

Fatty acid composition and health benefits of some seed oils of emerging interest

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Summary. Edible oils from the seeds of six different plant species were analyzed for their fatty acid composition. Such products are sold as food supplements. Species investigated were Hemp (*Cannabis sativa*), Flax (*Linum usitatissimum*), Milk Thistle (*Silybum marianum*), Perilla (*Perilla frutescens*), Borage (*Borago officinalis*) and Black Cumin (*Nigella sativa*). About half of the oils were produced under our supervision, the others were purchased on the market.

Analytical method. Sample preparation was performed in accordance with a published protocol^{a,b}. As regards the instrumentation it was used the dual detector gas chromatography technique: GC-FID (Gas Chromatography - Flame Ionization Detection) and GC-MS (Gas Chromatography - Mass Spectrometry). Results were validated by analyzing the NIST Reference Material 8183-3 *Flax seed oil*.

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^b *Molecules* 26 (2021) article number 5015

Tables S1-S7: Detailed fatty acid composition expressed as a percentage

Tables S8-S14: Detailed fatty acid composition expressed as mg per g of oil

Figures S1-S5: Gas chromatograms and mass spectra

TABLE S1. Hemp seed oil: 'Futura' variety produced in the Marche region, Italy (%)

	analysis1	analysis2	analysis3	mean	±	2σ	
14:0	0.04	0.05	0.05	0.05	±	0.01	14:0
15:0	0.02	0.02	0.02	0.02	±	0.002	15:0
16:0	6.77	7.09	6.84	6.90	±	0.34	16:0
16:1 ω-7	0.12	0.12	0.12	0.12	±	0.01	16:1 ω-7
17:0	0.05	0.05	0.05	0.05	±	0.004	17:0
18:0	2.12	2.08	2.10	2.10	±	0.05	18:0
18:1 ω-9	11.42	11.25	11.36	11.34	±	0.17	18:1 ω-9
18:1 ω-7	0.91	0.90	0.91	0.91	±	0.01	18:1 ω-7
18:2 ω-6	54.69	54.53	54.70	54.64	±	0.19	18:2 ω-6 LA
18:3 ω-6	4.42	4.44	4.41	4.42	±	0.03	18:3 ω-6
18:3 ω-3	16.47	16.50	16.44	16.47	±	0.06	18:3 ω-3 ALA
18:4 ω-3	1.40	1.42	1.40	1.41	±	0.02	18:4 ω-3
20:0	0.62	0.59	0.62	0.61	±	0.03	20:0
20:1 ω-9	0.33	0.31	0.32	0.32	±	0.02	20:1 ω-9
20:2 ω-6	0.07	0.06	0.07	0.07	±	0.01	20:2 ω-6
21:0	0.01	0.01	0.01	0.01	±	0.004	21:0
22:0	0.22	0.21	0.23	0.22	±	0.02	22:0
22:1 ω-9	0.02	0.02	0.03	0.02	±	0.001	22:1 ω-9
23:0	0.02	0.02	0.02	0.02	±	0.003	23:0
24:0	0.07	0.08	0.08	0.07	±	0.02	24:0
others	0.23	0.24	0.23	0.23	±	0.01	others
total	100.00	100.00	100.00	100.00	±	0.00	
LA				54.64	±	0.19	%
ALA				16.47	±	0.06	%
LA/ALA				3.32	±	0.02	
Σ ω6				59.13	±	0.19	%
Σ ω3				17.87	±	0.06	%
Σ ω6/Σ ω3				3.31	±	0.02	
Σ PUFA				77.00	±	0.20	%
Σ MUFA				12.71	±	0.17	%
Σ SFA				10.05	±	0.34	%

TABLE S2. Hemp seed oil: ‘Codimono’ variety produced in the Veneto region, Italy (%)

	analysis1	analysis2	analysis3	mean	±	2σ	
12:0	0.002	0.003	0.004	0.003	±	0.002	12:0
14:0	0.04	0.04	0.04	0.04	±	0.004	14:0
15:0	0.02	0.02	0.02	0.02	±	0.001	15:0
16:0	6.24	6.57	6.40	6.40	±	0.323	16:0
16:1 ω-7	0.11	0.11	0.11	0.11	±	0.008	16:1 ω-7
17:0	0.04	0.04	0.04	0.04	±	0.002	17:0
18:0	1.87	1.93	1.80	1.87	±	0.123	18:0
18:1 ω-9	10.30	10.40	10.06	10.25	±	0.347	18:1 ω-9
18:1 ω-7	0.92	0.91	0.94	0.92	±	0.024	18:1 ω-7
18:2 ω-6	55.74	55.31	54.86	55.30	±	0.880	18:2 ω-6 LA
18:3 ω-6	1.30	1.30	2.14	1.58	±	0.973	18:3 ω-6
18:3 ω-3	21.35	21.19	21.03	21.19	±	0.320	18:3 ω-3 ALA
18:4 ω-3	0.53	0.53	0.85	0.64	±	0.364	18:4 ω-3
20:0	0.53	0.54	0.50	0.52	±	0.037	20:0
20:1 ω-9	0.33	0.39	0.37	0.36	±	0.056	20:1 ω-9
20:2 ω-6	0.05	0.06	0.06	0.06	±	0.005	20:2 ω-6
21:0	0.01	0.03	0.01	0.02	±	0.018	21:0
22:0	0.20	0.20	0.18	0.19	±	0.019	22:0
22:1 ω-9	0.02	0.02	0.03	0.03	±	0.004	22:1 ω-9
23:0	0.03	0.03	0.02	0.02	±	0.006	23:0
24:0	0.09	0.08	0.07	0.08	±	0.015	24:0
24:1 ω-9	0.01	0.01	0.01	0.01	±	0.003	24:1 ω-9
others	0.27	0.31	0.47	0.35	±	0.205	others
total	100.00	100.00	100.00	100.00	±	0.000	
LA				55.30	±	0.88	%
ALA				21.19	±	0.32	%
LA/ALA				2.61	±	0.08	
Σ ω6				56.94	±	1.31	%
Σ ω3				21.82	±	0.49	%
Σω6/Σω3				2.61	±	0.12	
Σ PUFA				78.76	±	1.40	%
Σ MUFA				11.69	±	0.35	%
Σ SFA				9.20	±	0.35	%

TABLE S3. Flax seed oil produced in the Marche region, Italy (%)

	analysis1	analysis2	analysis3	mean	±	2σ	
12:0	0.004	0.004	0.005	0.004	±	0.001	12:0
14:0	0.03	0.03	0.04	0.03	±	0.01	14:0
15:0	0.01	0.01	0.02	0.01	±	0.003	15:0
16:0	5.69	5.91	5.60	5.73	±	0.32	16:0
16:1 ω-7	0.07	0.07	0.07	0.07	±	0.01	16:1 ω7
17:0	0.04	0.04	0.04	0.04	±	0.001	17:0
18:0	2.91	2.94	2.95	2.93	±	0.04	18:0
18:1 ω-9	12.71	12.92	13.03	12.89	±	0.32	18:1 ω9
18:1 ω-7	1.38	1.40	1.65	1.48	±	0.30	18:1 ω7
18:2 ω-6	11.55	11.55	11.56	11.55	±	0.01	18:2 ω6
19:0	0.01	0.02	0.01	0.02	±	0.01	19:0
18:3 ω-3	64.01	63.45	63.23	63.56	±	0.80	18:3 ω3
18:4 ω-3	0.04	0.04	0.03	0.04	±	0.01	18:4 ω3
20:0	0.07	0.08	0.08	0.08	±	0.02	20:0
20:1 ω-11	0.01	0.01	0.01	0.01	±	0.001	20:1 ω11
20:1 ω-9	0.24	0.27	0.26	0.26	±	0.03	20:1 ω9
20:2 ω-6	0.03	0.06	0.05	0.05	±	0.03	20:2 ω-6
21:0	0.002	0.002	0.001	0.001	±	0.001	21:0
22:0	0.08	0.09	0.10	0.09	±	0.01	22:0
22:1 ω-9	0.71	0.73	0.75	0.73	±	0.04	22:1 ω9
23:0	0.01	0.01	0.01	0.01	±	0.003	23:0
24:0	0.03	0.03	0.03	0.03	±	0.001	24:0
24:1 ω-9	0.03	0.03	0.03	0.03	±	0.003	24:1 ω-9
others	0.33	0.32	0.44	0.36	±	0.14	others
total	100.00	100.00	100.00	100.00	±	0.000	
LA				11.55	±	0.01	%
ALA				63.56	±	0.80	%
LA/ALA				0.18	±	0.003	
Σ ω6				11.60	±	0.03	%
Σ ω3				63.60	±	0.80	%
Σω6/Σω3				0.18	±	0.003	
Σ PUFA				75.20	±	0.80	%
Σ MUFA				15.46	±	0.44	%
Σ SFA				8.98	±	0.32	%

TABLE S4. Milk Thistle seed oil produced in the Marche region, Italy (%)

	analysis1	analysis2	analysis3	mean	±	2σ	
12:0	0.005	0.004	0.01	0.005	±	0.001	12:0
14:0	0.08	0.08	0.09	0.08	±	0.011	14:0
15:0	0.01	0.02	0.02	0.02	±	0.002	15:0
16:0	8.32	8.30	8.49	8.37	±	0.216	16:0
16:1 ω-7	0.08	0.08	0.09	0.08	±	0.009	16:1 ω7
17:0	0.07	0.07	0.07	0.07	±	0.005	17:0
18:0	3.95	3.97	4.03	3.98	±	0.080	18:0
18:1 ω-9	31.36	32.61	31.91	31.96	±	1.248	18:1 ω9
18:1 ω-7	1.43	0.40	0.41	0.75	±	1.177	18:1 ω7
18:2 ω-6	48.37	48.00	48.16	48.17	±	0.373	18:2 ω6 LA
19:0	0.03	0.02	0.02	0.02	±	0.005	19:0
18:3 ω-3	0.27	0.31	0.29	0.29	±	0.037	18:3 ω3 ALA
20:0	2.49	2.47	2.48	2.48	±	0.015	20:0
20:1 ω-9	0.94	0.91	1.20	1.02	±	0.311	20:1 ω9
20:2 ω-6	0.03	0.03	0.03	0.03	±	0.004	20:2 ω-6
21:0	0.02	0.02	0.02	0.02	±	0.0004	21:0
22:0	1.67	1.72	1.74	1.71	±	0.075	22:0
22:1 ω-9	0.16	0.17	0.17	0.16	±	0.013	22:1 ω9
23:0	0.02	0.05	0.02	0.03	±	0.032	23:0
24:0	0.41	0.43	0.43	0.42	±	0.029	24:0
24:1 ω-9	0.01	0.06	0.02	0.03	±	0.052	24:1 ω-9
others	0.29	0.28	0.30	0.29	±	0.024	others
total	100.00	100.00	100.00	100.00	±	0.000	
LA			48.17	±	0.37	%	
ALA			0.29	±	0.04	%	
LA/ALA			167.06	±	22.52		
Σ ω6			48.21	±	0.37	%	
Σ ω3			0.29	±	0.04	%	
Σω6/Σω3			167.18	±	22.538		
Σ PUFA			48.50	±	0.38	%	
Σ MUFA			34.00	±	1.74	%	
Σ SFA			17.21	±	0.25	%	

TABLE S5. Perilla seed oil purchased on the market (%)

	analysis1	analysis2	analysis3	mean	±	2σ	
12:0	0.003	0.004	0.004	0.004	±	0.001	12:0
14:0	0.03	0.03	0.03	0.03	±	0.002	14:0
15:0	0.01	0.01	0.01	0.01	±	0.001	15:0
16:0	5.38	5.21	5.35	5.31	±	0.180	16:0
16:1 ω-7	0.06	0.06	0.06	0.06	±	0.002	16:1 n7
17:0	0.03	0.03	0.03	0.03	±	0.002	17:0
18:0	2.18	2.17	2.19	2.18	±	0.014	18:0
18:1 ω-9	14.90	13.67	14.51	14.36	±	1.258	18:1 n9
18:1 ω-7	0.66	1.17	0.65	0.83	±	0.595	18:1 n7
18:2 ω-6	13.46	13.59	13.62	13.56	±	0.175	18:2 n6
19:0	0.01	0.01	0.01	0.01	±	0.005	19:0
18:3 ω-3	62.30	62.91	62.68	62.63	±	0.609	18:3 n3
18:4 ω-3	0.04	0.03	0.03	0.03	±	0.016	18:4 n3
20:0	0.09	0.09	0.09	0.09	±	0.003	20:0
20:1 ω-9	0.09	0.09	0.10	0.09	±	0.011	20:1 n9
20:2 ω-6	0.03	0.17	0.13	0.11	±	0.147	20:2 n6
21:0	0.004	0.002	0.003	0.003	±	0.002	21:0
22:0	0.05	0.05	0.05	0.05	±	0.007	22:0
23:0	0.01	0.01	0.01	0.01	±	0.004	23:0
24:0	0.03	0.04	0.03	0.03	±	0.016	24:0
others	0.62	0.65	0.42	0.56	±	0.246	others
total	100.00	100.00	100.00	100.00	±	0.000	
LA				13.56	±	0.18	%
ALA				62.63	±	0.61	%
LA/ALA				0.22	±	0.005	
Σ ω6				13.66	±	0.23	%
Σ ω3				62.66	±	0.61	%
Σω6/Σω3				0.22	±	0.006	
Σ PUFA				76.33	±	0.65	%
Σ MUFA				15.34	±	1.39	%
Σ SFA				7.77	±	0.18	%

TABLE S6. Borage seed oil purchased on the market (%)

	analysis1	analysis2	analysis3	mean	±	2σ	
12:0	0.003	0.003	0.004	0.003	±	0.001	12:0
14:0	0.06	0.07	0.07	0.07	±	0.01	14:0
15:0	0.01	0.01	0.01	0.01	±	0.001	15:0
16:0	10.37	10.55	10.67	10.53	±	0.29	16:0
16:1 ω-7	0.14	0.15	0.16	0.15	±	0.02	16:1 n7
17:0	0.04	0.04	0.04	0.04	±	0.002	17:0
18:0	3.37	3.25	3.17	3.26	±	0.20	18:0
18:1 ω-9	16.10	16.07	15.90	16.02	±	0.21	18:1 n9
18:1 ω-7	0.87	0.71	0.67	0.75	±	0.21	18:1 n7
18:2 ω-6	38.08	38.50	38.64	38.41	±	0.59	18:2 n6 LA
18:3 ω-6	22.54	23.07	23.35	22.98	±	0.82	18:3 n6
18:3 ω-3	0.26	0.22	0.22	0.23	±	0.05	18:3 n3 ALA
18:4 ω-3	0.13	0.15	0.14	0.14	±	0.02	18:4 n3
20:0	0.23	0.21	0.29	0.24	±	0.08	20:0
20:1 ω-9	3.71	3.45	3.32	3.50	±	0.40	20:1 n9
20:2 ω-6	0.16	0.15	0.15	0.15	±	0.01	20:2 n6
22:0	0.12	0.10	0.10	0.11	±	0.03	22:0
22:1 ω-9	2.34	1.98	1.87	2.07	±	0.49	22:1 ω9
23:0	0.01	0.01	0.01	0.01	±	0.004	23:0
24:0	0.04	0.05	0.04	0.04	±	0.01	24:0
24:1 ω-9	1.17	1.00	0.93	1.03	±	0.25	24:1 ω-9
others	0.24	0.26	0.24	0.24	±	0.02	others
total	100.00	100.00	100.00	100.00	±	0.00	
LA				38.41	±	0.59	%
ALA				0.23	±	0.05	%
LA/ALA				164.76	±	35.74	
Σ ω6				61.54	±	1.01	%
Σ ω3				0.37	±	0.05	%
Σ ω6/Σ ω3				165.26	±	25.20	
Σ PUFA				61.91	±	1.01	%
Σ MUFA				23.53	±	0.74	%
Σ SFA				14.32	±	0.37	%

TABLE S7. Black Cumin seed oil purchased on the market (%)

	analysis1	analysis2	analysis3	mean	±	2σ		
12:0	0.01	0.01	0.005	0.005	±	0.001	12:0	
14:0	0.15	0.15	0.15	0.15	±	0.002	14:0	
15:0	0.02	0.03	0.03	0.03	±	0.002	15:0	
16:0	11.23	11.29	11.25	11.26	±	0.06	16:0	
16:1 ω-7	0.17	0.17	0.17	0.17	±	0.01	16:1 n7	
17:0	0.06	0.06	0.05	0.06	±	0.002	17:0	
18:0	2.68	2.62	2.58	2.63	±	0.10	18:0	
18:1 ω-9	21.19	20.94	21.07	21.06	±	0.25	18:1 n9	
18:1 ω-7	1.29	1.40	1.38	1.36	±	0.12	18:1 n7	
18:2 ω-6	59.05	59.37	59.42	59.28	±	0.40	18:2 n6	LA
19:0	0.04	0.03	0.03	0.03	±	0.01	19:0	
18:3 ω-3	0.25	0.25	0.28	0.26	±	0.03	18:3 n3	ALA
20:0	0.18	0.18	0.17	0.18	±	0.01	20:0	
20:1 ω-9	0.39	0.38	0.37	0.38	±	0.02	20:1 n9	
20:2 ω-6	2.87	2.76	2.70	2.78	±	0.17	20:2 n6	
22:0	0.03	0.03	0.03	0.03	±	0.002	22:0	
22:1 ω-9	0.08	0.07	0.07	0.07	±	0.01	22:1 ω9	
23:0	0.01	0.01	0.01	0.01	±	0.0003	23:0	
24:0	0.003	0.005	0.002	0.003	±	0.003	24:0	
others	0.33	0.27	0.24	0.28	±	0.09	others	
total	100.00	100.00	100.00	100.00	±	0.00		
			LA	59.28	±	0.40	%	
			ALA	0.26	±	0.03	%	
			LA/ALA	228.78	±	31.65		
			Σ ω6	62.06	±	0.44	%	
			Σ ω3	0.26	±	0.03	%	
			Σ ω6/Σ ω3	239.50	±	33.19		
			Σ PUFA	62.32	±	0.44	%	
			Σ MUFA	23.04	±	0.28	%	
			Σ SFA	14.37	±	0.12	%	

TABLE S8. Hemp seed oil: 'Futura' variety produced in the Marche region, Italy (mg/g)

	analysis1	analysis2	analysis3	mean	±	2σ	
14:0	0.41	0.49	0.46	0.45	±	0.08	14:0
15:0	0.17	0.20	0.19	0.19	±	0.02	15:0
16:0	63.58	66.93	64.52	65.01	±	3.46	16:0
16:1 ω-7	1.08	1.16	1.18	1.14	±	0.10	16:1 ω-7
17:0	0.45	0.46	0.43	0.45	±	0.03	17:0
18:0	19.94	19.60	19.81	19.78	±	0.34	18:0
18:1 ω-9	107.20	106.21	107.19	106.87	±	1.14	18:1 ω-9
18:1 ω-7	8.52	8.52	8.56	8.53	±	0.05	18:1 ω-7
18:2 ω-6	513.55	514.79	516.36	514.90	±	2.81	18:2 ω-6 LA
18:3 ω-6	41.54	41.87	41.59	41.67	±	0.36	18:3 ω-6
18:3 ω-3	154.62	155.75	155.17	155.18	±	1.13	18:3 ω-3 ALA
18:4 ω-3	13.11	13.38	13.25	13.25	±	0.27	18:4 ω-3
20:0	5.82	5.61	5.82	5.75	±	0.25	20:0
20:1 ω-9	3.05	2.91	3.06	3.01	±	0.17	20:1 ω-9
20:2 ω-6	0.62	0.58	0.68	0.63	±	0.11	20:2 ω-6
21:0	0.10	0.12	0.14	0.12	±	0.04	21:0
22:0	2.03	2.00	2.15	2.06	±	0.16	22:0
22:1 ω-9	0.23	0.22	0.24	0.23	±	0.01	22:1 ω-9
23:0	0.20	0.22	0.23	0.22	±	0.03	23:0
24:0	0.61	0.73	0.76	0.70	±	0.16	24:0
others	2.16	2.25	2.20	2.20	±	0.09	others
total fatty acids	939,00	944,00	944,00	942,33	±	5,77	
			LA	514.90	±	2.81	mg/g
			ALA	155.18	±	1.13	mg/g
			LA/ALA	3.32	±	0.04	
			Σ ω6	557.20	±	2.84	mg/g
			Σ ω3	168.43	±	1.16	mg/g
			Σω6/Σω3	3.31	±	0.04	
			Σ PUFA	725.63	±	3.07	mg/g
			Σ MUFA	119.78	±	1.16	mg/g
			Σ SFA	94.72	±	3.49	mg/g

TABLE S9. Hemp seed oil: ‘Codimono’ variety produced in the Veneto region, Italy (mg/g)

	analysis1	analysis2	analysis3	mean	±	2σ	
12:0	0.02	0.02	0.04	0.03	±	0.02	12:0
14:0	0.36	0.40	0.39	0.38	±	0.04	14:0
15:0	0.15	0.16	0.16	0.15	±	0.01	15:0
16:0	57.31	60.73	59.46	59.17	±	3.46	16:0
16:1 ω-7	1.01	1.06	0.99	1.02	±	0.07	16:1 ω-7
17:0	0.33	0.34	0.35	0.34	±	0.02	17:0
18:0	17.15	17.82	16.75	17.24	±	1.08	18:0
18:1 ω-9	94.56	96.18	93.46	94.73	±	2.73	18:1 ω-9
18:1 ω-7	8.47	8.45	8.70	8.54	±	0.28	18:1 ω-7
18:2 ω-6	511.70	511.63	509.66	511.00	±	2.31	18:2 ω-6 LA
18:3 ω-6	11.94	12.01	19.90	14.61	±	9.15	18:3 ω-6
18:3 ω-3	196.00	195.96	195.37	195.78	±	0.71	18:3 ω-3 ALA
18:4 ω-3	4.88	4.89	7.86	5.87	±	3.43	18:4 ω-3
20:0	4.84	4.97	4.66	4.82	±	0.31	20:0
20:1 ω-9	3.05	3.59	3.40	3.35	±	0.55	20:1 ω-9
20:2 ω-6	0.49	0.54	0.53	0.52	±	0.05	20:2 ω-6
21:0	0.11	0.26	0.13	0.16	±	0.17	21:0
22:0	1.80	1.84	1.69	1.78	±	0.16	22:0
22:1 ω-9	0.22	0.23	0.26	0.24	±	0.04	22:1 ω-9
23:0	0.23	0.26	0.20	0.23	±	0.06	23:0
24:0	0.78	0.72	0.65	0.72	±	0.13	24:0
24:1 ω-9	0.09	0.10	0.08	0.09	±	0.03	24:1 ω-9
others	2.51	2.84	4.32	3.22	±	1.93	others
total fatty acids	918.00	925.00	929.00	924.00	±	11.14	
LA				511.00	±	2.31	mg/g
ALA				195.78	±	0.71	mg/g
LA/ALA				2.61	±	0.02	
Σ ω6				526.13	±	9.44	mg/g
Σ ω3				201.65	±	3.50	mg/g
Σ ω6/Σ ω3				2.61	±	0.09	
Σ PUFA				727.78	±	10.07	mg/g
Σ MUFA				107.97	±	2.80	mg/g
Σ SFA				85.02	±	3.65	mg/g

TABLE S10. Flax seed oil produced in the Marche region, Italy (mg/g)

	analysis1	analysis2	analysis3	mean	±	2σ		
12:0	0.03	0.04	0.04	0.04	±	0.01	12:0	
14:0	0.29	0.32	0.35	0.32	±	0.06	14:0	
15:0	0.12	0.13	0.14	0.13	±	0.02	15:0	
16:0	53.14	55.25	52.44	53.61	±	2.92	16:0	
16:1 ω-7	0.62	0.67	0.70	0.66	±	0.08	16:1 ω7	
17:0	0.34	0.36	0.36	0.35	±	0.01	17:0	
18:0	27.22	27.48	27.63	27.44	±	0.42	18:0	
18:1 ω-9	118.73	120.77	121.93	120.48	±	3.23	18:1 ω9	
18:1 ω-7	12.92	13.09	15.45	13.82	±	2.83	18:1 ω7	
18:2 ω-6	107.86	107.96	108.20	108.00	±	0.35	18:2 ω6	LA
19:0	0.11	0.18	0.13	0.14	±	0.07	19:0	
18:3 ω-3	597.83	593.25	591.86	594.31	±	6.25	18:3 ω3	ALA
18:4 ω-3	0.40	0.40	0.32	0.37	±	0.10	18:4 ω3	
20:0	0.62	0.71	0.78	0.71	±	0.16	20:0	
20:1 ω-11	0.07	0.08	0.07	0.07	±	0.01	20:1 ω11	
20:1 ω-9	2.23	2.49	2.48	2.40	±	0.30	20:1 ω9	
20:2 ω-6	0.29	0.54	0.45	0.42	±	0.26	20:2 ω-6	
21:0	0.01	0.02	0.01	0.01	±	0.01	21:0	
22:0	0.77	0.83	0.89	0.83	±	0.12	22:0	
22:1 ω-9	6.63	6.85	7.00	6.83	±	0.38	22:1 ω9	
23:0	0.11	0.08	0.08	0.09	±	0.03	23:0	
24:0	0.31	0.32	0.33	0.32	±	0.01	24:0	
24:1 ω-9	0.26	0.24	0.24	0.25	±	0.02	24:1 ω-9	
others	3.09	2.97	4.14	3.40	±	1.28	others	
total fatty acids	934.00	935.00	936.00	935.00	±	2.00		
LA				108.00	±	0.35	mg/g	
ALA				594.31	±	6.25	mg/g	
LA/ALA				0.18	±	0.002		
Σ ω6				108.43	±	0.43	mg/g	
Σ ω3				594.68	±	6.25	mg/g	
Σω6/Σω3				0.18	±	0.003		
Σ PUFA				703.11	±	6.27	mg/g	
Σ MUFA				144.50	±	4.32	mg/g	
Σ SFA				83.99	±	2.96	mg/g	

TABLE S11. Milk Thistle seed oil produced in the Marche region, Italy (mg/g)

	analysis1	analysis2	analysis3	mean	±	2σ	
12:0	0.05	0.04	0.05	0.05	±	0.01	12:0
14:0	0.74	0.76	0.83	0.78	±	0.10	14:0
15:0	0.14	0.14	0.16	0.15	±	0.02	15:0
16:0	79.08	78.89	80.75	79.57	±	2.05	16:0
16:1 ω-7	0.74	0.78	0.82	0.78	±	0.08	16:1 ω7
17:0	0.65	0.69	0.70	0.68	±	0.05	17:0
18:0	37.54	37.80	38.28	37.87	±	0.76	18:0
18:1 ω-9	298.26	310.10	303.49	303.95	±	11.87	18:1 ω9
18:1 ω-7	13.56	3.84	3.90	7.10	±	11.20	18:1 ω7
18:2 ω-6	459.99	456.46	457.96	458.14	±	3.55	18:2 ω6 LA
19:0	0.25	0.20	0.22	0.22	±	0.05	19:0
18:3 ω-3	2.56	2.91	2.76	2.74	±	0.35	18:3 ω3 ALA
20:0	23.65	23.51	23.61	23.59	±	0.15	20:0
20:1 ω-9	8.93	8.70	11.37	9.67	±	2.96	20:1 ω9
20:2 ω-6	0.29	0.32	0.33	0.31	±	0.04	20:2 ω-6
21:0	0.19	0.20	0.20	0.20	±	0.004	21:0
22:0	15.87	16.35	16.57	16.26	±	0.71	22:0
22:1 ω-9	1.49	1.57	1.61	1.56	±	0.12	22:1 ω9
23:0	0.22	0.49	0.22	0.31	±	0.31	23:0
24:0	3.85	4.05	4.12	4.01	±	0.28	24:0
24:1 ω-9	0.14	0.60	0.20	0.31	±	0.50	24:1 ω-9
others	2.79	2.62	2.83	2.75	±	0.23	others
total fatty acids	951.00	951.00	951.00				
			LA	458.14	±	3.55	mg/g
			ALA	2.74	±	0.35	mg/g
			LA/ALA	167.06	±	22.52	
			Σ ω6	458.45	±	3.55	mg/g
			Σ ω3	2.74	±	0.35	mg/g
			Σω6/Σω3	167.18	±	22.538	
			Σ PUFA	461.19	±	3.57	mg/g
			Σ MUFA	323.37	±	16.59	mg/g
			Σ SFA	163.69	±	2.35	mg/g

TABLE S12. Perilla seed oil purchased on the market (mg/g)

	analysis1	analysis2	analysis3	mean	±	2σ		
12:0	0.03	0.04	0.04	0.04	±	0.01	12:0	
14:0	0.25	0.26	0.27	0.26	±	0.02	14:0	
15:0	0.10	0.09	0.09	0.09	±	0.01	15:0	
16:0	50.34	48.76	50.05	49.72	±	1.69	16:0	
16:1 ω-7	0.60	0.58	0.59	0.59	±	0.01	16:1 n7	
17:0	0.32	0.31	0.31	0.31	±	0.02	17:0	
18:0	20.42	20.34	20.48	20.41	±	0.13	18:0	
18:1 ω-9	139.47	127.96	135.84	134.42	±	11.77	18:1 n9	
18:1 ω-7	6.17	10.94	6.07	7.73	±	5.57	18:1 n7	
18:2 ω-6	125.94	127.24	127.45	126.88	±	1.64	18:2 n6	LA
19:0	0.14	0.12	0.09	0.12	±	0.05	19:0	
18:3 ω-3	583.15	588.80	586.65	586.20	±	5.70	18:3 n3	ALA
18:4 ω-3	0.39	0.26	0.25	0.30	±	0.15	18:4 n3	
20:0	0.85	0.84	0.82	0.83	±	0.03	20:0	
20:1 ω-9	0.85	0.86	0.94	0.88	±	0.11	20:1 n9	
20:2 ω-6	0.26	1.59	1.21	1.02	±	1.37	20:2 n6	
21:0	0.04	0.02	0.03	0.03	±	0.02	21:0	
22:0	0.50	0.44	0.47	0.47	±	0.06	22:0	
23:0	0.10	0.13	0.12	0.12	±	0.03	23:0	
24:0	0.25	0.38	0.25	0.29	±	0.15	24:0	
others	5.85	6.05	3.96	5.29	±	2.30	others	
total fatty acids	936.00	936.00	936.00					
			LA	126.88	±	1.64	mg/g	
			ALA	586.20	±	5.70	mg/g	
			LA/ALA	0.22	±	0.005		
			Σ ω6	127.90	±	2.14	mg/g	
			Σ ω3	586.50	±	5.70	mg/g	
			Σω6/Σω3	0.22	±	0.006		
			Σ PUFA	714.40	±	6.09	mg/g	
			Σ MUFA	143.62	±	13.03	mg/g	
			Σ SFA	72.69	±	1.70	mg/g	

TABLE S13. Borage seed oil purchased on the market (mg/g)

	analysis1	analysis2	analysis3	mean	±	2σ		
12:0	0.03	0.03	0.04	0.03	±	0.01	12:0	
14:0	0.60	0.67	0.69	0.65	±	0.10	14:0	
15:0	0.06	0.07	0.07	0.07	±	0.01	15:0	
16:0	97.73	99.41	100.48	99.21	±	2.77	16:0	
16:1 ω-7	1.34	1.45	1.49	1.43	±	0.16	16:1 n7	
17:0	0.40	0.38	0.38	0.39	±	0.02	17:0	
18:0	31.74	30.57	29.87	30.73	±	1.89	18:0	
18:1 ω-9	151.68	151.37	149.80	150.95	±	2.02	18:1 n9	
18:1 ω-7	8.24	6.70	6.36	7.10	±	2.01	18:1 n7	
18:2 ω-6	358.67	362.68	363.99	361.78	±	5.55	18:2 n6	LA
18:3 ω-6	212.30	217.30	219.94	216.51	±	7.76	18:3 n6	
18:3 ω-3	2.45	2.07	2.07	2.20	±	0.44	18:3 n3	ALA
18:4 ω-3	1.21	1.37	1.36	1.31	±	0.18	18:4 n3	
20:0	2.19	1.97	2.74	2.30	±	0.79	20:0	
20:1 ω-9	34.96	32.54	31.31	32.94	±	3.72	20:1 n9	
20:2 ω-6	1.48	1.43	1.42	1.44	±	0.07	20:2 n6	
22:0	1.16	0.98	0.90	1.02	±	0.27	22:0	
22:1 ω-9	22.06	18.69	17.64	19.46	±	4.62	22:1 ω9	
23:0	0.05	0.05	0.08	0.06	±	0.04	23:0	
24:0	0.38	0.47	0.38	0.41	±	0.10	24:0	
24:1 ω-9	11.03	9.39	8.77	9.73	±	2.34	24:1 ω-9	
others	2.23	2.41	2.24	2.29	±	0.20	others	
total fatty acids	942.00	942.00	942.00					
			LA	361.78	±	5.55	mg/g	
			ALA	2.20	±	0.44	mg/g	
			LA/ALA	164.76	±	35.74		
			Σ ω6	579.73	±	9.54	mg/g	
			Σ ω3	3.51	±	0.48	mg/g	
			Σ ω6/Σ ω3	165.26	±	25.20		
			Σ PUFA	583.24	±	9.55	mg/g	
			Σ MUFA	221.61	±	6.99	mg/g	
			Σ SFA	134.86	±	3.46	mg/g	

TABLE S14. Black Cumin seed oil purchased on the market (mg/g)

	analysis1	analysis2	analysis3	mean	±	2σ	
12:0	0.05	0.05	0.04	0.04	±	0.01	12:0
14:0	1.34	1.34	1.36	1.35	±	0.02	14:0
15:0	0.22	0.23	0.23	0.23	±	0.01	15:0
16:0	100.93	101.49	101.15	101.19	±	0.56	16:0
16:1 ω-7	1.51	1.54	1.57	1.54	±	0.06	16:1 n7
17:0	0.50	0.50	0.49	0.50	±	0.02	17:0
18:0	24.08	23.59	23.20	23.62	±	0.88	18:0
18:1 ω-9	190.47	188.21	189.39	189.36	±	2.26	18:1 n9
18:1 ω-7	11.58	12.60	12.37	12.18	±	1.06	18:1 n7
18:2 ω-6	530.85	533.74	534.19	532.93	±	3.62	18:2 n6 LA
19:0	0.34	0.27	0.30	0.31	±	0.07	19:0
18:3 ω-3	2.26	2.22	2.50	2.33	±	0.31	18:3 n3 ALA
20:0	1.62	1.58	1.54	1.58	±	0.08	20:0
20:1 ω-9	3.48	3.38	3.32	3.39	±	0.16	20:1 n9
20:2 ω-6	25.76	24.86	24.27	24.96	±	1.51	20:2 n6
22:0	0.27	0.26	0.25	0.26	±	0.02	22:0
22:1 ω-9	0.69	0.65	0.62	0.66	±	0.07	22:1 ω9
23:0	0.06	0.06	0.06	0.06	±	0.003	23:0
24:0	0.02	0.04	0.02	0.03	±	0.02	24:0
others	2.94	2.39	2.15	2.49	±	0.82	others
total fatty acids	899.00	899.00	899.00				
			LA	532.93	±	3.62	mg/g
			ALA	2.33	±	0.31	mg/g
			LA/ALA	228.78	±	31.65	
			Σ ω6	557.89	±	3.92	mg/g
			Σ ω3	2.33	±	0.31	mg/g
			Σ ω6/Σ ω3	239.50	±	33.19	
			Σ PUFA	560.22	±	3.94	mg/g
			Σ MUFA	207.13	±	2.50	mg/g
			Σ SFA	129.16	±	1.05	mg/g

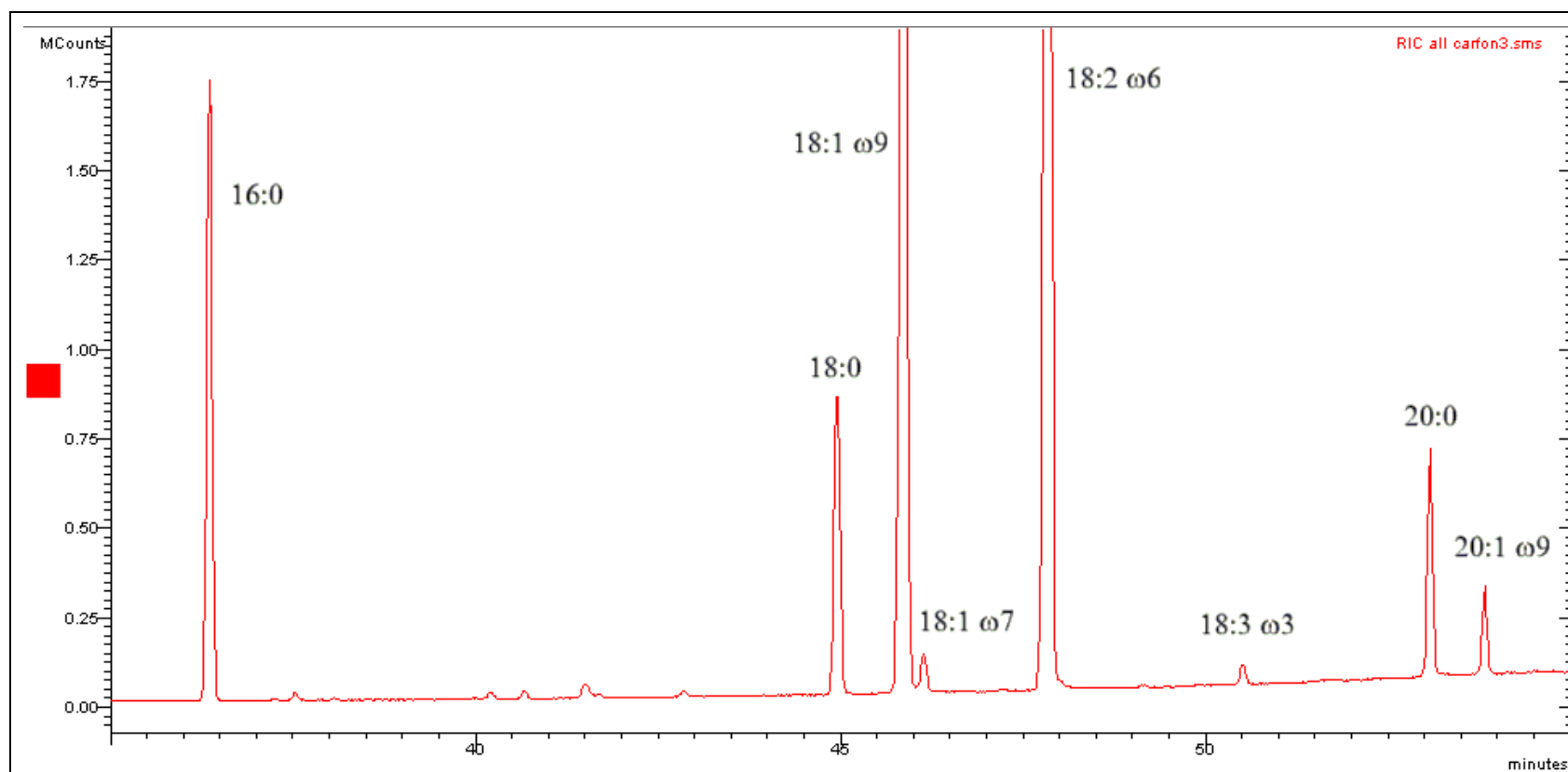


Figure S1. Gas chromatogram of the sample Milk Thistle seed oil (analysis number 3) in the time range 35-55 min obtained by Mass Spectrometry (GC-MS). Fatty acid methyl esters.

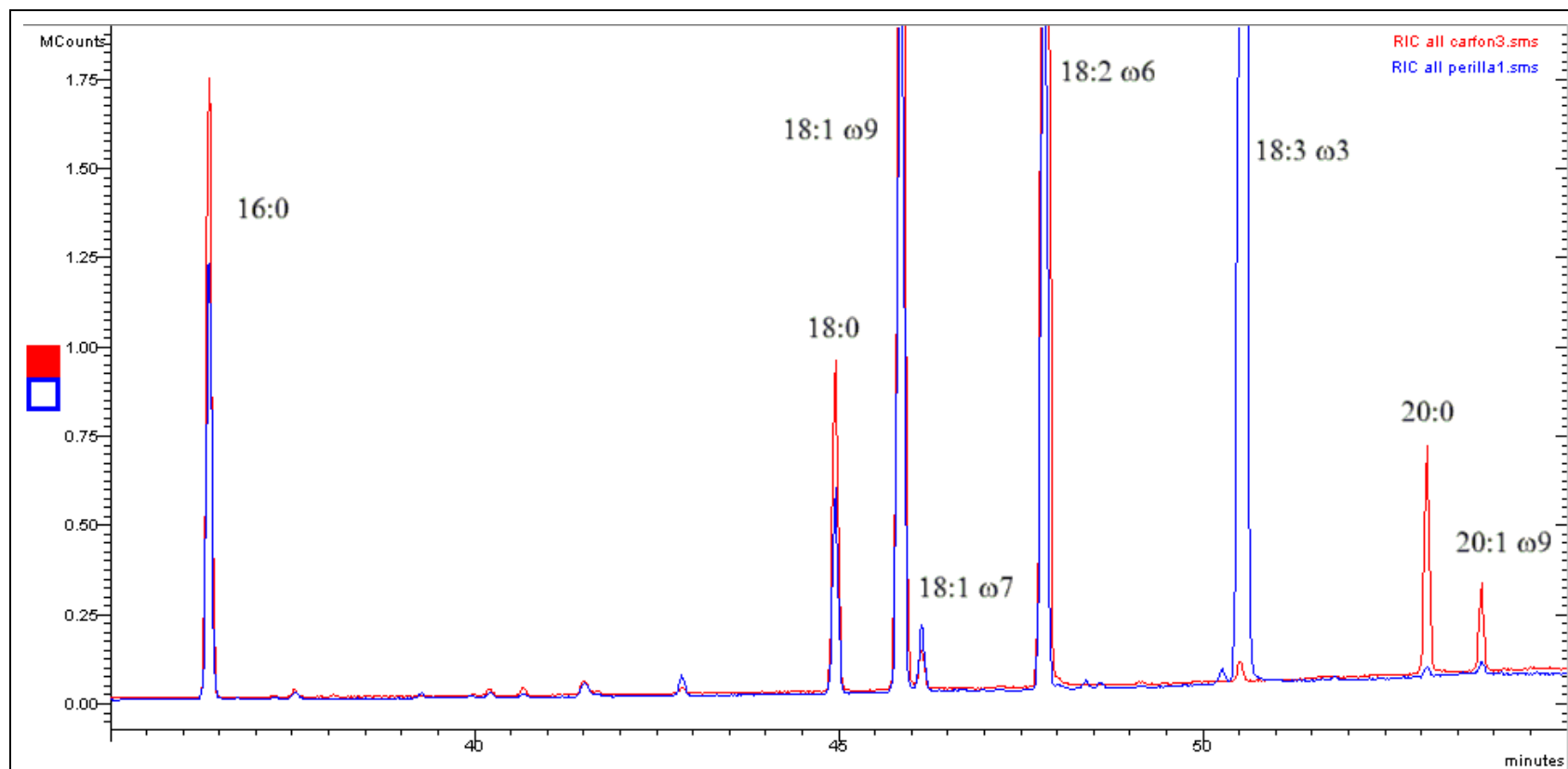


Figure S2. Gas chromatograms obtained by Mass Spectrometry (GC-MS) in the time range 35-55 min. Overlapping between the sample Milk Thistle seed oil (analysis number 3) traced in red and the sample Perilla seed oil (analysis number 1) traced in blue. Fatty acid methyl esters. Note the very different intensities of 18:3 ω3, with a high concentration in the Perilla seed oil. Differences in the concentrations of Arachidic acid (20:0) and Gondoic acid (20:1 ω9) are also observed.

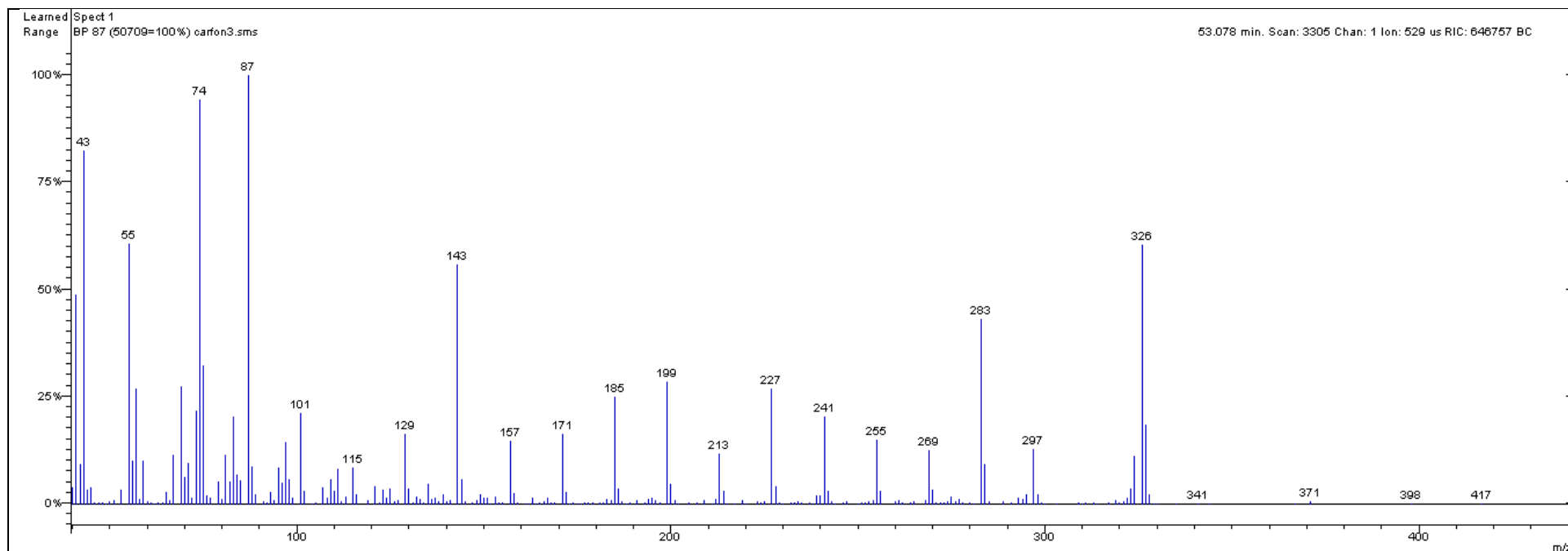


Figure S3. Mass spectrum of the peak related to 20:0 methyl ester in Milk Thistle seed oil of Figure S1. They can be seen the characteristic ionic fragments. The molecular weight of 20:0 methyl ester is 326 amu.

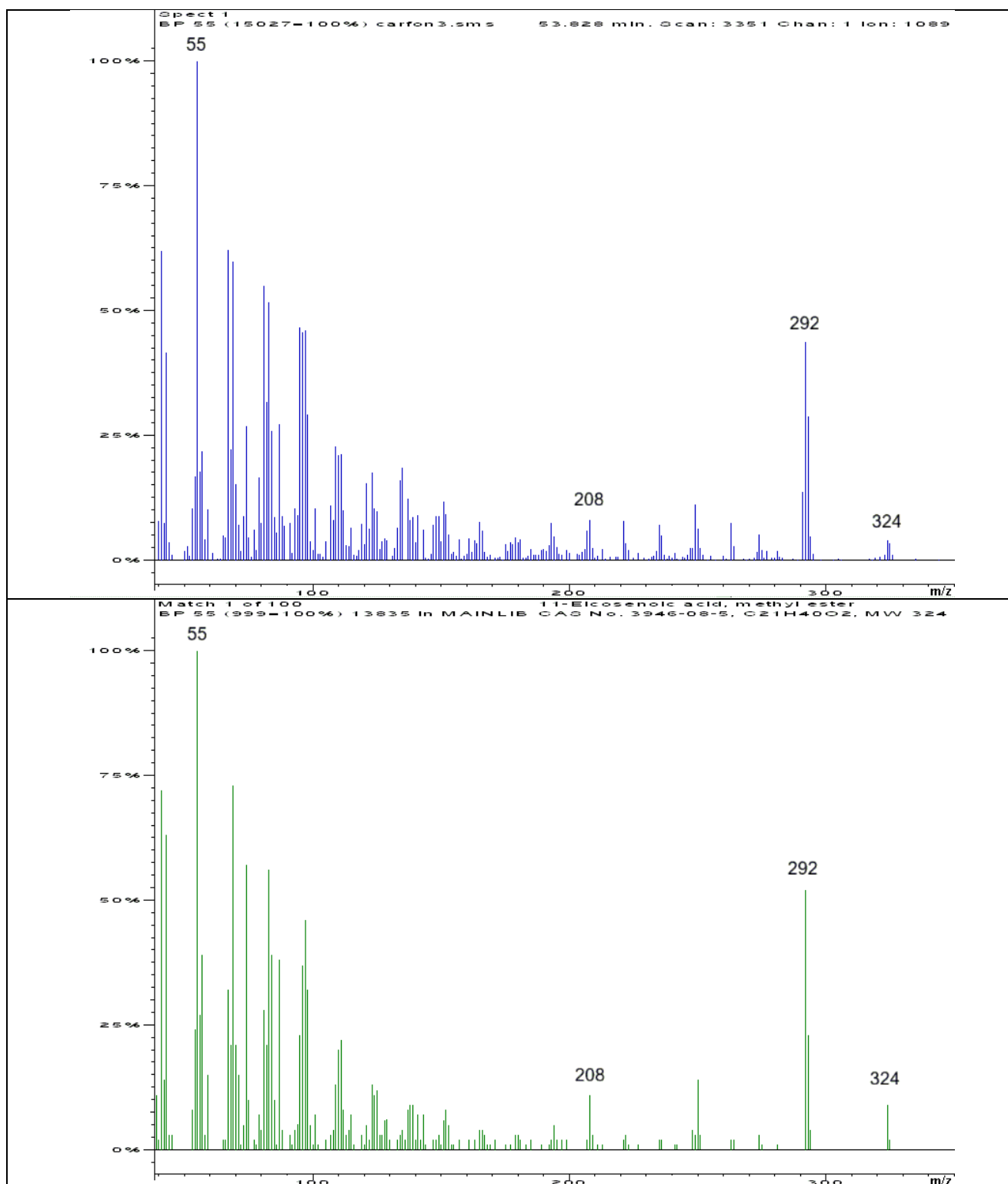


Figure S4. Top: mass spectrum of the peak related to 20:1 ω 9 methyl ester in Milk Thistle seed oil of Figure S1. Bottom: mass spectrum of 20:1 ω 9 methyl ester from the NIST mass spectrum database. The coincidence of the two spectra is evident. This fact, combined with the coincidence of the retention times of 20:1 ω 9 methyl ester (in the sample and when injected as a pure standard) gives absolute certainty of the identification. As a further identification criterion, it should be considered that the injection of the pure standard of 20:1 ω 9 methyl ester gave an identical mass spectrum to the ones showed above.

