FIVE-MEMBERED 2,3-DIOXOHETEROCYCLES.

10.* REACTION OF 5-ARYL-2,3-DIHYDROFURAN-2,3-DIONES WITH N-SUBSTITUTED UREAS AND THEIR THIO AND SELENO ANALOGS

Yu. S. Andreichikov, D. D. Nekrasov, M. A. Rudenko, and Yu. A. Nalimova

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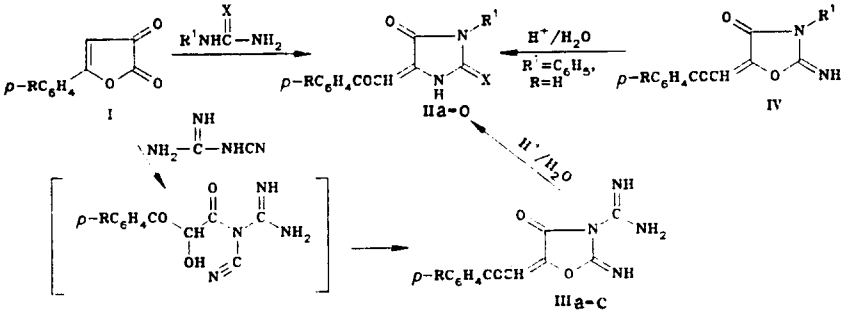
3-Aryl-5-phenacylideneimidazolidine-2,4-diones, 3-aryl-5-phenacylidene-4-oxoimidazolidine-2-thiones, and 5-phenacylidene-4-oxoimidazolidine-2-selenones were obtained from 5-aryl-2,3-dihydrofuran-2,3-diones and arylureas, arylthioureas, and selenoureas respectively in glacial acetic acid. In the reaction of 5-aryl-2,3-dihydrofuran-2,3-diones with cyanoguanidine in 98% acetic acid 5-phenacylideneimidazolidine-2,4-diones were isolated, and in anhydrous acetic acid 2-imino-3-amidino-5-phenacylidene-4-oxazolidones were isolated. When heated in a water—dioxane solution of hydrochloric acid, the latter are converted into 5-phenacylideneimidazolidine-2,4-diones.

Earlier it was shown that in reaction with urea 5-aryl-2,3-dihydrofuran-2,3-diones form 5-phenacylideneimidazolidine-2,4-diones, which exhibit antispasmodic activity [2]. In this connection it seemed of interest to bring N-substituted ureas and thio- and selenoureas into an analogous reaction.

It was established that 5-aryl-2,3-dihydrofuran-2,3-diones (I) do not enter into reaction with N-substituted ureas under the previously described conditions [2] (temperature 100-110°C, 20 min, without a solvent), and it was only possible to isolate the dimers of furandiones (I), i.e., 4-hydroxy-6-aryl-3-aroyl-2-pyranones from the reaction mass [3]. However, if the reaction is conducted in boiling glacial acetic acid, the 3-substituted 5-phenacylideneimidazolidine-2,4-diones (IIa-c) are formed with good yields. Under these conditions the thioureas and selenoureas form 3-aryl-5-phenacylidene-4-oxoimidazolidine-2-thiones (If-m) and 5-phenacylidene-4-oxoimidazolidine-2-selenones (IIn, o) respectively with the furandiones (I).



In the PMR spectra of compounds (IIa-c), in addition to the multiplet for the aromatic protons centered at 7.51 ... 7.63 ppm, there is a singlet for the methine proton at 6.88 ... 6.93 ppm and a broad signal for the proton of the NH group at 11.05 ... 11.25 ppm. The IR spectra of the compounds contain bands at 3320 ... 3335 (NH), 1782 ... 1792 and 1725 ... 1735 (C=O at positions 2 and 4) and at 1660 ... 1670 cm^{-1} (aliphatic (>C=C<). As a result of the formation of an intramolecular hydrogen bond with the NH group of the heterocycle and conjugation with the olefin or phenyl group the carbonyl vibrations in the phenacylidene substituent coincide with the vibrations of the aromatic ring at 1600 ... 1610 cm^{-1}. The IR and PMR spectra of compounds (IIf-o) are similar to the spectra of compounds (IIa-c). However, the band at 1782 ... 1792 cm^{-1} disappears in the IR spectra of compounds (IIf-o), and

*For Communication 9, see [1].

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TABLE 1. Characteristics of the Synthesized Compounds

Compound	R*	mp, °C	Found, %			Molecular formula	Calculated, %			Yield, %
			C	H	N (Hal)		C	H	N (Hal)	
IIa	H	224 ... 225	69.9	4.0	9.6	$C_{17}H_{12}N_2O_3$	69.8	4.1	9.6	79
IIb	Cl	250 ... 252	62.5	3.1	8.5 (10.6)	$C_{17}H_{11}ClN_2O_3$	62.4	3.4	8.5 (10.8)	98
IIc	CH_3O	227 ... 228	67.0	4.2	8.6	$C_{18}H_{14}N_2O_4$	67.1	4.3	8.7	80
IId	H	268 ... 270 (207 ... 208 [2])	60.9	3.6	12.5	$C_{11}H_8N_2O_3$	61.1	3.7	12.9	82
IIe	CH_3	286 ... 287 (245 ... 246 [2])	62.6	3.4	12.2	$C_{12}H_{10}N_2O_3$	62.6	3.3	12.1	48
IIf	H	178 ... 180	66.3	4.0	9.2	$C_{17}H_{12}N_2O_2S$	66.2	3.9	9.1	65
IIg	CH_3	235 ... 237	63.8	4.1	8.3	$C_{18}H_{14}N_2O_2S$	63.9	4.1	8.2	89
IIh	Cl	218 ... 220	60.6	3.7	7.8 (9.8)	$C_{17}H_{11}ClN_2O_2S$	60.5	3.6	7.8 (9.9)	95
IIi	CH_3O	235 ... 236	64.7	4.5	8.0	$C_{19}H_{16}N_2O_3S$	64.7	4.5	7.9	85
IIj	CH_3	187 ... 188	67.9	4.8	8.3	$C_{19}H_{16}N_2O_2S$	67.8	4.8	8.3	61
IIk	H	239 ... 240	56.7	3.5	12.1	$C_{11}H_8N_2O_2S$	56.9	3.5	12.0	92
IIl	Br	271 ... 272	42.4	2.1	8.9	$C_{11}H_7BrN_2O_2S$	42.7	2.3	9.0	91
IIm	CH_3O	216 ... 247	51.8	3.7	10.3	$C_{12}H_{10}N_2O_3S$	54.9	3.8	10.6	90
IIn	H	156 ... 157	47.1	3.0	9.9	$C_{11}H_8N_2O_2Se$	47.3	2.9	10.0	23
IIo	CH_3	222 ... 223	49.0	3.3	9.4	$C_{12}H_{10}N_2O_2Se$	49.1	3.4	9.5	24
IIIa	H	274 ... 276	55.8	4.0	21.1	$C_{12}H_{10}N_4O_2$	55.8	3.9	21.7	65
IIIb	CH_3	296 ... 297	57.1	4.1	19.7	$C_{13}H_{12}N_4O_2$	57.3	4.4	20.5	68
IIIc	Cl	287 ... 288	49.3	3.1	19.0 (12.0)	$C_{12}H_9ClN_4O_2$	49.2	3.0	19.1 (12.1)	63

*IIa-c,f,g $R^1 = C_6H_5$, IIh-j R^1 = o-$CH_3C_6H_4$, IId,e,k-o R^1 = H; IIa-e X = O, IIf-IIm X = S, IIn,o X = Se.

contrary to data in [2, 4] this indicates that it belongs to the stretching vibrations of the C=O group at position 4 in the diones (IIa-c).

The substituent R^1 in compounds (II) lies at position 3 and not at position 1. This was demonstrated by an alternative synthesis of one of the diones (IIa) by rearrangement of the imine (IV) [4].

In the reaction of equimolar amounts of the furandiones (I) and cyanoguanidine in glacial acetic acid the iminooxazolidones (IIIa-c) were isolated. The reaction probably takes place with the formation of the intermediate N-aroylpyruvoyl-N-cyanoguanidines and their subsequent cyclization [5]. If this reaction is conducted in 98% acetic acid, the diones (IId, e) are formed. They are clearly the results from hydrolytic cleavage of the amidine fragment and rearrangement of the 2-iminooxazolidine ring into the imidazolidinedione ring, as during the conversion of the imine (IV) into the dione (IIa). Evidence for this is provided by the formation of the imidazolidinediones (IId, e) from the oxazolidones (IIIa, b) when the latter are heated in concentrated hydrochloric acid.

The IR spectra of compounds (IIIa-c) contain absorption band at 3365 ... 3360 (=NH), 3200 ... 3100 (NH_2), 1722 ... 1720 (C=O group at position 4 of the oxazolidine ring), 1670 ... 1665 (C=N) and 1615 ... 1610 cm^{-1} (C=O group in the phenacylidene substituent), and this agrees with published data [4]. The PMR spectra of the compounds contain signals for the protons of the imino group at position 3 at 2.17 ... 2.19 ppm, the methine proton at 6.95 ... 6.98 ppm, and a broad signal for the protons of the NH_2 group at 11.66 ... 11.75 ppm. The signal for the proton of the amino group at position 2 is superimposed on the signals for the aromatic protons. In the mass spectrum of (IIIa) there are peaks with the following m/z values: 258 $[M]^+$, 242 $[M - NH_2]^+$, 214 $[M - C(=NH)NH_2]^+$, 187 $[CH_3COCHCOCONH]^+$, 146 $[C_6H_5COCH=C=O]^+$, 105 $[C_6H_5CO]^+$, 77 $[C_6H_5]^+$.

EXPERIMENTAL

The IR spectra were recorded in Vaseline oil on a UR-20 instrument. The PMR spectra were obtained on an RYa-2310 instrument at 60 MHz in DMSO-d_6 with HMDS as internal standard. The mass spectrum was obtained on an AEJM-50 instrument with direct injection into the ion source at 50 eV with an electron inversion current 1.5 mA at temperatures close to the melting points of the substances.

The characteristics of the synthesized compounds are given in Table 1.

3-Phenyl-5-phenacylideneimidazolidine-2,4-diones (IIa-c). To a solution of 0.01 mole of (I) in 20 ml of glacial acetic acid we added 0.01 mole of phenylurea. The mixture was heated for 1 h. After the solution had cooled the precipitate was filtered off and recrystallized from acetic acid.

3-Aryl-5-phenacylidene-4-oxoimidazolidine-2-thiones (IIf-m). To a solution of 0.01 mole of (I) in 15 ml of glacial acetic acid we added 0.01 mole of the arylthiourea, and we heated the mixture for 30-40 min. After the mixture had cooled the precipitate was filtered off and recrystallized from acetic acid.

5-Phenacylidene-4-oxoimidazolidine-2-selenones (IIn, o). To a solution of 0.01 mole of (I) in 20 ml of glacial acetic acid we added 0.01 mole of selenourea, and we heated the mixture for 20-25 min. After the mixture had cooled the precipitate was filtered off and recrystallized from DMFA.

2-Imino-3-amidino-5-phenacylidene-4-oxazolidones (IIIa-c). To a solution of 0.01 mole of (I) in 20 ml of glacial acid we added 0.01 mole of cyanoguanidine, and we heated the mixture for 1 h. The precipitate which separated after cooling was filtered off and recrystallized from acetic acid.

5-Phenacylideneimidazolidine-2,4-diones (IId, e). A. To a suspension of 0.01 mole of (III) in 10 ml of dioxane we added 5 ml of concentrated hydrochloric acid. The mixture was heated at 100°C for 3 h. When the solution had cooled, the precipitate was filtered off, washed with water, dried, and recrystallized from acetic acid.

B. To a solution of 0.01 mole of (I) in 20 ml of 98% acetic acid we added 0.01 mole of cyanoguanidine. The mixture was heated for 30-40 min, and the precipitate was filtered off and recrystallized from acetic acid.

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