



Effect of Processing Methods on the Microbial and Physicochemical Qualities of Palm Oil Produced in Ondo State, Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. Author AOD designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors OA and AFA supervised the study and the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

This study was aimed at assessing the physicochemical and microbiological quality of Palm oil produced in Ondo State, Nigeria. Three palm oil extraction methods were used for the study. The oil samples were stored for six months, while the microbiological and physicochemical quality assessment were investigated monthly. Results show that the Free Fatty Acids (FFA), Acid Value, Peroxide Value, Iodine Value and Microbial counts of all the oil samples examined varied from one extraction method to the other over the storage period. The samples obtained through the traditional extraction methods had the least quality over the storage period. The total bacteria counts ranged from 0.66 – 3.45 x 10⁴ cfu/ml for the mechanized, 1.25 – 4.50 x 10⁴ cfu/ml for the semi-mechanized and 1.20 – 6.50 x 10⁴ cfu/ml for the traditional method while the fungi count ranged from 0.30 - 5.33 x 10⁴ sfu/ml for mechanized, 1.22 – 7.56 x 10⁴ sfu/ml for the semi-mechanized and 2.30 – 8.56 x 10⁴ sfu/ml for the traditional method. A range of microbes including some pathogenic, were isolated from Palm oil samples. *Aspergillus flavus*, *Pseudomonas aeruginosa*, *Aspergillus saprophyticus*, *Varicosporum elodeae*, *Bacillus licheniformis*,

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Pseudomonas aeruginosa and *Staphylococcus aureus* were the predominant species. However, *Bacillus subtilis*, *Trichoderma viridae* and *Bacillus cereus* are the least isolated microorganisms. The oil extracted through the mechanized method had the lowest Free Fatty Acid (5.60 – 9.77%), Acid Value (11.20 – 20.18 MgKOH/g), Iodine Value (40.00 - 55.43 Wijs), and Peroxide Value (3.02 – 10.33 Meq/Kg) before and after storage than those extracted by the other methods. The sensory evaluation also showed preference for the palm oil extracted using the mechanized process compared to the other methods, as it retained its qualities significantly over the storage period.

Keywords: Palm oil; extraction; organoleptic; physicochemical; microbiological.

1. INTRODUCTION

Palm oil is obtained from the fleshy body of oil palm fruit (*Elaeis guineensis* Jacq.). Palm oil is orange-red to brownish or yellowish-red in colour [1]. Globally, Palm oil is one of the mostly consumed vegetable oils, estimated at 35% in 2015 [2]. Oil palm fruit yields two types of oils viz. palm kernel oil and palm oil. Palm kernel oil is obtained from the endocarp while palm oil is obtained from the fleshy mesocarp [3]. Evaluating the quality of palm oil is necessary for its consumption. About 55% of palm oil consumed in Nigeria is produced domestically and the rest 45% deficit are met through importation from major producing nation such as Indonesia and Malaysia [4]. Malaysia and Indonesia currently produce around 89% of the globally consumed palm oil, with Thailand, Columbia and Nigeria accounting for about 6% and other oil palm producing nations producing 5% [4].

Oil palm comprises mainly triglycerides or triacylglycerols as 95% of the total constituents. It also contains minor compounds such as diacylglycerol, mono glycerol and free fatty acids (FFA) produced from the biosynthesis and / or hydrolysis of triacylglycerols. Sterol, tocopherol, tocotrienols, pigments and metal ions are also present [5]. Most fatty acids contained therein are palmitic acid and oleic acids [6,7,5].

Palm oil constituents have been studied for an understanding of its purported nutritional and health properties, such as antioxidant activities, cholesterol lowering, anti-cancer effects and protection against atherosclerosis [8]. Another compound from the oil palm fruit is the water-soluble phenolic flavonoid rich antioxidant complex, which has been reported to possess potent antioxidant properties and also, modulatory effects against skin and breast cancer. Its water solubility properties is also being assessed for use as nutraceuticals and in

cosmetics for potentials in alleviating skin aging [5].

Oil palm quality in Nigeria is often a product of the level of hygiene practiced by oil palm processors. These individuals seldom practice modern aseptic production techniques and are unaware of the microbiological implications of poor sanitation and storage methods [4]. Therefore, palm oil often gets contaminated by microorganisms from the environment, raw materials and processing equipment, as well as during storage and distribution [9,8]. Whereas contamination of imported palm oil is often as a result of prolonged storage and unsuitable distribution constrains. The microbial and physicochemical properties of oil palm influences some of its down streams applications, such as biodiesel production [4].

Palm oil quality is usually a product of its acid content (indicator of FFA content) and impurities [10,11]. However, high acidity values as a result of lipase activity is indicative of quality defect with a resulting effect in the sensory qualities of the palm oil. Without refining, such oil would be unedible ([12]; Enyoh Christian Ebere & Enyoh Emmanuel Chinedu, 2018).

The microbial flora of processed palm oil is mostly influenced by the originating environment, the microbial quality of raw product and the sanitary conditions of the processing plant and environment (Alima Senkoh Ngangjoh & Ejoh, 2020; [5]).

Heating the oil during cooking reduces the microbial load of oil palm, but it has been observed overtime that some individuals in the rural areas consume palm oil raw, which often results in health complications when the microbial load of the consumed palm oil is high. It is against this background that this research was carried out with the aim of determining the microbial quality and physicochemical

characteristics of palm oil sold in Akure, Ondo state, Nigeria.

2. MATERIALS AND METHODS

2.1 Sample Collection

Fresh palm oil samples were collected in sterile sample bottles from traditional processors; semi-mechanized processors and mechanized processing mills in Akure, Ondo state, Nigeria (7.26408,5.23947; 7.14078,5.10645; 6.50677,4.79246; 6.51763,4.78163; 6.50247,4.77951; N07.128105,E05.399671). The production methods are shown in Fig. 1.

2.2 Extraction of Control Oil

Palm oil was extracted in the laboratory according to the method adopted by (Ariyo

Dokun Olanrewaju & Adetutu, 2019; [1]). The oil was concentrated by distilling off the solvent, and then used as control (Olanrewaju & Adetutu, 2016).

2.3 Enumeration of Total Heterotrophic Bacteria and Fungi Counts

The Microbial population from the palm oil samples were enumerated using serial dilution pour plate the method described by Pepper and Gerba [13].

2.4 Isolation and Identification of Degrading Microorganisms

Microorganisms were isolated and identified every month using the methods described by Ariyo Dokun Olanrewaju & Adetutu, 2019; Odoh, Chuks K., Tarfen Y. Amapu et al., 2016.

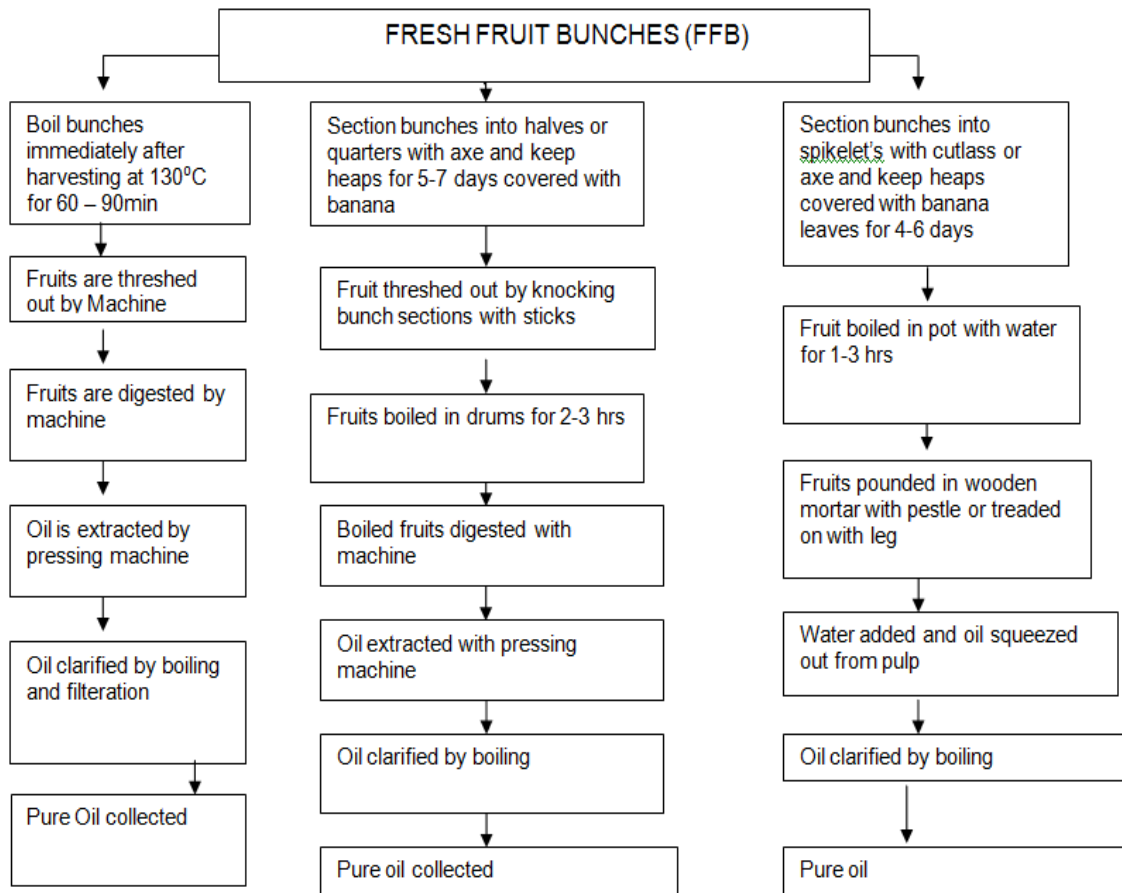


Fig. 1. Flow diagram of palm oil extraction methods in Nigeria. Mm: Mechanized method; Sm: Semi-mechanized method; T Traditional method

2.5 Physicochemical Characteristics

The effect of the production methods on the physicochemical characteristics (peroxide, free fatty acid, iodine and acid values) were investigated using the method of American Oil Chemists' Society (AOCS) Cd 1c-85; ISO 3961:2018 [14].

2.6 The Sensory Evaluation

The sensory evaluation were carried out on the palm oil samples using a 5-point Hedonic scale (Nwagu et al. 2011) by a 10 man untrained panel. The palm oil samples were evaluated on the basis of appearance, aroma, taste and mouth feel (Szydłowska-Czerniak, Aleksandra & Trokowski, György Karlovits, 2013).

3. RESULTS AND DISCUSSION

Table 1 and 2 depicts the microbial (bacterial and fungal) counts of palm oil from processing sites in Ondo State, Nigeria. The total heterotrophic bacterial count as observed ranged from 0.66 – 6.20 cfu/mL. Total fungi ranged from 0.30 – 8.56 cfu/mL. This microbial load closely agrees with report by other authors, for instance the microbial load of palm oil sold in Jos metropolis, Plateau state Nigeria ranged from 9.4×10^4 to 1.61×10^4 cfu/ml [8], 8.0×10^3 to 3.7×10^4 cfu/ml for mould load [15]. Although this findings differs widely from 7.6 Log cfu/ml reported for palm oil sold in some markets in Nigeria after 8 months of storage [1]. The microbial load is also a reflection of the palm oil extraction method. The varying differences observed in the microbial load could be attributed to the duration of storage after processing. The identification of the bacterial population showed a mixture of Gram positive and negative rods and cocci. While biochemical identification grouped them as *Staphylococcus aureus*, *Bacillus subtilis*, *Bacillus cereus*, *Pseudomonas aeruginosa*, *Micrococcus* species (Table 3). These findings are in close agreement with reports by Okechalu et al. [8], Tagoe et al. [16], Ohimain et al. [17] and Constant et al. [12] who isolated *Bacillus*, *Staphylococcus*, *Pseudomonas* and *Micrococcus* species. Constant et al. [12] attributed that the activities of *Bacillus* and *Pseudomonas* species were responsible for the production of lipase and amylase enzymes. While *Staphylococcus aureus* and *Micrococcus* species were implicated as contaminants [17,12]. The fungi were identified as *Articulospora inflata*, *Penicillium italicum*, *Aspergillus flavus*, *Trichoderma viridae* and

Aspergillus saprophyticus. These findings are in close agreement with reports by Okechalu et al. [8], Tagoe et al. [16], Agu et al. (2013), Izah et al. (2013) and Ohimain et al. [17] who reported the isolation of *Aspergillus* and *Penicillium* species. Constant et al. [12] attributed their roles to the production of lipase enzyme.

The free fatty acids (FFA) of the palm oil stored at room temperature (25 - 28°C) increased with the increasing period of storage for six months. The FFA for the mechanized extraction method ranged from 5.60 – 9.77; while the FFA for the semi-mechanized extraction method ranged from 13.11 – 27.45 and the FFA for the Traditional extraction method ranged from 18.17 – 33.45 (Table 4). The FFA of all the palm oil samples from the various extraction points increased across the storage periods, exceeding the prescribed SON standard of FFA (2.000) in edible palm oils ([18], Milwidsky and Gabriel, 1982). These could be as a result of microorganisms secreting lipase, which then triggers the hydrolysis of palm oil triglycerides, thus increasing FFA content [12].

This study showed that the acid value of the palm oil stored at room temperature (25 - 28°C) increased with the increasing period of storage (six months). The acid value for the mechanized extraction method ranged from 11.20 – 20.18; while the acid value for the semi-mechanized extraction method ranged from 25.51 – 54.68 and the acid value for the Traditional extraction method ranged from 40.00 – 66.00 (Table 5) This is higher than findings by Olaofe et al. [19] and (Emmanuel Agomuo, Peter Amadi et al., 2017) who reported 4.77, 9.36 and 5.99 mg KOH/g for white and yellow cultivars of melon seed oil and groundnut oil respectively. Noviar et al. [20] highlighted that, several human activities in the informal palm oil production sector were liable to increase the acidity of crude palm oil. The high acid values indicates that the palm oils will need further refining to be edible [21]. The acid value is indicative of the decomposition extent of triglycerides in the oil by lipase action into free fatty acids and other physical factors such as light and heat [22].

The iodine value of the palm oil from the mechanized method of extraction increased over a five months storage period, after which a gradual decrease in the iodine value was observed 42.68-69.00 (Table 6). The iodine value was relatively close to the acceptable standards by Standard Organization of Nigeria

[18]. This agrees with the findings of Nwanekezi and Onyeagba (2007) who reported that the higher the iodine value, the greater the degree of unsaturated fats that exist in the oils. It is also indicative of adulteration of palm oil. The iodine value of the semi-mechanized method of extraction also increased over a two months period after which a gradual decline was observed in the iodine value. While the iodine value of the Traditional extraction method fluctuated by increasing and decreasing over a six months period. This findings agree with reports by Babatunde and Bello (2011) who highlighted that 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). Oils with high iodine value are useful as raw materials in the manufacture of vegetable oil-based ice cream [23]. Although the increase in the iodine value beyond the stipulated SON [18] standards is indicative of its unfitness for consumption [18].

The peroxide value is indicative of the susceptibility to rancidity in oils, thus a high peroxide value of oil indicates a poor resistance of the oil to peroxidation during storage [24]. The peroxide value of the mechanized and semi-mechanized method of extraction increased over a six months period (3.02-13.01), while the peroxide value of the Traditional method of extraction decreased over a two months period (6.28-10.20) after which a steady rise in the peroxide value was observed (10.27-14.45) (Table 7). This findings indicate the onset of rancidity with increasing storage period. This findings differ from reports by Nwosu-Obieogu Kenechi et al. [25] who reported lower peroxide values (6.89-8.88) for palm oil sold in Isialangwa Traditional government, Abia, Nigeria. The peroxide value is a determining indicator of rancidity in oils, thus a high peroxide value of oil indicates a poor resistance of the oil to peroxidation during storage [24]. The peroxide values from this study were close to SON (2003) standards indicating that the oils were relatively stable to oxidative rancidity with time.

Colour and turbidity were the appearance attributes measured during the study (Tables 8-13). The intensity ranged from 1.00-2.00 with a variation observed in the colour attributes based

on the processing methods. The colour intensity also significantly different during the months spent in storage. The turbidity also was higher in the traditionally prepared palm oil which also differed significantly across the storage period. This indicates that the palm oil was affected by the scale of processing and other inherent components such as moisture of the palm oil. Moisture in oils is a key component that dictates physical properties of oils [26].

Distinct differences were observed in the aroma of the palm oil across the various stages of processing. The palm oil produced using mechanized and semi-mechanized means had a fresh palm oil aroma when compared to the traditionally prepared palm oil which had a relatively burnt smoky smell. The palm oil also had low levels of rancidity. Rancidity refers to as the offensive odours and flavours resulting from lipolysis (hydrolytic rancidity) or lipid oxidation (oxidative rancidity) (Abdulkadir, A.G. and Jimoh, 2013). It is also attributed to presence of or level of unsaturation in the lipid sample. Rancidity test is used to detect the extent of spoilage in fat and oil (Nielsen, 2002). The differences across the scale of production indicates that the aroma is also a result of mechanization of the extraction process.

Two basic tastes (sweet and aroma) were identified. The palm oil samples were relatively sweet with a significant drop in the sweetness (bitterness) observed during the fourth month from the traditionally prepared palm oil samples. The presence of FFA, the underlining cause of rancidity in oils can contribute to bitter/ soapy flavours [27]. The storage of palm fruits for extended periods of time increases the FFA which causes rancidity in oils ([1]; Frank et al. 2011). The rancidity in the palm oil samples was a result of extended storage.

The roughness and mouth coating attributes were evaluated for mouth feel of the palm oil samples. An oily mouth coating signifies very thin film of residual oil on the tongue after swallowing while a waxy mouth coating signifies thick residual oil on the tongue. Smooth oils with less mouth coating were relatively desired than rough oils with waxy coating on the mouth. The sensory results of the samples depicts their acceptability as reported by (Myat et al., 2009).

Table 1. Bacteria count of palm oil extracted from different processing methods over 6 months period (Colony forming unit x 10⁴/ml)

Periods (Months)	Mechanized			Semi-Mechanized			Traditional			Control
	A	B	C	D	E	F	G	H	I	J
0	1.66 ±0.22	0.66 ±0.19	1.00 ±0.09	2.33 ±0.13	2.00 ±0.01	3.20 ±0.22	3.25 ±0.03	2.25 ±0.39	2.70 ±0.06	0.00
1	2.60 ±0.03	2.2 ±0.04	1.30 ±0.07	3.30 ±0.32	3.40 ±0.02	4.30 ±0.02	4.60 ±0.02	3.20 ±0.11	3.25 ±0.23	0.00
2	2.50 ±0.30	2.45 ±0.04	2.3 ±0.39	4.00 ±0.33	4.50 ±0.03	4.40 ±0.23	5.40 ±0.23	3.50 ±0.23	4.35 ±0.33	1.66 ±0.23
3	2.60 ±0.54	2.70 ±0.05	3.33 ±0.40	4.50 ±0.31	4.40 ±0.02	4.00 ±0.11	5.80 ±0.04	4.50 ±0.33	5.50 ±0.09	1.66 ±0.03
4	2.34 ±0.04	0.00	3.45 ±0.05	4.33 ±0.34	4.00 ±0.11	4.05 ±0.23	5.60 ±0.03	5.30 ±0.02	5.50 ±0.09	2.70 ±0.43
5	0.00	0.00	2.00 ±0.43	3.43 ±0.44	3.31 ±0.21	4.051 ±0.22	4.60 ±0.29	6.20 ±0.34	5.20 ±0.08	0.00
6	0.00	0.00	2.60 ±0.023	3.00 ±0.09	1.25 ±0.01	2.10 ±0.02	2.05 ±0.03	3.25 ±0.22	1.20 ±0.03	0.00

Key: Mechanized Extraction Method

A: Okpoke Oil Processing, Okitipupa; B: Okitipupa Oil palm estate Processing Okitipupa; C: Abbis Farm, Ala Ogbese road

Semi Mechanized Extraction Method

D: Mama Sarah Oil, Ode- Irele; E: Blessing Oil, Oktipupa; F: Federal College of Agriculture, Akure

Traditional Extraction Method

G: Sunday Oil Akure Idanre road, Idanre; H: Oluwatobi Oil Okitipupa; I: Musilat Oil Processing Mill Ode – Irele

Control J: Laboratory

Table 2. Fungal count of palm oil extracted from different processing methods over 6 months period (Spore forming unit x 10⁴/ml)

S/N	Periods (Months)	Mechanized			Semi Mechanized			Traditional			Control
		A	B	C	D	E	F	G	H	I	J
0		2.33 ±0.35	0.00 ±0.09	2.66 ±0.23	3.33 ±0.39	3.56 ±0.02	4.33 ±0.02	4.56 ±0.02	4.56 ±0.03	2.3 ±0.22	0
1		4.33 ±0.34	3.45 ±0.09	4.2 ±0.11	4.54 ±0.49	5.66 ±0.03	4.54 ±0.03	5.66 ±0.03	6.66 ±0.04	4.34 ±0.23	2.3 ±0.34
2		4.15 ±0.09	3.1 ±0.22	2.45 ±0.23	7.56 ±0.04	8.56 ±0.02	5.62 ±0.03	7.86 ±0.03	8.26 ±0.02	3.36 ±0.39	2 ±0.03
3		1.4 ±0.02	2.00 ±0.23	5.33 ±0.22	5.66 ±0.03	4.22 ±0.23	6.56 ±0.02	7.44 ±0.05	8.56 ±0.34	5.34 ±0.29	1.33 ±0.04
4		3.3 ±0.03	2.75 ±0.33	2.32 ±0.20	3.34 ±0.02	4.34 ±0.03	5.89 ±0.30	6.55 ±0.03	6.54 ±0.43	6.54 ±0.39	2.34 ±0.04
5		0.3 ±0.11	0.7 ±0.23	2.33 ±0.03	1.22 ±0.23	5.33 ±0.04	5.78 ±39	5.6 ±0.03	5.22 ±0.44	4.54 ±0.39	1.66 ±0.0
6		0.6 ±0.23	0.6 ±0.33	2.34 ±0.03	2.34 ±0.34	3.23 ±0.34	4.35 ±0.29	3.33 ±0.32	4.34 ±0.34	3.34 ±0.49	0.00

Keys: Mechanized Extraction Method

A: Okpoke Oil Processing, Okitipupa; B: Okitipupa Oil Processing Comany Okitipupa; C: Abbis Farm, Ala Ogbese road

Semi Mechanized Extraction Method

D: Mama Sarah Oil, Ode- Irele; E: Blessing Oil, Oktipupa; F: Federal College of Agriculture, Akure

Traditional Extraction Method

G: Sunday Oil Akure Idanre road, Idanre; H: Oluwatobi Oil Okitipupa; I: Musilat Oil Processing Mill Ode – Irele

Control J: Laboratory

Table 3. Biochemical characteristics of bacterial isolates

Isolates	Gram reaction	C.M	IN	MR	VP	CIT	CAT	OXI	Sugar test					Probable Org
									M	G	X	S	L	
1	-	Rods	+	-	+	+	+	-	+	-	+	+	+	<i>Staphylococcus aureus</i>
2	+	Rods	-	-	+	-	+	-	-	+	+	+	-	<i>Bacillus subtilis</i>
3	+	Rods	-	-	+	-	-	+	-	+	-	+	-	<i>Bacillus cereus</i>
4	-	Rods	-	+	-	+	+	+	-	+	+	-	-	<i>Pseudomonas aeruginosa</i>
5	-	Cocci	+	-	+	+	+	-	+	+	-	+	+	<i>Micrococcus sp.</i>

Keys: VP= Voges proskauer, Cit = Citrate, IN = Indole, MR = Methyl red, G= Glucose, OX= Oxidase, S= Sucrose, M= Maltose, X= Xylose, L= Lactose, Cat=Catalase.

Physiochemical Properties

Table 4. Free fatty acid value of palm oil extracted from different processing methods over 6 months period (Stored at room temperature 25-28°C)

Periods (Months)	Mechanized			Semi Mechanized			Traditional			Control
	A	B	C	D	E	F	G	H	I	J
0	6.03 ±0.39	6.00 ±0.32	5.6 ±0.22	13.11 ±0.33	14.34 ±0.21	13.23 ±0.30	18.17 ±0.22	20.00 ±0.12	20.34 ±0.05	4.88 ±0.04
1	6.51 ±0.03	6.40 ±0.03	6.00 ±0.02	17.80 ±0.22	18.34 ±0.34	14.40 ±0.31	18.44 ±0.02	22.30 ±0.32	23.67 ±0.03	5.77 ±0.05
2	6.63 ±0.03	6.90 ±0.02	7.50 ±0.03	19.40 ±0.22	20.45 ±0.33	15.45 ±0.08	19.20 ±0.19	24.45 ±0.23	25.21 ±0.12	6.71 ±0.23
3	8.06 ±0.02	7.95 ±0.12	8.78 ±0.04	20.75 ±0.43	23.45 ±0.21	17.67 ±0.02	26.40 ±0.23	27.80 ±0.04	27.34 ±0.01	9.20 ±0.22
4	8.08 ±0.23	8.89 ±0.32	9.10 ±0.05	20.56 ±0.11	24.44 ±0.31	19.32 ±0.17	27.46 ±0.02	29.02 ±0.09	30.23 ±0.23	9.57 ±0.32
5	9.26 ±0.13	9.30 ±0.22	9.27 ±0.31	20.70 ±0.21	26.34 ±0.22	20.34 ±0.18	23.36 ±0.01	30.34 ±0.03	32.45 ±0.31	9.97 ±0.15
6	9.77 ±0.12	9.40 ±0.39	9.43 ±0.67	21.22 ±0.23	27.45 ±0.33	21.22 ±0.27	27.98 ±0.02	32.03 ±0.29	33.45 ±0.39	10.50 ±0.23

Keys: Mechanized Extraction Method

A: Okpoke Oil Processing, Okitipupa; B: Okitipupa Oil Processing Company Okitipupa; C: Abbis Farm, Ala Ogbese road

Semi Mechanized Extraction Method

D: Mama Sarah Oil, Ode- Irele; E: Blessing Oil, Okitipupa; F: Federal College of Agriculture, Akure

Traditional Extraction Method

G: Sunday Oil Akure Idanre road, Idanre; H: Oluwatobi Oil Okitipupa; I: Musilat Oil Processing Mill Ode – Irele

Control J: Laboratory

Table 5. Acid value of palm oil extracted from different processing methods over 6 months period (Stored at room temperature 25-28°C)

Periods (Months)	Mechanized			Semi Mechanized				Traditional		Control
	A	B	C	D	E	F	G	H	I	J
0	12.60 ±0.23	12.00 ±43.0	11.20 ±3.80	25.51 ±30.0	28.63 ±03	26.46 ± 32	48.08 ±02	40.00 ±02	40.68 ±02	9.88 ±04
1	13.50 ±0.02	12.80 ±40	12.34 ±11	35.57 ±32	36.68 ±07	28.80 ± 03	48.22 ±03	44.60 ±03	47.34 ±07	6.23 ±21
2	11.26 ±0.03	13.80 ±50	15.00 ±02	38.80 ±32	40.90 ±12	30.90 ±05	38.40 ±23	48.90 ±23	60.46 ±41	13.55 ±03
3	17.12 ±0.34	15.90 ±62	17.56 ±24	41.71 ±35	46.90 ±03	35. 32 ±07	52.80 ±02	55.60 ±12	64. 90 ±07	18.50 ±21
4	16.61 ±0.23	17.78 ±63	18.20 ±63	41.10 ±12	48.88 ±08	38.64 ±03	55.32 ±23	58.04 ±02	60. 46 ±08	20.09 ±23
5	19.54 ±0.08	18.60 ±22	18.54 ±36	43.40 ±07	52.6 ±02	40.68 ±23	46.52 ±07	60.68 ±06	64.90 ±06	20.12± 05
6	20.18 ±0.04	18.80 ±45	18.86 ±02	43.44 ±06	54.68 ±03	31. 09 ±12	47.96 ±12	64.06 ±06	66.90 ±07	21.75 ±23

Mechanized Extraction Method

A: Okpoke Oil Processing, Okitipupa; B: Okitipupa Oil Processing Comany Okitipupa; C: Abbis Farm, Ala Ogbese road

Semi Mechanized Extraction Method

D: Mama Sarah Oil, Ode- Irele; E: Blessing Oil, Oktipupa; F: Federal College of Agriculture, Akure

Traditional Extraction Method

G: Sunday Oil Akure Idanre road, Idanre; H: Oluwatobi Oil Okitipupa; I: Musilat Oil Processing Mill Ode – Irele

Control J: Laboratory

Table 6. Iodine value of palm oil extracted from different processing methods over 6 months period (Wijs) (Stored at room temperature 25-28°C)

Periods (Months)	Mechanized			Semi Mechanized				Traditional		Control
	A	B	C	D	E	F	G	H	I	J
1	44.95 ±0.32	44.09 ±0.54	40.00 ±0.23	46.94 ±0.02	50.4 ±0.39	48.90 ±0.31	58.88 ±0.33	60.45 ±0.09	62.00 ±0.43	42.98 ±0.34
2	45.25 ±0.02	45.50 ±0.05	42.00 ±0.11	54.21 ±0.43	56.50 ±0.49	49.77 ±0.23	54.22 ±0.23	63.34 ±0.09	64.45 ±0.34	44.17 ±0.03
3	45.71 ±0.03	46.70 ±0.09	43.34 ±0.32	55.21 ±0.43	57. 45 ±0.43	50.88 ±0.03	55.71 ±0.02	64.55 ±0.09	65.67 ±0.33	47.11 ±0.34
4	48.19 ±0.31	49.34 ±0.03	45.56 ±0.11	54.44 ±0.05	57.00 ±0.03	53.45 ±019	60.72 ±0.01	67.77 ±0.09	68.78 ±0.44	48.80 ±0.45
5	49.21 ±0.29	50.09 ±0.05	45.90 ±0.23	54.07 ±0.43	57.89 ±0.09	56.89 ±0.29	61.74 ±0.02	68.00 ±0.09	69.80 ±0.22	49.21 ±0.03
6	49.04 ±0.34	53.50 ±0.23	49.02 ±0.02	54.07 ±0.34	60.00 ±0.03	60.22 ±0.49	57.04 ±0.04	69.00 ±0.09	71.67 ±0.09	52.21 ±0.04
7	47.87 ±0.09	55.43 ±0.22	49.45 ±0.09	54.08 ±0.03	59.00 ±0.23	63.34 ±0.34	58.26 ±0.44	68.00 ±0.11	71.70 ±0.39	55.22 ±0.53

Mechanized Extraction Method

A: Okpoke Oil Processing, Okitipupa; B: Okitipupa Oil Processing Comany Okitipupa; C: Abbis Farm, Ala Ogbese road

Semi Mechanized Extraction Method

D: Mama Sarah Oil, Ode- Irele; E: Blessing Oil, Oktipupa; F: Federal College of Agriculture, Akure

Traditional Extraction Method

G: Sunday Oil Akure Idanre road, Idanre; H: Oluwatobi Oil Okitipupa; I: Musilat Oil Processing Mill Ode – Irele

Control J: Laboratory

Table 7. Peroxide value of palm oil extracted from different processing methods over 6 months period (Meq/Kg) (Stored at room temperature 25-28°C)

Periods (Months)	Mechanized			Semi Mechanized				Traditional		Control
	A	B	C	D	E	F	G	H	I	J
0	3.80 ±0.39	3.02 ±0.02	4.45 ±0.39	5.54 ±0.03	6.30 ±0.09	6.02 ±0.09	8.74 ±0.34	8.73 ±0.43	9.80 ±0.32	2.52 ±0.32
1	4.78 ±0.34	4.34 ±0.01	5.00 ±0.21	6.21 ±0.02	6.50 ±0.09	6.20 ±0.09	6.28 ±0.34	9.03 ±0.39	9.00 ±0.013	2.90 ±0.36
2	4.92 ±0.23	4.94 ±0.02	5.32 ±0.02	8.20 ±0.22	7.80 ±0.09	8.20 ±0.09	7.08 ±0.34	10.23 ±0.09	10.30 ±0.06	6.27 ±0.11
3	7.01 ±0.02	5.45 ±0.03	6.00 ±0.63	8.53 ±0.02	8.10 ±0.09	8.50 ±0.09	10.72 ±0.23	11.23 ±0.32	12.34 ±0.05	8.56 ±0.02
4	9.81 ±0.02	6.78 ±0.03	7.89 ±0.34	10.04 ±0.32	9.50 ±0.09	9.80 ±0.09	12.83 ±0.03	12.78 ±0.12	13.03 ±0.04	9.08 ±0.04
5	9.24 ±0.23	8.90 ±0.04	8.90 ±0.45	11.22 ±0.54	12.20 ±0.09	12.04 ±0.09	13.19 ±0.04	14.34 ±0.34	14.45 ±0.02	7.84 ±0.05
6	10.04 ±0.44	10.33 ±0.03	9.02 ±0.04	11.84 ±0.45	13.01 ±0.09	12.45 ±0.09	14.20 ±0.03	14.23 ±0.64	13.30 ±0.21	11.55 ±0.32

Mechanized Extraction Method

A: Okpoke Oil Processing, Okitipupa; B: Okitipupa Oil Processing Comany Okitipupa; C: Abbis Farm, Ala Ogbese road

Semi Mechanized Extraction Method

D: Mama Sarah Oil, Ode- Irele; E: Blessing Oil, Oktipupa; F: Federal College of Agriculture, Akure

Traditional Extraction Method

G: Sunday Oil Akure Idanre road, Idanre; H: Oluwatobi Oil Okitipupa; I: Musilat Oil Processing Mill Ode – Irele

Control J: Laboratory

Table 8. Sensory analysis of palm oil samples from different processing procedures in the first month

Sample	Appearance		Aroma			Taste		Mouth feel	
	Colour	Turbidity	Rancidity	Smoky	Burnt	Sweet	Bitter	Rough	Mouth coating
A	2.00±0.00 ^a	3.00±0.00 ^a	1.00±0.00 ^a	1.00±0.00 ^a	3.00±0.00 ^a	2.00±0.00 ^a	3.00±0.00 ^a	1.00±0.00 ^a	3.00±0.00 ^a
B	2.00±0.00 ^a	3.00±0.00 ^a	1.00±0.00 ^a	1.00±0.00 ^a	3.00±0.00 ^a	2.00±0.00 ^a	3.00±0.00 ^a	1.00±0.00 ^a	3.00±0.00 ^a
C	2.00±0.00 ^a	3.00±0.00 ^a	1.00±0.00 ^a	1.00±0.00 ^a	3.00±0.00 ^a	2.00±0.00 ^a	3.00±0.00 ^a	1.00±0.00 ^a	3.00±0.00 ^a
D	2.00±0.00 ^a	3.00±0.00 ^a	1.00±0.00 ^a	1.00±0.00 ^a	3.00±0.00 ^a	2.00±0.00 ^a	3.00±0.00 ^a	1.00±0.00 ^a	3.00±0.00 ^a
E	2.00±0.00 ^a	3.00±0.00 ^a	1.00±0.00 ^a	1.00±0.00 ^a	3.00±0.00 ^a	2.00±0.00 ^a	3.00±0.00 ^a	1.00±0.00 ^a	3.00±0.00 ^a
F	2.00±0.00 ^a	3.00±0.00 ^a	1.00±0.00 ^a	2.00±0.00 ^a	3.00±0.00 ^a	2.00±0.00 ^a	3.00±0.00 ^a	1.00±0.00 ^a	3.00±0.00 ^a
G	1.33±0.33 ^a	3.67±0.33 ^a	1.00±0.00 ^a	2.00±0.00 ^a	3.00±0.00 ^a	2.00±0.00 ^a	3.00±0.00 ^a	1.33±0.33 ^a	3.00±0.00 ^a
H	1.67±0.33 ^a	3.33±0.33 ^a	1.00±0.00 ^a	2.00±0.00 ^a	4.00±0.00 ^a	2.00±0.00 ^a	3.00±0.00 ^a	2.00±0.00 ^a	3.00±0.00 ^b
I	1.33±0.33 ^a	3.67±0.33 ^a	1.00±0.00 ^a	2.00±0.00 ^a	4.00±0.00 ^a	1.00±0.00 ^a	4.00±0.00 ^a	2.00±0.00 ^a	3.00±0.00 ^b
J	1.57±0.33 ^a	3.33±0.33 ^a	1.00±0.00 ^a	1.00±0.00 ^a	4.00±0.00 ^a	2.00±0.00 ^a	3.00±0.00 ^a	1.00±0.00 ^a	3.00±0.00 ^a

Means followed by the same superscript in a column are not significantly different ($p < 0.05$).

Keys: Mechanized Extraction Method

A: Okpoke Oil Processing, Okitipupa; B: Okitipupa Oil Processing Company Okitipupa; C: Abbis Farm, Ala Ogbese road

Semi Mechanized Extraction Method

D: Mama Sarah Oil, Ode- Irele; E: Blessing Oil, Okitipupa; F: Federal College of Agriculture, Akure

Traditional Extraction Method

G: Sunday Oil Akure Idanre road, Idanre; H: Oluwatobi Oil Okitipupa; I: Musilat Oil Processing Mill Ode – Irele

Control J: Laboratory

Table 9. Sensory analysis of palm oil samples from different processing procedures in the second month

Sample	Appearance		Aroma			Taste		Mouth feel	
	Colour	Turbidity	Rancidity	Smoky	Burnt	Sweet	Bitter	Rough	Mouth coating
A	1.67±0.33 ^a	3.67±0.67 ^a	1.00±0.00 ^a	1.33±0.33 ^{ab}	3.33±0.33 ^{ab}	2.00±0.00 ^c	3.00±0.00 ^a	1.00±0.00 ^a	3.00±0.00 ^a
B	1.67±0.33 ^a	3.33±0.33 ^a	1.00±0.00 ^a	1.33±0.33 ^{ab}	3.33±0.33 ^{ab}	2.00±0.00 ^c	3.00±0.00 ^a	1.00±0.00 ^a	3.00±0.00 ^a
C	1.67±0.33 ^a	3.67±0.67 ^a	1.00±0.00 ^a	1.00±0.00 ^{ab}	3.33±0.33 ^{ab}	2.00±0.00 ^c	3.00±0.00 ^a	1.00±0.00 ^a	3.00±0.00 ^a
D	1.67±0.33 ^a	3.00±0.00 ^a	1.00±0.00 ^a	1.00±0.00 ^{ab}	3.33±0.33 ^{ab}	2.00±0.00 ^c	3.00±0.00 ^a	1.00±0.00 ^a	3.00±0.00 ^a
E	1.67±0.33 ^a	3.67±0.33 ^a	1.00±0.00 ^a	1.67±0.33 ^a	3.00±0.00 ^a	2.00±0.00 ^c	3.00±0.00 ^a	1.00±0.00 ^a	3.00±0.00 ^a
F	1.33±0.33 ^a	4.00±0.57 ^a	1.00±0.00 ^a	1.33±0.33 ^{ab}	3.33±0.33 ^{ab}	2.00±0.00 ^c	3.00±0.00 ^a	1.00±0.00 ^a	3.00±0.00 ^a
G	1.67±0.33 ^a	3.33±0.33 ^a	1.00±0.00 ^a	1.00±0.00 ^{ab}	3.67±0.33 ^{ab}	2.00±0.00 ^c	3.67±0.33 ^a	1.33±0.33 ^{ab}	3.00±0.00 ^a
H	2.00±0.00 ^a	3.00±0.00 ^a	1.00±0.00 ^a	2.00±0.00 ^{ab}	3.33±0.33 ^{ab}	2.00±0.00 ^c	3.00±0.00 ^a	1.67±0.33 ^{bc}	3.00±0.00 ^a
I	2.00±0.00 ^a	3.00±0.00 ^a	1.67±0.33 ^b	1.67±0.33 ^b	4.00±0.00 ^b	1.33±0.33 ^b	4.33±0.33 ^a	1.33±0.33 ^{ab}	3.67±0.33 ^b
J	1.33±0.33 ^a	3.00±0.00 ^a	1.33±0.33 ^{ab}	1.00±0.00 ^b	4.00±0.00 ^b	1.00±0.00 ^a	4.67±0.33 ^a	2.00±0.00 ^c	3.33±0.33 ^{ab}

Means followed by the same superscript in a column are not significantly different ($p < 0.05$).

Keys: Mechanized Extraction Method

A: Okpoke Oil Processing, Okitipupa; B: Okitipupa Oil Processing Company Okitipupa; C: Abbis Farm, Ala Ogbese road

Semi Mechanized Extraction Method

D: Mama Sarah Oil, Ode- Irele; E: Blessing Oil, Okitipupa; F: Federal College of Agriculture, Akure

Traditional Extraction Method

G: Sunday Oil Akure Idanre road, Idanre; H: Oluwatobi Oil Okitipupa; I: Musilat Oil Processing Mill Ode – Irele

Control J: Laboratory

Table 10. Sensory analysis of palm oil samples from different processing procedures in the third month

Sample	Appearance			Aroma		Taste		Mouth feel	
	Colour	Turbidity	Rancidity	Smoky	Burnt	Sweet	Bitter	Rough	Mouth coating
A	2.00±0.00 ^b	3.67±0.67 ^a	1.00±0.00 ^a	1.33±0.33 ^{ab}	3.00±0.00 ^a	2.00±0.00 ^c	3.00±0.00 ^a	1.33±0.00 ^{ab}	3.00±0.00 ^a
B	2.00±0.00 ^b	3.33±0.33 ^a	1.00±0.00 ^a	1.33±0.33 ^{ab}	3.33±0.33 ^{ab}	2.00±0.00 ^c	3.00±0.00 ^a	1.00±0.00 ^a	3.00±0.00 ^a
C	2.00±0.00 ^b	3.67±0.67 ^a	1.00±0.00 ^a	1.00±0.00 ^a	3.00±0.00 ^a	2.00±0.00 ^c	3.00±0.00 ^a	1.00±0.00 ^a	3.00±0.00 ^a
D	2.00±0.00 ^b	3.00±0.00 ^a	1.00±0.00 ^a	1.00±0.00 ^a	3.00±0.00 ^a	2.00±0.00 ^c	3.00±0.00 ^a	1.00±0.00 ^a	3.00±0.00 ^a
E	1.67±0.33 ^{ab}	3.67±0.33 ^a	1.00±0.00 ^a	1.67±0.33 ^{ab}	3.33±0.33 ^{ab}	2.00±0.00 ^c	3.00±0.00 ^a	1.33±0.33 ^{ab}	3.33±0.33 ^a
F	2.00±0.00 ^b	4.00±0.57 ^a	1.33±0.33 ^a	1.33±0.33 ^{ab}	3.33±0.33 ^{ab}	2.00±0.00 ^c	3.00±0.00 ^a	1.00±0.00 ^a	3.33±0.33 ^a
G	1.67±0.33 ^{ab}	3.33±0.33 ^a	1.33±0.33 ^a	1.00±0.00 ^a	3.00±0.00 ^a	2.00±0.00 ^c	3.67±0.33 ^{ab}	1.33±0.33 ^{ab}	3.33±0.33 ^a
H	2.00±0.00 ^b	3.00±0.00 ^a	1.00±0.00 ^a	2.00±0.00 ^b	4.00±0.00 ^{ab}	2.00±0.00 ^c	3.00±0.00 ^a	1.67±0.33 ^{ab}	3.00±0.00 ^a
I	2.00±0.00 ^b	3.00±0.00 ^a	1.67±0.33 ^a	1.67±0.33 ^{ab}	3.67±0.33 ^b	1.33±0.33 ^b	4.33±0.33 ^{bc}	1.33±0.33 ^{ab}	3.67±0.33 ^a
J	1.33±0.33 ^a	3.00±0.00 ^a	1.67±0.33 ^a	1.00±0.00 ^a	3.00±0.00 ^a	1.00±0.00 ^a	4.67±0.33 ^c	2.00±0.00 ^b	3.67±0.33 ^a

Means followed by the same superscript in a column are not significantly different ($p < 0.05$)

Keys: Mechanized Extraction Method

A: Okpoke Oil Processing, Okitipupa; B: Okitipupa Oil Processing Company Okitipupa; C: Abbis Farm, Ala Ogbese road

Semi Mechanized Extraction Method

D: Mama Sarah Oil, Ode- Irele; E: Blessing Oil, Okitipupa; F: Federal College of Agriculture, Akure

Traditional Extraction Method

G: Sunday Oil Akure Idanre road, Idanre; H: Oluwatobi Oil Okitipupa; I: Musilat Oil Processing Mill Ode – Irele

Control J: Laboratory

The counts are means of three replicates \pm standard deviation

Table 11. Sensory analysis of palm oil samples from different processing procedures in the fourth month

Sample	Appearance		Aroma			Taste		Mouth feel	
	Colour	Turbidity	Rancidity	Smoky	Burnt	Sweet	Bitter	Rough	Mouth coating
A	2.00±0.00 ^a	3.67±0.67 ^a	1.00±0.00 ^a	1.33±0.33 ^a	3.00±0.00 ^a	2.00±0.00 ^c	3.00±0.00 ^a	1.00±0.00 ^a	3.00±0.00 ^a
B	2.00±0.00 ^a	3.33±0.33 ^a	1.00±0.00 ^a	1.33±0.33 ^a	3.33±0.33 ^{ab}	2.00±0.00 ^c	3.00±0.00 ^a	1.00±0.00 ^a	3.00±0.00 ^a
C	2.00±0.00 ^a	3.67±0.67 ^a	1.00±0.00 ^a	1.00±0.00 ^a	3.00±0.00 ^a	2.00±0.00 ^c	3.00±0.00 ^a	1.00±0.00 ^a	3.00±0.00 ^a
D	2.00±0.00 ^a	3.00±0.00 ^a	1.00±0.00 ^a	1.00±0.00 ^a	3.00±0.00 ^a	2.00±0.00 ^c	3.00±0.00 ^a	1.00±0.00 ^a	3.00±0.00 ^a
E	1.67±0.33 ^a	3.67±0.33 ^a	1.00±0.00 ^a	1.67±0.33 ^a	3.33±0.33 ^{ab}	2.00±0.00 ^c	3.00±0.00 ^a	1.33±0.33 ^{ab}	3.67±0.33 ^{ab}
F	1.67±0.33 ^a	3.33±0.33 ^a	1.33±0.33 ^{ab}	1.33±0.33 ^a	3.33±0.33 ^{ab}	1.67±0.33 ^{bc}	3.67±0.33 ^b	1.67±0.33 ^{ab}	3.67±0.33 ^{ab}
G	1.67±0.33 ^a	3.33±0.33 ^a	1.67±0.33 ^{ab}	1.00±0.00 ^a	3.00±0.00 ^a	1.00±0.00 ^a	4.00±0.00 ^{bc}	1.67±0.33 ^{ab}	3.67±0.33 ^{ab}
H	1.33±0.33 ^a	4.33±0.33 ^a	1.67±0.33 ^{ab}	1.33±0.33 ^a	4.00±0.00 ^b	1.33±0.33 ^{ab}	3.67±0.33 ^b	1.67±0.33 ^{ab}	3.33±0.33 ^{ab}
I	1.33±0.33 ^a	3.67±0.33 ^a	2.00±0.00 ^b	1.67±0.33 ^a	3.67±0.33 ^b	1.00±0.00 ^a	4.00±0.00 ^{bc}	1.67±0.33 ^{ab}	3.67±0.33 ^{ab}
J	1.33±0.33 ^a	3.67±0.33 ^a	1.67±0.33 ^{ab}	1.00±0.00 ^a	3.00±0.00 ^a	1.00±0.00 ^a	4.33±0.33 ^c	2.00±0.00 ^b	4.00±0.00 ^b

Means followed by the same superscript in a column are not significantly different ($p < 0.05$).

Keys: Mechanized Extraction Method

A: Okpoke Oil Processing, Okitipupa; B: Okitipupa Oil Processing Company Okitipupa; C: Abbis Farm, Ala Ogbese road

Semi Mechanized Extraction Method

D: Mama Sarah Oil, Ode- Irele; E: Blessing Oil, Okitipupa; F: Federal College of Agriculture, Akure

Traditional Extraction Method

G: Sunday Oil Akure Idanre road, Idanre; H: Oluwatobi Oil Okitipupa; I: Musilat Oil Processing Mill Ode – Irele

Control J: Laboratory

Table 12. Sensory analysis of palm oil samples from different processing procedures in the fifth month

Sample	Appearance		Aroma			Taste		Mouth feel	
	Colour	Turbidity	Rancidity	Smoky	Burnt	Sweet	Bitter	Rough	Mouth coating
A	2.00±0.00 ^b	3.67±0.67 ^{ab}	1.00±0.00 ^a	1.33±0.33 ^a	3.00±0.00 ^a	2.00±0.00 ^c	3.00±0.00 ^a	1.33±0.33 ^{ab}	3.33±0.33 ^a
B	2.00±0.00 ^b	3.33±0.33 ^{ab}	1.67±0.33 ^{ab}	1.33±0.33 ^a	3.33±0.33 ^{ab}	2.00±0.00 ^c	3.00±0.00 ^a	1.67±0.33 ^{ab}	3.67±0.33 ^a
C	2.00±0.00 ^b	3.67±0.67 ^{ab}	1.00±0.00 ^a	1.00±0.00 ^a	3.00±0.00 ^a	2.00±0.00 ^c	3.00±0.00 ^a	1.00±0.00 ^a	3.00±0.00 ^a
D	2.00±0.00 ^b	3.00±0.00 ^a	2.00±0.00 ^b	1.00±0.00 ^a	3.00±0.00 ^a	1.00±0.00 ^a	4.00±0.00 ^{bc}	1.67±0.33 ^{ab}	3.67±0.33 ^a
E	1.00 ± 0.00 ^a	4.33±0.33 ^b	1.67±0.33 ^{ab}	1.67±0.33 ^a	3.33±0.33 ^{ab}	1.33±0.33 ^{ab}	3.33±0.33 ^{ab}	1.33±0.33 ^{ab}	3.67±0.33 ^a
F	1.33±0.33 ^{ab}	4.00±0.00 ^{ab}	1.67±0.33 ^{ab}	1.33±0.33 ^a	3.33±0.33 ^{ab}	1.67±0.33 ^{bc}	3.67±0.33 ^{abc}	1.67±0.33 ^{ab}	3.67±0.33 ^a
G	1.33±0.33 ^{ab}	4.00±0.00 ^{ab}	1.67±0.33 ^{ab}	1.00±0.00 ^a	3.00±0.00 ^a	1.00±0.00 ^a	4.00±0.00 ^{bc}	2.00±0.00 ^b	3.67±0.33 ^a
H	1.33±0.33 ^{ab}	4.33±0.33 ^b	1.67±0.33 ^{ab}	1.33±0.33 ^a	4.00±0.00 ^b	1.33±0.33 ^{ab}	3.67±0.33 ^{abc}	2.00±0.00 ^b	3.33±0.33 ^a
I	1.00±0.00 ^a	3.67±0.33 ^{ab}	2.00±0.00 ^b	1.67±0.33 ^a	3.67±0.33 ^{ab}	1.00±0.00 ^a	4.00±0.00 ^{bc}	1.67±0.33 ^{ab}	3.67±0.33 ^a
J	1.33±0.33 ^{ab}	4.00±0.00 ^{ab}	1.67±0.33 ^{ab}	1.00±0.00 ^a	3.00±0.00 ^a	1.00±0.00 ^a	4.33±0.33 ^c	2.00±0.00 ^b	4.00±0.00 ^a

Means followed by the same superscript in a column are not significantly different ($p < 0.05$).

Keys: Mechanized Extraction Method

A: Okpoke Oil Processing, Okitipupa; B: Okitipupa Oil Processing Company Okitipupa; C: Abbis Farm, Ala Ogbese road

Semi Mechanized Extraction Method

D: Mama Sarah Oil, Ode- Irele; E: Blessing Oil, Okitipupa; F: Federal College of Agriculture, Akure

Traditional Extraction Method

G: Sunday Oil Akure Idanre road, Idanre; H: Oluwatobi Oil Okitipupa; I: Musilat Oil Processing Mill Ode – Irele

Control J: Laboratory

Table 13. Sensory analysis of crude palm oil samples from different processing procedures in the sixth month

Sample	Appearance			Aroma		Taste		Mouth feel	
	Colour	Turbidity	Rancidity	Smoky	Burnt	Sweet	Bitter	Rough	Mouth coating
A	1.67±0.33 ^{ab}	3.00±0.00 ^a	1.00±0.00 ^a	1.00±0.00 ^a	3.00±0.00 ^a	1.67±0.33 ^{ab}	3.67±0.67 ^{ab}	1.00±0.00 ^a	3.33±0.33 ^a
B	2.00±0.00 ^b	3.00±0.00 ^a	1.33±0.33 ^{ab}	1.33±0.33 ^a	3.33±0.33 ^{ab}	1.67±0.33 ^{ab}	3.33±0.33 ^{ab}	1.67±0.33 ^{ab}	3.33±0.33 ^a
C	2.00±0.00 ^b	3.67±0.67 ^{ab}	1.00±0.00 ^a	1.00±0.00 ^a	3.00±0.00 ^a	2.00±0.00 ^b	3.00±0.00 ^a	1.00±0.00 ^a	3.00±0.00 ^a
D	1.67±0.33 ^{ab}	3.00±0.00 ^{ab}	1.67±0.33 ^{ab}	1.00±0.00 ^a	3.00±0.00 ^a	1.00±0.00 ^a	4.00±0.00 ^{ab}	1.67±0.33 ^{ab}	3.67±0.33 ^a
E	1.00 ± 0.00 ^a	4.33±0.33 ^b	1.67±0.33 ^{ab}	1.33±0.33 ^a	3.33±0.33 ^{ab}	1.33 ±0.33 ^{ab}	4.00±0.57 ^{ab}	1.33±0.33 ^{ab}	3.67±0.33 ^a
F	1.33±0.58 ^{ab}	4.33±0.33 ^b	1.67±0.33 ^{ab}	1.33±0.33 ^a	3.33±0.33 ^{ab}	1.67±0.33 ^{ab}	3.67±0.33 ^{ab}	1.33±0.33 ^{ab}	3.67±0.33 ^a
G	1.33±0.58 ^{ab}	4.00±0.00 ^b	1.67±0.33 ^{ab}	1.33±0.33 ^a	3.00±0.00 ^a	1.00±0.00 ^a	4.00±0.00 ^{ab}	2.00±0.00 ^b	3.67±0.33 ^a
H	1.33±0.58 ^{ab}	4.33±0.33 ^b	1.67±0.33 ^{ab}	1.33±0.33 ^a	4.00±0.00 ^b	1.33±0.33 ^{ab}	3.67±0.33 ^{ab}	2.00±0.00 ^b	3.33±0.33 ^a
I	1.00±0.00 ^a	3.67±0.33 ^a	2.00±0.00 ^b	1.67±0.33 ^a	3.67±0.33 ^{ab}	1.00±0.00 ^a	4.00±0.00 ^{ab}	1.67±0.33 ^{ab}	3.67±0.33 ^a
J	1.33±0.58 ^{ab}	4.00±0.00 ^b	1.67±0.33 ^{ab}	1.00±0.00 ^a	3.00±0.00 ^a	1.00±0.00 ^a	4.33±0.33 ^b	2.00±0.00 ^b	4.00±0.00 ^a

Means followed by the same superscript in a column are not significantly different ($p < 0.05$).

Keys: Mechanized Extraction Method

A: Okpoke Oil Processing, Okitipupa; B: Okitipupa Oil Processing Company Okitipupa; C: Abbis Farm, Ala Ogbese road

Semi Mechanized Extraction Method

D: Mama Sarah Oil, Ode- Irele; E: Blessing Oil, Okitipupa; F: Federal College of Agriculture, Akure

Traditional Extraction Method

G: Sunday Oil Akure Idanre road, Idanre; H: Oluwatobi Oil Okitipupa; I: Musilat Oil Processing

Control J: Laboratory

4. CONCLUSION

The quality of the palm oil produced varied across the traditional to mechanized processing methods. The microbiological, physicochemical properties and the sensory results showed variations across the various palm oil processing methods. The samples obtained through the mechanized method have the best quality (FFA 5.60 – 9.77; Peroxide value 18.17 – 33.45) while the traditional extraction methods had the least quality (FFA 18.17 – 33.45; Peroxide value 10.27-14.45).

DISCLAIMER

The products used for this study are commonly and predominantly used products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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APPENDIX

Table 14. Standard Organization of Nigeria: Standard for Edible palm oil

Parameters	Standard values
Relative density	0.898-0.907
Moisture contest	0.200 max
Free fatty acid	Nil
Acid value (mg KOH / g of oil)	Nil
Saponification value (mg KOH / g of oil)	185-205
Iodine value	45-55
Titre value	42.000
Peroxide value (meq / kg)	10.000
Rancidity	-

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