Picrasinol C a New Quassinoid, and Its Related Compounds from the Stem Wood of Picrasma ailanthoides

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PICRASINOL C, A NEW QUASSINOID, AND ITS RELATED COMPOUNDS FROM THE STEM WOOD OF *PICRASMA AILANTHOIDES*

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ABSTRACT.—A new quassinoid, picrasinol C [**1**], and twelve known quassinoids have been isolated from the stem wood of *Picrasma ailanthoides*. The structures of these compounds were elucidated from spectral evidence.

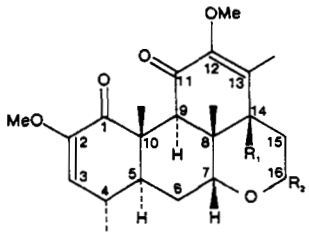
More than twenty quassinoids (aglycones) have been isolated by Murae *et al.* (1–6) and Hikino *et al.* (7) from *Picrasma ailanthoides* Planchon (Simaroubaceae), but their glycosides were not isolated. We have isolated seven new quassinoid glucosides, picrasinosides A–G, and two new quassinoid hemiacetals, picrasinols A and B, from the stem bark of *P. ailanthoides* (8). Recently (9), we isolated a new quassinoid glucoside, picrasinoside H, along with the five known quassinoid glucosides, picrasinosides B–G, from the stem wood of this plant. Reinvestigation of the stem wood quassinoid aglycones of this plant has led to the isolation of a new quassinoid, picrasinol C [**1**], along with the twelve known quassinoids, quassin [**2**] (1), neoquassin [**8**] (2), picrasins A [**10**] (7), B [**3**] (7), D [**4**] (7), E [**7**] (7), and G [**13**] (7), nigakilactones E [**5**] (1), F [**6**] (1), H [**11**] (7), and L [**12**] (3), and picrasinol B [**9**] (8). These quassinoids were identified first by comparing their ir and ^{1}H-nmr spectra with those of the literature, and more detailed identification was done by mass and ^{13}C-nmr spectral analyses. We report herein on the results of this study.

RESULTS AND DISCUSSION

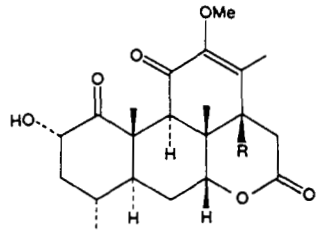
A new compound **1** was obtained as an amorphous solid. Its ir spectrum showed the presence of a hydroxy group (3450 cm^{-1}), δ-lactone (1730 cm^{-1}), and α,β-unsaturated carbonyl group (1700 and 1685 cm^{-1}). The uv spectrum of **1** exhibited maximum absorption at 256 nm due to a conjugated enone system. Compound **1** was assumed to be a new quassinoid, because its ir, ^{1}H-nmr, and ^{13}C-nmr spectra did not coincide with those of any one of the known quassinoids. As we have already isolated picrasinols A and B from the same plant, the name picrasinol C is tentatively used for compound **1**. Picrasinol C [**1**] has the empirical formula $C_{22}H_{28}O_7$ as determined by a mass peak at *m/z* 404.1821 $[M]^+$.

A comparison of ^{1}H-nmr spectra (Table 1) of **1** and **2** indicated that the spectral patterns were very similar, except that the signals of **1** shifted to relatively lower field than those of **2**. On the other hand, the ir spectrum of **1** showed absorption at 3450 cm^{-1} due to a hydroxy group, although **2** did not show that absorption. These observations suggested that **1** has a modified quassin structure in which a proton was replaced with a hydroxy group.

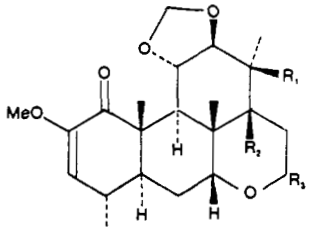
The ^{13}C-nmr (Table 2) signals for C-8, C-14, and C-15 of **1** were found at lower field than those of **2**. The shift value for C-14 is 28.3 ppm, although the shift values for C-8 and C-15 signals are 6.6 and 8.3 ppm, respectively. These facts suggested that the replaced position of a hydroxy group is C-14 in **2**. This conclusion was also supported by the following data. The ^{13}C-nmr signals of C-7, 8-Me, and 13-Me of **1** are at higher field than those of **2** (the shift values are 2.1, 5.7, and 4.2 ppm, respectively) due to the



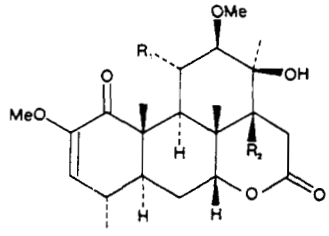
1 R_1=OH, R_2==O
2 R_1=H, R_2==O
8 R_1=H, R_2= ~~~ OH



3 R=H
13 R=OH



4 R_1=R_2=H, R_3==O
9 R_1=R_2=H, R_3= ~~~ OH
7 R_1=H, R_2=OH, R_3==O
12 R_1=OH, R_2=H, R_3==O



5 R_1=AcO, R_2=H
6 R_1=OH, R_2=H
11 R_1=R_2=OH

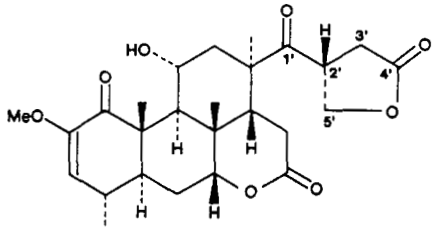


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TABLE 1. ^{1}H-nmr Spectra of Compounds **1** and **2**.

Proton	Compound	
	1	**2**
2-OMe	3.50 s	3.48 s
H-3	5.30 d (2.5)	5.25 d (2.2)
H-4	2.34 m	*
4-Me	0.92 d (6.5)	0.89 (6.6)
H-5	1.92 m	*
H-6α	2.05 m	*
H-6β	1.83 m	*
H-7	4.90 brs	4.33 brs
8-Me	1.34 s	1.14 s
H-9	3.51 s	3.40 s
10-Me	1.71 s	1.62 s
12-OMe	3.78 s	3.73 s
13-Me	2.11 s	1.85 s
H-15α	3.42 d (18)	*
H-15β	3.57 d (18)	*

*Not assignable.

TABLE 2. ^{13}C-nmr Spectra of Compounds **1–7** and **10–13**.

Carbon	Compound										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**10**	**11**	**12**	**13**
C-1	197.5	197.6	213.7	197.8	199.6	205.7	197.8	204.9	205.7	198.1	213.7
C-2	148.5	148.5	70.5	148.9	149.3	148.6	148.9	148.6	148.5	149.0	70.5
2-OMe	54.9	54.9	—	54.8	55.0	55.0	54.9	55.0	55.0	54.9	—
C-3	117.0	116.8	48.0	115.5	113.9	118.6	115.7	118.7	118.8	115.5	48.0
C-4	31.4	31.3	28.6	31.9	32.0	32.0	31.8	32.0	32.0	32.0	28.6
4-Me	19.2	19.1	18.4	19.2	19.3	19.1	19.2	19.1	19.1	19.2	18.5
C-5	43.8	43.7	47.2	43.3	44.5	43.8	43.4	43.8	44.1	43.4	47.9
C-6	26.1	26.0	26.6	25.9	25.6	25.5	25.7	25.6	25.3	25.8	26.6
C-7	79.8	81.9	82.0	81.9	81.9	82.0	79.4	81.9	79.3	81.7	80.1
C-8	43.8	37.2	36.9	37.6	36.8	37.0	42.4	38.0	41.9	38.7	43.4
8-Me	16.5	22.2	22.8	22.0	25.5	25.7	16.9	22.7	21.4	25.0	16.6
C-9	50.1	46.7	47.7	36.8	37.3	38.9	37.7	40.1	39.8	38.2	50.9
C-10	46.9	46.5	48.8	46.9	47.2	48.3	47.0	48.1	48.4	47.2	49.2
10-Me	12.8	12.9	15.2	13.2	12.7	12.8	13.4	12.7	13.0	13.3	15.1
C-11	192.0	191.9	191.6	78.1	72.0	71.8	78.1	65.8	71.7	75.4	191.7
11-OAc	—	—	—	—	170.6	—	—	—	—	—	—
C-12	148.8	148.7	148.5	82.5	86.7	89.5	83.2	34.1	89.6	84.4	148.6
12-OMe	59.3	59.4	59.5	—	61.8	62.5	—	—	62.5	—	59.5
C-13	141.8	139.2	140.9	33.0	76.2	75.9	40.6	52.0	78.3	73.9	143.7
13-Me	11.0	15.2	15.4	14.1	23.5	23.7	10.9	22.7	17.3	24.0	11.2
C-14	75.1	46.8	47.8	45.3	49.7	49.6	76.2	42.1	75.9	51.3	75.0
C-15	40.0	31.7	31.6	28.5	30.4	30.6	37.4	29.4	38.9	31.0	39.8
C-16	169.3	169.2	169.1	170.2	170.1	170.2	170.4	169.8	170.4	170.4	169.2
$-OCH_2O-$	—	—	—	95.7	—	—	96.3	—	—	95.9	—
C-1′	—	—	—	—	—	—	—	214.3	—	—	—
C-2′	—	—	—	—	—	—	—	44.5	—	—	—
C-3′	—	—	—	—	—	—	—	41.7	—	—	—
C-4′	—	—	—	—	—	—	—	175.6	—	—	—
C-5′	—	—	—	—	—	—	—	71.6	—	—	—

γ-effect, and the ^{1}H-nmr signals of H-7, 8-Me, and 13-Me of **1** are lower field than those of **2** (the shift values are 0.57, 0.20, and 0.26 ppm, respectively). From these data, the structure of **1** was assumed as that shown.

The structure of **1** was confirmed by CH long-range correlations in the ^{1}H-detected heteronuclear multiple-bond multiple-quantum coherence (HMBC) spectrum, which are depicted by arrows in Figure 1: (1) H-3 proton correlated with C-1, C-2, 4-Me, and C-5 carbons; (2) 10-Me protons correlated with C-1, C-5, C-9, and C-10 carbons; (3) 8-

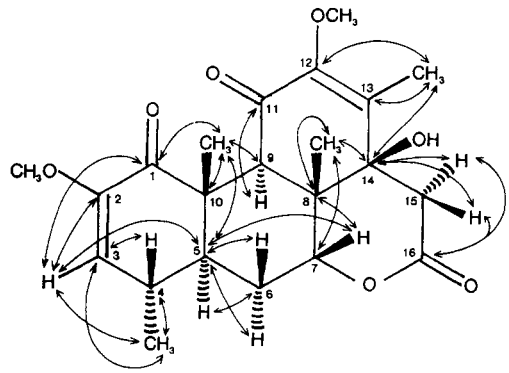

FIGURE 1. CH long-range correlations in the HMBC spectrum ($J = 8$ Hz) of **1**.

Me protons correlated with C-7, C-8, C-9, and C-14 carbons; (4) 15-methylene protons correlated with C-14 and C-16 carbons. These facts supported the structure of **1**.

The relative stereochemistry of **1** was confirmed by the NOESY spectra. As shown by arrows in Figure 2, nOe was observed between H-4 and 10-Me, between 8-Me and 10-Me, between H-6β and 8-Me, and between H-7 and 8-Me. These facts also supported the structure of **1**.

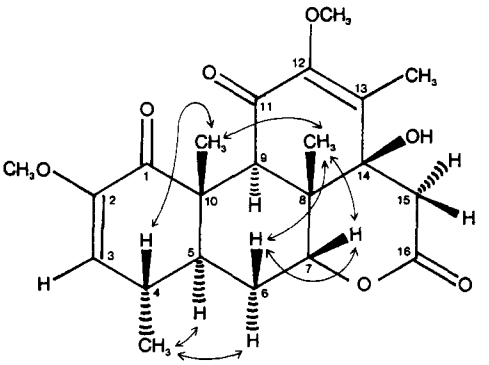

FIGURE 2. NOe correlation of **1**.

EXPERIMENTAL

GENERAL EXPERIMENTAL PROCEDURES.—Melting points were determined on an MRK air-bath-type melting point apparatus and were uncorrected. Specific rotations were obtained on a JASCO DIP-370 polarimeter (L = 0.5 dm). Ir and uv spectra were recorded on a JASCO IR-810 spectrometer and a HITACHI 320-S spectrometer, respectively. ^{1}H- and ^{13}C-nmr spectra were determined on a VARIAN XL-200 (200.6 MHz for ^{1}H nmr), a VARIAN VXR-500 (499.8 MHz for ^{1}H nmr and 125.7 MHz for ^{13}C nmr), and a JASCO GSX-500 (500.1 MHz for ^{1}H nmr and 125.7 MHz for ^{13}C nmr) instrument in C_5D_5N, using TMS as an internal standard. Mass spectra were recorded on a HITACHI M80 or a HITACHI M-2500 instrument. Si gel (Merck, type 60, 70–230 mesh) was used for cc. Precoated Si gel plates (Merck, $60F_{254}$) of 0.25 mm thickness were used for analytical tlc, and plates of 1 mm and 2 mm thickness were used for preparative tlc. Detection of components was made by using a uv lamp. Analytical hplc was performed on a TOSOH liquid chromatograph equipped with a uv detector at 254 nm and reversed-phase column (TSK-gel ODS-80T_M, 4.6 × 150 mm), using a mixed solvent of MeOH-H_2O (1:1 and 4:6).

Preparative hplc was carried out on a Waters or a TOSOH liquid chromatograph equipped with a reversed-phase column (Lichrosorb RP-18) and a uv monitor set at 254 nm, using the same solvent as that used in the analytical hplc.

PLANT MATERIAL AND EXTRACTION.—The stem of *P. ailanthoides* was procured and identified by Professor K. Kondo, Laboratory of Plant Chromosome and Gene Stock, Faculty of Science, Hiroshima University. A voucher specimen was deposited in the above department. Half-dried stem of *P. ailanthoides* was separated into bark and wood. The wood (40 kg) was shattered into small chips and soaked in MeOH (90 liters) at room temperature for a week (×2) to make an MeOH extract. The fatty substance in the MeOH extract was removed by hexane extraction (×2), and the material used for this investigation was obtained by $CHCl_3$ extraction (×3), as a brown resinous substance (143 g) (9).

SEPARATION BY COLUMN CHROMATOGRAPHY.—The resinous substance (100 g) was subjected to Si gel cc using a mixed solvent of $CHCl_3$-MeOH-H_2O (50:14:3, lower layer) and then MeOH to afford 31 fractions. Tlc and hplc analyses of all these fractions indicated that fractions 5–8 contain quassinoid aglycones.

ISOLATION OF QUASSIN [**2**], PICRASIN B [**3**], AND PICRASIN D [**4**].—These compounds were isolated by preparative tlc and hplc from fraction 5 (5.46 g) and characterized as follows. Quassin [**2**] (1): 68.9 mg: 0.00017%; colorless amorphous solid; mp 215–218°; $[\alpha]^{23}_D$ +27.5°. Picrasin B [**3**] (7): 266 mg; 0.00066%; colorless amorphous solid; mp 247–249°; $[\alpha]^{23}_D$ −4.2°. Picrasin D [**4**] (7): 173 mg; 0.00043%; colorless needles; mp 265–267°; $[\alpha]^{23}_D$ +21.8°. These compounds were identified by comparing their ir and ^{1}H-nmr spectra with those of the authentic compounds (1,7), and structures were also confirmed by eims, cims, and ^{13}C-nmr (Table 2) spectral analyses.

ISOLATION OF NIGAKILACTONES E [**5**] AND F [**6**].—These compounds were isolated by preparative tlc and hplc from fraction 6 (3.28 g) and characterized as follows. Nigakilactone E [**5**] (1): 57.1 mg; 0.00014%; colorless amorphous solid; mp 268–270°, $[\alpha]^{23}D$ +35.4°. Nigakilactone F [**6**] (1): 214 mg; 0.00053%; colorless amorphous solid; mp 256–260°; $[\alpha]^{23}D$ +45.5°. Compounds **5** and **6** were identified by comparing their ir and ^{1}H-nmr spectra with those of the authentic compounds and by eims, cims, and ^{13}C-nmr (Table 2) spectral analyses.

ISOLATION OF PICRASIN E [**7**], PICRASINOL C [**1**], NEOQUASSIN [**8**], PICRASINOL B [**9**], PICRASIN A [**10**], AND NIGAKILACTONES H [**11**] AND L [**12**].—These compounds were isolated by preparative tlc and hplc from fraction 7 (4.13 g) and characterized as follows. Picrasin E [**7**] (7): 51.7 mg; 0.000129%; colorless amorphous solid; mp 273–275°, $[\alpha]^{23}D$ +38.6°. Picrasinol C [**1**]: 15.2 mg; 0.000038%. Neoquassin [**8**] (2,8): 241 mg; 0.00060%; colorless amorphous solid; mp 198–200°, $[\alpha]^{23}D$ +36.0°. Picrasinol B [**9**] (2,8): 73.6 mg; 0.00018%; colorless amorphous solid; mp 222–225°; $[\alpha]^{23}D$ +9.0°. Picrasin A [**10**] (7): 46.5 mg; 0.000116%; colorless needles; mp 295–297°, $[\alpha]^{23}D$ +39.0°. Nigakilactone H [**11**] (7): 13.0 mg; 0.000033%; colorless amorphous solid, mp 276–278°; $[\alpha]^{23}D$ +28.9°. Nigakilactone L [**12**] (3): 16.5 mg; 0.000041%; colorless needles; mp 260–262°; $[\alpha]^{23}D$ +44.4°. All of these compounds, except compound **1**, were identified by comparing their ir and ^{1}H-nmr spectra with those of authentic compounds. These compounds, except compound **1**, were also identified by eims, cims, and ^{13}C-nmr spectral analyses. However, ^{13}C-nmr data of compounds **8** and **9** are not listed in Table 2, as the data are complicated because of their hemiacetal structure.

Picrasinol C [**1**].—Colorless amorphous solid: mp 137–139°; $[\alpha]^{23}D$ +8.0° (c = 0.2, EtOH); uv λ max (EtOH) 256 nm (ε 10600); ir (KBr) 3450 (OH), 1730 (δ-lactone C=O), 1700, 1685 (α,β-unsaturated C=O) 1640 (C=C) cm^{-1}; ^{1}H nmr see Table 1; ^{13}C nmr see Table 2; hreims found *m/z* $[M]^+$ 404.1821 (calcd for $C_{22}H_{28}O_7$, 404.1833), $[M-H_2O]^+$ 386.1749 (calcd for $C_{22}H_{26}O_6$, 386.1729), $[M-H_2O-Me]^+$ 371.1511 (calcd for $C_{21}H_{23}O_6$, 371.1494).

ISOLATION OF PICRASIN G [**13**].—Compound **13** was isolated by preparative tlc and hplc from fraction 8 (4.00 g) and characterized as follows. Picrasin G [**13**] (7): 132 mg, 0.00033%, colorless amorphous solid, mp 147–149°, $[\alpha]^{23}D$ −33.3°. Compound **13** was identified by comparison of its ir and ^{1}H-nmr spectra with those of the authentic compound and by eims, cims, and ^{13}C-nmr (Table 2) spectral analyses.

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