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The Study of the Characteristics and Rancidity of Three Species of *Elaeis guineensis* in South East of Nigeria

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Abstract: Palm Oil (*Elaeis guineensis*) samples were extracted by two methods of extraction, cold (Eketeke) and normal. The palm oil samples extracted by cold method (Eketeke) have significantly low mean values of peroxide 2.30 (meg/kg), free fatty acid 0.12 mg/KOH/g, acid 0.19 mgKOH/g and with high iodine value 47.2 mg/KOH/g. Whereas normal method have considerable high mean values of peroxide 2.5 (meg/kg), free fatty acid, 0.23 mg/KOH/g, acid 0.16 mg/g and with low iodine value of 45.7 mg/KOH/g. The acid values of all the oil samples are not higher than 0.6 mg/g recommended for most vegetable oils in Nigeria. Steady increase of peroxide values of oils leads to rancidity. The GLC result showed that oil sample A_1 (Eketeke) at 100°C was a mixture of unsaturated (47.56%) and saturated (43.85%) fatty acid. Whereas oil sample B at 100°C was a mixture of unsaturated (49.82%) and saturated (50.17%) fatty acid. Also sample C at 100°C was a mixture of unsaturated (45.2%) and saturated (54.80%) fatty acid.

Key words: *Elaeis guineensis*, characteristics, rancidity

INTRODUCTION

Palm oil, like other oil seeds, is a fatty acid ester of glycerol commonly called triglycerides. It has a high proportion of saturated palmitic acid (C_{16}) content to which may be attributed its value in soap making. It also contains high quantity of unsaturated fats, principally those derived from oleic acid. In its natural state, palm oil contains carotenoids (0.05-0.2%) which give it the red colour (Bagepalli and Narasinga, 2003).

Other minor constituents of palm oil are sterols (0.03%), phosphatides (0.1%) and tocopherols (0.05%). Tocopherols (vitamin E active) are important and naturally occurring and widely distributed antioxidants (Carl *et al*., 2003). Antioxidants tend to protect fats by inhibiting auto-oxidation and subsequent rancidity. The amount of tocopherol present is thus a good criterion for the quality of Natural palm oil since any pro-oxidant conditions will reduce the tocopherol content of the oil (Kirk and Sawyer, 1991). RMRDC (Raw materials research and development council. Ekpa *et al*. (2001) have carried out a comparative study of triglyceride and fatty acid composition of palm oils. Osagie *et al*. (1986) studied the chemical quality and parameters and fatty acid compositions of oils of some under exploited tropical seeds.

It is therefore, the aim of this work to extract palm oil from three species of *Elaeis guineensis*, dura (Ojukwu), tenera (osukwu) and Okpuruka, using two methods namely; cold (Eketeke) and normal. Analyses of their chemical properties in its raw form were carried out. Chemical properties such as the peroxide value, free fatty acid value, iodine value, acid value, saponification value were analyzed.

MATERIALS AND METHODS

Fresh palm fruits were collected from three different communities at Umuneke-Ugiri, namely, Umuehie, Umuezealameri and Umudike in Isiala Mbano, Imo State, Nigeria.

About 700 g of each of the samples were collected. Two methods of extraction were used; cold (Eketeke) and normal.

Cold method (Eketeke) is a process where freshly harvested ripe oil palm fruits are separated from the bunch and pounded in the mortar or pit without boiling. The whole mass was fried in a clay pot at about 100°C and the fibre was pressed or squeezed for the natural oil to be collected in a container. Then the oil was filtered from impurities (Oyelola, 1979).

The normal method involves boiling freshly harvested palm fruits with about 2 litres of water for 2 h at temperature range of (100-160°C). The mass pulp was produced by pounding the boiled fruits in a mortar/pit. The whole mass was immersed in water (5 litres), stirred and the natural oil, which rose to the surface was skimmed off into another pot. The fibres where then sifted out of the water manually and finally the nuts were collected and separated from the remaining fibres. The natural oil thus obtained was boiled in smaller vessels where any fibre still present sank to the bottom. The oil was again skimmed to further remove traces of water (Ihekoronye and Ngoddy, 1985). Methylations of the extracted oil fraction prior to gas chromatography were as described by International Union of Pure and Applied Chemistry (IUPAC). HP 6890 (USA) gas chromatography with a flame ionization detector was used. The iodine, acid, peroxide, free fatty acid values were determined according to AOAC (1984).

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RESULTS AND DISCUSSION

PV - Peroxide value
AV - Acid value
IV - Iodine value
SV - Saponification value
FFA - Free fatty acid
A_1 - Oil sample (by cold method-Eketeke)
B_1 - Oil sample (by cold method-Eketeke)
C_1 - Oil sample (by cold method-Eketeke)
A_2 - Oil sample (by normal method)
B_2 - Oil sample (by normal method)
C_2 - Oil sample (by normal method)

The acid values in Table 1, showed that samples A_1, B_2 and C_1 (Eketeke) have 0.1, 0.14 and 0.13 mg/KOH/g, whereas the acid values of these samples A_2, B_2 and C_2 (Normal) increased at weekly intervals thus; 0.15, 0.16 and 0.16 mg/KOH/g. The steady weekly increase in acid values of samples A_2, B_2 and C_2 (Normal) showed that hydrolytic oxidation was gradually taken place. Also natural palm oil with high acid values are considered to be inferior to palm oils with low acid values.

The results in Table 2, showed that sample C_2 (Normal) has the highest Free Fatty Acid (FFA) value which increased at weekly intervals (0.75-1.68 mg/KOH/g) while samples A_1 (Eketeke) has the lowest FFA value which ranged between 0.5-1.35 mg/KOH/g at weekly intervals. Deterioration of a fat leads to the liberation of free fatty acid from triglycerides. The amount of Free Fatty Acid (FFA) in a fat or oil is an indicative of its level of spoilage. Palm oil samples extracted by (Eketeke) are better oils than palm oil samples processed by normal.

The iodine value of sample A_1 (Eketeke) in the first week of this research work recorded the highest value of 58.01 mg/KOH/g which gradually decreased to 52.35 mg/KOH/g, while sample C_2 (Normal) in the first week has the lowest IV value which gradually decreased to 49.93. According to the results in Table 3, samples extracted by Eketeke method have the highest iodine values but decreased at weekly intervals. The iodine value is a measure of the degree of unsaturation. High IV assures of better quality but it retards with time, more especially when environmental factors begin to reduce the potency of natural antioxidants present in natural palm oil.

The low peroxide value in the first week of carrying out this research indicated that there was no primary oxidation at the time of this analysis. The results in Table 4 showed that sample C_2 (Normal) has the highest PV of 2.68 (meg/kg) which increased weekly from 2.15-2.68 (meg/kg) while sample C_1 (Eketeke) has the lowest PV of 2.32 (meg/kg) which also increased at weekly intervals from 2.12-2.32 (meg/kg). The steady increase of the PV leads to rancidity of oil samples. The results of these research showed that palm oil samples extracted by the normal method will spoil or go rancid fast than palm oil samples extracted by Eketeke method.

Table 1: Acid Value (AV) of samples at weekly intervals

Samples	WKI	WKII	WKIII	WKIV
	(mg/KOH/g)			
A_1	0.11	0.13	0.13	0.14
B_1	0.1	0.12	0.13	0.14
C_1	0.1	0.11	0.11	0.13
A_2	0.11	0.12	0.14	0.15
B_2	0.1	0.13	0.15	0.16
C_2	0.11	0.14	0.14	0.16

Table 2: Free Fatty Acid (FFA) of samples at weekly intervals

Samples	WKI	WKII	WKIII	WKIV
	(mg/KOH/g)			
A_1	0.5	0.75	1.2	1.35
B_1	0.5	0.45	0.95	1.25
C_1	0.7	0.65	1.1	1.4
A_2	0.45	0.55	1.25	1.52
B_2	0.8	0.95	1.35	1.65
C_2	0.75	0.9	1.45	1.68

Table 3: Iodine Values (AV) of samples at weekly intervals

Samples	WKI	WKII	WKIII	WKIV
	(mg/KOH/g)			
A_1	58.01	56.7	55.25	52.35
B_1	57.87	55.67	53.65	51.35
C_1	56.65	55.43	53.45	52.45
A_2	55.63	53.45	51.61	49.45
B_2	53.12	51.45	50.13	48.15
C_2	52.14	50.15	49.75	49.95

Table 4: Peroxide Value (PV) of samples at weekly intervals

Samples	WKI	WKII	WKIII	WKIV
	(meg/Kg)			
A_1	2.1	2.15	2.25	2.35
B_1	2.1	2.13	2.14	2.4
C_1	2.12	2.22	2.18	2.32
A_2	2.13	2.14	2.2	2.38
B_2	2.14	2.15	2.25	2.48
C_2	2.15	2.16	2.31	2.68

Table 5: Saponification Value (SV) of samples at weekly intervals

Samples	WKI	WKII	WKIII	WKIV
	(mg/KOH/g)			
A_1	181.6	184.7	185.2	185.9
B_1	182.7	184.8	186.3	187.2
C_1	184.3	185.7	188.2	186.6
A_2	185.5	187.8	188.6	189.6
B_2	185.4	186.8	188.7	189.9
C_2	185.7	187.5	189.4	190.7

The results in Table 5 showed that sample C_2 (Normal) has the highest saponification value which increased in the first week of this research. The SV of sample A_1 (Eketeke) has the lowest value of 181.6 mg/KOH/g. The saponification value of oil gives an idea of the fatty acid constituents of the lipid since with long chain fatty acid constituents in a fat, lower saponification values are obtained per gram.

GLC results (Table 6) showed that palm oil sample A_1 at 100°C has almost equal concentration level of saturated (43.85621%) and unsaturated (47.56078%).

Palmitic acid has the highest concentration with a value of 38.94428%, followed by Oleic acid 37.35074%, linoleic acid 10.21004%, stearic acid 3.88235% and myristic acid respectively. The GLC spectra also shows that the saturated fatty acid to unsaturated fatty acid ratio of palm oil is close to unity and it contains a high amount of antioxidants, beta-carotene and vitamin E.

Oleic acid peaked higher with % concentration value of 38.30161% and was followed by palmitic acid 37.28138%, linoleic acid 11.52734, stearic acid 4.79217% and myristic acid 1.09285%. Caprylic, linolenic and myristoleic were not observable at this level. GLC results show that the oil sample at 100°C has almost equal concentration level of saturated 50.17105% and unsaturated 49.82895% fatty acid.

Palmitic acid (C_{16}) has the highest concentration level at 100°C with a value of 39.90422% followed by Oleic acid ($C_{18:1}$). 33.09497%, linoleic acid ($C_{18:2}$) 12.10825%, stearic acid C_{18} 5.44203% and myristoleic acid 1.07924%. The result of the oil sample has almost equal concentration level of saturated and unsaturated fatty acids.

Table 6: GLC spectra results of palm oil sample A_1 at 100°C

Peak No.	Area %	Name	
1	5.84128	-	-
2	1.80034	-	-
3	0.67605	-	-
4	1.02958	Myristic acid	C_{14}
5	0.26534	-	-
6	38.94428	Pamitic acid	C_{16}
7	3.88235	Stearic acid	C_{18}
8	37.35074	Oleic acid	$C_{18:1}$
9	10.21004	Linoleic acid	$C_{18:2}$

Saturated (43.85621%); Unsaturated (47.56078%)

Table 7: GLC spectra results of palm oil sample B_1 at 100°C

Peak No.	Area %	Name	
1	4.27925	-	-
2	1.93808	-	-
3	0.78732	-	-
4	1.09285	Myristic acid	C_{14}
5	37.38138	Palmitic acid	C_{16}
6	4.79217	Stearic acid	C_{18}
7	38.30161	Oleic acid	$C_{18:1}$
8	11.52734	Linoleic acid	$C_{18:2}$

Saturated (50.17105%); Unsaturated (49.82895%)

Table 8: GLC Spectra results of palm oil sample C_1 at 100°C

Peak No.	Area %	Name	
1	5.25882	-	-
2	2.04445	-	-
3	0.76463	-	-
4	1.07924	Myristoleic acid	$C_{14:1}$
5	0.30338	-	-
6	39.90422	Palmitic acid	C_{16}
7	5.44203	Stearic acid	C_{18}
8	33.09497	Oleic acid	$C_{18:1}$
9	12.10825	Linoleic acid	$C_{18:2}$

Saturated (54.79678%); Unsaturated (45.20322%)

Conclusion: From the foregoing investigation carried out on palm oil samples of three species of *Elaeis guineensis* oil carried out at weekly intervals, using two methods of extraction i.e Eketeke and normal palm oil. The following observations were made.

All the palm oil samples were prepared under high degree of consumable levels and quality.

The palm oils prepared by Eketeke method proved to be of high quality with regards to high iodine value, low peroxide values, low acid values low FFA% and moderate saponification value. Whereas palm oil extracted by the normal have high values of peroxide, acid, FFA, saponification values than palm oil samples extracted by Eketeke method. The results showed that oil processed by normal method are more prune/susceptible to both hydrolytic and oxidative rancidity than palm oils extracted by Eketeke method. Oxidative rancidity is a serious flavor defect and highly objectionable. It starts with the formation of hydroperoxides which then decompose to form aldehydes which have a pungent, disagreeable flavor and odor. Retardation of oxidation is brought about by using opaque, airtight containers, or nitrogen blanketing if clear glass bottles are used. For better storage, palm oils are preserved in airtight plastic containers and not with metal containers. Metal containers made of iron, copper and zinc are not good storage facilities for natural palm oil, because, these metals are pro-oxidants.

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