AMINOMETHYLENE DERIVATIVES OF AZOLES

XXII.* ISOMERISM OF 4-AMINOETHYLIDENE AND 4-AMINOMETHYLENE-5-IMIDAZOLONES

I. Ya. Kvitko, L. N. Kurkovskaya,
R. V. Khozeeva, and A. V. El'tsov

UDC 547.781.5'783:541.62

4-Aminoethylidene and 4-aminomethylene derivatives of 5-imidazolone exist in the enamine form as two isomers that are stabilized by intramolecular hydrogen bonds of the NH···N and NH···O type. In solution the enamine with a five-membered H ring is gradually converted to the corresponding isomer with a six-membered H ring with an NH···O bond. Because of steric hindrance, rotation about the carbon–carbon double bond is realized more slowly in the aminoethylidene derivatives than in the aminomethylene derivatives of 5-imidazolone.

In a paper devoted to the synthesis and structure of aminoethylidene and aminomethylene derivatives of 5-imidazolone [2] it was reported that, judging from the PMR spectra, for some of them in solutions in $CDCl_3$ one observes another isomer of this compound in addition to an enamine structure stabilized by an intramolecular hydrogen bond of the NH···O type. The PMR spectra of similar compounds at several concentrations and various temperatures were analyzed to ascertain the structure of this isomer.

Depending on the time of preparation of the solutions, one or two groups of signals with the following positions are observed in the PMR spectra of 1,2-dimethyl-4-methylaminoethylidene-5-imidazolone (I) ($CDCl_3$, 20°C): For freshly prepared solutions one observes one form (1) containing the proton of an amino group with $\delta \sim 6.6$ ppm ($J_{NH,CH_3} = 5.0$ Hz), after 30 min 5% of another form (2) with δ_{NH} 9.2 ppm ($J_{NH,CH_3} = 5.2$ Hz) appears, after 24 h the ratio of both forms is 1:1, after 2 days one observes 13% of form (1) and 87% of a new form, and after one week this ratio is approximately the same (10:90) and remains virtually unchanged as the temperature is changed from −60 to +60°C. The δ_{NH} chemical shifts of the two forms depend only slightly on the temperature or on the concentration (Table 1).

TABLE 1. Dependence of the δ_{NH} Chemical Shifts of the Two Forms on the Temperature and Concentration

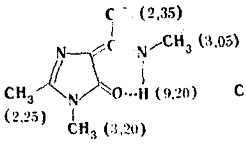
Temp., °C	δ_{NH}, ppm	
	(1)	(2)
+60	6,49	9,16
+27	6,66	9,17
−60	6,88	9,18
Concn., mole %		
10	6,66	9,17
2	6,57	9,17
1	6,57	9,17

---

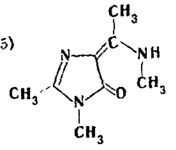
*See [1] for communication XXI.

Lensovet Leningrad Technological Institute, Leningrad 198013. L. Ya. Karpov Scientific-Research Physicochemical Institute, Moscow 107120. Translated from Khimiya Geterotsiklicheskikh Soedinenii, No. 12, pp. 1677-1679, December, 1978. Original article submitted March 15, 1978.

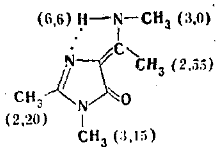
If, in analogy with similar compounds (for example, 5-pyrazolone derivatives [3]), one assumes an enamine structure with an intramolecular hydrogen bond for form (2), one of the following structures (Ib-d) can be assumed for form (1):



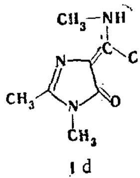
I a



I b

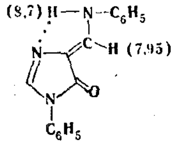


I c

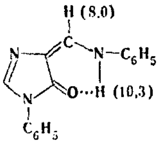


I d

A substantial difference in the $\delta_{\mathrm{CH_3}}$ values (0.18 ppm) is observed only for the singlet signals of the protons of one methyl group ($\mathrm{CH_3{-}C{=}C<}$), whereas the difference is only ~0.05 ppm for the remaining $\mathrm{CH_3}$ groups. This may be a consequence of the anisotropic effect of the carbonyl group, and structure Ib should consequently be excluded from the three possible structures. The absence of the characteristic spin-spin coupling constants of the protons of the methyl group attached to the $\mathrm{H_3C-NH}$ bond made it impossible to identify structures Ic and Id, and we therefore studied the PMR spectra of other 5-imidazolone derivatives. Thus two groups of signals are also observed in the spectra of freshly prepared solutions of 1-phenyl-4-phenylaminomethylene-5-imidazolone (II) in $\mathrm{CDCl_3}$, and the $J_{\mathrm{NH,CH}}$ values of 12.0 and 13.0 Hz make it possible to assign form (1) to the structure with a trans-oriented amino group (IIc) and form (2) to cis structure IIa.



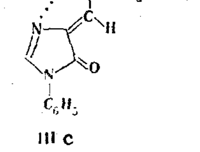
II c



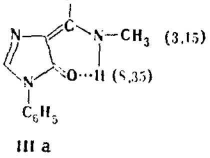
II a

It is possible that a structure of the IIa type is realized in the case of cleavage of the intramolecular hydrogen bond by dimethyl sulfoxide (DMSO) in the aminomethylene derivatives of 5-pyrazolone and 5-pyrrolone [4]; however, in contrast to 5-imidazolone derivatives, structures of the IIc type were not observed in chloroform solutions for them. Their existence in the case of 5-imidazolone derivatives is evidently explained by the possibility of stabilization by an intramolecular hydrogen bond of the NH···N type with the ring nitrogen atom, as evidenced by the absence of temperature and concentration dependences of δ_{NH}.

The formation of an intramolecular hydrogen bond increases the energy barrier to conversion of form (1) to form (2). As compared with aminoethylidene derivative I, aminomethylene derivative II in a freshly prepared solution in $\mathrm{CDCl_3}$ contains only ~30% of form (1), and the entire (1) → (2) conversion is complete in a few hours. The difference in the δ_{NH} shifts of the two forms, which to a certain degree reflects the difference in energies, is greater for 1,2-dimethyl-4-methylaminoethylidene-5-imidazolone than for 1-phenyl-4-phenylaminomethylene-5-imidazolone (2.60 and 1.64 ppm, respectively), and the (1) → (2) conversion should consequently have been more rapid. The presence at the double bond of a methyl group evidently hinders the (1) → (2) conversion because of steric strain, since, all other things being equal, the difference in the shifts of the two forms should determine the ease of the conversion. To verify this we measured the PMR spectrum of 1-phenyl-4-methylaminomethylene-5-imidazolone (III), in which two groups of signals were also observed:



III c



III a

The difference in the δ_{NH} shifts for the two forms of this compound is 1.96 ppm, which is somewhat greater than for II; however, as one might have expected, the initial percentage of form (1) was correspondingly smaller (~15%). Insofar as the formation of aminoethylidene or aminomethylene derivatives of 5-imidazolone is concerned, in the process of synthesis in structures Ic and IIc it may be assumed that in concentrated solutions, as a consequence of an intermolecular interaction, the "unfolded" trans form is more favorable and that I-III are generated in it. During dissolving slow rotation of the amino group about the carbon-carbon double bond and the formation of an enamine stabilized by a six-membered chelate ring (structures Ia and IIa) occur. This process also takes place in the dark at approximately the same rate.

EXPERIMENTAL

The synthesis of the investigated compounds is described in [2]. The PMR spectra were measured with a JNM-PS-100 spectrometer; the accuracy in the measurement of the chemical shifts was ± 0.05 ppm, and the accuracy in the measurement of the coupling constants was ± 0.5 Hz.

LITERATURE CITED

1. L. N. Kurnovskaya, E. A. Panfilova, L. V. Alam, I. Ya. Kvitko, and A. V. El'tsov, Zh. Strukt. Khim., 19, 620 (1978).
2. I. Ya. Kvitko, R. V. Khozeeva, and A. V. El'tsov, Khim. Geterotsikl. Soedin., No. 10, 1384 (1975).
3. L. N. Kurkovskaya, N. N. Shapet'ko, I. Ya. Kvitko, Yu. N. Koshelev, and E. D. Samartseva, Zh. Org. Khim., 10, 2210 (1974).
4. L. N. Kurkovskaya, N. N. Shapet'ko, N. B. Sokolova, and I. Ya. Kvitko, Zh. Org. Khim., 11, 1091 (1975).

HETEROCYCLIC QUINONES

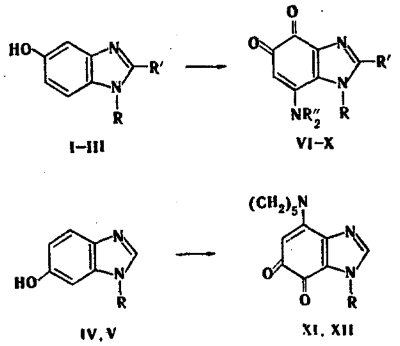
XXXIII.* OXIDATIVE AMINATION OF 5(6)-HYDROXYBENZIMIDAZOLES

Yu. S. Tsizin and S. A. Chernyak

UDC 547.785.5:542.958.3

A number of benzimidazole-4,5(6,7)-quinones containing a secondary amine residue in the quinone ring were obtained by oxidation of N-substituted 5(6)-hydroxybenzimidazoles with oxygen in the presence of copper(II)–piperidine (dimethylamine) complexes. It is shown that the reaction proceeds in the presence of catalytic amounts of copper acetate and is not accompanied by amination of the $C_{(2)}$ atom.

The aim of the present research was to study the applicability of oxidative amination for the synthesis of o-benzimidazolequinones, since the existing methods for their preparation are based on the oxidation of difficult-to-obtain bifunctional derivatives [2-5]. For this purpose two fundamental questions had to be answered: Will stable chelate complexes of the products of oxidation of I-III be formed with copper (see [6]), and is amination of the $C_{(2)}$ atom during the oxidation of IV and V possible (as in the case of the previously observed [7] amination of benzothiazole-6,7-quinones)? It should be noted that N-substituted benzimidazole-4,5-quinones have not been previously described.



I–III, VI–X, IV, V, XI, XII

I $R=CH_3$, $R'=H$; II $R=C_6H_5$, $R'=H$; III $R=C_6H_5$, $R'=CH_3$; IV $R=C_6H_5$; V $R=CH_3$; VI $R=CH_3$, $R'=H$, $NR''_2=N(CH_2)_5$; VII $R=C_6H_5$, $R'=H$, $NR''_2=N(CH_2)_5$; VIII $R=C_6H_5$, $R'=H$, $R''=CH_3$; IX $R=C_6H_5$, $R'=CH_3$, $NR''_2=N(CH_2)_5$; X $R=C_6H_5$, $R'=R''=CH_3$; XI $R=C_6H_5$; XII $R=CH_3$

---

*See [1] for communication XXXII.

E. I. Martsinovskii Institute of Medicinal Parasitology and Tropical Medicine, Moscow 119435. Translated from Khimiya Geterotsiklicheskikh Soedinenii, No. 12, pp. 1680-1683, December, 1978. Original article submitted April 12, 1977; revision submitted February 8, 1978.