Acta Crystallographica Section E
Structure Reports
Online
ISSN 1600-5368

16β,17-Dihydroxy-*ent*-kauran-19-oic acid

Nasir Rasool,[a] Viqar Uddin Ahmad,[a] M. Iqbal Choudhary,[a] Shazia Anjum,[a]* Hoong-Kun Fun[b] and Shamsher Ali[a]

[a]HEJ Research Institute of Chemistry, International Centre for Chemical Sciences, University of Karachi, Karachi 75270, Pakistan, and [b]X-ray Crystallography Unit, School of Physics, Universiti Sains Malaysia, 11800 USM, Penang, Malaysia

Correspondence e-mail:
anjumshazia@yahoo.com

Received 15 August 2005
Accepted 19 August 2005
Online 27 August 2005

Key indicators

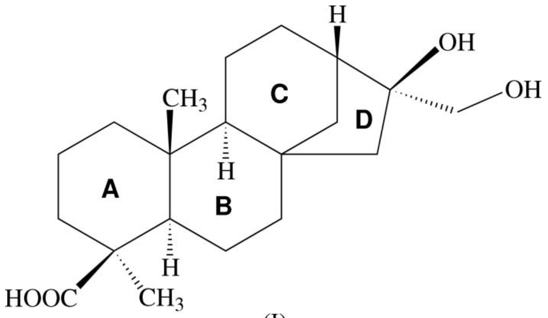
Single-crystal X-ray study
T = 293 K
Mean σ(C–C) = 0.003 Å
R factor = 0.032
wR factor = 0.087
Data-to-parameter ratio = 7.7

For details of how these key indicators were automatically derived from the article, see http://journals.iucr.org/e.

The title compound, $C_{20}H_{32}O_4$, was isolated from *Pulicaria unduleta*. It has an *ent*-kaurane diterpeniod ring system. In the crystal structure, the molecules are linked *via* O—H···O hydrogen bonds into a ribbon structure.

Comment

Pulicaria unduleta is a herbaceous plant belonging to the family Asteracea (Compsitae), the largest family of the flowering plants. It comprises about 10,100 genera and 20,000 species, commonly found in frigid, temperate, subtropical and tropical regions of Asia and Africa (Nasir & Ali, 1972). The genus *Pulicaria* has 11 species distributed in tropical and temperate regions in Pakistan (Ayoub & Elassam, 1981). Plants of this genus are known to contain flavones, alkaloids, monoterpenes, sesquiterpenes, sesquiterpene lactones (Bohlmann *et al.*, 1979), diterpenoids, polyacetylene and thymol derivatives (Metwally *et al.*, 1986). *ent*-Kauranoic acid is found to exhibit significant activity against HIV replication in H9 lymphocyte cells, with an EC$_{50}$ value of 0.8 µg ml^{-1} with therapeutic index >5 (Wu *et al.*, 1996). The title compound, (I), has been isolated from *Helianthus petioaries* (Herz & Kulanthaivel, 1984) and *Annona squamasa* (Wu *et al.*, 1996). We have undertaken the X-ray crystal-structure determination of (I) isolated from *Pulicaria unduleta* in order to establish its molecular conformation and relative stereochemistry.



(I)

The bond lengths in (I) show normal values (Allen *et al.*, 1987). The C—C bond lengths lie in the range 1.514 (3)–1.574 (2) Å. All the ring junctions in the *ent*-kaurane diterpenoid ring system are *trans*-fused. Rings *A* and *B* adopt chair conformations and ring *C* is in a distorted chair conformation, with puckering amplitude Q = 0.625 (2)°, θ = 27.3 (2)° and φ = 294.6 (4)° (Cremer & Pople, 1975). The distortion may be attributed to the narrowing of the C13—C14—C8 bond angle to 101.95 (14)°. The five-membered ring *D* adopts an envelope conformation with atom C14 displaced from the C8/C15/C16/C13 plane by 0.707 (3) Å. The C2—C3—C4—C20 torsion

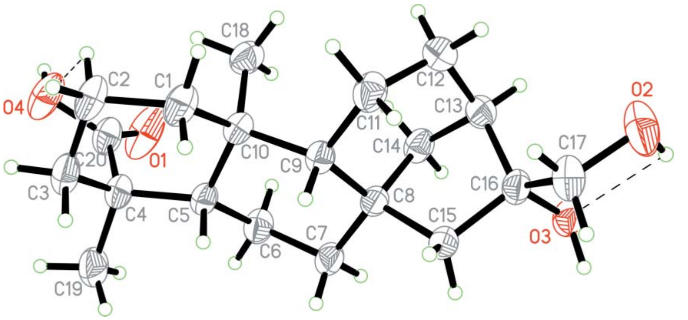


Figure 1
The molecular structure of (I), showing 50% probability displacement ellipsoids and the atom-numbering scheme. Dashed lines indicate the intramolecular hydrogen bonds.

angle of −71.0 (2)° describes the β-orientation of the carboxylic acid group with respect to the *ent*-kaurane nucleus, whereas the hydroxymethylene group at atom C16 is α-oriented, the C15—C16—C17—O2 torsion angle being 175.67 (17)°. Intramolecular O2—H1*O*2···O3 and C2—H2*C*···O4 hydrogen bonds generate rings of graph-set motif $R_1^1(5)$ and $R_1^1(6)$, respectively (Bernstein *et al.*, 1995).

The crystal structure is stabilized by O—H···O hydrogen bonds (Table 1). These hydrogen bonds link the molecules into a ribbon-like structure (Fig. 2).

Experimental

The dry plant material was chopped and soaked in methanol for a period of 30 d. The combined methanolic extract was evaporated under vacuum to yield a crude methanolic extract. The methanol extract (253 g) was then fractionated with petroleum ether (161.5 g), chloroform (32.5 g), ethyl acetate (10.0 g) and butanol (50.5 g). The chloroform-soluble fraction was subjected to column chromatography using silica-gel absorbent, eluted with petroleum ether, and the polarity was gradually increased with chloroform and methanol. Various subfractions with the same constituents were combined and further purified using flash column chromatography (Si gel) and eluted with increasing polarities of petroleum ether and ethyl acetate to afford the title compound, (I). An R_F value of 0.67 was noted on thin-layer chromatography (0.5% methanol–95.5% chloroform) and the compound was recrystallized from chloroform (m.p. 571–573 K).

Crystal data

$C_{20}H_{32}O_4$
$M_r = 336.46$
Orthorhombic, $P2_12_12_1$
$a = 7.8190\ (7)$ Å
$b = 10.5726\ (9)$ Å
$c = 21.8360\ (19)$ Å
$V = 1805.1\ (3)$ Å^3
$Z = 4$
$D_x = 1.238$ Mg m^{-3}
Mo $K\alpha$ radiation
Cell parameters from 9632 reflections
$\theta = 1.9–25.0°$
$\mu = 0.08$ mm^{-1}
$T = 293\ (2)$ K
Block, colourless
0.44 × 0.32 × 0.21 mm

Data collection

Siemens SMART CCD area-detector diffractometer
ω scans
Absorption correction: multi-scan (*SADABS*; Sheldrick, 1996)
$T_{\min} = 0.964$, $T_{\max} = 0.983$
9150 measured reflections
1849 independent reflections
1801 reflections with $I > 2\sigma(I)$
$R_{\rm int} = 0.016$
$\theta_{\max} = 25.0°$
$h = -9 \rightarrow 7$
$k = -12 \rightarrow 11$
$l = -25 \rightarrow 25$

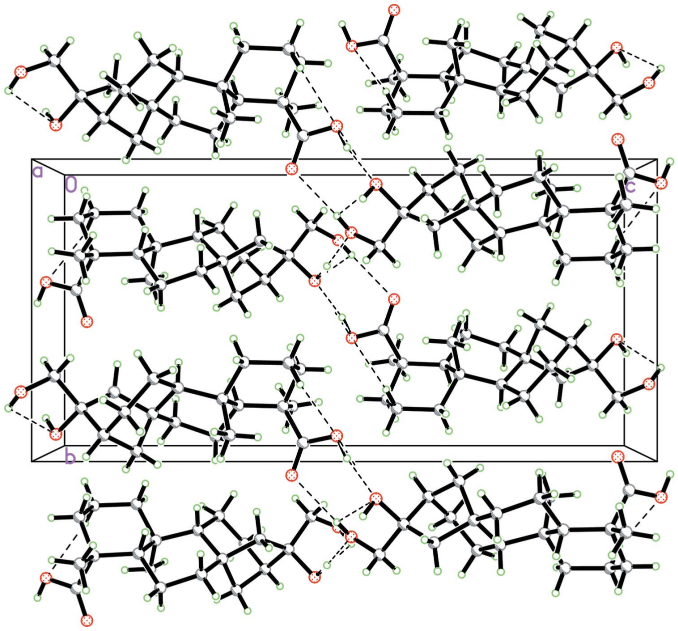


Figure 2
The crystal packing of (I), viewed down the *a* axis. Dashed lines indicate hydrogen bonds.

Refinement

Refinement on F^2
$R[F^2 > 2\sigma(F^2)] = 0.033$
$wR(F^2) = 0.087$
$S = 1.05$
1849 reflections
240 parameters
H-atoms treated by a mixture of independent and constrained refinement
$w = 1/[\sigma^2(F_o^2) + (0.0557P)^2 + 0.309P]$ where $P = (F_o^2 + 2F_c^2)/3$
$(\Delta/\sigma)_{\max} = 0.001$
$\Delta\rho_{\max} = 0.19$ e Å^{-3}
$\Delta\rho_{\min} = -0.20$ e Å^{-3}
Extinction correction: *SHELXTL*
Extinction coefficient: 0.021 (3)

Table 1
Hydrogen-bond geometry (Å, °).

D—H···*A*	*D*—H	H···*A*	*D*···*A*	*D*—H···*A*
O2—H1*O*2···O3$^{\rm i}$	0.88 (3)	2.36 (4)	2.773 (2)	109 (3)
O2—H1*O*2···O1$^{\rm ii}$	0.88 (3)	2.25 (3)	3.038 (2)	149 (3)
O3—H1*O*3···O2$^{\rm iii}$	0.94 (3)	1.80 (3)	2.734 (2)	173 (2)
O4—H1*O*4···O3$^{\rm iv}$	0.87 (3)	1.78 (3)	2.635 (2)	168 (3)
C2—H2*C*···O4$^{\rm i}$	0.97	2.58	3.094 (3)	113

Symmetry codes: (i) x, y, z; (ii) $-x+\frac{1}{2}, -y+2, z-\frac{1}{2}$; (iii) $x-\frac{1}{2}, -y+\frac{3}{2}, -z$; (iv) $-x+\frac{1}{2}, -y+2, z+\frac{1}{2}$.

H atoms attached to O atoms, and atoms H11*A* and H11*B* were located in a difference map and were refined isotropically; the range of O—H bond lengths is 0.87 (3)–0.94 (3) Å. All other H atoms were placed in calculated positions and allowed to ride on their parent atoms, with C—H = 0.96–0.98 Å and $U_{\rm iso}$(H) = 1.2 or 1.5(methyl) times $U_{\rm eq}$(carrier atom). Friedel pairs were merged as no significant anomalous scattering effects were observed

Data collection: *SMART* (Siemens, 1996); cell refinement: *SAINT* (Siemens, 1996); data reduction: *SAINT*; program(s) used to solve structure: *SHELXTL* (Sheldrick, 1997); program(s) used to refine structure: *SHELXTL*; molecular graphics: *SHELXTL*; software used to prepare material for publication: *SHELXTL*, *PARST* (Nardelli, 1995) and *PLATON* (Spek, 2003).

o3054 Rasool *et al.* • $C_{20}H_{32}O_4$ *Acta Cryst.* (2005). E**61**, o3053–o3055

SA and HKF thank the Malaysian Government and Universiti Sains Malaysia for the Scientific Advancement Grant Allocation (SAGA) grant No. 304/PFIZIK/653003/A118.

References

Allen, F. H., Kennard, O., Watson, D. G., Brammer, L., Orpen, A. G. & Taylor, R. (1987). *J. Chem. Soc. Perkin Trans. 2*, S1–19.

Ayoub, S. M. H. & Elassam, (1981). *Fitoterapia,* **52**, 247–249.

Bernstein, J., Davis, R. E., Shimoni, L. & Chang, N.-L. (1995). *Angew. Chem. Int. Ed. Engl.* **34**, 1555–1573.

Bohlmann, F., Knoll, K-U. & Emery (1979). *Phytochemistry*, **18**, 1231–1233.

Cremer, D. & Pople, J. A. (1975). *J. Am. Chem. Soc.* **97**, 1354–1358.

Herz, W. & Kulanthaivel, P. (1984). *Phytochemistry*, **23**, 1453–1459.

Metwally, M., Dewidar, A-A. & Metwally, S. (1986). *Chem. Pharm. Bull.* **34**, 378–379.

Nardelli, M. (1995). *J. Appl. Cryst.* **28**, 659.

Nasir, E. & Ali, S. I. (1972). *Flora of Pakistan*, p. 770. Karachi: Fakhri Printing Press.

Sheldrick, G. M. (1996). *SADABS*. University of Göttingen, Germany.

Sheldrick, G. M. (1997). *SHELXTL*. Version 5.1. Bruker AXS Inc., Madison, Wisconsin, USA.

Siemens (1996). *SMART* and *SAINT*. Siemens Analytical X-ray Instruments Inc., Madison, Wisconsin, USA.

Spek, A. L. (2003). *J. Appl. Cryst.* **36**, 7–13.

Wu, Y. C., Hung, Y. C., Chang, F. R., Costino, M., Wang, H. K. & Lee, K. H. (1996). *J. Nat. Prod.* **59**, 635–637.

Acta Cryst. (2005). E**61**, o3053–o3055 Rasool *et al.* • $C_{20}H_{32}O_4$ **o3055**