.04	98.61^{a}±0.01	261.11^{a}±0.01	12.68^{a}±0.01

Values are means of duplicate determination ±SD. Means having the same letter within a column are not significantly different ($p<0.05$).

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Table 3: Mineral, Vitamin and Cholesterol Content of the Oil Samples

Sample	Iron (mg/100g)	Calcium (mg/100g)	Vitamin A (µg/g)	Vitamin E (mg/100g)	Cholesterol (mg/L)
Sunflower Oil	0.73^{d}±0.02	1.45^{c}±0.03	0.08^{cd}±0.01	0.74^{c}±0.01	0.00^{d}±0.00
Soya Oil	1.32^{a}±0.02	1.61^{a}±0.01	0.14^{b}±0.14	1.23^{a}±0.01	0.00^{d}±0.00
Laziz Soya Oil	1.27^{b}±0.01	1.55^{b}±0.01	0.16^{b}±0.02	1.18^{b}±0.02	0.00^{d}±0.00
Unbranded Oil 2	0.52^{e}±0.01	1.21^{e}±0.01	0.05^{de}±0.00	0.62^{d}±0.01	0.45^{c}±0.03
Olive Oil	0.48^{f}±0.01	1.38^{d}±0.01	0.10^{c}±0.00	0.77^{c}±0.01	0.00^{d}±0.00
Activa Oil	1.21^{c}±0.00	1.07^{f}±0.00	0.04^{e}±0.00	0.52^{e}±0.02	0.00^{d}±0.00
Mamador Oil	0.25^{g}±0.02	0.36^{h}±0.01	0.21^{a}±0.01	0.34^{f}±0.02	1.15^{b}±0.01
Unbranded Oil 1	0.15^{h}±0.01	0.47^{g}±0.02	0.23^{a}±0.07	0.27^{g}±0.02	3.96^{a}±0.02

Values are means of duplicate determination ±SD. Means having the same letter within a column are not significantly different ($p< 0.05$).