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The crystal structure of (8*R*,10*R*,12*R*,14*R*)-12-hydroxy-16-(5-(2-hydroxypropan-2-yl)-2-methyltetrahydrofuran-2-yl)-4,4,8,10,14-pentamethyltetradecahydro-3*H*-cyclopenta[*a*]phenanthrene-3,6(2*H*)-dione, C₃₀H₄₈O₅

<https://doi.org/10.1515/ncrs-2020-0453>

Received August 24, 2020; accepted October 12, 2020;

published online November 2, 2020

Abstract: C₃₀H₄₈O₅, orthorhombic, *P*2₁2₁2₁ (no. 19), *a* = 11.6608(10) Å, *b* = 14.8098(15) Å, *c* = 15.9975(16) Å, *V* = 2762.7(5) Å³, *Z* = 4, *R*_{gt}(*F*) = 0.0586, *wR*_{ref}(*F*²) = 0.1580, *T* = 293(2) K.

CCDC no.: 2024015

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The molecular structure is shown in the figure. Table 1 contains crystallographic data and Table 2 contains the list of the atoms including atomic coordinates and displacement parameters.

Table 1: Data collection and handling.

Crystal:	Colourless block
Size:	0.42 × 0.40 × 0.31 mm
Wavelength:	Cu Kα radiation (1.54178 Å)
μ:	0.62 mm ⁻¹
Diffractometer, scan mode:	Bruker SMART, φ and ω
θ _{max} , completeness:	66.0°, >99 %
<i>N</i> (<i>hkl</i>) _{measured} , <i>N</i> (<i>hkl</i>) _{unique} , <i>R</i> _{int} :	6065, 4116, 0.044
Criterion for <i>I</i> _{obs} , <i>N</i> (<i>hkl</i>) _{gt} :	<i>I</i> _{obs} > 2 σ(<i>I</i> _{obs}), 2044
<i>N</i> (<i>param</i>) _{refined} :	326
Programs:	Bruker [1], Olex2 [2], SHELX [3, 4]

Source of material

A solution of 20(*S*)-protopanaxatriol in dichloromethane was cooled to 270 K. A dichloromethane solution with *m*-chloroperoxybenzoic acid (*m*-CPBA) was added slowly. After stirring for 1 h, isopropanol was added and stirred for another 1 h. The organic phase was washed successively with saturated sodium bicarbonate solution, water and brine, and dried over sodium sulfate. The organic phase was evaporated in vacuum, yielding a white solid. The mixture of the intermediate above in dichloromethane was treated with pyridinium chlorochromate at room temperature for 6 h to obtain the title compound, which was purified by silica-gel column chromatography (petroleum ether: ethyl acetate = 1:2, v/v). Suitable crystal was obtained by slow evaporation in ethyl acetate.

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	0.1841 (4)	0.9592 (3)	0.8869 (4)	0.1043 (18)
O2	0.5365 (3)	0.7560 (3)	0.9715 (3)	0.0883 (14)
O3	0.1132 (4)	0.3882 (3)	0.8648 (3)	0.0867 (14)
H3	0.123919	0.336961	0.882448	0.130*
O4	0.2026 (3)	0.2327 (3)	0.9135 (2)	0.0606 (11)
O5	0.2499 (5)	0.2876 (4)	0.7412 (3)	0.1093 (18)
H5	0.215914	0.323060	0.771758	0.164*
C1	0.1760 (4)	0.7306 (4)	0.8353 (4)	0.0612 (16)
H1A	0.149391	0.691232	0.790909	0.073*
H1B	0.119683	0.728596	0.879875	0.073*
C2	0.1827 (5)	0.8273 (4)	0.8017 (4)	0.0735 (19)
H2A	0.229336	0.828044	0.751511	0.088*
H2B	0.106283	0.847606	0.786813	0.088*
C3	0.2334 (6)	0.8911 (5)	0.8653 (5)	0.073 (2)
C4	0.3497 (5)	0.8645 (4)	0.9033 (4)	0.0678 (18)
C5	0.3370 (4)	0.7649 (4)	0.9326 (3)	0.0588 (16)
H5A	0.277254	0.767547	0.975602	0.071*
C6	0.4398 (5)	0.7264 (4)	0.9778 (4)	0.0683 (18)
C7	0.4121 (5)	0.6436 (4)	1.0295 (4)	0.0692 (18)
H7A	0.355608	0.659230	1.071591	0.083*
H7B	0.480792	0.623217	1.057899	0.083*
C8	0.3649 (4)	0.5665 (4)	0.9742 (4)	0.0566 (15)
C9	0.2643 (4)	0.6054 (4)	0.9197 (4)	0.0531 (14)
H9	0.205477	0.623345	0.960192	0.064*
C10	0.2912 (4)	0.6937 (4)	0.8690 (4)	0.0563 (15)
C11	0.2074 (5)	0.5309 (4)	0.8667 (4)	0.0668 (18)
H11A	0.142774	0.556311	0.836687	0.080*
H11B	0.262064	0.508808	0.825871	0.080*
C12	0.1660 (5)	0.4522 (4)	0.9200 (4)	0.0643 (17)
H12	0.107454	0.474709	0.958771	0.077*
C13	0.2649 (5)	0.4139 (4)	0.9710 (4)	0.0554 (15)
H13	0.325496	0.397354	0.931453	0.066*
C14	0.3144 (4)	0.4891 (4)	1.0283 (4)	0.0581 (15)
C15	0.3987 (5)	0.4336 (4)	1.0819 (4)	0.0697 (18)
H15A	0.467097	0.418366	1.050372	0.084*
H15B	0.420865	0.466519	1.131791	0.084*
C16	0.3298 (5)	0.3485 (4)	1.1042 (4)	0.0697 (18)
H16A	0.287002	0.357760	1.155522	0.084*
H16B	0.380602	0.297318	1.111686	0.084*
C17	0.2462 (5)	0.3317 (4)	1.0293 (4)	0.0599 (16)
H17	0.167219	0.333136	1.050211	0.072*
C18	0.2692 (4)	0.2387 (4)	0.9909 (4)	0.0600 (16)
C19	0.3941 (4)	0.2216 (4)	0.9624 (4)	0.0687 (18)
H19A	0.440596	0.275048	0.971343	0.082*
H19B	0.427410	0.171921	0.993587	0.082*
C20	0.3887 (5)	0.1990 (6)	0.8709 (4)	0.090 (2)
H20A	0.436868	0.147365	0.858279	0.108*
H20B	0.413697	0.249849	0.837313	0.108*
C21	0.2633 (5)	0.1774 (4)	0.8541 (4)	0.0641 (17)
H21	0.249175	0.113663	0.866903	0.077*
C22	0.2229 (5)	0.1972 (5)	0.7650 (5)	0.075 (2)
C23	0.0948 (5)	0.1821 (5)	0.7571 (4)	0.092 (2)
H23A	0.054799	0.224532	0.791873	0.138*
H23B	0.076422	0.121744	0.774556	0.138*
H23C	0.072000	0.190333	0.699985	0.138*

Table 2: (continued)

Atom	<i>x</i>	<i>y</i>	<i>z</i>	<i>U</i> _{iso} */ <i>U</i> _{eq}
C24	0.2860 (6)	0.1355 (6)	0.7043 (5)	0.123 (3)
H24A	0.262886	0.149284	0.648157	0.184*
H24B	0.267832	0.073723	0.716691	0.184*
H24C	0.367193	0.144643	0.709833	0.184*
C25	0.4414 (5)	0.8819 (5)	0.8350 (4)	0.085 (2)
H25A	0.418420	0.853036	0.783942	0.127*
H25B	0.513739	0.857776	0.852908	0.127*
H25C	0.448747	0.945703	0.825834	0.127*
C26	0.3763 (7)	0.9243 (5)	0.9793 (5)	0.095 (2)
H26A	0.383365	0.985967	0.961668	0.142*
H26B	0.446838	0.904955	1.004537	0.142*
H26C	0.315184	0.919278	1.019301	0.142*
C27	0.4677 (4)	0.5325 (4)	0.9207 (4)	0.0695 (19)
H27A	0.509278	0.583419	0.899057	0.104*
H27B	0.439619	0.496670	0.875068	0.104*
H27C	0.517743	0.496629	0.954819	0.104*
C28	0.3729 (5)	0.6778 (5)	0.7935 (4)	0.0700 (18)
H28A	0.364549	0.616886	0.773958	0.105*
H28B	0.450725	0.687768	0.810719	0.105*
H28C	0.353751	0.718982	0.749307	0.105*
C29	0.2219 (5)	0.5249 (4)	1.0910 (4)	0.0734 (19)
H29A	0.259169	0.549041	1.139606	0.110*
H29B	0.172370	0.476198	1.107164	0.110*
H29C	0.177517	0.571442	1.064568	0.110*
C30	0.2271 (6)	0.1636 (4)	1.0489 (4)	0.082 (2)
H30A	0.148728	0.174878	1.064095	0.122*
H30B	0.273675	0.162298	1.098338	0.122*
H30C	0.232398	0.106621	1.020615	0.122*

Experimental details

All hydrogen atoms were included in calculated positions and refined as riding atoms, with O–H = 0.82 or 0.85 Å and $U_{iso}(H) = 1.2U_{eq}(O)$, H atoms on C atoms were placed in geometrically idealized positions and constrained to ride on their parent C atoms, with C–H = 0.96 Å, $U_{iso}(H) = 1.5U_{eq}(C)$ for methyl H atoms, and with C–H = 0.98 Å and 0.97 Å for methine and methylene H atoms, and both with $U_{iso}(H) = 1.2U_{eq}$. The absolute configuration was derived from the synthesis.

Comment

Ginsenosides can be classified as ocotillol-type, oleanolic acid type, protopanaxadiol (PPD) type, protopanaxatriol (PPT) type [5–7]. The ocotillol-type triterpenes are a rare kind of ginsenosides characterized by a tetrahydrofuran ring on the side chain [8–11]. It has been reported that ocotillol-type triterpenes have antibacterial, antioxidative, anti-inflammatory, neuroprotective and cardioprotective

properties [12–16]. It is worth noting that the stereo-configuration of the C-24 position may influence their stereoselectivity in pharmacological action and pharmacokinetics [17]. For example, the 24*R*-epimer exerted the cardioprotective effects, whilst the 24*S*-epimer had no effect and the bioavailability of the 24*R*-epimer was about 14 times that of the 24*S*-epimer. Moreover, our previous studies also showed that similar compounds have corresponding stereoselective bioactivities [18]. Therefore, the structural modification of ocotillol-type triterpenes may be of great value for obtaining novel derivatives for pharmacological screening and structure-activity relationship studies.

The asymmetric unit of the title compound consists of one molecule composed of tetrahydrofuran ring and a dammarane skeleton. The tetrahydrofuran ring adopts an envelope conformation with C18 forming the flap. The C20–C19–C18–C30 torsion angle is $110.7(7)^\circ$, suggesting the C18 with *S* form. The C19–C20–C21–H21 and C19–C20–C21–C22 torsion angles are $-86.1(6)$ and $150.9(6)^\circ$, suggesting the C21 is in the *R* configuration. Two carbon-oxygen double bonds exist in the compound, the C–O double bond distance (C3–O1) is $1.209(9)$ Å, the C–O bond distance (C6–O2) is $1.216(7)$ Å. The intramolecular O3–H3...O4 and O5–H5...O3 hydrogen bonds are present. The corresponding O3...O4 and H3...O4 distances are $2.646(6)$ and 1.8600 Å, respectively, and O3–H3...O4 is 159.200° . The corresponding O5...O3 and H5...O3 distances are $2.945(8)$ and 2.1400 Å, respectively, and O5–H5...O3 is 167.000° . The bond lengths and angles are all in the expected ranges [19, 20].

Acknowledgments: X-ray data were collected at Institute of Medical Biotechnology, Chinese Academy of Medical Sciences & Peking Union Medical College, Beijing, 100050, Peoples Republic of China.

Author contribution: All the authors have accepted responsibility for the entire content of this submitted manuscript and approved submission.

Research funding: This work was supported by the National Natural Science Foundation of China (No. 81473104, 81773563) and Science and Technology Innovation Development Plan of Yantai (No. 2020XDRH105).

Conflict of interest statement: The authors declare no conflicts of interest regarding this article.

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