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TWO NEW TRITERPENES FROM *BETULA PLATYPHYLLA*

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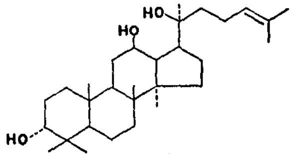
Abstract—Two new triterpenes, 3α,12β,20(*S*),24-tetrahydroxydammar-25-ene (III) and 3α,12β,20(*S*),25-tetrahydroxydammar-23-ene (V) were isolated from *Betula platyphylla* Sukatchev var. *japonica*. These betulafolientetraols were synthesized from betulafolientriol (I) by photo-oxidation.

INTRODUCTION

SITOSTEROL, betulafolientriol (I) and its 3-keto derivative (II) have been isolated from the leaves of the Japanese white birch, *Betula platyphylla* var. *japonica*.[1,2] During the course of our research on the same plant, we have isolated two new triterpenes, in addition to the above mentioned substances. The structural elucidation of these new triterpenes is described in this paper.

The ether extract of the leaves was saponified and the nonsaponifiable fraction was separated by silica gel chromatography. Sitosterol was obtained from the benzene fraction, betulafolientriol and its 3-keto compound from the benzene–ethyl acetate (9 : 1) fraction and more polar, unknown compounds from the benzene–ethyl acetate (1 : 1) fraction. This latter fraction was purified by further rechromatography and recrystallization gave two new triterpenes, betulafolientetraol-*A* and -*B*.



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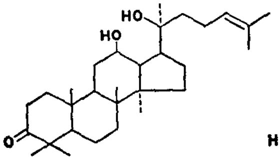

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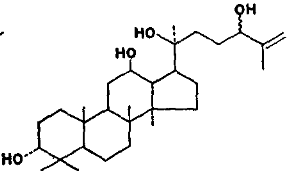

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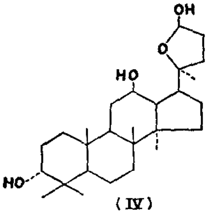

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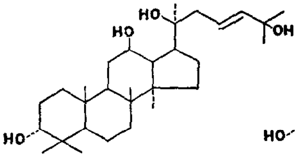

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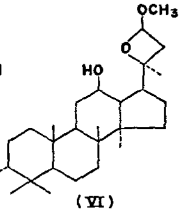

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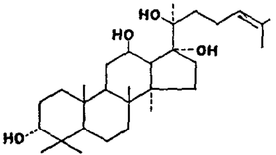

(VII)

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[1] S. SHIBATA, M. NAGAI and O. TANAKA, *Shoyakugakuzasshi* **18**, 27 (1962).

[2] M. NAGAI, N. TANAKA, S. ICHIKAWA and O. TANAKA, *Tetrahedron Letters* 4239 (1968).

RESULTS AND DISCUSSION

Betulafolientetraol-A(III)

The IR spectrum of betulafolientetraol-*A* exhibited an hydroxy band at 3300 cm^{-1} and an exomethylene band at 1650 and 900 cm^{-1}. The NMR spectrum showed singlet peaks for six methyl groups at 0·83 (3H), 0·88 (6H), 0·93 (3H), 0·96 (3H) and 1·16 (3H) δ. Signals for another methyl group located on an olefinic bond appeared at 1·72 δ (3H, s) and for exomethylene hydrogens at 4·85 δ (1H, s) and 4·96 δ (1H, s). The MS below *m/e* 341 exhibited a similar fragmentation pattern to that of betulafolientriol (I). The parent ion was located at *m/e* 458, which requires the presence of one additional oxygen atom in the basic structure of betulafolientriol, followed by loss of a molecule of water. The prominent peak at 341, which also appeared in the spectrum of the triol, may be the fragment due to the cleavage of the C_{20}–C_{22} bond and further loss of water. Thus tetraol-*A* has the same ring structure as the triol, but a different side chain possessing an additional hydroxy group. The evidence for the same ring structure as the triol was also confirmed by the oxidation products. Thus, oxidation of tetraol-*A* with OsO_4 followed by treatment with HIO_4 gave the acetal IV, which was identical with an authentic sample prepared from the triol by ozonzation.[3] From these results, 3α,12β, 20(*S*),24-tetrahydroxydammar-25-ene (III) has been proposed as the structure for tetraol-*A*.

Betrafolientetraol-B (V)

The MS of betrafolienetetraol-*B* is similar to that of the tetraol-*A*, showing *m/e* 458 as the parent ion and a strong peak at 341. The mass spectral fragmentation pattern below *m/e* 341 is quite similar to that of the triol (I), suggesting the same ring structure for both compounds. The NMR signals at 0·84 (3H), 0·90 (6H), 0·94 (3H), 0·98 (3H), 1·14 (3H), 3·40 (1H, C_3–H), and 3·64 ppm (1H, C_{12}–H), were also observed in the spectrum of tetraol-*A*. The signals characteristic of tetraol-*B* were two olefinic protons at 5·66 ppm and two singlet peaks of methyl groups at 1·32 and 1·28 ppm, suggesting that a hydroxy group and the two methyl groups were attached to the same carbon. Hydrogenation of tetraol-*B* with Pd–charcoal gave a dihydro-deoxy compound which was identical to the dihydrobetrafolientriol obtained by hydrogenation of the triol. Treatment of tetraol-*B* with Ac_2O-pyridine yielded a diacetate, leaving two hydroxy groups in the free form. Ozonization followed by Zn–MeOH reduction gave a methoxy compound, instead of the expected aldehyde. The NMR data indicate that this product is the acetal VI. Thus, the signal at 3·34 ppm (3H) may be attributed to a methoxy group. *ABX*-Type coupling of C_{22}–H and C_{23}–H was observed in the signal at 1·88 ppm (1H, *q*, $J_{AB} = 15$ Hz, $J_{AX} = 7\cdot5$ Hz), 2·12 ppm (1H, *q*, $J_{AB} = 15$ Hz, $H_{BX} = 5$ Hz) and 4·62 ppm (1H, *a*, $J_{AX} = 7\cdot5$ Hz, $J_{BX} = 5$ Hz). The acetal VI was also obtained from V by OsO_4 oxidation followed by HIO_4 treatment in methanol. From the above results the structure of tetraol-*B* was assigned as 3α,12β,20(*S*),25-tetrahydroxydammar-23-ene (V).

Photo-oxidation of Betulafolientriol (I → III + V)

Photo-oxidation of triol (I) was carried out in isopropanol using rosebengal as a sensitizer, followed by $NaBH_4$ reduction. The products were separated by silica gel chromatography, affording III and V identical in m.p., IR and NMR spectra to the plant materials.

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[3] F. G. FISCHER and N. SEILER, *Ann. Chem.* **626**, 185 (1959).

Furthermore, OsO_4 oxidation and HIO_4 treatment of these compounds gave IV and VI respectively.

The information obtained from the NMR and IR spectra were insufficient for indicating the configuration of the C-24 hydroxy group of tetraol-*A* and also the geometric isomerism of the C-23 double bond of tetraol-*B*. Fischer[4] has reported the isolation of betulafolientetraol (VII) from *Betula alba* L., but we could not repeat this isolation.

The co-occurrence of triol (I), tetraols III and V in the same plant suggests that tetraols may be biosynthesized from the triol by photo-oxidation. Djerassi[5,6] and Atallah[7] had also noted that cycoartenol is accompanied by cycloart-25-ene-3β,24-diol and cycloart-23-ene-3β,25-diol, and the synthesis of these compounds from cycloartenol was reported by Fourrey.[8]

EXPERIMENTAL

Extraction and isolation. Fresh leaves (16 kg) collected at Katashina, Gunma Prefecture, Japan, on July, were extracted with hot EtO_2. The extract (756 g) was dissolved in a solution of 3 l. of MeOH, 750 ml of H_2O and 150 g of KOH, this mixture was refluxed for 3 hr. The nonsaponifiable fraction (185 g) was obtained by removal of MeOH, addition of H_2O and extraction with Et_2O. This extract was separated by silica gel chromatography. Hydrocarbons, sitosterol and a higher alcohol were eluted in the hexane and benzene fractions. From the benzene–EtOAc (9 : 1) fraction, 3-keto derivative of triol (II) and the triol (I) were obtained. The more polar fraction eluted with benzene–EtOAc (1 : 1) was rechromatographed on a silica gel column; 5·4 g of crude III was obtained from the benzene–EtOAc (3 : 2) fraction and 6 g of crude V from the benzene–EtOAc (1 : 1) fraction. Further GLC on silica gel and recrystallization from acetone of the crude material III, afforded 4·6 g of pure compound, as prisms, m.p. 134–136°, $[\alpha]_D$ +16·3° (MeOH). *Anal.* Calcd. for $C_{30}H_{52}O_4$: C, 75·58; H, 11·00. Found: C, 75·59; H, 10·89. IR: 3400 cm^{-1} (OH), 1650, 890 cm^{-1} (C=CH_2). MS: *m/e* 458 (M^+–H_2O), 440 (M^+–$2H_2O$), 443 (M^+–H_2O–CH_3), 425 (M^+–$2H_2O$), 422 (M^+–$3H_2O$), 407 (M^+–$3H_2O$–CH_3), 377 (M^+–$C_6H_{11}O$), 370 (M^+–C_4H_7O–$2H_2O$ + H), 355 (M^+–C_5H_9O–$2H_2O$), 341 (M^+–$2H_2O$–$C_6H_{11}O$). Recrystallization of crude V from $CHCl_3$ gave 5·1 g of pure material V, as prisms, m.p. 130–133°, $[\alpha]_D$ −4·9 ($CHCl_3$). *Anal.* Calcd. for $C_{30}H_{52}O_4$: C, 75·58; H, 11·00. Found: C, 75·73; H, 10·82. MS: *m/e* 458, 443, 440, 425, 422, 407, 377, 357, 341. IR: 3250 cm^{-1} (OH), 980 cm^{-1}(s). The strong absorption at 980 cm^{-1} in the IR spectrum suggests that the double bond is *trans*, but this is not definitive because triol (I) also exhibited moderate absorption at 980 cm^{-1}.

*Oxidation of tetraol-*A (III). Tetraol (III) was dissolved in 10 ml of Et_2O and 90 mg of OsO_4 were added. After stirring overnight at room temp., 263 mg of $NaHSO_3$ and 10 ml of H_2O were added and the mixture was refluxed for 5 hr. Extraction with CH_2Cl_2 gave 104 mg of product. This substance was dissolved in a mixture of MeOH (4 ml), H_2O (0·4 ml) and HIO_4 (80 mg) and stirred for 2 hr at room temp. After removal of solvent *in vacuo*, the residue was extracted with Et_2O. Recrystallization of the product from MeOH gave prisms, m.p. 215–216°, identical with respect to m.p., IR and NMR spectra with the authentic specimen obtained from triol (I) by the same oxidation procedure.

*Catalytic hydrogenation of tetraol-*B (V). Catalytic reduction of V, (260 mg) was carried out on 20% Pd/C in EtOH. The product, after chromatography, crystallized as prisms (162 mg) from acetone, m.p. 196°, and was identical with respect to m.p. and spectral data with dihydrobetulafolientriol obtained from triol (I) by catalytic reduction. *Anal.* Calcd. for $C_{30}H_{54}O_3$: C, 77·86; H, 11·76. Found: C, 77·85; H, 11·73.

*Ozonization of tetraol-*B (V). To a 90% AcOH (7 ml) solution of V (987 mg), O_3 gas was introduced under ice-cooling until the starting material had disappeared. MeOH (4 ml) and Zn (1·5 g) were added to the solution and the mixture was allowed to stand overnight. After extraction with Et_2O, the crude products (830 mg) were purified on a silica gel column and recrystallized from CH_2Cl_2 affording 92 mg of prisms (VI), m.p. 210°, $[\alpha]_D$ +83·7° (MeOH). *Anal.* Calcd. for $C_{27}H_{46}O_4$: C, 74·61; H, 10·67. Found: C, 74·90; H, 10·82. MS: *m/e* 384 (M^+–MeOH–H_2O), 356 (M^+–$OCHOCH_3$–H_2O), 341 (M^+–$OCHOCH_3$–H_2O–CH_3).

*Oxidation of tetraol-*B (V). Oxidation of V (511 mg) with OsO_4 in Et_2O followed by HIO_4 treatment in MeOH was carried out, as described for III. The crude product (403 mg) was purified by silica gel chromatog-

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[4] F. G. Fischer and N. Seiler, *Ann. Chem.* **644,** 146 (1961).

[5] R. McCrindle and C. Djerassi, *Chem. & Ind.* 1311 (1961).

[6] C. Djerassi and R. McCrindle, *J. Chem. Soc.* 4034 (1962).

[7] A. M. Atallah and H. J. Nicholas, *Phytochem.* **10,** 3139 (1971).

[8] J. L. Fourrey, J. Rondest and J. Polonsky, *Tetrahedron* **26,** 3839 (1971).

raphy, affording 77 mg of VI, m.p. 209–210°. It proved to be identical (m.p., IR and NMR spectra) with VI obtained by ionization of V.

Photo-oxidation of triol (I). A solution of triol (I) (3 g) in isopropanol (300 ml) was stirred with rosebengal (60 mg) as a sensitizer in sunlight for 8 hr. After removal of the solvent, the residue was dissolved in MeOH (20 ml) and 3 g of $NaBH_4$ was added under stirring. After standing for 30 min the MeOH was evaporated, and the residue was dissolved in EtO_2. Rosebengal was removed by washing with H_2O. Chromatography of the product on a silica gel column afforded 0·98 g of starting material from the benzene fraction, 0·90 g of III, m.p. 134·5°, $[\alpha]_D$ +15·2° (MeOH), from the benzene–EtOAc (3 : 2) fraction and 0·88 g of V, m.p. 133°, $[\alpha]_D$ −5·9° ($CHCl_3$), from the EtOAc fraction.

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