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Crystal structure of (*E*)-*N*-((2*S*,3*S*,4*R*,10*R*,13*S*, 17*S*)-17-(1-(dimethylamino)ethyl)-2,4-dihydroxy-10,13-dimethylhexadecahydro-1*H*-cyclopenta[*a*]phenanthren-3-yl)-2-methylbut-2-enamide, C₂₄H₄₈N₂O₃

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Abstract

C₂₄H₄₈N₂O₃, monoclinic, *P*2₁ (no. 4), *a* = 14.805(3) Å, *b* = 10.0557(18) Å, *c* = 18.061(3) Å, β = 98.935(5)°, *V* = 2656.3(8) Å³, *Z* = 4, *R*_{gt}(*F*) = 0.0674, *wR*_{ref}(*F*²) = 0.1955, *T* = 173 K.

CCDC no.: 1876201

The asymmetric unit of the title crystal structure is shown in the figure. Tables 1 and 2 contain details on crystal structure

Table 1: Data collection and handling.

Crystal:	Colourless block
Size:	0.28 × 0.15 × 0.12 mm
Wavelength:	Mo Kα radiation (0.71073 Å)
μ:	0.07 mm ⁻¹
Diffractometer, scan mode:	Bruker APEX-II, ω and φ
θ _{max} , completeness:	26.3°, >99%
<i>N</i> (<i>hkl</i>) _{measured} , <i>N</i> (<i>hkl</i>) _{unique} , <i>R</i> _{int} :	22053, 10586, 0.063
Criterion for <i>I</i> _{obs} , <i>N</i> (<i>hkl</i>) _{gt} :	<i>I</i> _{obs} > 2 σ(<i>I</i> _{obs}), 6703
<i>N</i> (<i>param</i>) _{refined} :	614
Programs:	Olex2 [1], SHELX [2, 3]

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and measurement conditions and a list of the atoms including atomic coordinates and displacement parameters.

Source of material

The stems and roots of *Sarcococa hookeriana* (14.5 kg) were extracted three times using MeOH with ultrasonic. The extract was concentrated and then partitioned between EtOAc and 1% aq. H₂SO₄. The acid-soluble fraction was alkalized with aq. Na₂CO₃ to pH 9 and followed by exhaustive extraction with CH₂Cl₂ to afford crude alkaloids. The crude alkaloids were roughly separated by CC(SiO₂; CH₂Cl₂/MeOH/Et₂NH, 100:0:0–10:1:0–5:1:1) to give five fractions: *Frs. A–E*. The title

Table 2: Fractional atomic coordinates and isotropic or equivalent isotropic displacement parameters (Å²).

Atom	<i>x</i>	<i>y</i>	<i>z</i>	<i>U</i> _{iso} */ <i>U</i> _{eq}
O1	0.11565(18)	0.4342(3)	0.42753(15)	0.0447(8)
H1	0.1118	0.4572	0.3824	0.067*
O2	−0.01866(17)	0.3441(3)	0.50558(16)	0.0429(7)
H2	0.0137	0.4073	0.4942	0.064*
O3	0.0572(2)	0.0274(3)	0.31575(15)	0.0480(8)
O4	0.20444(18)	0.9290(3)	0.41425(15)	0.0441(8)
H4	0.1532	0.9399	0.3877	0.066*
O5	0.34144(19)	0.8956(3)	0.32612(15)	0.0410(7)
H5	0.3102	0.9450	0.3498	0.061*
O6	0.1374(2)	0.5184(3)	0.29035(16)	0.0565(9)
N1	0.0098(2)	0.2077(4)	0.37207(18)	0.0453(9)
H1A	−0.0323	0.2701	0.3691	0.054*
N2	0.5668(3)	0.2131(4)	0.97171(18)	0.0506(10)
N3	0.1900(2)	0.7288(3)	0.29739(18)	0.0393(8)
H3	0.1845	0.8080	0.2765	0.047*
N4	0.7356(2)	0.7318(4)	0.90779(18)	0.0468(10)
C1	0.2250(2)	0.2942(5)	0.5073(2)	0.0380(10)
H1B	0.2699	0.3665	0.5051	0.046*
H1C	0.2583	0.2088	0.5069	0.046*
C2	0.1538(2)	0.3012(4)	0.4369(2)	0.0400(10)
H2A	0.1840	0.2796	0.3926	0.048*
C3	0.0768(3)	0.2021(4)	0.4402(2)	0.0383(10)
H3A	0.1041	0.1109	0.4438	0.046*
C4	0.0324(3)	0.2244(4)	0.5092(2)	0.0388(10)
H4A	−0.0122	0.1501	0.5107	0.047*
C5	0.1055(2)	0.2093(4)	0.5797(2)	0.0348(9)
H5A	0.1315	0.1182	0.5761	0.042*
C6	0.0659(3)	0.2094(5)	0.6525(2)	0.0474(11)
H6A	0.0149	0.1450	0.6489	0.057*
H6B	0.0416	0.2988	0.6611	0.057*
C7	0.1400(3)	0.1716(5)	0.7185(2)	0.0506(12)
H7A	0.1146	0.1814	0.7658	0.061*
H7B	0.1564	0.0769	0.7136	0.061*
C8	0.2267(2)	0.2557(4)	0.7234(2)	0.0333(9)
H8	0.2114	0.3492	0.7356	0.040*
C9	0.2618(2)	0.2557(4)	0.6470(2)	0.0324(9)
H9	0.2738	0.1605	0.6357	0.039*
C10	0.1882(2)	0.3053(4)	0.5822(2)	0.0305(9)
C11	0.3542(2)	0.3277(4)	0.6518(2)	0.0379(10)
H11A	0.3444	0.4243	0.6578	0.045*
H11B	0.3781	0.3145	0.6041	0.045*
C12	0.4262(3)	0.2788(5)	0.71723(19)	0.0384(10)
H12A	0.4426	0.1855	0.7079	0.046*
H12B	0.4822	0.3335	0.7196	0.046*
C13	0.3909(3)	0.2872(4)	0.79265(19)	0.0322(9)
C14	0.3017(3)	0.2054(4)	0.7846(2)	0.0384(10)
H14	0.3176	0.1137	0.7694	0.046*
C15	0.2813(3)	0.1947(5)	0.8642(2)	0.0564(13)
H15A	0.2469	0.1122	0.8708	0.068*
H15B	0.2452	0.2720	0.8768	0.068*
C16	0.3760(3)	0.1922(5)	0.9135(2)	0.0530(12)
H16A	0.3865	0.1054	0.9393	0.064*
H16B	0.3805	0.2633	0.9519	0.064*
C17	0.4470(3)	0.2150(4)	0.8603(2)	0.0379(10)
H17	0.4639	0.1257	0.8423	0.045*

Table 2 (continued)

Atom	<i>x</i>	<i>y</i>	<i>z</i>	<i>U</i> _{iso} */ <i>U</i> _{eq}
C18	0.3769(3)	0.4358(4)	0.8120(2)	0.0437(11)
H18A	0.3316	0.4759	0.7731	0.066*
H18B	0.4351	0.4834	0.8148	0.066*
H18C	0.3552	0.4418	0.8605	0.066*
C19	0.1633(3)	0.4517(4)	0.5971(2)	0.0368(10)
H19A	0.1378	0.4567	0.6439	0.055*
H19B	0.1180	0.4838	0.5556	0.055*
H19C	0.2184	0.5069	0.6011	0.055*
C20	0.5356(3)	0.2807(4)	0.8993(2)	0.0410(10)
H20	0.5194	0.3739	0.9116	0.049*
C21	0.6094(3)	0.2906(5)	0.8491(2)	0.0500(12)
H21A	0.6679	0.3139	0.8796	0.075*
H21B	0.5924	0.3593	0.8111	0.075*
H21C	0.6152	0.2048	0.8245	0.075*
C22	0.6059(5)	0.0793(6)	0.9629(3)	0.0812(19)
H22A	0.5635	0.0275	0.9269	0.122*
H22B	0.6155	0.0337	1.0114	0.122*
H22C	0.6645	0.0883	0.9445	0.122*
C23	0.6302(4)	0.2913(6)	1.0228(2)	0.0674(15)
H23A	0.6878	0.3007	1.0029	0.101*
H23B	0.6419	0.2468	1.0717	0.101*
H23C	0.6040	0.3795	1.0287	0.101*
C24	0.0075(3)	0.1252(4)	0.3135(2)	0.0383(10)
C25	−0.0608(3)	0.1558(5)	0.2455(2)	0.0478(12)
C26	−0.0773(5)	0.0609(7)	0.1905(3)	0.0903(19)
H26	−0.0456	−0.0214	0.1974	0.108*
C27	−0.1424(6)	0.0818(10)	0.1210(4)	0.152(3)
H27A	−0.1265	0.1636	0.0965	0.228*
H27B	−0.2045	0.0895	0.1331	0.228*
H27C	−0.1395	0.0062	0.0872	0.228*
C28	−0.1047(5)	0.2817(7)	0.2351(3)	0.109(2)
H28A	−0.1430	0.2954	0.2741	0.164*
H28B	−0.1430	0.2846	0.1857	0.164*
H28C	−0.0584	0.3520	0.2384	0.164*
C30	0.3465(2)	0.7647(4)	0.3584(2)	0.0314(9)
H30	0.3689	0.7038	0.3214	0.038*
C31	0.2519(2)	0.7152(4)	0.3690(2)	0.0318(9)
H31	0.2568	0.6187	0.3823	0.038*
C32	0.2171(2)	0.7899(4)	0.4331(2)	0.0346(9)
H32	0.1569	0.7513	0.4406	0.041*
C33	0.2852(2)	0.7722(4)	0.50548(19)	0.0305(9)
H33	0.2898	0.6741	0.5141	0.037*
C34	0.2513(3)	0.8292(5)	0.5744(2)	0.0431(11)
H34A	0.1880	0.7986	0.5755	0.052*
H34B	0.2506	0.9275	0.5714	0.052*
C35	0.3132(2)	0.7852(4)	0.6469(2)	0.0361(9)
H35A	0.2929	0.8304	0.6901	0.043*
H35B	0.3060	0.6882	0.6535	0.043*
C36	0.4142(2)	0.8164(4)	0.64651(19)	0.0272(8)
H36	0.4214	0.9153	0.6482	0.033*
C37	0.4462(2)	0.7662(4)	0.57300(19)	0.0271(8)
H37	0.4385	0.6674	0.5725	0.033*
C38	0.3845(2)	0.8195(3)	0.50077(19)	0.0271(8)
C39	0.5487(2)	0.7922(4)	0.57444(19)	0.0295(9)
H39A	0.5588	0.8892	0.5710	0.035*
H39B	0.5682	0.7501	0.5300	0.035*

Table 2 (continued)

Atom	<i>x</i>	<i>y</i>	<i>z</i>	U_{iso}^*/U_{eq}
C40	0.6083(2)	0.7387(4)	0.64545(19)	0.0312(9)
H40A	0.6040	0.6404	0.6460	0.037*
H40B	0.6729	0.7628	0.6444	0.037*
C41	0.5790(2)	0.7941(4)	0.71643(19)	0.0280(8)
C42	0.4769(2)	0.7592(4)	0.71355(19)	0.0299(9)
H42	0.4725	0.6603	0.7084	0.036*
C43	0.4574(3)	0.7917(4)	0.7924(2)	0.0370(10)
H43A	0.4058	0.7379	0.8049	0.044*
H43B	0.4429	0.8872	0.7970	0.044*
C44	0.5476(3)	0.7552(4)	0.8437(2)	0.0424(11)
H44A	0.5682	0.8299	0.8778	0.051*
H44B	0.5386	0.6760	0.8743	0.051*
C45	0.6192(3)	0.7257(4)	0.79245(19)	0.0327(9)
H45	0.6193	0.6276	0.7836	0.039*
C46	0.5952(3)	0.9446(4)	0.7218(2)	0.0361(10)
H46A	0.5557	0.9890	0.6806	0.054*
H46B	0.6593	0.9637	0.7184	0.054*
H46C	0.5808	0.9772	0.7697	0.054*
C47	0.3945(3)	0.9719(3)	0.4973(2)	0.0329(9)
H47A	0.3844	1.0109	0.5450	0.049*
H47B	0.3493	1.0073	0.4567	0.049*
H47C	0.4562	0.9943	0.4879	0.049*
C48	0.7167(3)	0.7662(4)	0.8274(2)	0.0385(10)
H48	0.7190	0.8655	0.8247	0.046*
C49	0.7883(3)	0.7147(6)	0.7821(2)	0.0625(15)
H49A	0.8494	0.7268	0.8110	0.094*
H49B	0.7837	0.7641	0.7349	0.094*
H49C	0.7777	0.6199	0.7713	0.094*
C50	0.8116(3)	0.8062(6)	0.9477(2)	0.0651(15)
H50A	0.8682	0.7790	0.9301	0.098*
H50B	0.8166	0.7884	1.0015	0.098*
H50C	0.8014	0.9014	0.9384	0.098*
C51	0.7466(4)	0.5929(5)	0.9229(3)	0.0753(18)
H51A	0.6921	0.5451	0.8989	0.113*
H51B	0.7550	0.5779	0.9771	0.113*
H51C	0.8004	0.5602	0.9029	0.113*
C52	0.1420(3)	0.6300(4)	0.2621(2)	0.0389(10)
C53	0.0936(3)	0.6579(5)	0.1841(2)	0.0515(12)
C54	0.1019(5)	0.7901(7)	0.1518(3)	0.117(3)
H54A	0.0703	0.8554	0.1789	0.175*
H54B	0.0743	0.7894	0.0989	0.175*
H54C	0.1667	0.8141	0.1561	0.175*
C55	0.0406(4)	0.5617(6)	0.1492(3)	0.0746(16)
H55	0.0350	0.4823	0.1767	0.089*
C56	−0.0109(6)	0.5678(10)	0.0707(4)	0.140(3)
H56A	0.0043	0.4897	0.0426	0.211*
H56B	0.0063	0.6487	0.0460	0.211*
H56C	−0.0767	0.5688	0.0723	0.211*
C57	0.4143(2)	0.7542(4)	0.43116(19)	0.0304(9)
H57A	0.4727	0.7952	0.4228	0.036*
H57B	0.4264	0.6589	0.4422	0.036*

compound was obtained from *Fr. C* by silica gel column chromatography using petroleum ether/acetone/diethylamine (30:1:1) and dichloromethane/methanol (20:1) as the eluent.

Recrystallization with dichloromethane was undertaken at room temperature.

Experimental details

The crystal structure was solved by direct methods and refined by full-matrix least-squares methods on F^2 using Olex2 [3]. All hydrogen atoms were positioned geometrically, with the $d(C-H) = 0.95-1.00$ Å. The $U_{iso}(H)$ were set to 1.2 times $U_{eq}(C)$ for the methylene groups as well as methenyl groups, at 1.5 times $U_{eq}(C)$ for the methyl groups. Due to the quality of the data the Flack parameter isn't conclusive.

Comment

Steroidal alkaloids have a wide spectrum of biological activities, such as cholinesterase inhibiting, antiplasmodial [4], antiinflammatory [5], antibacterial and cytotoxic [6] activities.

Compared with the previous crystal structure report of our team [7], the asymmetric unit of the title structure contains two crystallographically independent but chemically identical molecules (figure). Geometric parameters of the title structure are in the usual ranges. The compound contains two hydroxys, one amide, one double bond and one dimethylamino group. The C2—O1 distance is 1.452(5) Å and C4—O2 distance is 1.418(5) Å. The amide was confirmed by the distance of 1.226(5) Å, and 1.340(5) Å (C24—O3 and C24—N1). The C25—C26 distance is 1.372(8) Å. The dimethylamino group was confirmed by the distance of 1.443(6) Å, and 1.483(7) Å for C23—N2 and C22—N2, respectively. The compound contains three six-membered rings and one five-membered ring. The intermolecular connection were achieved by van der Waals interactions and hydrogen bonds.

In the molecules, there are strong intramolecular O—H...O hydrogen bonds (O1—H2...O2: $d(O1...O2) = 2.763$ Å and O5—H5...O4: $d(O5...O4) = 2.786$ Å). In addition, the structure of the title compound formed a chain structure *via* strong intermolecular hydrogen bonds (O1—H1...O6: $d(O1...O6) = 2.685$ Å, O4—H4...O3: $d(O4...O3) = 2.773$ Å) (*cf.* the figure).

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