The Crystal Structure and Configuration of *syn*- and *anti*-Ethyl Benzohydroximate

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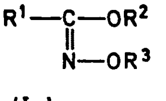
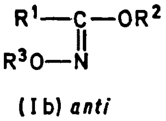
Summary The configuration on the C=N bond of the title compounds has been determined by *X*-ray analysis and is in agreement with the previous assignment based on dipole moments.

DERIVATIVES of hydroxamic acids derived from the tautomeric hydroximic form can exist in two stereoisomeric forms (Ia) and (Ib). Werner[1] recognized that stereoisomerism is involved and attempted to determine the configuration by means of a reaction analogous to the Beckmann rearrangement. From a dipole moment study of the ethyl benzohydroximates (IIa and b) and their *p*-nitro-derivatives we concluded[2] that Werner's assignment should be reversed. The configuration of other derivatives of the type (I) could be deduced from their relationship to the compounds (IIa or b) or from their analogy to them.[2]



$$\begin{array}{ccc} R^1- & C & -OR^2 \\ & \| & \\ & N & -OR^3 \end{array}$$

(Ia) *syn*



$$\begin{array}{ccc} R^1- & C & -OR^2 \\ & \| & \\ R^3O- & N & \end{array}$$

(Ib) *anti*

(IIa and b); R^1 = Ph, R^2 = Et, R^3 = H

The ethyl benzohydroximates (IIa), m.p. 53°, and (IIb), m.p. 67°, thus have a key importance for the stereochemistry of all other derivatives. We attempted to refine the analysis of dipole moments[3] and to support it with n.m.r. measurements.[4] The results obtained were in agreement but the reasoning was complicated. We decided, therefore, to do a complete three-dimensional *X*-ray investigation on crystals of both stereoisomers.

Both compounds crystallize in the space group $P2_1/c$, the lattice parameters for (IIa) and (IIb), respectively, being $a = 12{\cdot}00$, $b = 5{\cdot}799$, $c = 17{\cdot}44$ Å, $\beta = 132{\cdot}01°$, $Z = 4$, and $a = 11{\cdot}44$, $b = 6{\cdot}456$, $c = 15{\cdot}80$ Å, $\beta = 128{\cdot}17°$, $Z = 4$. The configuration determined from dipole moments[2,3] is confirmed. The same sequence of events in the determination of the configuration of oximes has been repeated with hydroximic acid derivatives (see Table).

In the older literature concerning hydroximic acid derivatives, reversed stereochemical formulae are given to individual isomers, but the designations *syn* and *anti* refer to the same compounds as in more recent work.[2]

As to the conformation of the compounds (IIa and b), the phenyl rings are twisted from the C_{Ar}–C=N plane with dihedral angles of 29 and 46°, respectively. Both oxygen atoms lie near this plane but the ethyl groups are twisted 35 and 8°, respectively, the larger angle in the *syn*-isomer being due to steric repulsion of the hydroxyl group. The position of the O–C_{ethyl} bond is thus near to the *cis*-conformation with respect to the C=N bond. The same conformation is the stable one in the molecules of esters and other derivatives with a –C(=X)–O– grouping.[6] However, unlike that of esters, the conformational stability does not persist[2,3] in solutions of compounds (IIa and b) and several forms of comparable stability must exist. Hence, there is certainly a difference between the conformation in the crystalline state and in solution.

The presence of a weak intramolecular hydrogen bond in solutions of (IIa) was postulated on the basis of cryoscopy[7] and n.m.r. spectra[4] but could not be detected by i.r. spectroscopy.[4] Its presence would be consistent with the unusual *cis*-conformation[2] (with respect to the N=C bond) of the OH group. In the crystal structures of both compounds only intermolecular hydrogen bonds occur, the molecules being coupled to dimers by two O–H · · · N bonds. Accordingly, the conformation of the NOH group in both (IIa) and (IIb) is *trans* to N=C.[3,5] The position of the hydrogen atoms is therefore different in solution and in the crystalline state. An intramolecular hydrogen bond in (IIa), if present in solution, must be very weak.

	Oximes	Hydroximic acid derivatives
Recognized as stereoisomers	Hantzsch, Werner 1890	Werner[1] 1893
First incorrect determination of configuration	Hantzsch 1891	Werner[1] 1893
Reversal of the configuration	Meisenheimer 1921	Exner, Jehlička, Reiser[2] 1959
Final confirmation by *X*-ray	Jerslev[5] 1957	This work

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