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FATTY ACID COMPOSITION OF SEEDS OF THE PAPAVERACEAE AND FUMARIACEAE

PETAR MARIN,* VESNA SAJDL,* SLOBODAN KAPOR and BUDISLAV TATIĆ

Faculty of Science, Botanical Institute and Garden, Takovska 43, 11000 Belgrade, Yugoslavia; *INEP, Laboratory of Biophysical and Analytical Chemistry, Banatska 31b, 11080 Zemun, Yugoslavia

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Key Word Index—Papaveraceae; Fumariaceae; seed lipids; fatty acids; lipid classes.

Abstract—Fatty acids were analysed in the seeds of 40 species from 12 genera of the Papaveraceae and 14 species from four genera of the Fumariaceae. Linoleate was predominant in both families; however, its content was 11% greater on average in the Papaveraceae. With *Papaver orientale* and *Corydalis cava* intraspecific variability of fatty acid patterns of seed lipids was studied; no large differences between samples were encountered. Triacylglycerols were the dominant lipid class. Members of Papaveraceae show a higher triacylglycerol but lower free fatty acid content than members of Fumariaceae.

INTRODUCTION

Data quoted in literature on fatty acid composition in the seed of the Papaveraceae are limited to four species only (*Papaver rhoeas*, *Macleaya cordata* var. *japonica*, *Argemone intermedia*, Argemone *hispida*) and one species of the Fumariaceae (*Dicentra ochroleuca*) [1, 2]. It has been demonstrated that the content and composition of fatty acids of seed lipids can serve as chemotaxonomic markers in higher plants [3, 4]. The present study was undertaken to provide detailed information on seed lipid composition of Papaveraceae and Fumariaceae.

RESULTS AND DISCUSSION

The content and composition of fatty acids in the species *Papaver orientale* and *Corydalis cava* originating from several localities are presented in Table 1. No large differences between samples were observed.

The content and fatty acid composition of total seed lipids of 40 species from the Papaveraceae and 14 species from the Fumariaceae are presented in Table 2. The classification is that according to Boissier [5]. In both families the dominant fatty acid was linoleate. Its content ranged from 62.4 to 84.9% (Papaveraceae) and 55.1 to 75.0% (Fumariaceae). The differences in the contents of unsaturated and saturated fatty acids in the analysed families may be depicted from the index U/S. The means of their ratio are significantly different in the two families examined (Table 2). The content and composition of certain lipid classes in three Papaveraceae and two Fumariaceae genera are presented in Tables 3 and 4. The analysis was based on genera with differing content of linolenic acid, i.e. those genera which, within each family, have the greatest and the lowest acid content.

The dominant lipid class in all species were triacylglycerols, members of Papaveraceae show higher triacylglycerol. On the other hand, a high content of free fatty acids was observed in species of the Fumariaceae. The content of free fatty acids is in agreement with the previous studies of some species of Fumariaceae [6].

Based on these results, it may be concluded that content of triacylglycerols, free fatty acids, linoleic acid and ratio of unsaturated and saturated fatty acids differ between the two families.

EXPERIMENTAL

Seeds were collected primarily in Yugoslavia, during summer 1982. The additional seeds have been supplied by several European botanic gardens. In most cases, seed samples were germinated, the plants were grown to maturity and verified taxonomically, by reference to herbarium specimens.

Seed supplies (50 mg dry wt) were homogenized in 8 ml $CHCl_3$–MeOH (2 : 1). The homogenate was centrifuged at 3500 *g* and the supernatant was separated. The solvent was evapd in N_2, and the lipids were dissolved in a minimum volume of $CHCl_3$. The aliquot of total lipids was incubated with 3.4% H_2SO_4 in MeOH. The methyl esters obtained of fatty acids were extracted with $CHCl_3$.

The lipid residue was placed on a silica gel TLC after development in petrol–Et_2O–HOAc (80:20:1). Spots were visualised at 254 nm after spraying with a solution of Rodamin B (0.1% aq). Each lipid class was determined quantitatively on the basis of the analysis of methyl esters of fatty acids obtained by internal esterification, as described above.

GC analysis of methyl esters of fatty acids was performed on a Packard 427 gas chromatograph with FID. N_2 was the carrier gas. The Pyrex column 2 m × 1/4″ 25% DEGS on a Chromosorb W AW DMCS (at 180°C) was used. Peak surfaces were measured on an electron integrator Spectra Physics 4100. The content of fatty acids was determined using an internal standard C_{17}-methyl ester.

Table 1. Variability of fatty acid composition of seed lipids in *Papaver orientale* and *Corydalis cava*

Genus Species	Place of Collection		Content (mg/g dry wt)	Fatty acid composition (% total)						
				14:0	16:0	18:0	18:1	18:2	18:3	Uns/Sat.
Papaver										
P. orientale L.	Ljubljana		448.6	0.2	7.2	2.2	9.0	80.9	0.5	9.4
P. orientale	Urbino		467.3	0.2	7.6	2.3	13.5	75.9	0.5	8.9
P. orientale	Moscow		401.1	0.2	6.3	2.2	10.2	80.8	0.3	10.5
P. orientale	Montpellier		439.2	0.2	7.1	2.5	13.0	77.0	0.2	9.2
P. orientale	Bratislava		434.1	0.1	7.5	2.2	10.5	79.4	0.3	9.2
P. orientale	Košice		297.2		7.8	1.9	9.7	80.1	0.5	9.3
P. orientale	Berlin		312.0	0.1	7.5	2.1	8.3	81.7	0.3	9.3
P. orientale	Nijmegen		286.4	—	7.8	2.7	13.3	75.6	0.6	8.6
		$\bar{X}$	385.7 ± 74.8		7.4 ± 0.5	2.3 ± 0.2	10.9 ± 2.0	78.9 ± 2.4	0.4 ± 0.1	9.3 ± 0.6
		C_v	19.4		6.7	8.7	18.3	3.0		6.4
Corydalis										
C. cava Schweigg. et Kort.	Ljubljana		211.0	4.7	12.1	2.5	18.1	57.5	5.1	4.2
C. cava	Belgrade		204.2	—	12.8	2.4	22.7	60.8	1.3	5.6
C. cava	Urbino		197.6	0.2	12.3	2.2	21.3	60.9	3.1	5.9
C. cava	Halle		225.6	4.1	11.9	1.9	22.3	53.2	6.6	4.6
C. cava	Halle-Aschersleben		192.7	—	12.6	3.4	25.5	54.6	3.9	5.2
C. cava	Berlin		179.7	—	13.6	2.5	21.4	58.9	3.6	5.2
C. cava	Halle-b. Eisleben		185.0	—	12.3	2.9	15.1	56.0	7.1	6.6
		$\bar{X}$	199.4 ± 15.7		12.5 ± 0.6	2.5 ± 0.5	20.9 ± 3.4	57.4 ± 2.9	4.4 ± 2.0	5.3 ± 0.8
		Cv	7.8		4.8	20.0	16.2	5.0		15.1

Table 2. Content and fatty acid composition of total lipids in seeds of Papaveraceae and Fumariaceae

Family Genus Species	Place of collection	Content (mg/g dry wt)	Fatty acid composition (% total)						
			14:0	16:0	18:0	18:1	18:2	18:3	Uns/Sat.
Papaveraceae									
Papaver									
1. *P. somniferum* L.	Leiden	391.2	0.2	9.6	1.9	9.0	79.3	—	7.5
2. *P. dubium* L.	Belgrade	303.8	0.4	9.3	2.0	10.3	78.0	—	7.5
3. *P. rhoeas* Pall	Belgrade	369.1	0.6	9.1	2.2	9.6	78.5	—	7.4
4. *P. heldreichii* Boiss.	Strasbourg	457.1	0.3	11.4	2.1	10.8	74.8	0.6	6.2
5. *P. lateritium* C. Koch	Bern	489.1	0.2	9.0	2.2	9.9	78.7	—	7.8
6. *P. macrostomum* Boiss. et Huet	Moscow	464.1	0.4	9.5	2.3	8.5	78.7	0.6	7.2
7. *P. nudicaule* L.	Bratislava	221.2	0.1	12.7	2.4	10.9	73.4	0.5	5.6
8. *P. hybridum* L.	Ljubljana	307.4	—	9.4	2.5	10.0	76.8	1.3	7.4
9. *P. argemone* L.	Ljubljana	350.4	0.1	7.7	2.0	15.6	73.3	1.3	9.2
10. *P. rupifrangum* Boiss. et Huet	Leningrad	246.2	0.5	13.2	4.0	11.9	69.8	0.6	4.6
11. *P. atlanticum* Ball	Nijmegen	236.4	—	11.8	1.6	10.8	75.8	—	6.5
12. *P. bracteatum* Lindl.	Nijmegen	219.0	—	9.6	2.3	9.6	78.5	—	7.4
13. *P. caucasicum* Bieb.	Mainz	255.1	—	4.6	1.8	8.7	83.2	1.7	14.6
14. *P. pilosum* Sibth. et Sm.	unknown	255.7	—	5.7	3.2	10.7	79.3	1.1	10.2
15. *P. alboroseum* Hulten	Leningrad	144.1	1.3	2.7	1.0	17.2	70.2	7.6	19.0
16. *P. spicatum* Boiss. et Bal.	Jena	210.1	1.6	9.4	3.4	11.4	73.1	1.1	5.9
17. *P. glaucum* Boiss et Housskn	Lisabon	206.6	0.5	12.5	4.0	12.1	70.0	0.9	4.9
18. *P. amurense* N. Busch	Vladivostok	170.0	0.6	4.5	1.3	23.8	66.3	3.5	14.6
19. *P. californicum* A. Gray	Toscolano	181.4	0.8	11.7	3.1	13.5	70.5	0.4	5.4
20. *P. schinzianum* Fedde	Toscolano	248.5	1.8	7.8	2.0	12.0	76.0	0.4	7.6
21. *P. alpinum* L.	Toscolano	296.7	1.0	9.7	2.6	12.4	73.9	0.4	6.5
22. *P. orientale* L.	Moscow	401.1	0.2	6.3	2.2	10.2	80.7	0.4	10.5
23. *P. orientale* 'Princess Elisabeth'	Zagreb	152.1	2.3	8.9	2.4	11.6	74.0	0.8	6.3
24. *P. orientale* 'Splendidissimum'	Zagreb	136.8	0.5	10.3	3.9	14.9	69.7	0.7	5.8
25. *P. orientale* 'Feneriese'	Zagreb	245.4	1.7	8.3	2.5	11.6	75.6	0.3	7.0
Argemone									
26. *A. mexicana* L.	Berlin	232.7	—	5.4	2.8	14.0	76.7	1.1	11.2
27. *A. grandiflora* Sweet	Berlin	150.6	—	10.9	3.2	15.7	70.2	—	6.1
28. *A. platyceras* Link et otto var. *hispida*	Strasbourg	204.5	—	4.1	1.4	8.5	84.9	1.1	17.2
Meconopsis									
29. *M. cambrica* Vig.	Nijmegen	214.0	—	12.4	1.5	19.1	67.0	—	6.2
Hunnemannia									
30. *H. fumariifolia* Sweet	Mainz	279.7	—	6.2	2.4	17.0	73.5	0.9	10.6
Chelidonium									
31. *Ch. majus* L.	Halle	537.6	2.5	6.1	1.3	14.8	74.7	0.6	9.1
Sanguinaria									
32. *S. canadensis* L.	Berlin	216.0	—	7.2	1.9	28.5	62.4	—	10.0
Dicranostigma									
33. *D. franchetianum* Fedde	Mainz	220.2	—	7.2	2.8	8.1	79.0	2.9	9.0
Macleaya									
34. *M. cordata* R. Br.	Nijmegen	191.7	—	7.4	2.1	14.2	76.3	—	9.5
Bocconia									
35. *B. frutescens* L	Mainz	197.9	—	12.4	3.0	10.1	73.7	0.8	5.5
Eschscholtzia									
36. *E. californica* Cham.	Berlin	230.0	1.1	15.0	2.4	24.7	54.9	1.9	4.4
Hylomecon									
37. *H. vernalis* Maxim.	Moscow	324.6	2.2	8.3	1.8	20.9	66.6	0.2	7.1
Glaucium									
38. *G. flavum* Crantz	Halle	463.1	0.6	6.3	1.6	16.1	75.4	—	10.8
39. *G. corniculatum* Curt.	Strasbourg	178.0	0.1	6.4	1.1	10.9	81.1	0.4	10.5
40. *G. fimbrilligerum* Boiss.	Moscow	212.4	0.6	5.7	2.4	14.6	76.3	0.4	10.5
									8.6 ± 3.3

Table 2. *Continued*

Family Genus Species	Place of collection	Content (mg/g dry wt)	Fatty acid composition (% total)						
			14:0	16:0	18:0	18:1	18:2	18:3	Uns/Sat.
Fumariaceae									
Dicentra									
1. *D. eximia* Jorr.	Berlin	285.7	0.9	8.2	2.1	17.3	70.7	0.8	7.9
Corydalis									
2. *C. cava* Schweigg. et Kort.	Ljubljana	211.0	4.7	12.1	2.5	18.1	57.5	5.1	4.2
3. *C. solida* Sw.	Ljubljana	378.1	4.0	11.1	1.4	16.0	64.2	3.3	5.1
4. *C. lutea* D.C.	Leiden	219.4	5.4	10.6	1.7	11.8	63.2	7.3	4.6
5. *C. bulbosa* D.C.	Strasbourg	312.2	3.4	11.7	1.9	24.6	56.7	1.7	4.9
6. *C. pumila* Koch	Halle	347.6	9.5	9.3	1.9	21.2	55.1	3.0	3.8
7. *C. claviculata* D.C.	Bremen	138.6	0.1	12.9	2.4	11.0	73.1	0.5	5.5
8. *C. glauca* Pursh.	Antwerpen	117.0	0.7	11.2	1.7	16.4	68.9	1.1	5.5
9. *C. bracteata* Pers.	Leningrad	241.5	0.7	11.0	2.2	26.4	56.8	2.7	6.2
10. *C. nobilis* Pers.	Jena	184.5	1.4	8.7	2.4	18.9	67.4	1.2	7.0
Fumaria									
11. *F. capreolata* L.	Antwerpen	157.9	0.4	25.3	4.1	6.8	62.4	1.0	2.4
12. *F. officinalis* L.	Benkovac	91.3	4.2	17.6	2.7	19.6	55.7	0.2	3.1
13. *F. vaillantii* Loisel.	Zemun	247.7	0.4	13.0	1.8	24.2	60.6	—	5.6
Adlumia									
14. *A. fungosa* Irmisch	Strasbourg	129.2	—	6.7	3.7	9.6	75.0	5.0	8.6
									5.3 ± 1.7

Table 3. Composition and fatty acid content of lipid classes in seeds of *Glaucium corniculatum*, *Papaver orientale* and *Eschscholtzia californica* (Papaveraceae)

Genus Species (Locality),	Fatty acid	Fatty acid composition (% total)			
		Triacyl glycerols	Diacyl glycerols	Free fatty acids	lipids
Glaucium					
39. *G. corniculatum*	Total	92.9	3.1	2.6	1.2
(Strasbourg)	14:0	0.1	<0.1	<0.1	<0.1
	16:0	7.5	0.3	0.4	0.2
	18:0	1.2	0.1	0.1	<0.1
	18:1	15.2	0.4	0.4	0.2
	18:2	68.5	2.3	1.9	0.8
	18:3	0.4	<0.1	—	<0.1
Papaver					
22. *P. orientale*	Total	91.5	2.3	4.9	1.2
(Moscow)	14:0	0.1	<0.1	<0.1	<0.1
	16:0	6.8	0.2	0.5	0.2
	18:0	2.6	0.1	0.2	0.1
	18:1	11.7	0.3	0.6	0.2
	18:2	69.8	1.7	3.5	0.7
	18:3	0.5	—	0.1	—
Eschscholtzia					
36. *E. californica*	Total	94.2	3.2	1.1	1.4
(Berlin)	14:0	1.0	<0.1	<0.1	0.1
	16:0	12.0	0.4	0.2	0.3
	18:0	2.4	<0.1	0.1	0.1
	18:1	23.9	1.0	0.2	0.4
	18:2	52.5	1.8	0.5	0.5
	18:3	2.4	<0.1	0.1	<0.1

Table 4. Composition and fatty acid content of lipid classes in seeds of *Dicentra eximia* and *Fumaria officinalis* (Fumariaceae)

Genus Species (Locality)	Fatty acid	Fatty acid composition (% total)			
		Triacyl glycerols	Diacyl glycerols	Free fatty acids	Polar lipids
Dicentra					
1. *D. eximia*	Total	87.9	4.7	6.2	1.1
(Berlin)	14:0	0.1	<0.1	<0.1	<0.1
	16:0	6.2	0.4	1.1	0.3
	18:0	2.0	0.2	0.4	0.1
	18:1	17.7	0.6	2.4	0.1
	18:2	61.2	3.5	2.3	0.5
	18:3	0.7	<0.1	<0.1	<0.1
Fumaria					
12. *F. officinalis*	Total	63.3	6.2	26.7	3.6
(Benkovac)	14:0	0.2	—	0.1	<0.1
	16:0	10.3	1.2	4.4	1.1
	18:0	2.4	0.2	1.0	0.2
	18:1	13.1	1.2	5.3	0.5
	18:2	37.3	3.6	16.0	1.6
	18:3	—	—	—	0.2

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