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SEED FATS OF SOME NEW ZEALAND CYPERACEAE

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Key Word Index—*Cyperus*; *Desmoschoenus*; *Morelotia*; *Gahnia*; *Carex*; *Uncinia*; Cyperaceae; seeds; fatty acids.

Abstract—Seed fats and the constituent fatty acids of *Cyperus ustulatus*, *Desmoschoenus spiralis*, *Morelotia affinis*, 6 species of *Gahnia*, 2 species of *Carex* and 25 species of *Uncinia*, all New Zealand members of the Cyperaceae, are described. Fat content ranges from 2–20%, linoleic acid from 34–78%, oleic acid from 11–48% and palmitic acid from 5–32%.

INTRODUCTION

The Cyperaceae (sedges) is a world wide family of about 4000 species [1]. One member, *Cyperus esculentus*, is valued for its fatty tubers, sometimes called tiger nuts, which are eaten or are extracted for their oil [2]. There has been, however, little investigation of the seed oils of the family. Earle and Jones [3] found the oil content of seeds of *Cyperus virens*, *Rhyncospora indianolensis* and four species of *Carex*. Lotti and Averna [4, 5] reported on the seed oil and constituent fatty acids of *Cladium mariscus*, three species of *Cyperus*, two of *Scirpus* and three of *Carex*. Gunstone *et al.* [6] in a survey of tropical seeds determined the oil content and fatty acid composition of *Gahnia tristis*.

In this work most of the plant species investigated are from genera belonging to the Pacific and South East Asian regions, 3 only being from the world wide genera *Cyperus* and *Carex*. The fat content and the constituent fatty acids, were determined in seeds of *Cyperus ustulatus*, *Desmoschoenus spiralis*, *Morelotia affinis*, all 6 New Zealand species of *Gahnia*, 2 species of *Carex* and 25 species of *Uncinia*. All species except 3 are endemic in New Zealand. *Gahnia xanthocarpa* occurs also in Fiji, New Hebrides and Lord Howe Island, *Uncinia filiformis* in the Philippines and *U. uncinata* in Hawaii [1].

RESULTS AND DISCUSSION

The amounts of fat with I_2 values are shown in Table 1 as are percentages of unsaponifiable matter in the species of *Cyperus*, *Desmochoenus*, *Morelotia*, *Gahnia* and *Carex*. Members of the Cyperaceae do not appear to be rich in oil. Gunstone *et al.* [6] found 20% in *G. tristis*, but Earle and Jones [3] found only 4–13% in species of *Cyperus*, *Rhyncospora* and *Carex*, and Lotti and Averna, [4, 5] 3–8% in species of *Cyperus*, *Scirpus*, *Cladium and Carex*. Similarly most of the New Zealand sedges reported here have a seed fat content below 15%, *Cyperus ustulatus*, *M. affinis*, *G. lacera* and eight species of *Uncinia* being the only ones with a higher yield, 15.3–19.5%. The I_2 values are an indication of the proportions of unsaturated fatty acids. In general *Uncinia* with values from 128–147 has a higher content of linoleic acid than the other genera investigated here. The percentages of unsaponifiable matter are low, the greatest being those of samples with the lowest percentages of oil, a not unusual occurrence. Those of two species of *Uncinia* were found to be small (2.3, 2.6) and values were not determined for the remaining species.

Table 2 shows the amounts of the component fatty acids as percentages of the total fatty acids. In most samples linoleic is the chief acid. *Cyperus ustulatus* has a fatty acid pattern somewhat like that of *C. papyrus* [5]. In the tribe Scirpeae *D. spiralis* has a pattern like those of *Scirpus holoschoenus* and *S. lacuster* [5]. Members of the tribe Rhyncosporeae except *G. pauciflora* and *G. xanthocarpa* [2] contain less linoleic acid than *C ustulatus*, *D. spiralis* and *Uncinia*, the percentages varying from 34–52. In *G. lacera* [2] and *G. procera* [2] oleic is the predominant acid, as it is in *G. tristis* [6] and in *Cladium mariscus* [5], other members of the Rhyncosporeae. The two samples of *G. rigida* differ from the other Rhyncosporeae in containing higher percentages of palmitic acid.

The representatives of the tribe Cariceae, except *Carex carsei*, contain high amounts of linoleic acid, 60–78%. *C. solandri* is similar in fatty acid pattern to *C. dioica* and *C. pendula* [5] and to *Uncinia*, whereas *C. carsei* is more like *C. flava* [5]. The series into which the genus *Uncinia* has been divided [1] do not show any outstanding differences in fatty acid composition, but from the samples tested here members of the series Leptostachyae, Ripariae and Australes appear to have slightly higher proportions of linoleic acid and lower of oleic acid than those of the Compactae except *U. gracilenta*. While the two samples of *U. zotovii* are alike in their fatty acid patterns, as are those of *U. rupestris* and the three of *U. ferruginea*, the riper seeds of *U. astonii* differ from the greener ones. Degree of ripeness may be a factor, and this may apply also to differences between two samples of the same species of *Gahnia*. *Gahnia* seeds are said to hang on the plant for up to two years [1].

Although *Uncinia* has a consistently high content of linoleic acid, for most species the number of seeds is small. In the series Australes, which has the most

Table 1. Characteristics and fatty acid composition of seed fats of Cyperaceae

TRIBE Series *Genus* and species	Fat (% dry wt)	Iodine value (Wijs 1 hr)	Unsaponifiable matter (% wt of fat)
CYPEREAE			
Cyperus ustulatus A. Rich., Point Howard	18 4	127	4.2
SCIRPEAE			
Desmoschoenus spiralis (A. Rich.) Hook. f., Fitzroy Bay[a,b]	1.8	121	10.8
RHYNCOSPOREAE			
Morelotia affinis (Brong.) Blake, Eastbourne[c]	16.8	119	1.5
Gahnia lacera (A. Rich.) Steud. 1 Kerr Point	15.7	125	1.5
Gahnia lacera (A. Rich.) Steud. 2 Kai-iwi[c,d]	17.3	121	2.0
G. procera J. R. & G. Forst. 1 Ruapehu[b,c]	5.8	124	2.0
G. procera J. R. & G. Forst. 2 Mt Egmont[b,c]	4.5	115	3.0
G. pauciflora Kirk 1 Wakatikei[c]	11.7	132	1.5
G. pauciflora Kirk 2 Aorangi Reserve[c]	12.8	135	2.1
G. setifolia (A. Rich.) Hook. f., Wainuiomata[c]	8.8	117	5.4
G. xanthocarpa (Hook. f.) Hook. f., 1 Smith Stream[c,d]	10.9	124	2.9
G. xanthocarpa (Hook. f.) Hook. f., 2 Taita[c,d]	4.9	135	3.0
G. rigida Kirk 1 Mangaroa[c]	2.3	88	8.0
G. rigida Kirk 2 Taylorville[c]	4.9	107	3.0
CARICEAE			
Carex solandri Boott, Rimutaka Hill	2.4		11.0
C. carsei Petrie, Gouland Downs	8.5	113	8.2
Uncinia			
Macrolepidae			
U. sinclairii Boott, Lincoln* (Molesworth)	13.3	131	
U. elegans (Kük.) Hamlin, Lincoln* (Simons Hill)	10.5		
Leptostachyae			
U. leptostachya Raoul, Lincoln* (Red Rocks)	19.5	146	
U. scabra Boott, Lincoln* (Mt Fyffe)	14.4		
U. distans Boott, Mt Holdsworth	14.8	141	
Ripariae			
U. fuscovaginata Kük., Lincoln* (Rock & Pillar Range)	14.4	142	
U. rubra Boott 1 Lincoln* (Banks Peninsula)	12.9	145	
U. rubra Boott 2 Lincoln* (Dunedin)	12.2	143	
U. silvestris Hamlin, Mt Holdsworth	18.5	143	
U. affinis (C. B. Clarke) Hamlin, Southern Ruahine Range	14.4	141	
U. laxiflora Petrie, Gwavas	16.6		
U. strictissima Petrie, Lincoln* (Lake Rotoiti)	14.6	147	
Compactae			
U. zotovii Hamlin 1 Kauaeranga	18.2	141	
U. zotovii Hamlin 2 Dun Mountain	14.7	138	
U. rupestris Raoul 1 Ruapehu	15.3	144	
U. rupestris Raoul 2 Mt Holdsworth	16.9	140	
U. angustifolia Hamlin, Taita	16.7	138	
U. filiformis Boott, Southern Ruahine Range	15.8	140	
U. gracilenta Hamlin, Waikaremoana	5.9		
U. caespitosa Boott, Southern Ruahine Range	11.0	133	
U. divaricata Boott, Ruapehu	13.4	144	
U. nervosa Boott, Lincoln* (Mt Robert)	7.6	138	
U. unnamed species, Kakaramea	16.6	128	
Graciles			
U. astonii Hamlin, Mt Holdsworth 1 riper	13.3	135	
U. astonii Hamlin, Mt Holdsworth 2 greener	14.6		
U. banksii Boott, Kerikeri	11.1		
Australes			
U. uncinata (Linn. f.) Kük., Mt Holdsworth	11.1	141	2.6
U. clavata (Kük.) Hamlin, Southern Ruahine Range	12.8	140	
U. ferruginea Boott 1 Southern Ruahine Range	6.5	140	
U. ferruginea Boott 2 Mt Holdsworth	6.2	142	
U. ferruginea Boott 3 Orongorongo	6.2	140	

Table 2. Fatty acids (Expressed as area per cent of total acids)

4:0†	16:1	16:0	18:3	18:2	18:1	18:0	19:0	20:1	20:0	22:0
0.1	0.2	7.6	0.5	55.7	30.2	2.0	tr	0.7	0.6	2.4
2.2	0.2	6.1	0.8	58.2	26.5	2.6	0.1	0.2	0.5	0.8
—	0.1	6.2	0.3	49.8	41.4	1.8	0.1	0.1	0.1	tr
tr	0.2	6.2	—	51.1	40.6	1.9	—	tr	tr	—
0.1	0.1	6.0	0.2	42.8	45.2	2.5	0.1	0.3	0.2	0.2
0.1	0.3	6.9	0.4	48.6	40.2	2.0	0.1	0.1	0.3	0.8
0.4	0.3	8.4	0.2	38.9	48.3	1.7	0.4	0.2	0.2	0.1
tr	0.2	6.3	—	61.7	26.9	1.3	1.2	0.7	0.7	0.2
tr	tr	6.1	0.6	58.2	29.1	1.3	0.9	0.3	0.3	0.2
—	tr	6.8	—	49.0	37.3	4.6	—	1.0	0.2	0.1
tr	—	6.5	0.1	51.7	37.9	1.6	0.7	0.1	0.2	0.1
—	0.2	6.1	tr	66.1	21.8	1.4	0.9	0.4	0.5	0.3
0.2	0.6	32.4	0.1	34.1	25.6	3.4	2.0	0.1	0.3	0.3
0.1	0.3	13.9	0.4	41.6	38.9	1.7	2.3	0.1	0.1	tr
0.4	0.4	7.0	1.6	68.4	18.3	1.8	0.1	0.4	0.7	0.9
0.2	0.2	12.7	2.5	46.8	32.1	4.0	0.3	0.3	0.5	0.4
0.1	0.3	10.0	0.9	62.8	21.9	2.0	0.2	0.6	0.7	0.5
0.1	0.2	10.0	0.3	71.3	16.3	1.2	tr	0.1	0.3	0.2
tr	0.1	5.1	0.4	74.8	15.3	3.6	0.1	0.1	0.1	0.4
0.1	0.1	6.1	0.4	78.1	12.9	1.6	tr	0.2	0.3	0.2
0.1	tr	6.1	0.2	72.7	18.7	1.7	0.1	0.2	0.1	0.1
0.1	0.1	6.0	0.4	73.6	16.6	2.0	tr	0.2	0.3	0.7
0.1	0.2	6.7	0.5	77.6	10.5	2.7	0.1	0.3	0.4	0.9
0.1	0.2	7.2	0.6	72.0	16.5	1.9	0.1	0.3	0.5	0.6
0.1	0.1	7.3	0.4	73.3	17.1	1.4	tr	0.1	0.1	0.1
0.1	0.1	7.0	0.7	69.6	18.5	3.3	0.1	0.1	0.3	0.2
tr	tr	5.3	0.1	77.5	14.7	2.3	—	0.1	tr	tr
0.1	0.2	5.4	0.5	76.0	14.8	2.3	0.1	0.2	0.2	0.2
0.1	0.1	5.7	0.4	69.4	20.9	2.3	0.1	0.3	0.3	0.4
tr	tr	5.4	0.2	71.5	20.1	2.3	tr	0.2	0.2	0.1
0.1	0.2	7.0	1.1	69.6	19.7	1.4	0.1	0.2	0.2	0.4
0.1	0.1	6.6	0.2	68.7	21.4	2.4	tr	0.1	0.2	0.2
0.1	0.2	7.2	0.5	67.0	21.7	2.2	0.1	0.2	0.4	0.4
0.1	0.1	5.7	0.5	67.0	23.2	2.6	tr	0.2	0.3	0.3
tr	0.2	6.0	0.3	76.0	15.7	1.5	0.1	0.1	tr	0.1
0.1	0.2	8.9	1.2	62.0	21.4	4.5	0.1	0.3	0.6	0.7
0.1	0.2	6.9	1.0	70.8	18.6	1.6	tr	0.2	0.4	0.2
0.1	0.3	7.7	1.1	66.9	19.4	3.0	0.1	0.2	0.5	0.7
0.1	0.1	7.6	0.2	59.6	30.1	2.0	tr	0.1	0.1	0.1
0.1	tr	7.9	0.6	64.4	24.2	2.3	0.1	0.1	0.2	0.1
0.2	0.1	6.5	0.7	72.1	18.4	1.6	0.1	0.1	0.1	0.1
tr	0.1	4.5	0.2	73.9	19.5	1.5	0.1	0.1	tr	0.1
0.1	0.1	7.4	0.3	71.2	17.5	2.7	0.1	0.2	0.2	0.2
0.1	0.1	7.5	0.5	69.0	17.5	4.3	tr	0.3	0.4	0.3
0.1	0.2	9.5	0.8	69.3	16.2	2.3	0.1	0.3	0.5	0.7
0.1	0.1	8.4	0.6	71.5	16.5	1.7	tr	0.3	0.3	0.5
0.1	0.2	9.0	0.7	72.1	14.7	1.8	0.1	0 3	0.4	0.6

*Cultivated, origin of plant in parentheses. [a] Also 10:0 1.1%, 24:0 0.5%; [b] Also 12:0 0.2–0.7%; [c] Also 21:1 tr–1.5%, 21:0 tr–0.9%; [d] Also 22:1 0.3–0.8%; tr = trace.

†Number of carbon atoms followed by number of double bonds.

abundant seeds, the fat content, particularly of *U. ferruginea*, is low and unlikely to be of economic use.

EXPERIMENTAL

The seed samples were obtained from the localities shown in Table 1. Names and authors are those given by Moore and Edgar [1]. Seeds of *Carex* and *Uncinia* are surrounded by a utricle which was not removed. The fatty oils and unsaponifiable matter were obtained as described for the Agavaceae [7]. The Me esters were obtained by MeOH–H_2SO_4 [8] or by MeOH–BF_3 [9], treatment of the acids and analysed by GLC as described for the Juncaceae [10].

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