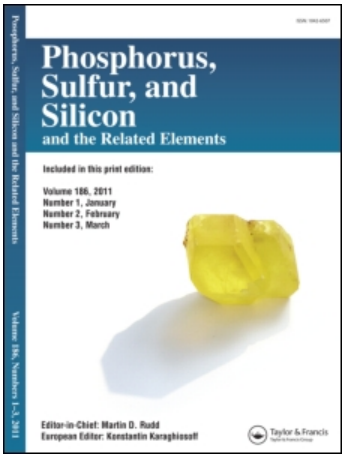

Phosphorus, Sulfur, and Silicon and the Related Elements
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713618290

Synthesis of Some New Polyfused Thienothiophenes Part 4: Synthesis of Thienopyrimidine, Thienotriazine, Thienoimidazotriazine, Thienotriazolotriazine, and Thienotetrazolotriazine Derivatives

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Online publication date: 27 October 2010

To cite this Article Moustafa, H. M. , Khodairy, A. and El-Saghier, A. M. M.(2003) 'Synthesis of Some New Polyfused Thienothiophenes Part 4: Synthesis of Thienopyrimidine, Thienotriazine, Thienoimidazotriazine, Thienotriazolotriazine, and Thienotetrazolotriazine Derivatives', Phosphorus, Sulfur, and Silicon and the Related Elements, 178: 6, 1211 — 1224
To link to this Article: DOI: 10.1080/10426500307907
URL: http://dx.doi.org/10.1080/10426500307907

Phosphorus, Sulfur, and Silicon, 178:1211–1224, 2003

ISSN: 1042-6507 print
DOI: 10.1080/10426500390200486

Taylor & Francis
Taylor & Francis Group

SYNTHESIS OF SOME NEW POLYFUSED THIENOTHIOPHENES PART 4: SYNTHESIS OF THIENOPYRIMIDINE, THIENOTRIAZINE, THIENOIMIDAZOTRIAZINE, THIENOTRIAZOLOTRIAZINE, AND THIENOTETRAZOLOTRIAZINE DERIVATIVES

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(Received September 10, 2002; accepted November 5, 2002)

3,4-Diamino-2,5-dicarboxamidothieno(2,3-b)thiophene ***1*** *was allowed to react with* CS_2*, carbonyl compounds, ethyl chloroformate, S,S-acetals, and oxallyl chloride to give thienopyrimidines* ***2–6*** *and thieno-1,4-diazepine* ***7****. Treatment of compound* ***1*** *with nitrous acid afforded compound* ***8****, which converted into the corresponding chloro derivative* ***9*** *by using* PCl_5*. Compound* ***9*** *was reacted with amino reagents to afford the corresponding thienoimidazotriazines* ***10*** *and* ***11****, thienotriazolotriazines* ***12*** *and* ***13*** *and 4-hydrazinothienotriazine* ***14****. Treatment of compound* ***14*** *with aldehydes, triethyl orthoformate,* CS_2*, nitrous acid and ylidenemalononitriles, afforded thienotriazolotriazine* ***16–18****, thienotetrazolotriazine* ***19****, and 4-pyrazolyl-thienotriazine* ***20–22*** *derivatives respectively.*

Keywords: 3,4-Diamino-2,5-dicarboxamidothieno(2,3-b)thiophene; 4-pyrazolylthienotriazines; thienoimidazotriazines; thienopyrimidines; thienotetrazolotriazines; thienotriazolotriazines

In our previous work[1,2] we reported the synthesis of some new functionally substituted thieno(2,3-b)thiophenes in a one-pot reaction using phase-transfer catalysis technique. The biological and pharmaceutical activities of condensed pyrimidines,[3–6] thienopyrimidines,[4,6–10] triazolothienopyrimidines,[11,12] and thienotriazines[6,13–15] motivated us to continue our work[1,2,16–18] which deals with synthesis of polyfused thienothiophenes. So, we reported herein the synthesis of new polyfused thienopyrimidine, thienotriazine, thienoimidazotriazine,

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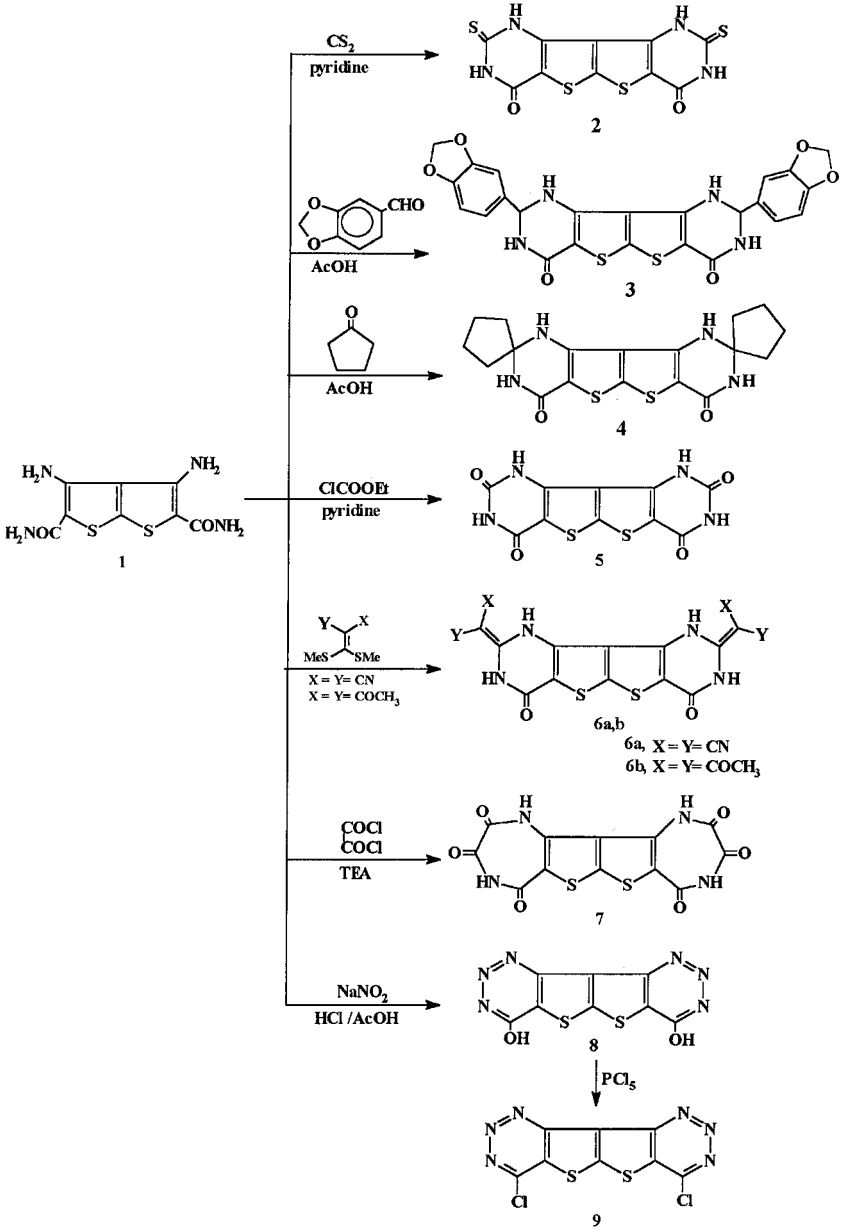
thienotriazolotriazine, and thienotetrazolotriazine derivatives starting with 3,4-diamino-2,5-dicarboxamidothieno(2,3-b)thiophene.[1]

RESULTS AND DISCUSSION

3,4-Diamino-2,5-dicarboxamidothieno(2,3-b)thiophene **1** was allowed to react with carbon disulphide to give 2,9-dithioxo-1,2,3,4,7,8,9,10-octahydro-pyrimido[4″,5″:4′,5′]thieno[3′,2′:4,5]thieno[3,2-d]pyrimidine-4,7-dione **2**. The condensation of **1** with piperonal or cyclopentanone did not afford the expected Schiff bases as reported for a similar function but afforded 2,9-dibenzo[d][1,3]-dioxol-5-yl-1,2,3,4,7,8,9,10-octahydropyrimido[4″,5″:4′,5′]thieno[3′,2′:4,5]thieno[3,2-d]pyrimidine-4,7-dione **3** or dispiro[cyclopentane-1,2′-(3′,4′,7′,10′-tetra-hydro-1′H, 8′H-pyrimido[4″,5″:4′,5′]thieno[3′,2′:4,5]thieno[3,2-d]pyrimidine-9′,1″-cyclopentane]-4′,7′-dione **4**. While the cyclocondensation of compound **1** with ethyl chloroformate, 2-[di(methylthio)methylene]malononitrile or 3-[di-(methylthio)methylene]pentan-2,4-dione yielded 1,2,3,4,7,8,9,10-octahydropyri-mido[4″,5″:4′,5′]thieno[3′,2′:4,5]thieno[3,2-d]pyrimidine-2,4,7,9-tetrone **5**, 2,9-di(1,1-dicyanomethylidene)-1,2,3,4,7,8,9,10-octa-hydropyrimido[4″,5″:4′,5′]thieno[3′,2′:4,5]thieno[3,2-d]pyrimidine-4,7-dione **6a** or 2,9-di(1-acetyl-2-oxopropyl-idene)-1,2,3,4,7,8,9,10-octa-hydropyrimido[4″,5″:4′,5′]thieno[3′,2′:4,5]thieno[3,2-d]pyrimidine-4,7-dione **6b** respectively (cf. Scheme 1). The formation of compounds **6a**,**b** was suggested to be a nucleophilic attack of the amino group to the ethylenic bond with elimination of MeSH molecule followed by intramolecular cyclization through the elimination of another MeSH molecule. Also, treatment of compound **1** with oxallyl chloride in presence of triethyl amine as a base catalyst, afforded 2,3,4,5,9,10,11,12-octahydro-H,8H-[1,4]diazepino[5″,6″:4′,5′]thieno[3′,2′:4,5]-thieno[3,2-e][1,4]diazepine-2,3,5,8,10,11-hexaone **7** (cf. Scheme 1).

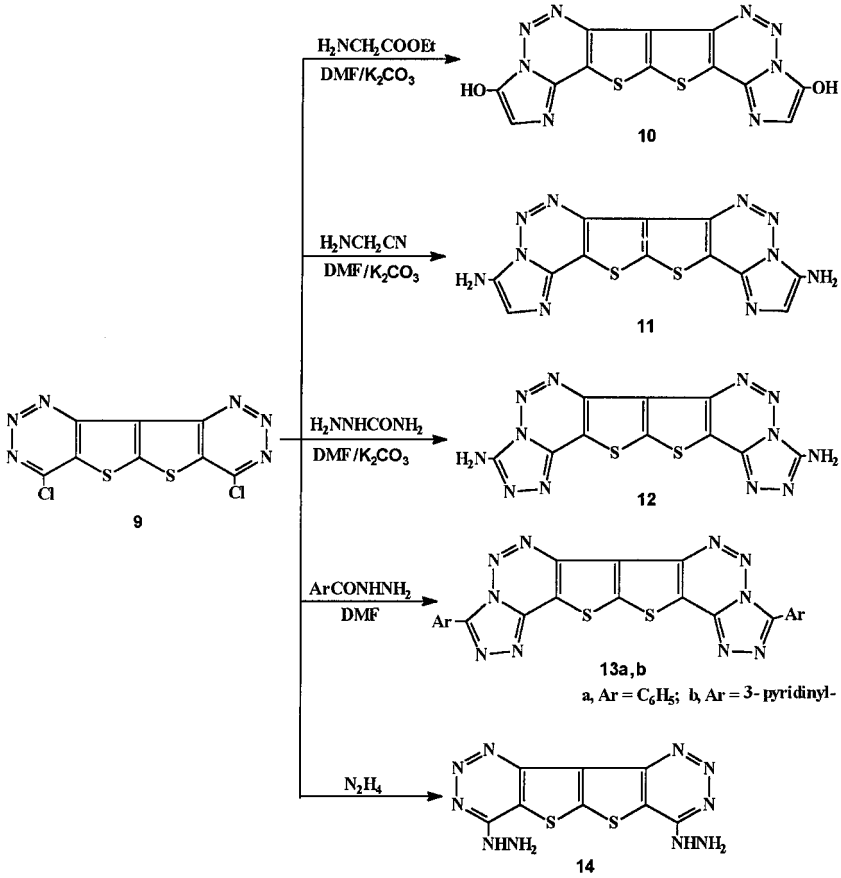
On treating a solution of *o*-aminoamide **1** in AcOH-HCl mixture with sodium nitrite solution resulted in diazotization followed by self coupling[6] to furnish (1,2,3)triazino[4″,5″:4′,5′]thieno[3′,2′:4,5]thieno [3,2-d][1,2,3]triazine-4,7-diol **8**. Chlorination of compound **8** with an excess amount of phosphorus pentachloride gave 4,7-dichloro(1,2,3)-triazino[4″,5″:4′,5′]thieno[3′,2′:4,5]thieno[3,2-d][1,2,3]triazine **9** in good yield (cf. Scheme 1).

Chlorotriazine derivative **9** was allowed to react with ethyl glycinate, aminoacetonitrile or semicarbazide in refluxing dimethyl formamide in presence of anhydrous potassium carbonate to give the promising imidazo[1,2-c]imidazo[2‴,1‴:6″,1″](1,2,3)triazino[4″,5″:4′,5′]thieno[3′, 2′: 4,5]thieno[3,2-d](1,2,3)triazine-4,11-diol **10**, 4,11-diaminoimidazo-



SCHEME 1

[1,2-c]imidazo[2‴,1‴:6″,1″](1,2,3)triazino[4″,5″:4′,5′]thieno[3′,2′:4,5]-thieno[3,2-d](1,2,3)triazine **11** or 4,11-diamino(1,2,4)triazolo[4,3-c][1,2,4]triazolo[3‴,4‴:6″,1″](1,2,3)triazino[4″,5″:4′,5′]thieno[3′,2′:4,5]thieno-[2,3-e](1,2,3)triazine **12** respectively. Moreover, the interaction of compound **9** with benzoic acid hydrazide or nicotinic acid hydrazide in refluxing dimethyl formamide, afforded 4,11-diphenyl(3-pyridinyl)-[1,2,4]triazolo[4,3-c][1,2,4]triazolo[3‴,4‴:6″,1″][1,2,3]triazino[4″,5″:4′,5′]thieno[3′,2′:4,5]thieno[2,3-e][1,2,3]triazine **13a**,**b** respectively (cf. Scheme 2). The reaction mechanism for the formation of compounds **10–13a**,**b** was postulated to proceed via a nucleophilic substitution reaction followed by intramolecular cyclization through the elimination



SCHEME 2

of either ethanol molecule in case of compound **10** or water molecule to give compounds **12** and **13a**,**b**. In case of compound **11** the intramolecular cyclization was carried out via the addition of the NH group to the cyano group.

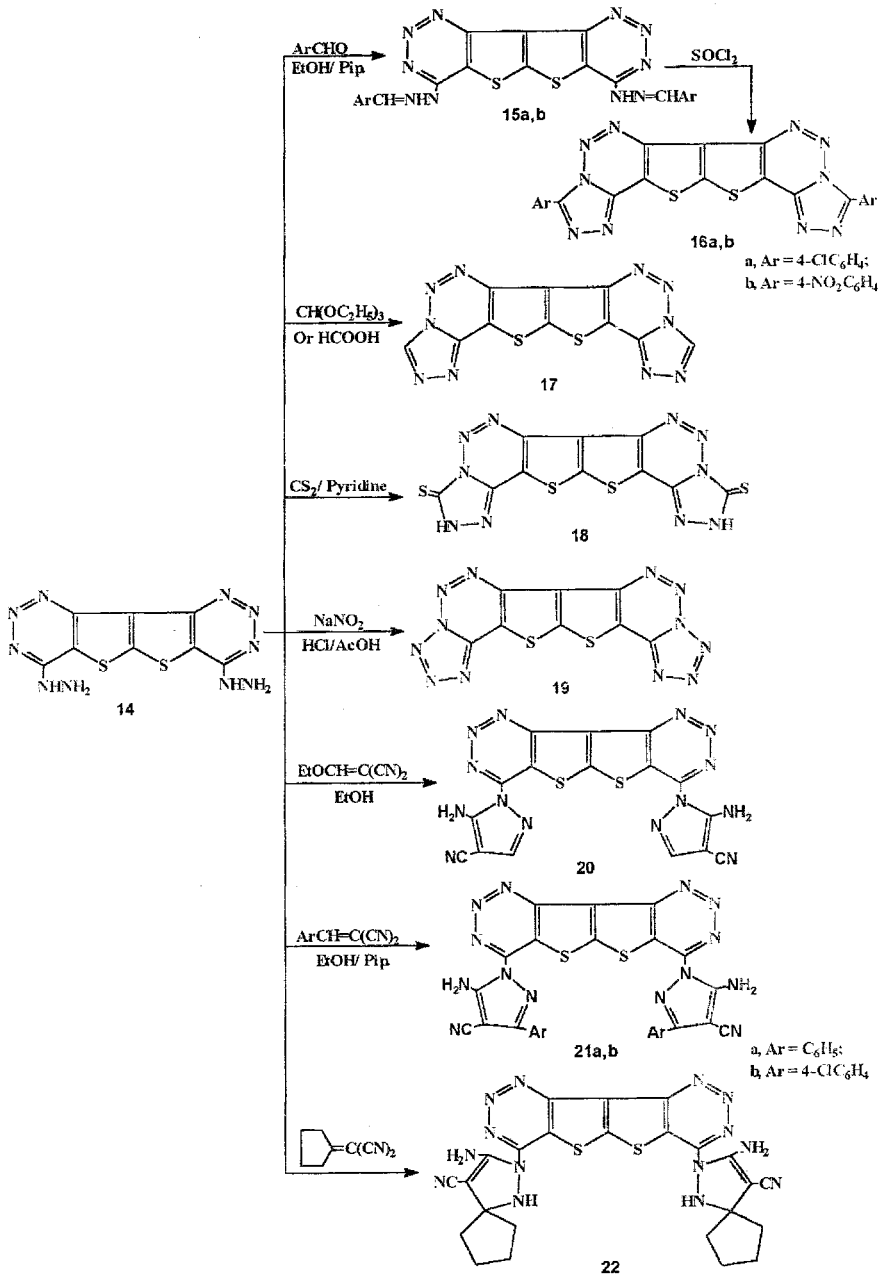
On treating compound **9** with hydrazine, nucleophilic displacement took place and the 4,7-dihydrazino(1,2,3)triazino[4″,5″**:**4′,5′]-thieno[3′,2′**:**4,5]thieno[3,2-d][1,2,3]triazine **14** was obtained in good yield (cf. Scheme 2).

Condensation of compound **14** with *p*-chlorobenzaldehde or *p*-nitrobenzaldehyde afforded the corresponding Sciff bases **15a**,**b**. Oxidative cyclisation of compounds **15a**,**b** with thionyl chloride afforded 4,11-di(4-chlorophenyl or 4-nitropheny)[1,2,4]triazolo[4,3-c][1,2,4]triazolo-[3‴,4‴**:**6″,1″][1,2,3]triazino[4″,5″**:**4′,5′]thieno[3′,2′**:**4,5]thieno[2,3-e][1,2,3]triazine **16a**,**b** respectively (cf. Scheme 3).

Also, compound **14** easily underwent ring closure with triethyl orthoformate and gave [1,2,4]triazolo[4,3-c][1,2,4]triazolo[3‴,4‴**:**6″,1″][1,2,3]-triazino[4″,5″**:**4′,5′]thieno[3′,2′**:**4,5]thieno[2,3-e][1,2,3]triazine **17**. While refluxing of compound **14** in formic acid yielded product which is identical in all respects with authentic sample of compound **17** (cf. Scheme 3).

4,5,10,11-Tetrahydro[1,2,4]triazolo[4,3-c][1,2,4]triazolo[3‴,4‴**:**6″,1″]-[1,2,3]triazino[4″,5″**:**4′,5′]thieno[3′,2′**:**4,5]thieno[2,3-e][1,2,3]triazine-4,11-dithione **18** could be synthesized by refluxing hydrazino compound **14** with carbon disulfide in pyridine (cf. Scheme 3).

Also, [1,2,3,4]tetrazolo[1,5-c][1,2,3,4]tetrazolo[5‴,1‴**:**6″,1″][1,2,3]-triazino[4″,5″**:**4′,5′]thieno[3′,2′**:**4,5]thieno[2,3-e][1,2,3]triazine **19** was obtained upon treatment of compound **14** with nitrous acid. On the other hand, compound **14** was allowed to react with a variety of ylidenemalononitriles namely, ethoxymethylenemalononitrile, benzylidenemalononitrile, *p*-chlorobenzylidene-malononitrile, or cyclopentylidenemalononitrile to give 4,7-di(5-amino-4-cyano-1H-pyrazol-1-yl)-[1,2,3]triazino[4″,5″**:**4′,5′]thieno[3′,2′**:**4,5]thieno[3,2-d][1,2,3]triazine **20**, 4,7-di(5-amino-3-phenyl(4-chlorophenyl)-4-cyano-1H-pyrazol-1-yl)-[1,2,3]triazino[4″,5″**:**4′,5′]thieno[3′,2′**:**4,5]thieno[2,3-e][1,2,3]triazine **21a**,**b** or 4,7-di(5′-amino-4′-cyano-spiro[cyclopentane-1-3′-(1′,2′-dihydropyrazole)]-1-yl)-[1,2,3]triazino[4″,5″**:**4′,5′]thieno[3′,2′**:**4,5]thieno[3,2-d][1,2,3]triazine **22** respectively (cf. Scheme 3). The reaction pathway was assumed to proceed via the nucleophilic addition of the amino group to the ethylenic bond followed by intramolecular cyclization through the addition of the imino group to the cyano group. In case of compounds **21a**,**b**, aromatization was gained by elimination of hydrogen molecule and absorbed by another molecule of arylidenemalononitrile.[19,20]



SCHEME 3

All the new synthesized products are proved by their analytical and spectral (IR and ^{1}H-NMR) data (cf. Table I).

EXPERIMENTAL

Synthesis of Compound 2

A mixture of compound **1** (0.05 mmol), carbon disulfide (0.1 mmol) and dry pyridine (20 ml) was refluxed until the evolution of H_2S ceased (20 h). The reaction mixture was allowed to cool, the solid product formed upon pouring onto ice containing few drops of hydrochoric acid (pH = 6) was collected and crystallized from the suitable solvent (cf. Scheme 1, Table I).

Synthesis of Compounds 3 and 4: General Procedure

To a solution of compound **1** (0.01 mmol) in glacial acetic acid (20 ml), piperonal (0.02 mmol) or cyclopentanone (0.02 mmol) was added. The reaction mixture was treated with sodium acetate (3 g), refluxed for 5 h, evaporated in vacuo and the residual solid was washed with water, dried and crystallized from the suitable solvent (cf. Scheme 1, Table I).

Synthesis of Compound 5

A mixture of compound **1** (0.05 mmol), ethyl chloroformate (0.1 mmol), and pyridine (10 ml) was refluxed for 4 h and then allowed to cool. The solid product formed upon pouring onto ice/HCl was collected by filtration and crystallized from the suitable solvent (cf. Scheme 1, Table I).

Synthesis of Compounds 6a,b: General Procedure

To a solution of compound **1** (0.005 mmol) in ethanol (30 ml), (0.01 mmol) of 2-[di(methylthio)methylene]malononitrile or 3-[di(methylthio)methylene]pentane-2,4-dione and TEA (0.012 mmol) were added. The reaction mixture was refluxed for 12 h, till the MeSH had ceased, evaporated in vacuo and the remaining product was triturated with pet. ether (40/60°C). The residual solid was collected by filtration and crystallized from the suitable solvent (cf. Scheme 1, Table I).

Synthesis of Compound 7

To a solution of compound **1** (0.01 mmol) in dry pyridine (20 ml), oxallyl chloride (0.02 mmol) was added. The reaction mixture was refluxed for

TABLE I Analytical and Spectral Data of the New Compounds

Comp. No.	M.P. (°C)[a] Cryst. Solvent	Yield (%)	Mol. Form. (Mol. wt.)	Analytical Data[b] Cal./Found C	H	N	S	Cl	IR (Cm^{-1})[c]	^{1}H-NMR ∂ (ppm)[d]
2	322 ethanol	66	$C_{10}H_4N_4O_2S_4$ (340.41)	35.28 34.88	1.18 1.11	16.45 16.31	37.67 37.29		3400, 3211(NH), 1689 (CO), 1451 (C═S).	11.3 (s, 2H, 2NH), 9.1 (s, 2H, 2NH).
3	340-2 dioxan	72	$C_{24}H_{16}N_4O_6S_2$ (520.52)	55.37 55.03	3.09 2.97	10.76 10.48	12.32 12.17		3420, 3210 (NH), 3040, ($CH_{arom.}$), 3091(CH aliph.), 1690 (CO).	13.0 (s, 2H, 2NH), 9.3 (s, 2H, 2NH), 7.7-7.1 (m, 6H, arom.), 6.0 (s, 2H, 2CH), 4.9 (s, 4H, $2CH_2$).
4	263-5 ethanol	71	$C_{18}H_{20}N_4O_2S_2$ (388.49)	55.64 55.23	5.19 5.07	14.42 14.26	16.50 16.19		3400, 3211 (NH), 1689 (CO).	12.2 (s, 2H, 2NH), 10.20 (s, 2H, 2NH) 1.5-1.0 (m, 16H, cyclic CH_2).
5	300 ethanol	48	$C_{10}H_4N_4O_4S_2$ (308.28)	38.95 38.69	1.31 1.22	18.17 17.89	20.80 20.57		3249, 3158 (NH), 1698 (CO).	9.8 (s, 2H, 2NH), 9.0 (s, 2H, 2NH).
6a	120 ethanol	68	$C_{16}H_4N_8O_2S_2$ (404.37)	47.52 47.19	0.99 0.90	27.71 27.44	15.85 15.61		3410, 3241(NH), 2203 (CN), 1699 (CO).	13.0 (s, 2H, 2NH), 10.1 (s, 2H, 2NH)
6b	175 ethanol	59	$C_{20}H_{16}N_4O_6S_2$ (472.48)	50.83 50.39	3.41 3.25	11.85 11.59	13.57 13.27		3400, 3211 (NH), 1711 (CO), 1689 (CO_{amidic}).	11.9 (s, 2H, 2NH), 9.0 (s, 2H, 2NH), 2.2 (s, 6H, $2CH_3$).
7	260 dioxan	63	$C_{12}H_4N_4O_6S_2$ (364.30)	39.56 39.19	1.10 0.99	15.38 15.07	17.60 17.38		3430, 3311 (NH), 1680–1692 (CO).	12.0-11.3 (br, 4H, 4NH).
8	198 ethanol	81	$C_8H_2N_6O_2S_2$ (278.26)	34.53 34.17	0.72 0.93	30.20 29.98	23.04 22.88		3430 (OH), 1623(C═N) 1589 (N═N).	9.2 (s, 2H, 2OH).
9	179 benzene	69	$C_8N_6S_2Cl_2$ (315.15)	30.49 30.11	0.00 0.00	26.66 26.39	20.35 20.17	22.50 22.17	1613 (C═N), 1583 (N═N), 743 (C-Cl).	—

10	281-3 dioxan	74	$C_{12}H_4N_8O_2S_2$ (356.33)	40.44 40.13	1.13 1.09	31.44 31.12	17.99 17.74	3479 (OH), 1633 (C=N) 1585 (N=N).	9.9 (s, 2H, 2OH), 8.1 (s, 2H, 2CH).
11	216 etanol	70	$C_{12}H_6N_{10}S_2$ (354.36)	40.67 40.77	1.70 1.73	39.52 39.78	18.09 18.21	3430, 3337 (NH_2), 1611 (C=N), 1582 (N=N).	8.0 (s, 2H, 2CH), 5.1-4.8 (br, 4H, $2NH_2$).
12	273-4 ethanol	81	$C_{10}H_4N_{12}S_2$ (356.34)	33.70 33.39	1.13 1.07	47.17 46.79	17.99 17.64	3441, 3352 (NH_2), 1619 (C=N), 1599 (N=N).	5.4-5.1 (br, 4H, $2NH_2$).
13a	303-5 DMF	79	$C_{22}H_{10}N_{10}S_2$ (478.49)	55.22 54.83	2.10 1.99	29.27 29.03	13.40 13.21	3061 (C-H arom.), 1611 (C=N), 1579 (N=N).	6.9-6.3 (m, 10H, aromatic).
13b	339 DMF	75	$C_{20}H_8N_{12}S_2$ (480.47)	49.99 49.61	1.67 1.53	34.98 34.68	13.34 13.09	3078 (C-H arom.), 1629 (C=N), 1591 (N=N).	7.8-7.3 (m, 8H, aromatic).
14	203 ethanol	85	$C_8H_6N_{10}S_2$ (306.32)	31.36 31.59	1.97 1.89	45.72 45.43	20.93 20.70	3441, 3352, 3298 (NH_2+ NH), 1627 (C=N), 1580 (N=N).	10.8 (s, 2H, 2NH), 4.9-4.6 (br, 4H, $2NH_2$).
15a	281-3 ethanol	77	$C_{22}H_{12}N_{10}S_2Cl_2$ (551.42)	47.91 47.50	2.19 2.11	25.40 25.09	11.63 11.42	3323 (NH), 3041 (C-H arom.), 1612 (C=N), 1588 (N=N).	11.3 (s, 2H, 2NH), 7.2-6.6 (m, 8H, arom.).
15b	254-6 ethanol	75	$C_{22}H_{12}N_{12}O_4S_2$ (572.52)	46.15 46.48	2.11 2.20	29.35 29.60	11.20 11.38	3300 (NH), 3053 (C-H arom.), 1622 (C=N), 1601 (N=N).	10.9 (s, 2H, 2NH), 8.0-7.4 (m, 8H, arom.).
16a	312-4 dioxan	61	$C_{22}H_8N_{10}S_2Cl_2$ (547.38)	48.27 47.91	1.47 1.41	25.59 25.33	11.71 11.60	3053 (C-H arom.), 1610 (C=N), 1591 (N=N).	7.1-6.6 (m, 8H, arom).
16b	326-8 ethanol	59	$C_{22}H_8N_{12}O_4S_2$ (568.49)	46.47 46.03	1.41 1.30	29.56 29.30	11.28 11.09	3081 (C-H arom.), 1617 (C=N), 1603 (N=N).	7.9-7.4 (m, 8H, arom).
17	261 dioxan	73	$C_{10}H_2N_{10}S_2$ (326.31)	36.81 36.39	0.62 0.55	42.92 42.53	19.65 19.49	3033 (C-H arom.), 1637 (C=N), 1600 (N=N).	8.3 (s, 2H, 2 =CH).

(Continued on next page)

TABLE I Analytical and Spectral Data of the New Compounds *(Continued)*

Comp. No.	M.P. (°C)[a] Cryst. Solvent	Yield (%)	Mol. Form. (Mol. wt.)	Analytical Data[b] Cal./Found C	H	N	S	Cl	IR (Cm^{-1})[c]	^{1}H-NMR ∂ (ppm)[d]
18	301 ethanol	80	$C_{10}H_2N_{10}S_4$ (390.44)	30.76 30.89	0.52 0.55	35.87 35.99	32.85 32.93		3302 (NH), 1639 (C=N), 1603 (N=N), 1402 (C=S).	10.8 (s, 2H, 2NH).
19	356-9 DMF	75	$C_8N_{12}S_2$ (328.29)	29.27 28.86	0.00 0.00	51.20 50.88	19.53 19.33		1621 (C=N), 1589 (N=N).	—
20	165-6 ethanol	83	$C_{16}H_6N_{14}S_2$ (458.43)	41.91 41.59	1.32 1.28	42.77 42.43	13.99 13.73		3411, 3329 (NH_2), 3207 (CN), 1600 (C=N), 1583 (N=N).	8.7 (s, 2H, 2 =CH), 5.0-4.7 (br, 4H, $2NH_2$).
21a	209 ethanol	72	$C_{28}H_{14}N_{14}S_2$ (610.61)	55.07 54.81	2.31 2.17	32.12 31.87	10.50 10.22		3380, 3289 (NH_2), 3044 (CH, arom), 2211 (CN), 1619 (C=N), 1589 (N=N).	7.0-6.6 (m, 10H, arom.), 5.0-4.7 (br, 4H, $2NH_2$).
21b	217 ethanol	77	$C_{28}H_{12}N_{14}S_2Cl_2$ (679.50)	49.49 49.09	1.78 1.62	28.86 28.60	9.43 9.29		3410, 3319 (NH_2), 3089 (CH, arom), 2206 (CN), 1623 (C=N), 1599 (N=N).	7.2-6.6 (m, 8H, arom.), 5.1-4.8 (br, 4H, $2NH_2$).
22	181 ethanol	58	$C_{24}H_{22}N_{14}S_2$ (570.64)	50.51 50.11	3.88 3.69	34.36 34.00	11.24 11.02		3411, 3340, 3283 ($NH_2 + NH$), 2980 (CH, aliph.), 3201 (CN), 1611 (C=N), 1586 (N=N).	11.3 (br, 2H, 2NH), 5.0-4.7 (br, 4H, $2NH_2$), 1.4-1.0 (m, 16H, cyclic $8CH_2$).

[a]Uncorrected.
[b]Satisfactory microanalysis obtained C; ±0.44, H; ±0.19, N; ±0.39, S; ±0. 35.
[c]Measured by Nicolet FT-IR 710 Spectrophotometer.
[d]Measured by a Varian EM 360 L spectrometer at 60 MHz using TMS as internal standard and DMSO as a solvent.

2 h, cooled and poured into ice/HCl mixture. The formed precipitate was filtered off, dried and crystallized from the suitable solvent (cf. Scheme 1, Table I).

Synthesis of Compound 8

To a solution of compound **1** (0.01 mmol) in acetic acid (10 ml) and conc. hydrochloric acid (10 ml), sodium nitrite solution (0.05 mmol) was added dropwise at 0–5°C with stirring. The reaction mixture was stirred at the same temperature for 1 h. The obtained solid product was filtered off, washed with water, and crystallized from the proper solvent (cf. Scheme 1 and Table I).

Synthesis of Compound 9

A mixture of compound **8** (0.01 mmol) and phosphorus pentachloride (0.05 mmol) was fused at 160–170°C for 1 h. After cooling, the reaction mixture was added gradually to ice/cold water mixture. The formed precipitate was collected by filtration, dried and crystallized from the suitable solvent (cf. Scheme 1, Table I).

Synthesis of Compounds 10–12: General Procedure

A mixture of compound **9** (0.005 mmol), K_2CO_3 (0.01 mmol), DMF (30 ml) and ethyl glycinate hydrochoride, aminoacetonitrile sulphate or semicarbazide hydrochoride (0.01 mmol) was refluxed for 8 h. The reaction mixture was filtered while hot. The filtrate was concentrated and cooled. The formed precipitate was collected by filtration, washed with water and crystallized from the suitable solvent (cf. Scheme 2, Table I).

Synthesis of Compounds 13a,b: General Procedure

A solution of compound **9** (0.005 mmol) in DMF (30 ml) was treated with benzoic acid hydrazide or nicotinic acid hydrazide (0.01 mmol). The reaction mixture was refluxed for 8 h. The obtained solid products after cooling were filtered off and crystallized from the proper solvent (cf. Scheme 2 and Table I).

Synthesis of Compound 14

Compound **9** (0.01 mmol) in hydrazine hydrate 99% (8 ml) was refluxed for 3 h. The excess hydrazine hydrate was removed by distillation

under reduced pressure, the residue was triturated with petrolum ether (60–80°C). The product was collected by filtration and crystallized from the suitable solvent (cf. Scheme 2 and Table I).

Synthesis of Compounds 15a,b: General Procedure

A solution of compound **14** (0.005 mmol) in ethanol (40 ml) was treated with the suitable aldehyde (0.01 mmol) and piperidine (0.01 mmol). The reaction mixture was refluxed for 5 h. The obtained solid products after cooling were filtered off and crystallized from the proper solvents (cf. Scheme 3 and Table I).

Synthesis of Compounds 16a,b: General Procedure

A solution of compound **15a** or **15b** (0.005 mmol) in thionyl chloride (20 ml) was refluxed for 2 h, cooled, and poured onto ice/cold water. The obtained solid product was filtered off, washed with water, and crystallized from the proper solvent (cf. Scheme 3 and Table I).

Synthesis of Compound 17

Method A

A mixture of compound **14** (0.01 mmol), triethyl orthoformate (0.02 mmol) and acetic anhydride (10 ml) was refluxed for 4 h and allowed to cool. The formed solid product upon pouring onto ice/water was collected by filtration and crystallized from the suitable solvent.

Method B

Compound **14** (0.005 mmol) in formic acid (8 ml) was refluxed for 2 h and the unreacted formic acid was removed by distillation under reduced pressure. The formed solid product was washed with water, dried, and crystallized from the suitable solvent (cf. Scheme 3, Table I).

Synthesis of Compound 18

A mixture of compound **14** (0.01 mmol), carbon disulfide (0.02 mmol) and dry pyridine (20 ml) was refluxed until the evolution of H_2S ceased (20 h). The reaction mixture was allowed to cool. The formed solid product upon pouring onto ice containing few drops of hydrochoric acid (pH = 6) was collected by filtration and crystallized from the suitable solvent (cf. Scheme 3, Table I).

Synthesis of Compound 19

To a solution of compound **14** (0.01 mmol) in acetic acid (10 ml) and conc. hydrochloric acid (10 ml) mixture, sodium nitrite solution (0.05 mmol) was added dropwise at 0–5°C with stirring. The reaction mixture was stirred at the same temperature for 1 h. The solid product obtained was filtered off, washed with water, and crystallized from the proper solvent (cf. Scheme 3 and Table I).

Synthesis of Compounds 20–22: General Procedure

A solution of compound **14** (0.005 mmol) in ethanol (30 ml) was treated with the suitable ylidenemalononitrile (0.01 mmol) and piperidine (0.01 ml). The reaction mixture was refluxed for 5 h. The obtained solid prcoducts after cooling were filtered off and crystallized from the proper solvents (cf. Scheme 3 and Table I). (*Note*: In case of arylidenemalononitriles (0.02 mmol) was used.)

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