Heteroatom Chemistry
Volume 12, Number 6, 2001

Reaction with Hydrazonoyl Halides. Part 32 [1]: Reaction of *C*-acyl-*N*-(3-Phenyl-5-pyrazolyl)hydrazonoyl Chlorides with Potassium Thiocyanate and Synthesis of Some New 2,3-dihydro-1,3,4-Thiadiazoles and Slenadiazoles*

Abdou O. Abdelhamid, M. M. M. Sallam, and S. A. Amer

Department of Chemistry, Faculty of Science, Cairo University, Giza 12613, Egypt

Received 14 August 2000; revised 29 January 2001

ABSTRACT: *C-acyl-N-(3-phenyl-5-pyrazolyl)hydrazonoyl chlorides* **1a,b** *react with potassium thiocyanate and potassium selenocyanate to give 5-acyl-2,3-dihydro-2-imino-3-(3′-phenyl)pyrazol-5′-yl)-1,3,4-thiadiazoles* **2a,b** *and 5-acetyl-2,3-dihydro-2-imino-3-(3′-phenyl)pyrazol-5′-yl)-1,3,4-selenadiazole* **10a,b**. *Also, 2-[mercapto-(methylthio)methylene]indan-1,3-dione* **16** *reacts with hydrazonoyl halides* **15** *and* **22–25** *to afford 2,3-dihydro-1,3,4-thiadiazoles* **19** *and* **26–29**, *respectively. Structures of the newly synthesized compounds are elucidated on the basis of spectral data, chemical transformations, and alternative synthesis methods.* © 2001 John Wiley & Sons, Inc. Heteroatom Chem 12:468–474, 2001

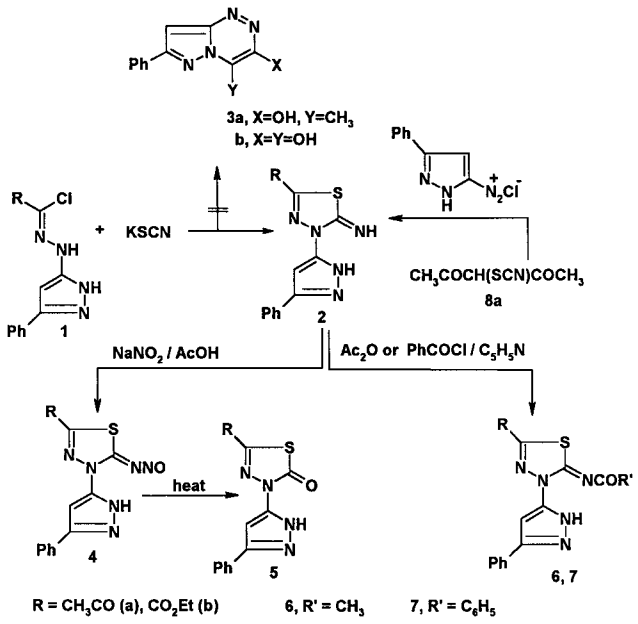
The reported biological activity of 1,3,4-thiadiazoles [1–5] makes them attractive targets for synthesis. The reactions between *C*-acyl-*N*-pyrazolylhydrazonoyl bromides and potassium thiocycyanate have been examined [6] and give exclusively pyrazolo[5,1-*c*] triazines **3**. The formation of 5-acyl-2,3-dihydro-2-imino-3-pyrazol-3′-yl-1,3,4-thiadiazole **2**, although expected in principle, was not observed. In the present study, we investigated this reaction, and we isolated 5-acyl-2,3-dihydro-2-imino-3-(3′-phenyl)pyrazol-5′-yl)-1,3,4-thiadiazoles as the sole product in each case and in about 80% yield. Structures were supported by both spectral data and chemical transformations. Thus, the IR (cm^{-1}) spectrum **2a** revealed bands at 3306 due to the imino (NH) group, 1653 (CO), 1618 (C = N), and no band at 2000–2200 showing the absence of a free SCN group [7]. Its ^1H NMR spectrum showed signals at $\delta = 2.51$ (s, 3H, CH_3CO), 6.49 (s, 1H, pyrazole C-4), 7.20–7.59 (m, 6H, ArHs and NH), and 10.82 (s, br., 1H, NH). Upon shaking compound **2a** with D_2O, a new singlet at 4.38 assignable to DOH was observed. Unequivocal support of the structure of **2a** was further confirmed by treatment of 5-phenylpyrazole-3-diazonium chloride with 3-thiocyanato-2,4-pentandione (**8a**) [8] in ethanolic sodium acetate to produce a product that proved to be identical in all respects (m.p., mixed m.p., and spectra) with **2a** (cf. Scheme 1).

Nitrosation of the imino derivative **2a** gave a 2-*N*-nitroso derivative **4a**. The structure of **4a** was confirmed on the basis of elemental analyses, spectral

*Part 31: Abdelhamid, A. O.; Zohdi, H. F.; Sallam, M. M. M., Ahmed, A. A. Molecules 2000, 5, 967.

Correspondence to: Abdou O. Abdelhamid. E-mail: Abdou@main-scc.cairo.eun.eg

© 2001 John Wiley & Sons, Inc.



SCHEME 1

data, and its thermal decomposition. Thus, the IR (cm^{-1}) spectrum of **4a** revealed bands at 3310 (NH), 1660 (CO), and 1530 (NO). The ^1H NMR spectrum of **4a** showed signals at $\delta = 2.51$ (s, 3H, CH_3CO), 6.56 (s, 1H, pyrazole C-4), 7.20 –7.59 (m, 5H, ArHs), and 10.82 (s, br, 1H, NH). The nitroso derivative **4a** decomposed to the corresponding 2,3-dihydrothiadiazolone **5a**, when heated in a refluxing xylene solution. The structure of **5a** was confirmed on the basis of analytical and spectral data studies. The IR (cm^{-1}) spectrum of **5a** revealed absorption bands at 3340 (NH), 1690, 1653 (COs) groups. The ^1H NMR spectrum of **5a** showed signals at $\delta = 2.52$ (s, 3H, CH_3CO), 6.56 (s, 1H, pyrazole C-4), 7.20–7.58 (m, 5H, ArHs), and 10.82 (s, 1H, NH). Acylation of **2a** with acetic anhydride (and benzoyl chloride in pyridine) afforded the corresponding acetyl and benzoyl derivatives **6a** and **7b**, respectively (cf. Scheme 1). Both elemental analyses and spectral data were consistent with the assigned structure of the products **6a** and **7a**. The ^1H NMR spectrum of 6a showed signals at $\delta = 2.52$ (s, 3H, CH_3CO), 2.72 (s, 3H, $CH_3CON=$), 6.61 (s, 1H, pyrazole C-4), 7.22–7.51 (m, 5H, ArHs) and 10.56 (s, br 1H, NH). Its IR (cm^{-1}) spectrum revealed bands at 1664 and 1638 (COs). The ^1H NMR spectrum of **7a** showed signals at $\delta = 2.51$ (s, 3H, CH_3), 6.60 (s, 1H pyrazole C-4), 7.22–7.81 (m, 10H, ArHs), and 10.84 (s, br, 1H, NH). Its IR (cm^{-1}) spectrum revealed bands at 1661 and 1640 (CO groups).

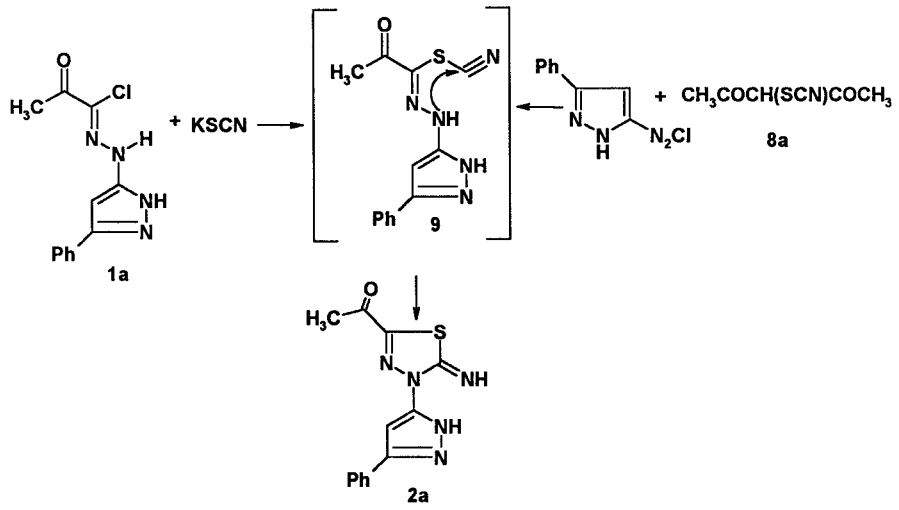
Such results indicate that both the azo coupling of **8a** and the reaction of **1a** with potassium thiocyanate proceed through the hydrazone **9**. The latter is cyclized readily under the reaction conditions to give 5-acetyl-2-imino-2,3-dihydro-5′-phenylpyrazol-3′-yl-1,3,4-thiadiazole (**2a**).

Also, C-ethoxycarbonyl-*N*-(5-phenyl)pyrazol-3-ylhydrazonoyl chloride (**1b**) reacted with potassium thiocyanate in ethanol at room temperature to afford 5-ethoxycarbonyl-2, 3-dihdro-2-imino-3-(5′-phenyl) pyrazol-3′-yl-2,3-dihydro-1,3,4-thiadiazole (**2b**). The structure was elucidated on the basis of elemental analysis, spectral data, and chemical reactions (acylation, nitrosation, thermal decomposition of the nitroso product) (cf. Scheme 1 and Experimental section).

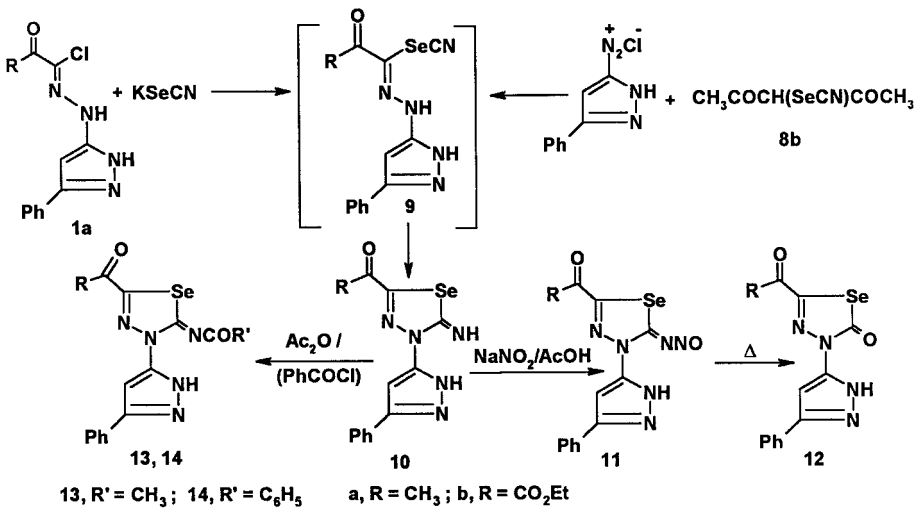
Moreover, hydrazonoyl chlorides **1a,b** reacted with potassium selenocyanate to afford 2,3-dihydro-1,3,4-selenadiazoles **10a,b**. Structure 10a was elucidated on the basis of spectral data, chemical transformation, and an alternative synthesis (by coupling of diazotized aminopyrazole with 3-selnocyanato-2,4-pentane dione (**8b**) [8] (cf. Scheme 3 and Experimental section).

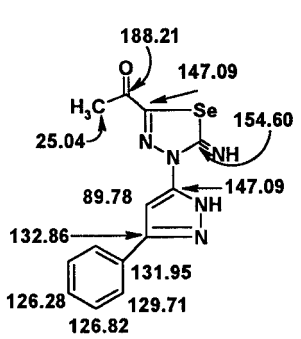
Next, the reaction of *C*-ethoxycarbonyl-*N*-phenylhydrazonoyl chloride **15a** with 2-[mercapto-(methylthio)methylene]indan-1,3-dione **16** [9] in the presence of triethylamine gave 2,3-dihydro-1,3,4-thiadiazole **19a**. The structure was deduced from its spectra and elemental analysis. The IR (cm^{-1}) spectrum revealed bands at 1741, 1697, 1645 (COs), and 1593 (C = C). Its ^1H NMR spectrum showed signals at $\delta = 1.44$ (t, 3H, CH_3CH_2), 4.53 (q, 2H, CH_2CH_3), and 7.25–7.57 (m, 9H, ArHs). The structure **19** was further confirmed by the reaction of hydrazonoyl chloride **15a** with thioanilide **20** (which was prepared from 1,3-indandione and phenyl isothiocyanate) in *N*,*N*-dimethylformamide solution containing potassium hydroxide to give a product identical in all respects (m.p., mixed m.p. and spectra) with **19a** (cf. Scheme 4). The formation of thiadiazole **19** can be explained on the basis of the elimination of methanthiol from the cycloadduct **18**, which is assumed to be formed by a 1,3-dipolar cycloaddition of the nitrile imide (generated in situ by treatment of **15a** with triethylamine) to the C = S double bond of **16** or by a stepwise path involving substitution via a 1,3-addition of thiol 16 to the nitrile imide to give a cyclic hydrazone **17**, which was transformed into the cyclic intermediate **18**. Cyclization of the latter could be achieved by elimination of methanthiol to afford the final product **19**.

It is worthwhile to mention that the elimination of aniline by the reaction of thioanilide **20** with hydrazonoyl chloride **15a** came about from the thioanilide, based on comparison spectral data with the product obtained from the reaction of thioanilide **20**

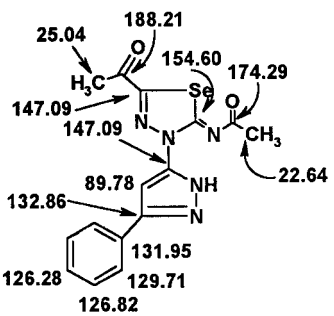


SCHEME 2



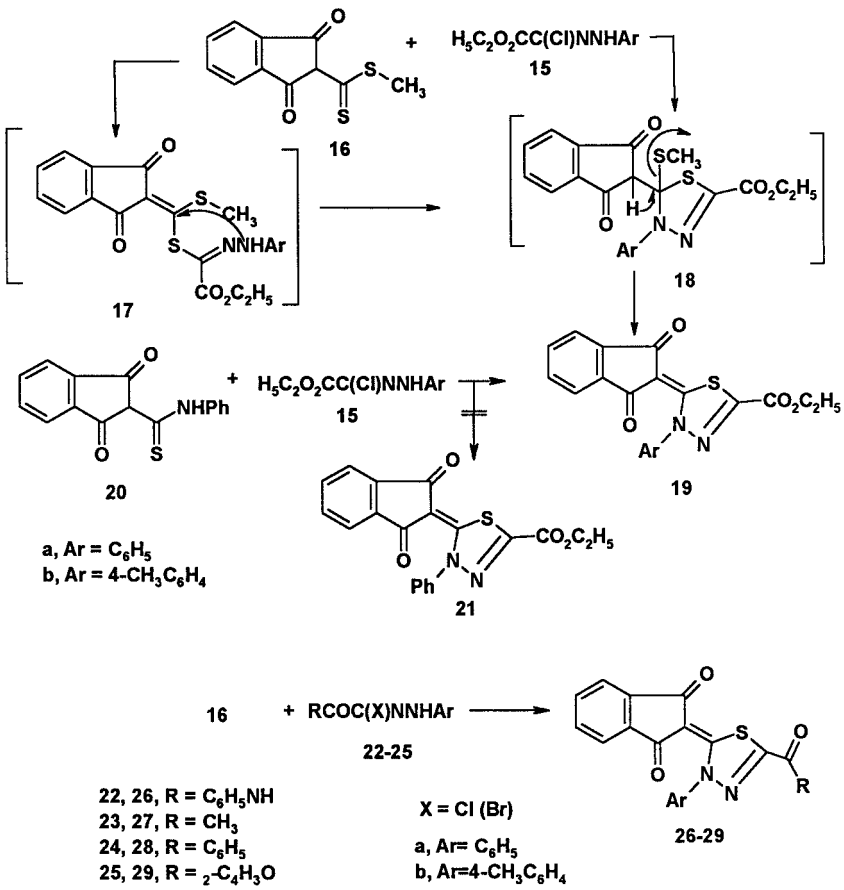


^{13}C NMR Spectra of 10a



^{13}C NMR Spectra of 13a

SCHEME 3



SCHEME 4

with *C*-ethoxycarbonyl-*N*-*p*-tolylhydrazonoyl chloride (**15b**) (cf. Scheme 4). Thus, The ^{1}H NMR spectrum of **19b** showed signals at $\delta = 1.44$ (t, 3H, CH_3CH_2), 2.45 (s, 3H, 4-$CH_3C_6H_4$), 4.52 (q, 2H, CH_3CH_2), and 7.22–7.58 (m, 8H, ArHs). Similarly, the 2-[mercapto(methylthio)methylene]indan-1,3-dione (**16**) reacted with hydrazonoyl halides **22–25** in ethanolic triethylamine to give the corresponding 2,3-dihydro-1,3,4-thiadiazoles **26–29**, respectively (cf. Scheme 4).

EXPERIMENTAL

All melting points were determined on an electrothermal apparatus and are uncorrected. IR spectra were recorded (KBr discs) on a Shimadzu FT-IR 8201 PC spectrophotometer. ^{1}H NMR spectra were recorded in $CDCl_3$ and $(CD_3)_2SO$ solutions on a Varian Gemini 300 MHz spectrometer, and chemical shifts are expressed in δ units using tetramethylsilane (TMS) as an internal reference. Elemental analyses were carried out at the Microanalytical Center of the Cairo University. Hydrazonoyl bromides **1a,b** [6], **15** [10], and **22–25** [11–14] were prepared as previously reported.

*Synthesis of 5-Acyl-2,3-dihydro-2-imino-3-(3′-phenyl) pyrazol-5′-yl)-1,3,4-thiadiazole and 5-Acetyl-2,3-dihydro-2-imino-3-(3′-phenyl)pyrazol-5′-yl)-1,3,4-selenadiazole (**2a,b**) and **10a,b***

Method A A mixture of the appropriate *C*-acyl-*N*-5-phenylpyrazol-3-ylhydrazonoyl chloride (**1a,b**) and potassium thiocyanate (or potassium selenocyanate) (5 mmol) in ethanol (25 mL) was stirred at room temperature for 2 hours. The resulting solid was collected and crystallized from ethanol to give the thiadiazole **2a,b** and the selenadiazole **10a,b**, respectively.

Method B Diazotized 3-amino-5-phenylpyrazole [15] (5 mmol) was added to ethanol (50 ml) containing sodium acetate (1.3 g) and 3-thiocyanato- (or 3-selenacyanato)-2,4-pentanedione (5 mmol) at 0–5°C with stirring. Stirring was continued for 3 hours, and then the resulting solid was collected by

TABLE 1 Characterization Data of the Newly Synthesized Compounds

Compound No.	*m.p. (°C) Color*	*Yield (%)*	*Mol. Formula Mol. Wt*	*% Analyses, Calcd./Found*			
				%C	*%H*	*%N*	*%S*
2a	197–98	85	$C_{13}H_{11}N_5OS$	54.72	3.89	24.54	11.24
	Yellow		285.33	54.60	4.10	24.30	11.40
2b	180–82	80	$C_{14}H_{13}N_5O_2S$	53.32	4.16	22.21	10.17
	Yellow		315.36	53.20	4.20	22.40	10.00
4a	142–43 dec	91	$C_{13}H_{10}N_6O_2S$	49.68	3.21	26.74	10.20
	Red		314.33	49.80	3.40	26.60	10.30
4b	134–35 dec	89	$C_{14}H_{12}N_6O_3S$	48.83	3.51	24.41	9.31
	Red		344.35	48.90	3.40	24.60	9.50
5a	215–16	87	$C_{13}H_{10}N_4O_2S$	54.54	3.52	19.57	11.20
	Pale yellow		286.31	54.40	3.70	19.70	11.00
5b	165–67	89	$C_{14}H_{12}N_4O_3S$	53.16	3.82	17.71	10.14
	Pale yellow		316.34	53.00	3.90	17.60	10.30
6a	195–96	88	$C_{15}H_{13}N_5O_2S$	55.04	4.00	21.39	9.79
	Pale yellow		327.37	55.00	4.20	21.10	9.90
6b	213–14	90	$C_{16}H_{15}N_5O_3S$	53.77	4.23	19.60	8.97
	Pale yellow		357.39	53.50	3.30	19.70	8.80
7a	284–85	89	$C_{20}H_{15}N_5O_2S$	61.68	3.88	17.98	8.23
	Buff		389.44	61.80	3.90	18.10	8.40
7b	220–22	91	$C_{21}H_{17}N_5O_3S$	60.13	4.09	16.70	7.64
	Pale yellow		419.47	60.10	3.90	16.50	7.40
10a	179	85	$C_{13}H_{11}N_5OSe$	47.00	3.34	21.08	—
	Pale yellow		332.23	46.80	3.50	21.20	—
10b	145–147	78	$C_{14}H_{13}N_5O_2Se$	46.42	3.62	19.33	—
	Yellow		362.25	46.40	3.50	19.10	—
11a	132 dec.	92	$C_{13}H_{10}N_6O_2Se$	43.23	2.79	23.27	—
	Red		361.22	43.30	2.60	23.40	—
11b	134 dec.	63	$C_{14}H_{12}N_6O_3Se$	42.98	3.09	21.48	—
	Red		391.25	43.10	3.20	21.60	—
12	187–88	73	$C_{13}H_{10}N_4O_2Se$	46.86	3.03	16.81	—
	Pale yellow		333.21	46.60	3.10	17.00	—
13	197–98	82	$C_{15}H_{13}N_5O_2Se$	48.14	3.50	18.71	—
	Pale yellow		374.26	48.20	3.60	18.60	—
13b	174–6	79	$C_{16}H_{15}N_5O_3Se$	47.53	3.74	17.32	—
	Pale yellow		404.29	47.30	3.60	17.30	—
14	254–5	85	$C_{20}H_{15}N_5O_2Se$	55.05	3.74	16.05	—
	Pale yellow		436.33	54.90	3.60	16.20	—
19a	257–58	81	$C_{20}H_{14}N_2O_4S$	63.48	3.73	7.40	8.47
	Yellow		378.41	63.60	3.60	7.50	8.30
19b	245–48	82	$C_{21}H_{16}N_2O_4S$	64.27	4.11	7.14	8.17
	Yellow		392.44	64.20	4.00	6.90	8.30
26a	312–14	78	$C_{24}H_{15}N_3O_3S$	67.75	3.55	9.88	7.54
	Yellow		425.47	67.60	3.70	10.10	7.40
26b	322–25	87	$C_{25}H_{17}N_3O_3S$	68.32	3.90	9.56	7.29
	Yellow		439.50	68.20	3.80	9.60	7.10
27a	297–98	81	$C_{19}H_{12}N_2O_3S$	65.51	3.47	8.04	9.20
	Yellow		348.38	65.70	3.60	7.80	9.40
27b	326–27	84	$C_{20}H_{14}N_2O_3S$	66.28	3.89	7.73	8.85
	Yellow		362.41	66.10	4.00	7.60	8.70
28a	266–68	79	$C_{24}H_{14}N_2O_3S$	70.23	3.44	6.82	7.81
	Yellow		410.45	70.30	3.30	6.90	7.90
28b	315–18	86	$C_{25}H_{16}N_2O_3S$	70.74	3.80	6.60	7.55
	Yellow		424.48	70.90	3.90	6.50	7.40
29a	153–54	76	$C_{22}H_{12}N_2O_4S$	65.99	3.02	7.00	8.01
	Yellow		400.42	65.80	3.10	6.90	8.20
29b	>330	74	$C_{23}H_{14}N_2O_4S$	66.66	3.40	6.76	7.74
	Yellow		414.44	66.50	3.30	6.60	7.80

TABLE 2 IR and ^{1}H NMR Spectra of the Newly Synthesized Compounds

Compound No.	*IR (cm^{-1})*	*^{1}H NMR (δ ppm)*
2b	3306 (NH), 1715 (CO), and 1615 (C═N).	1.31 (t, 3H, $CH_2\underline{CH_3}$), 4.43 (q, 2H, $\underline{CH_2}$ CH_3) 6.51(s, 1H, pyrazole C-4), 7.21–7.56 (m,6H, ArHs and NH) and 10.82 (s, br., 1H, NH).
4b	3320 (NH), 1715 (CO), and 1535 (NO).	1.34 (t, 3H, $CH_2\underline{CH_3}$), 4.22 (q, 2H, CH_2CH_3), 6.52 (s, 1H, pyrazole C-4), 7.21–7.55 (m, 5H, ArHs) and 10.62 (s, br, 1H, NH).
5b	3327 (NH), 1715, and 1695 (COs).	1.41 (t, 3H, $CH_2\underline{CH_3}$), 4.21 (q, 2H, $\underline{CH_2}$ CH_3), 6.43 (s, 1H, pyrazole C-4), 7.21–7.54 (m, 5H, ArHs) and 10.33 (s, 1H, NH).
6b	3330 (NH), 1713, and 1655 (COs)	1.30 (t, 3H, $CH_2\underline{CH_3}$), 2.53 (s, 3H, CH_3CON═), 4.42 (q, 2H, $\underline{CH_2}CH_3$), 6.60 (s, 1H, pyrazole C-4), 7.21–7.56 (m, 5H, ArHs) and 10.82 (s, br, 1H, NH).
7b	3335 (NH), 1715, and 1660 (COs)	1.32 (t, 3H, $CH_2\underline{CH_3}$), 4.21 (q, 2H,$\underline{CH_2}$ CH_3), 6.45(s, 1H, pyrazole C-4), 7.21–7.85 (m, 10H, ArHs)and 10.62 (s, br, 1H, NH).
10a	3306 (NH), 1653 (CO), 1618 (C═N)	2.51 (s, 3H, CH_3CO), 6.44 (s, H, pyrazole C-4),7.49–7.87 (m, 6H, ArHs and NH) and 10.82 (s, br, 1H, NH).
10b	3306 (NH), 1715 (CO), and 1615 (C═N).	1.31 (t, 3H, $CH_2\underline{CH_3}$), 4.43 (q, 2H, $\underline{CH_2}CH_3$) 6.51 (s, 1H, pyrazole C-4), 7.21–7.56 (m, 6H, ArHs and NH) and 10.82 (s, br, 1H, NH).
12a	3340 (NH), 1690, 1653 (COs)	2.52 (s, 3H, CH_3CO), 6.56 (s, 1H, pyrazole C-4), 7.20–7.58 (m, 5H, ArHs) and 10.32 (s, 1H, NH).
13a	3340 (NH), 1664, and 1638 (COs).	2.52 (s, 3H, CH_3CO), 2.72 (s, 3H, CH_3CON═),6.64 (s, 1H, pyrazole C-4), 7.42–7.87 (m, 5H, ArHs) and 10.89 (s, br, 1H, NH).
14a	3340 (NH), 1661, and 1640 (COs).	2.52 (s, 3H, CH_3), 6.65 (s, 1H pyrazole C-4), 7.42–7.81 (m, 10H, ArHs) and 10.91 (s, br, 1H, NH).
26a	3350 (NH), 1695, 1680, 1652 (COs) and 1600 (C═C).	7.21–7.82 (m, 14H, ArHs) and 8.34 (s, 1H, NH).
26b	3342 (NH), 1690, 1685, 1655 (COs) and 1595 (C═C)	2.39 (s, 3H, 4-$CH_3C_6H_4$), 7.23–7.81 (m, 13H, ArHs) and 8.41 (s, br, 1H, NH).
27a	1695, 1655, 1652 (COs) and 1600 (C═C).	2.22 (s, 3H, CH_3CO), and 7.21–7.83 (m, 14H, ArHs).
27b	1694, 1660, 1653 (COs) and 1600 (C═C).	2.21 (s, 3H, CH_3CO), 2.41 (s, 3H, 4-CH_3C_6 H4) and 7.15–7.82 (m, 13H, ArHs).
28b	1990, 1665, 1652 (COs) and 1600 (C═C)	2.38 (s, 3H, 4-$CH_3C_6H_4$) and 7.23–8.12 (m, 13H, ArHs).

filtration. The crude product was crystallized from ethanol to give a products identical in all respects (m.p., mixed m.p., and spectra) with the compound obtained by method A.

Nitrosation of **2a,b** *and* **10a,b**

A saturated solution of $NaNO_2$ (10 mL) was added dropwise to a solution of the appropriate 2,3-dihydro-1,3,4-thiadiazole **2a,b** or 2,3-dihydro-1,3,4-selenadiazole **10a,b** (1 g) in acetic acid (20 mL) with stirring at 0–5°C. The red precipitate in each case was collected, washed with water, and crystallized from ethanol, to give a 5-acyl-2,3-dihydro-2-*N*-nitroso-3-(3′-phenyl)pyrazol-5′-yl)-1,3,4-thiadiazole (**4a,b**) and 5-acetyl-2,3-dihydro-2-imino-3-(3′-phenyl)pyrazol-5′-yl)-1,3,4-selenadiazole (**11a,b**), respectively.

Decomposition of **4a,b** *and* **11a**

The appropriate *N*-nitroso derivative **4a,b** or **11a** (1 g) in xylene (10 mL) was heated for 10 minutes under refluxing, conditions and the solution was evaporated under reduced pressure. The residual oil in each case was triturated with petroleum ether (40–60°C), and the resulting solid was collected and crystallized from acetic acid to give 2,3-dihydro-1,3,4-thiadiazolonones **5a,b** and **12a,** respectively.

Acylation of **2a,b** *and* **10a**

The appropriate **2a,b** and **10a** (1 g) was boiled with acetic anhydride (10 mL) for 5 minutes and poured onto crushed ice (10 g). The resulting solid was collected, washed, and then crystallized from acetic acid to give the *N*-acetyl derivatives **6a, 7a,** and **13a,** respectively. An equimolar amount of each **2a,b** and **10a** and benzoyl chloride in pyridine was refluxed for 5 minutes, poured onto ice-cold water, and acidified with hydrochloric acid. The solid was collected, washed with hot water, and then crystallized from *N,N*-dimethylformamide to afford *N*-acetyl- and *N*-benzoyl derivatives **6b, 7b,** and **14a,** respectively.

Syntheses of 2,3-Dihydro-1,3,4-thiadiazoles **19, 26–29** *(***a,b***)*

Equimolar amounts of indane-1,3-dione, potassium hydroxide and carbon disulfide (5 mmol, each) in *N,N*-dimethylformamide (15 mL) was stirred at room temperature for 3 hours until the potassium hydroxide dissolved, and then methyl iodide (0.5 mL) was added. Each hydrazonoyl halide **15, 22–25** (**a,b**) (5 mmol) was added to the solution with stirring and then triethyamine (0.75 mL) was added. The resulting solid was collected, washed, and then crystallized from acetic acid to afford thiadiazoles **19** and **26–29** (**a,b**), respectively.

REFERENCES

[1] Lubrizol Corp. U.S. Patent 42 46126, 1981; Chem Abstr 1981, 94, 142505.
[2] Schering, A. G. German Patent 2853 196 1980; Chem Abstr 1980, 93, 220754.
[3] Akad Wissen DDR. German (East) Patent 136 963, 1979; Chem Abstr 1980, 92, 41963.
[4] Reckitt and Colman Products Ltd. German Patent 2727 146, 1978; Chem Abstr 1978, 88, 105357.
[5] Inst Phys Chem Res. Jpn Kokai 77 25 028, 1977; Chem Abstr 1977, 87, 147054.
[6] Elnagdi, M. H.; Elmoghayar, M. R. H.; Kandeel, E. M., and Ibrahim, M. K. A. J Heterocycl Chem 1977, 14, 227.
[7] Williams, D. H.; Fleming, I. "Spectroscopic Methods in Organic Chemistry", McGraw-Hill Company. (U.K.), 2nd Edn., (1973).
[8] Yoshida, Z.; Ogoshi, H.; Tokumitsu, T. Tetrahedron 1970, 26, 5691.
[9] Tominago, Y.; Hajime, N.; Matsuda, Y.; Kobayashi, G. Yakugaku Zasshi 1983, 103, 1243; Chem Abstr 1984, 100, 209677d.
[10] Favrel, G.; Chrz, J. Bull Soc Chim France 1927, 41, 1603.
[11] Favrel, G.; Justoni, R. Gazz Chem Ital 1937, 67, 3.
[12] Shawali, A. S.; Osman, A. Tetrahedron 1971, 27, 2528.
[13] Eweiss, N. F.; Osman, A. J Heterocycl Chem 1980, 17, 1713.
[14] Shawali, A. S.; Abdelhamid, A. O. Bull Chem Soc Jpn 1976, 49, 321.
[15] Elnagdi, M. H.; Elmoghayer, M. R. H.; Fleita, D. H.; Hafez, A. A.; Fahmi, S. M., J Org Chem 1976, 41, 3781.