THE OILS OF SOME PLANTS OF THE FAMILY CRUCIFERAE

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UDC 547.915+665.3

Some oils of the family Cruciferae are widely used as edible and technical fats. Rapeseed, colza, and crambe oils are used in the food industry in the production of bakers' and confectioners' articles and preserves [1]; for technical purposes (as lubricants) in steel rolling mills, in the rubber industry [2], and in the production of plastics and poly(vinyl chloride) resins [3].

We have studied the oil from the seeds of four plants of the family Cruciferae: Crambe schugnana, Brassica campestris, Erysimum gypsaceum, and Camelina rumelica. Table 1 gives the physical and chemical indices of the oils and of the combined fatty acids isolated from them.

In addition, enzymatic hydrolyses of the oils [5] were performed with the isolation of the fatty-acid radicals in the α,α' positions of the glyceride molecules and, therefore, the production of β-monoglycerides. The fatty-acid compositions of the initial triglycerides (TG) and of the monoglycerides (MG) obtained were determined by thin-layer and gas-liquid chromatography (Table 2).

The figures of Table 2 show that in the triglyceride molecules the β positions are occupied mainly by unsaturated acids (93.70-98.46%). If we compare these figures with the total amounts of unsaturated acids in the oils, there for the Brassica and Crambe oils, having total amounts of unsaturated acids of 95.53 and 96.26%, it is high in the β position, which is quite natural. But in the case of the Erysimum and Camelina oils which have total contents of unsaturated fatty acids of 81.43 and 90.08%, their presence in the β position in amounts of 93.70 and 97.16% shows a peculiar selectivity in the process of the biosynthesis of the fats.

The selectivity of the biosynthesis is confirmed by the behavior of the arachidic and erucic acids.

TABLE 1. Compositions of the Oils and of the Fatty Acids

Index	Erysimum gypsaceum	Brassica campestris	Crambe schugnana	Camelina rumelica
Oil content of the seeds, %	34,41	34,83	18,58	27,01
Oil				
Density, g/ml	0,9117	0,9144	0,9087	0,9185
Refractive index, n_D^{20}	1,4764	1,4858	1,4733	1,4835
Relative viscosity, E^0	8,20	—	12,60	11,20
Acid No., mg/g	1,80	1,94	2,78	2,83
Hehner No., %	94,65	97,51	93,97	94,68
Saponification No., mg/g	181,28	181,83	180,90	191,12
Amount, % of unsaponifiables	1,25	1,37	1,45	1,24
phosphatides	0,43	Traces	0,11	Traces
Acids				
Neutralization No., mg/g	188,8	193,61	187,06	196,61
Mean mol. wt.	298,17	289,80	299,95	285,39
Unsaturation No. [4]	156,62	160,49	161,77	217,01

Institute of the Chemistry of Plant Substances, Academy of Sciences of the Uzbek SSR. Translated from Khimiya Prirodnykh Soedinenii, No. 1, pp. 24-27, January-February, 1972. Original article submitted October 19, 1971.

TABLE 2. Fatty-Acid Compositions of the Oils

Acids	Erysimum gypsaceum		Brassica campestris		Crambe schugnana		Camelina rumelica	
	MG	TG	MG	TG	MG	TG	MG	TG
Undecylic	0,18	0,17	—	—	—	—	—	—
Lauric	0,24	0,22	—	—	0,26	0,28	—	—
Tridecylic	—	0,37	—	—	—	—	—	—
Myristic	0,32	0,35	—	—	0,10	0,18	0,43	0,20
Palmitic	4,34	4,04	3,62	2,92	1,18	2,54	2,41	5,42
Stearic	1,22	1,83	—	1,55	—	0,74	·	2,44
Arachidic	—	11,59	—	—	—	—	—	1,86
Total saturated acids	6,30	18,57	3,62	4,47	1,54	3,74	2,84	9,92
Palmitoleic	1,31	1,49	4,22	0,72	0,58	0,54	—	—
Oleic	20,02	13,37	35,84	26,94	49,27	21,64	20,35	16,27
Linoleic	37,34	20,54	37,27	20,12	32,90	12,93	28,93	16,23
Linolenic	35,03	27,34	19,05	22,42	15,71	26,29	47,88	55,35
Erucic	—	18,69	—	25,33	—	34,86	—	2,23
Total unsaturated acids	93,70	81,43	96,38	95,53	98,46	96,26	97,16	90,08

TABLE 3. Glyceride Compositions of the Oils

Glycerides	Erysimum gypsaceum	Brassica campestris	Crambe schugnana	Camelina rumelica
Gl SSS	0,39	0,01	0,01	0,05
Gl SSU	2,34	0,34	0,12	0,66
Gl SUS	5,74	0,24	0,23	1,76
Gl SUU	34,90	8,98	9,06	22,64
Gl USU	5,57	3,27	1,41	2,13
Gl UUU	53,06	87,16	89,17	72,76

Of the saturated acids, the relatively low-melting C_{11}-C_{16} acids are distributed between the α,α' and β positions, while the particularly high-melting acids – C_{18} (mp 69.6°C) and C_{20} (mp 75.3°C) – are almost wholly in the α,α' positions. This mainly relates to the C_{20} arachidic acid, which even in the case of the Erysimum oil in which it is present in fairly large amount (11.59%) is attached wholly to the terminal C atoms of the glycerol.

Furthermore, and this is particularly strange, the erucic acid, an unsaturated acid with mp 34.7°C, is found exclusively in the α,α' positions. However, Swedish workers [6] have found about 4% of erucic acid in the β position in some oils of the family Cruciferae containing it to a total amount of 36-56%.

We still find it difficult to say what is responsible for the selectivity of biogenesis in relation to the distribution of the fatty-acid radicals in the triglyceride molecules.

The glyceride compositions of the oils have been calculated on the basis of the figures given in Table 2. The results of these calculations are shown in Table 3.

By recrystallization, the mixture of fatty acids from Erysimum gypsaceum yielded erucic acid [7, 8]. For it we found mp 33-34°C; I. No. 73.13 (theoretical 74.98).

EXPERIMENTAL

The oils were extracted from the seeds with petroleum ether (bp 40-60°C). The physical and chemical indices of the oils were determined by generally accepted methods [9].

To isolate the erucic acid, 10 g of the mixture of fatty acids was dissolved in 96% ethanol (double volume). The solution was cooled to 0°C. The precipitate of solid saturated acids that separated out from the solution was separated off by filtration. The solvent was distilled off from the filtrate and the residue was extracted with 75% ethanol (four volumes). The resulting solution was cooled to −20°C. A white crystalline precipitate of erucic acid deposited. It was purified by recrystallization from acetone–water (5:1) at −11°C.

SUMMARY

The physical and chemical properties of the oils of four plants – Erysimum gypsaceum, Brassica campestris, Crambe schugnana, and Camelina rumelica – have been determined. Their fatty-acid and glyceride compositions have been established. In these triglycerides, erucic acid occupies only the α,α' positions. Erucic acid has been isolated from the mixed fatty acids of Erysimum gypsaceum.

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