Molecular and Crystal Structure of (1SR, 3RS)-3-p-Chloro Anilino-1,3-Diphenyl-1-Propanol

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Received: March 18, 1991; September 13, 1991

O composto $C_{21}H_{20}ONCl$ com Mr = 337,89 é triclínico, grupo espacial P$\bar{1}$ com dimensões de cela a = 6,147(2), b= 11,438(2), c = 12,926(2)Å , α = 79,91(1)°, β = 86,86(2), γ = 80,48(2), V = 882,1(5) Å^3; Z = 2, D_{calc} = 1,27 Mg m^{-3}, λ (Mo Kα) = 0,71073 Å, μ = 1,82 cm^{-1}, F(000) = 356, T = 298 K, R = 5,6% para 1312 reflexões observadas com I ≥ 3,0 σ(I). A estrutura foi investigada para detrminar a configuração relativa dos carbonos C(1), C(2) e C(3), que não pôde ser estabelecida por RMN. As moléculas estão ligadas por pontes de hidrogênio N-H···O e O-H···N.

The compound $C_{21}H_{20}ONCl$ com Mr = 337.89 is triclínic, space grup P$\bar{1}$ with cell dimensions a = 6.147(2), b= 11.438(2), c = 12.926(2)Å , α = 79.91(1)°, β = 86.86(2), γ = 80.48(2), V = 882.1(5) Å^3; Z = 2, D_{calc} = 1,27 Mg m^{-3}, λ (Mo Kα) = 0.71073 Å, μ = 1.82 cm^{-1}, F(000) = 356, T = 298 K, R = 5.6% for 1312 observed reflections with I ≥ 3.0 σ(I). The structure was investigated to determine the relative configuration at C(1), C(2) and C(3), which could not be established unambiguously by NMR. The molecules are linked by N-H···O and OH···N hydrogen bonding.

Key words: *$C_{21}H_{20}ONCl$; 1,3-aminoalcohols.*

Introduction

γ-aminoalcohols are chiral building blocks presented in several natural products and pharmaceutícals. During our efforts to develop synthetic methodologies to both the *syn*- and *anti*- series of γ-aminoalcohols we disclosed[1] a promis-ing solution through the diasteroselective reduction of the corresponding β-aminoketones. However, the unambiguous assignment of the γ-aminoalcohols obtained was not achieved by analysis of their ^{1}H- and ^{13}C- NMR spectra or of the corresponding cyclic urethanes.

Herein we disclose the crystallographic data of the title compound obtained in >70% diastereomeric excess by $Zn(BH_4)_2$ reduction of the corresponding β-aminoketone.

Experimental

A colorless crystal of approximate dimensions 0.13 x 0.45 x 0.25 mm was mounted on an Enraf-Nonius CAD-4 diffractometer. The unit cell dimensions and the orientation matrix for the data collection were obtained by a least squares fit of 25 reflections (4.5 < θ < 16.5°). The intensity data were collected with graphite-monochromated MoKα radiation, using ω-2θ scan technique, and scan width calculated using the expression (1.00 + 0.35 tan θ)°, with a maximum time spent on any reflection measurement of 20 s. The range of hkl was -7≤ h ≤ 7; -13 ≤ k ≤ 13; 0 ≤ l ≤ 15 with θ_{max} = 25°. Two standard reflection 1 5 $\bar{3}$ and 1 0 7, measured every 30 min, varied ± 1.2% of the mean intensities over data collection. A total number of 3440 reflections measured out of which 2544 were unique and 1312 were significant [I≥ 3 σ(I)]. It was applied Lp and absorption corrections, with maximum and minimum transmission

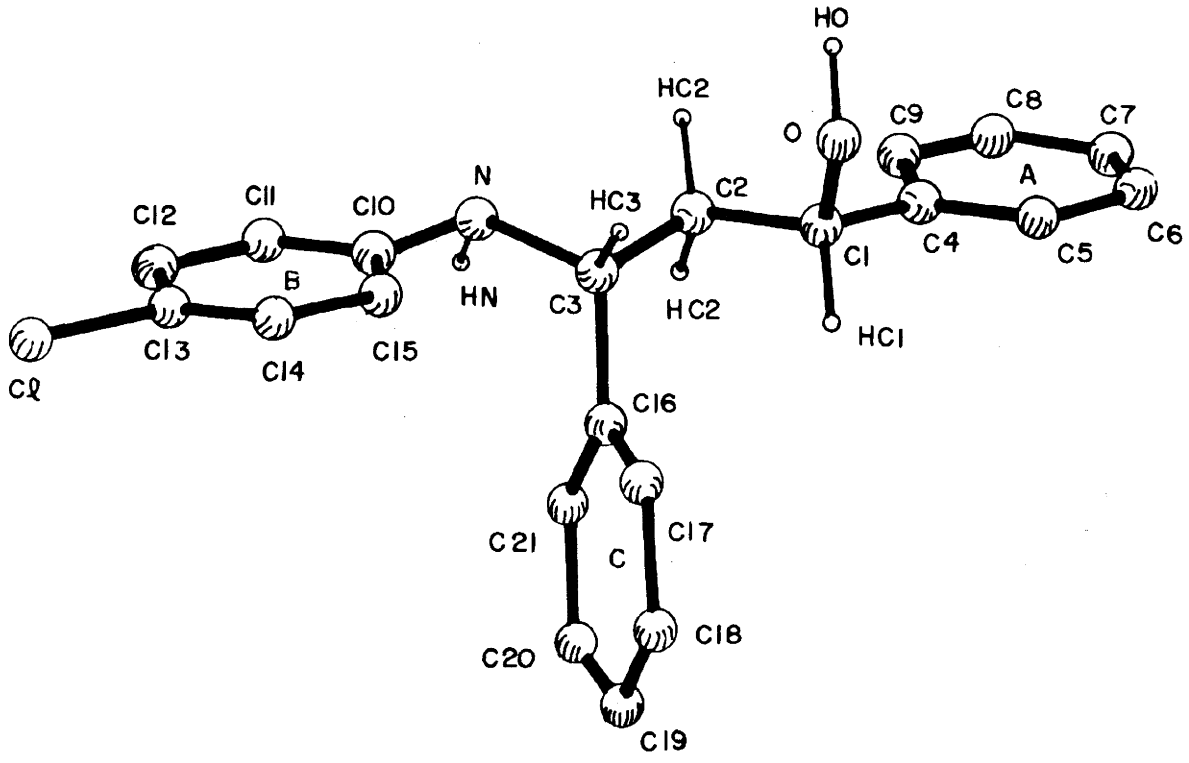

Figure 1. *A diagram of the title molecule with atom numbering. Atoms are of arbitrary size.*

Table 1. *Final positional parameters and equivalent isotropic temperature factors with e.s.d.'s in parentheses*

$B_{eq} = 4/3 \Sigma_i \Sigma_j \beta_{ij} a_i . a_j$

	x	y	z	$B_{eq}(Å^2)$
Cl	0.4733(3)	0.2138(2)	0.4862(2)	7.12(9)
N	0.3119(6)	-0.0454(3)	0.1452(3)	3.2(2)
O	-0.2581(6)	-0.1418(3)	0.0434(2)	3.6(1)
C(1)	-0.0631(8)	-0.2307(4)	0.0455(4)	3.4(2)
C(2)	0.1388(8)	-0.1724(4)	0.0534(4)	3.3(2)
C(3)	0.1482(8)	-0.1271(4)	0.1579(4)	3.2(2)
C(4)	-0.0563(9)	-0.2991(5)	-0.0447(4)	4.0(2)
C(5)	-0.224(1)	-0.3559(9)	-0.0567(8)	10.7(6)
C(6)	-0.232(2)	-0.418(1)	-0.140(1)	12.3(7)
C(7)	-0.066(2)	-0.4285(7)	-0.2074(6)	7.9(5)
C(8)	0.104(2)	-0.374(1)	-0.1983(8)	12.3(7)
C(9)	0.106(1)	-0.3072(8)	-0.1161(7)	9.8(6)
C(10)	0.3454(8)	0.0115(4)	0.2307(3)	3.2(2)
C(11)	0.5410(8)	0.552(5)	0.2335(4)	5.0(3)
C(12)	0.5771(9)	0.1175(5)	0.3115(5)	5.7(3)
C(13)	0.4197(9)	0.1349(5)	0.3887(4)	4.5(3)
C(14)	0.2286(9)	0.0921(5)	0.3887(4)	4.9(3)
C(15)	0.1914(8)	0.0295(5)	0.3100(4)	4.6(3)
C(16)	0.1898(8)	-0.2305(4)	0.2484(4)	3.3(2)
C(17)	0.0291(9)	-0.2556(5)	0.3260(5)	4.3(3)
C(18)	0.072(1)	-0.3511(6)	0.4067(5)	5.1(3)
C(19)	0.273(1)	-0.4249(5)	0.4118(5)	5.4(3)
C(20)	0.437(1)	-0.4005(5)	0.3369(5)	5.0(3)
C(21)	0.3963(9)	-0.3048(5)	0.2556(4)	3.9(2)

Table 2. *Bond lengths (Å) and angles(°) with e.s.d.'s in parentheses*

Cl	- C(13)	1.748(6)
C(13)	- C(12)	1.368(8)
C(12)	- C(11)	1.379(9)
C(11)	- C(10)	1.381(8)
C(10)	- C(15)	1.375(7)
C(15)	- C(14)	1.391(8)
C(14)	- C(13)	1.345(9)
N	- C(10)	1.417(6)
N	- C(3)	1.467(6)
C(3)	- C(2)	1.537(7)
C(2)	- C(1)	1.519(7)
C(1)	- O	1.438(5)
C(1)	- C(4)	1.510(8)
C(4)	- C(5)	1.336(11)
C(5)	- C(6)	1.397(17)
C(6)	- C(7)	1.308(14)
C(7)	- C(8)	1.326(16)
C(8)	- C(9)	1.414(15)
C(9)	- C(4)	1.323(10)
C(3)	- C(16)	1.510(6)
C(16)	- C(17)	1.396(7)
C(17)	- C(18)	1.374(8)
C(18)	- C(19)	1.374(9)
C(19)	- C(20)	1.386(9)
C(20)	- C(21)	1.378(7)
C(21)	- C(16)	1.404(7)

C(10)	- N	- C(3)	118.6(4)
N	- C(3)	- C(2)	108.0(4)
N	- C(3)	- C(16)	114.2(4)
C(2)	- C(3)	- C(16)	111.2(4)
C(3)	- C(2)	- C(1)	113.4(4)
C(2)	- C(3)	- O	109.5(4)
C(2)	- C(3)	- C(4)	115.1(4)
O	- C(3)	- C(4)	111.1(4)
C(3)	- C(4)	- C(5)	119.5(6)
C(3)	- C(4)	- C(9)	124.8(6)
C(4)	- C(5)	- C(6)	122.7(3)
C(5)	- C(6)	- C(7)	120.6(9)
C(6)	- C(7)	- C(8)	118.7(9)
C(7)	- C(8)	- C(9)	120.9(9)
C(9)	- C(4)	- C(5)	115.7(7)
C(3)	- C(16)	- C(17)	122.3(4)
C(3)	- C(16)	- C(21)	118.2(4)
C(16)	- C(17)	- C(18)	120.6(5)
C(17)	- C(18)	- C(19)	120.7(6)
C(18)	- C(19)	- C(20)	119.8(5)
C(19)	- C(20)	- C(21)	120.1(5)
C(20)	- C(21)	- C(16)	120.5(5)
N	- C(10)	- C(11)	118.4(4)
C(10)	- C(11)	- C(12)	120.9(5)
C(11)	- C(12)	- C(13)	120.0(6)
C(12)	- C(13)	- Cl	118.4(5)
Cl	- C(13)	- C(14)	121.2(4)
C(12)	- C(13)	- C(14)	120.4(6)
C(13)	- C(14)	- C(15)	119.7(5)
C(14)	- C(15)	- C(10)	121.3(5)
C(8)	- C(9)	- C(4)	122.3(9)
C(15)	- C(10)	- N	123.9(5)
C(15)	- C(10)	- C(11)	117.6(5)

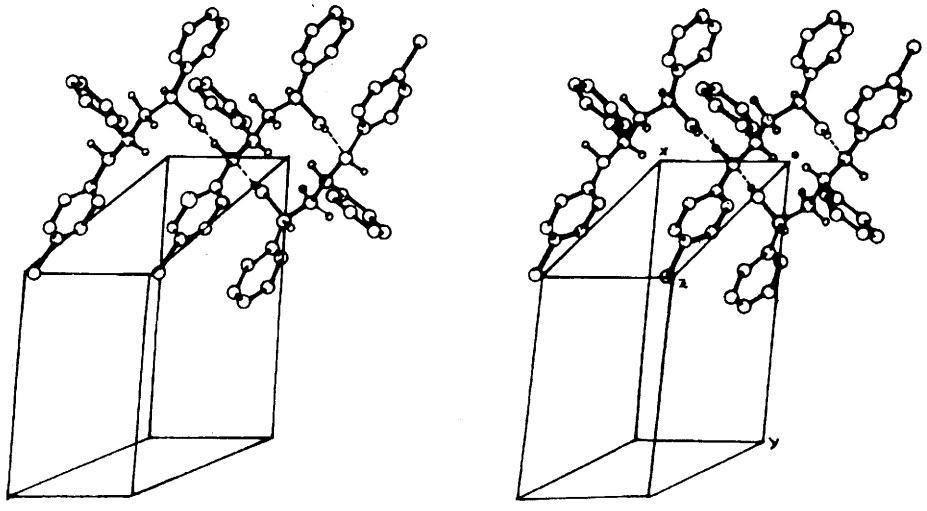

Figure 2. *Stereodrawing of the molecular packing with the hydrogen bonds shown by broken lines.*

Table 3. *Selected torsion angles(°). The estimated standard deviation is 0.9°.*

HN	- N	- C(3)	- C(2)	-63.4
HN	- N	- C(3)	- HC3	-175.6
HN	- N	- C(10)	- C(11)	40.4
HN	- N	- C(10)	- C(15)	-141.7
C(10)	- N	- C(3)	- C(2)	178.0
C(10)	- N	- C(3)	- HC3	65.6
C(3)	- N	- C(10)	- C(11)	159.1
C(3)	- N	- C(10)	- C(15)	-23.1
HO	- O	- C(1)	- HC1	-177.1
HO	- O	- C(1)	- C(4)	-59.5
HO	- O	- C(3)	- C(2)	68.8
C(4)	- C(1)	- C(2)	- C(3)	-167.8
HC1	- C(1)	- C(2)	- C(3)	-45.5
C(2)	- C(1)	- C(4)	- C(5)	178.4
C(2)	- C(1)	- C(4)	- C(9)	-2.3
HC1	- C(1)	- C(4)	- C(5)	57.3
HC1	- C(1)	- C(4)	- C(9)	-123.3
C(1)	- C(2)	- C(3)	- HC3	-46.8
C(1)	- C(2)	- C(3)	- C(16)	69.1
C(1)	- C(2)	- C(3)	- N	-164.8
C(2)	- C(3)	- C(16)	- C(21)	69.1
C(2)	- C(3)	- C(16)	- C(17)	-110.8
HC3	- C(3)	- C(16)	- C(17)	1.2
HC3	- C(3)	- C(16)	- C(21)	-178.9
C(3)	- C(16)	- C(17)	- C(18)	179.4
C(3)	- C(16)	- C(21)	- C(20)	-179.3

factors 0.973, 0.946 and with an average of 0.964, after which the equivalent reflections were merged with R_{int} = 1.98%.

The structure was solved using MULTAN80[2]. The hydrogen atoms have been found from difference electron density map all with B = B_{eq} of attached atoms. All non-hydrogen atoms were refined with anisotropic thermal parameters. Blocked-matrix refinement led to an R of 0.056 and ωR = 0.068 with the function minimized $\Sigma\omega(|F_o| - |F_c|)^2$, where $w = 0.7495 \mid \sigma(F_o) + (0.005914F_o) \mid^{-1}$ and σ (I) is based on counting statistics. Ratio of maximum shift to estimated standard deviation was 0.49, and the largest feature in the final difference electron map were 0.14 and -0.13 e Å^{-3}. The number of refined parameters was 218 and the standard deviations of unitary weight was 1.05. Programs from SHELX76[3]. Atomic scattering factors from *International Tables for X-ray Crystallography*[4]. Most of the calculations were performed on a IBM 3090 computer.

Discussion and Conclusion

The final atomic coordinates are given in Table 1 and bond distances and angles in Table 2. Selected torsion angles are shown in Table 3. Anisotropic temperature factors and the hydrogen atoms coordinates are given in Tables 4 and 5, respectively. The crystallographic atomic numbering and a view of the molecule are shown in Fig. 1.

The hydroxyl and the amino groups are *cis* in relation to the plane of the C(1), C(2) and C(3) atoms, as it was found in the compound[5] $C_{15}H_{23}O_2N.HBr$.

The benzene rings are planar with only slight deviations

Table 4. *Anisotropic temperature factors*

Atom	U(1,1)	U(2,2)	U(3,3)	U(2,3)	U(1,3)	U(1,2)
Cl	0.097(1)	0.099(1)	0.091(1)	-0.060(1)	-0.021(1)	-0.010(1)
N	0.038(2)	0.045(2)	0.040(2)	-0.013(2)	0.006(2)	-0.013(2)
O	0.038(2)	0.053(2)	0.047(2)	-0.012(2)	0.002(2)	-0.003(2)
C(1)	0.049(3)	0.040(3)	0.039(3)	-0.005(2)	-0.009(2)	-0.005(3)
C(2)	0.037(3)	0.051(3)	0.039(3)	-0.016(2)	-0.004(2)	-0.002(2)
C(3)	0.031(3)	0.050(3)	0.043(3)	-0.016(3)	0.002(2)	-0.001(2)
C(4)	0.053(3)	0.043(3)	0.062(4)	-0.019(3)	-0.006(3)	-0.009(3)
C(5)	0.055(4)	0.187(9)	0.21(1)	-0. 153(3)	0.000(5)	-0.021(5)
C(6)	0.077(6)	0.19(1)	0.25(1)	-0.17(1)	-0.048(7)	0.000(6)
C(7)	0.123(7)	0.099(6)	0.094(6)	-0.053(5)	-0.034(5)	-0.009(6)
C(8)	0.18(1)	0.21(1)	0.137(8)	-0.131(9)	0.068(7)	-0.106(9)
C(9)	0.140(7)	0.154(8)	0.122(7)	-0.103(6)	0.056(6)	-0.086(7)
C(10)	0.045(3)	0.044(3)	0.036(3)	-0.010(2)	-0.002(2)	-0.007(2)
C(11)	0.045(3)	0.085(4)	0.070(4)	-0.039(3)	0.003(3)	-0.015(3)
C(12)	0.049(4)	0.087(4)	0.095(5)	-0.044(4)	0.001(3)	-0.019(3)
C(13)	0.060(4)	0.064(3)	0.054(3)	-0.028(3)	-0.009(3)	-0.003(3)
C(14)	0.064(4)	0.075(4)	0.056(3)	-0.033(3)	0.013(3)	-0.022(3)
C(15)	0.051(3)	0.065(3)	0.068(4)	-0.034(3)	0.013(3)	-0.023(3)
C(16)	0.046(3)	0.045(3)	0.043(3)	-0.018(2)	-0.004(3)	-0.015(3)
C(17)	0.052(3)	0.062(4)	0.053(3)	-0.017(3)	0.008(3)	-0.020(3)
C(18)	0.077(5)	0.070(4)	0.050(4)	0.005(3)	0.007(3)	-0.036(4)
C(19)	0.097(5)	0.058(4)	0.054(4)	0.002(3)	-0.023(4)	-0.032(4)
C(20)	0.072(4)	0.056(4)	0.062(4)	-0.013(3)	-0.016(3)	-0.007(3)
C(21)	0.055(4)	0.049(3)	0.043(3)	-0.006(3)	-0.008(3)	-0.006(3)

Table 5. *Hydrogen atoms coordinates and equivalent isotropic temperature factors.*

	x	y	z	Beq*
HN	0.4709	-0.1003	0.1301	3.2
HO	-0.2520	-0.0858	-0.0263	3.6
HC1	-0.0799	0.2860	0.1134	3.4
H'C2	0.2849	-0.2340	0.0478	3.3
H''C2	0.1309	-0.1089	-0.0079	3.3
HC3	0.0004	-0.0853	0.1662	3.2
HC5	-0.3617	-0.3583	0.0052	10.4
HC6	-0.3737	-0.4581	-0.1533	12.1
HC7	-0.0577	-0.4591	-0.2796	7.9
HC8	0.2385	-0.3741	-0.2565	12.4
HC9	0.2251	-0.2449	-0.1365	9.5
HC11	0.6680	0.0424	0.1717	4.9
HC12	0.7025	0.1588	0.2994	5.7
CH14	0.1189	0.0986	0.4430	4.7
HC15	0.0455	0.0018	0.3144	4.5
HC17	-0.1226	-0.2056	0.3214	4.2
HC18	-0.0644	-0.3623	0.4592	5.1
HC19	0.2834	-0.4876	0.4772	5.3
HC20	0.6013	-0.4577	0.3413	5.0
HC21	0.5270	-0.2864	0.1956	3.9

from planarity. The dihedral angles between rings A and B, rings A and C, and rings B and C, are 3.6(3)°, 92.0(2)° and 95.3(2)°, respectively. The bond lengths in ring B are shorter than 1.395 Å, the standard C-C bond length in aromatic compounds probably due to the large thermal motion.

The C(sp^3)-Cl bond length do not differ significantly from the values determined in crystal structures of similar compounds. So, the C(13)-Cl bond is almost symmetrical in the plane of the phenyl ring and does not undergo any bending as indicated by the angles Cl-C(13)-C(14) [121,2(4)°] and Cl-C(13)-C(12) [118.4(5)°] and the distances Cl-C(14)[2.703(6) and Cl-C(12)[2.684(6)Å].

The molecular packing is assured by two hydrogen bonds: in one of them, the N atom acts as an acceptor and the O^i atom as a donor of H atom; in the other, the N atom acts as a donor of H atom and O^{ii} as an acceptor, with the distances and angles N. . . HO^i-O^i [N. . .O^i 2.942(9) Å, HO^i - O^i 1.02 Å, N. . . HO^i 164.5(9)°, with i = -x, -y, -z] and N - HN. . . O^{ii} [N. . .O^{ii} 3.015(9) Å, N - HN 1.10 Å, N - HN. . .O^{ii} 153.3(9)°, with ii = 1 + x, y, z]. A stereo drawing of the molecular packing with the hydrogen bonds is shown in Figure 2.

The hydrogen bonding seem to distort the angles C(3)-N-C(10) = 118.6(4)° and O^i-N-O^{ii} = 86.0(5)° for the sp^3 coordination of N but the mean value of the six angles around the N atom is 108.7(6)°, which is the expected tetrahedral value, within the standard deviation.

Supplementary material

The list of the observed and calculated structure factors is available from one of the authors (I.V.)upon request.

Acknowledgments

Financial support was received from FINEP, FAPESP, CNPq and IFS (International Foundation for Science).

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