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Chemical Constituents of *Galium tortumense*

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From the aerial parts of *Galium tortumense* Ehrend & Schönb.-Tem., 8 iridoid glycosides, a flavonol glycoside, a oleanane-type triterpene acid, an ursan-type triterpene acid and a sterol were isolated. The structures of the compounds were elucidated by high field 1D and 2D NMR and EIMS spectroscopies.

Key Words: *Galium tortumense*, Rubiaceae, iridoid glycosides, triterpenoids, flavonol glycoside, steroid.

Introduction

The medicinal plant genus *Galium* L. (Rubiaceae) is represented in Turkey by 101 species in 10 sections[1]. *Galium tortumense* is an endemic species. *Galium* species are traditionally used to coagulate milk because of an enzyme in their chemical composition. For this reason, this plant is known as "yoğurt herb"[2]. *G. aparine*, *G. cruciata* and *G. verum* are used as diuretics, choleretics, against diarrhea and in the treatment of some stomach complaints, gout and epilepsy in folk medicine[3,4]. Iridoids[5−19], anthraquinones[20−26], triterpenic saponins[11,12], napthalene derivatives[27], flavonoids[18], lignan bis-glucosides[28] and alkaloids[29] have been reported from *Galium* species. In the present study, we report the isolation and structure elucidation of 8 iridoid glycosides, scandoside methyl ester (1), daphylloside (2), geniposide (3), geniposidic acid (4), loganin (5), 7-ketologanin (6), loganic acid (7) and deacetyl-asperulosidic acid (8); a flavonol glycoside, rutin (9); a oleanane-type triterpene acid, oleanolic acid (10); an ursan-type triterpene acid, ursolic acid (11); and a sterol, β-sitosterol, (12) from the aerial parts of *Galium tortumense*.

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Experimental

General Experimental Procedures: The UV (MeOH) spectra were recorded on a Thermospectronic HeλIOS β spectrophotometer. ^{1}H- and ^{13}C-NMR spectra were recorded on a Varian Mercury plus 400 MHz for proton and 100 MHz for carbon using TMS as internal standard. The solvents were $CDCl_3$, and CD_3OD. EIMS were performed on a Finnigan MAT 95 spectrometer. Silica gel 60 (0.063-0.200 mm, Merck) and Sephadex LH-20 (Fluka) were used for open column chromatographic separations. Lichroprep RP-18 (25-40 μm, Merck) reversed phase material was used for vacuum liquid chromatography (VLC). TLC was carried out on pre-coated Kieselgel 60 F_{254} aluminum sheets (Merck), and compounds were detected under UV (254 nm) fluorescence and spraying with 1% vanillin-H_2SO_4 reagent, followed by heating at 105 °C for 1-2 min.

Plant Material: *Galium tortumense* (Rubiaceae) was collected from Erzurum, near Tortum Lake, (1100 m), in July 2002. A voucher specimen has been deposited in the Herbarium of the Biology Department, Atatürk University, Erzurum, Turkey (ATA 9765).

Extraction and Prepurification: Air-dried and powdered aerial parts of the plant (460 g) were extracted 3 times with MeOH at 40 °C (3 × 2 L). After evaporation of the combined extracts in vacuo, 91 g of MeOH extract was obtained. The crude extract was dissolved in water and partitioned in $CHCl_3$. The $CHCl_3$ layer was evaporated to dryness (17 g). Water extract was lyophilized (56 g).

Isolation of the Compounds: An aliquot of the water extract (20 g) was fractioned over a silica gel column with $CHCl_3$-MeOH-H_2O mixtures (80:20:2→ 61:32:7) to afford 4 main fractions (A-D). Fr. A was subjected to VLC using reversed–phase material, and MeOH-H_2O mixtures (0% -100%) as solvent to give Fr. A_1 and Fr. A_2. Silica gel chromatography of Fr. A_1 eluting with $CHCl_3$-MeOH-H_2O mixtures (61:32:7) gave compound **1** (28 mg). Fr. A_2 was purified by preparative TLC using $CHCl_3$-MeOH-H_2O (61:32:7) mixtures to give compounds **3** (21 mg), **5** (20 mg) and **6** (28 mg). Fr. B was subjected to VLC on reversed-phase material, using MeOH-H_2O mixtures (0% -100%) to give compounds **2** (11 mg) and **9** (45 mg). Fr. C was subjected to VLC using reversed-phase material, and MeOH-H_2O mixtures (0% -100%) as solvent to give Fr. C_1, Fr. C_2 and Fr. C_3. Silica gel chromatography of Fr. C_1 eluting with $CHCl_3$-MeOH-H_2O mixtures (61:32:7) gave compound **8** (31.7 mg). Fr. C_2 was purified by preparative TLC using $CHCl_3$-MeOH-H_2O (61:32:7) mixtures to give compound **4** (20 mg). Fr. C_3 was subjected to a silica gel column using $CHCl_3$-MeOH-H_2O mixtures (61:32:7) to yield compound **7** (10 mg). The chloroform extract (20 g) was fractioned over a silica gel column with n-hexane: EtOAc mixtures (95:5, 90:10, ..., 0:100) to afford Fr. 1 (20-21) and Fr. 2 (25-26). Silica gel chromatography of Fr. 1 eluting with n-hexane:EtOAc mixtures (70:30→60:40) gave compound **12** (15 mg). Silica gel chromatography of Fr. 2 eluting with n-hexane:EtOAc mixtures (60:40) gave a mixture **10** and **11** (20 mg).

Results

Scandoside methyl ester (1): UV (MeOH) λ_{max}238 nm; EIMS m/z 404 $[M]^+$ (calc. for $C_{17}H_{24}O_{11}$). ^{1}H NMR (CD_3OD, 400 MHz): δ 5.19 (1H, *d*, J = 6.3 Hz, H-1), 7.50 (1H, *d*, J = 1.1 Hz, H-3), 2.96 (1H, *ddd*, J = 7.4/4.7/1.1Hz, H-5), 4.54 (1H, d*t*, J = 4.7/1.9 Hz, H-6), 5.80 (1H, *t*, J = 1.9 Hz, H-7), 3.03 (1H, *bt*, J = 6.9 Hz, H-9), 4.20 (1H, *brd*, J = 15.6 Hz, H_a-10), 4.35 (1H, *brd*, J = 15.2 Hz, H_b-10), 3.75 (3H, *s*, COOMe),

4.67 (1H, *d*, J = 7.8 Hz, H-1′), 3.20-3.40 (4H, *m*, H-2′, H-3′, H-4′, H-5′), 3.64 (1H, *dd*, J = 12.0/5.8 Hz, H_a-6′), 3.83 (1H, *dd*, J = 12.0/2.0 Hz, H_b-6′); ^{13}C NMR (CD_3OD, 100 MHz): Table.

Daphylloside (2): UV (MeOH) λ_{max}235.8 nm; EIMS m/z 446 $[M]^+$ (calc. for $C_{19}H_{26}O_{12}$). ^{1}H NMR (CD_3OD, 400 MHz): δ 5.06 (1H, *d*, J = 8.4 Hz, H-1), 7.65 (1H, *d*, J = 1.8 Hz, H-3), 3.03 (1H, *td*, J = 6.6/1.8 Hz, H-5), 4.80 (1H, *m*, H-6), 6.02 (1H, *d*, J = 1.8 Hz, H-7), 2.64 (1H, *brt*, J = 8.2 Hz, H-9), 4.80 (1H, *m*, H_a-10), 4.93 (1H, *brd*, J = 15.0 Hz, H_b-10), 3.74 (3H, *s*, COOMe), 2.08 (3H, *s*, COMe), 4.72 (1H, *d*, J = 7.7 Hz, H-1′), 3.21-3.39 (4H, *m*, H-2′, H-3′, H-4′, H-5′), 3.61 (1H, *dd*, J = 12.0/6.2 Hz, H_a-6′), 3.85 (1H, *dd*, J = 11.9/1.4 Hz, H_b-6′); ^{13}C NMR (CD_3OD, 100 MHz): Table.

Geniposide (3): UV (MeOH) λ_{max}235 nm; EIMS m/z 226 $[M\text{-}162]^+$ (calc. for $C_{17}H_{24}O_{10}$). ^{1}H NMR (CD_3OD, 400 MHz): δ 5.16 (1H, *d*, J = 7.6 Hz, H-1), 7.50 (1H, *d*, J = 1.4 Hz, H-3), 3.16 (1H, *m*, H-5), 2.08 (1H, *dd*, J = 16.4/8.0 Hz, H_a-6), 2.81 (1H, *dd*, J = 16.3/8.0 Hz, H_b-6), 5.79 (1H, *brs*, H-7), 2.71 (1H, *t*, J = 7.6 Hz, H-9), 4.19 (1H, *brd*, J = 14.3 Hz, H_a-10), 4.30 (1H, *brd*, J = 14.3 Hz, H_b-10), 3.70 (3H, *s*, COOMe), 4.70 (1H, *d*, J = 7.7 Hz, H-1′), 3.19-3.38 (4H, *m*, H-2′, H-3′, H-4′, H-5′), 3.63 (1H, *dd*, J = 12.8/5.1 Hz, H_a-6′), 3.83 (1H, *brd*, J = 12.8 Hz, H_b-6′); ^{13}C NMR (CD_3OD, 100 MHz): Table.

Geniposidic acid (4): UV (MeOH) λ_{max}232 nm; EIMS m/z 212 $[M\text{-}162]^+$, (calc. for $C_{16}H_{22}O_{10}$).^{1}H NMR (CD_3OD, 400 MHz): δ 5.09 (1H, *d*, J = 7.6 Hz, H-1), 7.35 (1H, *d*, J = 1.1 Hz, H-3), 3.21 (1H, *m*, H-5), 2.08 (1H, *dd*, J = 16.1/7.8 Hz, H_a-6), 2.84 (1H, *dd*, J = 16.1/7.8 Hz, H_b-6), 5.77 (1H, *brs*, H-7), 2.68 (1H, *t*, J = 7.6 Hz, H-9), 4.18 (1H, *d*, J = 14.4 Hz, H_a-10), 4.30 (1H, *d*, J = 14.4 Hz, H_b-10), 4.71 (1H, *d*, J = 7.8 Hz, H-1′), 3.22-3.41 (4H, *m*, H-2′, H-3′, H-4′, H-5′), 3.64 (1H, *dd*, J = 11.8/5.4 Hz, H_a-6′), 3.84 (1H, *dd*, J = 11.5/1.9 Hz, H_b-6′); ^{13}C NMR (CD_3OD, 100 MHz): Table.

Loganin (5): UV (MeOH) λ_{max}237 nm; EIMS m/z 228 $[M\text{-}162]^+$, (calc. for $C_{17}H_{26}O_{10}$). ^{1}H NMR (CD_3OD, 400 MHz): δ 5.27 (1H, *d*, J = 4.7 Hz, H-1), 7.38 (1H, *d*, J = 1. 1Hz, H-3), 3.10 (1H, *m*, H-5), 1.62 (1H, *m*, H_a-6), 2.02 (1H, *m*, H_b-6), 4.03 (1H, *t*, J = 4.7 Hz, H-7), 1.87 (1H, *m*, H-8), 2.22 (1H, *m*, H-9), 1.09 (3H, *d*, J = 6.9 Hz, H-10), 3.68 (3H, *s*, COOMe), 4.64 (1H, *d*, J = 8.0 Hz, H-1′), 3.16-3.38 (4H, *m*, H-2′, H-3′, H-4′, H-5′), 3.65 (1H, *dd*, J = 12.0/5.9 Hz, H_a-6′), 3.89 (1H, *dd*, J = 2.0/1.8 Hz, H_b-6′); ^{13}C NMR (CD_3OD, 100 MHz): Table.

7-Ketologanin (6): UV (MeOH) λ_{max}234 nm; EIMS m/z 226 $[M\text{-}162]^+$, (calc. for $C_{17}H_{24}O_{10}$). ^{1}H NMR (CD_3OD, 400 MHz): δ 5.63 (1H, *d*, J = 3.3 Hz, H-1), 7.48 (1H, *d*, J = 1.4 Hz, H-3), 3.19-3.31 (1H, m, H-5), 2.51 (1H, *bddd*, J = 19.0/3.2/1.4 Hz, H_a-6), 2.62 (1H, *bdd*, J = 19.4/8.0 Hz, H_b-6), 2.11 (1H, *m*, H-8), 2.34 (1H, *ddd*, J = 10.4/7.3/3.2 Hz, H-9), 1.14 (3H, *d*, J = 7.3 Hz, H-10), 3.69 (3H, *s*, COOMe), 4.66 (1H, *d*, J = 8.0 Hz, H-1′), 3.19-3.31 (4H, *m*, H-2′, H-3′, H-4′ H-5′), 3.64 (1H, *dd*, J = 11.9/6.0 Hz, H_a-6′), 3.90 (1H, *dd*, J = 12.0/2.1 Hz, H_b-6′); ^{13}C NMR (CD_3OD, 100 MHz): Table.

Loganic acid (7): UV (MeOH) λ_{max}233 nm; EIMS m/z 214 $[M\text{-}162]^+$ (calc. for $C_{16}H_{24}O_{10}$). ^{1}H NMR (CD_3OD, 400 MHz): δ 5.23 (1H, *d*, J = 3.5 Hz, H-1), 7.03 (1H, *s*, H-3), 3.11 (1H, *m*, H-5), 1.73 (1H, *ddd, J*= 14.0/5.5 Hz, H_a-6), 2.17 (1H, *ddd*, J = 14.0/8.1/1.9 H_b-6), 4.03 (1H, *td*, J = 3.5/5.0 Hz, H-7), 1.85 (1H, *m*, H-8), 2.00 (1H, *td*, J = 9.5/3.5 Hz, H-9), 1.06 (3H, *d*, J = 7.0 Hz, H-10), 4.63 (1H, *d*, J = 8.1 Hz, H-1′), 3.15-3.40 (4H, *m*, H-2′, H-3′, H-4′, H-5′), 3.66 (1H, *dd*, J = 11.5/5.4 Hz, H_a-6′), 3.87 (1H, *dd*, J = 11.5/1.5 Hz, H_b-6′); ^{13}C NMR (CD_3OD, 100 MHz): Table.

Deacetyl-asperulosidic acid (8): UV (MeOH) λ_{max}234 nm; EIMS m/z 390 $[M]^+$ (calc. for

$C_{18}H_{22}O_{11}$). ^{1}H NMR (CD_3OD, 400 MHz): δ 5.00 (1H, *d*, J = 9.1 Hz, H-1), 7.51 (1H, *d*, J = 1.4 Hz, H-3), 3.02 (1H, *t*, J = 7.3 Hz, H-5), 4.85 (1H, *dd*, J= 5.1/1.8 Hz, H-6), 5.99 (1H, *d*, J = 1.8 Hz, H-7), 2.53 (1H, *t*,J = 8.4 Hz, H-9), 4.20 (1H, *brd*, J = 15.7 Hz, H_a-10), 4.45 (1H, *brdd*, J = 15.7/1.4 Hz, H_b-10), 4.71 (1H, *d*, J = 8.0 Hz, H-1′), 3.21-3.42 (4H, *m*, H-2′, H-3′, H-4′, H-5′), 3.61 (1H, *dd*, J = 12.0/5.8 Hz, H_a-6′), 3.83 (1H, *dd*, J = 11.8/1.6 Hz, H_b-6′); ^{13}C NMR (CD_3OD, 100 MHz): Table.

Rutin [=quercetin 3-*O*-rutinoside] (9): UV (MeOH) λ_{max}365, 255 nm, EIMS m/z 610 $[M]^+$, 611$[M+H]^+$ (calc. for $C_{27}H_{30}O_{16}$), ^{1}H NMR (CD_3OD, 400 MHz): δ_H 6.20 (1H, *d*, J = 1.8 Hz, H-6), 6.39 (1H, *d*, J = 2.2 Hz, H-8), 7.66 (1H, *d*, J = 1.8 Hz, H-2′), 6.86 (1H, *d*, J = 8.0 Hz, H-5′), 7.60 (1H, *dd*, J = 8.0/1.8 Hz, H-6′), 5.09 (1H, *d*, J = 7.8 Hz, H-1″), 3.25-3.47 (4H, *m*, H-2″, H-3″, H-4″, H-5″), 3.38 (1H, *m*, H_a-6″), 3.80 (1H, *d*, J = 10.5 Hz, H_b-6″), 4.51 (1H, *d*, J = 1.8 Hz, H-1‴), 3.63 (1H, *dd*, J = 3.5/1.5 Hz, H-2‴), 3.53 (1H, *dd*, J = 9.5/3.5 Hz, H-3‴), 3.28 (1H, *m*, H-4‴), 3.44 (1H, *m*, H-5‴), 1.11 (3H, *d*, J = 6.0 Hz, CH_3-6‴); ^{13}C NMR (CD_3OD, 100 MHz): δ_C158.5 (C-2), 135.6 (C-3), 179.4 (C-4), 162.5 (C-5), 99.9 (C-6), 166.0 (C-7), 94.8 (C-8), 159.3 (C-9), 105.6 (C-10), 123.1 (C-1′), 117.6 (C-2′), 145.8 (C-3′), 149.7 (C-4′), 116.1 (C-5′), 123.5 (C-6′), 104.7 (C-1″), 75.7 (C-2″), 77.2 (C-3″), 71.4 (C-4″), 78.1 (C-5″), 68.6 (C-6″), 102.4 (C-1‴), 72.0 (C-2‴), 72.2 (C-3‴), 73.9 (C-4‴), 69.7 (C-5‴), 17.9 (C-6‴).

Oleanolic acid (10): UV (MeOH) λ_{max}215 nm; EIMS m/z 456 $[M]^+$(calc. for $C_{30}H_{48}O_3$). ^{1}H NMR ($CDCI_3$, 400 MHz): δ_H5.24 (1H, *t*, J = 3.6 Hz, H-12), 3.21 (1H, *dd*, J = 10.2/4.4 Hz, H-3), 2.82 (1H, *dd*, J = 12.7/4.3 Hz, H-18), 0.96 (3H, *s*, Me-23), 0.78 (3H, *s*, Me-24), 0.84 (3H, *s*, Me-25), 0.76 (3H, *s*, Me-26), 1.25 (3H, *s*, Me-27), 0.87 (3H, *s*, Me-29), 0.93 (3H, *s*, Me-30). ^{13}C NMR ($CDCI_3$, 100 MHz): δ_C38.6 (C-1), 26.7 (C-2), 78.5 (C-3), 39.2 (C-4), 55.5 (C-5), 18.3 (C-6), 32.6 (C-7), 39.6 (C-8), 48.1 (C-9), 37.0 (C-10), 22.7 (C-11), 122.4 (C-12), 144.1 (C-13), 42.0 (C-14), 27.7 (C-15), 22.8 (C-16), 46.7 (C-17), 41.5 (C-18), 46.1 (C-19), 30.4 (C-20), 33.7 (C-21), 32.3 (C-22), 28.8 (C-23), 14.7 (C-24), 15.1 (C-25), 16.5 (C-26), 25.2 (C-27), 180.4 (C-28), 32.8 (C-29), 23.3 (C-30).

Ursolic acid (11): UV (MeOH) λ_{max}215 nm; EIMS m/z 456 $[M]^+$(calc. for $C_{30}H_{48}O_3$). ^{1}H NMR ($CDCI_3$, 400 MHz): δ_H5.28 (1H, *t*, J = 3.6 Hz, H-12), 3.21 (1H, *dd*, J = 10.2/4.4 Hz, H-3), 2.18 (1H, *d*, J = 11.7 Hz, H-18), 1.19 (1H, *m*, H_a-22), 2.00 (1H, *dd*, J = 13.0/4.0 Hz, H_b-22), 1.25 (3H, *s*, Me-23), 0.98 (3H, *s*, Me-24), 0.77 (3H, *s*, Me-25), 1.08 (3H, *s*, Me-26), 1.14 (3H, *s*, Me-27), 0.93 (3H, *d*, J = 6.5 Hz, Me-29), 0.91 (3H, *d*, J = 5.9 Hz, Me-30). ^{13}C NMR ($CDCI_3$, 100 MHz): δ_C39.2 (C-1), 27.5 (C-2), 78.5 (C-3), 38.7 (C-4), 55.5 (C-5), 18.3 (C-6), 33.1 (C-7), 39.6 (C-8), 47.8 (C-9), 36.9 (C-10), 16.6 (C-11), 125.7 (C-12), 138.4 (C-13), 41.7 (C-14), 29.5 (C-15), 24.1 (C-16), 47.7 (C-17), 53.1 (C-18), 39.2 (C-19), 39.2 (C-20), 30.5 (C-21), 36.9 (C-22), 28.0 (C-23), 15.2 (C-24), 14.8 (C-25), 16.4 (C-26), 23.1 (C-27), 180.4 (C-28), 22.9 (C-29), 22.8 (C-30).

β-sitosterol (12): UV (MeOH) λ_{max}205 nm; EIMS m/z 414 $[M]^+$(calc. for $C_{29}H_{50}O$). ^{1}H NMR ($CDCI_3$, 400 MHz): δ_H3.52 (1H, *m*, H-3), 5.35 (1H, *m*, H-6), 0.68 (3H, *s*, Me-18), 0.98 (3H, *s*, Me-19), 0.91 (3H, *d*, J = 6.4 Hz, Me-21), 0.83 (3H, *d*, J = 6.8 Hz, Me-26), 0.81 (3H, *d*, J = 6.9 Hz, Me-27), 0.85 (3H, *t*, J = 7.8 Hz, Me-29). ^{13}C NMR ($CDCI_3$, 100 MHz): δ_C37.4 (C-1), 31.8 (C-2), 72.0 (C-3), 42.5 (C-4), 140.9 (C-5), 121.9 (C-6), 32.1 (C-7), 29.9 (C-8), 50.3 (C-9), 36.7 (C-10), 21.3 (C-11), 40.0 (C-12), 42.5 (C-13), 56.9 (C-14), 24.5 (C-15), 28.4 (C-16), 56.2 (C-17), 12.0 (C-18), 19.6 (C-19), 36.3 (C-20), 19.0 (C-21), 34.1 (C-22), 26.3 (C-23), 46.0 (C-24), 29.3 (C-25), 20.0 (C-26), 19.2 (C-27), 23.2 (C-28), 12.2 (C-29).

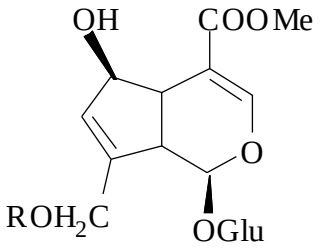
Discussion

In this study, from the aerial parts of *Galium tortumense*, scandoside methyl ester (**1**)[30], daphylloside (**2**)[31], geniposide (**3**)[32], geniposidic acid (**4**)[33], loganin (**5**)[34], 7-ketologanin (**6**)[35], loganic acid (**7**)[36–37], deacetyl-asperulosidic acid (**8**)[7,31], quercetin 3-O- rutinoside (rutin) (**9**)[38], oleanolic acid (**10**)[39–40], ursolic acid (**11**)[40–41] and β-sitosterol (**12**)[42] were obtained.

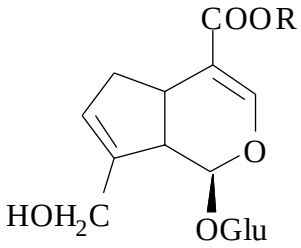
Spectroscopic methods (NMR and MS) were used for the structure determination of these compounds and their spectral data were compared with those given in the literature[30–42]. To our knowledge, scandoside methyl ester, daphylloside, geniposide, geniposidic acid, loganin, loganic acid, deacetyl-asperulosidic acid, quercetin 3-*O*-rutinoside, and oleanolic acid have been reported from different *Galium* species. This study is the first report on the isolation and structure elucidation of 7-ketologanin, ursolic acid and β-sitosterol from *Galium* species.

Table. ^{13}C-NMR (CD_3OD, 100 MHz) data of compounds **1-8**.

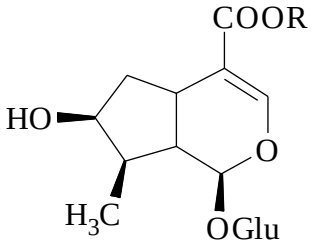
Position	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Aglycone								
1	98.3	99.4	100.9	96.8	100.4	98.0	95.5	99.1
3	153.8	154.2	156.1	149.6	154.8	156.0	145.3	151.9
4	110.8	106.9	115.2	114.8	116.7	113.8	118.7	110.4
5	45.6	41.2	39.3	36.2	34.9	30.9	31.6	42.3
6	82.2	74.2	42.4	38.8	44.9	46.2	41.3	74.6
7	130.1	130.6	131.0	127.3	77.8	220.0	74.1	128.5
8	147.5	144.8	147.5	143.7	45.4	47.3	40.6	150.3
9	47.1	45.0	49.7	46.0	49.2	49.2	45.8	45.0
10	61.1	62.6	64.1	60.3	16.1	16.4	12.1	60.6
11	170.3	168.3	172.2	173.1	172.2	171.6	175.0	172.6
COO<u>Me</u>	52.0	50.6	54.5		54.4	54.5		
<u>C</u>OMe		171.3						
CO<u>Me</u>		19.5						
1′	100.3	100.1	103.0	99.1	102.7	102.9	98.6	99.9
2′	74.8	73.7	77.6	73.7	77.4	77.4	73.6	73.8
3′	78.4	77.4	80.5	76.6	80.7	80.7	76.7	76.6
4′	71.5	70.4	74.2	70.3	74.3	74.3	70.4	70.4
5′	77.9	76.7	81.1	77.1	81.1	81.1	77.0	77.2
6′	62.7	61.8	65.3	61.4	65.4	65.4	61.5	61.7



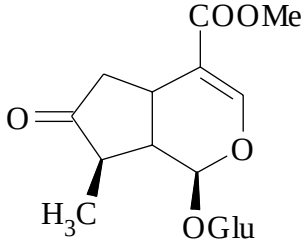
R	Compound
H	Scandoside methyl ester **(1)**
COMe	Daphylloside **(2)**



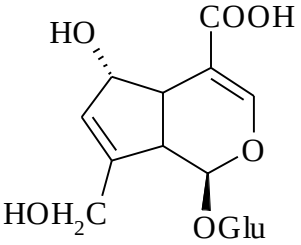
R	Compound
Me	Geniposide **(3)**
H	Geniposidic acid **(4)**



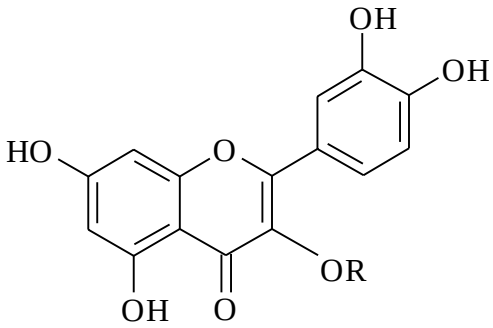
R	Compound
Me	Loganin **(5)**
H	Loganic acid **(7)**



7-Ketologanin **(7)**

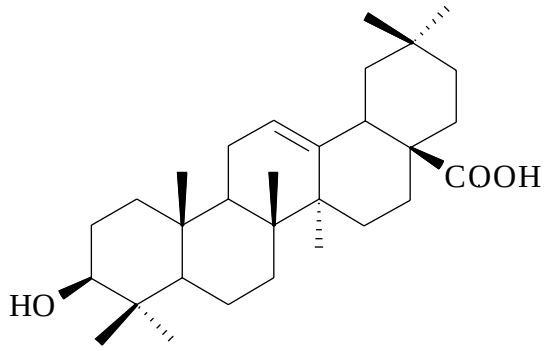


Deacetyl-asperulosidic acid **(8)**

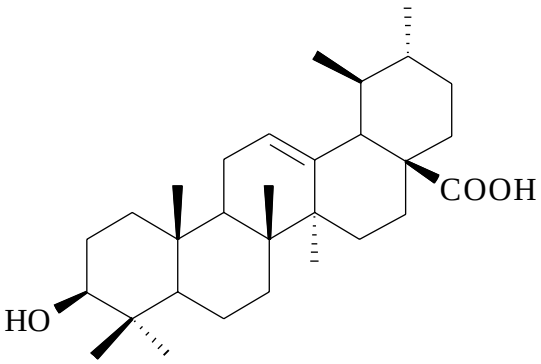


R	Compound
Glu and Rha	Rutin **(9)**

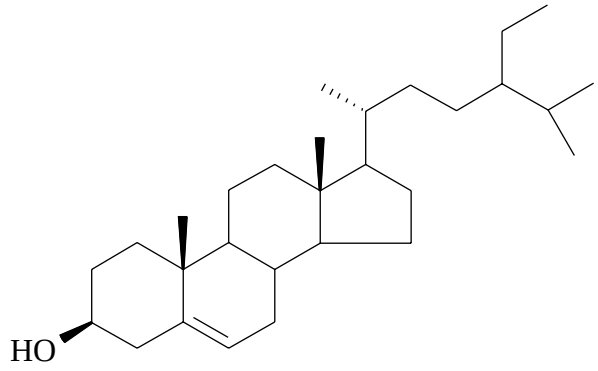
Figure. Chemical structures of the isolated compounds.



Oleanolic acid **(10)**



Ursolic acid **(11)**



β-sitosterol (12)

Figure. Contunied

Conclusion

Eight iridoid glycosides (**1-8**), a flavonol glycoside (**9**), 2 triterpene acids (**10-11**) and a sterol (**12**) were isolated and identified from the aerial parts of *Galium tortumense*.

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