References

Andres, C. J. & MacDonald, T. L. (1993). *J. Org. Chem.* **58**, 6609–6613.

Baldwin, J. E., Hulme, C., Schofield, C. J. & Edwards, A. J. (1993). *J. Chem. Soc. Chem. Commun.* pp. 935–936.

Cordes, A. W. (1982). *MPLN. Program to Calculate Least-Squares Planes and Dihedral Angles with Associated E.s.d.'s.* Univ. of Arkansas, Fayetteville, Arkansas, USA.

Larson, A. C. (1970). *Crystallographic Computing*, edited by F. R. Ahmed, S. R. Hall & C. P. Huber, pp. 291–294. Copenhagen: Munksgaard.

Larson, S. B. (1982). *FUER. Program for Generating Positional and Thermal Parameters and Geometrical Quantities.* Univ. of Texas, Austin, Texas, USA.

Lynch, V. M., Hulme, C., Magnus, P. & Davis, B. E. (1994). *Acta Cryst.* C51, 262–265.

Magnus, P., Hulme, C. & Weber, W. (1994). *J. Am. Chem. Soc.* **116**, 4501–4502.

Sheldrick, G. M. (1991). *SHELXTL-Plus.* Release 4.1. Siemens Analytical X-ray Instruments Inc., Madison, Wisconsin, USA.

Shono, T. (1984). *Tetrahedron*, **40**, 811–850.

Siemens (1989). *P3/V Diffractometer Program.* Version 4.16. Siemens Analytical X-ray Instruments Inc., Madison, Wisconsin, USA.

Wong, P. L. & Moeller, K. D. (1993). *J. Am. Chem. Soc.* **115**, 11434–11445.

N α-tert-Butoxycarbonyl-N τ-benzylhistidine p-Nitrobenzyl Ester

ANATOLY F. MISHNEV, ANDREJS A. KEMME AND JURIS J. ANCANS

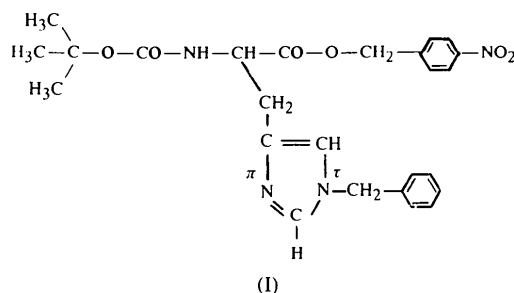*Latvian Institute of Organic, Synthesis, LV1006, Riga, Latvia*

Abstract

The determination of the structure of the title compound, $C_{25}H_{28}N_4O_6$, shows that the benzyl group is attached to the N atom at the τ position of the imidazole ring of histidine. In the solid state, the molecule displays a conformation that is favourable for intramolecular α-C proton abstraction by the π-N atom of the imidazole ring, as has been suggested in the explanation of the racemization mechanism.

Comment

Activated histidine derivatives are more prone to racemization during peptide synthesis than other amino acids (Fields & Noble, 1990). The racemization mechanism has been proposed to be an intramolecular α-C proton abstraction by the π-N atom of the imidazole ring (Fletcher, Jones, Ramage & Stachulski, 1979).

It was interesting to verify whether there were conformational features of [Boc-His(N^τ-Bzl)-O-Bzl(NO_2)], (I), favourable for such an interaction in the crystalline state. To our knowledge, this is the first report of a crystal structure of an N^τ isomer of an N^{im}-modified histidine derivative. As seen in Fig. 1, the histidine derivative has been modified at the τ-N atom of the imidazole ring.

(I)

The molecule adopts a closed conformation, similar to that found in molecule A of L-N-acetylhistidine monohydrate (Kistenmacher, Hunt & Marsh, 1972), in which the imidazole ring is folded back on top of the carboxylate group. The torsion angles C(1')—C(1A)—C(1B)—C(1C) and C(1')—C(1A)—N(1)—C(1) in the molecule have values of 73.2 (6) and −72.4 (5)°, respectively. In the crystalline state, the molecule displays a conformation that is favourable for intramolecular α-C proton abstraction by the imidazole π-N atom, as suggested for the racemization mechanism for activated histidine derivatives (Brown, Jones & Wallis, 1982). The distance between the α-C H atom [H(C1A)] and the π-N atom of the imidazole ring [N1D1] is 2.71 (3) Å.

The atoms of the imidazole ring are coplanar. The dihedral angle between the plane of the imidazole and the plane of the adjacent phenyl ring is 113.8 (4)°.
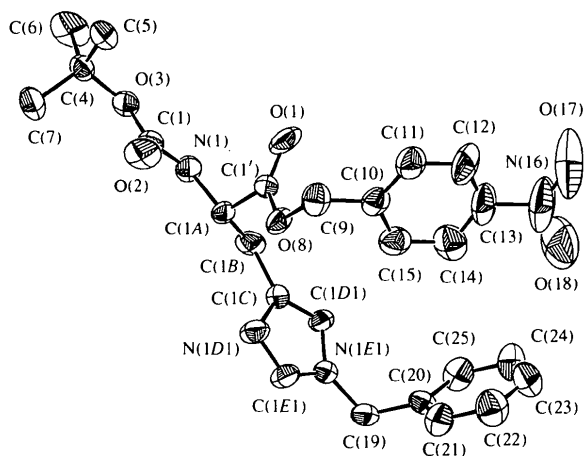

Fig. 1. View of the title compound showing the atomic numbering scheme. Displacement ellipsoids are shown at the 50% probability level.

The bond distances and angles in the imidazole ring and in the amide group are in good agreement with the values found in N^α-tert-butoxycarbonyl-N^π-benzyloxy-methyl-L-histidine (Brown, Jones & Wallis, 1982). The only difference is the inversion of the single and double bonds due to different positions of the substituents on the imidazole ring.

The molecules in the crystal are packed at van der Waals distances with the exception of the contact N(1)—H$\cdots$O(2) [N$\cdots$O 3.364(6), H$\cdots$O 2.62(4) Å, N—H$\cdots$O 159(4)°; symmetry operation: $1 + x$, y, z], which may be described as a weak hydrogen bond.

Experimental

The title compound (I) was obtained as described by Feinberg & Merrifield (1972). Single crystals were grown from ethanol–water solution.

Crystal data

C$_{25}$H$_{28}$N$_4$O$_6$	Mo $K\alpha$ radiation
$M_r = 480.52$	$\lambda = 0.71073$ Å
Monoclinic	Cell parameters from 20
$P2_1$	reflections
$a = 5.558 (2)$ Å	$\theta = 12–16°$
$b = 8.776 (3)$ Å	$\mu = 0.09$ mm^{-1}
$c = 25.153 (7)$ Å	$T = 293$ K
$\beta = 95.46 (2)°$	Parallelepiped
$V = 1221.3 (7)$ Å^3	$0.45 \times 0.3 \times 0.2$ mm
$Z = 2$	Colourless
$D_x = 1.31$ Mg m^{-3}	

Data collection

Syntex $P2_1$ diffractometer	$\theta_{max} = 25°$
$\theta/2\theta$ scans	$h = -6 \rightarrow 5$
Absorption correction:	$k = 0 \rightarrow 10$
none	$l = 0 \rightarrow 29$
2221 measured reflections	2 standard reflections
2107 independent reflections	monitored every 60
1953 observed reflections	reflections
$[I > 2\sigma(I)]$	intensity decay: none
$R_{int} = 0.032$	

Refinement

Refinement on F	$(\Delta/\sigma)_{max} = 0.173$
$R = 0.049$	$\Delta\rho_{max} = 0.14$ e Å^{-3}
$wR = 0.049$	$\Delta\rho_{min} = -0.17$ e Å^{-3}
$S = 0.988$	Extinction correction: none
1953 reflections	Atomic scattering factors
427 parameters	from *International Tables*
H atoms refined isotropically	*for X-ray Crystallography*
Unit weights applied	(1974, Vol. IV)

Table 1. *Fractional atomic coordinates and equivalent isotropic displacement parameters* (Å^2)

$$B_{eq} = (8\pi^2/3)\Sigma_i\Sigma_jU_{ij}a_i^* a_j^* \mathbf{a}_i.\mathbf{a}_j.$$

	x	y	z	B_{eq}
O(1)	0.4076 (8)	0.7674	0.2659 (1)	4.5 (1)
O(2)	0.1060 (6)	0.7689 (6)	0.3829 (2)	4.3 (1)
O(3)	0.4006 (5)	0.6168 (6)	0.4236 (1)	3.2 (1)
O(8)	0.2156 (6)	0.9906 (6)	0.2613 (1)	3.4 (1)
O(17)	0.6449 (12)	0.9098 (14)	0.0001 (2)	10.4 (3)
O(18)	0.8099 (16)	1.1171 (12)	0.0331 (3)	10.7 (5)
N(1)	0.5022 (7)	0.8108 (7)	0.3762 (1)	3.1 (1)
N(16)	0.6691 (14)	1.0115 (15)	0.0339 (3)	7.4 (3)
N(1D1)	0.4938 (7)	1.2788 (7)	0.3236 (2)	3.6 (1)
N(1E1)	0.7646 (7)	1.4027 (6)	0.2811 (1)	3.0 (1)
C(1A)	0.4624 (8)	0.9421 (7)	0.3409 (2)	2.6 (1)
C(1B)	0.7029 (9)	1.0263 (7)	0.3394 (2)	3.4 (1)
C(1C)	0.6839 (8)	1.1827 (7)	0.3152 (2)	2.8 (1)
C(1D1)	0.8491 (8)	1.2564 (7)	0.2889 (2)	3.0 (1)
C(1E1)	0.5529 (9)	1.4085 (7)	0.3026 (2)	3.5 (2)
C(1')	0.3638 (8)	0.8872 (7)	0.2855 (2)	2.9 (1)
C(1)	0.3151 (9)	0.7349 (7)	0.3939 (2)	3.3 (1)
C(4)	0.2375 (8)	0.5108 (8)	0.4487 (2)	3.2 (1)
C(5)	0.0642 (10)	0.4346 (8)	0.4069 (2)	4.3 (2)
C(6)	0.4156 (10)	0.3965 (9)	0.4743 (2)	4.8 (3)
C(7)	0.1050 (11)	0.5970 (9)	0.4895 (2)	5.0 (2)
C(9)	0.0967 (11)	0.9469 (9)	0.2098 (2)	4.4 (2)
C(10)	0.2545 (9)	0.9660 (8)	0.1645 (2)	3.7 (2)
C(11)	0.2051 (13)	0.8737 (9)	0.1200 (2)	4.9 (2)
C(12)	0.3379 (15)	0.8895 (12)	0.0769 (2)	5.8 (2)
C(13)	0.5204 (13)	0.9972 (11)	0.0794 (2)	5.1 (2)
C(14)	0.5690 (12)	1.0908 (11)	0.1223 (3)	5.5 (2)
C(15)	0.4358 (11)	1.0741 (9)	0.1659 (2)	4.5 (2)
C(19)	0.8889 (10)	1.5281 (8)	0.2567 (2)	3.5 (2)
C(20)	0.8881 (9)	1.5118 (7)	0.1966 (2)	3.4 (1)
C(21)	0.7021 (10)	1.5707 (9)	0.1630 (2)	4.5 (2)
C(22)	0.7028 (12)	1.5545 (10)	0.1081 (3)	5.5 (2)
C(23)	0.8904 (13)	1.4807 (10)	0.0873 (3)	5.6 (2)
C(24)	1.0776 (13)	1.4218 (10)	0.1202 (3)	5.6 (2)
C(25)	1.0752 (10)	1.4387 (9)	0.1752 (2)	4.8 (2)

Table 2. *Selected geometric parameters* (Å, °)

C(1')—O(1)	1.196 (6)	C(1D1)—C(1C)	1.347 (7)
C(1)—O(2)	1.206 (6)	C(5)—C(4)	1.513 (7)
C(1)—O(3)	1.338 (7)	C(6)—C(4)	1.510 (9)
C(4)—O(3)	1.481 (7)	C(7)—C(4)	1.520 (8)
C(1')—O(8)	1.333 (7)	C(10)—C(9)	1.512 (8)
C(9)—O(8)	1.449 (6)	C(11)—C(10)	1.388 (8)
N(16)—O(17)	1.231 (14)	C(1D1)—N(1E1)	1.375 (8)
N(16)—O(18)	1.214 (15)	C(1E1)—N(1E1)	1.342 (6)
C(1A)—N(1)	1.459 (8)	C(19)—N(1E1)	1.465 (8)
C(1)—N(1)	1.346 (7)	C(1B)—C(1A)	1.531 (7)
C(13)—N(16)	1.479 (10)	C(1')—C(1A)	1.526 (7)
C(1C)—N(1D1)	1.384 (7)	C(1C)—C(1B)	1.501 (8)
C(1E1)—N(1D1)	1.310 (8)		
O(1)—C(1')—O(8)	123.4 (4)	C(1D1)—N(1E1)—C(19)	126.4 (4)
O(1)—C(1')—C(1A)	125.8 (5)	C(1E1)—N(1E1)—C(19)	127.4 (5)
O(2)—C(1)—O(3)	127.1 (5)	N(1E1)—C(19)—C(20)	112.9 (5)
O(2)—C(1)—N(1)	124.0 (5)	C(1A)—C(1B)—C(1C)	115.1 (4)
O(3)—C(1)—N(1)	108.9 (4)	C(1B)—C(1A)—C(1')	111.6 (4)
C(1)—O(3)—C(4)	121.7 (4)	C(1B)—C(1C)—C(1D1)	127.8 (5)
O(3)—C(4)—C(5)	110.9 (4)	C(5)—C(4)—C(6)	110.6 (6)
O(3)—C(4)—C(6)	101.3 (4)	C(5)—C(4)—C(7)	111.8 (4)
O(3)—C(4)—C(7)	109.3 (5)	C(6)—C(4)—C(7)	112.5 (4)
O(8)—C(1')—C(1A)	110.8 (5)	N(16)—C(13)—C(12)	118.9 (7)
C(1')—O(8)—C(9)	115.9 (5)	N(16)—C(13)—C(14)	118.6 (8)
O(8)—C(9)—C(10)	113.4 (5)	N(1D1)—C(1C)—C(1B)	121.4 (5)
O(17)—N(16)—O(18)	124.7 (8)	N(1D1)—C(1C)—C(1D1)	110.4 (5)
O(17)—N(16)—C(13)	116.1 (9)	C(1C)—N(1D1)—C(1E1)	104.1 (4)
O(18)—N(16)—C(13)	119.1 (9)	N(1D1)—C(1E1)—N(1E1)	113.1 (5)
N(1)—C(1A)—C(1B)	108.3 (4)	N(1E1)—C(1D1)—C(1C)	106.2 (4)
N(1)—C(1A)—C(1')	109.1 (5)	C(1D1)—N(1E1)—C(1E1)	106.2 (4)
C(1A)—N(1)—C(1)	121.0 (4)		

Direct methods revealed all non-H atoms of the structure which was then refined isotropically to $R = 0.09$ and anisotropically to $R = 0.049$. At that stage H atoms had been localized by difference synthesis and refined isotropically.

Data reduction: Syntex diffractometer system. Structure solution: *SHELXS86* (Sheldrick, 1985). Structure refinement: *SHELX76* (Sheldrick, 1976). Molecular graphics: *ORTEP*II (Johnson, 1976), implemented on an IBM-PC/AT.

Lists of structure factors, anisotropic displacement parameters, H-atom coordinates and complete geometry have been deposited with the IUCr (Reference: VS1017). Copies may be obtained through The Managing Editor, International Union of Crystallography, 5 Abbey Square, Chester CH1 2HU, England.

References

Brown, T., Jones, J. H. & Wallis, J. D. (1982). *J. Chem. Soc. Perkin Trans.* 1, pp. 3045–3048.
Feinberg, R. S. & Merrifield, R. B. (1972). *Tetrahedron*, **28**, 5865–5871.
Fields, G. B. & Noble, R. L. (1990). *Int. J. Peptide Protein Res.* **35**, 161–214.
Fletcher, A. R., Jones, J. H., Ramage, W. I. & Stachulski, A. V. (1979). *J. Chem. Soc. Perkin Trans.* 1, pp. 2261–2265.
Johnson, C. K. (1976). *ORTEPII*. Report ORNL-5138. Oak Ridge National Laboratory, Tennessee, USA.
Kistenmacher, T. J., Hunt, D. J. & Marsh, R. E. (1972). *Acta Cryst.* **B28**, 3352–3358.
Sheldrick, G. M. (1976). *SHELX76. Program for Crystal Structure Determination.* Univ. of Cambridge, England.
Sheldrick, G. M. (1985). *SHELX86. Program for the Solution of Crystal Structures.* Univ. of Göttingen, Germany.

Commentaire

La planéité ou la non-planéité des molécules, l'empilement moléculaire plus ou moins compact et l'existence d'une tautomérie sont des éléments qui déterminent les propriétés de thermochromie ou de photochromie des salicylidèneanilines. Les liaisons hydrogène intermoléculaires semblent aussi jouer un rôle important dans la manifestation de ces propriétés. En effet, des études menées dans notre laboratoire (Carles, Mansilla-Koblavi, Tenon, N'guessan & Bodot 1993; Mansilla-Koblavi, 1993) ont montré que tous les composés ayant un deuxième groupement hydroxyle en *ortho* du premier sur le fragment salicyclidène s'associent en dimère par liaisons hydrogène et sont thermochromes. La synthèse d'un dérivé possédant un deuxième groupement hydroxyle en position 5 (*méta*), comme *N*-(5-hydroxysalicylidène)-2,4,6-triméthylaniline, (I), a été effectuée pour essayer de mieux appréhender l'influence de la nature du réseau de liaisons hydrogène intermoléculaires sur les propriétés de thermochromie ou de photochromie.

(I)

N-(5-Hydroxysalicylidène)-2,4,6-triméthylaniline

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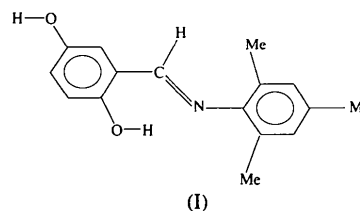
Abstract

The structure of the title compound, *N*-(5-hydroxysalicylidene)-2,4,6-trimethylaniline, $C_{16}H_{17}NO_2$, has been resolved in order to study the influence of intermolecular hydrogen-bond networks on the thermochromic and photochromic properties of salicylideneaniline. The molecules stack in layers and are associated by an infinite chain of hydrogen bonds. The mean distance between the planes of the two layers is about 3.37 Å. The two C—O [1.365 (4) Å] and the C7—N [1.273 (4) Å] distances show that the phenol–phenol form is the major conformation. The title compound is thermochromic.

Les valeurs des longueurs de liaison (Tableau 2) sont compatibles avec celles trouvées dans des composés de la même famille (Bregman, Leiserowitz & Osaki, 1964; Bregman, Leiserowitz & Schmidt, 1964; Moustakali-Mavridis, Hadjoudis & Mavridis, 1978, 1980; Hadjoudis, Vittarakis & Moustakali-Mavridis, 1987; Lindeman, Shklover, Struchkov, Kravcheny & Potapov, 1982; Mansilla-Koblavi, Touré, Lapasset, Carles & Bodot, 1989) et sont conformes à celles proposées par Allen *et al.* (1987). Pour ce type de composé susceptible de manifester le phénomène de tautomérie, les distances
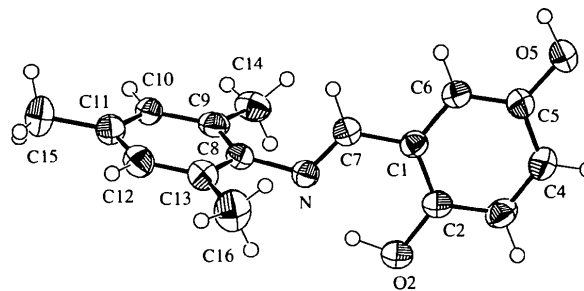

Fig. 1. Dessin *ORTEP*II (Johnson, 1976) de la *N*-(5-hydroxysalicylidène)-2,4,6-triméthylaniline. Les ellipsoïdes sont représentées à 50% de probabilité. La représentation des hydrogènes est arbitraire.