Crystal structure of 1,1′-disinomenine tetrahydrate, $C_{38}H_{44}N_2O_8 \cdot 4H_2O$

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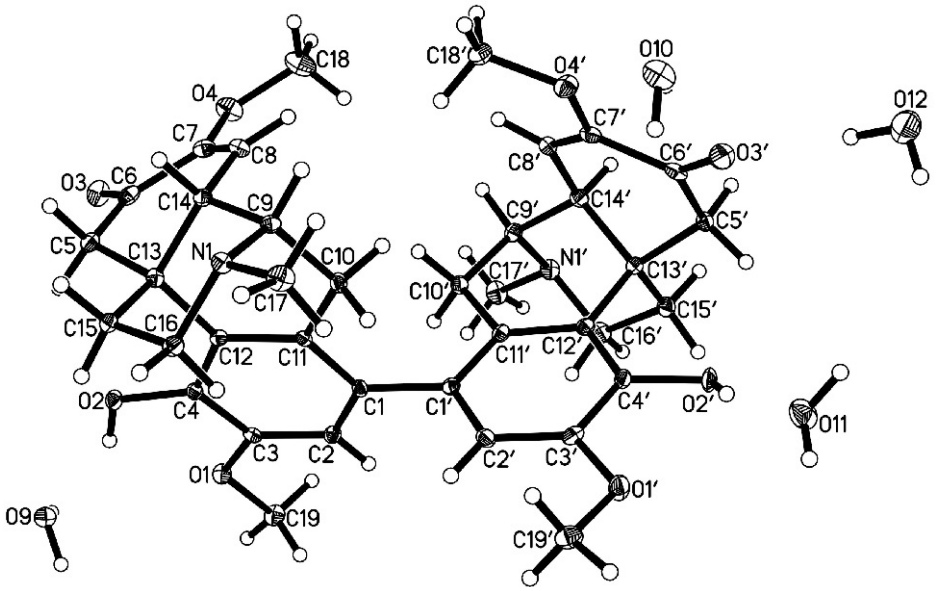

Abstract

$C_{38}H_{52}N_2O_{12}$, monoclinic, $P2_1$ (no. 4), a = 9.101(2) Å, b = 9.559(2) Å, c = 21.030(5) Å, β = 93.879(3)°, V = 1825.3 Å^3, Z = 2, $R_{gt}(F)$ = 0.039, $wR_{ref}(F^2)$ = 0.089, T = 293 K.

Source of material

Sinomenine is the main pharmacologically active alkaloid in the traditional Chinese plant medicine of *Sinomenium acutum*. It was produced from the powder of the plant roots by the Baoji Yongjia Plant Medicine Extracting Limited Company, Baoji, P. R. China, under the patent technology [1], and crystallized from the concentrated benzene extract of the powder. The remaining sticky mother liquor (3 kg) after the extraction of sinomenine was obtained from the company. The sticky residue was fractionated by column chromatography on silica gel (100 mesh) eluted gradually with chloroform to chloroform/methanol (30:1; 10:1 and 4:1) to afford 7 fractions, QT1 to QT7. The QT4 (5.5 g) was subjected to column chromatography on silica gel (300-400 mesh) eluted with chloroform/methanol (20:1 to 5:1) to give 7 subfractions, QT4-1 to QT4-7. The QT4-6 was crystallized repeatedly from methanol to yield the colorless crystals of the title compound (25 mg) suitable for single crystal X-ray diffraction analysis at room temperature.

Experimental details

Only the eight H atoms from four crystal water molecules have been refined; they were determined from Fourier map. All other H atoms attached to C atoms and O atoms of the title compound molecule were calculated by theoretical method and were not refined. The Flack parameter was 0(10).

Discussion

S. acutum is distributed mainly in hilly regions of southwest, northwest and southeast China. The dried stems and roots of the plant are a traditional Chinese medicine to cure rheumatism, arthralgia, dropsy and dermatophytosis recorded in the Chinese Pharmacopoeia [2]. The plant is a rich source of alkaloids of bisbenzylisoquinoline, aporphine, isoaporphine, protoberberine and morphinane types. The diversity of the alkaloids and activities of this medicinal plant motivated our research work, we have studied the remaining mother benzene liquor of roots of *S. acutum* and obtained nearly 20 alkaloidal compounds, including the title compound. We once obtained them as the amorphous powder from the stems of the same plant [3]. We have already reported the isolation and crystal structures of cheilanthifoline [4], 8-oxotetrahydropalmatine [5], tetrahydroepiberberine [6], 8-oxocanadine [7], sinoacutine [8], 8-demethoxyrunanine [9,10], sinoracutine [11,12], *N*-formylanonaine [13] and two new morphinane alkaloid dimers [3].

The title compound disinomenine tetrahydrate is a dimer of sinomenine, in which the two monomers are interconnected at C1 position. The two benzene rings from each monomer are perpendicular to each other in order to decrease the steric hindrance. Each monomer is composed of rings A, B, C and D. The two methoxy groups at each C3 are basically coplanar to their attached benzene rings A, the rings B and C adopt half-chair conformations whereas the rings D adopt chair conformations.

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In the crystal, the supermolecular structure was formed through the complicated intermolecular hydrogen bonds between the molecules of the title compound and crystal water. Each molecule of disinomenine is bonded to four crystal water molecules. Here, it crystallized as the tetrahydrate from methanol, while the monohydrate, crystallized from chloroform/methanol/ethyl acetate (80:15:5), has been reported earlier [14]. It is likely that water more easily permeates into the polar solvent of methanol than in the non-polar solvent of chloroform/methanol/ethyl acetate (80:15:5); as the result, the permeated water molecules can strengthen interaction of disinomenine and crystal water by more intermolecular hydrogen bonds.

Table 1. Data collection and handling.

Crystal:	colorless prism, size 0.10 × 0.17 × 0.40 mm
Wavelength:	Mo K_α radiation (0.71073 Å)
μ:	0.98 cm^{-1}
Diffractometer, scan mode:	Rigaku SPIDER, ω
$2\theta_{max}$:	54.96°
$N(hkl)_{measured}$, $N(hkl)_{unique}$:	16570, 4408
Criterion for I_{obs}, $N(hkl)_{gt}$:	$I_{obs} > 2\ \sigma(I_{obs})$, 3816
$N(param)_{refined}$:	507
Programs:	SHELXS-97, SHELXL-97 [15]

Table 2. Atomic coordinates and displacement parameters (in Å^2).

Atom	Site	x	y	z	U_{iso}
H(2)	2*a*	0.7714	0.6283	0.3501	0.017
H(5A)	2*a*	0.6375	0.1106	0.4953	0.019
H(5B)	2*a*	0.5323	–0.0083	0.4685	0.019
H(8)	2*a*	0.5152	0.0455	0.2782	0.020
H(9)	2*a*	0.2676	0.1523	0.2913	0.016
H(10A)	2*a*	0.4234	0.3121	0.2635	0.018
H(10B)	2*a*	0.3192	0.4081	0.3004	0.018
H(14)	2*a*	0.3679	0.0245	0.3780	0.017
H(15A)	2*a*	0.3218	0.1313	0.4813	0.018
H(15B)	2*a*	0.4033	0.2699	0.5026	0.018
H(16A)	2*a*	0.1628	0.3166	0.4569	0.020
H(16B)	2*a*	0.2825	0.3929	0.4190	0.020
H(17A)	2*a*	–0.0160	0.2937	0.3691	0.028
H(17B)	2*a*	0.0326	0.2452	0.3025	0.028
H(17C)	2*a*	0.0863	0.3895	0.3308	0.028
H(18A)	2*a*	0.7344	0.0414	0.2284	0.039
H(18B)	2*a*	0.6723	–0.1101	0.2363	0.039
H(18C)	2*a*	0.8404	–0.0878	0.2274	0.039
H(19A)	2*a*	1.0096	0.6155	0.3998	0.024
H(19A)	2*a*	1.0511	0.6536	0.4713	0.024
H(19B)	2*a*	0.9108	0.7195	0.4357	0.024
H(2')	2*a*	0.3911	0.6932	0.3002	0.019
H(5'A)	2*a*	0.4887	0.6234	0.0215	0.019
H(5'B)	2*a*	0.5802	0.4992	–0.0043	0.019
H(8')	2*a*	0.5968	0.2093	0.1329	0.019
H(9')	2*a*	0.8515	0.2949	0.1605	0.019
H(10C)	2*a*	0.7026	0.3423	0.2353	0.019
H(10D)	2*a*	0.8167	0.4629	0.2485	0.019
H(14')	2*a*	0.7461	0.3659	0.0623	0.018
H(15C)	2*a*	0.8043	0.6113	0.0358	0.023
H(15D)	2*a*	0.7339	0.7339	0.0730	0.023
H(16C)	2*a*	0.9759	0.6817	0.1159	0.025
H(16D)	2*a*	0.8602	0.6668	0.1676	0.025
H(17D)	2*a*	1.0437	0.5145	0.2236	0.030
H(17E)	2*a*	1.1465	0.5221	0.1668	0.030
H(17F)	2*a*	1.0926	0.3767	0.1906	0.030
H(18D)	2*a*	0.2443	0.0725	0.1391	0.029
H(18E)	2*a*	0.3774	0.1506	0.1746	0.029
H(18F)	2*a*	0.4045	0.0483	0.1183	0.029
H(19D)	2*a*	0.2505	0.8842	0.2864	0.028
H(19E)	2*a*	0.1462	0.7650	0.2591	0.028
H(19F)	2*a*	0.1182	0.9203	0.2376	0.028
H(09A)	2*a*	0.9792(9)	0.438(4)	0.601(2)	0.04(1)
H(09B)	2*a*	0.861(3)	0.526(4)	0.607(2)	0.05(1)
H(02A)	2*a*	0.1477	0.5160	–0.0629	0.051
H(02B)	2*a*	0.0413	0.6170	–0.0819	0.051
H(2O)	2*a*	0.782(5)	0.378(5)	0.522(2)	0.07(1)
H(2'O)	2*a*	0.322(5)	0.787(5)	0.095(2)	0.06(1)
H(0A)	2*a*	–0.010(4)	0.363(3)	0.071(2)	0.09(2)
H(0B)	2*a*	0.106(2)	0.308(4)	0.040(2)	0.07(1)
H(01A)	2*a*	0.107(4)	0.826(4)	0.028(1)	0.06(1)
H(01B)	2*a*	0.087(4)	0.915(4)	0.079(2)	0.08(2)

Table 3. Atomic coordinates and displacement parameters (in Å^2).

Atom	Site	x	y	z	U_{11}	U_{22}	U_{33}	U_{12}	U_{13}	U_{23}
O(1)	2*a*	0.8849(2)	0.5231(2)	0.45980(8)	0.0131(8)	0.0192(9)	0.0183(8)	–0.0050(7)	–0.0027(7)	0.0013(7)
O(2)	2*a*	0.7220(2)	0.3193(2)	0.50200(8)	0.0187(9)	0.0166(9)	0.0144(8)	–0.0021(7)	–0.0050(7)	0.0031(7)
O(3)	2*a*	0.8286(2)	–0.0201(2)	0.43871(9)	0.0160(9)	0.028(1)	0.029(1)	0.0035(8)	–0.0016(8)	0.0052(9)
O(4)	2*a*	0.7830(2)	–0.0396(2)	0.31325(9)	0.0167(9)	0.032(1)	0.029(1)	0.0064(8)	0.0032(8)	–0.0070(9)
N(1)	2*a*	0.1920(2)	0.2268(2)	0.37187(9)	0.012(1)	0.017(1)	0.015(1)	0.0004(8)	0.0002(8)	–0.0011(9)
C(1)	2*a*	0.5960(3)	0.5020(2)	0.3280(1)	0.013(1)	0.014(1)	0.010(1)	0.0018(9)	0.0026(9)	0.0002(9)
C(2)	2*a*	0.7195(3)	0.5517(3)	0.3641(1)	0.015(1)	0.014(1)	0.015(1)	–0.0015(9)	0.0031(9)	0.0008(9)
C(3)	2*a*	0.7641(3)	0.4869(2)	0.4206(1)	0.011(1)	0.014(1)	0.014(1)	0.0001(9)	0.0013(9)	–0.0033(9)
C(4)	2*a*	0.6852(3)	0.3722(2)	0.4426(1)	0.014(1)	0.013(1)	0.012(1)	0.0015(9)	0.0000(9)	0.0003(9)
C(5)	2*a*	0.5912(3)	0.0708(3)	0.4565(1)	0.016(1)	0.014(1)	0.018(1)	–0.0009(9)	–0.0017(9)	0.002(1)
C(6)	2*a*	0.7088(3)	0.0198(3)	0.4156(1)	0.014(1)	0.013(1)	0.026(1)	–0.0022(9)	–0.001(1)	0.003(1)
C(7)	2*a*	0.6705(3)	0.0123(3)	0.3458(1)	0.016(1)	0.015(1)	0.023(1)	–0.0005(9)	0.003(1)	–0.003(1)
C(8)	2*a*	0.5374(3)	0.0517(3)	0.3220(1)	0.017(1)	0.017(1)	0.016(1)	–0.000(1)	0.0011(9)	–0.004(1)
C(9)	2*a*	0.3103(3)	0.2023(2)	0.3288(1)	0.012(1)	0.013(1)	0.016(1)	–0.0018(9)	0.0005(9)	–0.0006(9)
C(10)	2*a*	0.3901(3)	0.3324(3)	0.3053(1)	0.016(1)	0.016(1)	0.012(1)	–0.002(1)	–0.0023(9)	0.0019(9)
C(11)	2*a*	0.5214(2)	0.3837(2)	0.3476(1)	0.012(1)	0.012(1)	0.010(1)	0.0002(9)	0.0011(9)	–0.0015(9)
C(12)	2*a*	0.5686(2)	0.3144(2)	0.4045(1)	0.011(1)	0.012(1)	0.014(1)	–0.0012(9)	0.0026(9)	–0.0010(9)
C(13)	2*a*	0.4895(3)	0.1807(2)	0.4238(1)	0.010(1)	0.015(1)	0.013(1)	–0.0014(9)	–0.0008(9)	0.0005(9)
C(14)	2*a*	0.4222(3)	0.1058(3)	0.3636(1)	0.014(1)	0.014(1)	0.014(1)	–0.0022(9)	–0.0007(9)	–0.0007(9)
C(15)	2*a*	0.3641(3)	0.2170(3)	0.4659(1)	0.017(1)	0.014(1)	0.014(1)	–0.0015(9)	0.0021(9)	0.002(1)
C(16)	2*a*	0.2440(3)	0.3021(3)	0.4301(1)	0.017(1)	0.015(1)	0.018(1)	0.0001(9)	0.003(1)	0.000(1)
C(17)	2*a*	0.0627(3)	0.2946(3)	0.3409(1)	0.016(1)	0.024(1)	0.028(1)	0.007(1)	–0.001(1)	–0.002(1)
C(18)	2*a*	0.7552(3)	–0.0499(4)	0.2458(1)	0.023(1)	0.043(2)	0.032(2)	0.003(1)	0.009(1)	–0.015(1)

Table 3. Continued.

Atom	Site	*x*	*y*	*z*	U_{11}	U_{22}	U_{33}	U_{12}	U_{13}	U_{23}
C(19)	2*a*	0.9711(3)	0.6372(3)	0.4401(1)	0.016(1)	0.021(1)	0.024(1)	–0.009(1)	–0.002(1)	0.001(1)
O(1')	2*a*	0.2851(2)	0.8322(2)	0.19816(8)	0.027(1)	0.026(1)	0.0191(9)	0.0127(8)	0.0048(8)	0.0036(8)
O(2')	2*a*	0.4174(2)	0.7621(2)	0.09447(8)	0.026(1)	0.0209(9)	0.0144(9)	0.0081(8)	–0.0008(8)	0.0062(7)
O(3')	2*a*	0.2815(2)	0.4470(2)	0.01551(9)	0.019(1)	0.026(1)	0.030(1)	0.0002(8)	–0.0076(8)	0.0006(9)
O(4')	2*a*	0.3198(2)	0.2287(2)	0.09016(9)	0.0185(9)	0.0190(9)	0.0263(9)	–0.0054(7)	–0.0015(8)	0.0016(8)
N(1')	2*a*	0.9371(2)	0.4814(2)	0.1390(1)	0.014(1)	0.022(1)	0.020(1)	–0.0024(8)	–0.0010(8)	0.0016(9)
C(1')	2*a*	0.5501(3)	0.5716(2)	0.2659(1)	0.016(1)	0.011(1)	0.014(1)	–0.0046(9)	0.0000(9)	0.0010(9)
C(2')	2*a*	0.4367(3)	0.6697(3)	0.2634(1)	0.018(1)	0.017(1)	0.013(1)	–0.0015(9)	0.003(1)	–0.0012(9)
C(3')	2*a*	0.3923(3)	0.7319(3)	0.2061(1)	0.018(1)	0.012(1)	0.023(1)	0.000(1)	0.000(1)	0.001(1)
C(4')	2*a*	0.4584(3)	0.6945(3)	0.1500(1)	0.018(1)	0.013(1)	0.014(1)	–0.0025(9)	–0.0012(9)	0.0023(9)
C(5')	2*a*	0.5284(3)	0.5314(3)	0.0318(1)	0.019(1)	0.017(1)	0.013(1)	0.001(1)	0.0015(9)	0.001(1)
C(6')	2*a*	0.4044(3)	0.4335(3)	0.0421(1)	0.017(1)	0.020(1)	0.016(1)	0.001(1)	–0.0004(9)	–0.007(1)
C(7')	2*a*	0.4394(3)	0.3122(3)	0.0839(1)	0.019(1)	0.016(1)	0.017(1)	–0.003(1)	0.003(1)	–0.005(1)
C(8')	2*a*	0.5766(3)	0.2901(3)	0.1094(1)	0.020(1)	0.014(1)	0.014(1)	0.000(1)	0.0010(9)	–0.000(1)
C(9')	2*a*	0.8139(3)	0.3907(3)	0.1562(1)	0.015(1)	0.016(1)	0.017(1)	0.0015(9)	0.0017(9)	0.002(1)
C(10')	2*a*	0.7413(3)	0.4275(3)	0.2178(1)	0.017(1)	0.017(1)	0.014(1)	0.001(1)	0.0013(9)	0.001(1)
C(11')	2*a*	0.6176(2)	0.5346(2)	0.2108(1)	0.011(1)	0.013(1)	0.016(1)	–0.0019(9)	0.0011(9)	0.0022(9)
C(12')	2*a*	0.5683(3)	0.5925(2)	0.1515(1)	0.017(1)	0.012(1)	0.016(1)	–0.0034(9)	0.0014(9)	0.0008(9)
C(13')	2*a*	0.6383(3)	0.5430(2)	0.0905(1)	0.017(1)	0.012(1)	0.014(1)	–0.0008(9)	0.0011(9)	0.001(1)
C(14')	2*a*	0.6978(3)	0.3929(3)	0.1007(1)	0.015(1)	0.017(1)	0.014(1)	0.0015(9)	0.0032(9)	–0.002(1)
C(15')	2*a*	0.7678(3)	0.6378(3)	0.0764(1)	0.021(1)	0.020(1)	0.016(1)	–0.003(1)	0.003(1)	0.002(1)
C(16')	2*a*	0.8923(3)	0.6277(3)	0.1283(1)	0.020(1)	0.023(1)	0.020(1)	–0.007(1)	0.001(1)	–0.001(1)
C(17')	2*a*	1.0660(3)	0.4730(3)	0.1838(1)	0.018(1)	0.031(2)	0.025(1)	–0.004(1)	–0.001(1)	0.001(1)
C(18')	2*a*	0.3380(3)	0.1159(3)	0.1341(1)	0.027(1)	0.021(1)	0.023(1)	–0.007(1)	0.001(1)	0.001(1)
C(19')	2*a*	0.1924(3)	0.8521(3)	0.2495(1)	0.021(1)	0.021(1)	0.028(1)	0.003(1)	0.006(1)	–0.003(1)
O(10)	2*a*	0.0173(2)	0.2946(2)	0.0484(1)	0.016(1)	0.037(1)	0.030(1)	0.0012(9)	0.0024(8)	–0.008(1)
O(11)	2*a*	0.1459(2)	0.8573(3)	0.0631(1)	0.029(1)	0.040(1)	0.027(1)	0.002(1)	–0.0067(9)	–0.003(1)
O(9)	2*a*	0.8870(2)	0.4411(2)	0.60142(9)	0.0149(9)	0.0200(9)	0.0225(9)	0.0023(8)	0.0000(7)	–0.0009(8)
O(12)	2*a*	0.0847(3)	0.5416(3)	–0.0944(1)	0.048(1)	0.035(1)	0.045(1)	–0.001(1)	–0.007(1)	0.006(1)

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