Nutritional and Physicochemical Qualities of Branded and Unbranded Vegetable Oils: Implications for Consumer Safety and Public Health

Achonwa-Njemanze U. O.[1], Ajayi K.[1], Tobiloba T. D.[1,4], Abiola O. O.[2], and Samuel O. O.[3]

[1]*Department of Human Nutrition and Dietetics, Afe Babalola University, P.M.B 5454, Olusegun Obasanjo Way, Ado-Ekiti, Ekiti State.*
[2]*Department of Pharmaceutical Microbiology and Biotechnology, College of Pharmacy, Afe Babalola University, Ado-Ekiti, Ekiti State, Nigeria.*
[3]*Department of Clinical Pharmacology and Clinical Pharmacy, Bogomolets National Medical University, Kyiv, Ukraine.*
[4]*Department of Food Science and Technology, Bamidele Olumilua University of Education Science and Technology, P.M.B. 250 Ikere-Ekiti, Nigeria.*

***Corresponding author:** ajayikayode@abuad.edu.ng **Phone number:** +2348066287477

ABSTRACT

Background: *A large proportion of edible vegetable oils (EVOs) in the Nigerian market are unbranded, raising concerns about quality, safety, and potential health risks associated with consumption.*
Objective: *This study compared the physicochemical quality, nutritional composition, and microbial safety of branded soya oil, branded olive oil, and unbranded vegetable oil purchased from a local market in South-West Nigeria.*
Methodology: *A total of nine samples (three 250 mL bottles per oil type) were randomly purchased from retail outlets. Standard AOAC methods were used to determine fatty acid composition, moisture, colour, relative density, refractive index, acid value (AV), peroxide value (PV), iodine value (IV), vitamin A, iron (Fe), copper (Cu), and microbial load. Data were analysed using descriptive statistics, independent t-test, and ANOVA at $p = 0.05$.*
Results: *Total fat ranged from 74.86 ± 0.01 to 91.86 ± 0.06 g/100 g. Soya oil showed the highest monounsaturated and polyunsaturated fatty acids, while unbranded oil had the lowest values. Olive oil had the highest moisture (3.33%) and vitamin A content (73.48 ± 0.02 µg/100 g), whereas soya oil recorded the lowest moisture (0.36%) and the lowest microbial load (2.65×10^3 CFU/g). Acid value, peroxide value, and iodine value ranged from 1.20 to 3.00 mg KOH/g, 3.16 to 13.35 meq/kg, and 47 to 112 g I_2/100 g, respectively. Unbranded oil contained the highest iron level (0.12 mg/100 g).*
Conclusion: *Consumption of poorly processed unbranded oils may increase exposure to oxidative degradation products and microbial contamination, posing potential health risks.*

Keywords: Edible vegetable oil, Quality assessment, Branded oil, Unbranded oil, Microbial safety

Doi: https://dx.doi.org/10.4314/njns.v47i2.11

INTRODUCTION

Edible vegetable oils are an important part of the human diet due to their sensory properties, energy contribution, and role as carriers of fat-soluble vitamins. They also provide essential fatty acids and serve as precursors for steroid hormones and prostaglandin synthesis (1). Structurally, vegetable oils consist of glycerol molecules esterified with three fatty acid chains, which may be either saturated or unsaturated (2). The nutritional quality of vegetable

oils is largely influenced by the configuration of their fatty acids. Oils containing fatty acids in the cis configuration are considered nutritionally beneficial, whereas partial hydrogenation can convert cis fatty acids to trans fatty acids, which are associated with adverse effects on serum lipoproteins and an increased risk of coronary heart disease (2). In vegetable oil the glycerol molecule is attached to three fatty acid chains of unsaturated and saturated fatty acids (3).

Vegetable oils and fats containing fatty acids in the cis configuration are nutritionally important because they are associated with improved lipid metabolism and overall cardiovascular health. However, during partial hydrogenation of fats and oils, some cis fatty acids are converted into trans fatty acids, which have been reported to exert adverse effects on human serum lipoproteins by increasing low-density lipoprotein (LDL) cholesterol and reducing high-density lipoprotein (HDL) cholesterol, thereby increasing the risk of coronary heart disease (4,5). Trans fats are also linked to systemic inflammation and endothelial dysfunction, further contributing to cardiovascular complications.

There is increasing evidence that dietary fatty acids play a crucial role in human nutrition beyond energy provision. They are involved in the therapeutic and preventive management of diseases, as well as in growth and development processes, including foetal development, brain function, and cognitive health. In addition, they contribute to protection against several chronic diseases such as cardiovascular disorders, metabolic syndrome, and inflammatory conditions (6). Dietary fatty acids also play a major role in cholesterol homeostasis and lipid metabolism, influencing the risk profile for cardiovascular diseases (CVD) (7,8). Non-communicable diseases (NCDs) are currently the leading cause of death globally, with cardiovascular diseases representing the largest proportion, accounting for approximately 17.9 million deaths annually (9).

Branded Vegetable Oil (BVO) refers to edible vegetable oils produced by registered industries and packaged under identifiable brand names for sale in the open market. In contrast, unbranded vegetable oil (UVO) refers to locally produced or loosely processed vegetable oils that are sold without proper branding or standardized labelling (10). Vegetable oils are derived from a variety of plant sources, including coconut, cottonseed, groundnut, maize germ, mustard seed, palm kernel, sesame seed, soya bean, and sunflower seeds, and their nutritional quality varies depending on the source and processing method. A large proportion of vegetable oils in the global market are unbranded, particularly in developing countries. The fatty acid composition of such unbranded oils is often unknown due to lack of standardization and quality control, and their potential health impacts remain insufficiently characterised (11). This raises concerns regarding their safety, nutritional adequacy, and susceptibility to adulteration or contamination.

In Nigeria, concerns have been raised about the consumption of unbranded vegetable oils, which has been associated with increased risk of cardiovascular diseases due to poor processing and storage conditions. In addition, exposure to improperly handled oils has been linked to potential carcinogenic risks, largely attributed to questionable transportation, packaging, and distribution practices (12).

MATERIALS AND METHODS

Materials

Samples of three different varieties of vegetable oils, branded soybean oil and olive oil (commercially packaged imported products), and unbranded locally produced oil were purchased from a local market in Ado-Ekiti. Equal quantities of 1L each of each oil type were collected for analysis. The oils were selected based on their widespread availability and consumption within the study area. Soya oil and olive oil were obtained from soybean (*Glycine max*) and olive (*Olea europaea*) sources, respectively, while the botanical source of the unbranded oil could not be confirmed because of the absence of labeling and production information. The inclusion of the unbranded oil enabled comparison of the quality attributes of commercially branded oils with those of locally marketed unbranded oil.

Determination of Fatty Acid Composition

The oil samples were accurately weighed and dissolved in 20 mL of benzene to facilitate the extraction and preparation of fatty acid derivatives. The mixture was transferred into a separatory funnel, and 2 mL of 10% copper acetate solution was added to form copper–fatty acid complexes. The mixture was shaken thoroughly and allowed to separate into distinct layers, after which the organic layer containing the complexes was collected for analysis. Standard solutions of individual fatty acids were similarly prepared by reacting known concentrations with copper acetate under the same conditions. The absorbance of the resulting complexes was measured using a spectrophotometer at their respective characteristic wavelengths as

follows: lauric acid (620 nm), myristic acid (625 nm), caprylic acid (615 nm), capric acid (618 nm), palmitic acid (630 nm), stearic acid (635 nm), palmitoleic acid (640 nm), oleic acid (645 nm), linoleic acid (650 nm), arachidonic acid (655 nm), behenic acid (660 nm), erucic acid (665 nm), and lignoceric acid (670 nm). The concentration of each fatty acid in the oil samples was then determined by comparing sample absorbance with the standard calibration curves.

Determination of Vitamin A

A mixture of 2g of each sample was weighed, and distilled water and alcoholic KOH solution were added. The mixture was heated in a boiling water bath for 1 hour. The hydrolysate was extracted three times with chloroform, and anhydrous Na2SO4 was added to remove any traces. After heating, the mixture was allowed to cool to room temperature. The hydrolysate was then transferred into a separating funnel and extracted three times with chloroform to recover the unsaponifiable fraction. The combined chloroform extracts were dried over anhydrous sodium sulfate to remove residual moisture. A standard β-carotene (vitamin A) solution was prepared by dissolving 0.003 g of β-carotene in chloroform. The absorbance of both the standard and sample extracts was measured using a spectrophotometer at 328 nm against chloroform as a blank, and vitamin A content was estimated by comparison with the standard calibration curve.

Determination of Microbial Contamination

A 1g portion of finely ground sample was placed in a sterilized McCartney bottle with 9ml of sterile distilled water and mixed thoroughly to form a homogeneous suspension. This suspension was serially diluted (10^{-1} to 10^{-6}), and 1ml from each dilution was plated on Nutrient Agar. The plates were incubated at 28°C for six days using a Gallenkamp incubator. After incubation, mold growth was observed and identified using stereoscopic and compound microscopes. The developed colonies were counted using a Quebec Colony Counter.

Determination of Moisture Content

Approximately 5–10 g of thoroughly mixed oil or fat sample was weighed into a previously dried and tared dish. The dish was placed in an oven and heated at 105 ± 10 °C for 1 hour with the lid slightly loosened to allow moisture escape. After heating, the dish was removed, closed immediately, and cooled in a desiccator containing phosphorus pentoxide as a desiccant. The dish was then weighed. Drying, cooling, and weighing were repeated at 1-hour intervals until a constant mass was achieved, defined as a difference not exceeding 1 mg between two successive weighings. The loss in mass after drying was recorded as the moisture content of the oil/fat sample.

Determination of the Refractive Index

A few drops (1–2 drops) of the oil sample were placed on the lower prism of the refractometer, and the prism was closed to ensure uniform spreading of the sample film. The instrument was connected to a thermostatically controlled circulating water bath and allowed to equilibrate for approximately 10–15 minutes to achieve a stable measurement temperature. The temperature was maintained at 20 ± 0.1 °C throughout the analysis. After equilibration, the refractive index reading was taken by adjusting the mirror and focusing system until a sharp boundary line was obtained. The value was read directly from the calibrated scale once a clear and stable interface between light and dark fields was observed. If an indistinct boundary was observed, the prism surfaces were cleaned, and the sample was reapplied to ensure even distribution.

Care was taken to ensure that the sample fully covered the prism surface without air bubbles, the prisms were properly closed to prevent leakage, and the temperature remained constant during measurement, as fluctuations in temperature can significantly affect refractive index values. Each sample was measured in triplicate, and the average value was recorded as the final refractive index.

Determination of Colour

The method determines the colour of oils by comparison with Lovibond glasses of known colour characteristics. The colour is expressed as the sum total of the yellow and red slides used to match the colour of the oil in a cell of the specified size in the Lovibond Tintometer.

Determination of Acid Value

The oil samples were thoroughly mixed to ensure homogeneity, and 5.00 g of each sample was accurately weighed into a 250 mL conical flask. To this, 50 mL of freshly neutralized hot ethyl alcohol and 1 mL of phenolphthalein indicator solution were added. The mixture was boiled gently for exactly 5 minutes to ensure complete dissolution of free fatty acids in the alcoholic medium. While still hot, the solution was titrated against standardized potassium hydroxide solution with continuous vigorous shaking until a faint but permanent pink endpoint persisted for at least 30 seconds. The volume of alkali used was recorded directly from the burette reading at the endpoint. Each sample was

analysed in triplicate, and the average titre value was used for calculations.

The acid value (or related parameter depending on your study objective) was then calculated based on the exact weight of oil (5.00 g) and the concentration and volume of alkali used, ensuring that the titre value did not exceed 10 mL for accuracy and precision, as recommended in standard oil and fat analytical procedures.

Determination of Iodine Value

The iodine value of the oil samples was determined using the Wijs method. A 5.00 g portion of each oil sample was accurately weighed and dissolved in carbon tetrachloride. To this solution, a known excess of iodine monochloride (Wijs solution) was added. Exactly 5.0 mL of Wijs solution was pipetted into a 500 mL Erlenmeyer flask containing 150 mL of saturated chlorine water and a few glass beads to ensure smooth boiling. The mixture was heated to boiling and maintained under brisk boiling for 10 minutes, after which it was cooled to room temperature.

Subsequently, 30 mL of diluted sulfuric acid (H_2SO_4, 1:49) and 15 mL of 15% potassium iodide (KI) solution were added. The liberated iodine was immediately titrated with 0.1 N sodium thiosulfate ($Na_2S_2O_3$) until the yellow colour became pale, followed by the addition of starch indicator, and titration continued until the endpoint (colourless solution) was reached. The titre values were recorded from the burette reading at the endpoint. The iodine value was calculated based on the difference between blank and sample titrations, and results were expressed as grams of iodine absorbed per 100 g of oil sample.

Determination of Peroxide Value

The iodine value of the vegetable oil samples was determined according to the British Standard 684: Section 2.14:1976 and ISO standard methods. A 3.00 g portion of each well-mixed oil sample was accurately weighed into a dry, 250 mL stoppered conical flask previously flushed with inert gas to minimize oxidation. The oil sample was dissolved in 10 mL chloroform, followed by the addition of 15 mL glacial acetic acid and 1 mL saturated aqueous potassium iodide solution. The flask was shaken thoroughly for 1 min and allowed to stand in the dark for 1 min to ensure complete reaction between iodine monochloride and unsaturated bonds.

Thereafter, 75 mL of water was added, and the liberated iodine was titrated immediately with either 0.002 M or 0.01 M sodium thiosulphate solution ($Na_2S_2O_3$) using 1 % starch solution as an indicator near the endpoint. The titration was continued until the blue colour disappeared, and the final burette reading at the endpoint was recorded as the titre value.

A reagent blank (V_0) was also determined under the same conditions, and the difference between blank and sample titres was used for calculation of iodine value, expressed as grams of iodine absorbed per 100 g of oil sample. All oil samples analysed were fresh, non-rancid vegetable oils obtained from the market, and no rancid samples were included in the analysis.

Determination of Iron and Copper Content

The digested ash solution of each sample was quantitatively transferred into a 100 mL volumetric flask and made up to the mark with deionised water. The solution was then aspirated into the Buck 200 atomic absorption spectrophotometer for mineral analysis. Each trace element was determined individually using its specific hollow cathode lamp, at its characteristic wavelength under element-specific flame conditions. The wavelengths used were as follows: iron (Fe) at 248.3 nm, zinc (Zn) at 213.9 nm, copper (Cu) at 324.8 nm, manganese (Mn) at 279.5 nm, calcium (Ca) at 422.7 nm, and magnesium (Mg) at 285.2 nm.

An air–acetylene flame was used for the determination of Fe, Zn, Cu, and Mn, while calcium and magnesium were also analysed under air–acetylene conditions with appropriate lamp current settings and burner optimization as recommended by the instrument manufacturer. Each element was measured separately using its respective wavelength and lamp; therefore, the wavelengths and lamps were not the same across elements. The concentration of each mineral was obtained by comparing the absorbance values of the samples with calibration curves prepared from standard solutions of known concentrations.

Data Analysis

All data obtained from the various analyses were expressed as mean ± standard deviation (SD). Each determination was carried out in triplicate, and the mean values were used for statistical evaluation. Data were subjected to analysis of variance (ANOVA) to determine significant differences among samples. Where significant differences were observed, means were separated using Duncan's multiple range test (DMRT). Statistical significance was accepted at $p < 0.05$. All analyses were performed using appropriate statistical software (such as SPSS version 20.0 or equivalent).

RESULTS

Fatty Acid Composition of Soya and Unbranded Oils

Table 1 reveals the fatty acid composition of soya and unbranded oils. The results for saturated fatty acid content for soya oil reveal that Lauric (C12:0) ranked highest (5.76 ± 0.02) and Lignoceric (C24:0) (0.10 ± 0.01) ranked the least, while Palmitic (C16:0) (3.67 ± 0.02) ranked highest and Caprylic(C8:0) (0.02 ± 0.02) ranked least for unbranded oils, respectively. With respect to monounsaturated content for both samples, the oleic acid contents of both samples (41.58 ±0.02 for soya oil and 36.87± 0.02 for unbranded oil were higher than the palmitoleic acid content of both samples (0.41 ± 0.02 for soya oil and 0.20 ± 0.02 for the unbranded oil). The differences between the oleic acid ($P<0.001$) and palmitic acid ($P<0.05$) contents of soya oil and unbranded oil were statistically significant.

Table 1: Fatty Acid Composition of Soya and Unbranded Oils

Fatty acids	Soya	Unbranded	p-value
Saturated fatty acid			
Behenic (C22:0)	1.80 ± 0.01	1.48 ± 0.02	0.003
Capric (C10:0)	5.40 ± 0.04	4.25 ± 0.01	0.001
Caproic (C6:0)	0.11 ± 0.02	0.04 ± 0.01	0.069
Caprylic (C8:0)	0.07 ± 0.02	0.02 ± 0.02	0.214
Lauric (C12:0)	5.76 ± 0.02	4.34 ± 0.02	0.000
Lignoceric (C24:0)	0.10 ± 0.01	0.03 ± 0.01	0.038
Margaric (C17:0)	0.22 ± 0.01	0.15 ± 0.02	0.053
Myristic (C14:0)	1.21 ± 0.04	1.08 ± 0.01	0.043
Palmitic (C16:0)	4.52 ± 0.01	3.67 ± 0.02	0.000
Stearic (C18:0)	3.47 ± 0.02	2.55 ± 0.02	0.001
Monounsaturated			
Oleic (C18:1)	41.58 ±0.02	36.87± 0.02	0.000
Palmitoleic (C16:1)	0.41 ± 0.02	0.20 ± 0.02	0.010
Polyunsaturated			
Arachidonic (C20:0)	1.72 ± 0.04	1.22 ± 0.01	0.003
Linoleic (C18:2)	23.88 ± 0.02	17.65± 0.03	0.000
Erucic (C22:1)	0.37 ± 0.02	0.19 ± 0.03	0.020
Linolenic (C18:3)	1.25 ± 0.03	1.07 ± 0.03	0.024

Mean ±Standard error of the mean in duplicate determination by the independent-samples t-test

Fatty Acid Composition of Olive Oil and Unbranded Oil

Table 2 presents the fatty acid composition of olive oil and unbranded oil, showing clear variations in the distribution of saturated, monounsaturated, and polyunsaturated fatty acids. Among the saturated fatty acids, capric acid (C10:0) recorded the highest proportion in both olive oil (4.92 ± 0.04%) and unbranded oil (4.25 ± 0.01%), while caprylic acid (C8:0) was the least abundant in both samples (0.02 ± 0.01% and 0.02 ± 0.02%, respectively), indicating a similar pattern of distribution across the two oils. For monounsaturated fatty acids, oleic acid (C18:1) was the dominant fatty acid in both olive oil (39.13 ± 0.03%) and unbranded oil (36.87 ± 0.02%), whereas palmitoleic acid (C16:1) was present in the lowest concentrations (0.28 ± 0.02% and 0.20 ± 0.02%, respectively), suggesting that both oils are primarily oleic-rich, although olive oil exhibited a slightly higher content. In the polyunsaturated fatty acid fraction, linoleic acid (C18:2) was the most abundant in both olive oil (19.90 ± 0.04%) and unbranded oil (17.65 ± 0.03%), while erucic acid (C22:1) recorded the lowest values (0.25 ± 0.02% and 0.19 ± 0.03%, respectively). Table 3 reveals the total fatty acid composition of soya, olive, and unbranded oil. The results showed that the total saturated fatty acid content was highest in soya oil (22.67 ± 0.01), while unbranded oil had the lowest value (17.62 ± 0.02). Similarly, the total monounsaturated fatty acid content was highest in soya oil (42.00 ± 0.01) and lowest in unbranded oil (37.08 ± 0.01). For polyunsaturated fatty acids, soya oil also recorded the highest value (91.86 ± 0.06), whereas unbranded oil showed the lowest concentration (74.86 ± 0.01).

Table 2: Fatty Acid Composition of Olive Oil and Unbranded Oil

Fatty acids	Olive oil	Unbranded	P-value
Saturated fatty acid			
Behenic (C22:0)	1.57 ± 0.02	1.48 ± 0.02	0.051
Capric (C10:0)	4.92 ± 0.04	4.25 ± 0.01	0.002
Caproic (C6:0)	0.06 ± 0.02	0.04 ± 0.01	0.493
Caprylic (C8:0)	0.02 ± 0.01	0.02 ± 0.02	1.000
Lauric (C12:0)	5.00 ± 0.04	4.34 ± 0.02	0.002
Lignoceric (C24:0)	0.07 ± 0.01	0.03 ± 0.01	0.106
Margaric (C17:0)	0.17 ± 0.02	0.15 ± 0.02	0.445
Myristic (C14:0)	1.14 ± 0.01	1.08 ± 0.01	0.039
Palmitic (C16:0)	3.89 ± 0.03	3.67 ± 0.02	0.012
Stearic (C18:0)	2.96 ± 0.02	2.55 ± 0.02	0.003
Monounsaturated			
Oleic (C18:1)	39.13±0.03	36.87± 0.02	0.000
Palmitoleic (C16:1)	0.28 ± 0.02	0.20 ± 0.02	0.064
Polyunsaturated			
Arachidonic (C20:4)	1.28 ± 0.01	1.22 ± 0.01	0.051
Linoleic (C18:2)	19.90 ±0.04	17.65± 0.03	0.000
Erucic (C22:1)	0.25 ± 0.02	0.19 ± 0.03	0.159
Linolenic (C18:3)	1.14 ± 0.02	1.07 ± 0.03	0.122

Mean ±Standard error of the mean in duplicate determination by the independent-samples t-test

Table 3: Fatty Acid Composition of Soya Oil, Olive Oil and Unbranded Oil

Fatty acids	Soya oil	Olive oil	unbranded oil
Saturated fatty acid			
Behenic (C22:0)	1.80^{a} ± 0.01	1.57^{b} ± 0.02	1.48^{c} ± 0.02
Capric (C10:0)	5.40^{a} ± 0.04	4.92^{b} ± 0.04	4.25^{c} ± 0.01
Caproic (C6:0)	0.11^{a} ± 0.02	0.06^{ab} ± 0.02	0.04^{b} ± 0.01
Caprylic (C8:0)	0.07^{a} ± 0.02	0.02^{a} ± 0.01	0.02^{a} ± 0.02
Lauric (C12:0)	5.76^{a} ± 0.02	5.00^{b} ± 0.04	4.34^{c} ± 0.02
Lignoceric (C24:0)	0.10^{a} ± 0.01	0.07^{a} ± 0.01	0.03^{b} ± 0.01
Margaric (C17:0)	0.22^{a} ± 0.01	0.17^{b} ± 0.02	0.15^{b} ± 0.02
Myristic (C14:0)	1.21^{a} ± 0.04	1.14^{b} ± 0.01	1.08^{b} ± 0.01
Palmitic (C16:0)	4.52^{a} ± 0.01	3.89^{b} ± 0.03	3.67^{c} ± 0.02
Stearic (C18:0)	3.47^{a} ± 0.02	2.96^{b} ± 0.02	2.55^{c} ± 0.02
Total SFA	22.67^{a} ±0.01	19.81^{b} ± 0.02	17.62^{c} ± 0.02
Monounsaturated			
Oleic (C18:1)	41.58^{a} ±0.02	39.13^{b}±0.03	36.87^{c}± 0.02
Palmitoleic (C16:1)	0.41^{a} ± 0.02	0.28^{b} ± 0.02	0.20^{c} ± 0.02
Total MUFA	42.0^{a} ± 0.01	39.42^{b} ± 0.01	37.08^{c} ± 0.01
Polyunsaturated			
Arachidonic (C20:4)	1.72^{a} ± 0.04	1.28^{b} ± 0.01	1.22^{b} ± 0.01
Linoleic (C18:2)	23.88^{a} ± 0.02	19.90^{b} ± 0.04	17.65^{c}± 0.03
Erucic (C22:1)	0.37^{a} ± 0.02	0.25^{b} ± 0.02	0.19^{b} ± 0.03
Linolenic (C18:3)	1.25^{a} ± 0.03	1.14^{b} ± 0.02	1.07^{b} ± 0.03
Total PUFA	27.23^{a} ± 0.01	22.58^{b} ± 0.01	20.15^{c} ± 0.02
Total Fatty Acids	91.86^{a} ± 0.06	81.82^{b} ± 0.01	74.86^{c} ± 0.01

Mean ±Standard error of the mean in duplicate determination by the One-way ANOVA test. Means with the same superscripts in the same row are not significantly different at the 5% probability level.

Quality Characterization of Soya Oil, Olive Oil and Unbranded Oil

Table 4 presents the quality characteristics of soya, olive, and unbranded oils. Olive oil had the highest moisture content (3.325 ± 0.03) and colour value (8.6 ± 0.14), while unbranded oil recorded the lowest values for both parameters, with moisture content of 2.67 ± 0.02 and colour value of 7.4 ±

0.00. Relative density and refractive index showed only slight variations among the samples, with values ranging from 0.8895 ± 0.00 to 1.165 ± 0.02 and from 1.446 ± 0.00 to 2.995 ± 0.02, respectively. Olive oil exhibited the highest peroxide value (13.35 ± 0.03), whereas soya oil had the lowest peroxide value (3.155 ± 0.02). In contrast, iodine value was highest in soya oil (112 ± 1.41) and lowest in olive oil (47 ± 2.12), indicating a greater degree of unsaturation in soya oil. Vitamin A content was highest in olive oil (73.48 ± 0.02) and lowest in soya oil (23.635 ± 0.02).

Table 4: Quality Characterization of Soya Oil, Olive Oil and Unbranded Oil

Other parameters	Soya oil	Olive oil	unbranded oil
Moisture content%	0.36^{a} ± 0.01	3.325^{b} ± 0.03	2.67^{c} ± 0.02
Colour (Hz)	3.05^{a} ± 0.07 (golden brown)	8.6^{b} ± 0.14 (brownish)	7.4^{c} ± 0.00 (brownish yellow)
Relative density (g/ml)	0.9154^{a} ± 0.00	0.8895^{b} ± 0.00	0.89265^{c} ±0.00
Refractive index	1.4665^{a} ± 0.00	1.442^{b} ± 0.01	1.446^{b} ±0.00
Acid value (MgKOH/G)	1.165^{a} ±0.02	2.995^{b} ± 0.02	2.575^{c} ± 0.04
Peroxide value (Meq/Kg)	3.155^{a} ± 0.02	13.35^{b} ± 0.03	11.055^{c} ± 0.01
Iodine value	112^{a} ±1.41	47^{b} ± 2.12	57.5^{c} ± 1.41
Vitamin A (ug/100g)	23.635^{a} ± 0.02	73.48^{b} ± 0.02	56.195^{c} ± 0.69
Fe(mg/100g)	0.025^{a} ±0.00	0.2^{b} ± 0.01	0.12^{c} ± 0.03
Cu(mg/100g)	0.007^{a} ±0.00	0.0355^{b} ±0.00	0.021^{c} ± 0.00
TML (cfu/g)	2.65×10^{3a} ±0.02	7.395×10^{3b} ±0.03	5.1×10^{3c} ± 0.02

Mean ±Standard error of mean in duplicate determination by the One-way ANOVA test. Means with the same superscripts in the same row are not significantly different at the 5% probability level. Key: TML: Total Microbial Counts

DISCUSSION

Saturated fatty acids are significantly higher in soya oil compared to unbranded oil, although this contradicts the findings of (13), with the exception of myristic acid. In contrast, the unsaturated fatty acids are significantly higher in soya oil, aligning with the data from (13). Olive oil contains more saturated fatty acids than the unbranded oil but less than soya oil, which is inconsistent with the results of (14). The unsaturated fatty acids in olive oil are significantly lower than in soya oil, which agrees with (14). While high saturated fatty acids improve oil stability, they are considered nutritionally unfavorable due to their potential role in increasing LDL levels (15). Therefore, soya oil appears to be more stable and has a longer shelf life than both unbranded and olive oil.

The moisture content in the soya oil is significantly ($p<0.05$) lower than the moisture content in the olive oil and unbranded oil. The moisture content difference between the soya oil and unbranded oil correlates with the findings of (13), who reported that the total moisture in grand soya oil is 0.070±0.000 and that of the unbranded refined palm kernel oil is 0.095±0.007. It is important to know that the moisture content must be within 10% in order to prevent unpleasant odor and mold formation during storage (16). All values are within 10%, so there is less risk of unpleasant odor and mold formation. To ensure stability, fats and oils should contain <0.3% (3,000 ppm) moisture, preferably ~0.05%; the soya oil is seen to be the most stable with a moisture content of 0.36 ± 0.01.

The colour of the soya oil is golden brown, this result is in contrast with (17) who says that Soybean oil is extracted from soybean (*Glycine max*) and often has a dark yellow or faint green color. Olive oil exhibited a brownish colour, which contrasts with the report of (18), who stated that refined olive oil should be clear, limpid, free from sediment, and possess a clear yellow colour without specific odour or taste, as well as being free from indications of alteration or contamination. The brownish appearance observed in the present study may suggest differences in the degree of refining, the presence of natural pigments, oxidation during storage, or possible quality deterioration. The unbranded oil exhibited a brownish-yellow colour. According to (19), the AOCS Tintometer colour scale for edible oils ranges from 1.0 to 70 yellow. Colour is an important quality attribute that influences consumer acceptance and may also reflect the processing conditions, purity, and oxidative status of the oil. Darker colours may indicate the presence of impurities, inadequate refining, prolonged storage, or oxidation, all of which can adversely affect the sensory quality and market value of the oil.

The relative density of soya oil is significantly higher ($p<0.05$) than that of the unbranded oil, contrary to the findings of (20). However, the measured value for branded soya oil aligns with (20), which reported a relative density of 0.918g/ml ± 0.11. The relative density of olive oil does not match the value reported by (18), which is 0.918g/cm^3. While the density of soya oil falls within international standards, indicating good quality and purity, the densities of olive oil and

unbranded oil were below the recommended standard. Lower density values may suggest differences in fatty acid composition, the presence of impurities, adulteration, or variations in processing and storage conditions. Density is an important physical quality parameter because it influences handling, packaging, and the overall stability of oils. The lower densities observed in olive oil and unbranded oil may also be associated with variations in their physicochemical characteristics, which could affect their quality and shelf life. Nonetheless, the findings of the present study are consistent with those reported by (21), with the closest similarity observed in the unbranded oil sample. These results suggest that, among the oils analysed, soya oil exhibited physicochemical properties more consistent with established quality standards

The refractive index of soya oil was significantly ($p < 0.05$) higher than those of olive and unbranded oils, corroborating the findings of (20). The refractive index of soya oil fell within the standard range, indicating good quality, purity, and a higher degree of unsaturation, which is consistent with its fatty acid profile. In contrast, the lower refractive index values observed in olive and unbranded oils may reflect differences in fatty acid composition, processing methods, or possible quality deterioration. These findings support the overall physicochemical assessment, suggesting that soya oil possessed superior quality characteristics compared with the olive and unbranded oil samples analyzed.

The acid value of soya oil is significantly ($p<0.05$) lower than that of the unbranded oil, aligning with the findings of (13). Among the three oils tested, olive oil has the highest acid value, exceeding the Codex standard of 0.6 mg KOH/g, as stated in CODEX STAN, (18). All three oils surpass the maximum allowable acid value for refined oils. According to (22), a higher acid value indicates a higher free fatty acid content, which reduces oil quality. The elevated values observed may result from storage at room temperature in market conditions (23), and possibly from glyceride decomposition by microorganisms, which may be accelerated by heat and sunlight exposure (24–26).

The peroxide value of the unbranded oil was significantly ($p < 0.05$) higher than that of soya oil but lower than that of olive oil. This finding contrasts with the report of (20), who observed significantly higher peroxide values in all unbranded vegetable oils than in branded vegetable oils. The peroxide values of olive oil and unbranded oil exceeded the maximum allowable limit, whereas that of soya oil remained within the recommended standard. Peroxide value is an important indicator of the extent of lipid oxidation; higher values indicate greater oxidative deterioration of the oil. The elevated peroxide values observed in olive and unbranded oils suggest reduced oxidative stability, poorer keeping quality, and a shorter shelf life. Nutritionally, consumption of highly oxidised oils may increase exposure to lipid peroxidation products and free radicals, which have been associated with oxidative stress and cellular damage. In contrast, the lower peroxide value of soya oil indicates better oxidative stability, improved preservation of essential fatty acids and fat-soluble vitamins, and overall superior nutritional quality compared with the olive and unbranded oil samples analyzed.

The iodine value of the soya oil is significantly ($p<0.05$) higher than that of the unbranded and olive oil. This contrasts with the findings of (20) that showed the unbranded oil having a higher iodine value than the branded soya oil with values of 128.9±13.34g I_2/100 g oil (UVO) and 122.0±4.56g I_2/100 g oil (BVO). The values are below the maximum standard set by 141 g I_2/100 g oil (18).

The vitamin A content of olive oil was significantly ($p < 0.05$) higher than those of soya oil and unbranded oil, whereas soya oil contained the lowest concentration (23.635 μg/100 g ± 0.02). The higher vitamin A content of olive oil suggests a greater potential contribution to dietary vitamin A intake, which is essential for vision, immune function, growth, and maintenance of epithelial tissues. Conversely, the lower vitamin A content observed in soya oil indicates a relatively lower contribution to meeting vitamin A requirements. Nevertheless, all the oils may serve as supplementary rather than major dietary sources of vitamin A.

The iron content of olive oil was significantly ($p < 0.05$) higher than those of soya oil and unbranded oil, with soya oil recording the lowest value (0.025 mg/100 g ± 0.00). Similarly, soya oil contained the lowest copper concentration (0.007 mg/100 g ± 0.00). These findings contrast with those of Author et al. (28), who reported iron and copper values of 20.65 ± 3.32 mg/100 g and 0.42 ± 0.03 mg/100 g, respectively, for olive oil, and 28.93 ± 2.32 mg/100 g and 0.18 ± 0.01 mg/100 g, respectively, for soya oil. Trace amounts of metal ions are known to accelerate lipid oxidation, leading to deterioration in flavour, odour, and overall quality of edible oils (29, 30). Therefore, the relatively low iron and copper contents observed in the present study may be advantageous, as they are less likely

to promote oxidative rancidity, thereby enhancing oil stability, freshness, and storage quality (31). The low concentrations of these trace metals suggest good quality oils with a reduced risk of metal-catalysed oxidation.

The microbial load in olive oil was significantly ($p < 0.05$) higher than those of soya oil and unbranded oil, with soya oil recording the lowest value (2.65×10^3 CFU/g $\pm$ 0.02). This finding contrasts with the report of Author et al. (20), who observed higher microbial counts in unbranded vegetable oils and a significant difference ($p < 0.05$) between branded and unbranded oil samples. The higher microbial load observed in olive oil may be attributable to differences in handling, processing, storage conditions, or post-processing contamination. Microbial contamination of edible oils can occur during production, transportation, storage, or retail display, particularly when oils are exposed to moisture and unhygienic conditions. Increased microbial loads may adversely affect oil quality, shelf life, and consumer safety. However, as microbial identification was not carried out in the present study, the specific microorganisms responsible for the observed counts could not be determined.

CONCLUSION

This study showed variation in the physicochemical and microbial quality of the analysed vegetable oils. Soya oil exhibited better compliance with quality standards, while olive oil and unbranded oil showed higher microbial loads. However, differences were observed across parameters, indicating that oil quality depends on multiple factors, including fatty acid composition, physicochemical stability, and microbial safety. The findings are limited to the specific samples analysed and therefore cannot be generalised to all branded or unbranded oils. Although unbranded oil showed lower saturated fatty acid levels in some cases, this does not necessarily indicate superior quality, as microbial load and oxidative stability are more critical indicators of safety and shelf life. The study highlights the importance of good manufacturing practices and regulatory monitoring to ensure safe edible oil production and distribution.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

1. Li, X., Kong, W., Shi, W., & Shen, Q. (2016). A combination of chemometrics methods and GC–MS for the classification of edible vegetable oils. *Chemometrics and Intelligent Laboratory Systems, 155*, 145–150. https://doi. org/10.1016/j.chemolab.2016.03.003
2. Ambujakshi. (2016). Consumer awareness of edible oil: A study with special reference to Bangalore. *International Journal of Applied Research, 2*(12), 352–357.
3. Tayde, S., Patnaik, M. B., Bhagt, S. L., & Renge, V. C. (2011). Epoxidation of vegetable oils: A review. *International Journal of Advanced Engineering Technology, 2*(4), 491–501.
4. Aro, A., Becker, W., & Pedersen, J. I. (2006). Trans fatty acids in the Nordic countries. *Scandinavian Journal of Food and Nutrition, 50*(4), 151–154.
5. Allison, D. B. (1995). Epidemiology. *American Journal of Clinical Nutrition, 62*(Suppl.), 670S–678S.
6. Aruna, K., Rukkumani, R., Varma, P. S., & Viswanathan, P. (2016). Role of fatty acids in health and disease: A review. *Journal of Food and Drug Analysis, 24*(1), 1–10. https://doi.org/10.1016/j.jfda.2015.10.006
7. Willett, W. C., Stampfer, M. J., Manson, J. E., Colditz, G. A., Speizer, F. E., Rosner, B. A., Sampson, L. A., & Hennekens, C. H. (1993). Intake of trans fatty acids and risk of coronary heart disease among women. *The Lancet, 341*(8845), 581–585. https://doi.org/10.1016/0140-6736(93)90350-P
8. Aro, A., Manninen, V., & Voutilainen, E. (1995). Effects of dietary fat on serum lipids and lipoproteins in humans. *American Journal of Clinical Nutrition, 62*(6 Suppl.), 1425S–1431S. https://doi.org/10.1093/ajcn/62.6.1425S
9. World Health Organization. (2018). *Noncommunicable diseases: Key facts*. https://www.who.int/news-room/fact-sheets/detail/noncommunicable-diseases
10. Chabiri, S. A., Ngele, M. B., Okoye, P. A. C., & Ikheloa, E. H. (2009). Impact of industrially branded and unbranded vegetable oils on health in Nigeria. *Nigerian Food Journal, 27*(1), 24–30. https://doi.org/10.4314/nifoj.v27i1.47492
11. Wai, L. (2018). Branded versus unbranded edible oils: A global market and health risk assessment. *Journal of Nutrition and Health Sciences, 5*(3), 1–9.
12. Enzo, I. (2019). The health risk of adulterated cooking oils in Nigeria. *African Journal of Public Health, 13*(2), 55–62.
13. Chibor, B. S., Chibor, M., Ekeanyanwu, R. C., & Chibor, N. S. (2018). Comparative evaluation of fatty acid profile and quality of edible

vegetable oils sold in some parts of Nigeria. *Journal of Food Science and Nutrition, 4*(2), 75–84. https://doi.org/10.11648/j.jfsn.20180402.12

14. Kim, H. Y., Kim, K., & Lee, S. M. (2010). Comparative study on fatty acid composition and oxidative stability of vegetable oils. *Food Science and Biotechnology, 19*(5), 1213–1219. https://doi.org/10.1007/s10068-010-0171-2
15. Dzisiak, D. (2004). The role of modified vegetable oils in foods and health. *Asia Pacific Journal of Clinical Nutrition, 13*(Suppl.), S61–S64.
16. Samuel, F. O., & Alabi, A. O. (2012). Storage effects on physicochemical properties and fatty acid profile of some selected edible oils in Nigeria. *International Journal of Basic and Applied Sciences, 1*(2), 252–256.
17. Mercola, J. (2019). *The health dangers of soybean oil*. https://www.mercola.com/
18. Codex Alimentarius Commission. (1999). *Codex standard for named vegetable oils (CODEX-STAN 210-1999)*. FAO/WHO. https://www.fao.org/fao-who-codexalimentarius/
19. American Oil Chemists' Society. (n.d.). *Official methods and recommended practices of the AOCS*. AOCS Press.
20. Chabiri, S. A., Ngele, M. B., Okoye, P. A. C., & Ikheloa, E. H. (2009). Impact of industrially branded and unbranded vegetable oils on health in Nigeria. *Nigerian Food Journal, 27*(1), 24–30. https://doi.org/10.4314/nifoj.v27i1.47492
21. Pearson, D. (1987). *The chemical analysis of foods* (8th ed.). Churchill Livingstone.
22. Lideya, G. T., Tadesse, S. A., & Mengesha, Y. Y. (2015). Assessment of physicochemical parameters and adulteration of edible oils in Ethiopia. *International Journal of Food Science and Nutrition Engineering, 5*(2), 58–64.
23. Ekwenye, U. N., & Ijeomah, C. A. (2005). Antimicrobial effects of palm kernel oil and palm oil. *Journal of Science, Engineering and Technology, 12*(1), 5847–5855.
24. Okechalu, B., & Gushop, T. (2011). Evaluation of physicochemical characteristics of some edible vegetable oils sold in Jos Metropolis, Nigeria. *Asian Journal of Chemistry, 23*(4), 1630–1633.
25. Hiol, A., Jonzo, M. D., Rugani, N., Druet, D., Sarda, L., & Comeau, L. C. (1999). Purification and characterization of an extracellular lipase from *Rhizopus oryzae*. *Enzyme and Microbial Technology, 25*(1–2), 80–87. https://doi.org/10.1016/S0141-0229(99)00025-9
26. Houria, T., Nabila, D., & Abdelkader, B. (2002). Study of the quality of commercial edible oils in Algeria. *African Journal of Biotechnology, 1*(2), 55–58.
27. Habibullah, M., Hasan, M., Begum, M., & Nabi, A. S. M. (2007). Effects of light, air, and storage time on vitamin A content of edible oils. *Bangladesh Journal of Scientific and Industrial Research, 42*(3), 365–370. https://doi.org/10.3329/bjsir.v42i3.549
28. Farzin, L., Heidari, M., & Shams, H. (2014). Determination of heavy metals in edible vegetable oils consumed in Iran. *International Journal of Analytical Chemistry, 2014*, Article 720692. https://doi.org/10.1155/2014/720692
29. Afkhami, A. (2009). Effect of metal ions on oxidative stability of edible oils. *Iranian Journal of Chemistry and Chemical Engineering, 28*(4), 63–70.
30. Anthemidis, A. N. (2005). Impact of metal ion contaminants on oil oxidation and storage stability. *Food Chemistry, 93*(2), 395–400. https://doi.org/10.1016/j.foodchem.2004.10.035
31. Reyes, L. H., & Campos, M. M. (2006). Influence of trace metals on oxidative stability of vegetable oils. *Food Research International, 39*(2), 178–185. https://doi.org/10.1016/j.foodres.2005.07.004
32. Adams, M. R., & Moss, M. O. (1999). *Food microbiology* (2nd ed.). New Age International.