16. M. Marx and C. Djerassi, J. Am. Chem. Soc., 90, 678 (1968).
17. P. A. Sharbatyan, N. Yu. Lebedenko, and A. N. Kost, Zh. Org. Khim., 13 (1977).
18. I. G. Farben, A. G., French Patent No. 688867 (1930); Chem. Abstr., 25, 968 (1931).
19. R. F. Hunter, J. Chem. Soc., 1385 (1926).
20. P. T. Paul and L. B. Tewksbury, US Patent No. 2435508 (1948); Chem. Abstr., 42, 5050 (1948).
21. G. M. Dyson and T. Harrington, J. Chem. Soc., 191 (1940).
22. R. F. Hunter and M. A. Wali, J. Chem. Soc., 1513 (1937).
23. R. Riemschneider and S. Georgi, Monatsh. Chem., 91, 630 (1960).

DAKIN–WEST REACTION IN THE 2-IMINO-3-THIAZOLINYLACETIC ACID SERIES

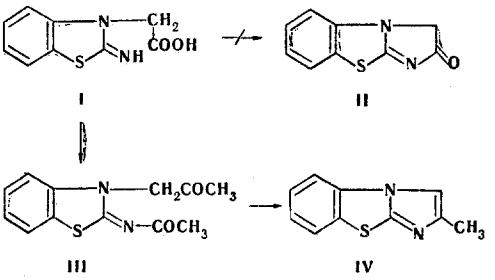
A. N. Krasovskii, N. P. Grin', A. K. Sheinkman, N. A. Klyuev, and A. B. Belikov

UDC 547.781'789.6

The reaction of 2-imino-3-benzothiazolinylacetic acid with acetic anhydride under the conditions of the Dakin–West reaction leads to 3-acetonyl-2-acetimidobenzothiazoline. Under the same conditions 2-imino-3-thiazolinylacetic acid gives 5-acetyl-6-hydroxyimidazo[2,1-b]thiazole. The structures of the compounds obtained were proved by means of their IR, PMR, and mass spectra.

It is known that the corresponding acylamino ketones (the Dakin–West reaction) [1] are formed in the reaction of various α-amino acids, including heterocyclic α-nitrogen-containing acids such as 1-uracilylacetic or 3-methyl-6-pyridazinonylacetic, with acetic anhydride in pyridine. In addition, it has been reported [2] that under similar conditions 2-imino-3-benzothiazolinylacetic acid (I) is converted to benzothiazolo[3,2-a]imidazol-2-one (II), whereas 2-imino-3-thiazolinylacetic acid reacts with acetic anhydride in benzene to give 5,6-dihydro-5,5-diacetylimidazo[2,1-b]thiazol-6-one [3]. It seemed of interest to ascertain the reasons for the unusual Dakin–West reaction in these cases.

In the reaction of 2-imino-3-benzothiazolinylacetic acid with acetic anhydride in pyridine under the conditions of the Dakin–West reaction [1] we obtained the expected product of this reaction — 3-acetonyl-2-acetimidobenzothiazoline (III), the conversion of which to the described benzothiazole IV [2, 4] proves its structure. The scheme of the transformations realized in this case is evidently similar to the Dakin–West reaction for N,N-disubstituted α-amino acids that are incapable of forming derivatives of the oxazole series [1].



I II III IV

We did not observe the formation of the previously described [2] II in this case.

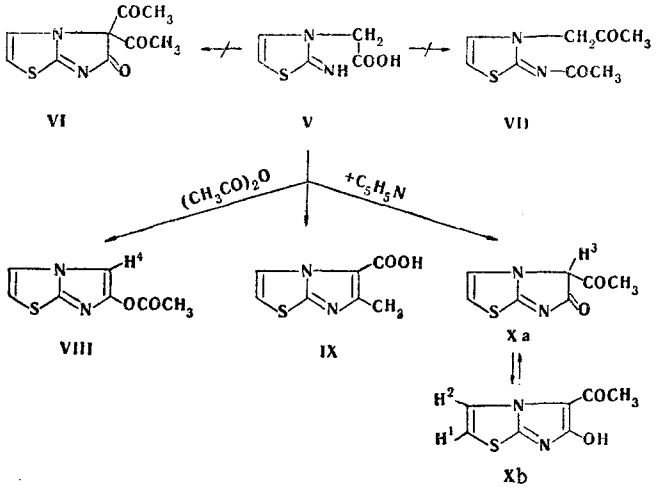
Distinct singlets of the protons of acetyl groupings at 2.11 and 2.23 ppm, a singlet at 5.79 ppm, which we assigned to the resonance of the protons of the N-methylene grouping, and a complex multiplet of aromatic protons at 7.09-7.90 ppm are observed in the PMR spectrum of III. The ratio (3:3:2:4) of the integral intensities of the signals confirms our assignment.

Zaporozhe Medical Institute, Zaporozhe 330074. Translated from Khimiya Geterotsiklicheskikh Soedinenii, No. 4, pp. 476-479, April, 1978. Original article submitted July 7, 1977.

 0009-3122/78/1404-0388$07.50

A molecular peak ([M^+]) with a mass number of 248 and a number of fragment ions that confirm the assigned structure are recorded in the mass spectrum of III. The presence of two acetyl groupings in the molecule is confirmed by the appearance in the IR spectrum of two characteristic ν_{CO} bands at 1680 and 1733 cm^{-1} and by their successive elimination under the influence of electron impact and the appearance in the mass spectrum of $[M - COCH_3]^+$ (m/e 205) and $[(M - COCH_2) - COCH_3]^+$ (m/e 162) ion peaks [5]. A rearrangement process leading to ring expansion to the 2-imino-1,4-thiazine structure evidently occurs in the step involving the formation of the $[M - 2COCH_3]^+$ ion (the intensity of the peak of this ion increases sharply when the ionizing-electron energy is decreased). The subsequent ejection of a neutral HCN particle from this ion is responsible for the presence in the spectrum of a fragment with m/e 135, which has a benzothiazole structure [6, 7]. The appearance of ions with m/e 134, 109, and 108 is dictated by the subsequent fragmentation of this fragment of the molecule. The formation of ions with m/e 233 and 190 is associated with the consecutive process $[M^+] \xrightarrow{-CH_3} [M-CH_3]^+ \xrightarrow{-COCH_3} [(M-CH_3)-COCH_3]^+$, which is extremely characteristic for a number of diacetyl derivatives [5, 8].

As a result of a study of the previously described [3] reaction of 2-imino-3-thiazolinylacetic acid (V) with acetic anhydride in pyridine we established that instead of the described VI and the expected product (VII) of the Dakin–West reaction, a new compound, which evidently has the structure of one of the isomers of VII, IX, or X (a-b), is formed under these conditions.



A characteristic feature of the PMR spectrum of this compound is the presence of the quartet of an AB system formed by the signals of the H_1 and H_2 protons: a doublet with δ 7.26 and a doublet with δ 8.22 ppm with $J_{1,2} = 4.25$ Hz.

The absence at strong field of the signal of the protons of a free methyl group excludes the IX structure. We assigned the singlet at 2.24 ppm to the signal of the methyl protons of the acetyl grouping [5]. Signals of the H_3 and H_4 protons were not observed in the spectrum. The latter excludes structure VIII and makes it possible to speak of the existence of only one tautomeric form — Xb. In fact, the IR spectrum does not contain the splitting of the ν_{CO} band that attests to the nonequivalence of the carbonyl groupings (for structure Xa). One strong ν_{CO} absorption band at 1680 cm^{-1}, which is characteristic for aromatic ketones, is observed in the spectrum. The IR spectrum also contains a broad absorption band with a maximum at 3240 cm^{-1}, which was assigned to the OH group.

The problem of the structure of this compound was solved definitively by a study of its mass spectrum. The absence of definite characteristic processes in the fragmentation of the molecular ion subsequently excluded the possibility of the existence of structures VIII-Xa. For example, the probable act of elimination of an $OCOCH_3$ particle from the molecular ion was not observed for structure VIII, and the $[M^+] \xrightarrow{-H_2O} [M-H_2O]^+$, process, which is due to the ortho effect [9] and should have been expected for structure IX, was absent. The absence of an $[M - CO]^+$ ion peak in the mass spectrum excludes structure Xa. The presence in the spectrum of peaks of ions with masses 167 ($[M - CH_3]^+$), 140 ($[M - COCH_2]^+$), 139 ($[M - COCH_3]^+$), 111 ($[(M - COCH_3) - CO]^+$), etc., constitutes evidence in favor of structure Xb. Thus the data

from the IR, PMR, and mass spectrometry confirm the anomalous Dakin–West reaction with V and make it possible to unambiguously assign the 5-acetyl-6-hydroxyimidazol[2,1-b]thiazole structure (Xb) to the reaction product.

EXPERIMENTAL

The IR spectra of KBr pellets of the compounds were recorded with a UR-20 spectrometer. The PMR spectra of 10% solutions of the compounds in d_6-DMSO were obtained with a Tesla spectrometer (80 MHz) with tetramethylsilane as the internal standard. The mass spectra were obtained with a Varian MAT-311 spectrometer under standard conditions (an ionizing voltage of 80 eV, a cathode emission current of 300 μA, and an accelerating voltage of 3 kV) with direct introduction of the samples into the ion source of the mass spectrometer. Monitoring of the individuality of the compounds obtained was accomplished by chromatography on Silufol.

2-Imino-3-thiazolinylacetic acid (V) [10] and 2-imino-3-benzothiazolinylacetic acid (I) [11] were obtained by described methods, and their physical properties were in agreement with the literature data.

3-Acetonyl-2-acetimidobenzothiazoline (III). Acetic anhydride (5 ml) and 7.5 ml of pyridine were added to 2.08 g (10 mmole) of 2-imino-3-benzothiazolinylacetic acid (I), and the mixture was refluxed for 30 min. It was then cooled and poured over ice, and the precipitate was removed by filtration to give 2.32 g (92%) of a product with mp 175-176°C (from ethanol). Mass spectrum:* 39 (6.2); 43 (100.0); 51 (6.0); 57 (9.5); 65 (10.7); 69 (7.7); 108 (7.9); 109 (15.8); 111 (5.1); 134 (8.9); 135 (24.6); 162 (49.1) 163 (11.0); 174 (7.2) 188 (15.1); 189 (6.5); 190 (19.3); 205 (9.5); 206 (7.9); 233 (50.9); 234 (9.1); 248 (32.4); 249 (7.0). Found: C 58.4; H 4.8; N 11.1; S 12.7%; M 248 (by mass spectrometry). $C_{12}H_{12}N_2O_2S$. Calculated: C 58.0; H 4.9; N 11.3; S 12.9%; M 248. IR spectrum: 1680 and 1733 cm^{-1} (C=O).

The hydrobromide was obtained as colorless crystals with mp 224-226°C (mp 224-226°C [2]) by the usual method.

2-Methylimidazo[2,1-b]benzothiazole (IV). A solution of 0.5 g (2 mmole) of III in 5 ml of 48% hydrobromic acid was refluxed for 1 h, after which it was cooled and poured into water. The aqueous mixture was neutralized with ammonium hydroxide, and the precipitate was removed by filtration to give 0.3 g (80%) of a product with mp 88-90°C (from hexane). No melting-point depression was observed for a mixture of this product with a sample obtained by the method in [4], and their IR spectra were identical.

5-Acetyl-6-hydroxyimidazo[2,1-b]thiazole (Xb). A) Pyridine (5 ml) and 10 ml of acetic anhydride were added to 1.58 g (10 mmole) of 2-imino-3-thiazolinylacetic acid, and the mixture was refluxed for 30 min. It was then cooled, and the precipitate was removed by filtration to give 1.57 g (87%) of a product with mp 234-235°C (from aqueous ethanol). Mass spectrum: 43 (49.2); 45 (9.2); 52 (9.2); 52 (8.1); 54 (9.8); 57 (11.1); 58 (15.9); 59 (19.0); 84 (8.7); 85 (12.7); 86 (8.6); 111 (24.8); 112 (7.1); 139 (25.4); 140 (9.8); 167 (100.0); 168 (11.3); 169 (7.8); 182 (84.1); 183 (12.7); 184 (6.5). Found: C 46.5; H 3.5; N 15.1; S 17.7%; M 182 (by mass spectrometry). $C_7H_6N_2O_2S$. Calculated: C 46.1; H 3.3; N 15.4; S 17.6%; M 182. IR spectrum, cm^{-1}; 1680 (C=O) and 3420 (OH).

B) Acetic anhydride (3 ml) was added to a suspension of 1.58 g (10 mmole) of V in 10 ml of benzene, and the mixture was refluxed for 30 h. It was then cooled, and the solvent was removed by evaporation. The precipitate was washed with water to give 0.51 g (27%) of product. The identical character of this compound and the compound obtained by method A was confirmed by the absence of a melting-point depression and by the IR spectra.

LITERATURE CITED

1. S. I. Zav'yalov, N. I. Aronova, and N. N. Makhova, in: Reakts. Metody Issled. Org. Soedin., 22, 9, (1971).
2. H. Ogura, T. Itoh, and Kitasato, Arch. Exp. Med., 42, 65 (1969).
3. J. P. Paolina and L. J. Lendvay, J. Med. Chem., 12, 1031 (1969).
4. I. Iwai and T. Hiraoka, US Patent No. 3267112; Chem. Abstr., 63, 18103 (1965).

*In the mass spectra the numbers in parentheses show the intensities of the ion peaks in percent of the maximum ion peak in the spectra. The m/e values of the peaks with intensities >5% are presented.

5. A. K. Sheinkman, T. V. Stupnikova, N. A. Klyuev, L. Yu. Petrovskaya, and V. G. Zhil'nikov, Khim. Geterotsikl. Soedin., No. 2, 238 (1977).
6. B. J. Millard and A. F. Temple, Org. Mass Spectrom., 1, 285 (1968).
7. Yu. G. Chikishev, N. A. Klyuev, and G. A. Vakhtberg, Khim. Geterotsikl. Soedin., No. 10, 1330 (1975).
8. W. J. Richter, J. M. Bursey, and A. L. Burlingame, Org. Mass Spectrom., 5, 1295 (1971).
9. F. W. McLafferty, Mass Spectrometry of Organic Ions, Academic Press, New York (1963), p. 337.
10. J. Druey, Helv. Chim. Acta, 24, 226 (1941).
11. C. F. H. Allen and J. A. Van Allen, J. Org. Chem., 13, 603 (1948).

INVERSION OF THE NITROGEN ATOM IN THE AZIRIDINE RING. CALCULATION OF 1-ETHYLIDENEAMINOAZIRIDINE BY THE CNDO/2 METHOD

A. V. Eremeev and M. A. Shoken

UDC 541.6 + 547.388.3

It is shown that in the ground state of the 1-ethylideneaminoaziridine molecule there is virtually no conjugation of its unshared pair of electrons with the π electrons of the N=C bond in the case of a pyramidal structure of the inversion center. A potential surface map was constructed for the conformational transitions due to the possibility of inversion of the nitrogen atom of the heteroring and rotation about the N–N bond. The equivalence of the vicinal protons of the heteroring that is observed in the PMR spectra of the hydrazone derivatives of 1-aminoaziridine is explained.

In the present research we analyzed the conformational transitions in the 1-ethylideneaminoaziridine (I) molecule. A number of compounds with analogous structure have been investigated by PMR spectroscopy [1]. A characteristic feature of their PMR spectra is the anisochronicity of the protons of the aziridine ring, the resonance signal of which is a complex multiplet of the AA'BB' type. It is shown that this form of the spectrum is due to the nonequivalence of the geminal protons of the heteroring [2]. The equivalence of the vicinal protons of the ring with retention of the pyramidal configuration of the inversion center can be explained in two ways: 1) Rapid rotation of the N=CH–CH_3 group about the N–N bond leads to averaging of their signals; 2) rotation about the N–N bond is inhibited; the stable conformation is the conformation in which the N=CH–CH_3 fragment is situated in a plane perpendicular to the heteroring.

It is obvious that one cannot answer the question of the rate of rotation about the N–N bond only on the basis of the results of PMR experiments. In our study of the inversion of the heteroring nitrogen atom we therefore also took into account the possibility of rotation about the nitrogen–nitrogen bond. The calculation was performed by the semiempirical MO self-consistent-field (SCF) method within the CNDO/2 (complete neglect of differential overlap) approximation [3] with parameters specially adjusted for the calculation of the barriers to inversion [4]. In our study of the dynamics of the process we varied only two internal coordinates of the molecule: the angle of inversion (φ) and the angle of rotation (θ) of the N=CH–CH_3 fragment relative to the heteroring about the N–N bond (Fig. 1; φ = 0 when N_8 lies in the plane of the heteroring, and θ = 0 when the N_8–C_9 bond lies in the plane perpendicular to the plane of the heteroring). The geometry of the aziridine ring used in the calculations is in agreement with the data in [5], and the standard values of the bond lengths and valence angles [6] were selected for the remainder of the molecule. The nitrogen–nitrogen bond length was optimized, since the calculated values of the conformational barriers depend substantially on this. Its length was varied in tetrahedral (φ = 65°, θ = 0°) and trigonal (φ = 0°, θ = 90°) configurations of the inversion center, and the variation was found to be almost identical in each case (1.31 Å). This also made it possible to dispense with the introduction of

Institute of Organic Synthesis, Academy of Sciences of the Latvian SSR, Riga 226006.
Translated from Khimiya Geterotsiklicheskikh Soedinenii, No. 4, pp. 480-482, April, 1978. Original article submitted February 18, 1977.

0009-3122/78/1404-0391$07.50