The Seed Lipids of the Palm Family

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ABSTRACT

The majority of palms, represented by *Elaeis guineensis,* contained mainly neutral lipids (triglycerides) in their seed fats with lauric and myristic acids as the major acids. In certain others, symbolized by the *Raphia* palms, polar lipids dominated, with the unsaturated acids, oleic and linoleic acids constituting the major fatty acids. Contrary to established belief, lauric and myristic acids were not the principal fatty acids in all palms.

INTRODUCTION

The family Palmae, estimated to consist of about 217 genera and about 2,500 species (1), is second to the grasses in economic importance to man. They are all indigenous to the tropical and subtropical regions of the world (from about 15 N of the Equator to 12 S of the Equator) where they are used for timber, building materials, fibre, oil, food, wax, wine and dyes, to mention a few. The palms provide ca. 14% of the world's supply of fats and oils, which is made up of tree crop oils, including palm oils and other industrial oils, (17.4%), vegetable oils (53%), animal fats (28%) and marine oils (1.7%) (2). Presently the entire world depends upon the palm family for needed oils and fats derived mainly from the coconut (*Cocos nucifera*) and the oil palm (*Elaeis guineensis*) trees. In the past coconut oil has been the largest source, while palm oil (a fruit coat fat) and palm kernel oil (palm seed fat) ranked second and third, respecitvely. Recently, with the emergence of large scale plantations, especially in the far east, the order has changed with palm oil taking the first place.

The possible increases in world economic growth and population will increase the demand for tree crop and vegetable oils for which the palms offer a potential. Many species of palms are prolific seed bearers, but unfortunately little data exist about the chemical constitution of the fats they contain. Of the 217 genera and about 2,500 species of known palms, not more than 30 genera and 50 species have been investigated in detail. Therefore, more studies of the Palmae seed fats and their chemical composition should be made in view of our very limited knowledge of the group. This investigation provides knowledge on the chemical composition of palm seeds as a basis for future developments. The data might prove useful not only in attempt to provide alternative supplementary sources of plant fats, but also to define the close relations between fatty acids and the botanical families where they are found.

MATERIALS AND METHODS

Seeds

The palm fruits except for those of *Raphia* were collected from the Palmetun of the Nigerian Institute for Oil palm Research (NIFOR). *Raphia* fruits were collected from experimental groves maintained by NIFOR in different parts of the country. In all cases the seeds were recovered from the fruits after removing the covering pericarp, including the testa.

Extraction of lipids

The seeds or kernels, where very hard, were pulverized in a ball mill. In other cases they were homogenized with a small volume of isopropyl alcohol in a mortar. The resulting powder or homogenate were extracted with chloroform-methanol (2:1, v/v) at room temperature. The filtrates were concentrated in vacuo, the water soluble impurities in the concentrates removed by the Folch's wash (3), and the chloroform layers concentrated and stored under nitrogen in the deep-freeze.

Column chromatography

Total lipid extracts were fractionated into neutral and polar lipids by column chromatography (silica gel, M.F.C., 100-200 mesh, Hopkin and Williams, Romford, England) according to the methods of Rouser et al. (4) using 200 ml of chloroform to yield neutral lipids and 200 ml of chloroform-methanol (2:1) to give the polar lipids.

Thin Layer chromatography

Qualitative TLC of the lipids was carried out on 250 nm prekotes (Applied Science) and developed in petroleum ether-ethyl ether-formic acid (70:30:1, v/v/v) for identifying neutral lipids. Polar lipids were identified using chloroform-methanol-acetic acid-water (85:15:10:4, v/v/v/v) as the solvent system. The lipid classes were identified through the use of authentic samples, spraying with specific reagents (5,6) and by reference to relative R_f values (7). Sterols and steryl esters were confirmed by the Komarowsky (8) and the Lieberman-Burchard (9) color reactions.

Gas Liquid Chromatography of Total Lipids

The fatty acid methyl esters of the total lipid extracts were prepared by transmethylation according to the methods of Feldman et al. (10). The concentrated hexane extracts of the methyl esters were chromatographed isothermally on 2.1 m x 6 mm (i.d.) glass column packed with HI-EFF i,4-butanediol succinate polyester (Applied Science) on AW-DMCS Chromosorb W (80-100 mesh), using a Pye Series 104 gas chromatograph equipped with a flame ionization detector. Oxygen-free nitrogen was used as the carrier gas at a flow rate of 50 ml min^{-1}. The identities of the peaks were established by comparison with standard methyl esters with respect to retention times and the use of the plot of log of retention times against carbon number. Concentrations of components were calculated from peak areas by triangulation and expressed as percentages of the total.

RESULTS AND DISCUSSION

The seed lipids of palms varied from a little under 1% in the *Raphia* species to well over 50% in *Elaeis guineensis* (Table I). In the majority of palm species, typified by *E. quineensis,* triglycerides were the principal storage lipids (95%) accompanied by trace amounts of sterols and phospholipids (4%). In this group belong species grown commercially, such as *Cocos nucifera.* Palm species of potential commercial interest also would be found in this group. In certain other species, represented by the *Raphia* series, the lipids contained varied polar types, mainly phospholipids and glycolipids (56%), and comparatively smaller amounts of triglycerides, waxes and sterols (11). In mature plant seeds, the major class of lipids is triglycerides, which may constitute between 10 and 70% of the dry weight, while phospholipids and glycolipids normally represent less than 2% of the total seed lipids (12). Known exceptions to this rule occur in the seeds of a member of the Graminae, *Briza spicata,* which contained some 20% of lipid, of which ca. 78% was glactosyl diglycerides (13), and in the plant species *Simmondsia california* (14) and *Murraya koenigii* (15), in

TABLE I

Total Lipid and Fatty Acid Distribution in Palm Seed Lipids

Palm sp.	Total lipid %	Major fatty acids (%)								
		8:0	10:0	12:0	14:0	16:0	18:0	18:1	18:2	18:3
Aiphanes acanthophylla	65.4	t	t	41.5	20.5	10.2	3.4	15.8	7.4	----
Areca sp.	6.1	t	t	18.5	19.8	12.0	2.2	22.3	25.3	----
Arecastrum romanizoffianum	36.9	t	1.8	58.1	21.4	6.1	2.4	10.3	t	----
Bactris major	25.4	1.8	1.6	50.8	24.6	7.0	2.7	7.6	3.8	----
Bentinckia nicobarica	---	t	t	32.9	24.4	13.3	4.2	11.8	13.9	----
Borassus flabellifer[a]	1.1	t	t	t	t	29.5	4.4	31.9	34.2	t
Buttia capitata	59.6	16.0	15.8	39.2	6.4	4.2	3.0	11.9	3.5	----
Caryota mitis	1.4	t	t	10.4	13.5	27.5	2.0	20.5	15.3	3.1
Caryota urens	1.1	1.8	1.8	24.0	15.3	27.3	t	17.5	12.4	t
Cocos nucifera	66.5	12.0	15.8	43.2	6.4	4.2	3.0	11.9	3.5	t
Coccothrinax argentea	7.6	0.6	0.8	43.8	14.4	7.7	4.4	17.6	10.7	----
Coccothrinax miraguama	6.3	t	t	44.9	15.1	8.0	4.5	14.6	13.0	----
Elaeis guineensis	51.1	2.7	7.0	46.9	14.1	7.8	1.3	18.5	1.7	----
Elaeis oleifera	36.9	1.4	1.3	31.7	20.8	11.3	2.8	26.0	4.8	----
Hyphaene schatan	5.4	t	t	34.6	16.5	9.0	3.7	30.0	4.8	----
Latania loddigesii	14.2	2.7	1.0	37.9	13.1	7.1	4.2	15.8	7.4	----
Livistonia rotundifolia[a]	1.0	t	t	t	0.5	22.4	8.5	38.3	29.8	t
Oncosperma horrida	17.9	t	t	54.2	23.0	7.2	t	15.6	t	----
Orbingya cohune	---	7.0	5.9	50.8	18.4	9.0	3.2	5.6	t	----
Raphia farinifera[a]	---	3.1	t	t	1.9	38.7	4.5	35.6	14.7	t
Raphia hookeri[a]	0.8	t	t	0.8	t	23.0	2.8	31.1	32.5	4.2
Raphia regalis[a]	0.9	7.3	t	4.0	6.8	25.6	5.3	19.3	30.5	t
Raphia sudanica[a]	0.6	t	t	1.0	1.2	27.0	3.9	35.8	28.8	1.6
Raphia vinifera[a]	0.8	t	t	0.7	1.1	28.3	3.7	22.9	38.6	2.8
Roystonia regia	14.4	t	t	44.5	14.0	7.5	3.3	18.5	9.9	----
Sabal blackburniana	7.8	0.5	0.5	24.4	11.9	8.1	2.0	37.1	15.6	----
Sabal mexicana	7.5	0.7	0.5	21.6	9.2	6.5	2.2	41.6	17.7	----
Sabal palmetto	8.0	t	t	15.9	10.4	7.1	5.1	46.4	15.2	----
Sabal texana	8.2	t	t	21.7	8.6	5.9	2.3	44.4	16.8	----
Veitchia merrillii[a]	0.9	t	0.4	t	1.2	22.9	5.2	27.7	40.7	----
Verschaffeltia splendida	1.8	t	t	14.9	23.6	18.1	3.2	20.0	20.2	----

[a]*Raphia* type palms.
[b]World commercial palm kernel oil produced from this species.

which the major lipid component was wax ester and hydrocarbon.

In this study two patterns of seed endosperms were recognized. The "oil palm kernel" type, with seeds consisting of relatively hard, oily endosperms greyish to brownish in color, and the "Raphia kernel" type made up of very hard, stony and waxy endosperms containing vegetable ivory. The former, which was typical of the generality of plant seed endosperms, yielded lipids the bulk of which were triglycerides containing the saturated shorter chain acids (lauric and myristic) as principal fatty acids, while the latter gave lipids which contained more polar types and yielded unsaturated acids (oleic and linoleic) as major fatty acids. In the past the regular persistence and the very high amounts of lauric and myristic acids in the species of palms investigated had led to the inclusion of the family Palmae among the few families of plants said to be lauric acid-rich (16). This study, on the other hand, has shown that in palms generally the dominance or presence of lauric or myristic acids or the unsaturated fatty acids (oleic and linoleic) depended on the anatomy of the endosperm. Those species possessing the "*Raphia* kernel" type of endosperm contained negligible quantities of lauric and myristic acids, while at the same time they possessed high percentages of the unsaturated fatty acids, oleic and linoleic acids.

The *Raphia* type palms possessed lipids which had much in common with mesocarp or fruit coat lipids of palms (17). They, therefore, may be classified with the very large number of oils whose component fatty acids include oleic and linoleic acids as well as palmitic acid as major fatty acids. Families with seed fats in this category include many herbaceous and shrubby plants and have a tendency to be more regularly native of tropical and subtropical regions (16). The above findings are supported by the results of Hilditch and Williams (16), that *Phoenix dactylifera* seeds which possessed the "*Raphia* kernel" type endosperm contained little endosperm fats with high saponification and iodine values which are indicative of unsaturated fatty acids. Although these authors tried to attribute the high unsaturation to the possible inclusion of testa fats in their extracts, this work clearly demonstrated that this might not be the case, since the lipid extracts were solely derived from pure endosperm material with no contamination from the testa. Testa fats in the seeds of Palmae have fatty acid composition resembling that of the fruit coat lipids (18-20).

The paucity of seed lipids (about 1%) in the *Raphia* type palms clearly indicates that these palms would be of little commercial value. On the other hand, three palms, *Aiphanes acanthophylla, Arecastrum romanzoffianum* and *Butia capitata,* belonging to the same subfamily as *E. guineensis* (21), appear to have potential as supplementary sources of commercial seed oils. Before commercial exploitation it would be significant to know the yield per hectare of each palm *vis a vis* those of *E. guineensis* and *Cocos nucifera.* The ultimate use to which such oils might be put would depend on characteristics such as taste, odor, color (carotene content, which affects bleachability), and fatty acid composition.

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