Sutchuenoside A: a New Kaempferol Glycoside from the Aerial Parts of Epimedium sutchuenense

Mizuo Mizuno, Munekazu Iinuma, Toshiyuki Tanaka, Hirobumi Yamamoto, and Zhi-ben Tu

J. Nat. Prod., **1991**, 54 (5), 1427-1429• DOI: 10.1021/np50077a036 • Publication Date (Web): 01 July 2004

Journal of Natural Products
Vol. 54, No. 5, pp. 1427-1429, Sep-Oct 1991

SUTCHUENOSIDE A: A NEW KAEMPFEROL GLYCOSIDE FROM THE AERIAL PARTS OF *EPIMEDIUM SUTCHUENENSE*

MIZUO MIZUNO,* MUNEKAZU IINUMA, TOSHIYUKI TANAKA, HIROBUMI YAMAMOTO,

Department of Pharmacognosy, Gifu Pharmaceutical University, 6-1 Mitahora-higashi 5 chome, Gifu 502, Japan

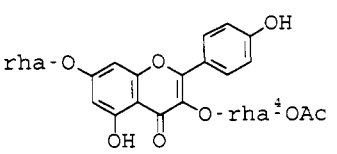
and ZHI-BEN TU

Wuhan Institute of Botany, Academia Sinica, Wuhan 430074, Hubei, China

ABSTRACT.—In addition to six known flavonol glycosides (kaempferol-3-*O*-rhamnoside, kaempferol-3,7-*O*-dirhamnoside, quercetin-3-*O*-glucoside, icariin, diphylloside B, and epimedin C), a new kaempferol glycoside, named sutchuenoside A [**1**], was isolated from the leaves of *Epimedium sutchuenense*. The structure was characterized as kaempferol 3-*O*-α-L-(4-*O*-acetyl)rhamnopyranoside-7-*O*-α-L-rhamnopyranoside.

Species of the genus *Epimedium* (Berberidaceae) are generally characterized by the presence of glycoside derivatives of desmethylanhydroicaritin (8-γ,γ-dimethylallyl-3,5,7,4′-tetrahydroxyflavone), such as diphylloside B, and anhydroicaritin (8-γ,γ-dimethylallyl-3,5,7-trihydroxy-4′-methoxyflavone), such as icariin and epimedin C (1–4). Recently glycosides lacking the γ,γ-dimethylallyl group in their aglycones, such as kaempferol or quercetin, have been isolated from some *Epimedium* species (5). It is interesting to survey chemotaxonomically the glycosides in *Epimedium* species to determine whether the presence of the γ,γ-dimethylallyl group is related to their medicinal potency. In order to accumulate more chemical information on the genus *Epimedium*, the constituents of *Epimedium sutchuenense* Franch., growing in Wuhan, China, were investigated. The structural elucidation of a new kaempferol glycoside is described in the present paper.

An EtOAc-soluble portion of the 95% EtOH extract of the aerial parts of *E. sutchuenense* was chromatographed on Si gel using $CHCl_3$/MeOH and $CHCl_3$/MeOH/H_2O systems to give **1** and six known flavonol glycosides.



1

Compound **1**, obtained as a pale yellow powder, showed uv absorption bands at 265, 315 sh, and 345 nm. Bathochromic shifts, on addition of $AlCl_3$ and NaOMe, indicated the presence of free hydroxyl groups at C-5 and C-4′, respectively. On the basis of a fragment ion (*m/z* 286) in the eims and ^{1}H-nmr signals [δ 6.55 and 6.87 (1H, each d, $J = 2$ Hz) assignable to A ring protons; δ 7.03 and 7.85 (2H, each d, $J = 9$ Hz) assignable to B ring protons], the aglycone moiety of **1** was identified as kaempferol. The products of acid hydrolysis of **1** produced kaempferol and rhamnose. In the ^{1}H- and ^{13}C-nmr spectra, two rhamnose residues, the anomeric protons of which were observed at δ 5.36 and 5.64 in a broad singlet, were exhibited. These findings suggested that the two rhamnoses were attached at different positions; that is, they were not in a rhamnosylrhamnoside. A carbon signal (δ 158.0) assigned to the C-2 of the aglycone was shifted to lower field than the C-2 of kaempferol itself (δ 146.8) by ca. 8 ppm. The anomeric proton (δ 5.36) caused a cross peak with H-2′ and H-6′ in the NOESY spectrum. A methyl signal of rhamnose was observed at δ 0.78 in the ^{1}H nmr (1). These findings supported the fact that one of the rhamnoses

was located at C-3. The remaining rhamnose unit, therefore, should be bonded to C-7, as was supported by the chemical shifts of H-6 and H-8 (δ 6.55 and 6.87), which were at rather lower field than those of kaempferol (usually at δ 6.20 and 6.40). Accordingly, **1** was considered to be a derivative of kaempferol-3,7-dirhamnoside.

The presence of an acetyl group in **1** was suggested by the following spectral data: $[M-H]^-$ at *m/z* 619 in the negative ion fabms, 1710 cm^{-1} in the ir, a singlet at δ 1.99 in the ^1H nmr, and δ 21.0 (quartet) and 169.9 (singlet) in the ^{13}C nmr. By the ^1H-^1H COSY, all protons of the rhamnose at C-3 could be clearly assigned (see Experimental). Among them, a proton at C-4 (δ 4.78) of the rhamnose appeared downfield by about 1.5 ppm, indicating that the acetyl group was esterified with a hydroxyl group at the C-4 of rhamnose, which was linked at the C-3 of kaempferol. By the data described above, the structure of **1** was concluded to be kaempferol-3-*O*-α-L-(4-*O*-acetyl)rhamnopyranoside-7-*O*-α-L-rhamnopyranoside and named sutchuenoside A.

The known compounds were determined to be kaempferol-3-*O*-α-L-rhamnopyranoside, kaempferol-3,7-*O*-α-L-dirhamnoside, quercetin-3-*O*-β-D-glucopyranoside, icariin, diphylloside B, and epimedin C by direct comparison with authentic samples.

It is a conspicuous feature of *E. sutchenense* that the species predominantly contains flavonol glycosides, the aglycones (such as kaempferol and quercetin) of which are free of the γ,γ-dimethylallyl group upon comparison to other *Epimedium* species (4).

EXPERIMENTAL

PLANT MATERIAL.—Leaves of *E. sutchuenense* were collected at Lichuan, Hubei Province in May 1989. Voucher specimens have been deposited in the Herbarium of the Wuhan Institute of Botany.

EXTRACTION AND ISOLATION.—The dried and pulverized aerial parts (2.7 kg) were extracted four times with 95% EtOH at room temperature. After concentration, the combined extract (184 g) was suspended in H_2O, and extracted with EtOAc and *n*-BuOH successively. The EtOAc layer was subjected repeatedly to cc on Si gel with $CHCl_3$-MeOH (3:1), and $CHCl_3$-MeOH-H_2O (13:7:2:) (lower phase) systems to give **1** (180 mg), kaempferol-3-rhamnoside (110 mg), kaempferol-3,7-dirhamnoside (100 mg), quercetin-3-glucoside (16 mg), icariin (50 mg), diphylloside B (35 mg), and epimedin C (30 mg). Diphylloside B and epimedin C were also obtained from the *n*-BuOH layer by the same procedures.

SUTCHENOSIDE A [**1**].—A pale yellow powder: eims (rel. int.) *m/z* 286 (100), 121 (24); negative ion fabms *m/z* $[M-H]^-$ 619, 473, 431, 285; ir ν max (KBr) 1710, 1650 cm^{-1}; uv λ max (MeOH) 265, 315 sh, 345, (+NaOMe) 268, 382, (+$AlCl_3$) 275, 300, 350, (+$AlCl_3$/HCl) 275, 300, 343, (+NaOAc) 266, 315 sh, 345; ^1H nmr (270 MHz, DMSO-d_6 assigned by ^1H-^1H COSY) δ 0.78 (3H, d, J = 6 Hz, Me-6″), 1.21

TABLE 1. ^{13}C-nmr Data of Compound **1**.[a]

Carbon	Parts per million
C-2	158.0
C-3	134.3
C-4	177.8
C-5	160.9
C-6	99.6
C-7	161.7
C-8	94.7
C-9	156.1
C-10	105.8
C-1′	120.2
C-2′, -6′	115.4
C-3′, -5′	130.7
C-4′	160.3
C-1″	101.5
C-2″	70.0
C-3″	67.9
C-4″	73.2
C-5″	68.0
C-6″	17.1
C-1‴	98.5
C-2‴	69.9
C-3‴	70.3
C-4‴	71.7
C-5‴	70.2
C-6‴	18.0
$COCH_3$	21.0
$COCH_3$	169.9

[a]Measured in DMSO-d_6. All carbons were assigned by ^1H-^1H and ^1H-^{13}C COSY experiments.

(3H, d, $J=6$ Hz, Me-6‴), 2.08 (3H, s, Ac), 3.27–3.30 (2H, m, H-4‴, -5″), 3.43 (1H, m, H-5‴), 3.64 (1H, m, H-3‴), 3.70 (1H, m, H-3″), 3.92 (1H, br s, H-2‴), 4.10 (1H, br s, H-2″), 4.78 (1H, t, $J=10$ Hz, H-4″), 4.93 (1H, s, 3‴-OH), 5.03 (1H, 3‴-OH), 5.05 (1H, s, 4‴-OH), 5.26 (1H, s, 2‴-OH), 5.36 (1H, br s, H-1″), 5.41 (1H, 2″-OH), 5.64 (1H, br s, H-1‴), 6.55 (1H, d, $J=2$ Hz, H-6), 6.87 (1H, d, $J=2$ Hz, H-8), 7.03 (2H, d, $J=9$ Hz, H-3′, -5′), 7.85 (2H, d, $J=9$ Hz, H-2′, -6′), 10.39 (1H, s, 4′-OH), 12.64 (1H, s, 5-OH); ^{13}C nmr see Table 1.

LITERATURE CITED

1. M. Mizuno, M. Iinuma, T. Tanaka, and N. Sakakibara, *J. Nat. Prod.*, **53**, 744 (1990).
2. M. Mizuno, M. Iinuma, T. Tanaka, N. Sakakibara, M. Nishi, A. Inada, and T. Nakanishi, *Phytochemistry*, **28**, 2527 (1989).
3. M. Mizuno, M. Iinuma, T. Tanaka, N. Sakakibara, T. Nakanishi, A. Inada, and M. Nishi, *Chem. Pharm. Bull.*, **37**, 2241 (1989).
4. M. Mizuno, M. Iinuma, T. Tanaka, S. Iwashima, N. Sakakibara, X. Liu, D. Shi, and H. Müssel, *Asian J. Plant Sci.*, **1**, 1 (1989).
5. Y. Oshima, M. Okamoto, and H. Hikino, *Planta Med.*, **55**, 309 (1989).

Received 11 February 1991