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8,10-Dibenzylimidazonorbornylene

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Key indicators

Single-crystal X-ray study
T = 150 K
Mean σ(C–C) = 0.002 Å
R factor = 0.059
wR factor = 0.147
Data-to-parameter ratio = 27.9

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

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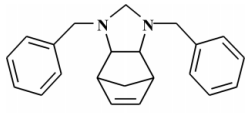
The title compound, 8,10-dibenzyl-1,4-methanobicyclo[4.3.0]-[8,10]diazanon-5-ene, $C_{22}H_{24}N_2$, was obtained through a [4 + 2]-cycloaddition reaction. It crystallizes in the monoclinic space group $P2_1/c$ (Z = 4). The 1,3-imidazole ring is *endo* with respect to the norbornylene skeleton. The benzyl protecting groups are situated along the sides of the molecule, towards the back.

Comment

Radioimmunotherapy is a new method for treating certain types of cancer, such as leukemia or lymphoma (Chatal *et al.*, 1993). This approach, which is complementary to conventional treatments, led us to develop new radionuclide chelating agents (Gouin, Gestin, Joly *et al.*, 2002; Gouin, Gestin, Reliquet *et al.*, 2002; Gouin, Gestin, Remaud *et al.*, 2002; Ouadi *et al.*, 2000). Moreover, numerous complexes of lanthanides and DTPA (diethylenetriaminepentaacetic acid) analogues have proved stable enough to be used in a physiological medium as radiopharmaceuticals (Liu & Edwards, 2001; Wu *et al.*, 1997). The most promising results relate to studies aimed at increasing the rigidity of the chelating structure. The introduction of a semi-rigid preformed skeleton minimizes the freedom of donor atoms and thereby has a significant effect on the stability of their metal complexes (Fossheim *et al.*, 1991; McMurry *et al.*, 1998). These considerations led us to synthesize ligands with a rigid norbornane skeleton.



(I)

The synthetic strategy was based on obtaining the intermediate title compound, (I), where the two N atoms, useful for further metal chelation, are protected by the benzyl groups. The structure determination was a key element in showing that the two amines are indeed in *endo* positions of the ring. Atom C7 is clearly on the opposite side from atoms N8 and N10 relative to the C1/C2/C3/C4 plane, with C7 0.921 (2) Å above that plane and N8 and N10 −1.199 (2) and −1.185 (2) Å, respectively, below it. The compound shows a staircase structure, with angles of 98.55 (9), 117.81 (9) and 104.20 (8)° for C7—C4—C3, C4—C3—N10 and C3—N10—C9, respectively. The orientation of the benzyl protecting groups minimizes the interactions. The compound was obtained after selective reduction of a carbonyl group in the C9 position by the action of lithium aluminium hydride. This selectivity is confirmed, insofar as the norbornylene double bond is conserved. The C5—C6 bond length is clearly in

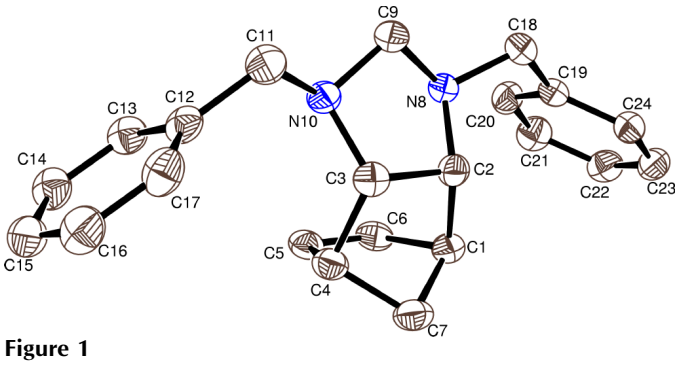


Figure 1
The molecular structure of (I), showing 50% probability displacement ellipsoids. H atoms have been omitted for clarity.

accordance with classical values for a $Csp^2—Csp^2$ bond [1.3318 (17) Å].

Experimental

The title compound was prepared by mixing 7,9-dibenzyl-2,5-methanobicyclo[4.3.0]-7,9-diazanon-3-en-8-one (0.88 g, 0.00267 mol) with $LiAlH_4$ (1 g, 0.0267 mol) and anhydrous tetrahydofuran (35 ml) under argon. The mixture was refluxed for 21 h and cooled to 273 K before a 15% solution of sodium hydroxide (2 ml) was slowly added, with continuous stirring, over a period of 10 min at room temperature. The mixture was filtered through a Celite pad and washed with water (200 ml) before the filtrate was extracted with dichloromethane (300 ml). The organic phase was washed with brine, dried ($MgSO_4$), filtered and evaporated. The residue was purified by flash chromatography on silica, using dichloromethane/ethyl acetate (95/5) as eluant. Single crystals suitable for X-ray analysis were obtained by slow evaporation at room temperature from diethyl ether.

Crystal data

$C_{22}H_{24}N_2$
M_r = 316.4
Monoclinic, $P2_1/c$
a = 15.4338 (4) Å
b = 8.2487 (2) Å
c = 13.8748 (3) Å
β = 92.7699 (8)°
V = 1764.32 (7) Å^3
Z = 4
D_x = 1.190 Mg m^{-3}
Mo Kα radiation
Cell parameters from 17065 reflections
θ = 2.9–32.0°
μ = 0.07 mm^{-1}
T = 150 K
Block, colourless
0.31 × 0.23 × 0.18 mm

Data collection

Nonius KappaCCD diffractometer
φ and ω scans
Absorption correction: none
17647 measured reflections
6050 independent reflections
4012 reflections with $I > 2\sigma(I)$
R_{int} = 0.056
θ_{max} = 32.0°
$h = -23 \rightarrow 22$
$k = -12 \rightarrow 11$
$l = -20 \rightarrow 13$

Refinement

Refinement on F^2
$R[F^2 > 2\sigma(F^2)]$ = 0.059
$wR(F^2)$ = 0.147
S = 1.45
6050 reflections
217 parameters
H-atom parameters constrained
$w = 1/[\sigma^2(I) + 0.0025I^2]$
$(\Delta/\sigma)_{max} < 0.001$
$\Delta\rho_{max}$ = 0.30 e Å^{-3}
$\Delta\rho_{min}$ = −0.25 e Å^{-3}

All H atoms were initially found in a difference Fourier synthesis but were fixed in idealized positions in the final refinement. Riding isotropic displacement parameters, with $U_{iso}(H) = 1.2U_{eq}(C)$, were used for all H atoms.

Data collection: *COLLECT* (Nonius, 1998); cell refinement: *HKL SCALEPACK* (Otwinowski & Minor, 1997); data reduction: *HKL DENZO* and *SCALEPACK* (Otwinowski & Minor, 1997); program(s) used to solve structure: *SHELXTL* (Sheldrick, 1995); program(s) used to refine structure: *JANA*2000 (Petricek & Dusek, 2000); molecular graphics: *DIAMOND* (Brandenburg & Berndt, 1999); software used to prepare material for publication: *JANA*2000.

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