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SHINJUDILACTONE, A NEW BITTER PRINCIPLE FROM AILANTHUS ALTISSIMA SWINGLE

Masami ISHIBASHI, Tatsushi MURAE, Hiroshi HIROTA, Hirokazu NAORA, Takahiko TSUYUKI, Takeyoshi TAKAHASHI,* Akiko ITAI,† and Yoichi IITAKA†

Department of Chemistry, Faculty of Science, The University of Tokyo
†Faculty of Pharmaceutical Sciences, The University of Tokyo
Hongo, Bunkyo-ku, Tokyo 113

Shinjudilactone, a new bitter principle with a new 13[12→11α]-abeo-picrasane skeletone, was isolated from root bark of Ailanthus altissima SWINGLE and the structure was determined.

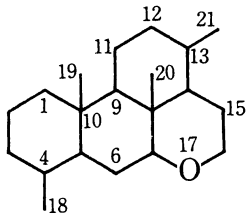
A number of investigations on the structure elucidation and anti-cancer activities of the bitter principles isolated from Simaroubaceous plants have been described.[1] We recently examined constituents of the root bark of Ailanthus altissima SWINGLE (Japanese name: Shinju or Niwaurushi) and isolated a new bitter principle, shinjudilactone (1), besides seven known quassinoids, amarolide,[2] ailanthone,[3,4] amarolide 11-acetate,[2] glaucarubinone,[3,5] $\Delta^{13(18)}$-dehydroglaucarubinone,[3,6] $\Delta^{13(18)}$-dehydroglaucarubolone,[7] and chaparrolide[8] from the extracts with hot water or ethyl acetate. We wish to report elucidation of the structure of shinjudilactone (1).

The aqueous extract of the root bark was continuously extracted with dichloromethane and the residue obtained from the organic layer was purified by silica gel column chromatography eluted with chloroform-methanol to afford shinjudilactone (1; 0.01% yield), mp 274-276 °C, $[\alpha]_D^{23}$ +102° (c 0.76, C_5H_5N); IR (KBr) ~3250, 1745, 1735, 1670, and 1620 cm^{-1}; UV (EtOH) 238 nm (ε 10800); ^1H NMR (90 MHz, C_5D_5N) δ 1.21 (3H, d, J=7Hz), 1.22 (3H, s), 1.77 (3H, br s), 2.01 (1H, m), ~2.2 (ca. 3H, m), 2.63 (2H, m), ~3.1 (2H, m), 4.17 (1H, s), 4.23 and 4.73 (each 1H, d, J=11Hz), 4.72 (1H, t, J=2.5Hz), and 6.05 (1H, m); ^{13}C NMR (22.6 MHz, C_5D_5N) δ 10.6 (q), 13.8 (q), 22.1 (q), 27.0 (t), 32.9 (t), 42.2 (d), 43.0 (s), 45.6 (d), 48.4 (s), 53.6 (d), 55.0 (d), 73.9 (d), 76.2 (t), 78.7 (s), 83.8 (d), 126.3 (d), 162.0 (s), 170.6 (s), 173.5 (s), and 196.9 (s); MS m/e (%) 376 (M^+; 80), 358 (20), 347 (30), 332 (60), 303 (98), and 288 (75); M^+ 376.1509 ($C_{20}H_{24}O_7$); Found: C, 62.03; H, 6.74% (Calcd for $C_{20}H_{24}O_7 \cdot 1/2\ H_2O$: C, 62.33; H, 6.54%). On treatment with diazomethane, 1 gave an O-methylated derivative (2), mp 291-294 °C; $[\alpha]_D^{23}$ +53.5° (c 0.27, $CHCl_3$); IR (Nujol) 3400, 1745, 1720, 1680, and 1630 cm^{-1}; UV (EtOH) 239.5 nm (ε 5400); ^1H NMR (90 MHz, $CDCl_3$) δ 1.05 (3H, s), 1.11 (3H, d, J=7Hz), 1.95 (3H, br s), 3.63 (1H, s), 3.75 (3H, s), 4.00 and 4.52 (each 1H, d, J=11.5Hz), 4.52 (1H, t, J=2.5Hz), 5.98 (1H, m), and 6.08 (1H, s); MS m/e (%) 390 (M^+; 60), 360 (100), 345 (50), 330 (20), 301 (10), and 288 (45); M^+ 390.1659 ($C_{21}H_{26}O_7$). Acetylation of 1 gave an acetate (3), mp 269-272 °C; IR (Nujol) 3480, 1730, 1680, and 1630 cm^{-1}; UV (EtOH) 240 nm (ε 8000), ^1H NMR (90 MHz, C_5D_5N) δ 1.12 (3H, d, J=7Hz), 1.36 (3H, s), 1.77 (3H, br s), 2.25 (3H,

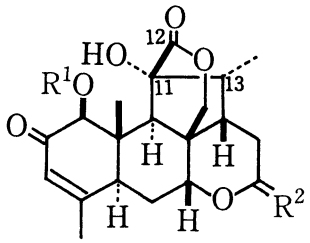
s), 4.26 and 4.73 (each 1H, d, J=12Hz), 4.64 (1H, t, J=2.5Hz), 5.78 (1H, s), and 6.05 (1H, m); MS m/e (%) 418 (M^+; 30), 400 (25), 358 (95), 330 (40), and 60 (100); M^+ 418.1678 ($C_{22}H_{26}O_8$).

Shinjudilactone (1) was reduced with sodium borohydride to afford a hemiacetal (4), mp 276-277.5 °C; IR (Nujol) 3300-3400, 1740, 1660, and 1610 cm^{-1}; UV (EtOH) 240 nm (ε 11500), ^1H NMR (90 MHz, C_5D_5N) δ 1.13 (3H, d, J=6Hz), 1.17 (3H, s), 1.76 (3H, br s), 4.20 and 4.43 (each 1H, d, J=12Hz), 4.26 (1H, t, J=2.5Hz), 4.35 (1H, s), 5.68 (1H, m), and 6.04 (1H, m); MS m/e (%) 378 (M^+; 20), 360 (70), 345 (40), 334 (40), and 316 (100); M^+ 378.1681 ($C_{20}H_{26}O_7$). Since the IR band at 1740 cm^{-1} reveals that a lactone moiety remains intact in the hemiacetal (4), shinjudilactone (1) possesses two δ-lactone moieties, which were supported by the presence of signals at δ 170.6 and 173.5 in the ^{13}C NMR spectrum of 1.

The spectral investigation of these compounds together with biogenetic considerations leads to the conclusion that shinjudilactone possesses a new migrated picrasane skeleton, 13[12→11α]abeo-picrasane, and should be formulated by the structure (1). The structures of 2, 3, and 4, derived from shinjudilactone, are compatible with their ^1H NMR spectra, respectively. The proposed structure (1) was unambiguously determined by X-ray diffraction analysis.[9] Figure 1 shows a computer-generated perspective drawing of the molecule of shinjudilactone.



Picrasane[10]



1 R^1= H, R^2= O
2 R^1= CH_3, R^2= O
3 R^1= Ac, R^2= O
4 R^1= H, R^2= H, OH

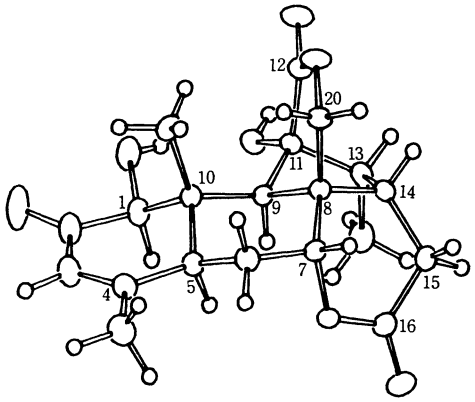


Fig. 1

References

1) J.Polonsky, Fortschr. Chem. Org. Naturst., 30, 101 (1973), and references cited therein.
2) C.G.Casinovi, V.Bellavita, G.Grandolini, and P.Ceccherelli, Tetrahedron Lett., 1965, 2273; W.Stöcklin, M.Stefanović, T.A.Geissman, and C.G.Casinovi, ibid., 1970, 2399.
3) The authors wish to thank Dr. J. Polonsky, Institut de Chimie des Substances Naturelles, C.N.R.S., for authentic samples of ailanthone and glaucarubinone, as well as the proton NMR spectral data of $\Delta^{13(18)}$-dehydroglaucarubinone.
4) J.Polonsky and J.-L.Fourrey, Tetrahedron Lett., 1964, 3983; C.G.Casinovi, P.Ceccherelli, G.Grandolini, and V.Bellavita, ibid., 1964, 3991.
5) A.Gaudemer and J.Polonsky, Phytochemistry, 4, 149 (1965).
6) J.Polonsky, Z.Varon, H.Jacquemin, and G.R.Pettit, Experientia, 34, 1122 (1978).
7) J.Moron, J.Rondest, and J.Polonsky, Experientia, 22, 511 (1966); S.M.Kupchan and J.A.Lacadie, J. Org. Chem., 40, 654 (1975).
8) R.E.Mitchell, W.Stöcklin, M.Stefanović, and T.A.Geissman, Phytochemistry, 10, 411 (1971).
9) Monoclinic, space group: $P2_1$, z=2; a=7.446, b=18.241, and c=6.679 Å, β=109.39°, D_c = 1.46 g cm^{-3}, a final R factor = 0.036.
10) Numbering of picrasane refers to the nomenclature described in the Chemical Abstracts.

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