# New Triterpenes from Cactaceous Plants

Kiyotaka Koyama, Toshiyuki Yama, Kaoru Kinoshita, Kunio Takahashi, Norio Kondo, and Hiroshi Yuasa

*J. Nat. Prod.*, **1993**, 56 (12), 2201-2203• DOI: 10.1021/np50102a029 • Publication Date (Web): 01 July 2004

*Journal of Natural Products*
*Vol. 56, No. 12, pp. 2201-2203, December 1993*



# NEW TRITERPENES FROM CACTACEOUS PLANTS

KIYOTAKA KOYAMA, TOSHIYUKI YAMA, KAORU KINOSHITA, KUNIO TAKAHASHI,*

*Department of Pharmacognosy and Phytochemistry, Meiji College of Pharmacy, 1-22-1 Yato-cho, Tanashi City, Tokyo 188, Japan*

NORIO KONDO, and HIROSHI YUASA

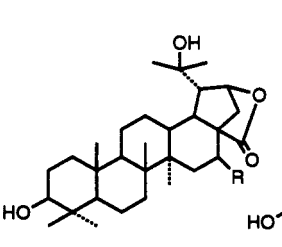
*The Research Institute of Evolutionary Biology, 4-28, 2-Chome, Kamiyoga, Setagayaku, Tokyo 158, Japan*

ABSTRACT.—A new lupane-type triterpenoid, 16β-hydroxystellatogenin [**1**], and a new oleanane-type triterpenoid, machaerogenin [**2**], were isolated from the hydrolysates of the glycosides of the aerial parts of *Stenocereus stellatus* and *Machaerocereus eruca*, respectively.

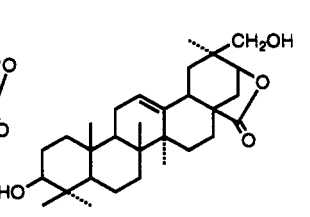
In our previous work, two new triterpenoids, bridgesigenins A and B, were isolated from *Trichocereus bridgesii* Britt. & Rose (1). As a part of our chemical investigations of the cacti, we have now examined *Machaerocereus eruca* Britt. & Rose and *Stenocereus stellatus* Riccob. (Cactaceae). In 1955, Djerassi and coworkers discovered that *M. eruca* contained stellatogenin [**3**] and betulinic acid (2–4) and *S. stellatus* contained oleanolic acid, betulinic acid, thurberogenin, and stellatogenin [**3**] (2–4). As a result of our work, seven triterpenoids were obtained, five of which are known compounds: oleanolic acid, queretaloic acid, betulinic acid, thurberogenin, and stellatogenin [**3**]. The other two are new, 16β-hydroxystellatogenin [**1**] and machaerogenin [**2**], from the hydrolysates of the glycosides of the aerial parts of *S. stellatus*. From *M. eruca*, five triterpenoids were obtained: oleanolic acid, betulinic acid, thurberogenin, **3**, and **2**. The structures of the new triterpenoids were determined from spectral data.

16β-Hydroxystellatogenin [**1**] had mp 255–258°, $[\alpha]^{20}D$ +15° ($c$=0.0008, $CHCl_3$). The molecular formula of **1**, $C_{30}H_{48}O_5$, was established by hrms measured on the ion at $m/z$ 488 $[M]^+$ (found 488.3534; calcd for $C_{30}H_{48}O_5$, 488.3530); eims $m/z$ 135, 189, 207, 389, 427, 455, 470; ir (KBr) $\nu$ max 3460, 3400, 2925, 1730, 1460, 1385, 1375, 1285, 1270, 1040. In the $^{13}C$-nmr spectrum of **1** in $C_5D_5N$, the signals of C-15 (δ 37.0), C-16 (δ 68.2), and C-17 (δ 59.0) were shifted downfield (10.2, 44.0, and 6.7 ppm, respectively) compared with those of stellatogenin [**3**]. The other carbon signals for **1** appeared at chemical shifts similar to those of **3** (Table 1). From these data, together with the molecular formula, the structure of **1** was concluded to be 16-hydroxystellatogenin. On irradiation of the $H_3$-27 methyl group (δ 1.03), a difference nOe was observed for H-16 (δ 4.37). Therefore, the configuration of the 16-OH was determined to be β.

Machaerogenin [**2**] had mp 292–294°, $[\alpha]^{20}D$ +14° ($c$=0.0011, $CHCl_3$). The molecular formula of **2**, $C_{30}H_{46}O_4$, was established by hrms measured on the ion at $m/z$ 470 $[M]^+$ (found 470.3348; calcd for $C_{30}H_{46}O_4$, 470.3398); eims $m/z$




**1** R=OH
**3** R=H




**2**

TABLE 1. $^{13}$C-nmr Spectra of Compounds **1–3**.

| Carbon | Compound | | |
|---|---|---|---|
| | **1** | **2** | **3** |
| C-1 | 39.2 | 38.6 | 39.1 |
| C-2 | 28.2 | 28.0 | 28.1 |
| C-3 | 78.0 | 78.0 | 78.0 |
| C-4 | 39.4 | 39.4 | 39.4 |
| C-5 | 55.7 | 55.9 | 55.7 |
| C-6 | 18.6 | 18.9 | 18.6 |
| C-7 | 34.9 | 32.8 | 34.8 |
| C-8 | 41.5 | 39.8 | 41.3 |
| C-9 | 50.3 | 47.8 | 50.6 |
| C-10 | 37.3 | 37.6 | 37.3 |
| C-11 | 21.3 | 23.8 | 21.2 |
| C-12 | 28.5 | 122.4 | 28.8 |
| C-13 | 40.1 | 141.1 | 40.9 |
| C-14 | 44.7 | 42.2 | 43.1 |
| C-15 | 37.0 | 24.0 | 26.8 |
| C-16 | 68.2 | 26.6 | 24.2 |
| C-17 | 59.0 | 44.1 | 52.3 |
| C-18 | 42.5 | 40.2 | 42.7 |
| C-19 | 56.4 | 30.0 | 55.7 |
| C-20 | 69.2 | 38.6 | 69.1 |
| C-21 | 81.6 | 80.4 | 81.8 |
| C-22 | 42.5 | 36.6 | 44.8 |
| C-23 | 28.6 | 28.6 | 28.6 |
| C-24 | 16.3 | 16.4 | 16.3 |
| C-25 | 16.3 | 15.6 | 16.3 |
| C-26 | 16.4 | 16.3 | 16.3 |
| C-27 | 15.6 | 23.5 | 14.1 |
| C-28 | 177.0 | 181.9 | 179.5 |
| C-29 | 30.7[a] | 22.1 | 30.7[a] |
| C-30 | 31.0[a] | 68.0 | 30.9[a] |

[a]Assignments may be interchanged.

175, 185, 190, 207, 216, 234, 393, 424, 442; ir (KBr) $\nu$ max 3475, 3400, 2945, 1730, 1460, 1450, 1390, 1380, 1140, 1110, 1040, 1030, 995, 950. The most characteristic fragment was observed at *m/z* 207 for the retro-Diels-Alder cleavage of ring C of machaerogenin [**2**] in the eims. The $^{13}$C values of the A, B, and C ring carbons of **2** were easily assigned by comparison with those of oleanolic acid. The oleanane skeleton generally possesses seven methyl groups, and one of the methyls in **2** seemed to have been oxidized to a carbinol by $^{1}$H-$^{13}$C COSY (δ 3.91, 3.59). Five methyl signals, δ 0.71, 0.91, 1.07, 1.14, and 1.25, were assigned to $H_3$-26, -25, -24, -27, and -23, respectively, by nOe difference spectra (Figure 1).

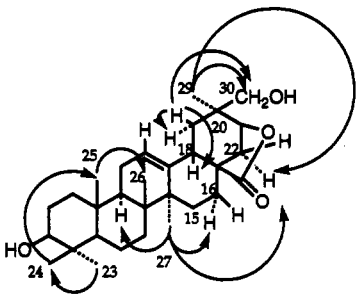



FIGURE 1. The observed positive nOe's from nOe difference spectra are indicated by arrows.

The remaining methyl signal (δ 1.28) is assigned to $H_3$-29 or $H_3$-30. The H-22α was observed to show a positive nOe when the remaining methyl signal (δ 1.28) was irradiated. This result clearly indicated that ring E is chair rather than boat form, and the methyl (δ 1.28) was assigned to $H_3$-29. One of the carbinol protons (δ 3.91) gave a positive nOe when the H-19β (δ 1.55) was irradiated. Therefore carbinol protons (δ 3.91 and 3.59) were assigned to $H_2$-30. The ir spectrum of **2** shows a band at 1730 cm$^{-1}$ corresponding to five-membered lactone absorption (the same as **1**). The signal of C-28 at δ 181.9 had a long range $^{1}$H-$^{13}$C correlation peak with proton H-22α (δ 2.47), which gave a positive nOe when $H_3$-27 (δ 1.14) was irradiated. The H-22β (δ 1.86), correlated with H-22α by $^{1}$H-$^{1}$H COSY, was coupled with a signal at δ 4.72 (H-21α). C-21 (δ 80.4), bearing H-21α (δ 4.72), correlated with $H_2$-30 (δ 3.59) and $H_3$-29 (δ 1.28) by a long range $^{1}$H-$^{13}$C COSY experiment. Thus, a five-membered lactone ring was evident between C-21 and C-28. On the basis of these results, the structure of machaerogenin was determined to be **2**.

## EXPERIMENTAL

PLANT MATERIALS.—*S. stellatus* and *M. eruca* were cultivated originally in the Research Institute of Evolutionary Biology (Setagaya-ku, Tokyo, Japan) and by Izu National History Park (Itoh, Shizuoka, Japan) and the Japan Cactus Planning Co. (Fukushima City, Fukushima, Japan). These cacti were identified by Dr. Norio Kondo and Dr.

Hiroshi Yuasa. The specimens are deposited at the Research Institute of Evolutionary Biology, Setagaya-ku, Tokyo, Japan.

INSTRUMENTS.—Mp's were determined on a Yanagimoto MP micromelting point apparatus. The ir spectra were measured with a JASCO A-102 ir spectrophotometer. The $^{1}H$- and $^{13}C$-nmr spectra were recorded using a JEOL GSX-400 ($^{1}H$ 400 and $^{13}C$ 100 MHz) spectrometer in $C_5D_5N$ with TMS as an internal standard. Chemical shifts are recorded in ppm. The $[\alpha]D$ values were determined with a JASCO DIP-140 digital polarimeter. Cc was carried out on 70–230 mesh Si gel (Merck). Hplc was performed using an SSC-3100-J pump with an Oyo-Bunko Uvilog 7 uv detector. Hrms and eims spectra were obtained using a JEOL JMS-DX 302.

EXTRACTION AND ISOLATION OF 16β-HYDROXYSTELLATOGENIN [**1**] AND MACHAEROGENIN [**2**].—Pulverized dried *S. stellatus* (52.9 g) was extracted with $CHCl_3$ to remove free triterpenes and then extracted with MeOH. After concentration of the MeOH extract in vacuo, approximately 5.4 g of residue remained. This residue was hydrolyzed with 1 N HCl at 115° for 2.5 h. The precipitates (2.1 g) produced were subjected to cc on Si gel [hexane-EtOAc (7:1)] to give three compounds. These were further purified by hplc on a Si gel column (Nucleosil 50-5, 1×25 cm) eluting with hexane-EtOAc (7:1) to give 16β-hydroxystellatogenin [**1**] (24 mg) and machaerogenin [**2**] (31 mg).

In the case of *M. eruca*, machaerogenin [**2**] (111 mg) was obtained from pulverized dried materials (67.8 g) by the method described above.

ACKNOWLEDGMENTS

The authors thank Mr. Toyoji Goto and Toshiaki Katagiri, the Staff of Izu Natural History Park, for supplying the cacti.

LITERATURE CITED

1. K. Kinoshita, K. Koyama, K. Takahashi, N. Kondo, and H. Yuasa, *J. Nat. Prod.*, **55**, 953 (1992).
2. C. Djerassi, L.H. Liu, E. Farkas, A.E. Lippman, A.J. Lemin, L.E. Geller, R.N. McDonald, and B.J. Taylor, *J. Am. Chem. Soc.*, **77**, 1200 (1955).
3. C. Djerassi, E Farkas, L.H. Liu, and G.H. Thomas, *J. Am. Chem. Soc.*, **77**, 5330 (1955).
4. M. Marx, J. Leclereq, B. Tursch, and C. Djerassi, *J. Org. Chem.*, **32**, 3150 (1967).

*Received 25 May 1993*