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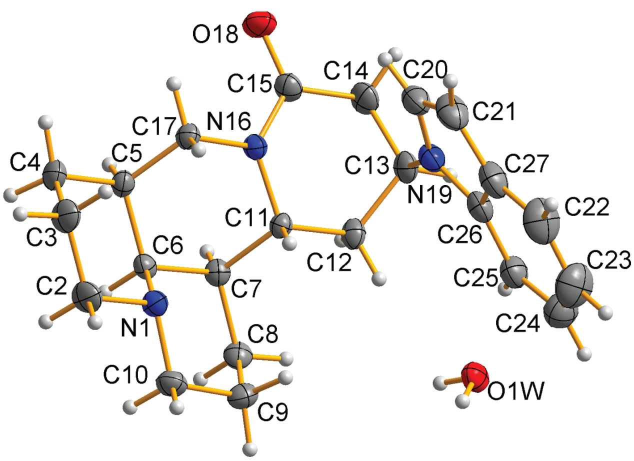
The crystal structure of the Matrine derivative: 12-(1*H*-indol-1-yl) dodecahydro-1*H*,5*H*,10*H*-dipyrido[2,1-*f*:3′,2′,1′-*ij*][1,6]naphthyridin-10-one hydrate, $C_{23}H_{29}N_3O$



https://doi.org/10.1515/ncrs-2017-0144
Received May 18, 2017; accepted September 21, 2017; available online October 9, 2017

Abstract

$C_{23}H_{29}N_3O$, orthorhombic $P2_12_12_1$ (no. 19), $a = 8.62130(10)$ Å, $b = 18.25770(10)$ Å, $c = 25.6873(2)$ Å, $V = 4043.31(6)$ Å^3, $Z = 8$, $R_{gt}(F) = 0.0305$, $wR_{ref}(F^2) = 0.0807$, T = 293(2) K.

CCDC no.: 1548881

One of the two crystallographically different title molecules and one of the two water molecules of the title crystal structure are shown in the figure. Tables 1 and 2 contain details on the crystal structure and measurement conditions and a list of the atoms including atomic coordinates and displacement parameters.

Table 1: Data collection and handling.

Crystal:	Colorless block
Size:	$0.36 \times 0.30 \times 0.20$ mm
Wavelength:	Cu *Kα* radiation (1.54178 Å)
μ:	0.64 mm^{-1}
Diffractometer, scan mode:	Multiwire, φ and ω-scans
$2\theta_{max}$, completeness:	73.9°, >99%
$N(hkl)_{measured}$, $N(hkl)_{unique}$, R_{int}:	38567, 8120, 0.039
Criterion for I_{obs}, $N(hkl)_{gt}$:	$I_{obs} > 2\ \sigma(I_{obs})$, 7843
$N(param)_{refined}$:	521
Programs:	OLEX2 [1], SHELX [2]

Source of materials

The synthesis of the title compound was carried out using the michael addition reaction. A mixture of sophocarpine (1.3 g, 5.0 mmol), indole (0.9 g, 8 mmol) and cesium chloride (0.8 g, 5 mmol) was dissolved in 12 mL petroleum ether, and stirred vigorously at 80 °C with nitrogen protection and condensation cycle. After 5 min, tetramethoxysilane (0.5 mL, 2.5 mmol) was added dropwise with continued stirring and reacting for 9 h. The crude reaction mixture was collected after adding 10 mL of dichloromethane and filtrated with filter tissue. A concentrated brown solution was obtained after removing dichloromethane using a rotary evaporator. The concentrated resulting solution was purified by the silica gel column chromatography eluting with ethyl acetate/ethanol = 10/1. The title compound was crystallized from *n*-hexane/ ethanol(6/1), whereupon a few colorless, rod-shape crystals were obtained.

Experimental details

Hydrogen atoms were placed in calculated positions and were included in the refinement in the riding model approximation, with U_{iso}(H) set to $1.2U_{eq}$(C).

Comment

Matrine is one of the main alkaloid components extracted from the Sophora root, which was first isolated and identified in 1958 from Sophora flavescens Ait, subprostrata and alopecuroides [3–6]. Matrine and its derivatives are known for their importance in pharmaceutical and agricultural applications because of their biological activities, such as anticancer, anti-inflammatory, antimicrobial, antiviral and insecticidal activity [7–11]. Considering the good pharmacological and agricultural effects of matrine, we are interested in developing a general and practical strategy for the preparation. The insecticidal activity and pharmacological activity for the title compound are part of an ongoing study in our laboratory.

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Table 2: Fractional atomic coordinates and isotropic or equivalent isotropic displacement parameters (Å^2).

Atom	x	y	z	U_{iso}*/U_{eq}
N1′	0.74083(12)	0.07011(6)	0.28353(4)	0.0258(2)
C2′	0.89274(16)	0.06038(9)	0.30794(6)	0.0340(3)
H2′A	0.8990	0.0116	0.3227	0.041*
H2′B	0.9039	0.0954	0.3361	0.041*
C3′	1.02461(15)	0.07085(9)	0.26943(6)	0.0356(3)
H3′A	1.0193	0.0334	0.2427	0.043*
H3′B	1.1232	0.0661	0.2873	0.043*
C4′	1.01348(15)	0.14630(9)	0.24436(6)	0.0329(3)
H4′A	1.0906	0.1504	0.2170	0.040*
H4′B	1.0352	0.1836	0.2702	0.040*
C5′	0.85187(14)	0.15903(7)	0.22143(5)	0.0257(3)
H5′	0.8445	0.2105	0.2109	0.031*
C6′	0.72494(14)	0.14408(7)	0.26169(5)	0.0225(2)
H6′	0.7350	0.1798	0.2900	0.027*
C7′	0.56495(13)	0.15343(7)	0.23640(5)	0.0219(2)
H7′	0.5562	0.2042	0.2244	0.026*
C8′	0.44009(14)	0.14068(8)	0.27769(5)	0.0295(3)
H8′A	0.4486	0.1777	0.3046	0.035*
H8′B	0.3383	0.1449	0.2619	0.035*
C9′	0.45798(15)	0.06524(10)	0.30179(6)	0.0360(3)
H9′A	0.4371	0.0280	0.2758	0.043*
H9′B	0.3837	0.0594	0.3298	0.043*
C10′	0.62156(16)	0.05566(9)	0.32280(5)	0.0355(3)
H10A	0.6366	0.0887	0.3520	0.043*
H10B	0.6336	0.0060	0.3356	0.043*
C11′	0.54679(13)	0.10304(6)	0.18859(5)	0.0192(2)
H11′	0.5604	0.0523	0.2001	0.023*
C12′	0.38618(13)	0.11015(7)	0.16423(5)	0.0209(2)
H12A	0.3118	0.0837	0.1854	0.025*
H12B	0.3561	0.1613	0.1640	0.025*
C13′	0.38059(13)	0.08069(6)	0.10895(5)	0.0209(2)
H13′	0.2762	0.0893	0.0951	0.025*
C14′	0.49483(14)	0.12404(6)	0.07620(5)	0.0231(2)
H14A	0.5062	0.0999	0.0428	0.028*
H14B	0.4516	0.1723	0.0698	0.028*
C15′	0.65406(14)	0.13309(6)	0.10019(5)	0.0207(2)
N16′	0.67150(11)	0.12046(6)	0.15120(4)	0.0219(2)
C17′	0.82799(14)	0.11180(8)	0.17319(5)	0.0259(3)
H17A	0.9042	0.1251	0.1471	0.031*
H17B	0.8444	0.0608	0.1822	0.031*
O18′	0.76480(10)	0.14995(5)	0.07147(3)	0.02536(19)
N19′	0.41092(12)	0.00158(5)	0.10717(4)	0.0204(2)
C20′	0.54803(14)	−0.03454(7)	0.09693(5)	0.0236(2)
H20′	0.6406	−0.0120	0.0875	0.028*
C21′	0.52813(16)	−0.10826(7)	0.10261(5)	0.0268(3)
H21′	0.6031	−0.1442	0.0976	0.032*
C22′	0.27984(19)	−0.18164(8)	0.12925(6)	0.0340(3)
H22′	0.3231	−0.2283	0.1281	0.041*
C23′	0.12632(19)	−0.17240(8)	0.14223(6)	0.0377(3)
H23′	0.0658	−0.2133	0.1496	0.045*
C24′	0.05930(16)	−0.10259(9)	0.14465(6)	0.0339(3)
H24′	−0.0448	−0.0980	0.1536	0.041*
C25′	0.14492(15)	−0.04024(8)	0.13400(5)	0.0272(3)
H25′	0.1008	0.0062	0.1358	0.033*
C26′	0.30079(14)	−0.04997(7)	0.12040(5)	0.0218(2)
C27′	0.37065(16)	−0.11980(7)	0.11769(5)	0.0256(3)
N1	0.56425(12)	0.62700(6)	0.05129(4)	0.0238(2)
C2	0.62153(17)	0.70209(7)	0.05779(7)	0.0352(3)
H2A	0.5582	0.7271	0.0834	0.042*
H2B	0.6113	0.7281	0.0250	0.042*
C3	0.78966(17)	0.70419(7)	0.07504(7)	0.0347(3)
H3A	0.7998	0.6811	0.1089	0.042*
H3B	0.8238	0.7546	0.0781	0.042*
C4	0.89048(16)	0.66403(7)	0.03543(6)	0.0313(3)
H4A	0.8909	0.6910	0.0029	0.038*
H4B	0.9963	0.6616	0.0481	0.038*
C5	0.82989(14)	0.58662(6)	0.02594(5)	0.0225(2)
H5	0.8859	0.5666	−0.0041	0.027*
C6	0.65623(14)	0.58709(6)	0.01221(5)	0.0213(2)
H6	0.6435	0.6117	−0.0214	0.026*
C7	0.59632(14)	0.50821(6)	0.00692(5)	0.0210(2)
H7	0.6537	0.4852	−0.0217	0.025*
C8	0.42432(15)	0.50899(7)	−0.00854(5)	0.0260(3)
H8A	0.4137	0.5290	−0.0433	0.031*
H8B	0.3849	0.4592	−0.0090	0.031*
C9	0.32931(14)	0.55472(8)	0.02939(5)	0.0281(3)
H9A	0.2238	0.5593	0.0167	0.034*
H9B	0.3260	0.5306	0.0630	0.034*
C10	0.40049(15)	0.63013(7)	0.03531(6)	0.0301(3)
H10C	0.3928	0.6560	0.0024	0.036*
H10D	0.3421	0.6576	0.0610	0.036*
C11	0.62982(14)	0.46343(6)	0.05660(4)	0.0195(2)
H11	0.5798	0.4879	0.0861	0.023*
C12	0.56533(15)	0.38624(7)	0.05242(5)	0.0251(3)
H12C	0.5727	0.3701	0.0165	0.030*
H12D	0.4564	0.3869	0.0619	0.030*
C13	0.64980(16)	0.33161(7)	0.08708(5)	0.0269(3)
H13	0.6058	0.2829	0.0808	0.032*
C14	0.81842(17)	0.33058(7)	0.07025(6)	0.0326(3)
H14C	0.8766	0.2999	0.0941	0.039*
H14D	0.8253	0.3085	0.0360	0.039*
C15	0.89277(15)	0.40555(7)	0.06847(5)	0.0267(3)
N16	0.79929(12)	0.46406(5)	0.06521(4)	0.0217(2)
C17	0.86376(14)	0.53735(6)	0.07247(5)	0.0221(2)
H17C	0.9751	0.5337	0.0773	0.027*
H17D	0.8198	0.5591	0.1036	0.027*
O18	1.03566(11)	0.41139(5)	0.07156(5)	0.0363(2)
N19	0.63303(13)	0.34846(6)	0.14266(4)	0.0276(2)
C20	0.74580(18)	0.37074(8)	0.17771(6)	0.0347(3)
H20	0.8495	0.3787	0.1695	0.042*
C21	0.6833(2)	0.37917(9)	0.22567(6)	0.0409(4)
H21	0.7357	0.3938	0.2556	0.049*
C22	0.3982(2)	0.35928(10)	0.25712(7)	0.0503(4)
H22	0.4128	0.3723	0.2918	0.060*
C23	0.2544(2)	0.33760(11)	0.23985(7)	0.0539(4)
H23	0.1717	0.3365	0.2631	0.065*
C24	0.2305(2)	0.31723(9)	0.18792(7)	0.0428(4)
H24	0.1324	0.3021	0.1774	0.051*
C25	0.34933(17)	0.31915(8)	0.15213(6)	0.0315(3)

Table 2 (continued)

Atom	*x*	*y*	*z*	$U_{iso}*/U_{eq}$
H25	0.3332	0.3058	0.1176	0.038*
C26	0.49531(17)	0.34203(7)	0.16959(5)	0.0279(3)
C27	0.5227(2)	0.36160(8)	0.22203(6)	0.0359(3)
O1W	0.20777(11)	0.29923(5)	0.02952(4)	0.0295(2)
O2W	0.09101(12)	0.17699(6)	0.08043(5)	0.0377(2)
H1WA	0.229(2)	0.3133(11)	0.0001(9)	0.048(5)*
H2WA	−0.011(3)	0.1734(13)	0.0756(9)	0.062(6)*
H1WB	0.164(3)	0.3366(12)	0.0448(9)	0.057(6)*
H2WB	0.122(2)	0.2160(12)	0.0602(8)	0.052(6)*

To explore the synthetic strategy, sophocarpine is a suitable starting material because it contains an a, b-unsaturated carbonyl group that is reactive toward a variety of useful nucleophiles. Therefore, in the present study, sophocarpine was used as starting material to design and synthesize a matrine derivative by introducing indole group to C13, forming a bond (C13—N19) with bond length 1.4685 Å. The planes of the phenyl groups (C12—C13) make dihedral angle with the mean plane of indole group (N19—C20) equal to 111.8 Å. The molecules were packed in the crystal structure without any hydrogen bonds.

Acknowledgements: This work was sponsored by the National Natural Science Foundation of China (no. 201376281–21406274).

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