J Am Oil Chem Soc (2008) 85:605–611
DOI 10.1007/s11746-008-1233-y

ORIGINAL PAPER

Fatty Acid Composition of Turkish *Rhododendron* Species

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Received: 21 December 2007 / Revised: 25 February 2008 / Accepted: 11 March 2008 / Published online: 17 May 2008

Abstract This study describes work aimed at the rapid evaluation of the fatty acid (FA) composition of Turkish *Rhododendron* species, particularly the leaves and the flowers of the toxic plants, *R. ponticum* and *R. luteum.* The FA profiles of the available parts of three other nonpoisonous *Rhododendron* species were also investigated. Subtotal extracts obtained (using *n*-hexane, chloroform and methanol) from total chloroform:methanol (1:1) extracts were analyzed and compared to each other. Palmitic acid was found to be the most abundant FA in almost all *Rhododendron* extracts, and the majority of leaf and flower extracts contained significant portions of C18 unsaturated FAs (18:1n-9, 18:2n-6, 18:3n-3). The *n*-hexane extracts of *R. ponticum* leaves and *R. luteum* flowers were unique, as they contained an unusual series of even-chain *iso* FAs (C16–C24). Especially the *n*-hexane extracts were found to comprise uncommon FAs with odd-numbered carbons (C13–C29). Overall, *n*-hexane proved to be the best solvent by representing the richest FA profile, whereas chloroform or methanol appeared less suitable for FA analyses. Appreciable intra-species variations in FA compositions among the leaves as well as other anatomical parts examined were observed. This study highlights the chemotaxonomical importance of the FAs for the genus *Rhododendron.*

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Keywords *Rhododendron* · Ericaceae · Fatty acid · GC-MS

Abbreviations

FA	Fatty acid
UFA	Unsaturated fatty acid
FAME	Fatty acid methyl ester
RPL	*R. ponticum* leaves
RLL	*R. luteum* leaves
RUL	*R. ungernii* leaves
RSL	*R. smirnovii* leaves
RSoL	*R. sochadzeae* leaves
RPF	*R. ponticum* flowers
RLF	*R. luteum* flowers
RUF	*R. ungernii* flowers
RSoFr	*R. sochadzeae* fruits

Introduction

Rhododendron species (family Ericaceae) are common garden plants with glossy, evergreen leaves and large, showy flower displays. *Rhododendron*, a large genus with 80 species worldwide, is represented by six native species in the flora of Turkey, one of which (*R. smirnovii*) is endemic [1]. The leaves and the flowers of some members of this genus, such as *R. ponticum* and *R. luteum*, are known for being poisonous to human and livestock [2, 3]. Intoxications caused by the consumption of "mad honey" produced from the nectar of these plants are common in northern Turkey [2, 4]. The toxic effects of these plants are attributed to grayanine-type diterpenes, also known as grayanotoxins, which bind to sodium channels in cell membranes and increase the permeability of sodium ions in

excitable membranes [4]. Ironically, these poisonous *Rhododendron* species (particularly *R. ponticum*) are widely used in traditional Turkish medicine both internally and externally [2, 5]. Other Turkish *Rhododendron* species have no reputation for being poisonous. Instead, local people eat the flowers of some species or suck their nectars [1, Tasdemir D, personal observation]. We have recently initiated a research project aimed at identifying the detailed chemical and biological profiles of Turkish *Rhododendron* plants, particularly the toxic species *R. ponticum* and *R. luteum* [6, 7]. The main goal of this study was thus the rapid identification of the fatty acid (FA) composition of the *n*-hexane-, $CHCl_3$- and MeOH-solubles of the total chloroform:methanol ($CHCl_3$:MeOH, 1:1) extracts prepared from the leaves and the flowers of these two species, by GC-MS after methylation. Furthermore, the available leaves, flowers or fruits of three other edible *Rhododendron* plants were also studied for comparison. The effect of solvents on the FA profile of the plant material was also discussed.

Experimental Procedures

Plant Material and Extraction

Plant materials were collected in July 2001 in northeast Anatolia and identified based on [1]. Voucher specimens were deposited at the Department of Biology, Hacettepe University (HUB) under the following numbers: *R. ponticum* L. AAD-9881, *R. luteum* Sweet AAD-9882, *R. sochadzeae* Charadze & Davlianidze AAD-9892, *R. ungernii* Trautv. AAD-9880 and *R. smirnovii* Trautv. AAD-9889. The used plant parts were the leaves (RPL, *R. ponticum* leaves; RLL, *R. luteum* leaves; RUL, *R. ungernii* leaves; RSL, *R. smirnovii* leaves; RSoL, *R. sochadzeae* leaves), flowers (RPF, *R. ponticum* flowers; RLF, *R. luteum* flowers; RUF, *R. ungernii* flowers) and fruits of *R. sochadzeae* (RSoFr). Ten grams of each dried plant material were ground and extracted with a 1:1 mixture of $CHCl_3$:MeOH at room temperature, and the solvent was removed under vacuum. The residue was dissolved in MeOH:H_2O mixture (70%) before partitioning against *n*-hexane and $CHCl_3$, successively, to yield three subtotal extracts (*n*-hexane, $CHCl_3$, and aq. MeOH). The solvents were evaporated to dryness under vacuum and the residue was used for GC-MS analyses. The extracts were kept at −20 °C until examination.

GC-MS Analyses of the Extracts

In order to analyze the FA composition of the *Rhododendron* species, the total FAs were converted to FA methyl esters (FAMEs) by reaction of the *n*-hexane, $CHCl_3$ and MeOH fractions with methanolic HCl followed by column chromatography on Si gel eluting with hexane:ether (9:1). The total FAMEs was analyzed qualitatively and quantitatively by GC-MS by comparing the mass spectra of the FAMEs with those in the literature (NIST/EPA/NIH Mass Spectral Library) [8] and comparing their equivalent chain length (ECL) values with known commercial standards (Sigma, St. Louis, MO, USA). The double bonds and methyl branching in these compounds were determined by pyrrolidide derivatization following the preparation procedure previously described [9]. The FAMEs were analyzed by electron ionization using GC-MS (5972A Chem Station, Hewlett–Packard, Palo Alto, CA, USA) at 70 eV equipped with a 30 m × 0.25 mm special performance capillary column (HP-5MS). The GC temperature program was: 130 °C for 1 min, increased at a rate of 3 °C/min to 270 °C, and maintained for 30 min at 270 °C.

A minimum of three samples ($n = 3$) were used to determine the average FA compositions of the flowers, as determined by the availability of material, and a minimum of five samples ($n = 5$) were used to determine the average FA compositions of the leaves. Replicates were done when the amount of material obtained was not enough for the FA analyses. The leaves and flowers of the plants were chosen for this study since these are the parts of the plants of the greatest interest for human consumption.

Results and Discussion

The overall FA composition of the *n*-hexane (H), $CHCl_3$ (C), and methanol (M) extracts obtained from the leaves (*R. ponticum* RPL, *R. luteum* RLL, *R. ungernii* RUL, *R. smirnovii* RSL, *R. sochadzeae* RSoL), the flowers (*R. ponticum* RPF, *R. luteum* RLF and *R. ungernii* RUF) and the fruits (*R. sochadzeae* RSoFr) of the *Rhododendron* species are shown in Tables 1, 2, and 3.

Fatty Acid Profiles of the *n*-Hexane Extracts

A total of 40 different FAs, ranging from C_{12} to C_{30}, were detected and quantified in the *n*-hexane extracts (Table 1). In total 21 FAs were detected in the leaf extract of RPL-H, with *iso*-16:0, 16:0, 18:1n-9, and 18:3n-3 being the major FAs (16–22%). Stearic (18:0) and arachidic (20:0) acids were also present to lesser extents. The FA compositions of RLL-H and RSL-H showed significant similarities to each other, as both contained an approximately 1:1:1 ratio of 16:0, 18:1n-9, and 18:3n-3 (>25%), plus lower levels of 18:0 and 18:2n-6 (4–7.7%). Palmitic acid (16:0) and the 18:3n-3 acids were the most predominant FAs in RUL-H, accounting for 78% of the total FA content. Moderate amounts of 18:2n-6 (10%) and 18:0 (4.4%) were also

Table 1 Fatty acid compositions of the hexane extracts (H) of the *Rhododendron* species investigated (wt%)

Fatty acid	RPL-H	RLL-H	RSL-H	RUL-H	RSoL-H	RPF-H	RLF-H	RUF-H	RSoFr-H
iso-12:0	0.1								
12:0	0.1	0.1	0.2	0.3	0.6	0.3	0.1	0.1	
13:0					0.1				
iso-14:0	1.1								
14:0	1.4	1.4	1.1	2.0	5.4	2.0	3.0	0.6	
15:0			0.2		0.4	0.7		0.4	
iso-16:0	**16**						**9.0**		
16:1		0.2						0.3	
16:0	**18**	**26**	**29**	**35**	**38**	**46**	**15**	**30**	**73**
iso-17:0	1.1						0.2		
17:0	0.7	0.7	0.6	0.5	2.2	3.0	0.3	1.2	
br-18:0							0.5		
iso-18:0							3.0		
18:1 (n-9)	**22**	**25**	**23**		**14**	1.0	**19**	0.2	**10**
18:2 (n-6)	2.3	4.0	7.7	10	4.5	2.0	**10**	**20**	
18:3(n-3)	**22**	**25**	**23**	**43**			**19**	**22**	
18:0	6.0	6.1	5.6	4.4	**9.0**	**16**	**8.0**	**10**	**12**
19:0	0.8	0.3	0.3	0.2	0.8	0.7		0.6	
br-20:0							0.7		
iso-20:0							1.2		
20:4 (n-6)						1.0			
20:5 (n-3)						2.0			
20:1(n-9)				0.5	1.0		0.9	0.8	
20:0	4.0	3.0	3.2	3.0	6.0	**8.0**	3.0	5.0	3.0
21:0	0.5	0.4	0.4	0.3	0.8	1.0	0.1	0.6	
br-22:0							0.4		
iso-22:0							2.0		
22:1					0.4	5.0	2.0		
22:0	1.2	1.0	3.0	1.1	5.0	4.0	0.4	3.0	2.4
23:1			-		0.2				
23:0	0.6	0.3	0.3	0.2	0.8	0.7	0.1	0.5	
iso-24:0							0.8		
24:1					0.4				
24:0	1.2	1.3	2.0	0.7	5.0	5.0	1.1	3.0	
25:0		0.4			0.6	0.5		0.6	
26:0	1.2	2.0	0.9	0.5	3.0	2.0	0.4	2.0	
27:0		0.2			0.3				
28:0	0.5	2.0	0.6	0.3	2.0	0.6		1.3	
29:0		0.2							
30:0	0.1	1.2						1.3	

The bold values indicate the most abundant Fatty acids (their percentage in the extracts)

Each value is the average of three determinations. *RPL*, *R. ponticum* leaves; *RSL*, *R. smirnovii* leaves; *RLL*, *R. luteum* leaves; *RUL*, *R. ungernii* leaves; *RSoL*, *R. sochadzeae* leaves; *RPF*, *R. ponticum* flowers; *RLF*, *R. luteum* flowers; *RUF*, *R. ungernii* flowers; *RSoFr*, *R. sochadzeae* fruits)

detected in this extract. The leaf extract of *R. sochadzeae* (RSoL-H) appeared to be poorer in C18 unsaturated FAs (UFAs) and was devoid of 18:3. Instead, palmitic acid was the main FA (38%), followed by 18:1 (14%) and 18:0 (9%) and almost equal amounts ($\approx$5%) of FAs with even number of carbons, 14:0, 18:2n-6, 20:0, 22:0, and 24:0.

The flower extract of *R. ponticum*, RPF-H, contained palmitic acid as the major FA (46%) followed by 18:0 (16%), 20:0 (8%), 22:0 (4%), and 24:0 (5%), as well as odd-numbered FAs, such as 15:0, 17:0, 19:0, and others. The FA profiles of the remaining flower extracts, RLF and RUF, appeared divergent from that of RPF-H. RLF-H exhibited the most diverse composition overall, with 25 identified FAs, and possessed almost equal percentages of 16:0 (15%), 18:1n-9 (19%), 18:3n-3 (19%), plus moderate amounts of 18:2n-6 (10%), *iso*-16:0 (9%), and 18:0 (8%).

Table 2 Fatty acid compositions of the $CHCl_3$ (C) extracts of the *Rhododendron* species investigated (wt%)

Fatty acid	RPL-C	RLL-C	RSL-C	RUL-C	RSoL-C	RPF-C	RLF-C	RUF-C	RSoFr-C
12:0						0.6	0.6		
14:0	1.3		4.0	3.4	2.2	2.3	7.7	1.5	1.5
15:0	0.3					0.6		0.7	0.8
16:0	**48.3**	**70.6**	**62.5**	**69.9**	**44.8**	**59.8**	**21.7**	**40.2**	**47.3**
17:0	2.9		1.3		2.6	3.2	0.3	1.7	2.3
18:1 (n-9)	**16.7**			**9.2**					
18:2 (n-6)	5.2		**6.4**	3.8	**6.5**		**23.1**	**22.4**	**13.7**
18:3 (n-3)	**16.7**	**25.7**	**19.1**	**9.2**	**35**		**30.1**	**18.5**	**25.1**
18:0	7.3	3.7	**6.0**	4.1	**7.0**	**14.5**	**9.4**	**8.7**	**6.8**
19:0	0.5				0.7			0.4	
20:1						1.0	1.3		
20:0	0.8		0.7	0.4	1.2	7.4	2.6	3.0	2.0
21:0						1.0		1.1	
22:1						1.7	1.6		
22:0						3.2	1.0	1.1	0.5
23:0						0.3			
24:0						3.2	0.6	0.7	
25:0						0.3			
26:0						0.6			
28:0						0.3			

The bold values indicate the most abundant Fatty acids (their percentage in the extracts)

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$CHCl_3$ (C) extracts of *RPL*, *R. ponticum* leaves; *RSL*, *R. smirnovii* leaves; *RLL*, *R. luteum* leaves; *RUL*, *R. ungernii* leaves; *RSoL*, *R. sochadzeae* leaves; *RPF*, *R. ponticum* flowers; *RLF*, *R. luteum* flowers; *RUF*, *R. ungernii* flowers; *RSoFr*, *R. sochadzeae* fruits

Table 3 Fatty acid compositions of the MeOH (M) extracts of the *Rhododendron* species investigated (wt%)

Fatty acid	RPL-M	RLL-M	RSL-M	RUL-M	RSoL-M	RPF-M	RLF-M	RUF-M	RSoFr-M
12:0	4.0								
14:0	4.4							**10**	
16:0	**39.6**	**45.7**	**77.8**	**83.7**	**100**	**35**	**65.2**		**74.5**
17:0	2.9	1.0						**18.8**	
18:1(n-9)	**11.1**								
18:2 (n-6)	2.0	4.2				**32.9**			**13.8**
18:3 (n-3)	**9.0**	**42.5**				**21.3**			
18:0	**26.3**	**6.6**	**22.2**	**16.3**		**10.8**	**34.8**	**65**	**11.7**
20:0	0.7							2.5	
22:0								3.7	

The bold values indicate the most abundant Fatty acids (their percentage in the extracts)

MeOH (M) extracts of *RPL*, *R. ponticum* leaves; *RSL*, *R. smirnovii* leaves; *RLL*, *R. luteum* leaves; *RUL*, *R. ungernii* leaves; *RSoL*, *R. sochadzeae* leaves; *RPF*, *R. ponticum* flowers; *RLF*, *R. luteum* flowers; *RUF*, *R. ungernii* flowers; *RSoFr*, *R. sochadzeae* fruits

The most abundant FAs in the RUF-H extract were 16:0 (30%), 18:2n-6 (20%), 18:3n-3 (22%), and 18:0 (10%). The fruits of *R. sochadzeae* (RSoFr-H) yielded the most distinct of all the *n*-hexane extracts; it was composed of only five FAs, with palmitic acid being the most predominant (73%). The other acids identified were 18:0, 18:1n-9, 20:0, and 22:0, all in lesser quantities (2.4–12%).

Palmitic acid (16:0) was detected in all *n*-hexane extracts and was generally the major FA constituent. The lowest levels of 16:0 were detected in RPL-H and RLF-H, which were the only extracts containing significant amounts of *iso*-16:0 (9 and 16%, respectively). Notably, the RPF-H and RLL-H extracts were devoid of *iso*-16:0. Stearic (18:0) and arachidic (20:0) acids were also present in all analyzed *Rhododendron* extracts to lesser extents. Generally, the FA composition varied in most of the anatomical organs. The FA profiles of the *n*-hexane extracts of RPL-H, RLL-H and the endemic RSL-H were closely related, as all of them contained approximately 50% saturated and 50% UFAs (mainly 18:1n-9, 18:2n-6 and 18:3n-3). The total proportion of C18 UFAs in RUL-H was similar (53%), except that it was devoid of 18:1. The most significant chemical variation among leaf *n*-hexane extracts was seen in RSoL-H, as the proportion of C-18 UFAs was less than 20% and 18:3n-3

was absent. The flower extracts investigated also exhibited significant differences in their FA compositions. RLF-H was unique inasmuch as it contained an unusual series of even-chain *iso* FAs (15% in total) ranging in chain length between 16 and 24 carbon atoms, reflecting the interesting, and unusual for plants, FA biosynthetic sequence *iso*-16:0 → *iso*-24:0. Also noteworthy was the fact that RPF-H contained much higher levels of 16:0 (46%) and only minute amounts of C18 UFAs (just 3%) when compared to the other flower extracts. Some significant differences were observed in the FA profiles of the leaf and flower *n*-hexane extracts of the same plant. For example, RPF-H contained 15-fold less C18 UFAs and 2.5-fold higher concentrations of 16:0 in comparison to the RPL-H. The RUF-H extract contained similar amounts of 16:0 to RUL-H, but its C18 UFA composition was significantly different from RUL-H, with two-fold higher levels of 18:2n-6 and practically no 18:1n-9. Indeed, RUF-H was the extract with the highest amount of 18:2n-6 (20%). The most strikingly different FA composition was observed in *R. sochadzeae* fruit, which was dominated by 16:0 and three other saturated FAs (90%). Another interesting point was the presence of very long chain FAs (>C20) in all *n*-hexane extracts, except for RSoFr-H, in significant amounts. Especially RSoL-H (24%), RPF-H (22.3%) and RUF-H (16%) had very high portions of these less common FAs. The majority of the *n*-hexane extracts were found to comprise odd-numbered FAs (C13–C29) in low quantities (0.1–3%).

FA Profiles of the $CHCl_3$ (C) and MeOH (M) Extracts (Tables 2, 3)

Altogether 20 FAs were identified in the nine $CHCl_3$ extracts studied. The principal FAs of the RPL-C extract were 16:0 (48.3%), 18:1n-9 (16.7%), and 18:3n-3 (16.7%), accounting for 81.7% of the total FA content. RLL-C was composed of only three FAs, 16:0 (70.6%), 18:3n-3 (25.7%) and 18:0 (3.7%). Among the seven FAs detected in the RSL-C extract, the predominant one was 16:0 (62.5%), followed by 18:3 (19.1%), and then equal amounts of 18:0 and 18:2n-6 (≈6%). RUL-C had a similar FA profile to RPL-C, but possessed even higher concentrations of 16:0 (69.9%) and lower but equal levels (9.2%) of 18:1n-9 and 18:3n-3. The FA composition of the RSoL-C extract resembled that of the RSL-C extract, with significant differences in the levels of 18:3n-3 (35%) and slight quantitative variations in the 16:0, 18:0 and 18:2n-6 contents. RPF-C proved to be the most chemically diverse of all of the $CHCl_3$ extracts, being composed of 16 FAs. Again 16:0 was the major FA (59.8%), followed by 18:0 and 20:0. Interestingly, RPF-C contained practically no UFA (only 2.8%). In contrast, the other two flower extracts RLF-C and RUF-C contained significant amounts of C18 UFAs (40–50%). Linolenic acid (18:3n-3) was the most abundant FA (30.1%) in RLF-C, followed by 18:2n-6 (23.1%), 16:0 (21.7%) and 18:0 (9.4%). RUF-C exhibited a similar FA profile, but 16:0 was the major FA at 40.2%. The FA composition of the only fruit extract investigated here, the RSoFr-C extract, was similar to that of RSoL-C, since it had 16:0 as its principal FA, plus significant amounts of 18:3n-3, 18:2n-6 and 18:0.

The MeOH extracts were chemically very conservative and limited numbers (10) of FAs with mainly even-numbered carbons were detected. Heptadecanoic acid (17:0) was the only odd-numbered FA detected in three MeOH extracts (RPL-M, RLL-M and RUF-M). The highest chemical diversity was presented by RPL-M, which comprised nine FAs, with 16:0 being the major one (39.6%), followed by considerable amounts of 18:0 (26.3%), 18:1n-9 (11.1%), and 18:3n-3 (9.0%). It was noteworthy that the RLL-M extract contained almost equal amounts of 18:3n-3 and 16:0 (≈45%). RSL-M, RUL-M and RLF-M were composed of only two FAs, 16:0 (65.2–83.7%) and 18:0 (16.3–34.8%), whereas RSoL-M contained only 16:0 (100%). RPF-M contained comparable amounts of saturated FAs 16:0 and 18:0 (45.8%) and UFAs 18:2n-6 and 18:3n-3 (54.2%). RUF-M was interesting, as it was the only MeOH extract that contained stearic acid (18:0) as the predominant FA and notable amounts of 17:0 (18.8%). RSoFr-M contained large amounts of 16:0 (74.5%) plus two additional FAs with even-numbered FAs, 18:0 and 18:2n-6.

In comparison to the *n*-hexane extracts, the FA profiles of the $CHCl_3$ and MeOH extracts were less diverse and less representative of the true FA composition of the *Rhododendron* species, and only a few trends were observed. With the exception of RLF-C and RUF-M, 16:0 was the major FA in all of the $CHCl_3$ and MeOH extracts. Most of the $CHCl_3$ extracts also contained significant amounts of C18 UFAs (25–53%), whereas only four MeOH extacts had low to high concentrations of the UFAs (13.8–54.2%). Insignificant levels of odd-numbered FAs (C15–C23) were found in $CHCl_3$ extracts, whereas 17:0 was the only such FA detected in the three MeOH extracts. Long-chain FAs were only detected in a few flower $CHCl_3$ extracts, with RPF-C being the most noteworthy. *Iso* FAs were not detected in any of the $CHCl_3$ or MeOH extracts. On the other hand, remarkable variations were observed in the plant parts investigated. For example, similar to RPF-H, RPF-C was completely devoid of C18 UFAs, whereas RPL-C contain about 40% UFAs. On the other hand, the other toxic species RLF-C had twice as much C18 UFA compared to RLL-C. Significant differences were also obvious between the $CHCl_3$ and MeOH extracts, in particular in the C18 UFA profiles. RPL-C had double the C18 UFA concentration compared to RPL-M, whereas this situation was reversed for RLL-M and RLL-C. Unlike RPF-C, RPF-M was very rich in C18 UFAs (54.2%).

Table 4 Key fatty acids in the leaf and the flower hexane extracts of *Rhododendron* species (wt%)

Fatty acid	Leaves[a]	Flowers[b]
12:0	0.3 ± 0.2	0.3 ± 0.2
13:0	0.1 ± 0.1	
14:0	2.1 ± 1.9	2.1 ± 1.2
15:0	0.3 ± 0.1	0.4 ± 0.4
16:0	**27.1 ± 7.7**	**33.3 ± 16.0**
17:0	0.9 ± 0.7	1.7 ± 1.4
18:3(n-3)	**26.3 ± 9.4**	**14.6 ± 11.6**
18:2(n-6)	**5.4 ± 3.1**	**11.4 ± 8.4**
18:1(n-9)	**19.7 ± 4.8**	**7.5 ± 10.5**
18:0	**5.8 ± 1.7**	**12.4 ± 4.9**
19:0	0.4 ± 0.3	0.5 ± 0.5
20:1(n-9)	0.3 ± 0.3	0.6 ± 0.5
20:0	3.6 ± 1.3	5.8 ± 2.5
21:0	0.4 ± 0.2	0.6 ± 0.5
22:0	2.1 ± 1.8	3.4 ± 1.1
23:0	0.4 ± 0.2	0.5 ± 0.4
24:0	1.9 ± 1.7	2.4 ± 2.4
25:0	0.2 ± 0.2	0.4 ± 0.3
26:0	1.5 ± 1.0	1.4 ± 1.0
27:0	0.1 ± 0.1	
28:0	1.1 ± 0.8	0.7 ± 0.7
30:0	0.2 ± 0.5	

The bold values indicate the most abundant Fatty acids (their percentage in the extracts)

[a] Mean ($n = 5$) ± standard error

[b] Mean ($n = 3$) ± standard error

Another striking example was the pair RUF-C and RUF-M, which differed remarkably in their major FA constituents.

n-Hexane was found to be the most suitable solvent for the current FA analysis. In order to give a more exact picture of the representative FAs for Turkish *Rhododendron* species, we averaged the FA compositions of the *n*-hexane extracts of the leaves of the species analyzed ($n = 5$) and the flowers analyzed ($n = 3$) and determined their standard deviations. Only FAs that were found in two or more species were included in this general scheme. As shown in Table 4, the leaves appear quite similar to the flowers in terms of the FA constituents. Palmitic acid (16:0) is the most abundant FA in both *Rhododendron* leaves and flowers (27.1 and 33.3%, respectively), followed by 18:3n-3 (26.3 and 14.6%, respectively). The most significant variations between the leaf and the flower extracts seem to be associated with the concentrations and the compositions of the C18 UFAs. It appears that the leaves are richer in C18 UFAs (51.4%) than the flowers (33.5%). The ratio of 18:3n-3/18:2n-6/18:1n-9 is approximately 5/1/4 in leaf extracts, whereas it is about 3/2/2.5 in flower extracts. Another notable difference is the level of 18:0, which occurs in twofold higher quantities in the flowers. The flowers contain slightly higher numbers of long-chain FAs as well as odd-numbered FAs.

In this study we aimed at the rapid identification and quantification of the FA constituents of different extracts prepared mainly from the leaves but also some of the flowers and fruits of both toxic and edible Turkish *Rhododendron* species. One further aim was to draw some conclusions regarding the chemotaxonomical importance of the FAs for the genus. This study showed that the leaves and flowers of almost all extracts from Turkish *Rhododendron* species are characterized by high levels of palmitic acid and C18 UFAs, such as oleic (18:1n-9), linoleic (18:2n-6) and linolenic (18:3n-3) acids. Polyunsaturated FAs are well known for their beneficial effects on human health, particularly in terms of decreasing the risk of heart disease and cancer [10, 11]. The high abundance of UFAs in *Rhododendron* species is intriguing, as it might indicate the potential of nontoxic *Rhododendron* species as a dietary supplement. Indeed, the flowers of some nonpoisonous species are consumed as food in Turkey, supporting this suggestion. Because the UFAs are more abundant in leaves, they can also be recommended for nutritional requirements. Interestingly, very long chain FAs, which presumably exist in the wax layer on the (leaf) surface, were also detected, particularly in most of the *n*-hexane extracts in significant amounts. Also, some unusual series of even-chain *iso* FAs ranging in chain length between 16 and 24 carbon atoms were identified in some *n*-hexane extracts. We also investigated the effect of the solvent on the FA profile of the plant material. *n*-Hexane proved to be a very good solvent for analyzing the FAs of *Rhododendron* sp., as 40 different FAs were detected and quantified. Therefore, the hexane fraction was quite representative of the FA compositions of the plants under investigation. The $CHCl_3$ and MeOH fractions of the plant extracts were less diverse in FA composition and did not present components that the *n*-hexane fractions missed. These solvents are also more expensive and less volatile than *n*-hexane. Despite of the existence of numerous studies on the secondary metabolites, such as diterpenes [12], triterpenes [13], flavonoids [13, 14] and prenylchromones [15], little is known about the FA compositions of *Rhododendron* species. Previous work on the saponifiable portion of *R. anthopogon* led to the isolation of a few FAs [16]. Wang et al. [17] investigated the epicuticular lipids of few *Rhododendron* sp. and identified *n*-alkanes (*n*-hentriacontane, *n*-nonacosane) and triterpenes (ursolic acid and amyrins) as the most abundant lipids. Thus, our study is the first detailed report on the FA profiles of Turkish *Rhododendron* species, which could be of chemotaxonomic significance.

Acknowledgments The authors thank Assoc. Prof. Dr. Ali A. Dönmez (Department of Biology, Hacettepe University, Turkey) for his assistance in the collection and taxonomical identification of the plants. This work was supported in part by a grant from the SCORE program of the National Institutes of Health (grant no. S06GM08102). M. Cartagena thanks the NIH-RISE program for a graduate fellowship.

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