Note

A New Quassinoid, Ailantinol H from *Ailanthus altissima*

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Summary

A new quassinoid, ailantinol H, was isolated from the aerial parts of *Ailanthus altissima*. The structure was elucidated based on spectral evidence.

Key words*: Ailanthus altissima*; Simaroubaceae; quassinoid

1. Introduction

Simaroubaceous plants contain many quassinoids with various biological activities, such as antitumor, antimalarial, antifeedant, insecticidal, antiinflammatory, amoebicidal, and herbicidal effects.[1, 2] We are interested in such biologically active compounds and have isolated many quassinoids from the plants, such as *Brucea antidysenterica*, [3] *Picrasma ailanthoides* PLANCHON,[4, 5] and *Brucea javanica*.[6, 7] As part of these studies, we investigated the isolation of quassinoids from *Ailanthus altissima* SWINGLE. We reported on the isolation and structural elucidation of four new quassinoids, ailantinols A—D, and related compounds from the stem bark of *A. altissima* grown in Japan.[8, 9] In previous papers, we also isolated three new quassinoids from the aerial parts of *A. altissima* grown in Taiwan.[10] In this paper, we report on the isolation and structural elucidation of a new quassinoid, ailantinol H (**1**) from *A. altissima*.

2. Results and Discussion

The aerial parts of *A. altissima* were extracted with MeOH to afford a crude extract. After evaporation of the solvent, the crude extract was dissolved in aqueous MeOH and re-extracted with *n*-hexane, chloroform, and then *n*-BuOH. The $CHCl_3$ extract was further fractionated using a combination of Si gel and Sephadex LH-20 column chromatography and preparative HPLC to give the new quassinoid **1**.

Compound **1** was obtained as a colorless amorphous solid. Its IR spectrum showed the presence of hydroxyl (3400 cm^{-1}), δ-lactone (1740 cm^{-1}), and α,β-unsaturated carbonyl (1680 cm^{-1}) groups. Its molecular formula was established to be $C_{20}H_{26}O_7$ based on its high-resolution MS (*m/z* 362.1730) and ^1H, ^{13}C, and DEPT-NMR spectra. The ^1H NMR spectrum (Table 1) of **1** showed three quaternary methyl groups [δ_H 1.51 (10-Me), 1.74 (3-Me), and 2.41 (4-Me)], a doublet methyl [δ_H 1.13 (13-Me)], three methylene protons, and six methine protons. The ^{13}C and DEPT NMR spectral data indicated the presence of two lactone carbonyls [δ_C 170.0 (C-16), 174.0 (C-2)], two olefinic carbons [δ_C 125.1 (C-3), 160.0 (C-4)], and three methylene carbons [δ_C 30.5 (C-15), 46.5 (C-6), 72.1 (C-20)]. The ^1H, ^{13}C, and DEPT NMR spectral data suggest that **1** has an A ring-destructed quassinoid skeleton, [10] and the ^1H–^1H COSY and HMBC experiment (Fig. 2) established the connectivities of these carbons.

In the HMBC spectrum, cross-peaks observed between H-5/C-4, C-3; H-18/C-3, C-5; H-22/C-2, C-3, and C-4 confirmed the partial structure of the γ-lactone moiety. The position of the γ-lactone moiety in **1** was confirmed by long-range correlations with the

respective B ring protons in the HMBC spectrum. Cross-peaks between the proton signal at δ 4.84 (H-5) and the carbon signals at δ 46.5 (C-6), 44.3 (C-9), 46.7 (C-10), and 18.5 (C-19) and the HMBC correlations between the carbon signals at δ 91.1 (C-5) and the proton signals at δ 3.38 (H-9) and 1.51 (H-19) suggest the position of the γ-lactone moiety at C-10.

Assignments of the cyclopentane ring (ring B) and δ-lactone moiety (ring D) were supported the following cross-peaks: H-6/C-7, C-10; H-7/C-6, C-9, C-10, and H-9/C-6, C-7, C-8, C-10; H-19/C-9; H-14/C-7, C-8, C-9, C-15, and C-16 and H-15/C-8, C-14, and C-16. The HMBC correlations between H-9/C-11; H-12/C-9, C-14; H-13/C-8, C-12, C-14; H-14/C-9, C-12, C-13, and C-21, and H-21/C-12, C-13, and C-14 confirmed the partial structure of ring C. The cross-peaks observed between the proton signals at δ 3.83 (H-20), 3.94 (H-20'), and the carbon signals at δ 57.1 (C-8), 44.3 (C-9), 111.4 (C-11), and 38.7 (C-14), and the HMBC correlation between the proton signal at δ 2.19 (H-14) and the carbon signal δ 72.1 (C-20) suggest the position of an oxymethelene bridge at C-11 and C-8.

The relative stereochemistry of **1** was determined by analysis of NOE correlations. Correlations between H-5/H-6', and H-5/H-9 indicated that H-5, H-6', and H-9 had α-orientations. The NOE correlations between H-6/H-7, H-7/H14, 10-Me/20-CH_2, 20-CH_2/H-14, and H-12/H-13 indicated that H-6, H-7, H-14, H-12, H-13, 10-Me, and 20-CH_2 had β-orientations. The arrows in Fig. 2 show these NOE correlations. From these data, the structure of **1** was assumed to be as that shown.

3. Experimental

3.1 General Experimental Procedures

Melting points were determined on a MRK air-bath-type melting point apparatus and are uncorrected. IR spectra were recorded on a JASCO IR-810 spectrophotometer, and UV spectra were obtained on a Hitachi 320-S or Shimadzu UV 3101 PC spectrophotometer. ^{1}H and ^{13}C NMR spectra were determined on a JEOL JNM-A400 in C_5D_5N using tetramethylsilane (TMS) as an internal standard. Mass spectra (MS) were recorded on a Hitachi M-80 instrument. Precoated silica gel plates (Merck, $60F_{254}$) 0.25 mm thick were used for analytical TLC, and plates 1 mm thick were used for preparative TLC. Components on TLC were detected using a UV lamp (254 and 365 nm). Analytical HPLC was performed on a Tosoh liquid chromatograph equipped with a UV detector set at 254 nm and a reverse-phase column (TSK-gel ODS-80Ts)

using a mixed solvent of MeOH/H_2O. Preparative HPLC was carried out on a Tosoh liquid chromatograph equipped with a reverse-phase column (Lichrosorb RP-18) at 254 nm using the same solvent as used for analytical HPLC.

3.2 Plant Material

In 1985, the aerial parts of *A. altissima* (330 kg) were collected in Taiwan and identified by Professor K. Kondo, Laboratory of Plant Chromosome and Gene Stock, Faculty of Science, Hiroshima University. A voucher specimen has been deposited in the Faculty of Integrated Arts and Science, Hiroshima University.

3.3. Extraction and isolation

The aerial parts of *A. altissima* were extracted with MeOH. The MeOH extract (24 kg) was obtained by evaporation of the solvent. Part of the MeOH extract (2.6 kg) was dissolved in MeOH–H_2O (2:1) and then extracted with *n*-hexane to give an *n*-hexane extract (716 g). Then the MeOH–H_2O layer was extracted with $CHCl_3$ and *n*-BuOH successively to give a $CHCl_3$ extract (514 g), an *n*-BuOH extract (216 g), and finally an H_2O-soluble residue (624 g). Si gel column chromatography of the $CHCl_3$ extract eluted with AcOEt–Et_2O (1:1) (54 l), gave 53 fractions (frs. A1－A53, total 123 g), that with $CHCl_3$–MeOH–H_2O (50:14:3, lower phase) (90 l) gave 90 fractions (frs. C1－C90, total 219 g), and that with MeOH (13 l) gave eight fractions (frs. M1－M8, total 14 g). Each fraction was checked by analytical TLC and HPLC. Frs. A30－39 were combined (3.7 g) and then subjected to column chromatography on Sephadex LH-20 to give 11 fractions. Fraction 5 (650 mg) was further purified with preparative HPLC (MeOH-H_2O, 3:7) to provide a new quassinoid, ailantinol H (**1**, 5.0 mg, 0.000014%).

3.4. Ailantinol H

Colorless amorphous powder; mp 115–118 °C; $[\alpha]_D^{25}$ +22° (c 0.10, MeOH); UV λ_{max} (MeOH) nm (ε): 215 (9100); IR (KBr) cm^{-1}: 3400 (OH), 1740 (C=O), and 1680 (C=O); EIMS *m/z*: 378 (M^+); HR-EIMS *m/z*: 378.1684 (calcd. for $C_{21}H_{24}O_7$: 378.1677); ^1H NMR (C_5D_5N) and ^{13}C NMR (C_5D_5N) data see Table 1.

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Table 1. ^{1}H and ^{13}C NMR Spectra of ailantinol H (**1**)

Proton	ppm	Carbon	ppm
H-5	4.84 s	C-2	174.0 (C=O)
H-6	2.32 dd (16, 5)	C-3	125.1 (C)
H-6'	2.95 d (16)	C-4	160.0 (C)
H-7	4.65 d (5)	C-5	91.1 (CH)
H-9	3.38 s	C-6	46.5 (CH_2)
H-12	3.95 br s	C-7	83.8 (CH)
H-13	2.38 m	C-8	57.1 (C)
H-14	2.19 m	C-9	44.3 (CH)
H-15	2.83 dd (18, 6)	C-10	46.7 (C)
H-15'	3.31 dd (18, 13)	C-11	111.4 (C)
H-20	3.83 d (9)	C-12	80.8 (CH)
H-20'	3.94 d (9)	C-13	33.5 (CH)
3-Me	1.74 s	C-14	38.7 (CH)
4-Me	2.41 s	C-15	30.5 (CH_2)
10-Me	1.51 s	C-16	170.0 (C=O)
13-Me	1.13 d (7)	C-18	14.0 (Me)
		C-19	18.5 (Me)
		C-20	72.1 (CH_2)
		C-21	12.8 (Me)
		C-22	8.5 (Me)

Measured in pyridine-d_5 (400MHz)