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Fungal Damage to Palm Kernel Oil

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ABSTRACT

Palm kernel oil prepared from palm kernels stored in warehouses in the Calabar region of Eastern Nigeria was studied. Oil was obtained from good quality kernels, discoloured kernels and kernels severely damaged by fungi. Considerable differences were found in the free fatty acid levels and also in the total fatty acid pattern.

INTRODUCTION

The West African oil palm (*Elaeis guineensis* Jacq) produces palm oil and palm kernel oil. The palm kernel oil is prepared from the kernel or endosperm of the palm fruit after removal of the palm oil. Several mechanical methods may be used to break the nuts to release the kernels, but in Nigeria where they are frequently harvested by peasant farmers, the nuts are usually cracked manually between two stones and the oil is then extracted in a press. There is little local use of palm kernel oil in Nigeria

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and much of the produce is exported, either as the intact kernels or as the extracted oil.

Several authors have analysed palm kernel oil from a variety of countries, and these have been reviewed by Cornelius (1977). These analyses have been on bulk samples and do not distinguish between good and poor quality kernels.

Crude oils from poor quality kernels, in which free fatty acids are high, suffer from significant oil losses during refining. Cornelius (1966) has studied the technical factors influencing the quality of palm kernel oil which is graded on the basis of its free fatty acid content, the oil from good quality kernels containing less than 4·75 % free fatty acids.

This work studies the total fatty acid pattern of palm kernel oil isolated from mouldy palm kernels compared with oil isolated from kernels in good condition, and those which are discoloured but which do not have any obvious fungal growth.

METHODS

Samples of palm kernels were collected from a number of warehouses in the Calabar region of the Cross Rivers State, Nigeria, where they were being stored prior to distribution to users. The kernels have a varied history, although all have been subjected to drying in an attempt to minimize fungal damage.

The kernels were washed in chloroform to remove any traces of palm oil and then were cut in half and separated into three groups. Good ones contained an endosperm which was pearly white in appearance. Discoloured ones had an endosperm which had undergone a darkening in colour but which showed no visible fungal growth, whilst decayed ones showed visible damage caused by fungi.

The endosperms were removed, macerated in an electric grinder for 3 min and then extracted with petroleum spirit (80–100 °C b.pt.) for 2 h. These oils were then dried at 105 °C briefly to remove the solvent.

Melting points were obtained on the samples and the free fatty acid values were obtained as described by the British Standards Institution (1958).

Thin layer chromatography was carried out on Silica gel G using a solvent of petroleum spirit (80–100): diethyl ether:glacial acetic acid, 80:20:1. Lauric acid was used as the marker for free fatty acids and a

mixture of mono-, di- and triglycerides was used as the lipid marker. The spots were visualized by spraying with 50 % H_2SO_4 and then charred in an oven at 120 °C for 2 h.

Samples were prepared for gas–liquid chromatography as follows. The samples were placed in a round-bottomed flask, 15 ml of redistilled anhydrous methanol and 2 drops of conc. H_2SO_4 were added. This was incubated at 37 °C for 3 days. The samples were treated with 15 ml of saturated NaCl solution and then extracted with an equal volume of redistilled hexane. The hexane layer was removed, placed in a rotary evaporator, reduced to approximately 1 ml and used for gas–liquid chromatography.

Gas chromatography was carried out using a Pye 104 chromatograph equipped with hydrogen flame detectors. The column (180 × 6 mm internal diameter) was packed with 10 % diethylene glycol succinate on Chromasorb W. The column was operated isothermally at 180 °C with the detector system set at 250 °C. The carrier gas was nitrogen (flow rate 40 ml/min). The recorder output was attached to a Spectrophysics SP 4270 integrator. All samples were analysed in triplicate and the results were expressed as an average.

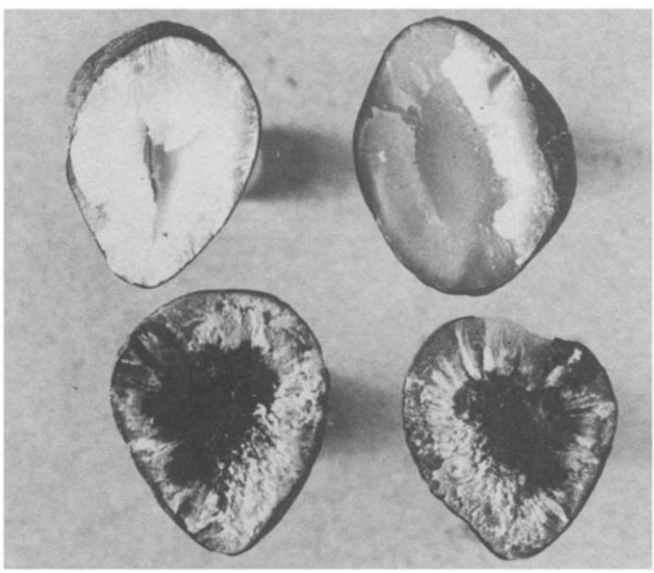

Fig. 1. Good (top) and damaged (below) palm kernels.

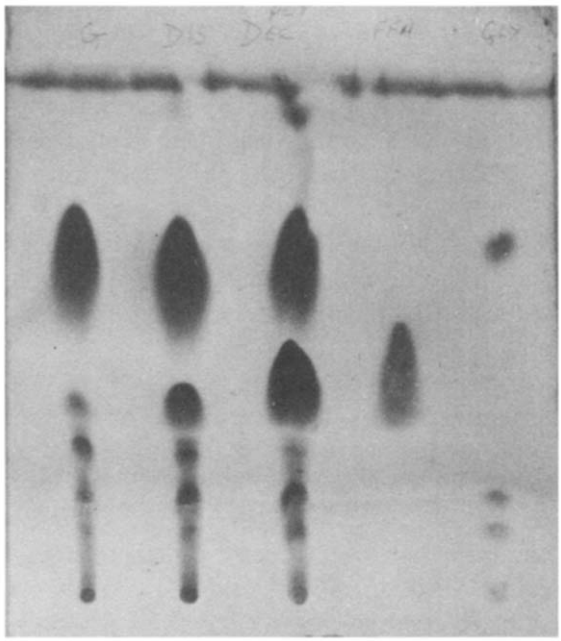

Fig. 2. Thin layer chromatography of samples of palm kernel oil on Silica gel G. From left to right: good; discoloured; decayed; free fatty acid marker; marker of mono-, di- and triglycerides. (Details in Methods section.)

TABLE 1
Fatty Acids of Good Palm Kernel Oil (16 samples)

	Fatty acids							
	8	*10*	*12*	*14*	*16*	*18*	*18:1*	*18:2*
Range (%)	3·4–4·8	3·8–4·7	48·1–50·7	15·9–17·5	8·0–9·8	2·0–2·9	11·2–14·8	T–1·6
Mean ± SD	4·07 ±0·32	4·2 ±0·29	49·32 ±0·78	16·48 ±0·46	8·79 ±0·44	2·44 ±0·23	13·55 ±1·08	1·11 ±0·55

Trace values (T) for linoleic acid ($C_{18:2}$) were given a value of 0·0 for the purpose of calculating the mean and standard deviations.
Melting points 25–30 °C.
Free fatty acid values: 2·9–4·9 (Mean ± SD = 3·61 ± 0·54).

RESULTS

Figure 1 shows a cross-section of palm kernels in good condition and those severely attacked by fungi.

Thin layer chromatography of good, discoloured and decayed samples is shown in Fig. 2.

The values for fatty acids present in the three types of samples are shown in Tables 1, 2 and 3.

TABLE 2
Fatty Acids of Discoloured Palm Kernel Oil (13 samples)

	Fatty acids							
	8	*10*	*12*	*14*	*16*	*18*	*18:1*	*18:2*
Range (%)	2·7–4·4	2·3–3·6	47·4–52·1	15·1–16·5	8·5–10·2	2·4–3·3	12·4–16·3	1·1–2·1
Mean ± SD	3·29 ±0·4	2·62 ±0·34	49·5 ±1·28	16·2 ±0·37	9·11 ±0·41	2·93 ±0·28	14·9 ±1·13	1·54 ±0·31

Melting points 17–25 °C.
Free fatty acid values: 6·7–21·2 (Mean ± SD = 11·5 ± 4·39).

TABLE 3
Fatty Acids of Palm Kernels Damaged by Fungi (14 samples)

	Fatty acids							
	8	*10*	*12*	*14*	*16*	*18*	*18:1*	*18:2*
Range (%)	2·4–2·9	2·1–3·0	39·9–43·4	17·2–19·1	9·9–10·9	2·9–4·5	17·2–18·9	2·1–2·9
Mean ± SD	2·67 ±0·16	2·49 ±0·24	42·0 ±0·83	18·1 ±0·54	10·5 ±0·35	3·64 ±0·39	18·1 ±0·62	2·54 ±0·26

Melting points 17–21 °C.
Free fatty acid values: 14·9–40·1 (Mean ± SD = 29·2 ± 7·4).

DISCUSSION

Several authors have described the effects of fungi on oil palm products (Coursey *et al.*, 1963; Cornelius, 1966; Oso, 1974; Ogundero, 1982) whilst Idem (1973) attempted to correlate the free fatty acid content with the percentage of mouldy and discoloured kernels. Fungi implicated in the damage of palm products include several species of the genus *Aspergillus*, several species of *Mucor* and *Penicillium* and one species each from the genera *Chaetomium*, *Humicola*, *Thermomyces* and *Torula* (Ogundero, 1981). These authors, however, have studied the free fatty acids in total, and there has been no attempt to identify the total fatty acids of good kernels compared with mouldy ones.

The fatty acids of palm kernel oil have been reviewed by Cornelius (1977), who quotes the data of Hilditch & Williams (1964). The values quoted for our good kernels generally lie towards the middle of the range given by Cornelius (1977).

Similar results are obtained for the discoloured kernels whose fatty acids are usually within one standard deviation of the value for the good nuts. The two exceptions, however, are for the short chain fatty acids, C8 and C10, although C8 is still within the range quoted by Cornelius (1977).

The most obvious differences are seen in the fatty acid profiles of the decayed nuts. Many of the individual components lie at the extremes of the ranges quoted by Cornelius or outside these ranges, whilst the mean value of lauric acid in the decayed samples is over nine standard deviations removed from that of the good sample. This is significantly below the range quoted by Cornelius (1977) for lauric acid and is also well below the value of $48{\cdot}39 \pm 1{\cdot}76\,\%$ found by Offem & Dart (1985) for 41 samples of fresh palm kernel oil.

There have also been significant changes in the free fatty acid levels of the discoloured and decayed samples, and falls in the value of the melting points.

The discolouration of palm kernels is possibly due to biological heating of large heaps of kernels in the warehouses, and our results are in contrast to those of Idem (1973), who considers such discolouration is not associated with rises in free fatty acids.

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