

Lists of structure factors, anisotropic thermal parameters and H-atom coordinates have been deposited with the British Library Document Supply Centre as Supplementary Publication No. SUP 55375 (12 pp.). Copies may be obtained through The Technical Editor, International Union of Crystallography, 5 Abbey Square, Chester CH1 2HU, England. [CIF reference: LI1016]

## References

- Johnson, C. K. (1965). *ORTEP*. Report ORNL-3794. Oak Ridge National Laboratory, Tennessee, USA.
- Palenik, G. J., Koziol, A. E., Katritzky, A. R. & Fan, W.-Q. (1990). *J. Chem. Soc. Chem. Commun.* pp. 715–716.
- Sheldrick, G. M. (1976). *SHELX76*. Program for crystal structure determination. Univ. of Cambridge, England.
- Sheldrick, G. M. (1985). *SHELXS86*. Program for the solution of crystal structures. Univ. of Göttingen, Germany.
- Walker, N. & Stuart, D. (1983). *Acta Cryst.* **A39**, 158–166.
- Zukerman-Schpector, J., Castellano, E. E., Pinto, A. Da C., da Silva, J. F. M. & Barcellos, M. T. F. C. (1992). *Acta Cryst.* **C48**, 760–762.

*Acta Cryst.* (1993). **C49**, 175–177

## Structure of Hydrocotarnine Hydrobromide†

J. SEETHARAMAN, S. S. RAJAN\* AND R. SRINIVASAN

*Department of Crystallography and Biophysics,  
University of Madras, Madras-25, India*

(Received 10 April 1992; accepted 10 August 1992)

### Abstract

The heterocyclic ring of the isoquinoline adopts a half-chair conformation and the dioxole ring an envelope conformation. The methyl group is rotated from the plane of the benzene ring attached to it by  $104.2(3)^\circ$ . The N atom of the heterocyclic ring is displaced from the plane of the ring by  $0.606(3)$  Å. The structure is stabilized by N—H $\cdots$ Br hydrogen bonds.

### Comment

As part of our studies on cough suppressants, the structure determination of the compound hydrocotarnine (5,6,7,8-tetrahydro-4-methoxy-6-methyl-1,3-dioxolo[4,5-g]isoquinoline) hydrobromide (1) was undertaken. The heterocyclic ring of the isoquinoline is in a half-chair conformation with an asymmetry parameter  $\Delta C_2 = 5.4(1)^\circ$  (Duax, Weeks & Rohrer, 1976) as in similar isoquinoline structures (Ahmed, 1978; Bernath, Kobor, Fulop, Sohar, Argay &

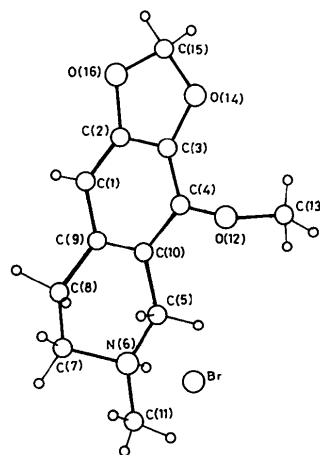


Fig. 1. *PLUTO* diagram of the molecule showing the atom-numbering scheme.

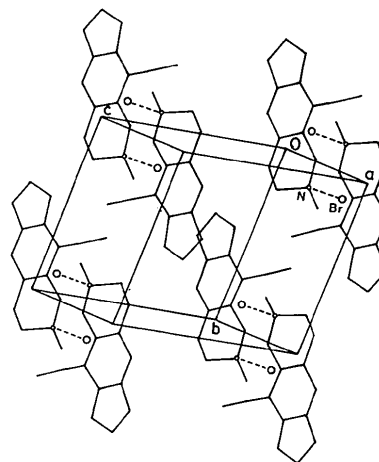
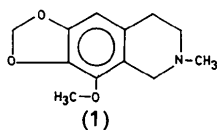


Fig. 2. View of the unit-cell packing viewed down the *c* axis. The H atoms are omitted for clarity. The hydrogen bonding is shown by dotted lines.

Kalman, 1986) and the dioxole ring is in an envelope conformation. C(15) is displaced from the least-squares plane of O(16), C(2), C(3) and O(14) by  $0.059(5)$  Å. The methoxy group is rotated from the plane of the benzene ring by  $104.2(3)^\circ$ . The bond lengths of the heterocyclic ring of the isoquinoline are in good agreement with similar isoquinoline rings of 1-phenyl-3-methylisoquinoline hydrobromide (Rychlewska, Palenik & Kosturkiewicz, 1975), 1-chloro-3-hydroxyisoquinoline (Ammon & Wheeler, 1974), 5-hydroxy-3-phenyl-1-(3-methyl-1-isoquinolyl)pyrazole (King & Reimlinger, 1971) and 1-(1-naphthyl)isoquinoline (Ljungstrom, Lindqvist & Overbeek, 1978). A *PLUTO* diagram (Motherwell, 1976) of the molecule with atom-numbering scheme is shown in Fig. 1 and a view of the unit-cell packing in Fig. 2. The molecules in the unit cell are stabilized by a hydrogen-bonding network involving N and Br, with an N—H $\cdots$ Br angle of  $175.9(4)^\circ$ , and N $\cdots$ Br

† DCB Contribution No. 798.

and H...Br distances of 3.188 (3) and 2.240 (24) Å respectively. The N...Br distance is in good agreement with values found in 1-phenyl-3-methylisoquinoline hydrobromide [3.269 (3) Å (Rychlewska, Palenik & Kosturkiewicz, 1975)], *p*-(dimethylamino)benzaldehyde hydrobromide [3.127 (18) Å (Dattagupta & Saha, 1973)] and corine hydrobromide [3.22 Å (Roques & Cotrait, 1974)].



## Experimental

### Crystal data

$C_{12}H_{16}NO_3 \cdot Br^-$

$M_r = 302.2$

Triclinic

$P\bar{1}$

$a = 7.345$  (2) Å

$b = 8.865$  (3) Å

$c = 10.644$  (2) Å

$\alpha = 72.07$  (3)°

$\beta = 88.69$  (3)°

$\gamma = 78.94$  (4)°

$V = 646.68$  Å<sup>3</sup>

$Z = 2$

$D_x = 1.552$  Mg m<sup>-3</sup>

Cu  $K\alpha$  radiation

$\lambda = 1.5418$  Å

Cell parameters from 20 reflections

$\theta = 20-30^\circ$

$\mu = 4.34$  mm<sup>-1</sup>

$T = 293$  K

Needles

$1.00 \times 0.05 \times 0.05$  mm

Colourless

### Data collection

Enraf-Nonius CAD-4 diffractometer

$\omega/2\theta$  scans

Absorption correction: empirical

2623 measured reflections

2333 independent reflections

2054 observed reflections

[ $I > 3\sigma(I)$ ]

$R_{int} = 0.013$

$\theta_{max} = 70^\circ$

$h = 0 \rightarrow 8$

$k = -10 \rightarrow 10$

$l = -12 \rightarrow 12$

3 standard reflections

monitored every 200

reflections

intensity variation:  $< 2\%$

### Refinement

Refinement on  $F^2$

Final  $R = 0.037$

$wR = 0.041$

$S = 2.3$

2054 reflections

214 parameters

$w = 0.3866/[\sigma^2(F)$

$+0.005821F^2]$

$(\Delta/\sigma)_{max} = 0.690$

$\Delta\rho_{max} = 0.4560$  e Å<sup>-3</sup>

$\Delta\rho_{min} = -0.6527$  e Å<sup>-3</sup>

Atomic scattering factors from *International Tables for X-ray Crystallography* (1974, Vol. IV)

Table 1. Fractional atomic coordinates and equivalent isotropic thermal parameters (Å<sup>2</sup>)

	$x$	$y$	$z$	$U_{eq}$
Br	0.15693 (5)	0.09131 (5)	0.17314 (4)	0.527 (2)
C(1)	-0.2451 (5)	-0.2535 (5)	0.5350 (3)	0.523 (11)
C(2)	-0.2444 (5)	-0.4077 (5)	0.5378 (3)	0.501 (18)
C(3)	-0.2590 (5)	-0.4510 (4)	0.4247 (3)	0.475 (17)

C(4)	-0.2777 (4)	-0.3381 (4)	0.3025 (3)	0.441 (16)
C(5)	-0.3192 (5)	-0.0525 (4)	0.1607 (3)	0.472 (17)
N(6)	-0.2796 (4)	0.1078 (3)	0.1580 (3)	0.464 (14)
C(7)	-0.3662 (5)	0.1577 (5)	0.2710 (4)	0.560 (20)
C(8)	-0.2727 (5)	0.0404 (4)	0.4004 (4)	0.533 (19)
C(9)	-0.2682 (4)	-0.1336 (4)	0.4100 (3)	0.453 (17)
C(10)	-0.2853 (4)	-0.1762 (4)	0.2961 (3)	0.415 (15)
C(11)	-0.3433 (7)	0.2294 (5)	0.0292 (4)	0.642 (23)
O(12)	-0.2964 (4)	-0.3776 (3)	0.1886 (2)	0.551 (14)
C(13)	-0.1267 (6)	-0.4529 (5)	0.1484 (4)	0.655 (25)
O(14)	-0.2562 (5)	-0.6149 (3)	0.4558 (3)	0.660 (17)
C(15)	-0.2318 (6)	-0.6752 (5)	0.5960 (4)	0.595 (22)
O(16)	-0.2329 (5)	-0.5440 (4)	0.6464 (3)	0.692 (18)

Table 2. Bond lengths (Å) and angles (°)

C(1)—C(2)	1.357 (7)	C(5)—C(10)	1.510 (4)
C(1)—C(9)	1.414 (4)	N(6)—C(7)	1.494 (6)
C(2)—C(3)	1.384 (5)	N(6)—C(11)	1.479 (4)
C(2)—O(16)	1.382 (4)	C(7)—C(8)	1.529 (5)
C(3)—C(4)	1.366 (4)	C(8)—C(9)	1.508 (5)
C(3)—O(14)	1.384 (4)	C(9)—C(10)	1.391 (5)
C(4)—C(10)	1.406 (5)	O(12)—C(13)	1.419 (5)
C(4)—O(12)	1.378 (5)	O(14)—C(15)	1.424 (5)
C(5)—N(6)	1.496 (5)	C(15)—O(16)	1.422 (6)
C(2)—C(1)—C(9)	117.3 (3)	C(7)—N(6)—C(11)	111.9 (3)
C(1)—C(2)—O(16)	128.5 (3)	N(6)—C(7)—C(8)	109.1 (3)
C(1)—C(2)—C(3)	122.9 (3)	C(7)—C(8)—C(9)	112.3 (3)
C(3)—C(2)—O(16)	108.7 (3)	C(1)—C(9)—C(8)	119.8 (3)
C(2)—C(3)—O(14)	110.9 (3)	C(8)—C(9)—C(10)	120.1 (3)
C(2)—C(3)—C(4)	121.1 (3)	C(1)—C(9)—C(10)	120.1 (3)
C(4)—C(3)—O(14)	127.9 (3)	C(5)—C(10)—C(9)	122.4 (3)
C(3)—C(4)—O(12)	122.2 (3)	C(4)—C(10)—C(9)	121.1 (3)
C(3)—C(4)—C(10)	117.6 (3)	C(4)—C(10)—C(5)	116.5 (3)
C(10)—C(4)—O(12)	120.2 (3)	C(4)—O(12)—C(13)	113.4 (3)
N(6)—C(5)—C(10)	112.7 (3)	C(3)—O(14)—C(15)	104.8 (3)
C(5)—N(6)—C(11)	109.8 (3)	O(14)—C(15)—O(16)	109.2 (3)
C(5)—N(6)—C(7)	110.7 (3)	C(2)—O(16)—C(15)	106.3 (3)

Cell refinement and data reduction: (Frenz, 1978). Program used to solve structure: *SHELXS86* (Sheldrick, 1986). Program used to refine structure: *SHELX76* (Sheldrick, 1976). Software used for geometrical calculations and to prepare material for publication: *PARST* (Nardelli, 1983). Most calculations were performed on VAX 730 and MicroVAX computers.

Refinement was by full-matrix least-squares methods. The H-atom positions were obtained from a difference Fourier synthesis. All H-atom coordinates were refined.

One of the authors (JS) thanks UGC (India) for the award of a junior research fellowship.

Lists of structure factors, anisotropic thermal parameters, H-atom coordinates least-squares-planes data and torsion angles have been deposited with the British Library Document Supply Centre as Supplementary Publication No. SUP 55443 (15 pp.). Copies may be obtained through The Technical Editor, International Union of Crystallography, 5 Abbey Square, Chester CH1 2HU, England. [CIF reference: AL1012]

## References

- Ahmed, F. R. (1978). *Acta Cryst.* **B34**, 2589–2594.  
 Ammon, H. L. & Wheeler, G. L. (1974). *Acta Cryst.* **B30**, 1146–1154.  
 Bernath, G., Kobor, J., Fulop, F., Sohar, P., Argay, Gy. & Kalman, A. (1986). *Tetrahedron*, **42**, 5139–5148.  
 Dattagupta, J. K. & Saha, N. N. (1973). *Acta Cryst.* **B29**, 1228–1233.  
 Duax, W. L., Weeks, C. M. & Rohrer, D. C. (1976). *Top. Stereochem.* **9**, 271–289.

- Frenz, B. A. (1978). *The Enraf-Nonius CAD-4 SDP - A Real-Time System for Concurrent X-ray Data Collection and Crystal Structure Solution*. In *Computing in Crystallography*, edited by H. Schenk, R. Olthof-Hazekamp, H. van Koningsveld & G. C. Bassi. Delft Univ. Press.
- King, G. S. D. & Reimlinger, H. (1971). *Chem. Ber.* **104**, 2694-2701.
- Ljungstrom, E., Lindqvist, O. & Overbeek, O. (1978). *Acta Cryst.* **B34**, 1727-1730.
- Motherwell, W. D. S. (1976). *PLUTO*. Program for plotting molecular and crystal structures. Univ. of Cambridge, England.
- Nardelli, M. (1983). *Comput. Chem.* **7**, 95.
- Roques, R. & Cotrait, M. (1974). *Cryst. Struct. Commun.* **3**, 141-144.
- Rychlewska, U., Palenik, G. J. & Kosturkiewicz, Z. (1975). *Acta Cryst.* **B31**, 2902-2904.
- Sheldrick, G. M. (1976). *SHELX76*. Program for crystal structure determination. Univ. of Cambridge, England.
- Sheldrick, G. M. (1986). *SHELXS86*. Program for the solution of crystal structures. Univ. of Göttingen, Germany.

*Acta Cryst.* (1993). **C49**, 177-179

## Structure of a Nucleoside Analogue: $\alpha$ -(1-Thyminylmethyl)- $\gamma$ -butyrolactone

A. K. DAS AND S. K. MAZUMDAR

*Crystallography and Molecular Biology Division,  
Saha Institute of Nuclear Physics, 1/AF, Bidhannagar,  
Calcutta-700 064, India*

N. DAS (NEÉ GHOSH DASTIDAR) AND S. K. TALAPATRA

*Department of Physics, Jadavpur University,  
Calcutta-700032, India*

P. SCHEINER

*York College, City University of New York, Jamaica,  
New York 11451, USA*

C. H. W. SCHWALBE

*Department of Pharmaceutical Sciences,  
Aston University, Birmingham B4 7ET, England*

(Received 5 February 1992; accepted 10 August 1992)

### Abstract

The lactone ring adopts an envelope conformation with C5' at a distance of 0.457 (4) Å from the least-squares plane containing C2', C3', O4' and C4'. The thymine base is almost perpendicular to the sugar moiety and bases are stacked together along the *b* axis forming double molecular sheets. The crystal

packing is further stabilized by N3—H...O4 hydrogen bonds across the screw axes and C—H...O close contacts.

### Comment

The title compound is an acyclic analogue of thymine nucleosides in which the sugar ring is cleaved at C1' to form a butyrolactone ring. The single crystals were grown by slow evaporation from an acetone/water (1/1) solution. The crystal structure analysis of the title compound was undertaken as part of our investigation of sugar-modified nucleoside analogues with particular reference to anti-AIDS compounds.

The bond distances and angles of the thymine base are within the normal range (Saenger, 1983). In the five-membered lactone ring, the C3'—O4' bond is 0.147 (4) Å shorter than the C4'—O4' bond usually found in the sugar moieties of nucleosides (Birnbaum, Stolarski, Kazimierzuk & Shugar, 1985). O4' is not adjacent to C1', the torsion angle  $\chi$  cannot be determined but C2—N1—C1'—C2' ( $-101^\circ$ ) shows that the C1'—C2' bond is approximately perpendicular to the aglycon as in other acyclonucleosides in which C1' is a secondary C atom (Birnbaum, Cygler & Shugar, 1984). The C2', C3', O4' and C4' atoms of the five-membered lactone ring are planar to within  $\pm 0.026$  Å and C5' is at a distance of 0.457 (4) Å from this plane, indicating that the lactone ring has an envelope configuration. The dihedral angle between the thymine base and the planar part of the lactone ring is  $65.3 (1)^\circ$ .

In the crystal lattice, the thymine bases form double molecular sheets by unit translation along the *b* axis and the molecular layers are stabilized by base stacking forces. There are close contacts between the thymine bases in the two layers [O2...C5 3.550 (4), C2...C5 3.469 (4), N1...C5 3.648 (4), N1...C7

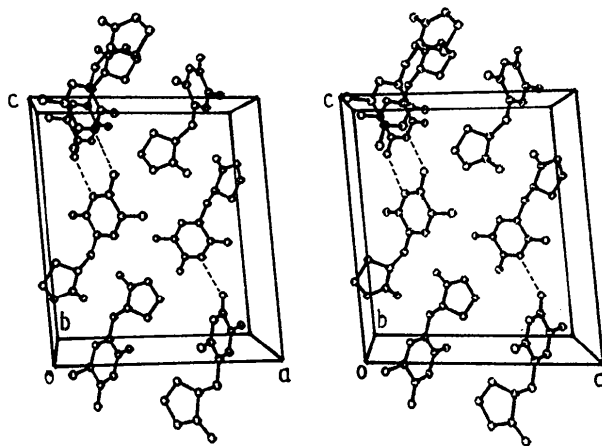


Fig. 1. Stereoscopic view of the molecular packing. Hydrogen bonds are shown by dashed lines.