Food Chemistry **23** (1987) 139–142

The Free Fatty Acids of Palm Kernel Oil Damaged by Fungi

R. K. Dart, E. B. Dede

Microbiology Section, Department of Chemistry, University of Technology, Loughborough, Leics., Great Britain

&

J. O. Offem

Department of Chemistry, University of Calabar, Calabar, Nigeria

(Received 4 April 1986; revised version received 27 May 1986; accepted 7 July 1986)

ABSTRACT

Examination of the free fatty acids and triglycerides of palm kernel oil decayed by fungi shows a significant fall in the level of lauric acid. Considerable differences in levels of free fatty acids are found, suggesting a wide variation in the ability of fungi to use these compounds.

INTRODUCTION

Palm kernel oil extracted from the West African oil palm (*Elaeis guineensis* Jacq.) is used industrially for a variety of purposes (Cornelius, 1966, 1977). There is little local use in Nigeria and most of the oil is exported either as the intact kernels or as the extracted oil.

The quality of the oil is decided on the basis of its free fatty acid content determined as lauric acid (Federation of Oils, Seeds and Fats Assocations trade agreement, 1982). Poor quality oils, which are high in free fatty acids, suffer significant losses during refining (Cornelius, 1966).

A number of authors have shown that a major cause of the loss of quality is contamination by fungi, leading to the hydrolysis of glycerides and the formation of free fatty acids (Cornelius, 1966; Ogundero, 1982; Dart *et al.*, 1985).

A type of deterioration known as ketonic rancidity is found in palm kernel oil (Forss, 1973) in which certain xerophilic fungi (Kinderlerer & Kellard, 1984) convert short chain fatty acids to a series of methyl ketones one carbon atom shorter than the parent compound (Forney & Markovetz, 1971).

There have been several attempts to relate the level of free fatty acids to the degree of fungal contamination and deterioration of palm products (Cornelius *et al.*, 1965; Idem, 1973; Ogundero, 1981, 1982) but, although free fatty acid levels are measured widely, there have been no reports showing the identities of the free fatty acids present in palm kernel oil.

METHODS

The palm kernel oil used in this study was obtained from palm kernels damaged by fungi as described by Dart *et al.* (1985). Thirteen of the fourteen samples used previously were assayed, there being insufficient of one sample for further work.

Free fatty acids and the triglycerides occurring after fungal hydrolysis were obtained by thin-layer chromatography using the solvent system described previously (Dart *et al.*, 1985). Plates were visualized by spraying with 0·1% 2:7 dichlorofluorescein in 95% methanol when lipids appear as yellow spots under ultraviolet light.

Spots corresponding to the free fatty acids and the triglycerides were scraped off the plates separately into filter papers and each was washed with 2 × 10 ml of petroleum spirit (40–60°C boiling point). These were carefully reduced to dryness on a rotary evaporator and 5 ml of redistilled methanol and one drop of concentrated H_2SO_4 were added. Mixtures were incubated at 37°C for 48 h to synthesize the methyl esters. Hexane (10 ml) and saturated NaCl (5 ml) were added; the mixture was shaken, allowed to separate and the hexane layer was recovered. This was reduced to 1 ml on a rotary evaporator and used for gas–liquid chromatography.

Gas chromatography of the methyl esters was carried out as described previously (Dart *et al.*, 1985).

RESULTS AND DISCUSSION

The results obtained for the total fatty acid pattern of the thirteen samples used in this study are shown in Table 1 and are derived from the data obtained by Dart *et al.* (1985) for fourteen samples.

TABLE 1
Total Fatty Acids of Palm Kernel Oil Damaged by Fungi (Thirteen Samples)

	C8	*C10*	*C12*	*C14*	*C16*	*C18*	*C18:1*	*C18:2*
Range	2·4	2·1	39·9	17·5	9·9	2·9	17·0	2·1
	2·9	2·8	43·4	19·1	10·9	4·5	18·9	2·9
Mean	2·7	2·4	42·0	18·2	10·5	3·7	18·0	2·5
±SD	0·17	0·2	0·86	0·49	0·35	0·4	0·67	0·27

Results obtained for the free fatty acid pattern of these thirteen damaged samples are shown in Table 2, whilst results for the fatty acids of the residual triglycerides are shown in Table 3.

Results presented in our previous paper (Dart *et al.*, 1985) show that free fatty acid levels rise considerably in damaged kernels whilst the mean level of lauric acid falls from 49·3% in good quality kernels to 42·0% in damaged kernels.

Results presented in this paper show that there is a further fall of lauric acid (Table 2) when the distribution pattern among the free fatty acids is examined. This result confirms the observation of Forney & Markovetz (1971) that there is conversion of lauric acid to undecan-2-one. However, as the total lauric acid content of decayed palm kernels is significantly lower than that of good quality kernels (Dart *et al.*, 1985) it is possible that there is preferential utilization of lauric acid by fungi causing this type of damage.

TABLE 2
Free Fatty Acids of Palm Kernel Oil Damaged by Fungi (Thirteen Samples)

	C8	*C10*	*C12*	*C14*	*C16*	*C18*	*C18:1*	*C18:2*
Range	1·3	1·2	31·4	16·5	11·1	1·3	15·2	1·5
	5·0	3·3	43·0	20·7	14·8	4·2	27·7	3·2
Mean	3·1	2·2	36·5	18·3	12·9	2·7	22·0	2·2
±SD	0·99	0·62	3·41	1·41	1·27	0·74	2·85	0·51

TABLE 3
Residual Triglycerides of Damaged Palm Kernel Oil After Removal of Free Fatty Acids

	C8	*C10*	*C12*	*C14*	*C16*	*C18*	*C18:1*	*C18:2*
Range	1·2	1·6	40·1	15·9	6·6	1·8	13·0	0
	−4·6	−5·4	−51·3	−22·3	−10·6	−4·2	−21·8	−4·1
Mean	3·3	2·9	45·8	18·3	8·3	3·0	16·4	2·1
±SD	±1·16	±1·2	±3·84	±2·04	±1·58	±0·88	±2·89	±1·06

Fungi implicated in damage to palm kernels include a number of thermophilic species from genera such as *Aspergillus*, *Penicillium*, *Mucor*, *Chaetomium*, *Humicola*, *Thermomyces* and *Torula* (Ogundero, 1981). Cornelius *et al.* (1965) have commented on a wide variation amongst spoilage fungi such as *Aspergillus* species in their ability to use free fatty acids liberated from palm oil. This is borne out by the greatly increased range of values both for the free fatty acids (Table 2) and residual triglycerides (Table 3) compared with total fatty acids (Table 1).

REFERENCES

Cornelius, J. A. (1966). Some technical factors influencing the quality of palm kernels. *Journal of the Science of Food and Agriculture*, **7**, 57–61.

Cornelius, J. A. (1977). Palm oil and palm kernel oil. *Progress in the Chemistry of Fats and other Lipids*, **15**, 5–27.

Cornelius, J. A., Eggins, H. O. W. & Wallbridge, A. (1965). Biodeterioration of palm oil constituents caused by fungi. *International Biodeterioration Bulletin*, **1**, 46–55.

Dart, R. K., Dede, E. B. & Offem, J. O. (1985). Fungal damage to palm kernel oil. *Food Chemistry*, **18**, 113–19.

Forney, F. W. & Markovetz, A. J. (1971). The biology of methyl ketones. *Journal of Lipid Research*, **12**, 383–95.

Forss, D. A. (1973). Odor and flavor compounds from lipids. *Progress in the Chemistry of Fats and Other Lipids*, **13**, 177–258.

Idem, W. D. (1973). Free fatty acid content of palm kernels as a function of mouldy discoloured kernels. *Oleagineux*, **28**, 243–8.

Kinderlerer, J. L. & Kellard, B. (1984). Ketonic rancidity in coconut due to xerophilic fungi. *Phytochemistry*, **23**, 2847–9.

Ogundero, V. W. (1981). Thermophilic fungi from Nigerian palm produce. *Mycologia*, **73**, 198–202.

Ogundero, V. W. (1982). Hydrolysis of vegetable oils and triglycerides by thermotolerant and zoopathogenic species of *Aspergillus* from Nigerian palm produce. *Mycopathologica*, **77**, 43–6.