Phytochemistry, 1970, Vol. 9, pp. 1829 to 1833. Pergamon Press. Printed in England.

SEED FATS OF SOME NEW ZEALAND AND AUSTRALIAN MONOCOTYLEDONS

ISOBEL M. MORICE

Wellington Laboratory, Applied Biochemistry Division, Department of Scientific and Industrial Research, Wellington, New Zealand

(*Received* 9 *December* 1969)

Abstract—Seed fats of twelve monocotyledons found in New Zealand and Australia have been examined. Those of two species of *Cordyline* (Agavaceae), *Xanthorrhoea hastilis* (Xanthorrhoeaceae) and *Hypoxis pusilla* (Hypoxidaceae) contain 45–84% linoleic acid and are similar to other members of the Agavaceae and Liliaceae. Two species of *Ripogonum* and two of *Smilax* (Smilacaceae) have as predominant fatty acids linoleic 26–49%, oleic 10–47% and palmitic 15–31%. *Luzuriaga parviflora* (Philesiaceae), unlike other monocotyledons studied, contains 15% *cis*-11-eicosenoic, 12% *cis*-13-docosenoic and 7% *cis*-15-tetracosenoic acids. Three species of *Rhopalostylis* (Palmae) differ from other members of the Palmae in containing less lauric (3–11%) and myristic (1–17%) acids and more linoleic acid (18–59%).

INTRODUCTION

STUDIES on seed fats of monocotyledons indigenous to New Zealand have included members of the families Agavaceae,[1] Juncaceae,[2] Liliaceae[3,4] and Iridaceae.[5] The families referred to in this paper are those used by Hutchinson[6] in his arrangement of the monocotyledons. In the present work the seed fats of *Hypoxis pusilla* (Hypoxidaceae), *Ripogonum scandens* (Smilacaceae), *Luzuriaga parviflora* (Philesiaceae) and *Rhopalostylis sapida* and *Rh. cheesemanii* (Palmae) have been investigated. Those of some monocotyledons from Australia and nearby islands, related to the foregoing and other New Zealand species, have also been examined. These are *Cordyline terminalis* and *C. cannifolia* (Agavaceae), *Xanthorrhoea hastilis* (Xanthorrhoeaceae). *Ripogonum discolor*, *Smilax glyciphylla* and *S. australis* (Smilacaceae) and *Rhopalostylis baueri* (Palmae). Hitherto nothing has been known of seed fats of the Hypoxidaceae, Philesiaceae and Xanthorrhoeaceae or the genus *Ripogonum*. Two species of *Smilax* have been investigated by other workers[7] whose figures are shown in Table 1, and characteristics of the New Zealand species of *Cordyline* have already been reported.[1]

TABLE 1. CHARACTERISTICS OF *Smilax* SEED FATS[7]

	Fat (% on dry wt.)	Iodine value	Saponification equiv.	Unsaponifiable matter (%)	Component fatty acids (%)		
					18:2	18:1	Satd.
Smilax china	11·2	110	293	1·0	39·1	48·4	12·5
Smilax nipponica	7·0	117	292	1·3	48·8	36·8	14·4

[1] I. M. MORICE, *J. Sci. Food Agri.* **13**, 666 (1962).
[2] I. M. MORICE, *J. Sci. Food Agri.* **18**, 129 (1967).
[3] I. M. MORICE, *J. Sci. Food Agri.* **18**, 343 (1967).
[4] I. M. MORICE, *J. Sci. Food Agri.* **20**, 262 (1969).
[5] I. M. MORICE, *J. Sci. Food Agri.* **20**, 611 (1969).
[6] J. HUTCHINSON, *The Families of Flowering Plants, II. Monocotyledons*, 2nd edition, Clarendon Press, Oxford (1959).
[7] Y. KOYAMA and Y. TOYAMA, *Abura Kagaku* **6**, 218 (1957).

Some members of the Palmae such as *Cocos nucifera* and *Elaeis guineensis* are of economic importance and have been extensively studied,[8] but nothing is known of *Rhopalostylis* and very little of its tribe Areceae. The limited fatty acid data that there are for this tribe[9–12] are shown in Table 2.

TABLE 2. COMPONENT FATTY ACIDS PER CENT OF FAMILY PALMAE, TRIBE ARECEAE

	10:0	12:0	14:0	16:1	16:0	18:3	18:2	18:1	18:0	Others
Subtribe Areceae										
Areca catechu[9]	0·2	16·6	44·9	7·8	13·8	—	6·4	7·4	2·0	0·9
A. catechu[10]	tr	15·9	50·6	—	14·8	1·1	6·9	4·9	3·4	2·4
Subtribe Oncospermeae										
Roystonea oreodoxa[11]	5·0	32·2	16·1	—	7·5	—	9·5	28·7	1·0	—
Subtribe Geonomeae										
Manicaria saccifera[12]	6·6	47·5	18·9	—	8·2	—	1·4	9·7	2·4	5·3

RESULTS AND DISCUSSION

In Table 3 the amounts of oil, iodine values, saponification equivalents and percentages of unsaponifiable matter are shown.

The amounts of oil of *Cordyline terminalis* and *C. cannifolia* are similar to those of other species of *Cordyline.*[1] *Xanthorrhoea hastilis* contains less oil than *Cordyline* and *Phormium,*[1] and *Hypoxis pusilla* an amount comparable with members of the Liliaceae,[3,4] but *Luzuriaga parviflora* has considerably less. *Ripogonum scandens* and *Ri. discolor* contain remarkably little oil, 0·7–1·3%, while *Smilax glyciphylla* and *S. australis* of the same family have 9–12% which is similar to amounts found for other species of *Smilax.*[7] *Rhopalostylis sapida* and *Rh. cheesemanii* contain small amounts compared with most other palms[13] and *Rh. baueri* even less. Although the fruits of *Rh. baueri* appeared ripe it is possible that the low oil content and high percentage of linoleic acid are due to some immaturity. It has been found for *Areca catechu*[14] that unripe seeds contain less oil and a greater proportion of unsaturated acids than ripe ones.

The amounts of the component fatty acids as percentages of the total fatty acids are shown in Table 4. The plants studied are placed in Hutchinson's scheme[6] in six different families and five different orders and, not unexpectedly, vary in their fatty acid content. *C. terminalis* has a similar fatty acid composition to *Phormium* and the New Zealand species of *Cordyline*[1] as has *X. hastilis* of a closely related family, but *C. cannifolia* contains less linoleic acid and more oleic acid. *H. pusilla*, although in classification not placed near either the Agavaceae or the Liliaceae, is similar in fatty acid composition with a high content of linoleic acid. In contrast *Ripogonum* and *Smilax* which are placed in the same order as the Liliaceae, the

[8] T. P. HILDITCH and P. N. WILLIAMS, *The Chemical Constitution of Natural Fats*, 4th edition, Chapman & Hall, London (1964).
[9] S. P. PATHAK and S. S. MATHUR, *J. Sci. Food Agri.* **5**, 461 (1954).
[10] A. MACKIE and D. G. MIERAS, *J. Sci. Food Agri.* **12**, 202 (1961).
[11] R. C. STILLMAN and R. M. REED, *Oil and Soap* **11**, 208 (1934).
[12] G. COLLIN, *Biochem. J.* **27**, 1366 (1933).
[13] E. W. ECKEY, *Vegetable Fats and Oils*, Reinhold, New York (1954).
[14] A. R. S. KARTHA, A. S. SETHI and R NARAYANAN, *J. Sci. Ind. Res. India* **18C**, 172 (1959).

Liliales, have a different fatty acid pattern with less linoleic, more palmitic and small amounts of tetracosanoic acid. This difference supports their removal by Hutchinson[6] from the

TABLE 3. CHARACTERISTICS OF SEED FATS

Order, family, genus and species	Fat (% on dry wt.)	Iodine value (Wijs, 1 hr)	Saponification equivalent	Unsaponifiable matter (% wt. of fat)
AGAVALES				
Agavaceae				
Cordyline terminalis, Mt. Alford, Queensland	29·0	130	296	1·5
C. cannifolia, Fraser Island, Queensland	34·6	108	292	1·5
Xanthorrhoeaceae				
Xanthorrhoea hastilis, New South Wales	19·1	142	302	5·2
HAEMODORALES				
Hypoxidaceae				
Hypoxis pusilla, Lincoln, New Zealand	32·8	152	297	2·3
LILIALES				
Smilacaceae				
Ripogonum scandens, 1, Akatarawa, New Zealand	0·8	80	316	12·9
Ripogonum scandens, 2, Hokitika, New Zealand	0·7	80	331	12·8
R. discolor, Mt. Gibberagunyah, New South Wales	1·3	85	384	6·5
Smilax glyciphylla, Babinda, Queensland	11·9	92	298	2·6
S. australis, Lord Howe Island	9·1	102	295	2·2
ALSTROEMERIALES				
Philesiaceae				
Luzuriaga parviflora, Stewart Island, New Zealand	9·6	106	325	6·7
PALMALES				
Palmae				
Rhopalostylis sapida, 1, Opotiki, New Zealand	3·7	82	285	4·2
Rhopalostylis sapida, 2, Paraparaumu, New Zealand	5·2	82	283	3·4
Rhopalostylis sapida, 3, Westhaven, New Zealand	5·5	68	277	4·2
R. cheesemanii, Kermadec Islands (Raoul)	4·7	67	277	1·9
R. baueri, Norfolk Island	0·5	114	361	15·3

Liliaceae to the Smilacaceae. The two species of *Smilax*, however, differ a little from *Ripogonum* and are more like *S. china* and *S. nipponica*.[7]

Luzuriaga parviflora is another plant whose transfer, from the Liliaceae to the Philesiaceae, seems amlpy justified by fatty acid composition. Unlike the Liliaceae or any other New

TABLE 4. FATTY ACID COMPOSITION, AREA PER CENT OF TOTAL ACIDS

Order, family, genus and species	10:0*	12:0	14:0	15:1	15:0	16:1	16:0	17:1	17:0	18:3	18:2	18:1	18:0	19:0	20:1	20:0	21:0	22:1	22:0	23:0	24:1	24:0
AGAVALES																						
Agavaceae																						
Cordyline terminalis	—	—	—	—	—	—	4·5	—	—	tr	73·6	20·2	1·4	—	0·1	0·1	—	0·1	tr	—	—	—
C. cannifolia	—	—	—	—	—	—	13·3	—	—	0·2	44·6	39·2	2·5	—	0·1	tr	—	0·1	tr	—	—	—
Xanthorrhoeaceae																						
Xanthorrhoea hastilis	—	—	0·2	—	—	0·4	8·7	—	—	—	82·4	6·5	1·8	—	tr	tr	—	—	tr	—	—	—
HAEMODORALES																						
Hypoxidaceae																						
Hypoxis pusilla	—	—	—	—	—	—	4·4	—	—	0·5	84·0	9·4	1·1	—	0·1	0·1	—	—	0·4	—	—	—
LILIALES																						
Smilacaceae																						
Ripogonum scandens, 1	—	tr	0·5	—	tr	1·0	24·9	—	tr	2·9	39·8	24·0	3·7	0·5	1·5	0·2	0·1	—	0·4	0·1	—	0·4
Ripogonum scandens, 2	tr	0·3	0·3	0·1	0·2	1·2	30·6	0·1	0·3	1·1	39·1	17·7	2·9	2·1	1·6	0·3	0·1	0·1	0·8	0·3	—	0·8
R. discolor	tr	0·1	0·2	0·3	0·3	0·7	28·0	0·1	0·3	4·7	48·7	9·8	4·2	0·6	0·3	0·2	tr	—	0·6	tr	—	0·9
Smilax glyciphylla	—	—	0·1	—	—	0·1	21·6	—	tr	—	25·8	47·3	4·2	tr	0·3	0·4	0·2	—	tr	—	—	tr
S. australis	—	—	0·1	—	tr	0·2	14·5	—	tr	—	43·1	34·7	4·4	0·3	0·9	1·0	0·6	—	tr	—	—	0·2
ALSTROEMERIALES																						
Philesiaceae																						
Luzuriaga parviflora	—	—	—	—	—	0·4	12·2	—	—	0·8	36·6	14·2	1·2	—	15·0	0·2	0·1	12·2	0·2	—	6·9	tr
PALMALES																						
Palmae																						
Rhopalostylis sapida, 1	tr	3·6	11·7	tr	tr	tr	25·7	tr	tr	0·5	19·7	32·6	4·9	0·2	0·3	0·2	0·3	—	0·1	0·1	—	0·1
Rhopalostylis sapida, 2	tr	3·3	8·0	tr	—	tr	23·8	tr	—	0·2	39·5	23·8	1·3	tr	0·1	tr	tr	—	tr	tr	—	tr
Rhopalostylis sapida, 3	0·1	9·4	16·5	—	0·1	0·1	22·6	—	0·1	0·3	17·6	30·5	2·4	tr	0·1	0·2	—	—	—	—	—	—
R. cheesemanii	0·1	11·0	14,6	0·1	—	0·2	19·6	—	0·1	0·1	18·0	32·6	2·8	—	0·4	0·3	—	—	0·1	—	—	—
R. baueri	0·1	0·2	0·5	0·7	—	0·6	31·0	tr	0·2	1·7	59·0	3·5	0·9	tr	0·3	0·1	0·1	0·1	0·2	0·3	—	0·5

* Designated by the number of carbon atoms followed by the number of double bonds.
tr = trace.

Zealand monocotyledons studied previously it contains 15·0% *cis*-11-eicosenoic, 12·2% *cis*-13-docosenoic (erucic) and 6·9% *cis*-15-tetracosenoic acids. Only *Luzula* (Juncaceae)[2] contains more than 1% of eicosenoic, docosenoic and tetracosenoic acids and then never more than 3·5%. The dicotyledon *Brassica napus* (rape) possesses a mechanism, which incidentally can be bred out of it, for elongating oleic acid at the carboxyl end of the molecule to form eicosenoic and erucic acids;[15] from the position of the double bond in the C_{20}, C_{22} and C_{24} acids of *Luzuriaga parviflora* it seems probable that a somewhat similar mechanism is present in this plant.

Members of the Palmae are noted for their high percentages of lauric (16–52%) and myristic (7–51%) acids and low percentages of linoleic acid which rarely exceed 10%.[8] The three species of *Rhopalostylis*, however, show a different pattern of fatty acids, containing only 0·2–11% lauric acid, 0·5–17% myristic acid and larger quantities, 18–59%, of linoleic acid. In lauric acid content they resemble *Areca catechu*,[9,10] the only other member of the same subtribe Areceae for which there are fatty acid data (Table 2), but show little similarity in the amounts of other fatty acids. Nor have they much resemblance to *Roystonea oreodoxa*[11] and *Manicaria saccifera*[12] of the same tribe but different subtribes. Nevertheless *Rh. sapida* and *Rh. cheesemanii* contain higher percentages of lauric acid than the other New Zealand monocotyledons examined and, with the exception of the genus *Libertia* (Iridaceae),[5] higher percentages of myristic acid also.

The species examined of *Rhopalostylis*, *Ripogonum*, *Smilax* and *Luzuriaga* do not yield enough oil to be of economic use and plants of *H. pusilla*, being only a few centimetres tall, naturally produce no great bulk of seeds. The seeds obtained from *C. terminalis* and *C. cannifolia*, however, measured from 4 to 6 mm in diameter and were considerably bigger than rape seed. These two plants with *X. hastilis* and perhaps other species of *Xanthorrhoea* might be possible sources of seed oil rich in linoleic acid.

EXPERIMENTAL

The seed samples were obtained from the localities shown in Table 3. The fatty oils, unsaponifiable matter and methyl esters of the fatty acids were obtained as described for the Agavaceae[1] and the methyl esters were analysed by gas–liquid chromatography as described for the Juncaceae.[2] The chain lengths of the unsaturated acids of *Ripogonum discolor, Smilax australis, Luzuriaga parviflora, Rhopalostylis sapida* 3 and *Rh. baueri* were further confirmed by hydrogenation.

The C_{20}, C_{22} and C_{24} unsaturated esters of *L. parviflora*, separated as much as possible from their saturated counterparts, were obtained by preparative gas–liquid chromatography. I.r. spectroscopy of these three fractions showed that the double bonds were *cis* and iodine values (Wijs, 1 hr) indicated monoenes only. The fractions were then oxidized by the periodate-permanganate method of von Rudloff[16] as described by Hansen and Meiklen.[17] The resulting monobasic and dibasic acids were converted to methyl esters with BF_3 in methanol.[18] The esters were compared with known C_6, C_8, C_9 and C_{10} alkanoic esters and C_9, C_{10}, C_{11}, C_{12}, C_{13} and C_{14} dicarboxylic esters by gas–liquid chromatography on 10% diethylene glycol succinate, 20% ethylene glycol adipate and 5% Apiezon L. Nonanoic and undecanedioic acids were obtained from methyl eiscosenoate, nonanoic and tridecanedioic acids from methyl docosenoate and nonanoic and pentadecanedioic acids from methyl tetracosenoate, showing the double bond of each ester to be in the 11, 13 and 15 positions respectively.

Acknowledgements—The author is grateful to Dr. L. B. Moore of the Botany Division, Department of Scientific and Industrial Research, for seeds and botanical advice and to Dr. I. A. E. Atkinson, Mr. R. Chinnock, Dr. C. C. J. Culvenor, Dr. J. S. Fitzgerald, Mrs. H. M. McCoy, Mr. N. Potts, Mr. L. S. Smith, Mr. W. R. Sykes and Mr. J. L. Willis for identified seeds.

[15] R. K. Downey and B. M. Craig, *J. Am. Oil Chemists' Soc.* **41**, 475 (1964).
[16] E. von Rudloff, *Can. J. Chem.* **34**, 1413 (1956).
[17] R. P. Hansen and S. M. Meiklen, *New Zealand J. Sci.* **12**, 324 (1969).
[18] D. van Wijngaarden, *Anal. Chem.* **39**, 848 (1967).