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X-RAY STRUCTURAL ANALYSIS OF (1*R*,2*R*,4*S*,5*S*,8*S*)-2,8-BIS(4-CHLOROPHENYL)-4-(4-NITROPHENYL)-1-AZA-3,7-DIOXABICYCLO[3,3,0]OCTANE

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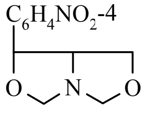
The configuration of the asymmetric atoms in the molecule of (1R,2R,4S,5S,8S)-2,8-bis(4-chlorophenyl)-4-(4-nitrophenyl)-1-aza-3,7-dioxabicyclo[3,3,0]octane has been determined using X-ray analysis.

Keywords: (1*R*,2*R*,4*S*,5*S*,8*S*)-2,8-bis(4-chlorophenyl)-4-(4-nitrophenyl)-1-aza-3,7-dioxabicyclo[3,3,0]-octane, X-ray analysis.

In recent years a significant interest has arisen in the chemistry of oxazolidines [1-3]. (1*S*,2*S*)-2-Amino-1-(4-nitrophenyl)-1,3-propanediol (**1**) (a by-product in the manufacture of the antibiotic chloramphenicol [4]) can be used as starting material in the synthesis of compounds containing an oxazolidine ring. We have previously shown that compound **1** reacts with the corresponding aldehydes to bring about the synthesis of (1*R*,4*S*,5*S*)-4-(4-nitrophenyl)-1-aza-3,7-dioxabicyclo[3,3,0]octane (**2**) and related quaternary ammonium salts [5, 6], a series of (1*R*,2*R*,4*S*,5*S*,8*S*)-2,8-diaryl-4-(4-nitrophenyl)-1-aza-3,7-dioxabicyclo[3,3,0]octanes **3** [7], and (1*S*,3*S*,4*S*,7*R*,11*R*)-3-(4-nitrophenyl)-11-aza-2,6-dioxatricyclo[5,3,1,$0^{4,11}$]undecane (**4**) [8].



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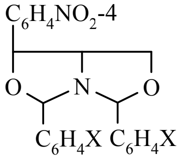
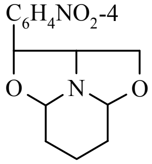


3a–d



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a X = H, **b** X = 4-Me, **c** X = 4-MeO, **d** X = 4-Cl

On the basis of AM1 calculations and ^{1}H NMR data including those obtained in the presence of shift reagents it was shown that in these compounds the rigid bicyclic system dictates the *R*-configuration of the nitrogen atom [6-8]. Based on the calculations and the ^{1}H NMR data one can also decide the configuration of the two asymmetric carbon atoms in compounds **3** and **4** arising as a result of the cyclization [7, 8].

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This work was designed to show the steric structure of compounds **3** *via* the X-ray analysis of a monocrystal of compound **3d** which had been recrystallized from 2-propanol. The configuration sequence of asymmetric atoms N-*R*, C(2)-*R*, C(4)-*S*, C(5)-*S*, C(8)-*S* obtained was in agreement with the AM1 calculations and the ^{1}H NMR spectroscopic data [7]. Since all of the compounds **3** were prepared by a similar method and have identical ^{1}H NMR properties it can be deduced that their structures are similar.

Analysis of the crystallographic data gave the bond lengths and observed angles (Tables 1-3) agreed with data in the Cambridge Structural Database [9]. The benzene rings are planar. The mean square deviations from the optimal plane and the angles between the planes are given in Table 4. In the solid state the nitro group is quasi-coplanar with the aromatic ring, the torsional angles O(441)–N(44)–C(44)–C(43) and O(442)–N(44)–C(44)–C(45) being 9.7(3) and 11.8(3)° respectively. However, the length of the N(44)–C(44) bond is 1.479(3) Å which points to the absence of a marked interaction (π-delocalization) involving the nitro group and the aromatic ring. The molecular packing is stabilized through the system of van der Waal bonds (interaction).

TABLE 1. Bond Lengths (l) in Compound **3d**

Bond	l, Å	Bond	l, Å
N(1)—C(8)	1.454(2)	C(6)—O(7)	1.424(3)
N(1)—C(2)	1.481(3)	O(7)—C(8)	1.442(3)
N(1)—C(5)	1.491(2)	N(44)—C(44)	1.479(3)
C(2)—O(3)	1.415(3)	N(44)—O(442)	1.211(3)
O(3)—C(4)	1.435(3)	N(44)—O(441)	1.218(3)
C(4)—C(5)	1.538(3)	C(24)—C(l24)	1.737(3)
C(5)—C(6)	1.533(3)	C(84)—Cl(84)	1.734(2)

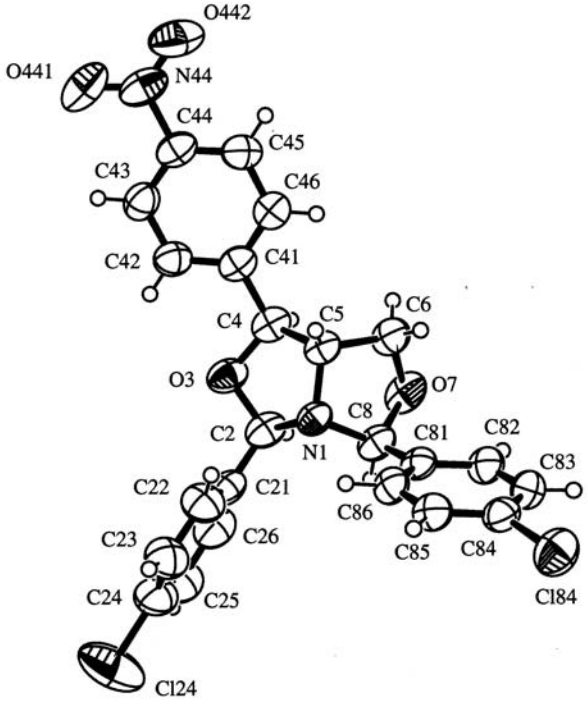

Fig. 1. Geometry of the molecule of compound **3d** in the crystal.

TABLE 2. Valence Angles (ω) in Compound **3d**

Angle	ω, deg.	Angle	ω, deg.
C(2)–O(3)–C(4)	104.11(17)	O(3)–C(4)–C(5)	104.02(15)
C(6)–O(7)–C(8)	103.52(14)	O(3)–C(4)–C(41)	110.66(18)
C(2)–N(1)–C(5)	106.03(15)	C(5)–C(4)–C(41)	116.53(17)
C(2)–N(1)–C(8)	112.81(16)	N(1)–C(5)–C(4)	102.93(15)
C(5)–N(1)–C(8)	105.24(16)	N(1)–C(5)–C(6)	104.12(15)
O(441)–N(44)–O(442)	124.1(2)	C(4)–C(5)–C(6)	114.69(16)
O(441)–N(44)–C(44)	117.6(2)	O(7)–C(6)–C(5)	104.35(18)
O(442)–N(44)–C(44)	118.2(2)	O(7)–C(8)–N(1)	105.68(15)
O(3)–C(2)–N(1)	103.99(15)	O(7)–C(8)–C(81)	111.49(18)
O(3)–C(2)–C(21)	110.33(19)	N(1)–C(8)–C(81)	112.88(15)
N(1)–C(2)–C(21)	112.71(17)		

TABLE 3. Dihedral Angles (φ) in Compound **3d**

Angle	φ, deg.	Angle	φ, deg.
C(2)–O(3)–C(4)–C(5)	-40.59(19)	C(2)–N(1)–C(8)–O(7)	87.42(19)
C(4)–O(3)–C(2)–N(1)	43.67(19)	C(2)–N(1)–C(5)–C(6)	-115.60(18)
C(4)–O(3)–C(2)–C(21)	164.78(17)	C(2)–N(1)–C(5)–C(4)	4.40(19)
C(2)–O(3)–C(4)–C(41)	-166.46(17)	C(5)–N(1)–C(2)–C(21)	-148.70(17)
C(8)–O(7)–C(6)–C(5)	-38.1(2)	O(441)–N(44)–C(44)–C(45)	-169.8(2)
C(6)–O(7)–C(8)–N(1)	41.8(2)	O(442)–N(44)–C(44)–C(43)	-168.7(2)
C(6)–O(7)–C(8)–C(81)	-81.19(19)	O(441)–N(44)–C(44)–C(43)	9.7(3)
C(8)–N(1)–C(2)–C(21)	96.6(2)	O(442)–N(44)–C(44)–C(45)	11.8(3)
C(8)–N(1)–C(5)–C(4)	124.15(16)	O(3)–C(4)–C(5)–N(1)	21.41(19)
C(5)–N(1)–C(2)–O(3)	-29.19(19)	O(3)–C(4)–C(5)–C(6)	133.82(17)
C(8)–N(1)–C(5)–C(6)	4.2(2)	C(41)–C(4)–C(5)–N(1)	143.46(17)
C(2)–N(1)–C(8)–C(81)	-150.46(16)	C(41)–C(4)–C(5)–C(6)	-104.1(2)
C(5)–N(1)–C(8)–O(7)	-27.7(2)	N(1)–C(5)–C(6)–O(7)	20.9(2)
C(5)–N(1)–C(8)–C(81)	94.40(18)	C(4)–C(5)–C(6)–O(7)	-90.81(19)
C(8)–N(1)–C(2)–O(3)	-143.86(16)		

TABLE 4. Aromatic Ring Parameters in Compound **3d**

Least squares planes		Interplanar angles, deg	
A	C(21), C(22), C(23), C(24),C(25), C(26) (0.0018)	A/B	75.32(8)
B	C(41), C(42), C(43), C(44), C(45), C(46) (0.0027)	A/C	70.59(8)
C	C(81), C(82), C(83), C(84), C(85), C(86) (0.0094)	B/C	86.10(6)

EXPERIMENTAL

The synthesis of (1*R*,2*R*,4*S*,5*S*,8*S*)-2,8-bis(4-chlorophenyl)-4-(4-nitrophenyl)-1-aza-3,7-dioxabicyclo-[3,3,0]octane (**3d**), $C_{23}H_{18}Cl_2N_2O_4$, has been reported before [7].

A monocrystal suitable for X-ray analysis was prepared by recrystallization from 2-propanol. The intensities were measured on an Enraf-Nonius CAD-4 diffractometer. Crystallographic cell parameters were obtained by least squares refinement for twenty five reflections for $16 < 2\theta < 30°$. X-ray parameters are given in

TABLE 5. X-ray Parameters for Compound **3d**

Crystallographic data	
Empirical formula	$C_{23}H_{18}Cl_2N_2O_4$
Molecular weight	457.29
Crystal system	Orthorhombic
Space group	$P2_12_12_1$ (No. 19)
a, Å	5.561(3)
b, Å	18.945(3),
c, Å	20.988(3)
Unit cell volume, $Å^3$	2211.1(13)
Z	4
d_{calc}, g/cm^3	1.374
$F(000)$	944
μ(MoKα), mm^{-1}	0.326
Crystal parameters, mm	0.26 × 0.38 × 0.51
Experimental conditions	
Temperature, K	293(2)
Irradiation, wavelength, Å	MoKα, 0.71073
θ_{max}, deg.	35.0
Scanning method	$\omega - 2\theta$
Number of standard reflections	2 each 120 min
Miller index range	$-8 \le h \le 8$; $-30 \le k \le 30$; $-33 \le l \le 33$
Number of observed reflections [$I \ge 2\,\sigma(I)$]	5149
Refinement parameters	
Flack parameter	-0.06(7)
Refinement parameters	0.011(2)
Final number of parameters	282
R_1 [$I \ge 2\,\sigma(I)$]	0.0595
$wR_2(F^2)$ [$I \ge 2\,\sigma(I)$]	0.1587
Convergence criteria (GOOF), S	1.007
$w = 1/[\sigma^2(Fo^2) + (0.1101\,P)^2 + 0.0435\,P]$, where	$P = (Fo^2 + 2\,Fc^2)/3$
$(\Delta\rho)_{min}$, $(\Delta\rho)_{max}$, e·$Å^{-3}$	-0.36, 0.27

Table 5. The unit cell refinement parameters and experimental data were obtained using the CAD-4 instrument program [10]. Two asymmetric sets were measured to $\theta_{max} = 35°$ to give a series of 9656 reflections. The data was then corrected with a Lorentz array and polarization effects using the XCAD-4 program [11]. The absorption coefficient was 0.326 mm^{-1}. After reduction of the series of experimental data and introduction of corrections the overall number of reflections was 5149 with $I \ge 2\sigma(I)$. The structure was solved by direct methods using the SHELXS-97 and SHELXL-97 programs [12, 13] as a result of which the final positions of the non-hydrogen atoms were refined in the anisotropic approximation. The positions of the hydrogen atoms were optimized and refined using the riding model. Final difference factors of R_1 0.0595 and R_2 0.1587 were obtained for 5149 reflections with $I \ge 2\sigma(I)$. The absolute structure agreed with Flack parameters [14]. Fig. 1 was obtained using the ORTEP-III program [15].

The X-ray results were deposited in the Cambridge Structural Data Bank and given the reference CCDC 252340.

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