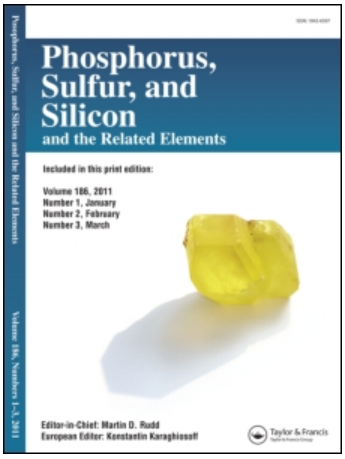

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SYNTHESIS OF POLYFUSED THIENO(2,3-b)THIOPHENES PART 1: SYNTHESIS OF THIENOPYRIMIDINE DERIVATIVES

A. Khodairy[a]; H. Abdel-ghany[a]
[a] Chemistry Department, Faculty of Science, Sohag, Egypt

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SYNTHESIS OF POLYFUSED THIENO(2,3-b)THIOPHENES

PART 1: SYNTHESIS OF THIENOPYRIMIDINE DERIVATIVES

A. KHODAIRY* and H. ABDEL-GHANY

Chemistry Department, Faculty of Science, Sohag, Egypt

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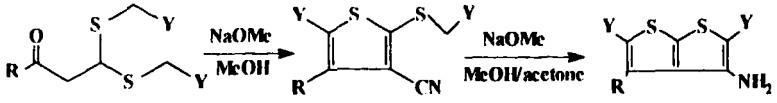
3,4-Diamino-2,5-dicarbethoxythieno(2,3-b)thiophene **1** reacted with malononitrile or ethyl cyanoacetate to afford bis(thienopyrimidin-4-one) derivatives $\mathbf{2}_{a,b}$ The reaction of compound **1** with o-aminothiophenol, o-aminophenol or o-phenylenediamine gave benzothiazolyl-, benzoxazolyl-, benzoimidazolylthienothiophene $\mathbf{3}_{a-c}$, Chloroacetylation of compound **1** and reacting the resulting compound **4** with malononitrile furnished thienopyrolopyrimidine **6**. Fusion of compound **1** with formamide yielded bis(thienopyrimidine) **7** which reacted with $POCl_3/PCl_5$ to yield the corresponding chloro derivative **8** which was converted into the corresponding hydrazine derivative **9**. Treatment of compound **1** with CS_2, NaOH and 1,2 dibromoethane produced the corresponding 1,3 dithiolane **11** which also treated with chloroacetyl chloride or ethyl mercaptoacetate to get the corresponding β-lactame **12** or thiazolidinone **13**. On reacting compound 1 with CS_2, NaOH and $(CH_3)_2SO_4$ produced the corresponding bi(dithiocarbamate methyl ester) **14** which treated with hydrazine hydrate to yield the corresponding bis(thienopyrimidine) derivative **15**. This compound reacted with Lawesson's reagent (LR) to give the desired compounds **16** and **17**. While its reaction with $(CH_3)_2$ SO_4 and NaOH furnished the corresponding methyl derivative **18**. Fusion of compound **18** with aniline afforded compound **19**. Compound **19** was allowed to react with ethyl acetoacetate, acetylacetone, α-oxoketene dithioacetal, ethoxymethylene malononitrile or LR to get the described compounds $\mathbf{20}_{a-b}$-**24** respectively.

Keywords: Thieno(2,3-b)thiophene; benzoimidazolylthienothiophene; thienopyrimidine; 1,3-dithiolane; Lawesson's reagent (LR)

* To whom correspondence should be addressed.

INTRODUCTION

Alkylation of dithioic dianions derived from α-cyanoketones[1] with α-haloesters and nitriles has been examined as a general route to thiophenes. The dithiolate dianions can be sequentially alkylated with CH_3I and XCH_2Y(Y=CN, COR, COOR) to afford mixed ketene dithioacetals or treated with two equivalents of the α-halocarbonyl or nitrile electrophile. The latter compound can be converted in two steps into thienothiophenes.



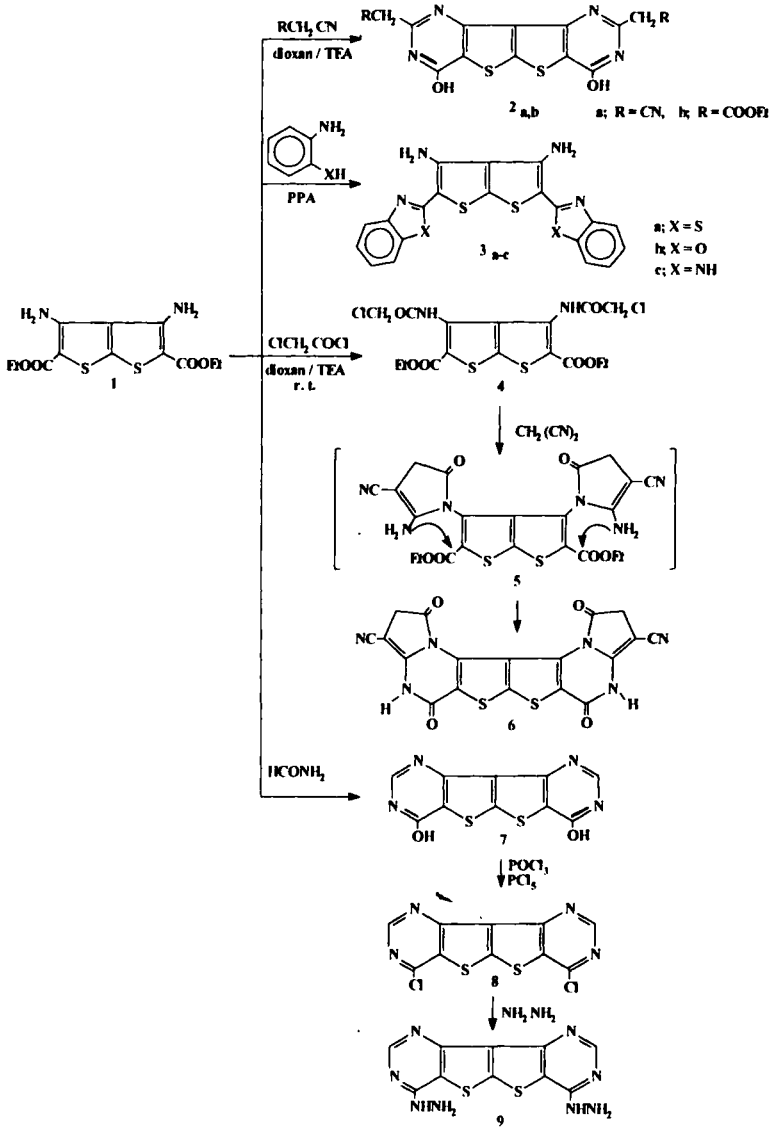
In our previous work[2] we reported the synthesis of some new functionally substituted thieno(2,3-b)thiophenes in a one-pot reaction using phase-transfer catalysis technique. The biological and pharmacological activities of condensed pyrimidines[3–5] and thienpyrimidines[4,6] motivated us to synthesis new polyfused thieno(2,3-b)thiophenes and thieno(3,2-d)pryrimidines starting with 3,4-diamino-2,5-dicarbethoxythieno(2,3-b) thiophene.

RESULTS AND DISCUSSION

It has been reported that the condensation of o-aminocarbonyl compound with active nitrile is essentially dry HCl gas catalysed condensation[7–9]. We report here the reaction of 3,4-diamino-2,5-dicarbethoxythieno(2,3-b)thiophene **1** with active nitriles namely, malononitrile and ethyl cyanoacetate can be carried out in refluxing dioxane in presence of Et_3N as a catalyst to afford the corresponding bis[2-substitutedthieno(3,2-d)pyrimidine] derivatives $\mathbf{2}_{a,b}$ (Scheme 1, Table I).

The condensation of compound **1** with selected o-substituted aromatic amines such as o-aminothiophenol, o-aminophenol, o-phenylenediamine in the presence of polyphosphoric acid afforded the corresponding 3,4-diamino-2,5-dihetarylthieno(2,3-b) thiophenes $\mathbf{3}_{a-c}$ respectively in one pot synthesis (Scheme 1, Table I).

Compound **1** was reacted with an equimolar amount of chloroacetyl chloride in dry dioxane at room temperature to yield 2,5-dicar-



SCHEME 1

bethoxy-3,5-di(α-chloroacetamido)thieno(2,3-b)thiophene **4** which in turn treated with malononitrile and Et_3N to get the corresponding bis[pyrrol-othieno(3,2-d)pyrimidinone] derivative **6**. Formation of compound **6** was

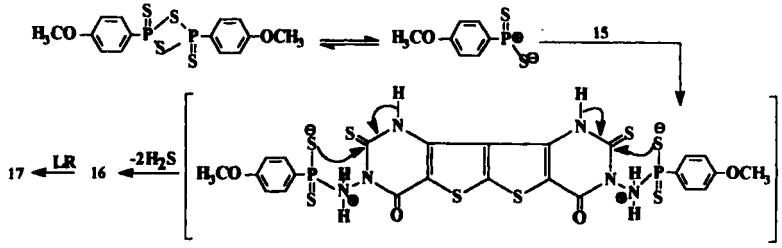
assumed to proceed via intermediate **5** followed by subsequent interamolecular cyclization through nucleophilic attack of the NH_2 group to the carbonyl ester group with elimination of EtOH molecule (Scheme 1, Table I).

Cyclization of compound **1** with formamide gave bis[thieno(3,2-d)pyrimidine] **7** which was chlorinated with PCl_5 in the presence of $POCl_3$to furnishe the corresponding chloro drevative **8**. Compound **8** upon treatment with hydrazine hydrate afforded the corresponding hydrazino derivative **9** (Scheme 1, Table I).

Compound **1** was treated with NaOH and CS_2 in 1:2:2 molar ratio using DMF as a solvent to get the corresponding bi(disodium dithiocarbamate) derivative **10** which was stirred with 1,2-dibromoethane to give 2,5-dicarbethoxy-3,4-bi[(1,3-dithiolan-2-ylidene)imino]thieno(2,3-b)thiophene **11**. Cyclocondensation of compound **11** with chloroacetyl chloride in dry dioxane in the presence of Et_3N and mercaptoacetic acid in dioxane, respectively gave the corresponding azetidinone **12** and 4-thiazolidinone **13** (Scheme 2, Table I).

Treatment of compound **1** with NaOH, CS_2 and $(CH_3)_2SO_4$ afforded the corresponding bi(dithiocarbamate methyl ester) derivative **14** which on treating with hydrazine hydrate yielded bis[3-amino-2-thioxothieno(3,2-d)pyrimidin-4(1H)-one] **15** (Scheme 2, Table I).

Compound **15** was allowed to react with Lawesson's reagent (LR) in refluxing toluene to afford compounds **16** and **17**. As to the concerted mechanism[10] for the formation of compounds **16** and **17** it is suggested that a nucleophilic attack by the NH_2 group on LR gives the transient intermediate, which underwent interamolecular cyclization via elimination of H_2S molecule to give **16**. Subsequent thiation of compound **16** produced compound **17** (Scheme A).



SCHEME A

TABLE I Analytical and spectral Data of the New Compounds

Product No.	*M.P. (°C)*[a]	*Yield (%)*	*Mole. Form. (Mol.wt.)*	*Analytical Data*[b] *Cal./Found*				*IR (Cm^{-1})*[c]	*^{1}H-NMR ∂ (ppm)*[d]
				C	*H*	*N*	*S*		
2a	220	66	$C_{14}H_6N_6O_2S_2$	47.45	1.70	23.71	18.09	3375 (OH), 2100 (CN).	4.1 (s, 4H, $2CH_2$), 2.4 (s, 2H, 2OH).
			(354.38)	47.80	1.91	23.82	18.23		
2b	301	90	$C_{18}H_{16}N_4O_6S_2$	48.20	3.59	12.49	14.29	3343(OH),1740(CO_{ester}	4.4–4.1 (q, 4H, $2CH_2$), 4.0 (s, 4H, $2CH_2$), 2.1 (s, 2H, 2OH), 1.3–1.0 (t, 6II, $2CH_3$).
			(448.49)	48.00	3.21	12.60	14.37		
3a	300	34	$C_{20}H_{12}N_4S_4$	55.01	2.77	12.83	29.37	3320,3219(NH_2), 3010 (CH arom.),	8.4–7.7(m, 8H,arom.),5.1–4.8(br,4H, $2NH_2$).
			(436.58)	55.23	2.60	12.69	29.11		
3b	291	29	$C_{20}H_{12}N_4O_2S_2$	59.38	2.99	13.85	15.85	3328,3242(NH_2), 3015 (CH arom.),	8.3–7.8(m, 8H,arom.),5.5–5.0(br,4H, $2NH_2$).
			(404.45)	59.41	2.78	13.60	15.76		
3c	219	40	$C_{20}H_{14}N_6S_2$	59.67	3.50	20.88	15.93	3340, 3249, 3310 (NH,NH_2), 3010 (CH arom.).	8.8–7.9(m, 10H,2NH + arom.), 6.1–5.7 (br,4H, $2NH_2$).
			(402.48)	59.81	3.72	20.66	15.76		
4	> 330	60	$C_{16}H_{16}N_2O_6S_2$	41.11	3.45	5.99	13.71	3300 (NH), 1740 (CO_{ester}), 1665 (CO).	8.8 (s, 2H, 2NH), 5.8(s,4H,$2CH_2$),4.4–4.1(q, 4H, $2CH_{2\ ester}$), 1.3–1.0 (t, 6II, $2CH_3$).
			(467.45)	41.00	3.70	5.79	13.59		

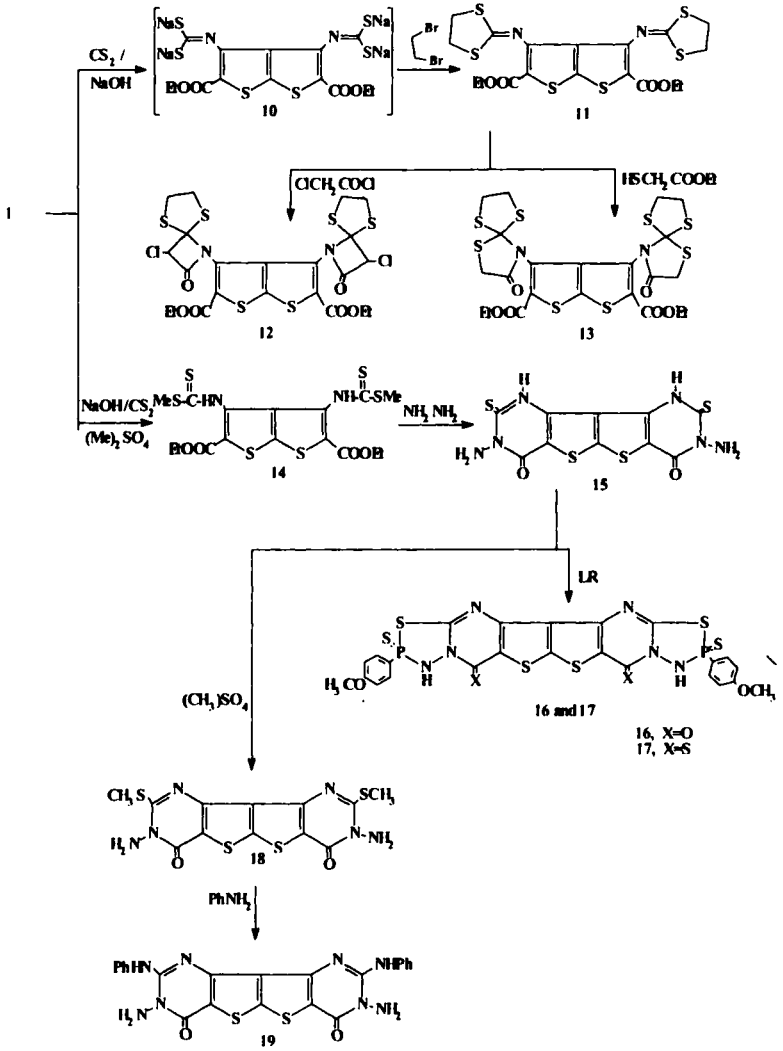
Product No.	*M.P. (°C)*[a]	*Yield (%)*	*Mole. Form. (Mol.wt.)*	*Analytical Data*[b] *Cal./Found*				*IR (Cm^{-1})*[c]	*^{1}H-NMR ∂ (ppm)*[d]
				C	*H*	*N*	*S*		
6	299	69	$C_{18}H_6N_6O_4S_2$	49.76	1.39	19.34	14.76	3310 (NH), 2110 (CN), 1690–1670 (CO).	9.2 (s, 2H, 2NH), 4.0 (s, 4H, $2CH_2$).
			(434.42)	49.89	1.63	19.51	14.83		
7	280	80	$C_{10}H_4N_4O_2S_2$	43.47	1.45	20.27	23.20	3370 (OH).	7.6 (s, 2H, 2=CH), 2.4 (s, 2H, 2OH)
			(276.3)	43.30	1.70	20.30	23.00		
8	> 340	90	$C_{10}H_2N_4S_2$	38.33	0.64	17.88	20.46		8.0 (s, 2H, 2 = CH).
			(313.29)	38.00	0.90	17.68	20.29		
9	296	70	$C_{10}H_8N_8S_2$	39.46	2.64	36.81	21.06	3320 –3115 (NH, NH_2).	7.5 (s, 2H, 2 = CH), 6.3 – 6.0 (br, 6II, 2NH, NH_2).
			(304.37)	39.11	2.41	36.91	21.29		
11	200	93	$C_{18}H_{18}N_2O_4S_6$	41.67	3.49	5.40	37.38	1730 (CO), 2930 (CH_{aliph}	4.3–4.0 (q, 4H, $2CH_{2\ ester}$), 3.0 (s, 8H, $4CH_2$), 1.3–1.0 (t, 6H, $2CH_3$).
			(518.75)	41.49	3.30	5.60	37.30		
12	189	30	$C_{22}H_{20}Cl_2N_2O_6S_6$	39.33	3.30	4.17	28.63	1730 (CO_{ester}), 1699 (CO).	6.6 (s, 2H, 2CH), 4.0–3.8 (q, 4H, $2CH_{2\ ester}$), 3.2 (s, 8H, $4CH_2$), 1.3–1.0 (t, 6H, $2CH_3$).
			(671.77)	39.51	3.44	4.24	28.45		
13	169	75	$C_{22}H_{22}N_2O_6S_8$	39.31	3.32	4.20	38.46	1740(CO_{ester}),1685(CO	4.4–4.1 (q, 4H, $2CH_{2\ ester}$), 3.9 (s, 4H, $2CH_{2,\ thiazolidinone}$), 3. 1 (s, 8H, $4CH_2$), 1.4–1.1 (t, 6H, $2CH_3$).
			(666.92)	39.51	3.51	4.00	38.27		

Product No.	M.P. (°C)[a]	Yield (%)	Mole. Form. (Mol.wt.)	Analytical Data[b] Cal./Found				IR (Cm^{-1})[c]	^1H-NMR ∂ (ppm)[d]
				C	H	N	S		
14	156–8	90	$C_{16}H_{18}N_2O_4S_6$	38.84	3.64	5.66	38.88	3170 (NH), 2950 ($CH_{aliph.}$), 1735 (CO), 1061 (CS).	8.0 (s, 2H, 2NH), 4.3–4.0 (q, 4H, $2CH_2$), 3.1 (s, 6H, $2SCH_3$), 1.3–1.0 (t, 6H, $2CH_3$).
			(494.73)	38.59	3.75	5.50	38.69		
15	195–7	95	$C_{10}H_6N_6O_2S_4$	32.42	1.63	22.68	34.62	3350, 3230, 3190 (NH, NH_2), 2715 (SH), 1675 (CO).	9.3 (s, 2H, 2NH), 5.3–5.0 (br, 4H, $2NH_2$).
			(370.44)	32.30	1.49	22.48	34.47		
16	180	35	$C_{24}H_{16}P_2N_6O_4S_6$	40.78	2.28	11.88	27.21	3310 (NH), 1690 (CO)	9.0 (s, 2H, 2NH), 8.0–7.5 (m, 8H, arom.), 4.0 (s, 6H, $2OCH_3O$).
			(706.83)	40.98	2.31	11.69	27.01		
17	210	58	$C_{24}H_{16}P_2N_6O_2S_8$	39.00	2.18	11.37	34.71	3215 (NH), 1065 (CS).	8.6–8.1 (m, 10H, 2NH + arom.), 3.9 (s, 6H, $2OCH_3$).
			(738.96)	38.70	2.00	11.19	34.57		
18	161–3	55	$C_{12}H_{10}N_6O_2S_4$	36.18	2.53	21.10	32.20	310, 3220 (NH_2), 2950 ($CH_{aliph.}$), 1681 CO).	6.4–6.1 (br, 4H, $2NH_2$), 2.3 (s, 6H, $2SCH_3$).
			(398.28)	36.00	2.40	21.30	32.00		
19	> 350	60	$C_{22}H_{16}N_8O_2S_2$	54.10	3.30	22.94	13.12	3350–3130 (NH, NH_2), 1680 (CO).	9.0 (s, 2H, 2NH), 7.9–7.2 (m, 10H, arom.), 5.5–5.2 (br, 4H, $2NH_2$).
			(488.43)	54.22	3.45	22.73	13.00		

Product No.	M.P. (°C)[a]	Yield (%)	Mole. Form. (Mol.wt.)	Analytical Data[b] Cal./Found				IR (Cm^{-1})[c]	^{1}H-NMR ∂ (ppm)[d]
				C	H	N	S		
20$_a$	298	30	$C_{30}H_{20}N_8O_4S_2$	64.72	3.62	20.12	11.51	3450 (OH), 2971 ($CH_{aliph.}$), 1679 (CO).	7.9–7.4 (m, 10H, arom.), 6.9 (s, 2H, 2=CH), 2.5 (s, 6H, $2CH_3$), 2. 1 (s, 2H, 2OH).
			(556.67)	64.51	3.44	20.30	11.39		
20$_b$	330	41	$C_{32}H_{24}N_8O_2S_2$	62.32	3.92	18.16	10.39	2870 ($CH_{aliph.}$), 1669 (CO).	8.0–7.4 (m, 10H, arom.), 6.8 (s, 2H, 2=CH), 2.4–2.1 (br, 12H, $4CH_3$).
			(616.73)	62.20	3.75	18.00	10.20		
21	310	56	$C_{42}H_{28}N_8O_2S_4$	62.66	3.50	13.92	15.93	2951 ($CH_{aliph.}$), 1683 (CO).	8.4–8.0 (m, 20H, arom.), 6.7 (s, 2H, 2=CH), 2.6 (s, 6H, $2SCH_3$).
			(805.00)	62.81	3.35	13.79	15.77		
22	183–5	70	$C_{30}H_{16}N_{12}O_2S_2$	56.24	2.51	26.23	10.00	3300, 3210 (NH_2), 2181 (CN), 1669 (CO).	8.0–7.2 (m, 12H, 2 =CH + arom.), 5.5–5.1 (br, 4H, $2NH_2$).
			(640.67)	56.43	2.70	26.00	9.79		
23	195	56	$C_{36}H_{26}P_2N_8O_4S_4$	52.41	3.17	13.58	15.54	3200 (NH), 2935 ($CH_{aliph.}$), 1671 (CO).	9.3 (s, 2H, 2NH), 8.1–7. 1 (m, 18H, arom.), 4.0 (s, 6H, $2OCH_3$).
			(824.92)	52.33	3.10	13.43	15.42		
24	172	40	$C_{36}H_{26}P_2N_8O_2S_6$	48.63	2.94	12.60	21.63	3120 (NH), 2890 ($CH_{aliph.}$) 1070 (CS).	8.0–7.3 (m, 18H, arom.), 5.6–5.4 (br, 2H, 2NH), 3.7(s, 6H, $2CH_3O$).
			(889.05)	48.49	2.73	12.50	21.80		

a. Uncorrected.
b. Satisfactory microanalysis obtained C; +0.35, H; ± 0.4, N; ± 0.2.
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.

Methylation of compound **15** with dimethyl sulphate in presence of NaOH afforded bis[3-amino-2-methylthiothieno(3,2-d)pyrimidin-4-one] **18**. Fusion of **18** with aniline gave bis[3-amino-2-anilinothieno(3,2-d)pyrimidin-4-one] **19**. (Scheme 2, Table I).



SCHEME 2

Bis[thienopyrimidinotriazepin] derivatives **20**$_{a,b}$-**22** were obtained from the reaction of compound **19** with ethyl acetoacetate, acetylacetone, 3,3-dimethylthio-1- phenyl-2-propen-1-one or ethoxymethylenemalononitrile respectively. On the other hand the reaction of compound **19** with LR furnished the desired compounds **23** and **24** (Scheme 3, Table I).

EXPERIMENTAL

Synthesis of Compounds **2**$_{a,b}$

General Procedure

A solution of compound **1** (0.003 mole) and malononitrile or ethyl cyanoacetate (0.003 mole) in dioxane (30 ml) containing drops of triethylamine was refluxed for 6 hr. The reaction mixture was evaporated in *vacuo*, the residue was triturated with ethanol. The solid material so formed was collected and recrystallised from ethanol affording compounds **2**$_{a,b}$. (Scheme 1, Table I).

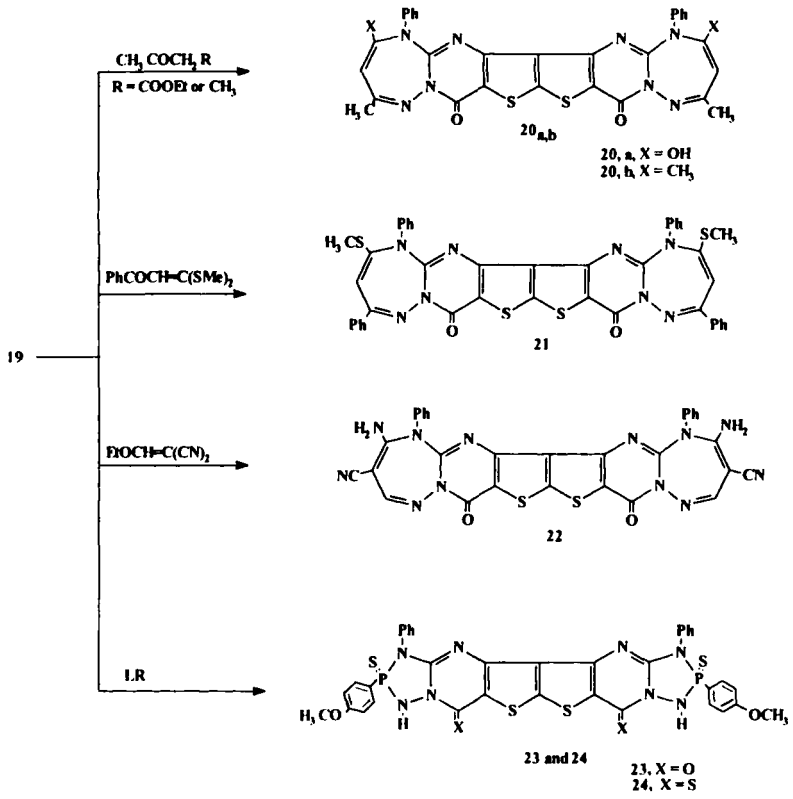
Synthesis of compounds **3**$_{a-c}$

General Procedure

A mixture of compound **1** (0.005 mole) and o-aminothiophenol, o-aminophenol or o-phenylenediamine (0.005 mole) in polyphosphoric acid (7 ml) was stirred and heated at 150°C for 2hr. The reaction mixture was cooled, slowly added into ice-water mixture and neutralised with aq. NH_3. The precipitated solid was filtered, washed with water and recrystallised from ethanol (Scheme 1, Table I).

Synthesis of 2,5-dicarbethoxy-3,5-di(α-chloroacetamido)thieno(2,3-b) thiohene 4

To a solution of compound **1** (0.005 mole) in dry dioxane (30 ml) was added chloroacetyl chloride (0.005 mole) dropwise with stirring. The reaction mixture was refluxed for 30 min., left overnight and poured into



SCHEME 3

ice-water mixture. The separated solid was collected by filtration and crystallised from ethanol (Table I).

Synthesis of compound 6

To a solution of compound **4** (0.004 mole) in dioxane (30 ml) containing Et_3N (0.5 ml) was added malononitrile (0.004 mole). The reaction mixture was refluxed for 3 hr, cooled and poured into ice-water mixture and neutralized with dilute HCl. The separated solid was collected by filteration and crystallised from dioxane (Table I) .

Synthesis of bis[4-hydroxythieno(3,2-d)pyrimidine] 7

A mixture of compound **1** (0.005 mole) and formamide (20 ml) was refluxed for 4 hr. The reaction mixture was cooled and the precipitate was filtered off and recrystallised from ethanol (Table I).

Synthesis of bis[4-chlorothieno(3,2-d)pyrimidine] 8

A mixture of compound **7** (0.005 mole), phosphorus pentachloride (0.006 mole) and phosphorus oxychloride (4 ml) was refluxed for 3hr. After cooling the mixture was poured carefully over ice and ammonia solution. The solid product was filtered off and recrystallised from benzene (Table I)

Synthesis of bis[4-hydrazinothieno(3,2-d)pyrimidine] 9

A solution of compound **8** (0.005 mole) and hydrazine hydrate (2 ml) in ethanol (20 ml) was refluxed for 2hr. On cooling the solid product was filtered off and recrystallised from ethanol (Table I).

Synthesis of compound 11

A mixture of compound **1** (0.01 mole) CS_2(0.025 mole) and NaOH (0.03 mole in 10 ml water) in DMF (30 ml) was stirred for 4 hr and then added 1,2-dibromoethane (0.02 mole) dropwise and NaOH (0.03 mole in 10 ml water) and the mixture was stirred again for 4 hr. The reaction mixture was poured into ice cold water (300 ml). The resulting solid mass was filtered, washed with ether and water successively, dried and recrystallised from aq. ethanol (Table I).

Synthesis of compound 12

To an ice cold solution of compound **11** (0.005 mole) and triethylamine (0.012 mole) in dry dioxane (30 ml) was added chloroacetyl chloride (0.01 mole) dropwise. The solution was stirred for 6 hr. The reaction mixture was concentrated in *vacuo* and poured into water. The resulting solid mass was filtered, washed and recrystallised from aq. ethanol (Table I).

Synthesis of compound 13

A mixture (0.005 mole) of compound **11** and mercaptoacetic acid (0.011 mole) in dioxane (30 ml) was refluxed for 6 hr. The reaction mixture was concentrated, poured into water. The separated solid was collected by filtration, washed with $NaHCO_3$ solution and water successively, dried and recrystallised from aq. ethanol (Table I).

Synthesis of compound 14

To a vigorously stirred solution of compound **1** (0.02 mole) in DMSO (10 ml) at room temperature were added CS_2 (0.052 mole) and aq. solution of NaOH (2.4 ml, 20 M). After stirring for 30 min., the reaction mixture was cooled in ice-bath (5–10°C) and dimethyl sulphate (0.05 mole) was added with stirring. The stirring was continued for additional 3 hr. and thereafter the reaction mixture was poured into ice-water mixture (500 ml). The separated solid was filtered, dried and crystallised from ethanol (Table I).

Synthesis of compound 15

To a refluxing solution of compound **14** (0.01 mole) in ethanol (30 ml) was added hydrazine hydrate (0.2 mole) dropwise. After the addition was over, the reaction mixture was further refluxed for 3 hr. On cooling, the solid that separated out was filtered, washed with ethanol and recrystallised from ethanol / chloroform (Table I).

Synthesis of compounds 16 and 17

General procedure

A mixture of compound **15** (0.005 mole) and LR (0.01 mole) was refluxed in dry toluene (60 ml) for 12 hr. The precipitate was collected by filtration and crystallised from ethanol where compound **16** was obtained. The filtrate was concentrated and the separated solid was filtered off, crystallised from dioxan affording compound **17** (Scheme 2, Table I).

Synthesis of compounds 18

To an ice cold solution of compound **15** (0.01 mole) in DMF (45 ml) was added NaOH (0.02 mole) and the mixture was stirred for 30 min. To this was added dimethyl sulphate (0.02 mole) dropwise with stirring. After the addition was complete the reaction mixture was further stirred for additional 2 hr at room temperature. The reaction mixture was poured into ice-water mixture and the separated solid was filtered, washed, dried and recrystallised from ethanol/chloroform (Table I).

Synthesis of compound 19

A mixture of compound **18** (0.01 mole) and aniline (0.04 mole) was refluxed for 30 hr in an oil bath. The reaction mixture was then cooled to room temperature and poured in dil aq. HCl solution. The solid separated was filtered, washed with water, dried, washed with pet. ether (40–60°C) and recrystallised from benzene (Table I).

Synthesis of compounds $20_{a,b}$

General procedure

Compound **19** (0.005 mole) and (0.01 mole) of acetylacetone or ethyl acetoacetate were mixed with polyphosphoric acid (6 ml). The reaction mixture was heated at 70°C for an hour. After cooling, water (30 ml) was added and the mixture was neutralized with Na_2CO_3. The solid formed was filtered and recrystallised from DMF (Scheme 3, Table I).

Synthesis of compound 21

A solution of 3,3-dimethylthio-1-phenyl-2-propen-1-one (0.01 mole) and compound **19** (0.005 mole) in acetic acid (30 ml) and water (7 ml) containing a drop of piperidine was refluxed for 8 hr. The reaction mixture was cooled, diluted with water (100 ml) and the precipitated solid was collected by filtration, washed free of acetic acid, dried and crystallised from chloroform/hexane (Table I).

Synthesis of compound 22

A solution of compound **19** (0.003 mole) and ethoxymethylenemalononitrile (0.006 mole) in acetic acid (20 ml) was refluxed for 5 hr. After cooling, the resulting solid product was collected by filtration, washed with water, dried and recrystallised from methanol (Table I).

Synthesis of compounds 23 and 24

General procedure

A mixture of compound **19** (0.003 mole) and LR (0.006 mole) was refluxed in dry toluene (40 ml) for 10 hr. The precipitate was collected by filtration and crystallised from acetic acid where compound **23** was obtained. The filtrate was evaporated *in vacuo*, the residue was triturated with ethanol. The solid material so formed was collected and recrystallised from ethanol affording compound **24**. (Scheme 3, Table I).

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