IKR Journal of Agriculture and Biosciences (IKRJAB)
Journal homepage: https://ikrpublishers.com/ikrjab/
Volume-1, Issue-3 (September-October) 2025
OPEN ACCESS
ISSN: 3107-5509 (Online)

Quality Evaluation and Vitamin A Determination of Palm Oil Samples From Different Markets in FCT – Abuja, Nigeria

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DOI:10.5281/zenodo.17360491

ARTICLE INFO

Article history:
Received : 03-10-2025
Accepted : 10-10-2025
Available online : 15-10-2025

Citation: Owoicho, I., Saidu, A. A., Aminu, R., Nnedimma, I. F., Valentina, I. F., El-Yakub, S. I., Odionyenma, E., Akudo, M. J., & Yusuf, M. M. (2025). Quality Evaluation and Vitamin A Determination of Palm Oil Samples From Different Markets in Fct – Abuja, Nigeria. *IKR Journal of Agriculture and Biosciences (IKRJAB)*, 1(3), 99-103.

ABSTRACT **Original research paper**

Eleven palm oil samples were obtained from different local markets within Abuja metropolis. The markets include; Lambata, big sheda, Kabusa, Gwala Dagiri, Gwala Angwandodo, Gwala Wazobia, four bedroom Saburi, tomato market Dei-dei, Dutse and Kubwa markets. The samples were labelled A – K respectively. The physicochemical properties were determined using the following parameters; acid value, free fatty acid (FFA), saponification value, iodine value, peroxide value, moisture content and density. The Total carotenoids (vitamin A) and test for water soluble adulterants of the samples were also investigated. The physicochemical analysis shows the parameters in the following range: acid value (34.31 – 67.32 mgKOH/g), saponification value (200.05 – 247.17mgKOH/g), iodine value (14.54 – 27.52 wijs), peroxide value (2.58 – 4.91meg/kg), density (0.83 – 0.94 g/ml) and moisture (0.51 – 15.80%). The vitamin A results is also in the range of 41.88 – 149.45 mg/100g), while the tests for adulterants were negative for all the oil samples.

Keywords: Palm oil, Physicochemical properties, Vitamin A, Adulterants, Quality assessment.

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1. Introduction

Palm oil, derived from the reddish mesocarp of *Elaeis guineensis* fruit, is widely recognized for its global industrial and nutritional significance (Kamal, 2024). As of 2012, palm oil made up 32% of worldwide vegetable oil production, surpassing soybean oil to become the most consumed vegetable oil globally (Voora et al., 2019). Unrefined palm oil contains various essential components, including triacylglycerols, carotenoids, tocopherols, tocotrienols, phytosterols, phospholipids, free fatty acids (FFAs), and oxidation products (Ayyildiz et al., 2023).

Its applications are extensive around 90% is consumed as food (in items like margarine, deep frying oils, ice cream, and chocolate substitutes), while the remaining 10% is used for industrial purposes such as producing soaps, detergents, surfactants, and fatty acid derivatives (Gupta & Singh, 2024). Notably, it's estimated that palm oil is present in approximately half of all packaged products on supermarket shelves (Meijaard et al., 2025). In various African nations such as Nigeria, Ghana, Benin, Angola, Liberia, and the Congo, palm oil also serves medicinal purposes in treating infections and digestive issues (Gruca et al., 2014).

However, palm oil is vulnerable to spoilage through oxidation and microbial activity, which diminishes its nutritional value and causes off-flavors (Akinoso et al., 2025). The extent of fruit spoilage before oil extraction significantly impacts the development of harmful oxidative by-products, which are linked to inflammatory health risks (Machado et al., 2023).

One pressing issue is the adulteration of palm oil, a widespread problem with major safety implications. This illegal practice, driven by profit motives, often involves mixing palm oil with harmful substances or dyes, reducing its nutritional quality and posing health risks (Momtaz et al., 2023). In Nigeria, unauthorized food colorants are sometimes used to enhance the appearance of palm oil (Abimbola et al., 2023).

Palm oil is especially valued for its high content of carotenoids (precursors of vitamin A), as well as vitamin E compounds such as tocopherols and tocotrienols, which function as potent antioxidants (Thurnham, 2012; Szewczyk et al., 2021). In fact, crude palm oil contains up to 15 times more carotenoids than carrots and 300 times more than tomatoes (Hoe et al., 2024).

This research aims to assess the quality and vitamin A (carotenoid) content of palm oil sold in various markets within the Abuja Federal Capital Territory (FCT), Nigeria.

2. Materials and Methods

Palm oil samples were collected from different markets in Abuja FCT, Nigeria. The markets included: Lambata, Big Sheda, Kabusa, Dagiri, Angwan Dodo, Wazobia, Saburi, Dei-Dei, Dutse, and Kubwa, labeled from A to K.

2.1 Acid Value Determination

A solution of 25 ml diethyl ether, 25 ml ethanol, and 1 ml of 1% phenolphthalein was neutralized using 0.1 M NaOH. Ten grams of oil were dissolved in this solvent and titrated with the NaOH solution until a pink color remained stable (Edo et al., 2022).

Formula:
Acid Value = (Titre Volume × 5.61) / Sample Weight

2.2 Iodine Value Determination

The oil was weighed based on the expected iodine value (using 20 as a reference). Ten ml of carbon tetrachloride was added, followed by 20 ml of Wiji's reagent. After 30 minutes in the dark, 15 ml of potassium iodide and 100 ml of water were added. The solution was titrated with 0.1 M sodium thiosulfate using starch as the indicator. A blank was also prepared (Almeida et al., 2021).

Formula:
Iodine Value = (V2 – V1) × 1.269 / Sample Weight

2.3 Peroxide Value Determination

One gram of oil was mixed with 1 g potassium iodide and 20 ml of a glacial acetic acid/chloroform mixture (2:1). After heating in a water bath, the solution was transferred into 20 ml of 5% potassium iodide and titrated with 0.002 N sodium thiosulfate, using starch as the indicator (Kenechi et al., 2017).

Formula:
Peroxide Value = (2 × V) / Sample Weight

2.4 Saponification Value

Two grams of oil were treated with 25 ml alcoholic KOH and heated for one hour. The mixture was titrated with 0.5 M HCl using phenolphthalein as an indicator. A blank was prepared and titrated similarly (Mâncio et al., 2017).

Formula:
Saponification Value = (V2 – V1) × 28.05 / Sample Weight

2.5 Specific Gravity

A 50 ml pycnometer was cleaned, dried, and weighed. It was then filled with water and oil separately, and weighed accordingly (Almeida et al., 2021).

Formula:
Specific Gravity = Weight of Oil Volume / Weight of Water Volume

2.6 Vitamin A (Carotenoids) Content

Five grams of oil were extracted with 20 ml acetone for 12 hours in the dark. The carotene-rich layer was separated using petroleum ether and dried over sodium sulfate. The optical density was read at 452 nm (Malau et al., 2019).

Formula:
Carotenoids (mg/100g) = 3.85 × OD × Volume Made Up × 100 / Sample Weight × 1000

2.7 Adulteration Test

Five ml of oil was mixed with 15 ml petroleum ether and 5 ml of 1:1 HCl:Water. A clear base indicated no adulteration, while reddish or yellowish bases suggested the presence of adulterants (Dixit et al., 2019).

3. Results and Discussion

3.1 Acid Value

Acid values ranged from 34.31 to 67.32 mgKOH/g, far exceeding NAFDAC's 4.00 mgKOH/g limit (NAFDAC, 2019). Lambata had the highest value, and Dutse the lowest. Elevated acid levels suggest ongoing hydrolysis, which may degrade oil quality and affect processing (Alhaji et al., 2024).

3.2 Saponification Value

The values (200.05–247.17 mgKOH/g) were mostly above regulatory standards, with the exception of the Angwan Dodo sample. High saponification values indicate the presence of short-chain fatty acids and are beneficial for soap-making due to the resulting product hardness (Alum et al., 2024).

3.3 Iodine Value

All samples displayed lower iodine values than the NAFDAC benchmark, suggesting reduced unsaturation. Oils with lower iodine values are more resistant to oxidation, extending shelf life (Gen et al., 2023).

3.4 Peroxide Value

The peroxide values were within acceptable limits (<10.00 meq/kg). Kabusa had the lowest at 0.59 meq/kg, and Gwagwalada-Dagiri the highest at 3.6 meq/kg. These low values indicate minimal rancidity and longer shelf stability (Pike et al., 2024; Maliki et al., 2020).

3.5 Moisture Content

Moisture levels in all samples exceeded NAFDAC's maximum of 0.2%. Higher moisture facilitates microbial growth and hastens spoilage. The sample from Kubwa market had the highest moisture content at 15.80% (Yu et al., 2021).

Table 1: Physicochemical Properties of Palm oil samples obtain from different markets in Abuja metropolis

Samples	AV mgKOH/g	SV mgKOH/g	IV wiijs	PV (meq/kg)	MC (%)	DS g/ml
A	67.32	239.85	20.45	2.1	1.24	0.9294
B	46.56	239.82	19.66	1.1	1.90	0.9000
C	59.98	230.58	22.39	0.59	2.72	0.9257
D	34.68	231.57	27.52	2.83	1.71	0.9035
E	45.94	247.17	14.54	3.61	0.43	0.9447
F	48.54	200.05	22.32	2.91	2.36	0.9197
G	42.07	237.47	17.18	1.29	1.93	0.9366
H	61.44	218.59	18.34	1.05	2.90	0.9170
I	43.41	216.26	16.58	3.40	1.80	0.9077
J	34.31	244.13	18.41	2.58	0.51	0.9259
K	66.88	231.26	19.84	1.54	15.80	0.8307
NAFDAC	4.00 max	190 – 209	50 – 55	10 max	0.2	0.891 – 0.899

AV=Acid value, SV=Saponification value, IV=Iodine value, PV=Peroxide value, MC= Moisture content, DS=Density

3.6 Total Carotenoid

The total carotenoids (vitamin A) expressed in ppm and adulterants test for palm oil are presented in Table. 2. The total carotenoids determined were in the range of 418.8 - 1494.5 ppm. The total carotenoid of the oil sample obtained from gwalawazobia park market was lower compared to the standard value which is in the range of 500 – 700 ppm. The samples from markets at lambata, kabusa, gwaladagiri, and saburideidei fall within the specification, while those from big sheda, kabusagbudunoyi, kabusa, gwalaangwan dodo, tomato deidei, dutse and kubwa. Reports also have it that some palm oil samples contain very high amount of carotenoids up to 4000 ppm (Choo et al 2005). Carotenoids impart the characteristic orange-red colour to crudepalm oil(Puteh et al., 2022).Palm oil also offer some oxidative protection by themselves being oxidized first, prior to the triglycerides (Sulaiman et al., 2022). Carotenoids, in particular α- and β-carotene, are precursors of vitamin A that are converted into vitamin A in vivo (Barua et al., 2000). The high total carotenoids contents in most of the palm oil samples makes them suitable and reliable source of vitamin A supplementation.

The test for adulteration of the oil as shown in Table 2 clearly indicated that the test was negative for all the oil samples obtained from the various markets making them safe for consumption.

Table 2: Vitamin A contents and adulterants test for the palm oil samples

Samples	Vitamin A (ppm)	Adulterants Test
A	680.7	Absent
B	1098.7	Absent
C	635.2	Absent
D	869.3	Absent
E	595.2	Absent
F	847.7	Absent
G	418.8	Absent

H	661.4	Absent
I	713.0	Absent
J	714.5	Absent
K	1494.5	Absent
NAFDAC	500 - 700	-

Conclusion

The quality of palm oil samples obtained from various local markets within the Federal Capital Territory (FCT), Abuja, was thoroughly assessed through the analysis of key physicochemical parameters. The evaluation revealed that all the sampled oils possessed significantly high acid values, which may be indicative of advanced hydrolysis and potential degradation of triglycerides. This elevated acidity could be attributed to prolonged storage, poor handling practices, or delayed processing of the oil palm fruits after harvest. Additionally, all samples demonstrated relatively low iodine values, which suggest a lower degree of unsaturation. While this may reduce the oil's susceptibility to oxidation and rancidity, it could also impact its nutritional composition and functional behaviour in certain culinary applications.

Notably, the saponification values recorded were consistently high across all samples, indicating a higher content of short- and medium-chain fatty acids. This makes the oils particularly suitable for industrial applications such as soap production, where high saponification value is desirable for achieving hard soap bars with good foaming properties. Importantly, qualitative tests for adulteration showed no presence of harmful substances or illegal colorants, affirming the authenticity and safety of the sampled oils for consumer use.

Furthermore, the assessment of vitamin A content, based on total carotenoid levels, revealed that the oils are rich in pro-vitamin A compounds, making them a valuable source of micronutrients. This is especially significant in combating vitamin A deficiency, which remains a public health concern in many developing regions. Overall, the findings suggest that while the oil samples may require further refinement to reduce acidity for direct edible use, they retain high nutritional value and industrial utility, particularly in soap manufacturing and as a dietary source of vitamin A.

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