BULLETIN OF THE CHEMICAL SOCIETY OF JAPAN, VOL. 51 (1), 327—328 (1978)

The Reaction of *N*-(Phenylsulfonyl)benzohydrazonoyl Chloride with Enamines

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(Received May 23, 1977)

Synopsis. 3-(Diethylamino)crotonic acid esters and 1-diethylamino-1-cyclohexene react with *N*-(phenylsulfonyl)-benzohydrazonoyl chloride to give substituted pyrazoles in 87—89% and 1.4% yields, respectively, the corresponding morpholine enamines affording no pyrazoles. The pyrazole formation is interpreted in terms of a step-by-step process involving the nucleophilic attack of the enamines on the hydrazonoyl chloride.

N-Phenylbenzohydrazonoyl chloride reacts with benzamidine to give 1,3,5-triphenyl-1*H*-1,2,4-triazole,[1] and with enamines to afford substituted pyrazoles;[2,3] the 1,3-dipolar cycloaddition mechanism has been suggested for these reactions.[2,4]

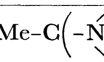
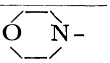
On the other hand, the reaction of *N*-(phenylsulfonyl)-benzohydrazonoyl chloride(**1**) with benzamidines and benzimidates proceeds through a two-step path involving the nuclephilic attack of amidines or imidates on the imidoyl carbon of the hydrazonoyl chloride, leading also to the formation of 1,2,4-triazoles.[5]

The present study shows a pyrazole-formation by the reaction of **1** with enamines which proceeds through the two-step path involving the nucleophilic process. When a mixed solution of **1** and one equivalent of ethyl or allyl 3-(diethylamino)crotonate(**2a** or **2b**) in THF was allowed to stand at room temperature, 4-ethoxycarbonyl- or 4-allyloxycarbonyl-5-methyl-3-phenyl-1-phenylsulfonylpyrazole(**3a** or **3b**) was formed in a good yield. Much the same result was obtained when two equivalents of **2** were used. In the reaction with 1-diethylamino-1-cyclohexene(**2c**), however, the corresponding pyrazole(**3c**) was obtained in a low yield, 3,6-diphenyl-1,4-bis(phenylsulfonyl)-1,4-dihydro-1,2,4,5-tetrazine(**4**) being formed together with a small amount of *N*-(phenylsulfonyl)-*N*-[*N*-(phenylsulfonyl)-benzohydrazonoyl]benzohydrazonoyl chloride(**5**)[5] and 3,5-diphenyl-4-phenylsulfonylamino-4*H*-1,2,4-triazole (**6**)(Scheme 1).

In contrast, the corresponding morpholine enamines (**2′a** and **2′c**) afforded no pyrazoles but **4** and/or **5** and **6**. *N*-Phenylsulfonylmorpholine was also obtained along with *N*²-(phenylsulfonyl)benzohydrazide[6] in the reaction with ethyl 3-morpholinocrotonate(**2′a**). The results are summarized in Table 1.

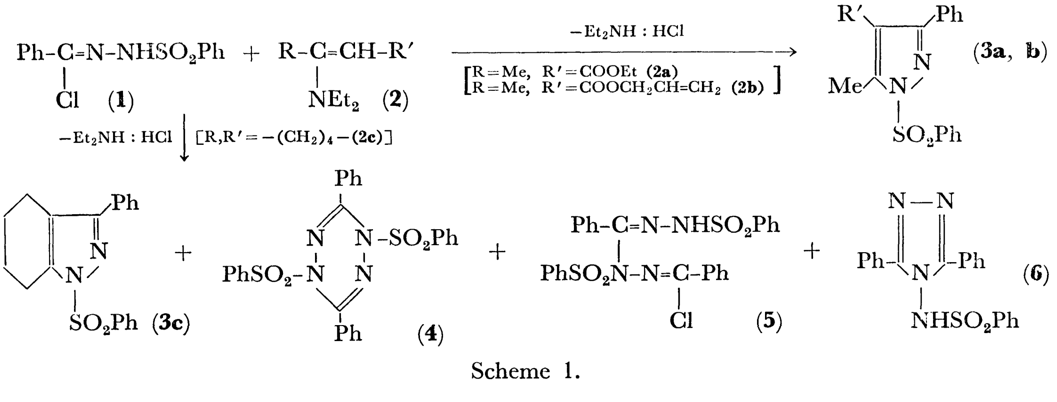
Table 1. Reaction of *N*-(phenylsulfonyl)benzohydrazonoyl chloride with enamines

Enamines[a)]	Yield(%) of Products[b)]			
	3	**4**	**5**	**6**
2a	89 (**3a**)	—	—	—
2b	87 (**3b**)	—	—	—
2c	1.4 (**3c**)	42	2.7	4.0
2′a[c)]	—	trace	14	13
2′c	—	48	—	—

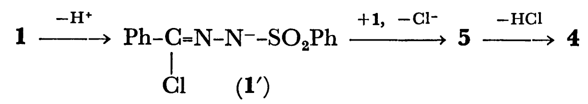
a) **2′a**: Me-C=CH-COOEt, **2′c**: C_6H_9. b) Yield(isolated) as mole per cent based on **1**. c) Yield of *N*-phenylsulfonylmorpholine: 18%. Yield of *N*²-(phenylsulfonyl)benzohydrazide: 24%.

In the hydrazonoyl chloride **1**, the electron-attractive phenylsulfonyl group may enhance the acidity of the amino group and also the electrophilicity of the imidoyl carbon of **1**. Thus, for the formation of **5** and **4**, the following reaction route can be given: (Scheme 2). Actually, **4** was obtained almost quantitatively by the treament of **5** with a base.

The attempted reactions of **1** with a number of dipolarophiles in the presence of a base were unsuccessful, but resulted in the formation of **4** in all cases:[5] the negative charge of the *N*-(phenylsulfonyl)benzohydrazonoyl chloride *N*-anion (**1′**) may be delocalized by the sulfonyl group, so that the anion becomes stable and will not release chloride anion to form the 1,3-dipolar nitrilimine. Furthermore, the 1,3-dipolar cycloaddition mechanism cannot explain the different reactivity of



Scheme 1.

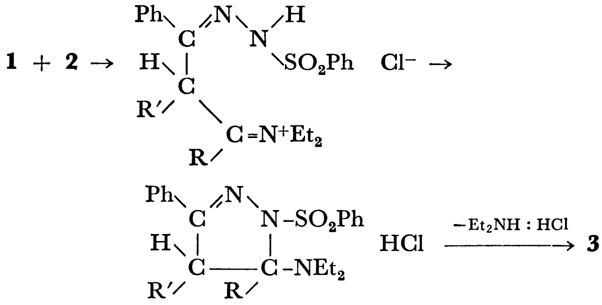


$$1 \xrightarrow{-\text{H}^+} \text{Ph-}\underset{\substack{|\\ \text{Cl}}}{\text{C}}\text{=N-N}^-\text{-SO}_2\text{Ph} \ (1') \xrightarrow{+1,\ -\text{Cl}^-} 5 \xrightarrow{-\text{HCl}} 4$$

Scheme 2.

enamines in the present pyrazole-formation.

Consequently, it is reasonable to consider that the pyrazole formation may proceed via the nucleophilic attack of **2** on the imidoyl carbon of **1** followed by the intramolecular cyclization of the resulting intermediate (Scheme 3).



Scheme 3.

Since enamine **2c** is a stronger base than **2a** and **2b**, the proton abstraction from **1** by **2c** takes place predominantly to lead to the formation of **5** and **4**. Owing to the internal strain which arises in the iminium salt structure of morpholine moiety, it may be difficult for the first step of pyrazole-formation to take place in the reaction with the morpholine enamines. These circumstances and the stronger basicity of morpholine enamines probably account for their different behavior.

Compound **5** may be the precursor of the triazole **6**: efforts have been made to verify this postulation, but no experimental evidence could be obtained.

Experimental

Melting points were determined with a Yanagimoto micromelting point apparatus Model MP-S3 and are uncorrected. The microanalysis was performed on a Perkin-Elmer elemental analyzer Model 240. The IR and NMR spectra were recorded with a JASCO DS-301 spectrometer and a JEOL JNH-4H-100 spectrometer, respectively.

N-(Phenylsulfonyl)benzohydrazonoyl chloride (**1**) was prepared by the method reported.[7] Ethyl and allyl 3-(diethylamino)crotonate (**2a**: bp 150—152 °C/18 mmHg, **2b**: bp 169—170 °C/20 mmHg), and ethyl 3-morpholinocrotonate (**2′a**: bp 172—174 °C/14 mmHg) were prepared according to the procedure of Décombe.[8] 1-Diethylamino-1-cyclohexene (**2c**: bp 66—67 °C/6 mmHg) and 1-morpholino-1-cyclohexene (**2′c**: bp 133—134 °C/17 mmHg) were obtained according to the method of Blanchard[9] and of Hünig *et al.*,[10] respectively.

The products were identified by their analytical and spectral data.

*Reaction of **1** with Enamines (1 : 1 mole ratio). General Procedure*: A solution of **2** (0.01 mol) in THF (20 ml) was mixed with a solution of **1** (0.01 mol) in THF (20 ml) at room temperature. In a few minutes, precipitates began to separate. The reaction mixture was allowed to stand for one day. The separated precipitates (amine hydrochloride) were filtered and washed with THF. The filtrate was concentrated and chromatographed over silica gel (20 g) using benzene as an eluent to give the products shown in Table 1.

*4-Ethoxycarbonyl-5-methyl-3-phenyl-1-phenylsulfonylpyrazole (**3a**).* Mp 111—112 °C (benzene). IR (KBr, cm^{-1}): 1700 (ν_{CO}); 1575, 1543 (ring $\nu_{\text{C=C}}$, $\nu_{\text{C=N}}$); 1370, 1184 (ν_{SO_2}), NMR (CDCl$_3$, δ): 1.13 ppm (3H t, J=7.5 Hz, $\underline{\text{CH}_3}\text{CH}_2$–); 2.91 ppm (3H s, 5-CH$_3$); 4.27 ppm (2H q, J=7.5 Hz, CH$_3$–$\underline{\text{CH}_2}$–); 7.40—8.00 ppm (8H m, 3-Ph, *m,m′* and *p*-protons of PhSO$_2$–); 8.16—8.35 ppm (2H m, *o,o′*-protons of PhSO$_2$–). Found: C, 61.49; H, 4.88; N, 7.57%. Calcd for $\text{C}_{19}\text{H}_{18}\text{N}_2\text{O}_4\text{S}$: C, 61.61; H, 4.90; N, 7.56%.

*4-Allyloxycarbonyl-5-methyl-3-phenyl-1-phenylsulfonylpyrazole (**3b**).* Mp 104—105 °C (CCl$_4$). IR (KBr, cm^{-1}): 1713 (ν_{CO}); 1575, 1532 (ring $\nu_{\text{C=C}}$, $\nu_{\text{C=N}}$); 1370, 1184 (ν_{SO_2}), NMR (CDCl$_3$, δ): 2.93 ppm (3H s, 5-CH$_3$); 4.73 ppm (2H brd, J=5.0 Hz, –O$\underline{\text{CH}_2}$–CH=CH$_2$); 5.21 ppm (1H brd, J=17.5 Hz, $\underset{-\text{OCH}_2}{\overset{\text{H}}{}}\!>\!\text{C=C}\!<\!\begin{smallmatrix}\text{H}\\ \underline{\text{H}}\end{smallmatrix}$); 5.24 ppm (1H brd, J=10.0 Hz, $\underset{-\text{OCH}_2}{\overset{\text{H}}{}}\!>\!\text{C=C}\!<\!\begin{smallmatrix}\underline{\text{H}}\\ \text{H}\end{smallmatrix}$); 5.90 ppm (1H m, –OCH$_2$–$\underline{\text{CH}}$=CH$_2$); 7.45—7.80 ppm (8H m, 3-Ph, *m,m′* and *p*-protons of PhSO$_2$–); 8.15—8.30 ppm (2H m, *o,o′*-protons of PhSO$_2$–). Found: C, 62.75; H, 4.65; N, 7.24%. Calcd for $\text{C}_{20}\text{H}_{18}\text{N}_2\text{O}_4\text{S}$: C, 62.81; H, 4.73; N, 7.33%

3-Phenyl-1-phenylsulfonyl-4,5,6,7-tetrahydrobenzo[c]*pyrazole (**3c**).* Mp 243—244 °C (acetone). IR (KBr, cm^{-1}): 1580, 1565 (ring $\nu_{\text{C=C}}$, $\nu_{\text{C=N}}$); 1372, 1183 (ν_{SO_2}), NMR (CDCl$_3$, δ): 1.50—2.00 ppm (4H m, C^5 and C^6–H); 2.66 ppm (2H m, C^4–H); 3.05 ppm (2H m, C^7–H); 7.45—7.95 ppm (8H m, 3-Ph, *m,m′* and *p*-protons of PhSO$_2$–); 8.10—8.30 ppm (2H m, *o,o′*-protons of PhSO$_2$–). Found: C, 67.56; H, 5.16; N, 8.21%. Calcd for $\text{C}_{19}\text{H}_{18}\text{N}_2\text{O}_2\text{S}$: C, 67.43; H, 5.36; N, 8.28%.

*3,5-Diphenyl-4-phenylsulfonylamino-4*H*-1,2,4-triazole (**6**).* Mp 312—315 °C (dec) (acetone). IR (KBr, cm^{-1}): 3171 (ν_{NH}); 1580 ($\nu_{\text{C=N}}$); 1353, 1165 (ν_{SO_2}); 1276 (triazole ring). Found: C, 63.51; H, 4.29; N, 14.59%. Calcd for $\text{C}_{20}\text{H}_{16}\text{N}_4\text{O}_2\text{S}$: C, 63.81; H, 4.28; N, 14.88%.

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