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Iridoid and Phenylpropanoid Glycosides from *Phlomis samia, P. monocephala* and *P. carica*

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From the aerial parts of *Phlomis samia* an iridoid glucoside, shanzhiside methylester (**1**), and three phenylethanoid glycosides, martynoside (**2**), 4″-*O*-acetylmartynoside (**3**) and samioside (**4**), were isolated. From the overground parts of *P. monocephala* two iridoid glucosides, lamiide (**5**) and ipolamiide (**6**), as well as three phenylethanoid glycosides, verbascoside (= acteoside) (**7**), forsythoside B (**8**), alyssonoside (**9**), and one lignan glucoside, syringaresinol 4′-*O*-β-D-glucopyranoside (**10**), were isolated. From the aerial parts of *P. carica* one phenylethanoid glycoside, verbascoside (= acteoside) (**7**) and three phenylpropanoid monomeric glucosides, syringin (**11**), dihydrosyringin (**12**) and coniferin (**13**), were isolated. The structures of the isolated compounds were elucidated by means of spectroscopic evidence. Phenylethanoid glycosides isolated from the title plants (**2**-**4**,**7**-**9**) demonstrated scavenging properties toward the 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical in TLC autographic assay.

Key Words: *Phlomis samia*, *P. monocephala*, *P. carica*, Lamiaceae, iridoid glucosides, shanzhiside methylester, lamiide, ipolamiide, phenylethanoid glycosides, martynoside, 4″-*O*-acetylmartynoside, samioside, verbascoside, forsythoside B, alyssonoside, phenylpropanoid monomeric glucosides, syringin, dihydrosyringin, coniferin, lignan glucoside, syringaresinol-4′-*O*-β-D-glucopyranoside, radical scavenging activity.

Introduction

Among the 34 *Phlomis* species recorded in the Flora of Turkey[1], *Phlomis monocephala* and *P. carica* are recorded to be endemic species, whereas *P. samia* is considered a Mediterranean element. A number of members of the genus growing in Turkish flora have been reported to contain iridoid and phenylpropanoid glycosides[2−12]. However, no work has been reported on the chemical constituents of *P. monocephala* and *P. carica*. Likewise, *P. samia* of Turkish origins has not been chemically investigated so far. The present

communication deals with the isolation and characterization of the iridoid and phenylpropanoid glycosides from the title plants.

Experimental

General Experimental Procedures: The UV (MeOH) spectra were recorded on a Hitachi HP 8452 A spectrophotometer. The FTIR (KBr) spectra were determined on a Perkin-Elmer 2000 FTIR spectrophotometer. NMR measurements in CD_3OD at room temperature were measured using Bruker AMX 300 and Bruker DRX 500 spectrometers (^{1}H: 300.13 and 500 MHz; ^{13}C: 75.5 and 125 MHz). FABMS were performed on a Finnigan 311 A spectrometer. Polyamide 6 (Fluka, 50-160 μm) and silica gel 60 (0.063-0.200 mm, Merck) were used for open column chromatographic separations. MPLC was performed on Labomatic (1.8 x 35.2 cm and 1.3 x 38 cm) and Büchi (2.5 x 46 cm) glass columns packed with LiChroprep RP-18 (Merck), using Lewa M5 (peristaltic) and Büchi B-684 pumps. VLC separation was realized on a small glass column (5.2 x 10 cm) packed with LiChroprep RP-18 (Merck). TLC analyses were carried out on pre-coated silica gel 60 F_{254} aluminum sheets (Merck). Compounds were detected by UV fluorescence and spraying 1% vanillin/H_2SO4, followed by heating at 100 $^\circ$C for 1-2 min.

Plant Material: *Phlomis samia* L. (Hub.-Mor.) was collected from Sütçüler, Isparta (S. Anatolia, Turkey) in July 2001. *P. monocephala* P.H. Davis was collected from Silifke, İçel (S. Anatolia, Turkey) in July 2001 and *P. carica* Rech. fil. was collected from Tavas, Denizli (W. Anatolia, Turkey) in July 2001. Voucher specimens of *P. samia* and *P. monocephala* have been deposited in the Herbarium of the Biology Department, Hacettepe University, Ankara, Turkey (HUB 9520 and HUB 9497, resp.), whereas the *P. carica* specimen has been deposited in the Herbarium of the Pharmacognosy Department, Faculty of Pharmacy, Hacettepe University, Ankara, Turkey (HUEF 01017).

Extraction and Isolation: The air-dried and powdered overground parts of each plant (500 g) were macerated with MeOH (5000 ml) overnight and successively extracted with MeOH at 40 °C. After filtration, the remaining plant material was then extracted with MeOH (2000 ml) at 40 °C for a second time. The combined methanolic extracts were evaporated under reduced pressure to give the crude methanolic extract (*P. samia*: 90 g, yield 18%; *P. monocephala*: 50 g, yield 10%; *P. carica*: 70 g, yield 14%). Each resultant extract was then dissolved in H_2O (200 ml) and the water soluble portion was partitioned between hexane (4 x 200 ml), $CHCl_3$ (4 x 200 ml) and *n*-BuOH (4 x 200 ml) to obtain the *n*-BuOH extract (*P. samia*: 40 g, yield 8%; *P. monocephala*: 26 g, yield 5.2%; *P. carica*: 22 g, yield 4.4%). The *n*-BuOH extracts of the title plants were chosen for further phytochemical studies as given below:

P. samia: An aliquot of the *n*-BuOH extract (10 g) was fractionated by polyamide CC employing H_2O (200 ml) and MeOH-H_2O mixtures (25-100%, 200 ml each) to yield eight main fractions (Frs. A-H). Fr. D (324 mg) was already a pure compound (**4**, 324 mg). Fr. B (1.49 g) was applied to a silica gel column with $CHCl_3$-MeOH-H_2O mixtures (98:2:0→80:20:2) to obtain 10 fractions (Frs. B_1-B_{10}). Fr. B_7 (150 mg) was then subjected to MPLC (Lichroprep RP-18). Elution with H_2O-MeOH mixtures (0-40%) afforded compound **1** (4 mg). Fr. E was rechromatographed over a silica gel column; elution with $CHCl_3$-MeOH-H_2O mixtures (90:10:0→80:20:2) yielded compounds **2** (5.4 mg) and **3** (5.7 mg). In Fr. E compound **7** was also detected by TLC comparison with an authentic sample, but not isolated.

P. monocephala: The *n*-BuOH extract (26 g) was subjected to polyamide CC and eluted with H_2O

(200 ml) and MeOH-H_2O mixtures (25-100%, 200 ml each) to obtain seven main fractions (Frs. A-G). Fr. A (2.5 g) was subjected to silica gel CC using $CHCl_3$-MeOH-H_2O mixtures (85:15:1→80:20:2) and 12 fractions were collected (Frs. A_1-A_{12}). Fr. A_7 (130 mg) was fractionated on a silica gel column eluting with $CHCl_3$-MeOH-H_2O mixtures (90:10:1→85:15:1) to yield a fraction containing mainly compound **6** (Fr. A_{7b}, 70 mg), which was rechromatographed over Sephadex LH-20 with $CHCl_3$-MeOH mixture (1:1) to give Fr. A_{7b1} (14 mg). Fr. A_{7b1} was finally purified by vacuum-liquid chromatography (VLC) using MeOH-H_2O mixtures (30-50% MeOH) to give compound **6** (3.6 mg). Fr. A_{10} (185 mg) was applied to silica gel CC and elution with $CHCl_3$-MeOH-H_2O mixture (90:10:1) yielded compound **5** (15 mg). Fr. B (5.3 g) was fractionated by MPLC eluting with MeOH-H_2O mixtures (10-100% MeOH) and 10 fractions were collected (Frs. B_1-B_{10}). Fr. B_{10} was then subjected to silica gel CC; elution with $CHCl_3$-MeOH-H_2O mixtures (90:10:1→70:30:3) afforded compounds **7** (35 mg), **9** (48 mg) and **10** (6.3 mg). Fr C (1.2 g) was subjected to MPLC (Lichroprep RP-18) with MeOH-H_2O mixtures (10-100% MeOH) to give 10 fractions (Frs. C_1-C_{10}). Fractionation of Fr. C_3 (432 mg) by MPLC using MeOH-H_2O mixtures (10-35% MeOH) yielded compound **8** (250 mg).

P. carica: A sample of 15 g of the *n*-BuOH extract was fractionated by polyamide CC with H_2O (200 ml) and MeOH-H_2O mixtures (25-100%, 200 ml each) to yield eight main fractions (Frs. A-H). Fr. B (1 g) was subjected to a silica gel column and eluted with a $CHCl_3$-MeOH mixture (90:10) to give Frs. B_1 and B_2. Fr. B_1 was then applied to MPLC. Elution with MeOH-H_2O mixtures (10-20% MeOH) afforded a mixture of compounds **11** and **12** that could not be separated by any chromatographic technique. Fr. B_2 was rechromatographed by MPLC eluting with MeOH-H_2O mixtures (5-40% MeOH) to give compound **13** (5 mg). Fr. C (1.5 g) was applied to a silica gel column. Elution with $CHCl_3$-MeOH-H_2O mixtures (90:10:1→80:20:2) yielded compound **7** (42 mg). Compound **8** was also detected in the same fraction by direct comparison with an authentic sample in TLC.

Shanzhiside methylester (1): UV, IR, ^{1}H (300.13 MHz, CD_3OD), and ^{13}C (75.5 MHz, CD_3OD) NMR data were identical to those reported in the literature[13].

Martynoside (2): UV, IR, ^{1}H NMR (300.13 MHz, CD_3OD) (Table 1), and ^{13}C NMR (75.5 MHz, CD_3OD) (Table 1) data were identical to those reported in the literature[14−16].

4″-*O*-acetylmartynoside (3): UV, IR, ^{1}H NMR (300.13 MHz, CD_3OD) (Table 1), and ^{13}C NMR (75.5 MHz, CD_3OD) (Table 1) data were identical to those reported in the literature[16,17]. FABMS m/z 717 $[M+Na]^+$.

Samioside (4): UV, IR, ^{1}H NMR (300.13 MHz, CD_3OD) (Table 2), and ^{13}C NMR (75.5 MHz, CD_3OD) (Table 2) data were identical to those reported in the literature[18]. FABMS m/z 779 $[M+Na]^+$.

Lamiide (5): UV, IR, ^{1}H (300.13 MHz, CD_3OD), and ^{13}C (75.5 MHz, CD_3OD) NMR data were identical to those reported in the literature[4,5,11].

Ipolamiide (6): UV, IR, ^{1}H (300.13 MHz, CD_3OD), and ^{13}C (75.5 MHz, CD_3OD) NMR data were identical to those reported in the literature[2,8].

Verbascoside (7): UV, IR, ^{1}H (300.13 MHz, CD_3OD), and ^{13}C (75.5 MHz, CD_3OD) NMR data were identical to those reported in the literature[5].

Forsythoside B (8): UV, IR, ^{1}H (300.13 MHz, CD_3OD), and^{13}C (75.5 MHz, CD_3OD) NMR data were identical to those reported in the literature[5].

Alyssonoside (9): UV, IR, ^{1}H (300.13 MHz, CD_3OD), and^{13}C (75.5 MHz, CD_3OD) NMR data

Table 1. ^{13}C (CD_3OD, 75.5 MHz) and ^{1}H (CD_3OD, 300.13 MHz) NMR data of martynoside (**2**) and 4″-*O*-acetylmartynoside (**3**).

C/H atom	**2**			**3**		
	Mult.	δ_C (ppm)	δ_H (ppm) J (Hz)	Mult.	δ_C (ppm)	δ_H (ppm) J (Hz)
Aglycone						
1	C	132.9		C	132.9	
2	CH	112.8	6.74 d (2.1)	CH	112.8	6.74 d (2.0)
3	C	147.9		C	147.6	
4	C	147.6		C	147.4	
5	CH	117.1	6.82 d (8.2)	CH	117.1	6.81 d (8.1)
6	CH	121.2	6.69 dd (8.2/2.1)	CH	121.2	6.68 dd (8.2/2.1)
α	CH_2	72.4	4.05 m 3.75 m	CH_2	72.1	4.05 m 3.74 m
β	CH_2	36.6	2.83 m	CH_2	36.5	2.83 d (7.3)
OMe	CH_3	56.5	3.82 s	CH_3	56.6	3.82 s
Glucose						
1′	CH	104.2	4.38 d (7.9)	CH	104.2	4.38 d (7.8)
2′	CH	76.2	3.29 dd (7.9/9.5)	CH	75.6	3.48 dd (7.8/9.8)
3′	CH	81.5	3.85 t (9.5)	CH	82.1	3.83 t (9.1)
4′	CH	70.6	4.95 t (9.5)	CH	70.1	4.93 t (9.0)
5′	CH	76.1	3.53[a]	CH	76.0	3.60-3.40[a]
6′	CH_2	62.4	3.66 dd (11.9/6.4)	CH_2	62.4	3.64[a]
			3.52 dd (11.9/2.3)			3.55[a]
Rhamnose						
1″	CH	103.0	5.20 d (1.5)	CH	103.0	5.18 d (1.6)
2″	CH	72.1	3.92 dd (3.2/1.7)	CH	72.1	3.90[a]
3″	CH	72.0	3.63 t (9.9)	CH	72.0	3.65-3.60[a]
4″	CH	73.8	3.29 t (9.5)	CH	75.6	4.83 t (9.5)
5″	CH	70.4	3.55 m	CH	70.5	3.55-3.50[a]
6″	CH_3	18.4	1.10 d (6.2)	CH_3	18.5	1.12 d (6.21)
OAc	-	-	-	C	172.7	2.07 s
	-	-		CH_3	21.1	
Acyl moiety						
1‴	C	127.6		C	127.6	
2‴	CH	111.7	7.20 d (1.8)	CH	111.7	7.20 br.s
3‴	C	149.4		C	149.4	
4‴	C	150.8		C	150.9	
5‴	CH	116.5	6.83 d (8.2)	CH	116.5	6.82 d (8.2)
6‴	CH	124.4	7.09 dd (8.2/1.8)	CH	124.4	7.09 dd (8.2/1.7)
α'	CH	115.1	6.39 d (15.9)	CH	115.1	6.36 d (15.9)
β'	CH	147.9	7.67 d (15.9)	CH	148.0	7.68 d (15.9)
C=O	C	168.3	3.89 s	C	168.3	
OMe	CH_3	56.4		CH_3	56.4	3.89 s

[a] Signal pattern unclear due to overlapping

Table 2. ^{13}C (CD_3OD, 75.5 MHz) and ^{1}H (CD_3OD, 300.13 MHz) NMR data of samioside (**4**).

C/H atom	**4**		
	Mult.	δ_C (ppm)	δ_H (ppm) J (Hz)
Aglycone			
1	C	131.4	
2	CH	116.6	6.69 d (2.0)
3	C	146.0	
4	C	142.0	
5	CH	117.1	6.68 d (8.1)
6	CH	121.2	6.56 dd (8.1/2.0)
α	CH_2	72.3	4.05 m 3.70 m
β	CH_2	36.5	2.79 t (7.5)
Glucose			
$1'$	CH	104.1	4.38 d (7.9)
$2'$	CH	76.4	3.41 dd (7.9/9.3)
$3'$	CH	80.5	3.83 t (9.1)
$4'$	CH	70.4	4.93 t (9.5)
$5'$	CH	75.9	3.55[(a)]
$6'$	CH_2	62.3	3.65[(a)] 3.55[(a)]
Rhamnose			
$1''$	CH	102.1	5.28 d (1.5)
$2''$	CH	72.4	3.90-3.85[(a)]
$3''$	CH	72.3	3.67 dd (9.5/3.3)
$4''$	CH	80.0	3.41 t (9.3)
$5''$	CH	68.8	3.55 m
$6''$	CH_3	18.7	1.12 d (6.2)
Apiose			
$1'''$	CH	111.4	5.22 d (2.7)
$2'''$	CH	78.5	3.65[(a)]
$3'''$	C	79.9	3.65[(a)]
$4'''$	CH_2	74.8	3.39 d (11.6)
$5'''$	CH_2	65.7	3.27 d (11.6)
Acyl moiety			
$1''''$	C	127.6	
$2''''$	CH	115.2	7.08 d (2.0)
$3''''$	C	146.9	
$4''''$	C	149.4	
$5''''$	CH	116.3	6.81 d (8.2)
$6''''$	CH	123.4	6.98 dd (8.2/2.0)
α'	CH	114.6	6.26 d (15.9)
β'	CH	148.0	7.59 d (15.9)
C=O	C	168.2	

[(a)]Signal pattern unclear due to overlapping

were identical to those reported in the literature[5].

Syringaresinol-4′-*O*-β-D-glucopyranoside (10): UV, IR, ^{1}H (300.13 MHz, CD_3OD), and ^{13}C (75.5 MHz, CD_3OD) NMR data were identical to those reported in the literature[19].

Syringin (11): UV, IR, and ^{1}H NMR (300.13 MHz, CD_3OD) data were identical to those reported in the literature[20,21].

Dihydrosyringin (12): UV, IR, and ^{1}H NMR (300.13 MHz, CD_3OD) data were identical to those reported in the literature[22,23].

Coniferin (13): UV, IR, and ^{1}H NMR (300.13 MHz, CD_3OD) data were identical to those reported in the literature[20,21].

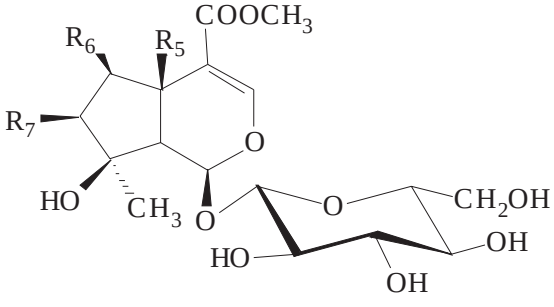
Free radical scavenging activity

Methanolic solutions (0.1%) of the *n*-BuOH extracts of each plant and the isolates were chromatographed on a silica gel TLC plate using $CHCl_3$-MeOH-H_2O mixtures (80:20:2 and 61:32:7). After drying, plates were sprayed with a 0.2% DPPH (Fluka) solution in MeOH. Extracts and compounds showing a yellow-on-purple spot were regarded as antioxidants[24].

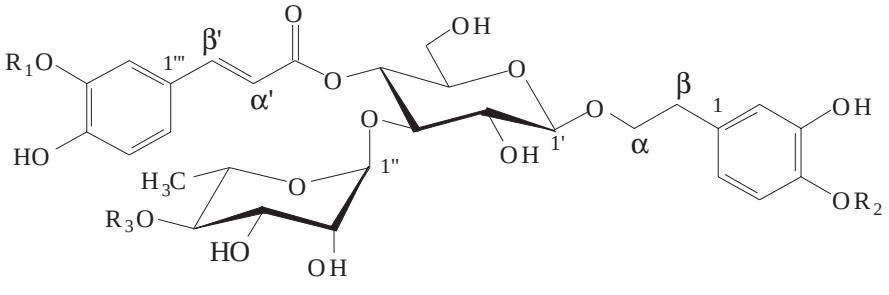
Results and Discussion

The *n*-BuOH extracts, prepared from the aerial parts of *P. samia*, *P. monocephala* and *P. carica,* were fractionated by a combination of open column chromatography (polyamide and silica gel), MPLC, and VLC to obtain the iridoid (**1**, **5** and **6)** and phenylpropanoid glycosides (**2-4**, **7-13**) (Figures 1 and 2). Compounds **1**, **2**, and **5-13** were identified by comparing their physical and spectroscopic data with those reported in the literature and by direct comparison with authentic samples on TLC as shanzhiside methylester (**1**)[13], martynoside (**2**)[14−16], lamiide (**5**)[4,5,11], ipolamiide (**6**)[2,8], verbascoside (= acteoside) (**7**)[5], forsythoside B (**8**)[5], alyssonoside (**9**)[5], syringaresinol-4′-*O*-β-D-glucopyranoside (**10**)[19], syringin (**11**)[20,21], dihydrosyringin (**12**)[22,23], and coniferin (**13**)[20,21]. The structures of **3** and **4** were identified based on the following evidence.

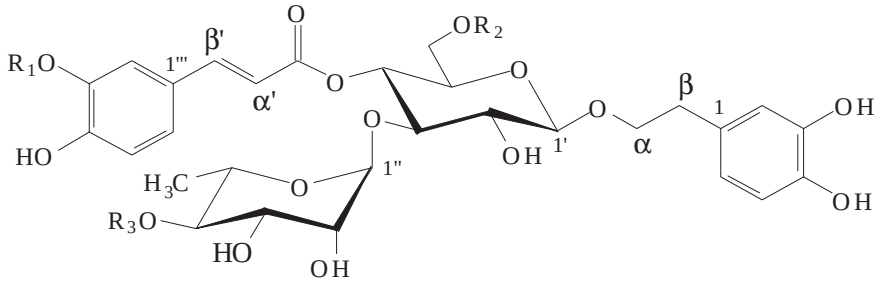
Compound **3** was isolated as an amorphous powder. The positive ion FABMS showed a molecular ion peak at m/z 717 $[M+Na]^+$, consistent with the molecular formula $C_{33}H_{42}O_{16}$. The UV spectrum indicated its polyphenolic nature and IR bands for hydroxyl groups (3390 cm^{-1}), an α,β-unsaturated ester ($\upsilon_{C=O}$ 1698, $\upsilon_{C=C}$ 1635 cm^{-1}), and aromatic rings (1610, 1515 cm^{-1}) were observed. The ^{1}H NMR spectrum of **3** (Table 1) exhibited the presence of six aromatic protons due to two ABX spin systems belonging to one ferulic acid moiety and the aglycone part. Two olefinic protons (d each, H-α' and H-β') forming an AB spin system with J_{AB} = 15.9 Hz indicated a *trans* geometry of the ferulic acid unit. Additionally, a benzylic methylene signal (δ_H 2.83, 2H, d, J = 7.3 Hz) and two non-equivalent proton signals (δ_H 4.05, 1H, m and 3.74 1H, m) were observed. The signals attributed to the aglycone part were suggestive of the presence of a 3-hydroxy-4-methoxyphenylethanol moiety. Two anomeric proton resonances that appeared at δ_H 4.38 (d, J = 7.8 Hz) and 5.18 (d, J = 1.6 Hz), indicating the dissaccharidic structure, were assigned to a β-glucose and an α-rhamnose, respectively. Its diglycosidic nature was also confirmed by the ^{13}C NMR spectrum (Table 1), in which two anomeric carbon resonances at δ_C 104.2 (β-glucose) and 103.0 (α-rhamnose) were observed. The assignments of all proton resonances were aided by a DQF-COSY experiment. The ^{1}H NMR spectrum suggested that the feruloyl moiety occupied the 4′-*O*-position of the glucose unit due to the downfield shift of the H-4′ signal (δ_H 4.93) of glucose. Likewise, the downfield shifted C-3′ resonance (δ_C



	R5	R6	R7
1	H	OH	H
5	OH	H	OH
6	OH	H	H



	R1	R2	R3
2	CH_3	CH_3	H
3	CH_3	CH_3	Ac
7	H	H	H



	R1	R2	R3
4	H	H	apiose
8	H	apiose	H
9	CH_3	apiose	H

Figure 1. Iridoid and phenylethanoid glycosides isolated from *P. samia*, *P. monocephala* and *P. carica.*

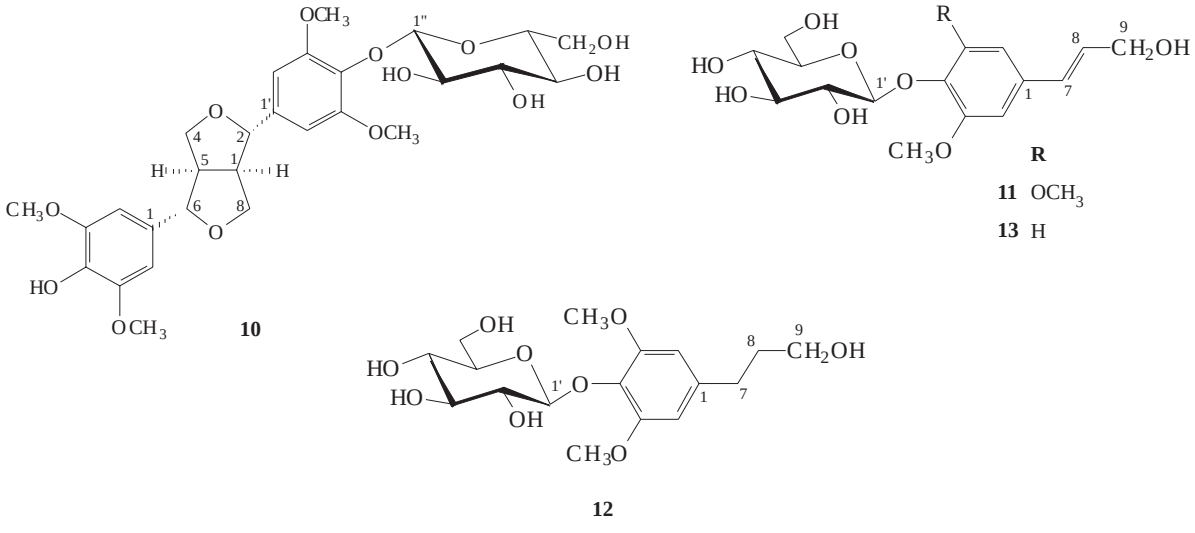


Figure 2. Lignan and phenylpropanoid monomeric glucosides isolated from *P. monocephala* and *P. carica.*

82.1) of glucose clearly indicated that the rhamnose unit should be attached to the C-3′ position of glucose. ^{1}H and ^{13}C NMR spectroscopic data of compound **3** revealed a close structural similarity to martynoside (**2**)[14−16] (Table 1), except for the presence of the signals attributed to an acetyl group (δ_H 2.07; δ_C 172.7 and 21.1). The chemical shift value of H-4″ (δ_H 4.83) proton resonance of rhamnose suggested that the site of the attachment of the acetyl group was the C-4″ carbon atom of the rhamnose unit. Moreover, a 1.8 ppm downfield shift of the C-4″ (δ_C 75.6) carbon resonance in comparison to that of martynoside (**2**) confirmed the above suggestion. Based on the above mentioned spectroscopic data, the structure of compound **3** was established to be 4″-*O*-acetylmartynoside[16,17].

Compound **4** was obtained as an amorphous yellowish powder. The positive ion FABMS showed a molecular ion peak at m/z 779 $[M+Na]^+$. The molecular formula of **4** was determined by FABMS, ^{13}C NMR, and DEPT (Table 2) data to be $C_{34}H_{44}O_{19}$. In the ^{13}C NMR and DEPT spectra of compound **4**, 34 carbon resonances (1 methyl, 5 methylene, 20 methine and 8 quaternary carbon atom signals) were observed. The ^{1}H NMR spectrum (Table 2) exhibited characteristic signals arising from (*E*)-caffeic acid and 3,4-dihydroxyphenethyl alcohol moiety together with the signals for two *trans*-olefinic protons (AB system, $J_{AB} = 15.9$ Hz), a benzylic methylene proton (δ_H 2.79, 2H, t, $J = 7.5$ Hz) and two non-equivalent protons (δ_H 4.05, 1H, m and 3.70, 1H, m). Additionally, three anomeric proton resonances were observed at δ_H 4.38 (d, J = 7.9 Hz), 5.28 (d, $J = 1.5$ Hz) and 5.22 (d, $J = 2.7$ Hz), indicating a trisaccharidic structure. The anomeric proton signals were consistent with the β configuration of a glucose, α configuration of a rhamnose and β configuration of an apiose. The ^{13}C NMR data of compound **4** confirmed the triglycosidic nature exhibiting three anomeric carbon resonances at δ_C 104.1 (β-glucose), 102.1 (α-rhamnose) and 111.4 (β-apiose). All proton and carbon resonances were assigned by DQF-COSY, ^{1}H-^{13}C HSQC and HMBC experiments. The caffeoyl group was supposed to be positioned at the C-4′ of the glucose unit on the basis of the significant deshielding of the H-4′ signal of glucose (δ_H 4.93) and the HMBC cross-peak observed between H-4′ and the carbonyl carbon (δ_C 168.2). A prominent HMBC correlation from the anomeric proton of glucose (δ_H 4.38) to the C-α atom of the 3,4-dihydroxyphenethyl moiety (δ_C 72.3) revealed that the glucose moiety was

attached at the C-α position. On the other hand, the downfield shifted H-3′ signal (δ_H 3.83) of glucose indicated that a glycosidation took place at the C-3′ carbon atom. A heteronuclear long-range correlation observed between the H-1″ (δ_H 5.28) of rhamnose and C-3′ (δ_C 80.5) of glucose showed that the rhamnose unit was attached to the C-3′ carbon atom of glucose. On the other hand, the upfield shift of the C-6′ (δ_C 62.3) resonance of glucose revealed the presence of a free OH group in this position. Furthermore, the deshielded carbon resonance of the C-4″ (δ_C 80.0) of the rhamnose unit was suggestive of glycosidation at this position. The HMBC coupling between the H-1‴ (δ_H 5.22) of apiose and C-4″ of rhamnose showed that the site of the glycosidation of apiose was the C-4″ position of rhamnose. This proposal was also confirmed by the nOe correlation observed between the H-1‴ of apiose and H-4″ of rhamnose. Consequently, the structure of compound **4** was determined to be 1-*O*-3,4-(dihydoxyphenyl)-ethyl-β-D-apiofuranosyl-(1→4)-α-L-rhamnopyranosyl-(1→3)-4-*O*-caffeoyl-β-D-glucopyranoside, which was identical to those of samioside[18].

Conclusion

As part of the ongoing screening project for the genus *Phlomis* in Turkey, we investigated the iridoid and phenylpropanoid constituents of three *Phlomis* taxa, *P. samia*, *P. monocephala,* and *P. carica*. Iridoid glucosides, shanzhiside methylester (**1**) isolated from *P. samia* as well as lamiide (**5**) and ipolamiide (**6**) isolated from *P. monocephala,* were previously reported from several Turkish *Phlomis* species[2,4,5,8,11]. However, in this study, surprisingly, no iridoid glucoside could be detected in *P. carica*. Therefore, *P. carica* is being reported as the first member of the genus that does not contain any iridoid glucoside.

Among the phenylethanoid glycosides isolated from the title plants, verbascoside (= acteoside) (**7**) is the common glycoside characterized in all three specimens. Together with verbascoside (= acteoside) (**7**) the phenylethanoid glycosides, martynoside (**2**) (from *P. samia*), forsythoside B (**8**) (detected also in *P. carica* by TLC), and alyssonoside (**9**), as well as the lignan glucoside syringaresinol-4′-*O*-β-D-glucopyranoside (**10**) (from *P. monocephala*) were previously identified in some Turkish *Phlomis* species[5,14]. Of the three plants studied, *P. carica* showed the lowest phenylethanoid glycoside content; however, this plant yielded three phenylpropanoid monomeric glucosides: syringin (**11**), dihydrosyringin (**12**) and coniferin (**13**). Although syringin (**11**) and dihydrosyringin (**12**) could be isolated by a mixture, a brief ^{1}H NMR study revealed the structure elucidation. Syringin (**11**) was previously isolated from *P. chimerae*[25], but this is the first case of the characterization of dihydrosyringin (**12**) and coniferin (**13**) in the genus *Phlomis*.

Recently, Kyriakopoulou et al.[18] have reported the isolation and structure elucidation of two phenylethanoid glycosides, samioside (**4**) and verbascoside (**7**), together with three flavonoids from *P. samia* collected in Greece. However, in this study we also characterized an iridoid glucoside, shanzhiside methylester (**1**), and two additional phenylethanoid glycosides, martynoside (**2**) and 4″-*O*-acetylmartynoside (**3**), from *P. samia* of Turkish origin. Comparing the results of these two reports, it can be demonstrated that the chemical composition of *P. samia* collected from the two different floras are slightly different, which may be of chemotaxonomical significance in future. Additionally, samioside (**4**) is reported for the second time in nature and for the first time in a Turkish *Phlomis* species. Likewise, 4″-*O*-acetylmartynoside (**3**), which was previously reported from *Buddleja davidii* (Buddlijaceae)[17] and *Aegiphila obducta* (Verbenaceae)[16], is reported for the first time in a member of the genus *Phlomis*.

n-BuOH extracts of all investigated plants as well as the isolated phenylethanoid glycosides (**2**-**4** and **7**-

9) demonstrated a significant scavenging activity toward 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical[26,27], while the phenylpropanoid monomeric glucosides (**10-13**) possesed a weak activity. Iridoid glucosides (**1**, **5**, **6**) showed no antioxidant activity, as expected.

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