TRANSFORMATIONS OF UNSYMMETRICAL N-HETARYLFORMAZANS IN ACIDIC MEDIA

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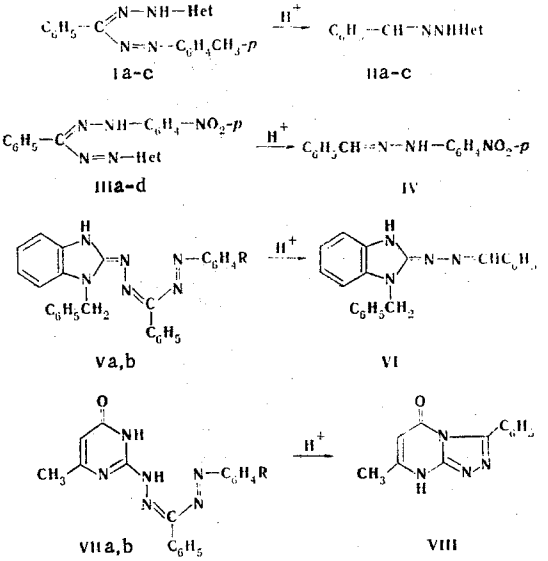
1-Aryl-3-phenyl-5-hetarylformazans undergo acid cleavage to give benzaldehyde hetarylhydrazones, whereas 1-hetaryl-3-phenyl-5-(4-nitrophenyl)formazans undergo acid cleavage to give benzaldehyde 4-nitrophenylhydrazones. 1-Aryl-3-phenyl-5-(6-oxo-4-methyl-2-pyrimidinyl)-formazans undergo cyclization to 1,2,4-triazolo[4,3-a]pyrimidine derivatives.

The direction of the conversion of formazans in acidic media is determined by the nature of the substituents attached to the 1-N and 5-N atoms of the formazan grouping. Thus 1,5-diarylformazans (which do not contain strong electron-acceptor groups) are cyclized in acidic media to 1,2,4-benzotriazines (with phenazine as an impurity), during which an aromatic amine molecule is split out [1, 2]. In refluxing glacial acetic acid 1-acyl-3,5-diarylformazans are converted to 2,5-diaryltetrazoles, and 1,3-diaryl-5-acylformazans to 2,5-diaryl-1,3,4-oxadiazoles [3], while 1(5)-aryl-5(1)-phthalazinylformazans are cyclized to 1,2,4-triazolo-[4,3-a]phthalazine derivatives [4]. Splitting out of arylazo (acylazo) groups is observed in these cases. It was also established that all of the formazans are initially protonated in acidic media [5]; the salts of 1,5-diarylformazans and of symmetrical dihetarylformazans are stable, whereas the salts of unsymmetrical hetarylformazans are unstable and undergo irreversible changes.

In the present research we investigated the behavior of some N-hetarylformazans in acidic media. It is known that unsymmetrical hetarylformazans [5], like unsymmetrical 1,5-diarylformazans [6-8], exist in solutions in the tautomeric form in which the hydrogen atom is localized near the nitrogen atom of the formazan grouping that has a better electron-acceptor substituent [9].



I-IV a Het = 2-benzothiazolyl; b Het = 2-quinazolyl; c Het = 6-methyl-4-methoxy-2-pyrimidinyl; III, IV d Het = 6-methyl-4-hydroxy-2-pyrimidinyl; V a R = H; b R = p-NO_2; VII a R = H; b R = CH_3

In conformity with this, 1-(4-tolyl)-3-phenyl-5-hetarylformazans (Ia-c) split out a tosylazo group in refluxing alcoholic hydrochloric acid solution to give the corresponding benzaldehyde hetarylhydrazones (IIa-c).

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TABLE 1. Products of Acid Cleavage of Formazans

Compound	mp, °C	Found, %			Empirical formula	Calc., %			NH, cm^{-1} (CCl_4)	Yield, %
		C	H	N		C	H	N		
IIa	220[15]	66.4	4.4	12.7	$C_{14}H_{11}N_3S$	66.4	4.3	12.6	3400	35
IIb	172	70.3	5.0	—	$C_{15}H_{12}N_4 \cdot {}^1/_2H_2O$	70.0	5.0	—	3400, 3460	40
IIc	150	61.6	6.0	21.6	$C_{13}H_{14}N_4O \cdot {}^1/_2H_2O$	62.1	6.0	21.1	3400, 3155	40
IVa	188[14]	64.8	4.6	—	$C_{13}H_{10}N_2O_2$	64.7	4.5	—	—	30
IVb	188[14]	60.1	5.2	—	$C_{13}H_{11}N_3O_2 \cdot H_2O$	60.2	5.0	—	—	30
IVc	189[14]	60.5	4.8	—	$C_{13}H_{11}N_3O_2 \cdot H_2O$	60.2	5.0	—	—	30
IVd	187[14]	60.6	4.9	—	$C_{13}H_{11}N_3O_2 \cdot H_2O$	60.2	5.0	—	—	30
VIa	197[13]	73.9	5.5	16.3	$C_{21}H_{18}N_4 \cdot H_2O$	73.2	5.2	16.2	3470	35
VIb	197[13]	73.8	5.7	15.9	$C_{21}H_{18}N_4 \cdot H_2O$	73.2	5.2	16.2	3470	45
VIIIa	>300[16]	63.4	4.4	24.7	$C_{12}H_{10}N_4O$	63.7	4.5	24.8	1740 (C=O)	80
VIIIb	>300[16]	63.4	4.5	24.7	$C_{12}H_{10}N_4O$	63.7	4.5	24.8	1740 (C=O)	80

Under the same conditions 1-hetaryl-3-phenyl-5-(4-nitrophenyl)formazans (IIIa-d) split out a hetarylazo group, and benzaldehyde 4-nitrophenylhydrazone (IV) was isolated in all of these cases.

Regardless of the nature of the substituent in the aryl residue attached to the N_1-formazan grouping, 5-(1-alkyl-2-benzimidazolyl)-3,5-diarylformazans exist primarily in the tautomeric imino form with a hydrogen atom attached to the heteroring nitrogen atom [5], i.e., in the form of 1-aryl-5-ylideneformazans [10] (formazenes). These formazans (Va,b) behave like formazans I in acidic media and undergo cleavage to benzaldehyde 1-benzyl-2-benzimidazolylhydrazone (VI). This is evidently explained by the common character of the structures of the protonated forms of formazans I and V.

1-Phenyl- (VIIa) and 1-(4-tolyl)-3-phenyl-5-(6-oxo-4-methyl-2-pyrimidinyl)formazans (VIIb) behave differently. In this case hydrazone cyclization products VIII rather than hydrazones are isolated.

The structures of Va-c, IV, VI, and VIII were confirmed by alternative syntheses. The mechanism of the acid cleavage of hetarylformazans to give hydrazones is not sufficiently clear, but it evidently has features in common with the exchange of the arylaza component in the reaction of arenediazonium salts with formazans and with processes that lead to the formation of 1,5-diarylformazans in the reaction of hetarenediazonium salts with aldehyde arylhydrazones in acidic media [11].

EXPERIMENTAL

The IR spectra were recorded with a UR-20 spectrometer. The electronic spectra were recorded with an SF-18 spectrophotometer. The ionization constants were determined by a spectrophotometric method [12].

Acid Cleavage of Formazans Ia-c, IIIa-d, Va,b, and VIIa,b. A solution of 2 mmole of the formazan in 100 ml of ethanol and 3 ml of concentrated HCl or in 100 ml of glacial acetic acid (in the case of VIIa,b) was refluxed until the solutions became colorless (20-30 min), after which the solvent was removed, and the residue was suspended in 20 ml of water. The aqueous suspension was neutralized to pH ~ 7 with 2 N NaOH, and the resulting precipitate was removed by filtration and recrystallized. The characteristics of the compounds obtained are presented in Table 1. No melting-point depression was observed for mixtures of the products with samples obtained by alternative synthesis.

Benzaldehyde 6-Methoxy-4-methyl-2-pyrimidinylhydrazone (IIc). Hydrazone IIc [4.5 g (90%)], with mp 150°C [ethanol–water (1 : 1)] and NH bands at 3445 and 3350 cm^{-1} (CCl_4), was obtained by heating a solution of 3 g of 6-methoxy-4-methyl-2-pyrimidinylhydrazine in 20 ml of ethanol with 2 g of benzaldehyde for 30 min. Found: C 64.5; H 6.0; N 23.2%. $C_{13}H_{14}N_4O$. Calculated: C 64.5; H 5.8; N 23.1%.

Benzaldehyde 2-Quinazolylhydrazone (IIb). A 0.8-ml sample of benzaldehyde was added to a solution of 0.9 g (5 mmole) of 2-quinazolylhydrazine in 20 ml of ethanol, and the mixture was refluxed for 1.5 h. It was then cooled and worked up to give 1 g (80%) of hydrazone IIb with mp 173°C [ethanol–water (1 : 1)] and NH bands at 3450 and 3355 cm^{-1} (CCl_4). Found: C 70.3; H 5.0, N 22.9%. $C_{15}H_{12}N_4$. Calculated: C 70.0; H 5.0; N 22.6%.

1-(2-Quinazolyl)-3-phenyl-5-(4-nitrophenyl)formazan (IIIb). A solution of 4-nitrobenzenediazonium chloride, prepared from 0.5 g of 4-nitroaniline, was added with cooling (to 0-3°C) and stirring to a solution of 1 g (4 mmole) of benzaldehyde 2-quinazolylhydrazone in 60 ml of ethanol and 15 ml of 2 M NaOH. The precipitate that formed almost immediately was removed by filtration after the mixture was allowed to stand for 2-3 h. Workup gave formazan IIIb with mp 188°C [$CHCl_3$–ethanol (1 : 1)] and an NH band at 3330 cm^{-1} (CCl_4), and λ_{max} 480 (ethanol) and 590 nm (alcohol + NaOH). The product had pK_a 12.43 ± 0.04. Found: C 63.1; H 3.9; N 24.3%. $C_{21}H_{15}N_7O_2$. Calculated: C 63.4; H 3.8; N 24.7%.

1,3-Diphenyl-5-(2-quinazolyl)formazan. This compound, with mp 196-197°C (ethanol) and an NH band at 3354 cm^{-1} (CCl_4), λ_{max} 454 (ethanol) and 570 nm (alcohol + NaOH), and pK_a 13.35 ± 0.04, was obtained in 90% yield by the method used to prepare formazan IIIb. Found: C 71.5; H 4.7; N 24.1%. $C_{21}H_{16}N_6$. Calculated: C 71.6; H 4.6; N 23.9%.

1-(4-Tolyl)-3-phenyl-5-(2-quinazolyl)formazan. This compound, with mp 203°C (ethanol), an NH band at 3356 cm^{-1} (CCl_4), λ_{max} 444 (ethanol) and 520 nm (ethanol + NaOH), and pK_a 13.54 ± 0.04, was obtained in 90% yield by the method used to prepare formazan IIIb. Found: C 72.1; H 5.1; N 23.1%. $C_{22}H_{18}N_6$. Calculated: C 72.1; H 4.9; N 22.9%.

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HETEROCYCLIC NITRO COMPOUNDS

XXI.* KETONES OF THE 3-NITRO-5-R-1,2,4-TRIAZOLE SERIES IN THE SCHMIDT REACTION

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Ketones of the 3-nitro-5-R-1,2,4-triazole series react with hydrazoic acid in concentrated sulfuric acid to give triazolyl-substituted acetamides. Acid hydrolysis of the latter leads to 1-aminoalkyl-3-nitro-5-R-1,2,4-triazoles. Intramolecular cyclization with the elimination of HNO_2 and the formation of 2-nitro-5,6-dihydro-1H-imidazo[2,3-b]-1,2,4-triazole was noted in the case of 1-(2'-aminoethyl)-3,5-dinitro-1,2,4-triazole.

The literature devoted to the Schmidt reaction contains no information on the reaction of hydrazoic acid with oxoalkyl derivatives of azoles. The accessibility of keto derivatives of 1,2,4-triazole [1] makes it possible to fill this gap.

The high aromaticity of the 1,2,4-triazole ring, in conjunction with its considerable polarity and the presence of acceptor substituents, determines the low basicities of ketones of this series. Consequently, protonation

*See [1] for communication XX.

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