

(4a*SR*,10a*RS*)-1,2,3,4,4a,10a-Hexahydro-6,7-dimethoxy-1,1,4a-trimethylphenanthrene-9,10-dioneYi Xiong,^a Cui-Rong Sun,^{a*}
Mao-Lin Hu^b and Miao-Chang
Liu^b^aDepartment of Chemistry, Zhejiang University, Hangzhou 310027, People's Republic of China, and ^bDepartment of Chemistry, Wenzhou University, Wenzhou 325027, People's Republic of China

Correspondence e-mail: cheyjpan@zju.edu.cn

Key indicatorsSingle-crystal X-ray study
T = 298 K
Mean $\sigma(\text{C}-\text{C}) = 0.004 \text{ \AA}$
R factor = 0.083
wR factor = 0.165
Data-to-parameter ratio = 13.9For details of how these key indicators were automatically derived from the article, see <http://journals.iucr.org/e>.The title diterpene, C₁₉H₂₄O₄, which was totally synthesized from geranic acid, has the tricyclic backbone of a podocarpic diterpene. The skeleton does not show a planar configuration, but is distinctly bent.

Received 19 October 2005

Accepted 24 October 2005

Online 31 October 2005

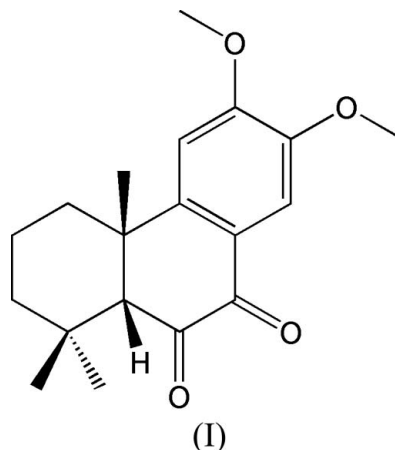
CommentDuring chemical studies of podocarpic diterpenes, these compounds were found to have broad bioactivities. The aim of the present work in our laboratory was to search for some potential antitumour compounds by modifying the structures of some bioactive podocarpic diterpenes. The title compound, (I), showed three to six times the activity of the current lead compound against three cultured human tumour cell lines, HeLa, CNE and MCF (IC₅₀ = 16.1, 5.6 and 16.5 µg/ml, respectively). We report here the crystal structure of compound (I).

Fig. 1 shows the molecular structure of (I), with the octahydrophenanthrene backbone. Selected bond distances and angles are listed in Table 1. Because of the different configuration of atom H9 compared with normal podocarpic diterpenes (Li *et al.*, 2003; Zambrano *et al.*, 2003), the skeleton of (I) is not planar, but distinctly bent. The C9–C14 ring, furthest from the benzene ring, adopts a chair conformation, while the other ring, fused to the benzene ring, adopts a half-chair conformation, due to the conjugation of the benzene ring and keto group. The C11–C10–C9–C14 torsion angle of 51.3 (3)° describes the *cis* configuration of the two fused rings. Also, the C14–C9–C10–C5 torsion angle of –74.3 (3)° suggests a *cis*-C9,C10 configuration.

There are no intramolecular hydrogen bonds to stabilize the molecular packing in the crystal structure of (I).

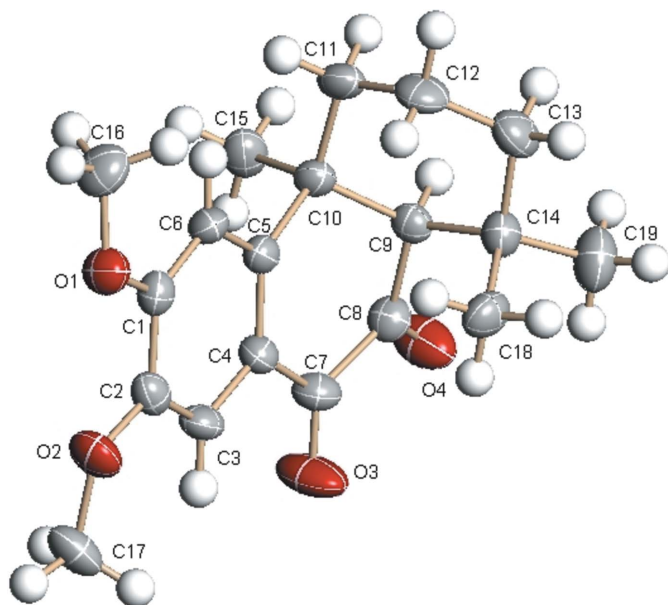


Figure 1
A view of the title molecule, (I), showing the atom-labelling scheme. Displacement ellipsoids are drawn at the 50% probability level. H atoms are represented as small spheres of arbitrary radii.

Experimental

The details of the synthesis and purification of compound (I) will be described elsewhere (Xiong *et al.*, 2005). Crystals appropriate for data collection were obtained by slow evaporation of an ethanol solution at room temperature for 3 d.

Crystal data

$C_{19}H_{24}O_4$
 $M_r = 316.38$
Monoclinic, $P2_1/n$
 $a = 7.7629$ (7) Å
 $b = 14.0592$ (12) Å
 $c = 15.0990$ (13) Å
 $\beta = 93.955$ (2)°
 $V = 1644.0$ (2) Å³
 $Z = 4$

$D_x = 1.278$ Mg m⁻³
Mo $K\alpha$ radiation
Cell parameters from 1849 reflections
 $\theta = 2.7$ – 24.1 °
 $\mu = 0.09$ mm⁻¹
 $T = 298$ (2) K
Block, colourless
 $0.29 \times 0.22 \times 0.14$ mm

Data collection

Bruker APEX area-detector diffractometer
 φ and ω scans
Absorption correction: multi-scan (SADABS; Bruker, 2002)
 $T_{\min} = 0.985$, $T_{\max} = 0.991$
8681 measured reflections

2960 independent reflections
2660 reflections with $I > 2\sigma(I)$
 $R_{\text{int}} = 0.027$
 $\theta_{\text{max}} = 25.2$ °
 $h = -9 \rightarrow 9$
 $k = -16 \rightarrow 12$
 $l = -17 \rightarrow 18$

Refinement

Refinement on F^2
 $R[F^2 > 2\sigma(F^2)] = 0.083$
 $wR(F^2) = 0.165$
 $S = 1.32$
2960 reflections
213 parameters
H-atom parameters constrained

$$w = 1/[\sigma^2(F_o^2) + (0.0452P)^2 + 1.0299P]$$

where $P = (F_o^2 + 2F_c^2)/3$
 $(\Delta/\sigma)_{\text{max}} = 0.001$
 $\Delta\rho_{\text{max}} = 0.24 \text{ e \AA}^{-3}$
 $\Delta\rho_{\text{min}} = -0.27 \text{ e \AA}^{-3}$

Table 1

Selected geometric parameters (Å, °).

O1—C1	1.352 (3)	O4—C8	1.204 (3)
O1—C16	1.423 (4)	C1—C6	1.380 (4)
O2—C2	1.362 (3)	C4—C7	1.461 (4)
O2—C17	1.421 (4)	C5—C10	1.533 (4)
O3—C7	1.210 (3)	C9—C10	1.556 (4)
C3—C2—C1	118.6 (2)	C8—C9—C10	110.0 (2)
C6—C5—C4	117.7 (2)	C10—C9—C14	116.2 (2)
O3—C7—C8	118.1 (3)	C11—C10—C5	114.2 (2)
O4—C8—C9	124.0 (3)	C13—C14—C19	109.0 (3)
C5—C4—C7—O3	-174.6 (3)	C8—C9—C10—C11	179.6 (2)
O3—C7—C8—O4	13.9 (4)	C14—C9—C10—C11	51.3 (3)
C7—C8—C9—C14	88.0 (3)	C14—C9—C10—C15	168.3 (2)

All H atoms were positioned geometrically and allowed to ride on their parent atoms, at distances of 0.93 for C_{sp^2} -H, 0.96 for C(methyl)-H and 0.97 Å for C(methylene)-H, and with $U_{\text{iso}}(\text{H}) = 1.5U_{\text{eq}}(\text{C})$ for methylene and methyl H and $1.2U_{\text{eq}}(\text{C})$ for other H atoms.

Data collection: SMART (Bruker, 2002); cell refinement: SAINT (Bruker, 2002); data reduction: SAINT; program(s) used to solve structure: SHELXS97 (Sheldrick, 1997); program(s) used to refine structure: SHELXL97 (Sheldrick, 1997); molecular graphics: SHELXTL (Bruker, 2002); software used to prepare material for publication: SHELXL97.

This work was supported by the National Natural Science Foundation of China (grant No. 20472073).

References

- Bruker (2002). SADABS (Version 2.03), SAINT (Version 6.02), SMART (Version 5.62) and SHELXTL. Bruker AXS Inc., Madison, Wisconsin, USA.
- Li, A.-P., She, X.-G., Zhang, J.-Y., Wu, T.-X. & Pan, X.-F. (2003). *Tetrahedron*, **59**, 5737–5741.
- Sheldrick, G. M. (1997). SHELXS97 and SHELXL97. University of Göttingen, Germany.
- Xiong, Y., Wang, K.-W., Pan, Y.-J., Sun, H.-X. & Tu, J. (2005). *Bioorg. Med. Chem. Lett.* Accepted.
- Zambrano, J. L., Rosales, V. & Nakano, T. (2003). *Tetrahedron Lett.* **44**, 1859–1862.