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Comparative Assessment of Some Physicochemical Properties of Groundnut and Palm Oils Sold Within Kaduna Metropolis, Nigeria.

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Abstract: *This study assessed some physicochemical properties of different brands of commonly consumed vegetable oil brands sold within Kaduna metropolis. The study revealed the ranged values of the following parameters for groundnut oil and palm oil respectively: Iodine value (29.25 ± 0.09 – 29.99 ± 0.48 g I2/g; 26.40 ± 0.54 – 30.87 ± 0.21 g I2/g), Saponification value (184.04 ± 5.00 – 194.48 ± 3.33 mg KOH/g; 182.62 ± 3.65 – 195.61 ± 0.56 mg KOH/g), Acid value (0.39 ± 0.08 – 0.86 ± 0.91 mg KOH/g; 0.16 ± 0.02 – 0.60 ± 0.02 mg KOH/g) and Peroxide value (1.87 ± 0.12 – 3.20 ± 0.28 meq/kg; 1.60 ± 0.10 – 4.00 ± 0.57 meq/kg). Mineral oils were absent in all the samples and no rancidity was observed in all the samples. The results show that most of the brands of commonly consumed oils have acceptable values as compared to the standard values of NAFDAC and CODEX.*

Keywords: *Groundnut Oil, Kaduna, Palm Oil, Physicochemical Properties*

I. Introduction

Vegetable oils have wide application in foods where they are used in frying, cooking, salad dressing, shortening of pasty etc. [1]. They mainly consist of lipids with some other minor components including antioxidants, colorants, flavors and emulsifiers [2]. Some of these compounds occur naturally and some are added during the manufacturing process. The presence of hydrocarbons or mineral oils such as n-alkenes in vegetable oils has also been reported [3]. Vegetable oils act as carriers of fat-soluble vitamins (A, D, E, and K) and play important sensory and functional roles in food products. They provide the most concentrated source of energy, supply essential fatty acids linoleic and linolenic acids which are precursors for important hormones, the prostaglandins and responsible for growth, provide satiety and increases the palatability of food [4].

In Nigeria, the major sources of edible oils are groundnut and palm oil. These vegetable oils are used mainly as cooking oils and for the production of soap, margarine, and cosmetics [5]. The quality of vegetable oils may be affected by several factors, from the choice of raw material to the methods of processing, refining, bottling and storage [6]. Therefore, appropriate control throughout the production chain is important to ensure the quality of vegetable oils delivered to food industries and final consumers. For this purpose a number of physical and/or chemical parameters are usually monitored such as acidity, density, viscosity, color, refractive index, moisture, volatility, dielectric constant, total polar compounds, as well as saponification, peroxide, iodine, ester and carbonyl values. Oil quality and its stability are therefore very important for the consumers and in applications to industries [7]. Various brands of vegetable oils are sold in markets; some are produced in the country while some are imported. Despite the strict regulations and enforcement by relevant regulatory agencies of the sale of standard commodities to consumers, at times manufacturers and importers do not comply with standards. In spite of the wide range applications of vegetable oils this study is aimed to investigate physicochemical properties of groundnut and palm oils sold in Kaduna metropolis.

II. Materials and Methods

All reagents used were of analytical grade.

2.1 Sampling

Six different brands of groundnut oils and four brands of palm oils sold within Kaduna metropolis was purchased. The samples were stored and labelled in a sterile capped glass bottles at room temperature in a cupboard to prevent exposure to light.

2.2 Determination of Colour and Odour

The colour of the oil samples was determined by visual comparison while the odour of the oil samples was determined using a glass stoppered bottle rinsed with 4 M HCl internally and externally and rinsed with distilled water. The bottle was halfway filled with the oil sample and shake vigorously for about 2 minutes. The stopper was then removed and the odour was observed by putting nostrils near the mouth of the bottle [8].

2.3 Determination of Moisture Content

The moisture content of the oil sample was determined using the method described by Pearson [9].

2.4 Determination of pH

The pH of the oil samples was determined with a pH meter. About 30 cm^3 of the oil sample was measured into a beaker, then the pH meter electrode was immersed into the beaker containing the oil sample and the pH value was recorded digitally.

2.5 Determination of Rancidity

The rancidity of the oil samples was determined qualitatively using Kries Test as described by Pearson [10]. 5 cm^3 of the oil samples was placed in a 100 cm^3 test tube vigorously mixed with 5 cm^3 of 0.1% Phloroglucinol solution in diethyl ether and 5 cm^3 of concentrated HCI for about 20s. The presence of pink colour indicates incipient rancidity.

2.6 Determination of the Presence of Mineral Oil

The presence of mineral oil in the oil samples was carried out using Holde's Test as described by Pearson [10]. 1 cm^3 of the oil sample and 25 cm^3 of 0.5 M alcoholic KOH was added into a conical flask.Then heated in a boiling water bath with frequent agitation to ensure complete reaction. 25 cm^3 of water was now be added to the hot solution at a time and continue shaking. The presence of turbidity indicates presence of mineral oil.

2.7 Determination of Iodine Value

One gram of the oil sample was weighed into a 250 cm^3 capacity and 10 cm^3 of carbon tetrachloride was added to the oil. 20 cm^3 of Wijs solution (Iodine monochloride + Acetic Acid) was then added and allowed to stand in the dark for 30 min. After 30 minutes, 15 cm^3 of (10%) potassium iodide and 100 cm^3 of water was added and then titrated with 0.1 mol/dm^3 thiosulphate solution using starch as indicator just before the end point. A blank was also prepared alongside the oil samples. The iodine value was obtained using equation (1) [11].

$$\text{Iodine Value} = \frac{(B-S) \times M \times 12.69}{W} \quad (1)$$

B and S are titre values of blank and sample respectively, M is the molaity of $Na_2S_2O_3$, 12.69 is the conversion factor from Meq $Na_2S_2O_3$ to gram iodine molecular weight of iodine and W is the weight of oil.

2.8 Refractive Index

Refractive Index was determined using a mathematical expression derived by Perkins [12].

$$RI = 1.45765 + 0.0001164\ IV \quad (2)$$

RI is the Refractive Index and IV is the Iodine Value

2.9 Determination of Saponification Value

Two grams of the oil sample was weighed into a clean dried conical flask and 25 cm^3 of alcoholic potassium hydroxide was added. The flask was heated for an hour with frequent shaking. 1 cm^3 of 1% phenolphthalein indicator was added and the hot excess alkali titrated with 0.5 mol/dm^3 hydrochloric acid (HCl) until it reached the end point where it turned colorless. A blank titration was carried out at the same time and under the same condition [13].

The saponification value was calculated using equation (3).

$$\text{Saponification Value} = \frac{(S-B) \times M \times 56.1}{W} \quad (3)$$

B and S are titre values of blank and sample respectively, M is the Molarity of HCl and 56.1 is the molecular weight of KOH

2.10 Determination of Peroxide Value

The peroxide value was determined by dissolving 5 g of the oil sample in 30 cm^3 of glacial acetic acid: chloroform (3:2 v/v) then 0.5 cm^3 of KI was added. The solution was then titrated with standardized sodium thiosulphate using starch indicator [13].

The peroxide value was calculated using equation (4).

$$\text{Peroxide Value (meq/kg)} = \frac{(S-B) \times M \times 1000}{\text{weight of oil}} \quad (4)$$

B and S are titre values of blank and sample respectively, M is the Molarity of $Na_2S_2O_3$

2.11 Determination of Acid Value

The oil sample (1.0g) was boiled with 50 cm^3 ethanol, then allowed to cool and 2 drops of phenolphthalein indicator was added. The resulting solution was titrated against 0.1 mol/dm^3 NaOH until a pink colour is obtained [13].

The acid value was calculated using equation (5).

$$\text{Acid Value (mgKOH/g)} = \frac{Vx\,5.6}{W} \quad (5)$$

V is the titre value and W is the weight of oil

2.12 Determination of Ester value

The ester value was obtained by subtracting acid value from saponification value [8].

III. Results and Discussion

The results obtained for the oil samples shown in Table 1 shows that the pH ranged between 6.59 – 6.79 for groundnut oil and 4.5 – 6.63 for palm oil samples. This shows that the oil samples are weakly acidic and almost neutral for most of the oil samples. This implies that they contain low amount of fatty acids making them fit for edible purposes. High concentrations of free fatty acids are undesirable in vegetable oils because they can reduce the palatability and the shelf-life of the oil [13]. There was no significant difference between the refractive index of the different oil samples. The range was between 1.4715 – 1.4726. These values obtained are in line with the results of some other literatures [14-15] and also within the standard limits set by NAFDAC and CODEX. The colors of the groundnut oils were either light yellow, golden yellow, amber yellow or light amber while the palm oils were reddish in color. These are acceptable colors of vegetable oils as reported by Anyasor [16]. The odor of all the oils analyzed were unobjectionable and acceptable.There was no rancidity and mineral oil in all the oil samples analyzed as the oil samples were kept in a cool place and protected from light and air. Anyasor *et al*., however reported the presence of mineral oil in some local and refined groundnut oi1 [16].

Table 1: Physical Properties of Selected Vegetable Oils

Sample	Colour	Odour	pH	Temp. ^oC	Refractive Index
Gg	Light yellow	Unobjectionable	6.77	24.9	1.4715
Ggp	Amber Yellow	Unobjectionable	6.61	24.9	1.4717
Gl	Golden Yellow	Unobjectionable	6.79	24.9	1.4716
Gk	Amber Yellow	Unobjectionable	6.60	24.9	1.4716
Gp	Light Amber	Unobjectionable	6.71	24.9	1.4717
Gm	Light Amber	Unobjectionable	6.59	24.9	1.4717
Pn	Red	Unobjectionable	4.50	24.9	1.4722
Pb	Red	Unobjectionable	6.63	24.9	1.4724
Pz	Red	Unobjectionable	6.18	24.9	1.4726
Pa	Red	Unobjectionable	6.52	24.9	1.4725

Table 2: Chemical properties of the selected vegetable oils obtained within Kaduna.

Samples	Iodine Value (g I_2/g)	Saponification Value (mg KOH/g)	Acid Value (mgKOH/g)	Peroxide Value (meq/kg)	Ester Value (mgKOH/g)	Rancidity	Moisture Content (%)	Mineral Oil
Gg	29.31 ± 1.62	194.07 ± 0.47	0.39 ± 0.08	2.90 ± 0.14	193.67 ± 0.55	Absent	0.07 ± 0.00	Absent
Ggp	29.63 ± 0.81	184.04 ± 5.00	0.57 ± 0.02	3.20 ± 0.28	183.46 ± 4.98	Absent	0.05 ± 0.03	Absent
Gl	29.25 ± 0.09	188.66 ± 1.88	0.56 ± 0.00	2.20 ± 0.85	188.10 ± 1.88	Absent	0.07 ± 0.04	Absent
Gk	29.99 ± 0.48	194.48 ± 3.33	0.45 ± 0.19	1.87 ± 0.12	194.04 ± 3.51	Absent	0.20 ± 0.10	Absent
Gp	29.63 ± 0.45	194.31 ± 2.21	0.39 ± 0.08	2.05 ± 0.92	193.92 ± 2.99	Absent	0.07 ± 0.00	Absent
Gm	29.69 ± 0.34	187.49 ± 1.56	0.86 ± 0.91	2.40 ± 0.53	186.63 ± 1.69	Absent	0.04 ± 0.01	Absent
Pn	30.87 ± 0.21	195.61 ± 0.56	0.60 ± 0.02	1.60 ± 0.11	195.01 ± 0.60	Absent	1.19 ± 0.04	Absent
Pb	26.40 ± 0.54	186.97 ± 2.67	0.40 ± 0.12	1.60 ± 0.10	186.57 ± 2.55	Absent	0.13 ± 0.02	Absent
Pz	28.55 ± 0.23	182.62 ± 3.65	0.16 ± 0.02	4.00 ± 0.57	182.46 ± 3.68	Absent	0.10 ± 0.09	Absent
Pa	27.54 ± 0.55	190.36 ± 0.89	0.25 ± 0.06	2.40 ± 0.23	190.11 ± 0.85	Absent	0.05 ± 0.11	Absent

Values are mean ± S.D (n=3)

The iodine values of the vegetable oil samples analysed ranged between 29.25 – 29.99 g I_2/g for groundnut oil and 26.40 – 30.87 g I_2/g for palm oils. These values were low compared to the results obtained by Musa *et al*., for groundnut oil samples [14] and much higher compared to the results obtained by Siyanbola *et al*., [15] and Akinola *et al*., for palm oil samples [17]. Iodine value is an indicator of double bindings in the molecular structure, which influences the long term stability properties of the oil (i.e. important for storage). The greater the iodine value, the more the unsaturation and the higher the susceptibility to oxidation [16]. It has been reported that lowering the iodine value improves the stability and good yield of the liquid oil [17].The ester values in the samples ranged between 183.46 – 194.04 mg KOH/g for groundnut oils and 182.46 – 195.01 mg

KOH/g for palm oil samples. The values are in agreement with what was reported by Akinola *et al*., [17]. The higher the ester value, the more intact the ester bond between the glycerol molecule and the fatty acids. Therefore, the oil samples analysed are of high quality and can be stored for a longer time [17]. The saponification value of the oil samples ranged between 184.04 – 194.48 mg KOH/g for groundnut oil and 182.62 – 195.61 mg KOH/g for the palm oil samples. The values obtained are in line with the standard guidelines set by NAFDAC and CODEX as well as some other literatures [7, 13-14, 18]. Studies show that the high saponification values indicate that the oils are normal triglycerides and will be useful in the production of soap [19]. Saponification is only of interest if the oil is for industrial purposes, as it has no nutritional significance. But due to the fact that each fat has within the limits of biological variation, a constant fatty acid composition, determination of the saponification value is a reasonable means of characterizing the fat [20].

The acid values of the vegetable oil samples ranged between 0.39 - 0.86 mg KOH/g for groundnut oil and 0.16 - 0.60 mg KOH/g for the palm oil samples. These values obtained are in agreement with other studies [7, 13-15]. Acid value of oil suitable for edible purposes should not exceed 4 mg/g [20]. Low level of acidity is referring to suitable quality of oil [21-22]. The peroxide value of the vegetable oil ranged between 1.87 – 3.20 meq/kg for groundnut oils and 1.60 – 4.00 meq/kg for palm oils. These low peroxide values indicates slow oxidation of the analyzed oil and the values obtained are in line with the standard guidelines set by NAFDAC and CODEX which says that peroxide value should be less than 10 meq/kg [23]. The moisture contents (0.04 – 1.19%) of all the oil samples analysed were similar to the result as obtained by Siyanbola *et al*., but very low compared to the amounts obtained by Kershaw and Hackett from edible oil seeds such as cottonseeds, peanuts, palm kernel, sesame, soybean and sunflower seeds [15,24-25].

IV. Conclusion

Vegetable oils makes an important contribution to the diet of people, serving as a good source of lipid and fatty acids for human nutrition including the repair of worn out tissues, new cells formation as well as a useful source of energy. The results obtained shows that the vegetable oils on average have high shelf lives and can be stored for long time, in addition to good nutritional values, with all falling within the standard limits set by NAFDAC and CODEX. Furthermore, the results indicated the groundnut oils, in general have more nutritional value than the palm oils. It can therefore, be suggested that these vegetable oils pose no significant health risks to the consumers in Kaduna metropolis. However, it is recommended that further studies should be carried out to determine other nutritional composition of various branded oils such as β-carotene, fatty acid compositions and also antimicrobial activities.

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