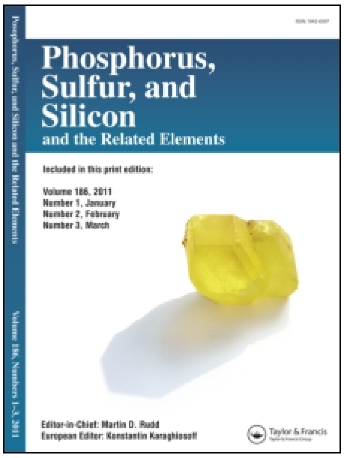

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REACTIONS OF HYDRAZONOYL HALIDES 37[1]: SYNTHESIS OF TRIAZOLO[4,3-*a*]PYRIMIDINES, 1,3,4-THIADIAZOLES AND 1,3,4-SELENADIAZOLES

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REACTIONS OF HYDRAZONOYL HALIDES 37[1]: SYNTHESIS OF TRIAZOLO[4,3-*a*]PYRIMIDINES, 1,3,4-THIADIAZOLES AND 1,3,4-SELENADIAZOLES

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1,2,4-Triazolo[4,3-a]pyrimidines, thiadiazolines and selenadiazolines synthesized via reactions of hydrazonoyl halides with each of ethyl 4-(3,4-dimethoxyphenyl)-6-methyl-2-methylthio-3,4-dihydropyrimidine-5-carboxylate (or ethyl 6-(3,4-dimethylphenyl)-4-methyl-2-thio-1,3,6-trihydropyrimidine-5-carboxylate), ethyl 4-(2,3-dimethoxyphenyl)-6-methyl-2-methylthio-3,4-dihydropyrimidine-5-carboxylate, potassium thiocyanate, potassium selenocyanate, and carbodithioates respectively.

Keywords: 1,3-Dipolar cycloaddition; 1,3,4-selenadiazoles; 1,3,4-thiadiazoles; hydrazonoyl halides; triazolo[4,3-*a*]pyrimidines

1,3,4-Thiadiazoles have activities on many biological systems such as: antitumor,[2] hypoglycemic,[3] antihistamine[4] and anticholinergic properties.[5] Also hydrazonoyl halides have been used widely for the synthesis of heterocyclic compounds.[6–10] We report here the synthesis of triazolo[4,3-*a*]pyrimidines, 2,3-dihydro-1,3,4-thiadiazoles, 2,3-dihydro-1,3,4-selenadiazoles and unsymmetrical azines.

RESULTS AND DISCUSSION

The reaction of equimolar amount of ethyl 4-(3,4-dimethoxyphenyl)-6-methyl-2-methylthio-3,4-dihydropyrimidine-5-carboxylate (**1**),[11] *C*-methoxycarbonyl-*N*-phenylhydrazonoyl chloride (**2a**), and sodium ethoxide in boiling ethanol furnished exclusively the corresponding methyl 4-(3,4-dimethoxyphenyl)-5-(ethoxycarbonyl)-6-methyl-1-phenyl-4,3-dihydro-1,2,4-triazolo[4,3-*a*]pyrimidine-3-carboxylate (**5a**)

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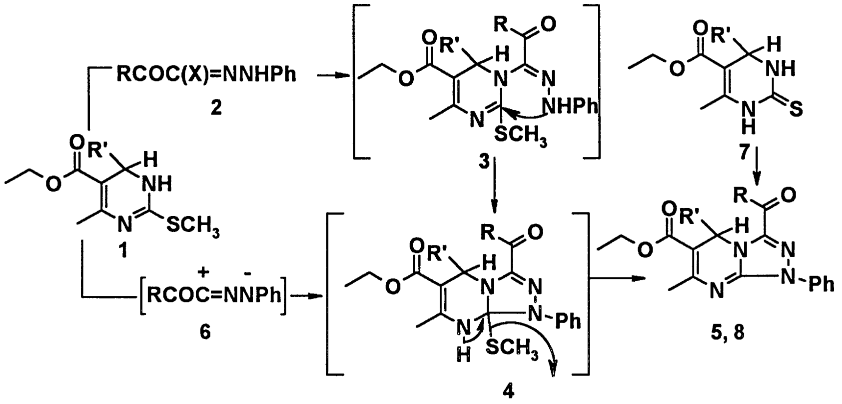
in excellent yield. Structure **5a** was elucidated by analytical, spectral data, and alternative synthesis. ^{1}H NMR spectrum showed signals at δ 1.20 (t, 3H, CH_2CH_3), 2.53 (s, 3H, CH_3), 3.82 (s, 3H, OCH_3), 3.94 (s, 3H, OCH_3), 3.95 (s, 3H, OCH_3), 4.08 (q, 2H, CH_2CH_3), 6.70 (s, 1H, CH), 6.91–6.97 (m, 3H, ArH), 7.28–7.51 (m, 3H, ArH) and 8.18 (d, 2H, ArH). IR spectrum revealed peaks at ν = 1735 (CO), 1626 (C=N) and 1604 cm^{-1} (C=C).

On the other hand, ethyl 6-(3,4-dimethoxylphenyl)-4-methyl-2-thio-1,3,6-trihydro-pyrimidine-5-carboxylate (**7**)[12] reacted with **2a** in boiling chloroform in the presence of triethylamine gave a product identical in all respects (m.p., mixed m.p., and spectra) with compound **5a**. The formation of **5a** can be explained by 1,3-addition or 1,3-dipolar cycloaddition of nitrile imide **6a** (generated in situ by the treatment of hydrazonoyl chloride **2a** with triethylamine) to **1** or **2**. The intermediate **4a** was converted to **5a** via elimination of methyl mercaptan (Scheme 1).

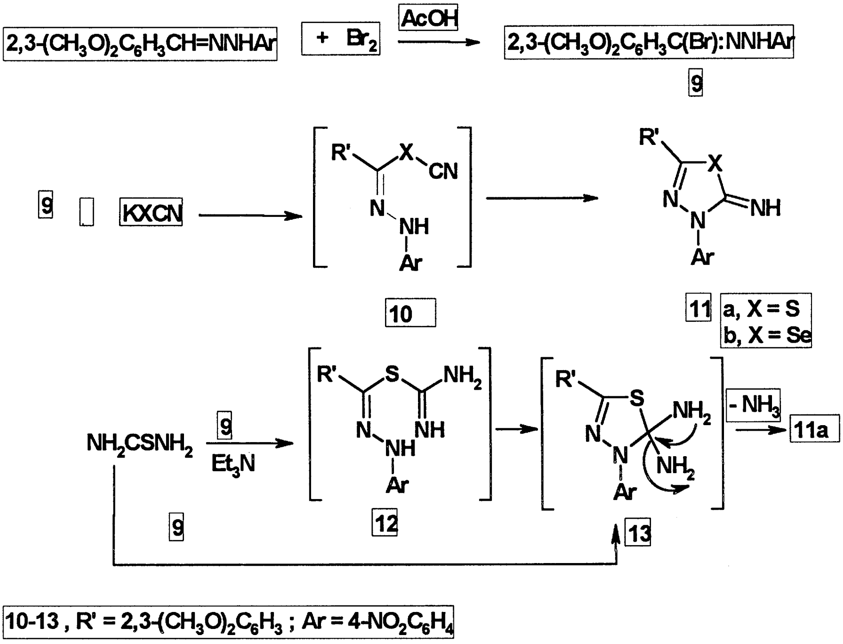


a, R = OCH_3
b, R = OC_2H_5
c, R = CH_3
d, R = NHC_6H_5
e, R = C_6H_5
f, R = 2-C_4H_3S
g, R = 2-$C_{10}H_7$
1a, 5, 7R' = 3,4-$(CH_3O)_2C_6H_3$
1b, 5, 8R' = 2,3-$(CH_3O)_2C_6H_3$

SCHEME 1

Similar, the appropriate hydrazonoyl halides **2a–g** reacted with each of **1a** and **1b** in boiling ethanolic sodium hydroxide gave triazolo[4,3-*a*]pyrimidines **5a–g** and **8a–g**, respectively in a good yields.

Treatment of 2,3-dimethoxybenzoylbromide 4-nitrophenylhydrazone (**9**), which prepared by brominating of 2,3-dimethoxyphenyl-4-nitrophenylhydrazone in acetic acid) with each of potassium thiocyanate and potassium selenocyanate in ethanol at room temperature

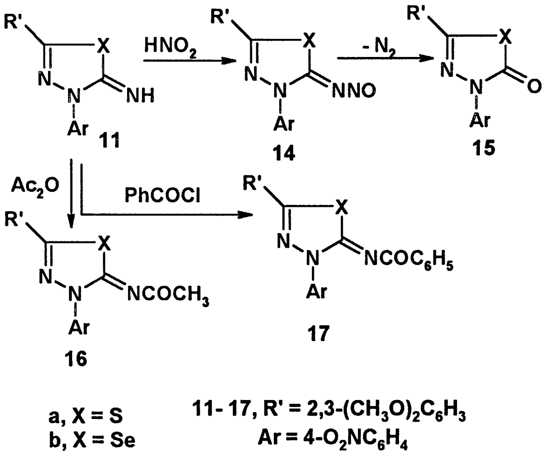


SCHEME 2

afforded 5-(2,3-dimethoxyphenyl)-3-(4-nitrophenyl)-1,3,4-thiadiazolin-2-imine (**11a**) and 5-(2,3-dimethoxyphenyl)-3-(4-nitrophenyl)-1,3,4-selenadiazolin-2-imine (**11b**) (Scheme 2). The structure of **11** was elucidated by elemental analyses, spectral data, alternative synthesis, and chemical transformation. Thus, IR spectra of **11** revealed the presence of the imino (NH) band near $\nu = 3280$ and 1519, 1458 cm^{-1} (NO_2). ^{1}H NMR spectrum of **11a** showed signals at $\delta = 3.92$ (s, 3H, OCH_3), 3.93 (s, 3H, OCH_3), 7.01–8.47 (m, 7H, ArH), and 9.15 (s, br., 1H, NH). Upon shaking with D_2O, a new singlet signal at $\delta = 4.72$ ppm assignable to DOH proton resonance and signals at $\delta = 3.92$ (s, 3H, OCH_3), 3.93 (s, 3H, OCH_3), and 6.99–8.46 (m, 7H, ArH). Also, hydrazonoyl bromide **9** reacted with thiourea gave a product identical in all respects (m.p., mixed mp. and spectra) with **11a**.

Two possible pathways can account for the formation of **11a**: i) 1,3-addition of thiol tautomer of thiourea to nitrilum imide (generated in situ by treatment **9** with base) can give **12a**, nucleophilic cyclization to yield **13a**. ii) Alternatively, 1,3-cycloaddition of the nitrilium imide to the C=S of thiourea can give **13a** and then afforded **11a** by loss of ammonia (Scheme 2).

Nitrosation of each **11a** and **11b** with sodium nitrite in acetic acid at 0–5°C gave 1-[2-(aza-nitrosomethylene)-3-(4-nitrophenyl)(1,3,4-thiadiazolin-5-yl)]-2,3-dimethoxybenzene (**14a**) and 1-[2-(aza-nitrosomethylene)-3-(4-nitrophenyl)(1,3,4-selenadiazolin-5-yl)]-2,3-dimethoxybenzene (**14b**) respectively. The structure **14** was confirmed by elemental analysis, spectral data and thermolysis reaction (Scheme 3). Thus, ^{1}H NMR spectrum of **14a** showed signals at $\delta = 3.93$ (s, 3H, OCH_3), 3.95 (s, 3H, OCH_3), and 7.04–8.52 (m, 7H, ArH). Its IR spectrum showed no band at region $\nu = 3100$–$3400\ cm^{-1}$ due to the absence of NH group.[13]



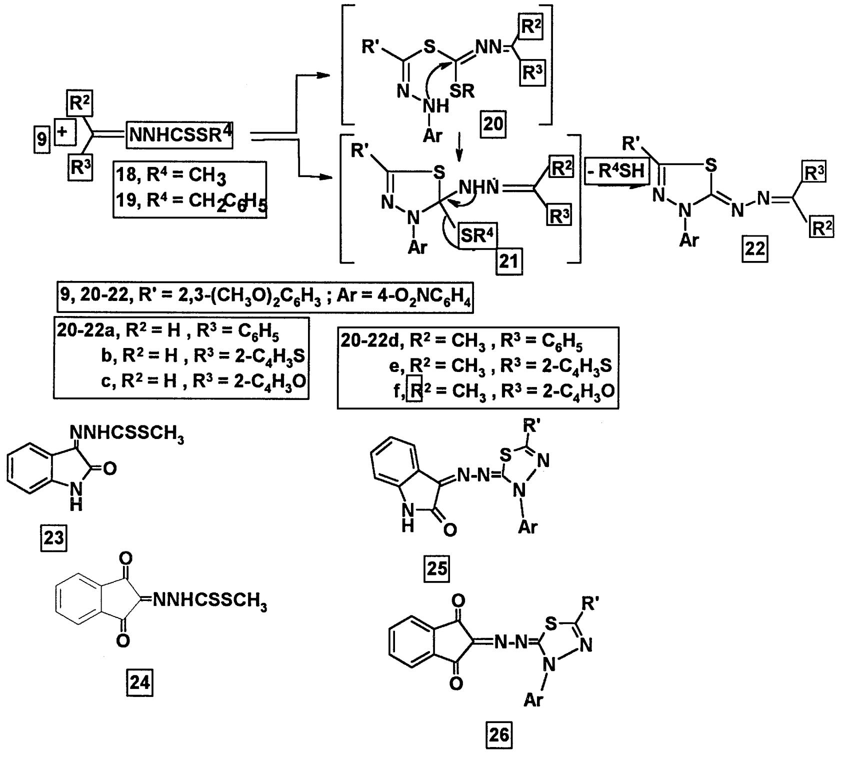
SCHEME 3

Thermolysis of each **14a** and **14b** by boiling in xylene gave 5-(2,3-dimethoxyphenyl)-3-(4-nitrophenyl)-1,3,4-thiadiazolin-2-one (**15a**) and 5-(2,3-dimethoxyphenyl)-3-(4-nitrophenyl)-1,3,4-selenadiazolin-2-one (**15b)** respectively. Structure **15** was elucidated by elemental analysis and spectral data. Thus, IR spectra of **15a**,**b** revealed bands at near $\nu = 1668$ (CO) and 1514, 1473 cm^{-1} (NO_2). ^{1}H NMR spectrum of **15a** showed signals at $\delta = 3.93$ (s, 3H, OCH_3), 3.95 (s, 3H, OCH_3), and 7.02–8.36 (m, 7H, ArH).

Acylation of each **11a** and **11b** with acetic anhydride or with benzoyl chloride in pyridine yielded [5-(2,3-dimethoxyphenyl)-3-(4-nitrophenyl)(1,3,4-thiadiazolin-2-ylidene)]acetamides (**16a**,**b**) and [5-(2,3-dimethoxyphenyl)-3-(4-nitrophenyl)(1,3,4-selenadiazolin-2-ylidene)]benzamides (**17a**,**b**) respectively. Both elemental analysis and spectral data of these products were consistent with their assigned structures. Thus, IR spectra of **16a** and **16a** revealed the presence of α, β-unsaturated acetyl band near $\nu = 1642$ (CO) and 1610 (C=N). The ^{1}H

NMR spectrum of **16a** showed signals at $\delta = 2.39$ (s, 3H, $CH_3CON=$), 3.93 (s, 3H, OCH_3), 4.03 (s, 3H, OCH_3), and 7.04–8.50 (m, 7H, ArH).

However, hydrazonoyl bromide **9** reacts with each of alkyl carbodithioate[14–16] **18a** and **19a** in ethanolic triethylamine at room temperature afforded the same isolable product (m.p., mixed m.p., and spectra) and formulated as: 1-[2-((2Z)-1,2-diaza-3-phenylprop-2-enylidene)-3-(4-nitrophenyl)-(1,3,4-thiadiazolin-5-yl)]-2,3-dimethoxybenzene (**22a**). Structure **22a** was confirmed by elemental analyses and spectral data. For example, IR spectrum of **22a** revealed absorption bands $\nu = 1514, 1470\ cm^{-1}$ (NO_2) group. Its ^1H NMR spectrum showed signals at $\delta = 3.93$ (s, 3H, OCH_3), 4.01 (s, 3H, OCH_3), 7.01–8.58 (m, 12H, ArH), and 8.58 (s, 1H, =CH). The formation of **22a** is assumed to proceed via 1,3-addition of thiol tautomer of carbodithioate **18a** or **19a** to nitrilum imide (generated in situ by treatment of **9** with triethylamine) can give **20a**, nucleophilic cyclization to yield **21a**. Alternatively, 1,3-cycloaddition of nitrilium imide to the C=S of carbodithioate **18a** or **19a** can give **21a** directly, and then afford **22a** by loss of alkyl mercaptan (Scheme 4).

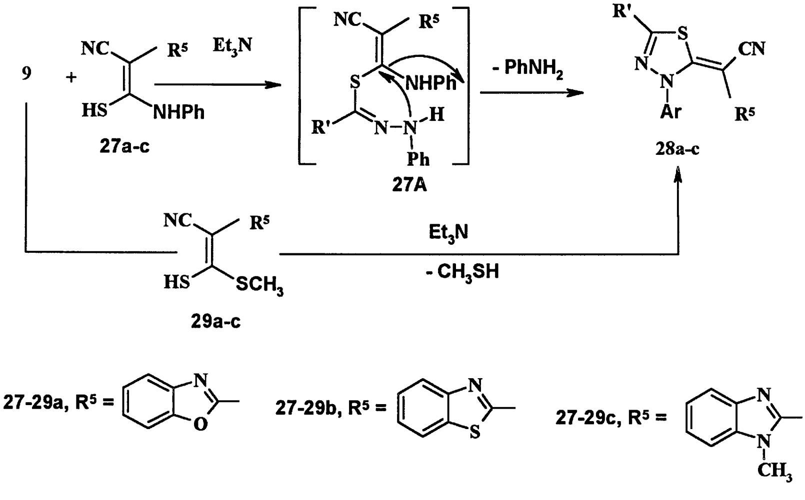


SCHEME 4

By similar route, the appropriate **18b–f** or **19b–f** reacts with hydrazonoyl bromide **9** in ethanolic triethylamine to give unsymmetrical azines **22b–f** respectively (Scheme 4).

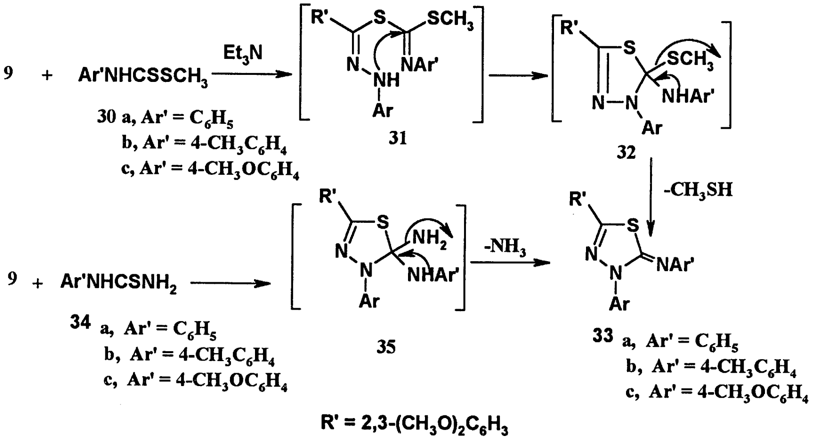
Analogy, hydrazonoyl bromide **9** reacts with the appropriate 3-{aza-[(methylthioxo-methyl)amino]methylene}indoline-2-one[17] (**23**) or 3-{aza-[(methylthioxo-methyl)amino]methylene}indane-1,3-dione[10] (**24**) to give unsymmetrical azines **25** and **26** respectively (Scheme 4).

Hydrazonoyl bromide **9** reacts with the appropriate cyanothioanilide **29a–c**[18–20] in ethanolic triethylamine at room temperature gave 1,3,4-thiadiazoles **28a–c** respectively. Structures **28a–c** were confirmed by elemental analysis, spectral data, and alternative synthesis. Thus, treatment of **9** with appropriate methyl carbodithioates **29a–c** in ethanolic triethylamine gave a product, in each case, identical in all respects (m.p., mixed m.p., and spectra) with corresponding **28a–c** (Scheme 5). The formation of **28** can be explained by a stepwise path involving substitution to give amidrazone **27A**, which readily converted to **28** via elimination of aniline (Scheme 5).



SCHEME 5

Treatment of hydrazonoyl bromide **9** with methyl dithiocarbamate **30a**[21] in ethanolic triethylamine at room temperature afforded one isolable product **33a**. Structure **33a** was confirmed by elemental analysis, spectral data, and alternative synthesis. ^{1}H NMR spectrum of **33a** showed signals at $\delta = 3.85$ (s, 3H, OCH_3), 3.90 (s, 3H, OCH_3), and 6.99–8.57 (m, 12H, ArH). Thus, treatment of **9** with phenylthiourea **34a** in ethanol gave a product identical in all respects (m.p., mixed



SCHEME 6

m.p., and spectra) with 1-[2-(azaphenylmethylene)-3-(4-nitrophenyl)-(1,3,4-thiadiazolin-5-yl)]-2,3-dimethoxybenzene (**33a**) (Scheme 6). Formation of **33** is assumed to proceed via 1,3-addition or 1, 3-dipolar cycloaddition of methyl dithiocarbamate **30** to nitrilum imide can give intermediate **31** and **32**, respectively and then loss methyl mercaptain (Scheme 6). Analogy, the hydrazonoyl bromide **9** reacts with the appropriate methyl dithiocarbamates **30b**,**c** or the appropriate arylthiourea **34b**,**c** to afford 2,3-dihydro-1,3,4-thiadiazole derivatives **33b**,**c** respectively (Scheme 6).

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 TMS as an internal reference. Elemental analyses were carried out at the Microanalytical Center of the Cairo University.

Synthesis of 1,2,4-triazolo[4,3-*a*]pyrimidines 5a–g and 8a–g

Method A: An equimolar amount of each of the appropriate hydrazonoyl halides **2a–g**, **1** or **1b** and sodium ethoxide (5 mmol) in ethanol

(20 ml) was refluxed for 3 h. The reaction mixture was cooled and the resulting solid was collected and crystallized from ethanol to give **5a–g** and **8a–g** respectively (Tables I and II).

Method B: A mixture of the appropriate hydrazonoyl halides **2a–g** (5 mmol) and compound **7** (1.68 g, 5 mmol) in chloroform (20 ml) containing triethylamine (0.5 g (0.75 ml), 5 mmol) was refluxed for 10 h. Chloroform was evaporated under reduced pressure and the residue solid was crystallized from ethanol to give products identical in all respects (m.p., mixed m.p., and spectra) with corresponding products obtained by method A.

Synthesis of 2,3-Dimethoxybenzoylbromide 4-nitrophenylhydrazone (9)

Bromine (4.8 g (1.5 ml), 3 mmol) in acetic acid (20 ml) was added dropwise while stirring to a suspension of 2,3-dimethoxyphenyl-4-nitrophenylhydrazone (8.85 g, 3 mmol) in acetic acid (25 ml) at room temperature. After complete addition the reaction mixture was stirred for 3 h. at room temperature, then poured onto crushed ice (50 g). The resulting solid was collected and crystallized from acetic acid to give **9** (Tables I and II).

Synthesis of 1,3,4-Thiadiazoline 11a and 1,3,4-Selenadiazoline 11b

Method A: A mixture of **9** (1.9 g, 5 mmol) and the appropriate of potassium thiocyanate (0.58 g, 6 mmol) (or potassium selenocyanate (0.086 g, 6 mmol)) in ethanol (25 ml) was stirred at room temperature for 3 h. The resulting solid was collected, washed with water and crystallized from ethanol to give **11a** and **11b** respectively (Tables I and II).

Method B: A mixture of **9** (1.9 g, 5 mmol) and thiourea (0.38 g, 5 mmol) in ethanol (20 ml) was refluxed for 30 min. The solid product, which formed after cooling, was collected and crystallized from ethanol. It was identical in all respects (m.p., mixed m.p., and spectra) with **11a**.

Nitrosation of 11a and 11b

A cold saturated solution of sodium nitrite (10 ml) was added dropwise to a solution of **11a** or **11b** (1 g) in acetic acid (20 ml) in an ice bath while stirring. The reaction mixture was stirred for 30 min. The resulting solid was collected, washed with water, and crystallized from acetone to give **14a** and **14b** respectively (Tables I and II).

TABLE I Characterization Data of the Newly Synthesized Compounds

No.	m.p.°C/ solvent of crystallization	Yield % color	Mol. formula Mol. Wt	% Analyses, calcd./(found)			
				C	H	N	S
5a	114–5	72	$C_{25}H_{26}N_4O_6$	62.75	5.48	11.71	—
	EtOH	Yellow	478.51	62.90	4.30	11.60	
5b	139–40	68	$C_{26}H_{28}N_4O_6$	63.40	5.73	11.36	—
	EtOH	Yellow	492.54	63.20	5.80	11.50	
5c	132–3	58	$C_{25}H_{26}N_4O_6$	64.92	5.67	12.11	—
	EtOH	Yellow	462.51	65.10	5.60	12.00	
5d	159–60	71	$C_{30}H_{29}N_5O_5$	66.68	5.42	12.98	—
	EtOH	Yellow	539.59	66.80	5.20	12.80	
5e	113–4	60	$C_{30}H_{28}N_4O_5$	68.69	5.38	10.68	—
	EtOH	Orange	524.58	68.90	5.10	10.50	
5f	182–4	80	$C_{28}H_{26}N_4O_5S$	63.38	4.94	10.56	6.04
	EtOH	Orange	530.61	63.40	5.00	10.60	6.20
5g	96–8	56	$C_{34}H_{30}N_4O_5$	71.07	5.26	9.75	—
	EtOH	Orange	574.64	71.10	5.30	9.80	
8a	134–5	78	$C_{25}H_{26}N_4O_6$	62.75	5.48	11.71	—
	EtOH	Yellow	478.51	62.50	5.50	11.50	
8b	131–2	84	$C_{26}H_{28}N_4O_6$	63.40	5.73	11.36	—
	EtOH	Yellow	492.54	63.20	5.60	11.50	
8c	158–8	68	$C_{25}H_{26}N_4O_6$	64.92	5.67	12.11	—
	EtOH	Yellow	462.51	64.80	5.60	12.20	
8d	196–7	85	$C_{30}H_{29}N_5O_5$	66.68	5.42	12.98	—
	EtOH	Yellow	539.59	66.70	5.30	13.10	
8e	147	66	$C_{30}H_{28}N_4O_5$	68.69	5.38	10.68	—
	EtOH	Yellow	524.58	68.80	5.50	10.60	
8f	185–7	80	$C_{28}H_{26}N_4O_5S$	63.38	4.94	10.56	6.04
	EtOH	Orange	530.61	63.40	5.10	10.70	5.90
8g	116–7	64	$C_{34}H_{30}N_4O_5$	71.07	5.26	9.75	—
	EtOH	Orange	574.64	71.20	5.00	9.90	
9	120–2	68	$C_{15}H_{14}BrN_3O_4$	47.39	3.71	11.05	
	AcOH	Yellow	380.20	46.90	4.10	11.10	
11a	215–7	82	$C_{16}H_{14}N_4O_4S$	53.62	3.94	15.63	8.95
	Dioxan	Yellow	358.38	53.40	4.20	15.50	9.10
11b	198–9	78	$C_{16}H_{14}N_4O_4Se$	47.42	3.48	13.82	—
	EtOH	Yellow	405.27	47.10	3.60	13.90	
14a	150 dec.	76	$C_{16}H_{13}N_5O_5S$	49.61	3.38	18.08	8.28
	Acetone	Pale red	387.38	49.50	3.10	18.00	8.40
14b	160 dec.	68	$C_{16}H_{13}N_5O_5Se$	44.25	3.02	16.13	—
	Acetone	Pale red	434.27	44.40	3.00	16.10	
15a	209–10	69	$C_{16}H_{13}N_3O_5S$	53.48	3.65	11.69	8.92
	AcOH	Pale yellow	359.36	55.30	3.50	11.60	9.10
15b	195–6	72	$C_{16}H_{13}N_3O_5Se$	47.30	3.23	10.34	
	AcOH	Pale Yellow	406.26	47.10	3.30	10.40	
16a	220–1	83	$C_{18}H_{16}N_4O_5S$	53.99	4.03	13.99	8.01
	AcOH	Pale yellow	400.42	53.70	3.80	14.10	8.20

(Continued on next page)

TABLE I Characterization Data of the Newly Synthesized Compounds *(Continued)*

No.	m.p.°C/ solvent of crystallization	Yield % color	Mol. formula Mol. Wt	% Analyses, calcd./(found)			
				C	H	N	S
16b	231–3	79	$C_{18}H_{16}N_4OSe$	48.33	3.61	12.53	
	AcOH	Pale yellow	447.31	48.50	3.80	12.40	
17a	235–7	68	$C_{23}H_{18}N_4O_5S$	59.73	3.92	12.11	6.93
	AcOH	Pale yellow	462.49	59.60	3.90	11.90	6.80
17b	276–7	71	$C_{23}H_{18}N_4O_5Se$	54.23	3.56	11.60	—
	AcOH	Page	609.38	84.40	3.70	11.70	
22a	195–8	87	$C_{23}H_{19}N_5O_4S$	59.86	4.15	15.18	6.95
	AcOH	Yellow	461.5	59.80	4.40	15.10	7.10
22b	208–11	64	$C_{21}H_{17}N_5O_4S_2$	53.95	3.67	14.98	13.72
	AcOH	Orange	467.53	53.70	3.80	15.00	13.60
22c	199–200	68	$C_{21}H_{17}N_5O_5S$	55.87	3.80	15.51	7.10
	AcOH	Yellow	451.46	55.80	4.00	15.40	7.00
22d	244–5	72	$C_{24}H_{21}N_5O_4S$	60.62	4.45	14.73	6.74
	AcOH	Yellow	475.53	60.80	4.50	14.50	6.60
22e	196–8	96	$C_{22}H_{19}N_5O_5S$	56.77	4.11	15.05	6.89
	AcOH	Yellow	465.49	56.80	3.90	14.80	6.90
22f	252–5	62	$C_{22}H_{19}N_5O_4S_2$	54.87	3.98	14.54	13.32
	AcOH	Yellow	481.56	54.70	3.80	14.60	13.50
25	283–5	42	$C_{24}H_{18}N_6O_5S$	57.37	3.60	16.72	6.38
	AcOH	Red	502.51	57.10	3.80	16.50	6.10
26	249–51	51	$C_{25}H_{17}N_5O_6S$	58.25	3.32	13.59	6.22
	AcOH	Red	515.50	58.40	3.20	13.70	6.40
28a	249–51	90	$C_{25}H_{17}N_5O_5S$	60.11	3.43	14.02	6.43
	DMF	Orange	499.51	60.20	3.40	14.20	6.30
28b	279–81	92	$C_{25}H_{17}N_5O_4S_2$	58.24	3.32	13.58	12.44
	DMF	Orange	515.57	58.10	3.50	13.30	12.50
28c	221–3	64	$C_{26}H_{20}N_6O_4S$	60.93	3.93	14.60	6.26
	DMF	Orange	512.55	60.90	3.80	14.50	6.10
33a	200–1	82	$C_{22}H_{18}N_4O_4S$	60.82	4.18	12.90	7.38
	AcOH	Yellow	434.48	60.60	4.10	12.70	7.20
33b	212–3	81	$C_{23}H_{20}N_4O_4S$	61.59	4.49	12.49	7.15
	AcOH	Yellow	448.48	61.30	4.20	12.20	7.10
33c	196–8	82	$C_{23}H_{20}N_4O_5S$	59.47	4.34	12.06	6.90
	AcOH	Yellow	464.50	59.10	4.10	12.20	7.10

Thermolysis of 14a and 14b

A solution of **11a**, **11b** (0.5 g) in xylene (20 ml) was refluxed for 15 min and then, the solvent was evaporated under reduced pressure. The residue oil was triturated with petroleum ether (40–60°C) and the solid formed was collected and crystallized from acetic acid to give 1,3,4-thiadiazolinone **15a** and 1,3,4-selenadiazolinone **15b** respectively (Tables I and II).

TABLE II ^{1}H NMR Spectra of Some Selected Synthesized Compounds

Compd. no.	^{1}H NMR (δ ppm)
5b	1.25 (t, 3H), 1.52 (t, 3H), 2.53 (s, 3H), 3.85 (s, 6H), 4.07 (q, 2H), 4.45 (q, 2H), 6.69 (d, 1H), 6.92–6.97 (m, 3H), 7.31–7.47 (m, 3H) and 8.14 (d, 2H).
5c	1.22 (t, 3H), 2.51 (s, 3H), 2.53 (s, 3H), 3.81 (s, 3H), 3.83 (s, 3H), 4.07 (q, 2H), 6.69 (d, 1H), 6.73–6.99 (m, 6H) and 8.17 (d, 2H).
5d	1.20 (t, 3H), 2.56 (s, 3H), 3.77 (s, 3H), 3.79 (s, 3H), 4.08 (q, 2H), 6.70 (d, 1H), 7.01–7.60 (m, 11H), 8.15 (d, 2H) and 8.38 (s, 1H).
5e	1.19 (t, 3H), 2.58 (s, 3H), 3.68 (s, 3H), 3.75 (s, 3H), 4.07 (q, 2H), 6.64 (d, 1H), 6.88–6.95 (m, 3H), 7.25–7.48 (m, 6H), 8.06 (d, 2H) and 8.21 (d, 2H).
5f	1.21 (t, 3H), 2.57 (s, 3H), 3.76 (s, 3H), 3.77 (s, 3H), 4.06 (q, 2H), 6.66 (d, 1H), 6.95–6.97 (m, 3H), 7.00–7.17 (m, 3H), 7.47–7.52 (t, 2H), 7.76–7.77 (d, 1H), and 8.23–8.27 (d, 2H).
5g	1.21 (t, 3H), 2.59 (s, 3H), 3.67 (s, 3H), 3.69 (s, 3H), 4.09 (q, 2H), 6.62 (d, 1H), 6.90–6.94 (m, 3H), 7.32–7.55 (m, 5H), 7.96–7.41 (m, 4H), 8.02 (d, 2H) and 8.84 (s, 1H).
8a	1.23 (t, 3H), 2.48 (s, 3H), 3.76 (s, 3H), 3.79 (s, 3H), 3.96 (s, 3H), 4.07 (q, 2H), 7.78 (d, 1H), 6.82–7.07 (m, 3H), 7.25–7.49 (m 3H), and 8.14 (d, 2H).
8b	1.23 (t, 3H), 1.32 (t, 3H), 2.48 (s, 3H), 3.75 (s, 3H), 3.79 (s, 3H), 4.07 (q, 2H), 4.31 (q, 2H), 6.78 (d, 1H), 6.82–7.07 (m, 4H), 7.26–7.49 (m, 3H) and 8.15 (d, 2H).
8c	1.24 (t, 3H), 2.43 (s, 3H), 2.47 (s, 3H), 3.76 (s, 3H), 3.79 (s, 3H), 4.19 (q, 2H), 6.77 (d, 1H), 6.81–7.51 (m, 6H) and 8.18 (d, 2H).
8d	1.24 (t, 3H), 2.48 (s, 3H), 3.76 (s, 3H), 3.78 (s, 3H), 4.05 (q, 2H), 6.76 (d, 1H), 6.78–7.53 (m, 11H), 8.15 (d, 2H) and 8.27 (s, 1H).
8e	1.25 (t, 3H), 2.54 (s, 3H), 3.72 (s, 3H), 3.75 (s, 3H), 4.08 (q, 2H), 6.66 (d, 1H), 6.78–7.02 (m, 3H), 7.26–7.57 (m, 6H), 7.97 (d, 2H) and 8.18 (d, 2H).
8f	1.24 (t, 3H), 2.54 (s, 3H), 3.74 (s, 3H), 3.76 (s, 3H), 4.07 (q, 2H), 6.71 (d, 1H), 6.75–7.00 (m, 3H), 7.26–7.35 (m, 2H), 7.45–7.53 (m, 2H), 7.69–7.72 (m, 1H), 8.14–8.17 (m, 1H) and 8.24–8.26 (d, 2H).
8g	1.26 (t, 3H), 2.56 (s, 3H), 3.66 (s, 3H), 3.77 (s, 3H), 4.11 (q, 2H), 6.77 (d, 1H), 6.98–7.86 (m, 11H), 8.26 (d, 2H) and 8.52 (s, 2H).
11b	3.92 (s, 3H), 3.94 (s, 3H) and 6.98–8.37 (m, 8H).
15b	3.93 (s, 3H), 3.96 (s, 3H) and 7.02–8.35 (m, 7H).
16b	2.42 (s, 3H), 3.93 (s, 3H), 4.03 (s, 3H) and 7.02–8.34 (m, 7H).
17a	3.95 (s, 3H), 4.08 (s, 3H) and 7.05–8.57 (m, 12H).
22b	3.93 (s, 3H), 4.01 (s, 3H), 6.52–8.56 (m, 10H) and 8.58 (s, 1H).
22c	3.93 (s, 3H), 4.01 (s, 3H), 6.52–8.56 (m, 10H) and 8.55 (s, 1H).
28a	3.95 (s, 3H), 4.12 (s, 3H) and 7.05–8.54 (m, 11H).
28b	3.96 (s, 3H), 4.11 (s, 3H) and 7.06–8.47 (m, 11H).
28c	3.91 (s, 3H), 3.93 (s, 3H), 4.04 (s, 3H) and 7.03–8.46 (m, 11H).
33b	2.35 (s, 3H), 3.86 (s, 3H), 3.90 (s, 3H) and 6.99–8.57 (m, 11H).
33c	3.84 (s, 3H), 3.86 (s, 3H), 3.90 (s, 3H) and 6.92–8.57 (m, 11H).

Synthesis of N-[5-(2,3-Dimethoxyphenyl)-3-(4-nitrophenyl)-3H-[1,3,4]thiadiazol-2-ylidene]acetamide (16a), N-[5-(2,3-Dimethoxyphenyl)-3-(4-nitrophenyl)-3H-[1,3,4]selenadiazol-2-ylidene]acetamide (16b), N-[5-(2,3-Dimethoxyphenyl)-3-(4-nitrophenyl)-3H-[1,3,4]thiadiazol-2-ylidene]benzamide (17a), and N-[5-(2,3-Dimethoxyphenyl)-3-(4-nitrophenyl)-3H-[1,3,4]selenadiazol-2-ylidene]benzamide (17b)

a) Acetylation: A mixture of **11a** or **11b** (1 g) in acetic acid (10 ml) and acetic anhydride (5 ml) was warmed for 5 min at 70°C. The reaction mixture was poured onto ice water (40 ml). The solid was collected and crystallized to give the *N*-acetyl derivatives **16a** and **16b** respectively (Tables I and II).

b) Benzoylation: **11a** or **11b** (0.5 g) and benzoyl chloride (3 ml) in pyridine (15 ml) were refluxed for 10 min, poured onto ice water (50 ml), and acidified with hydrochloric acid. The resulting product was collected and washed several time with boiling water. The resulting solid was crystallized from acetic acid or *N,N*-dimethylformamide to give the *N*-benzoyl derivatives **17a** and **17b** respectively (Tables I and II).

Synthesis of Thiadiazolines 22a–f, 25, 26, 29a–c, and 33a–c

Method A: Triethylamine (0.5 g (0.75 ml), 5 mmol) was added dropwise with stirring to a mixture of the appropriate alkyl carbodithioates **18a–f** (or **19a–f**) or **23** or **24** or **27a–c** (or **29a–c**) or **30a–c** (or **34a–c**) (5 mmol) and compound **9** (1.9 g, 5 mmol) in ethanol (20 ml). The resulting solid, which formed after 30 min, was collected and crystallized from acetic acid and gave the corresponding thiadiazolines **22a–f**, **25**, **26**, **29a–c**, and **33a–c**, respectively, in a good yield (Tables I and II).

Method B: A mixture of **9** and the appropriate arylthiourea (5 mmol each) in ethanol (20 ml) was refluxed for 2 h. The solid formed was collected, washed with water and crystallized from ethanol gave products identical in all respects (m.p., mixed m.p., and spectra) with **37a–c**.

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