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A COMPARATIVE STUDY OF THE TRIGLYCERIDE AND FATTY ACID COMPOSITIONS OF PALM OILS FROM PLANTATIONS IN SOUTH-EASTERN NIGERIA

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ABSTRACT

Triglyceride and fatty acid composition were determined for palm oils from three different oil palm plantations in South-Eastern Nigeria. Each of the plantations belong to slightly different vegetation belts. The red fruits of the *Tenera* variety exhibited significant variations ($P < 0.5$) across the locations. Much of the variations occured in triglycerides with two or more unsaturated fatty acids in their molecules (P00,000 and OLL) with P00 showing greater differences than the others. Most of the constituent unsaturated fatty acids were observed to vary in their concentrations across locations. Both the locations and varietal source appear to affect the mean total unsaturation of the oil samples.

Key words: oil palm, palm oil, *Elaeis guineensis,* Location, varieties, triglycerides, fatty acids, *Dura*, *Tenera*

INTRODUCTION

The oil palm produces two different fats namely, palm and kernel oils. Palm oil is processed from the fleshy mesocarp while the kernel oil is obtained from the kernels enclosed in the nuts. Palm oil is a versatile oil and has many uses, but its most important use is in the production of edible oils and fats. It is also used in making soaps, fatty acids, and animal feeds. In Nigeria, the oil is used in its crude form for cooking, deep frying and for processing of cassava into garri, a popular staple food. Apart from fatty acids, the oil is a rich source of vitamins A and E, which are present in the crude oil as carotenoids and tocopherols. A recent study (Manorama and Rukmini 1991) has shown that about 70% of the vitamin A in palm oil is preserved in foods after cooking or frying.

Studies in our laboratory have been carried out on the assessment of quality of palm oils produced by rural farmers (Ekpa et al., 1994a), the effect of blending cocnut oil with palm oil on the acidity of palm oil, (Ekpa and Ekpe 1995), and the antimicrobial activity of palm and kernel oils and their metallic soaps (Ekpa and Ebana 1996). Related studies have been done on the use of metallic soaps from palm and kernel oils as plasticizers in paints (Ekpa 1996) and the analysis and possible uses of the female inflorescence (Ekpa et al., 1994b; Ekpa 1995).

The present study is to consider the triglyceride composition of palm oils extracted from the *Dura* and *Tenera* varieties of the oil palm selected from three plantations in South-Eastern Nigeria. Each of the locations A, B and C belongs to separate vegetation belts of rain forest, palm forest and derived savanna respectively. The triglyceride determination is expected to indicate the distribution of the individual fatty acids on the constituent triglycerides of the oil samples from each of the plantations.

The expected data could serve as a guide to farmers in areas with similar vegetation belts in selecting proper varieties of the oil palm for their respective locations, in order to obtain the desired triglyceride and/or fatty acid distributions.

MATERIAL AND METHODS

Collection and Treatment of the Oil Samples

The oil samples were collected and processed in much the same way as reported by Ekpa et al., (1994c). Ripe fresh fruit bunches of each variety were collected from each of the plantations A, B and C, each about 200 km apart, and belonging to slightly different vegetation belts (Fig. 1). Five ripe bunches of the *Dura* and *Tenera* varieties of the oil palm were harvested from different mature trees randomly selected to represent the population of each plantation.

Oil palm in each of the plantations selected for this study were planted in 1954. Fresh unbruised fruits from the individual bunches were carefully selected and classified as yellow (YP, fruits situated at the distal end of the bunch) and red (RP, fruits at the uppermost end of the bunch) based on visual appearance of the exocarp of the individual fruits. The red and yellow fruits of each variety were used in the extraction of the oil samples.

The fruits of each sample (1kg) were boiled for 30 min in aluminum pan and then digested in a wooden mortar while still hot. The oils was extracted by squeezing the mashed mesocarp between the fin-

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gers. The crude palm oil was clarified by heating with one-third its volume of water after which the oil on the surface was drawn off and dried by heating for 5 min at 105°C. The dried oil was subsequently filtered to remove small particles of suspended matter and stored in stoppered plastic containers in a refrigerator until required.

Sample Codes: The first letter of the sample codes indicates variety, the middle two letters represent sample type, and the last letter, plantation. E.g.,TRPA, T = *Tenera*, RP = red palm oil, A = plantation A.

Treatment of Samples for Triglyceride Determination

The sample was melted in water bath at about 70°C and further clean-up was carried out by solid phase extraction (SPE) on silica gel cartridge (Baker, Phillisburg, NJ, USA). The sample (200µl) was absorbed on to the column and then eluted with 20 ml of anlytical grade n-hexane (Carlo Erba, Rodano (MI), Italy) by suction with a vacuum manifold Vac-Elut (Varian, Harbor City, CA, USA). The solvent was evaporated under a gentle nitrogen stream and warning. About 35µl of the cleaned-up oil was diluted with 200µl of acetone (HPLC grade), (BDH, Poole, England) and used in the triglyceride determinations.

Preparation of Fatty Acid Methyl Esters (FAMEs)

The transesterification method described by Biedermann et al., (1993) was used in the preparation of FAMEs. To 1mg of the melted sample, was added 40µl of methyl-terbutyl ether (MTBE), (Fluka, Bunchs, Switzerland), followed by 30µl of freshly prepared sodium methanolate (10% w/v in methanol) with shaking. The mixture was allowed to remain for 20min at room temperature after which period 60µl of distilled water was added. The FAMEs were extracted with 400µl of n-hexane (HPLC grade, Merck) and 30µl of citric acid (0.1% w/v in water) was added with shaking to the hexane extract and centrifuged. The n-hexane phase was transferred and then evaporated under nitrogen stream. A few drops of acetone was added to the residue and evaporated in order to dry the FAMEs. The dried FAMEs were taken-up in 30µl of n-hexane and injected into the GC column.

Determination of Triglyceride Composition

HPLC was carried out on the purified oil sample on the following equipment: Isocratic pump Milton Roy CP3000 (Riviera Beach, FL, USA), with injection valve Rheodyne Model 7125 (Cotati, CA, USA) with a 10µl loop; Merck RP-18 column, LichroCART 250-4 (Merck, Darmstad, Germany) with internal diameter (ID) of 4mm; length, 250 mm, and particle size, 4µm. LDC Refracto-Monitor IV, refractive index detector (RID) Riviera Beach, FL, USA) was used. Instrument range setting was 0.1 x 10E-03ΔR1; response time, 2.0 sec. The run time was 60 min. The column was eluted with an acetone: acetonitrile: tetrahydrofuran: dicloromethane solvent system (60:40:2:1), with flow rate of 2.0ml/min. All solvents were of HPLC grade: acetone, HiperSolv, BHD (Poole, England)., acetonitrile, Labscan (Stillorgan, Dublin, Ireland), dichloromethane and tetrahydrofuran, Baker (Deventer, The Netherlands). All analyses were done in triplicates and the results expressed as g/kg mean weight. Peaks were identified by their equivalent carbon numbers (ECN) Herlof et al., 1979; Jerrin and Naudet 1983; Podlana and Terogard 1982). Individual triglycerides were confirmed by injecting standard triglycerides individually and by matching retention time as described by Swe et al (1994).

Determination of Fatty Acid Composition

Gas chromatographic separation of the FAMEs was carried out on a Carlo Erba Instruments HRGC Mega Series (Carlo Erba Inst., Rodano (MI), Italy) fitted with a 50m CP sil 88 column (100% cyanoprophylpolysiloxane), 0.25mm internal diameter, and 0.2mm film thickness (Chrompak, Raritan, NJ, USA) coupled to a flame-ionisation detector (FID) and a Pye Unicam digital peak integrator. The injector temperature was maintained at 280° C and the detector temperature at300°C. Column temperature was maintained at 185°C for 6 min. and then raised to 215°C for 2min. The injection volume was 1µl in n-hexane, with hydrogen as the carrier gas. Confirmation runs for the FAMEs were made with FAME Standards (Supelco, Bellefonte, Ca, USA).

Statistical Analysis of Data

Computing was performed with Maxima 820 Software (water Dynamic Solution, Millipore, Milford, MA, USA) installed on an IBM PS2/H21 personal computer (Princeton, NJ, USA). The precision of the means for the various data were tested using Student t-test (Gordon and Ford 1972) at 95% confidence level. The significance of variations was determined by one way analysis of variance (ANOVA) according to Harmmerton (1975).

RESULTS

Triglyceride Composition

Palm oils from different plantations in South-Eastern Nigeria were analyzed for their triglyceride contents. Table 1 shows the distribution of triglycerides for the different plantations A, B and C. Among the varieties, palm oil from the red fruits of the *Tenera* showed greater differences in triglyceride composition across the three locations.

Much of the observed variations occurred in triglycerides with two or more unsaturated fatty acids in their molecules namely, OLL, 000 and POO. Considering 000, for instance, TRPB had a triglyceride content (g/kg) of 43.9 compared to 19.4 for TRPC. Variations also occurred between individual varieties of different plantations as indicated by 000 (C54) with DRPB recording 34.8, and TRPC 19.4.

A summary of the mean triglyceride carbon number distribution of the individual oils at the different locations is shown in Table 2. As indicated in the Table, the mean triglyceride carbon numbers for the major triglycerides (C50 and C52) ranged from (g/kg) 411.0 to 457.5 for C50, and 373.4 to 421.8 for C52. There were no appreciable differences in the mean triglyceride carbon numbers across the locations.

Fatty Acid Composition

Table 3 shows the constituent fatty acids and their respective abundances (g/kg). Differences ($P < 0.5$) in fatty acid contents were observed for the unsaturated fatty acids: for example, oleic acid (C18:1), recorded 447.7g/kg for DRPA compared to 338.0g/kg obtained for TRPC. For linoleic acid (C18:2), TYPA, TRPC and TYPC had nearly equal amounts of the acid: 114.7, 119.7, and 113.6g/kg respectively. The values for the rest of the plantations ranged between 68.2g/kg for TRPB and 95.5g/kg for TRPA. Similar trends were observed for the other unsaturated fatty acids except for myristoleic(C14:1) where no appreciable variation in values was observed. The major saturated

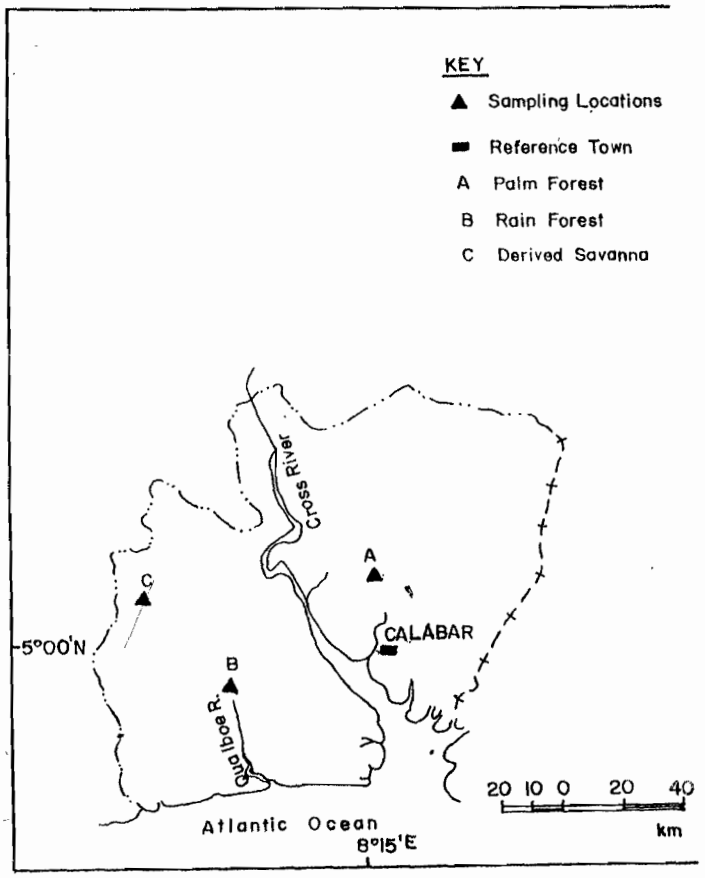

Fig. 1 Map of Sampling Locations and Rivers

fatty acid component, palmitic acid (C16:0) did not indicate any significant variation. It had values ranging from 388.0 for DRPA to 437.9g/kg for DYPC. Significant differences however, existed for stearic acid (C18:0), the second most abundant of the saturated fatty acids, with TRPC and TYPC recording almost equal amounts (114.4 and 114.9g/kg respectively), compared to the other locations with the lowest (53.6g/kg) observed for DRPC. Most of the samples contained trace amounts of elaidic acid (trans-C18:1) except DYPB, DYPC and TRPC, where the acid was not observed.

DISCUSSION

Analysis carried out on palm oils extracted from different varieties of the oil palm revealed that the constituent triglycerides and fatty acids are, to some extent, affected by the location where they are cultivated. In the case of the triglycerides, the red fruits of the *Tenera* variety was the most affected, as much of the unsaturated triglycerides (P00,000 and OLL) extracted from them varied from one location to another. The variation did not however, indicate any pattern for any of the locations, as each of the plantations differed in the amount of one triglyceride or the other. For example, TYPC recorded the highest value (123.5g/kg) for POS, while the same sample gave the lowest amount (168.0g/kg) for POO. However, TRPC exhibited greater variations between individual varieties than samples from the other locations. Studies carried out on Malaysian palm oil (Tan and Oh 1981) did not show any appreciable differences in triglyceride composition probably because mixed fruits of only one variety was considered. As indicated in Table 2, no appreciable differences across locations are observed than when the means of the red and yellow fruits of each variety are considered. The variations observed for the *Tenera* variety appear to be genetically related, since the *Dura*, grown under the same environmental conditions, did not show any significant differences in its unsaturated components.

The low values recorded for the C48 triglycerides could be attributed to the minor unidentified components (ECN 44), which standards were not available in our laboratory at the time of the analysis. Fatty acids of oils from the red fruits also showed appreciable variations ($P < 0.50$ across the locations, with the unsaturated fatty acids being the most affected. This is consistent with earlier observations on constituent triglycerides (Table 1) in which these with predominantly unsaturated fatty acids showed significant variations.

TABLE 1 TRIGLYCERIDES COMPOSITION AND THEIR RELATIVE ABUNDANCES

ECN	CN	Triglyceride type	Location/Variety/Abundances (g/kg)											
			A				B				C			
			TRPA*	TYPA	DRPA	DYPA	TRPB	TYPB	DRPB	DYPB	TRPC	TYPC	DRPC	DYPC
44	-	UN	3.4	1.6	1.2	3.3	2.6	1.0	1.8	ND	1.5	ND	12.0	ND
..	54	OLL	22.3	31.3	10.8	13.6	9.8	13.5	13.0	10.1	ND	10.8	12.0	15.9
..	-	UN	ND	ND	1.0	3.8	2.1	1.0	2.3	ND	ND	ND	6.3	ND
..	52	PLL	5.1	6.8	2.3	6.1	2.3	4.1	2.2	3.3	2.8	4.3	ND	6.5
46	54	OOL	12.8	11.7	14.4	16.0	15.3	12.0	15.3	13.7	13.5	10.6	10.8	13.2
..	52	POL	94.7	115.7	86.9	81.9	81.3	89.6	83.9	83.2	80.2	81.9	92.7	90.3
..	50	PPL	100.1	123.0	78.3	79.7	69.7	92.7	85.0	96.3	90.8	94.5	104.4	104.5
48	54	OOO	34.2	20.2	36.8	44.8	43.9	33.9	34.8	31.6	19.4	12.1	26.3	31.2
..	52	POO	217.0	195.9	260.4	242.6	220.5	210.3	245.8	237.2	180.5	168.0	225.5	223.0
..	50	PPO	328.0	334.5	333.3	331.1	338.8	356.8	346.2	345.6	350.0	359.6	333.7	338.6
..	48	PPP	47.8	42.4	50.8	42.3	53.0	47.7	34.3	48.8	66.7	56.5	42.3	45.9
50	54	OOS	30.3	24.9	32.8	34.0	41.4	31.8	30.9	28.8	30.8	23.8	25.5	28.4
..	52	POS	81.3	70.9	72.2	76.2	91.2	81.9	86.7	79.7	121.7	123.5	67.9	63.6
..	54	LSS	13.1	10.6	8.7	13.2	15.4	11.9	8.4	8.4	26.9	32.4	27.6	25.4
..	50	PPS	ND	ND	2.2	1.9	2.5	2.3	3.0	2.6	2.3	ND	2.5	3.6
52	54	SOS	9.0	9.6	6.1	8.8	9.5	9.5	6.1	9.5	12.6	21.0	9.3	9.0

* The first letter of the sample code indicates variety, eg. T = Tenera, D = Dura; the two middle letters inidicate oil type; eg. RP = red palm oil, YP = yellow palm oil; the last letters A,B,C represent sampling locations. ECN = Equivalent carbon number; CN = Triglyceride carbon number; UN = unidentified; ND = Not detected. For triglycerides; O = oleic (C18:1), P = palmitic (C16:0), L = Linoleic (C18:2), S = Stearic (C18:0).

eading to induction of specific desaturases.

In addition to the fatty acids traditionally ssociated with palm oil, trace amounts of other fatty cids were presented in each of the oil samples. 'hese fatty acids include myristoleic (C14:1), nargaric (C17:0), gadoleic (C20:1), and behenic C22:0). Trans-isomers of oleic and linoleic acids vere also observed in trace amounts (0.5g/kg) in ome of the oil samples. Margaric, heptadecanoic, adoleic, and behenic acids have been reported for groundnut (*Arachis)* oil (Padley et al, 1986). Gadoleic and behenic acids have also been found in oyabean and olive oils, while myristoleic acid C14:1) have been observed in lard and tallow Padley et al., 1986).

CONCLUSION

Constituent triglycerides and fatty acids of palm ils from the *Tenera* and *Dura* varieties of the oil palm ave been shown to vary with location, with the nsaturated triglycerides and fatty acids from the red fruits f the *Tenera* being the most affected.

Mean total unsaturated fatty acids calculated for ne oil samples showed that the *Dura* is richer in nsaturated fatty acids in all the locations than the *Tenera* vhich is consistent with our earlier report (Ekpa et al., 994c) on the two varieties. The high level of nsaturation in the *Dura* makes it preferable and more dequate nutritionally than the *Tenera*. But since the level f unsaturation is affected by the environment where the il palm is grown, a careful selection of planting location s necessary, if high unsaturation to saturation ratio is esired.

This study has shown that both varietal source and ocation contribute to the overall triglyceride and fatty acid omposition of palm oil. The extent of climatic ontribution to the variations observed in the various data s yet to be determined.

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