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Reaction of 3,4-Diaroyl-1,2,5-oxadiazole-2-oxide with Hydrazine Hydrate

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Reaction of 3,4-di (*m*-or *p*-substituted benzoyl) -1,2,5-oxadiazole-2-oxide with hydrazine hydrate in acetic acid gave 4,7-diaryl-1,2,5-oxadiazolo[3,4-*d*]pyridazine and/or its 1-oxide, depending upon a reaction temperature, an amount of hydrazine used, and the substituent of the substrate.

Introduction

Previously, 2,5-diphenylpyridines, which is annelated at 3 and 4 positions with a hetero-aromatic ring such as 1,2,5-oxa-, 1,2,5-thia-, and 1,2,5-selena-diazole, thiophene, *N*-methyl-pyrrole, 1,2,3-triazole, pyrazole, imidazole, pyridine, and pyrazine, were prepared. These compounds are fluorescent in a solid state and are of interest as a light emitting material for an electroluminescence device[1].

Earlier, it was reported that the reaction of 3,4-dibenzoyl-1,2,5-oxadiazole-2-oxide **(1a)** with hydrazine dihydrochloride in refluxing methanol gave 1,2,5-oxadiazolo[3,4-*d*]-pyridazine-1-oxide **2a**[2]. In the reaction with an excess amount of hydrazine, it was expected that the deoxygenation of 1-oxide **2** might occur to afford 1,2,5-oxadiazolo[3,4-*d*]-pyridazine **3**, which is an azaanalogue of strongly fluorescent 4,7-diaryl-1,2,5-oxadiazolo-[3,4-*d*]pyridine[1].

In the present article, it is described the reaction of 3,4-diaroyl-1,2,5-oxadiazole-2-oxide **1** with hydrazine hydrate in acetic acid, giving 4,7-diaryl-1,2,5-oxadiazolo[3,4-*d*]pyridazine-1-oxide **2** and/or oxadiazolo[3,4-*d*]pyridazine **3**.

Results and Discussion

According to the method[2] reported previously, 3,4-diaroyl-1,2,5-oxadiazole-1-oxides **1a-f** were prepared by the oxidative coupling reaction of the corresponding acetophenones with nitric acid (Scheme 1). Similarly, 2-acetylthiophene and acetylnaphthalenes gave the desired **1g-i**, however the treatment of 4- and 2-acetylpyridine, 2-acetylfuran, and 2-acetyl-pyrrole with nitric acid did not give the expected 1,2,5-oxadiazoles and produced only tarry materials.

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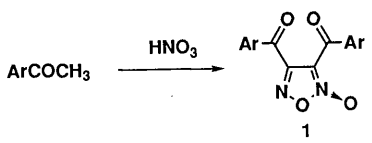
Table 1 Preparation of 4,7-diaryl-1,2,5-oxadiazolo[3,4-*d*]pyridazine-1-oxide **2** and 4,7-diaryl-1,2,5-oxadiazolo[3,4-*d*]pyridazine **3**.

1	Reaction temp.[a]	Reaction time (h)	$N_2H_4 \cdot H_2O$/**1** (mol/mol)	Product (Yield, %)
a	90℃	24	2	**2a** (24)
	reflux	24	4	**2a** (4), **3a** (16)
b	90℃	24	2.5	**2b** (40)
	reflux	48	3.5	**3b** (42)
c	90℃	24	1	**2c** (+)
	reflux	24	4	**2c** (3), **3c** (+)
	reflux	48	10	**3c** (42)
d	80℃	1	3.5	**2d** (71)
	reflux	24	4	**3d** (14)
e	reflux	24	4	**3e** (8)
f	80℃	4	4	**2e** (82)
	reflux	24	4	**2e** (20)
g	reflux	24	4	**3f** (3)
h	90℃	2	2	**3g** (3)[b]
	reflux	24	4	**3g** (+)
i	reflux	24	4	**3h** (25)

a) Reaction was carried out in acetic acid.
b) Compound **1h** was recovered in 74% yield.



1

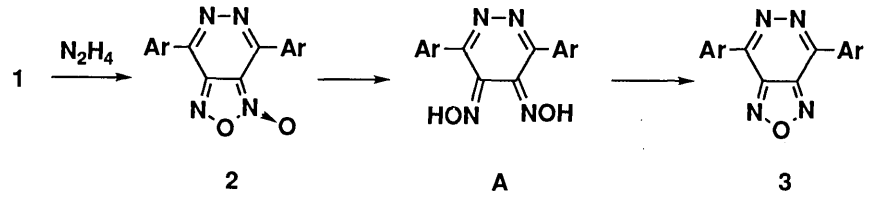
a; Ar = Ph, b; Ar = p-$CH_3C_6H_4$, c; Ar = p-$CH_3OC_6H_4$, d; Ar = m-$NO_2C_6H_4$, e; Ar = p-$NO_2C_6H_4$, f; Ar = p-BrC_6H_4, g; Ar = 2-Thienyl, h; Ar = 1-Naphthyl, i; Ar = 2-Naphthyl

Scheme 1

The reaction of **1** with hydrazine hydrate was carried out in acetic acid and the results are shown in Scheme 2 and Table 1.

The reaction of 3,4-dibenzoyl-1,2,5-oxadiazole-2-oxide (**1a**) with two folds amount of hydrazine hydrate was carried out in acetic acid at 90℃ and **2a** was produced in 24% yield. The reaction with four equivalents of hydrazine hydrate in acetic acid under reflux afforded the deoxygenated product **3a** in 16% yield, as a major product. The similar reaction of *p*-methylbenzoyl derivative **1b** afforded the corresponding **2b** and **3b** in 40% and 42% yields, respectively, depending upon the reaction temperature. Di-*p*-methoxybenzoyl-1,2,5-oxadiazole **1c** gave **2c** and/or **3c** in poor yields when four folds of hydrazine hydrate was used. Yield of **3c** was improved to 42% by using ten equivalent amount of hydrazine hydrate in refluxing acetic acid for 48h. The reaction of di-*m*-nitrobenzoyl derivative **1d** at 80℃ gave **2d** in a good yield. Deoxygenated product **3d** was obtained in the reaction in refluxing acetic acid. *p*-Nitrobenzoyl derivative **1e** afforded **3e** in a poor yield.

Deoxgenation reaction of **2b** and **2d** with hydrazine hydrate took place in refluxing acetic acid, affording the corresponding **3b** and **3d** in 10% and 8% yields, respectively. Although the formation pathway of **3** is not known, the analysis of the reaction mixture of **1**



a; Ar = Ph
b; Ar = p-$CH_3C_6H_4$
c; Ar = p-$CH_3OC_6H_4$
d; Ar = m-$NO_2C_6H_4$
e; Ar = p-BrC_6H_4

a; Ar = Ph, b; Ar = p-$CH_3C_6H_4$,
c; Ar = p-$CH_3OC_6H_4$,
d; Ar = m-$NO_2C_6H_4$,
e; Ar = p-$NO_2C_6H_4$, f; Ar = 2-Thienyl,
g; Ar = 1-Naphthyl, h; Ar = 2-Naphthyl

Scheme 2

and hydrazine hydrate by means of mass spectroscopic method showed the peak which is ascribed to the corresponding 4,5-diaroylpyridazine dioxime **A**. Intermediate **A** may cyclize with a loss of water, giving 1,2,5-oxadiazolo[3,4-*d*]pyridine **3**, as shown in Scheme 2.

Contrary to **1a**-**1d**, 3,4-di-*p*-bromobenzoyloxadiazole-2-oxide **1e** afforded only **2e**; The reaction carried out at 80℃ gave **2e** in 82% yield and the reaction in refluxing acetic acid also gave **2e** in a deceased yield (20%). Indeed, **2e** was treated with an excess amount of hydrazine hydrate in refluxing acetic acid and unchanged **2e** was recovered in a quantitative yield.

Compounds **3g** and **3h** were obtained, respectively, in the reaction of **1g** and **1h** with hydrazine hydrate and their yields are poor. 2-Naphthoyl compound **1i** gave **3i** in 25% yield. In these reactions, the corresponding 1-oxides **2** were not obtained.

Finally, 1,2,5-oxadiazolo[3,4-*d*]pyridazines **3** prepared in this study are only weakly fuluorescent in a solid sate.

Experimental

General. Melting points were determined on a Yanagimoto micro melting point apparatus and are uncorrected. IR spectra were recorded on a Nippon Bunko A-102 and IR Report-100 spectro-photometer as a KBr pellets. Mass spectra were measured on a JMS AX 505-HA spectrometer at 70 eV. ^{1}H NMR spectra were obtained on JEOL JSX-270 in deuteriochloroform using tetramethylsilane as an internal standard. Column chromatography was carried out on silica gel (Wako gel, C-300).

3,4-Dibenzoyl-1,2,5-oxadiazole-2-oxide (**1a**):mp 85-86℃ (lit.[2] 87℃).

3,4-Di-*p*-methylbenzoyl-1,2,5-oxadiazole-2-oxide (**1b**): mp 121-124℃ (lit.[3] 123-125℃).

3,4-Di-*p*-methoxybenzoyl-1,2,5-oxadiazole-2-oxide (**1c**): mp 139-140℃ (lit.[2] 139-140℃).

3,4-Di-*m*-nitrobenzoyl-1,2,5-oxadiazole-2-oxide (**1d**): mp 152-155℃ (lit.[2] 150℃).

3,4-Di-*p*-nitrobenzoyl-1,2,5-oxadiazole-2-oxide (**1e**): mp 154-155℃ (lit.[2] 154℃).

3,4-Di-*p*-bromobenzoyl-1,2,5-oxadiazole-2-oxide (**1f**): mp 138-141℃ (lit.[4] 128℃).

3,4-Di(2-thenoyl)1,2,5-oxadiazole-2-oxide (**1g**). To a mixture of 2-acetylthiophene

(19g) in acetic acid (80ml), a mixture of sodium nitrite (3.7g) and nitric acid (90ml) in acetic acid (200ml) was added dropwise for 10 min. at room temperature. After the mixture was stirred at 65℃ for 3h, it was allowed to stand at room temperature overnight and was poured into a large excess of water. The precipitates formed were filtered and recrystallized to give **1g** (16.1g, 70%): pale yellow prisms (ethanol); mp 111.5-113℃; IR 1638cm^{-1}; ^{1}H-NMR δ=7.10−7.38 (2H, m), 7.71 (1H, d, J=5.4 Hz), 7.80-8.02 (2H, m), 8.03 (2H, d, J=5.4 Hz); MS m/z (rel intensity, %) 306 (M^+, 0.8), 111 (100). Anal. Found: C, 46.87; H, 2.17; N, 8.96%. Calcd for $C_{12}H_6N_2O_4S_2$: C, 47.05; H, 1.97; N, 9.15%.

3,4-Di-(1-naphthoyl)-1,2,5-oxadiazole-2-oxide (**1h**). A mixture of sodium nitrite (8g) and nitric acid (d_{25}=1.42, 80ml) in acetic acid (160ml) was added at room temperature to a mixture of 1-acetylnaphtalene (26g) in acetic acid (80ml) for 10-20 minutes. During the addition, the mixture spontaneously warmed up to about 40℃. After the reaction mixture was stirred at room temperature for 24h, the precipitates formed were filtered and recrystllized to give **1h** (20.5g, 68%): yellow prisms (benzene); mp 157-159℃; IR 1640 cm^{-1}; ^{1}H-NMR δ=7.20−7.67 (6H, m), 7.72-8.23 (6H, m), 8.45-8.81 (2H, m); MS m/z (rel intensity, %) 394 (M^+, 7), 172 (100), 155 (85). Anal. Found: C, 72.99; H, 3.80; N, 6.62%. Calcd for $C_{24}H_{14}N_2O_4$: C, 73.03; H, 3.58; N, 7.10%.

The filtrate was poured into a large excess of water, affording naphthalene-1-carboxylic acid (3.9g 15%).

3,4-Di-(2-naphthoyl)-1,2,5-oxadiazole-2-oxide (**1i**). A mixture of 2-acetylnaphthalene (30g) in acetic acid (160 ml) was treated with a mixture of sodium nitrite (8g) in acetic acid (100ml) and worked up as described above, giving naphthalene-2-carboxylic acid (2.1g 7%) and **1i** (22.5g, 65%): yellow prisms (ethanol); mp 152-153℃; IR 1680cm^{-1}; ^{1}H-NMR δ=7.36−7.80 (4H, m), 7.80-8.26 (8H, m), 8.38 (1H, s), 8.89 (1H, s); MS m/z (rel intensity, %) 394 (M^+, 3), 172 (93), 155 (100). Anal. Found: C, 72.68; H, 3.81; N, 6.62%. Calcd for $C_{24}H_{14}N_2O_4$: C, 73.09; H, 3.58; N, 7.10%.

General procedure for the reaction of 1 with hydrazine hydrate. A mixture of **1** (1.00g) and a specified amount of hydrazine hydrate in acetic acid (50ml) was stirred at the reaction temperature for the reaction time given in Table 1. The mixture was condensed in vacuo to about 5ml and the condensate was chromatographed. Compounds **2** and **3** were obtained from the fractions eluted with benzene.

4,7-Diphenyl-1,2,5-oxadiazolo [3,4-*d*] pyridazine-1-oxide (**2a**): mp 214-215℃ (lit.[2] 210℃).

4,7-Di-*p*-tolyl-1,2,5-oxadiazolo [3,4-*d*] pyridazine-1-oxide (**2b**): pale orange needles (ethanol); mp 208-212℃; MS m/z (rel intensity, %) 318 (M^+, 38), 230 (100). Anal. Found: C, 68.22; H, 4.54; N, 17.67%. Calcd for $C_{18}H_{14}N_4O_2$: C, 67.92; H, 4.43; N, 17.60%.

4,7-Di-*p*-methoxyphenyl-1,2,5-oxadiazolo [3,4-*d*] pyridazine-1-oxide (**2c**): red plates (ethanol); mp 175-179℃; MS m/z (rel intensity, %) 350 (M^+, 10), 262 (100), 176 (90). Anal. Found: C, 62.18; H, 4.22; N, 16.37%. Calcd for $C_{18}H_{14}N_4O_4$: C, 61.71; H, 4.03; N, 15.99.

4,7-Di-*m*-nitrophenyl-1,2,5-oxadiazolo [3,4-*d*] pyridazine-1-oxide (**2d**): yellow

needles (toluene); mp 252-252.5℃ (decomp.) (lit.[2] 251℃).

4,7-Di-*p*-bromophenyl-1,2,5-oxadiazolo[3,4-*d*]pyridazine-1-oxide (**2e**) : dark orange needles (toluene); mp 256-257℃ (decomp.); MS m/z (rel intensity, %) 450 (M^+, 18), 448 (M^+, 35), 446 (M^+, 18), 360 (100). Anal. Found: C, 43.15; H, 1.90; N, 12.66%. Calcd for $C_{16}H_8Br_2N_4O_2$: C, 42.88; H, 1.80; N, 12.50.

4,7-Diphenyl-1,2,5-oxadiazolo[3,4-*d*]pyridazine (**3a**): orange needles (hexane); mp 191-192.5℃ (lit.[2] sublimed at 170℃); MS m/z (rel intensity, %) 274 (M^+, 62), 141 (100), 77 (77). Anal. Found: C, 70.03; H, 3.83; N, 20.25%. Calcd for $C_{16}H_{10}N_4O$: C, 70.07; H, 3.67; n, 20.43.

4,7-Di-*p*-tolyl-1,2,5-oxadiazolo[3,4-*d*]pyridazine (**3b**): orange needles (toluene); mp 251-253℃; MS m/z (rel. intensity, %) 302 (M^+, 100). Anal. Found: C, 71.69; H, 4.69; N, 18.46%. Calcd for $C_{18}H_{14}N_4O$: C, 71.51; H, 4.67; N, 18.53%.

4,7-Di-*p*-methoxyphenyl-1,2,5-oxadiazolo[3,4-*d*]pyridazine (**3c**): reddish brown needles (toluene); mp 256-259℃; MS m/z (rel intensity, %) 334 (M^+, 100). Anal. Found: C, 64.29; H, 4.26; N, 16.49%. Calcd for $C_{18}H_{14}N_4O_3$: C, 64.67; H, 4.22, N, 16.76%.

4,7-Di-*m*-nitrophenyl-1,2,5-oxadiazolo[3,4-*d*]pyridazine (**3d**):orange needles (benzene); mp 216-217℃; MS: m/z (rel intensity, %) 364 (M^+, 56) 186 (33) 76 (100). Anal. Found: C, 53.08; H, 2.49; N, 23.29%. Calcd for $C_{16}H_8N_6O_5$: C, 52.76; H, 2.21; N, 23.07%.

4,7-Di-*p*-nithrophenyl-1,2,5-oxadiazolo[3,4-*d*]pyridazine (**3e**): orange needles (ethanol); mp 269-270℃; MS: m/z (rel intensity, %) 364 (M^+, 88) 76 (100). Anal. Found: C, 53.01; H, 2.47; N, 22.85%. Calcd for $C_{16}H_8N_6O_5$: C, 52.76; H, 2.21; 23.07%.

4,7-Di (1-thienyl) -1,2,5-oxadiazolo[3,4-*d*]pyridazine (**3f**): orange needles (ethanol); mp 224-225℃; MS m/z (rel intensity, %) 286 (M^+, 100); ^{1}H-NMR δ=7.11−7.39 (2H, m), 7.63 (2H, d, J=6.1 Hz), 8.45 (2H, d, J=6.1 Hz). Anal. Found: C, 50.50; H, 2.36; N, 19.08%. Calcd for $C_{12}H_6N_4OS_2$: C, 50.33, H, 2.11, N, 19.57%.

4,7-Di (1-naphtyl) -1,2,5-oxadiazolo[3,4-*d*]pyridazine (**3g**): red plates (ethanol); mp 246-247℃; MS m/z 374 (M^+). Anal. Found: C, 77.42; H, 4.43; N, 14.96%. Calcd for $C_{24}H_{14}N_4O$: C, 76.99; H, 3.77; N, 14.94%.

4,7-Di (2-naphtyl) -1,2,5-oxadiazolo[3,4-*d*]pyridazine (**3h**): golden plates (dioxane); mp 265-166℃; MS m/z (rel intensity, %) 374 (M^+, 100). Anal. Found: C, 76.78; H, 4.05; N, 14.55%. Calcd for $C_{24}H_{14}N_4O$: C, 76.99; H, 3.77; N, 14.96%

References

1) K. Takahashi, A. Tori-i, O. Misumi, W.-H. Lin, S. Mataka, and M. Tashiro, *Senryo to Yakuhin* (*Dyestuffs and Chemicals*), **38**, 39 (1993).

2) H. R. Snyder and N. E. Boyer, *J. Amer. Chem. Soc.*, **77**, 4223 (1955).

3) D. A. Robert and U. Tadeusz, *Rocz. Chem.*, **42**, 289 (1968).

4) T. Okuda, *Yakugaku Zasshi*, **78**, 808 (1958).