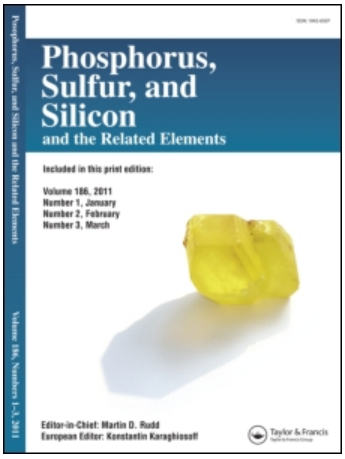

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REACTIONS OF STYRYLTHIENYL KETONE, STYRYL FURYL KETONE WITH THIOCYANOACETAMIDE: SYNTHESIS OF SEVERAL NEW PYRIDINES, THIENO[2,3-b]PYRIDINES, PYRIDO [2',3':4,5]THIENO[3,2-c]PYRIDAZINES AND PYRIDO-[3',2':4,5]THIENO[3,2-d]PYRIMIDIN ONE DERIVATIVES

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REACTIONS OF STYRYLTHIENYL KETONE, STYRYL FURYL KETONE WITH THIOCYANOACETAMIDE: SYNTHESIS OF SEVERAL NEW PYRIDINES, THIENO[2,3-b]PYRIDINES, PYRIDO [2′,3′:4,5]THIENO[3,2-c]PYRIDAZINES AND PYRIDO-[3′,2′:4,5]THIENO[3,2-d]PYRIMIDIN ONE DERIVATIVES

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Styryl thienyl ketone and Styryl furyl ketone **2**a,b reacted with thiocyanoacetamide(**1**) to give the dihydropyridinethiones **3**a,b which used as starting material for the synthesis of several heterocyclic compounds. Reaction with several halogeno-esters, halogeno- ketones and chloroacetamide gave 2-S-alkoyl pyridines **5**a-d, **10**a-d, **13**a,b and **19**a,b thieno[2,3-c] pyridines **6**a,b, **11**a,b **14**a,b and **20**a-d, pyrido[2′,3′,4:5]thieno[2,3-c]pyridazines **8**a,b and pyrido[2′.3′:-4,5]thieno[2,3-d]pyrimidinones **15**a, b **16**a,b and **17**a,b. Structures were established based on elemental analyses and spectral data studies.

INTRODUCTION

In continuation to our effort[1–6] in using of thiocyanoacetamide (**1**) for synthesis of several heterocyclic compounds. The reported biological activity of pyridines and pyridazines; as fungicidal,[7] antiarrhythmic,[8] antibactrial,[9] antipyretics[10] and antitubercular[11] agents, stimulated our interest for the synthesis of several new heterocyclic derivatives of these ring systems, the reactions of pyridinethiones **3**a,b with chloroacetone, α-chloroacetylacetone, chloroethylacetate, α-chloroethyl acetocetate, chloroacetamide and

ω-bromoacetophenones gave the corresponding 2-S-alkyl derivatives **5**a-d, **10**a-d, **13**a,b and **19**a,b which could be cyclized in ethanolic potassium hydroxide to give several new thieno[2,3-b]pyridines. Some of these thieno[2,3-b]pyridines were used to build new ring systems which fornulated as pyridothienopyridazine derivatives **8**a,b and pyridothienopyrimidinone derivatives **15**-**17**a,b.

RESULTS AND DISCUSSION

It has been found that thiocyanoacetamide (**1**) reacted with both styryl thienyl ketone (**2**a) and styryl furyl ketone (**2**b) in ethanol containing the catalytic amounts of triethylamine to afford the corresponding new dihydropyridinethione derivatives **3**a,b. The IR (cm^{-1}) of each **3**a,b showed the presence of NH (3200) and CN(2220). Their ^{1}H-NMR(δ ppm) revealed signals corresponding to pyridine H-5, thienyl, furyl and aromatic protones (c.f. table II). Moreover, the mass spectra of **3**a,b gave m/z=294 and 278 respectively which corresponded to the molecular weights of formulae $C_{16}H_{10}N_2S_2$ and $C_{16}H_{10}N_2SO$ of the assigned structures **3**a,b (c.f. Chart 1).

TABLE I Characterization data of the newly synthesized compounds

Comp	*solvent of cryst.*	*m.p. (°C)*	*yield (%)*	*Molecular formula*	*% of analysis (calc./found.)*				
					C	*H*	*N*	*S*	*Cl*
3a	Acetic acid	240	80	$C_{16}H_{10}N_2S_2$	65.3 65.5	3.40 3.4	9.52 9.6	21.77 21.8	--- ---
3b	Acetic acid	185	85	$C_{16}H_{10}N_2SO$	69.06 69	3.60 3.6	10.07 10.1	11.51 11.6	--- ---
5a	ethanol	190	74	$C_{19}H_{14}N_2S_2O$	65.14 65.2	4.00 4.1	8.00 8.0	18.29 18.3	--- ---
5b	Ethanol	210	70	$C_{19}H_{14}N_2SO_2$	68.26 68.3	4.19 4.2	8.38 8.4	9.58 9.5	--- ---
5c	Ethanol	150	80	$C_{21}H_{16}N_2S_2O_2$	64.29 64.3	4.08 4.1	9.68 9.7	16.33 16.4	--- ---
5d	Ethanol	130	74	$C_{21}H_{16}N_2SO_3$	67.02 67.1	4.26 4.3	7.45 7.5	8.51 8.6	--- ---

Comp	solvent of cryst.	m.p. (°C)	yield (%)	Molecular formula	% of analysis (calc./found.)				
					C	H	N	S	Cl
6a	DMF	290	70	$C_{19}H_{14}N_2S_2O$	65 14	4.0	8.00	18.29	---
					65.2	4.0	8.0	18.3	---
6b	Acetic acid	160	70	$C_{19}H_{14}N_2SO_2$	68.26	4.19	8.38	9.58	---
					68.3	4.2	8.3	9.6	---
8a	Ethanol	90 dec.	80	$C_{19}H_{11}N_3S_2O$	63.16	3.05	11.64	17.73	---
					63.2	3.1	11.7	17.8	---
8b	Ethanol	70 dec.	75	$C_{19}H_{11}N_3SO_2$	66.09	3.19	12.17	9.28	---
					66.1	3.2	12.2	9.3	---
10a	Acetic acid	190	60	$C_{20}H_{16}N_2S_2O_2$	63.16	4.21	7.37	16.84	---
					63.2	4.2	7.4	16.9	---
10b	Acetic acid	150	65	$C_{20}H_{16}N_2SO_3$	65.93	4.40	7.69	8.79	---
					66.0	4.4	7.7	8.8	---
10c	Ethanol	140	70	$C_{22}H_{18}N_2S_2O_3$	62.56	4.27	6.64	15.17	---
					62.6	4.3	6.7	15.2	---
10d	Ethanol	160	65	$C_{22}H_{18}N_2SO_4$	65.02	4.43.	6.90	7.88	---
					65.1	4.4	70	7.9	---
11a	DMF	300–1	60	$C_{20}H_{16}N_2S_2O_2$	63.16	4.21	7.37	16.84	---
					63.2	4.2	7.4	16.8	---
11b	Acetic acid	260–2	60	$C_{20}H_{16}N_2SO_3$	65.93	4.40	7.69	8.79	---
					66.0	4.4	7.7	8.7	---
13 a	Ethanol	210–1	75	$C_{18}H_{13}N_3S_2O$	61.54	3.70	11.97	18.23	---
					61.6	3.7	12.0	18.3	---
13b	Ethanol	250	78	$C_{18}H_{13}N_3SO_2$	64.48	3.88	12.54	9.55	---
					64.5	3.9	12.5	9.6	---
14a	Ethanol	195	75	$C_{18}H_{13}N_3S_2O$	61.54	3.70	11.97	18.23	---
					61.5	3.7	11.9	18.2	---
14b	Ethanol	205	80	$C_{18}H_{13}N_3SO_2$	64.48	3 88	12.54	9.55	---
					64.5	3.9	12.5	9.6	---
15a	Ethanol	>300	60	$C_{19}H_{11}N_3S_2O$	63.16	3.05	11.63	17.73	---
					63.2	3.1	11.6	17.7	---
15b	ethanol	>300	65	$C_{19}H_{11}N_3SO_2$	66.09	3.19	12.17	9.28	---
					66.1	3.2	12.2	9.3	---
16a	DMF	270	78	$C_{20}H_{13}N_3S_2O$	64.00	3.47	11.20	17.07	---
					64.0	3.5	11.2	17.1	---
16b	Acetic acid	250	75	$C_{20}H_{13}N_3SO_2$	66.85	3.62	11.70	8.91	---
					66.9	3.6	11.7	8.9	---
17a	Ethanol	220	68	$C_{19}H_{11}N_3S_3O$	58.02	2.80	10.69	24.43	---
					58.0	2.8	10.7	24.4	---

Comp	solvent of cryst.	m.p. (°C)	yield (%)	Molecular formula	% of analysis (calc./found.)				
					C	H	N	S	Cl
17b	Ethanol	290	65	$C_{19}H_{11}N_3S_2O_2$	60.48 60.5	2.92 3.0	11.14 11.1	16.98 17.0	--- ---
19a	Ethanol	210	80	$C_{24}H_{16}N_2S_2O$	69.9 70.0	3.88 3.9	6.80 6.8	15.53 15.5	--- ---
19b	Ethanol	260	85	$C_{24}H_{16}N_2SO_2$	72.73 72.7	4.04 4.1	7.07 7.1	8.08 8.1	--- ---
20a	Ethanol	160	70	$C_{24}H_{16}N_2S_2O$	69.90 69.8	3.88 3.9	6.80 6.8	15.53 15.6	--- ---
20b	Ethanol	180	70	$C_{24}H_{16}N_2SO_2$	72.73 72.8	4.04 4.0	7.07 7.0	8.08 8.0	--- ---
20c	Ethanol	140	78	$C_{24}H_{15}N_2S_2OCl$	64.50 64.5	3.36 3.4	6.27 6.3	14.33 14.4	7.95 8.0
20d	Ethanol	190	70	$C_{24}H_{15}N_2SO_2Cl$	66.90 67.0	3.48 3.5	6.50 6 5	7.43 7.5	8.25 8.3

TABLE II IR and ^{1}HNMR spectral data

Comp.	IR(cm^{-1})	^{1}H-NMR(δ ppm)
3a	3180 (NH); 3060 (aromatic CH); 2970(aliphatic CH); 2217 (CN) and 1600 (C=C).	5.4(s, br., 1H. NH); 6.6(s, 1H,pyridine H-5) and 7.2–7.9(m, 8H, ArH's and thienyl protons)
3b	3185 (NH); 3070 (aromatic CH); 2970(aliphatic CH); 2213 (CN) and 1600 (C=C).	5.3(s, br., 1H, NH) ; 6.2(s, 1H, pyridine H-5) and 7.1–7.8(m, 8H, ArH S and furyl protons).
5a	3070 (aromatic CH); 2970(aliphatic CH); 2218 (CN); 1720 (ketonic CO) and 1600 (C=C).	2.0(s, 3H, CO$\underline{CH_3}$); 3.2(s,2H, S-$\underline{CH_2}$-): 6.5(s, 1H, pyridine H-5) and 7.1–8.0(m,8H, ArH's and thienyl protons).
5d	2970(3080 (aromatic CH); aliphatic CH): 2220 (CN); 1700 (acetyl CO) and 1600 (C=C).	2.2(s,6H, S-CH(CO$\underline{CH_3}$)$_2$3.2(s, 1H, S-$\underline{CH}$-) ; 6.3(s, 1H,pyridine H-5) and 7.0–7.9(m, 8H, ArH's and furyl protons).
6a	3480,3290 (NH_2): 3050 (aromatic CH); 2970 aliphatic CH): 1650 (acetyl CO) and 1600 (C=C)	2.3(s, 3H, CO$\underline{CH_3}$); 5.8(s, br., 2H. NH_2-); 6.5(s. 1H. pyridine H-5) and 7.0–7.9(m, 8H, ArH S and thienyl protons).
8b	3225 (OH); 3070 (aromatic CH); 2950 aliphatic CH); 1625 (N=N) and 1600 (C=C).	3.4(s, 1H, pyridazine H-3); 6.4(s, 1H. pyridine H-5); 7.0-8.2(m, 8H, ArH′ and furylprotons) and 12.0(s, 1H. OH).

Comp.	*IR(cm^{-1})*	*^{1}H-NMR(δ ppm)*
10a	3070(aromatic CH); 2970 aliphatic CH); 2220(CN); 1730(ester CO) and 1600 (C=C).	1. l(t. 3H. $CH_2\underline{CH_3}$): 4. 1(q.2H, $CH_2\underline{CH_3}$); 4.4(s, 2H, S-$\underline{CH_2}$). 6.6(s. 1H. pyridine H-5): 7.0–8.2(m. 8H. ArH's and thienyl protons)
10d	3065(aromatic CH): 2980 aliphatic CH): 2215(CN); 1725(ester CO) and 1680 (acetyl CO) and 1600(C=C).	1.0(t, 3H, $CH_2\underline{CH_3}$): 2.3(s, 3H. $CO\underline{CH_3}$): 3.2(s. 1H, S$\underline{CH}$): 4.0(q. 2H. $\underline{CH_2}CH_3$); 6.4(s, 1H, pyridine H-5): 7.0-8.2(m. 8H. ArH's and furyl protons)
11b	3480,3370 (NH_2); 3070 (aromatic CH); 2980 aliphatic CH): 1680 (ester CO)and 1600 (C=C).	1.0(t, 3H, $CH_2\underline{CH_3}$); 4. 1(q, 2H, $\underline{CH_2}CH_3$); 5.7(s, br., 2H, NH_2): 6.5(s, 1H. pyridine H- 5): 7.0–8.1(m. 8H. ArH's and furyl protons)
13a	3380,3185 (NH_2); 3080 (aromatic CH); 2960 aliphatic CH): 2215(CN); 1660 (amidic CO) and 1600 (C=C).	4.0(s, 2H, S-CH_2): 5.6(s. br.,2H, NH_2); 6.6(s, 1 H, pyridine H-5); 7.0–8.2(m, 8H. ArH's and thienyl protons)
14b	3490, 3475, 3315, 3182(two NH_2): 3070(aromatic CH); 2980(aliphatic CH); 1670 (amidic CO)and 1600(C=C).	5.2(s, br., 2H. NH_2): 5.6(s, br., 2H, $CONH_2$): 6.6(s, 1H, pyridine H-5): 7.0–8.2(m, 8H, ArH's and furyl protons)
15a	3185(NH); 3040(aromatic CH); 2970(aliphatic CH): 1660(pyrimidinone CO) and 1600(C=C).	6.2(s, br., 1H. NH): 6.6(s, 1H, pyridine H-5) and 7.0–8.2(m, 9H, thienyl, aromatic and pyrimidinone H-2 protons).
16a	3165(NH); 3070(aromatic CH); 2960(aliphatic CH); 1660(pyrimidinone CO) and 1600(C=C)	1.3(s. 3H, CH_3); 6.2(s. br., 1H, NH); 6.6(s, 1H, pyridine H-5) and 7.0–8.2(m. 8H. aromatic and thienyl protons).
17b	3380, 3340(two NH) 3070 (aromatic CH); 2970(aliphatic CH); 1690(pyrimidinone CO) and 1600(C=C).	5.3(s, br., 1H, NH): 6.5(s, 1H. pyridine H-5); 7.0–8.1(m, 8H, ArH's and furyl protons) and 9.8(s. br., 1H.NH).
19a	3065(aromatic CH); 2970 (aliphatic CH); 2214(CN); 1697(aroyl CO) and 1600 (C=C)	3.1(s. 2H, S-$\underline{CH_2}$); 6.0(s, 1H, pyridine H-5) and 6.9–7.8(m, 13H. ArH'sand thienyl protons)
20b	3480, 3290(NH_2) 3080 (aromatic CH); 2975(aliphatic CH); 1700(aroyl CO) and 1 600(C=C).	6.2(s. 1H. pyridine H-5); 6.8 (s, br., 2H. NH_2) and 7.2-8.1(m. 13H, ArH's and furyl protons).
20d	3479, 3295(NH_2) 3070 (aromatic CH); 2979(aliphatic CH); 1690(aroyl CO) and 1600(C=C).	6.0(s. 1H, pyridine H-5); 6.8 (s, br., 2H. NH_2) and 7.1-8.2(m, 12H, ArH's and furyl protons).

The dihydropyridinethione derivatives **3**a,b could be used as a good and reactive starting material for the present study. Thus, it has been found that the 3-cyano-4-(2′-thienyl)-6-phenyl pyridinethione (**3**a) reacted with both chloroacetone (**4**a′) and α-chloroacetylacetone (**4**b) in methanolic sodium methoxide to give products formed through the loss of hydrogen chloride

whicl could be formulated as 2 -S-acetonylpyridine -thione derivative **5**a and 2-S-diacetylmethylpyridinethione **5**c. The structures of **5**a,c were proved using both elemental analyses, IR(cm^{-1}) and[1] H-NMR (δ ppm) spectroscopy(c.f. Tables I and II).

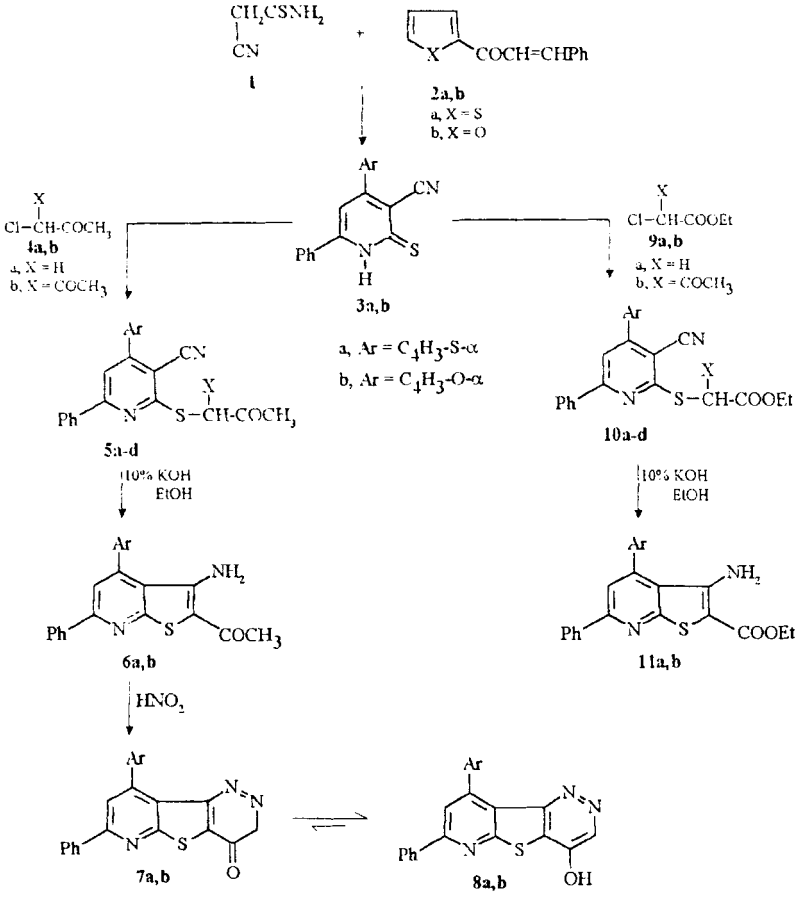

CHART 1

A further proof of **5**a,c structures was achieved through their cyclization in ethanolic solution of potassium hydroxide to give one product **6**a. The structure of **6**a was established based on both elemental analyses and spec-

tral data studies (c.f. Table s I and II). Moreover, its mass spectrum gave m/z=350 which corresponded to the exact nolecular weight of a molecular formula.$C_{19}H_{14}N_2S_2O$. Considering all the above data, compound **6**a was formulated as 2-acetyl-3-amino-5-(2′-thienyl)-7-phenyl thieno[2,3 -b]pyridine. The cyclization of **5**c to give the corresponding **6**a most probably proceeded through the initial addition of the anions from the S-$\underline{CH}(COCH_3)_2$ on the CN group to give the non-isolable 2,2-diacetyl-3-iminothieno[2,3 -b]pyridine The non-isolable product added one molecule of water to give acetic acid and **6**a.

The structure of **6**a was finally proved through its cyclization with nitrous acid to give pyrido[2′,3′:4,5]-thieno[3,2-c]pyridazinol **8**a rather than pyrido[2′,3′:4,5] thieno [3,2-c]pyridazinone **7**a. The structure of 8a was proved based on elemental analyses, spectral data studies(c.f. Table Iand II) and the intense blue coloration given with $FeCl_3$ solution was supported to **8**a rather than **7**a (c.f. chart I).

In a similar way 3-cyano-4-(2′-furyl)-6-phenylpyridinethione(**3**b) reacted with both chloroacetone and α-chloroacetylacetone **4**a,b respectively to give 2-S-acetonylpyridinethione (**5**b) and 2-S-diacetylmethylpyridinethione (**5**d) respectively Compounds **5**b,d could also, be cyclized in ethanolic solution of potassium hydroxide to give the corresponding thieno[2,3-b]pyridine **6**b which reacted also with nitrous acid to give the corresponding pyrido [2′,3′:4,5]thieno[3,2-c]pyridine **8**b. The structures of **5**b,d, **6**b and **8**b were established based on both elemental analyses and spectral studies (c.f. chart I, Tables I and II),

The work was extended to explore the synthetic potential of **3**a,b via their reactions with some halogenated ester. Thus, compounds **3**a,b reacted with chloroethyl acetate (**9**a) to give products formed via the loss of hydrogen chloride. The IR (cm^{-1})of these reaction products showed both CN (2218) and CO ester (1715) Their ^{1}H-NMR (δppm) revealed signals corresponded to COO$\underline{CH_2}\underline{CH_3}$, S-$\underline{CH_2}$, pyridine H-5, thienyl,furyl and aromatic protons (c.f. Table II). Considering all the above data, these reaction products were formulated as 2-S-methylethoxycarbonylpyridine derivatives **10**a,b. Moreover, the mass spectra of **10**a,b gave m/z =380 and 364 which corresponded to the exact molecular weights of the molecular formulae $C_{20}H_{16}N_2S_2O_2$ and $C_{20}H_{16}N_2SO_3$ of the assigned structures **10**a and **10**b respectively (c.f. chart 1). An additional evidence for structures **10**a,b as given through their cyclization with 10% ethanolic solution of potassium hydroxide. The IR (cm^{-1}) of

the cyclization products showed surprisingly the absence of CN group and their ^{1}H-NMR (6 ppm) revealed no signals corresponding to S-$\underline{CH_2}$ protons. This proved that both S-CH_2 and CN groups were involved in the cyclization step. Considering all the above data, the reaction products were formulated as thieno[2,3-b]pyridine derivatives **11**a,b.

In a similar manner, compounds **3**a,b reacted with α-chloroethylacetoacetate (**9**b) to give products formed via the loss of hydrogen chloride. The structures of these reaction products were formulated as 2-S-ethoxycarbonyl acetylmethylpyridine derivatives **10**c,d.

The structures of **10**c,d were established based oil elemental analyses, IR and ^{1}H-NMR spectral data(c.f. Tables I and II). Moreover, the mass spectra of **10**c,d gave m/z = 422 and 406 which represent the molecular weights of the molecular formulae $C_{22}H_{18}N_2S_2O_3$ and $C_{22}H_{18}N_2SO_4$ of the assigned structures (c.f. chart 1).

Compounds **10**c,d were cyclized in 10 % ethanolic solution of KOH to yield **11**a,b. The cyclization of 10c,d involved the initial addition of the anions from the S-CH to the CN group to give the non-isolable 3-imino-5-(2-thienyl or 2′-furyl)-7-phenylthieno-[2,3-b]pyridines. These nonisolable products added one molecule of water to give **11**a,b which are identical in all aspects (IR, ^{1}H-NMR, elemental analysis, m.p. and mix. m.p.) with that given from the cyclization of **10**a,b (c.f. chart 1, Tables I and II).

Furthermore compound **3**a reacted with chloroacetamide (**12**) to give a product formed via the loss of hydrogen chloride The IR (cm^{-1}) of this reaction product showed CN (2220), NH_2(3420, 3350) and amidic CO(1690). The ^{1}H-NMR(δppm) spectrum of this reaction product revealed the signals of S-$\underline{CH_2}$ and $\underline{NH_2}$ protons. Moreover, its mass spectrum gave m/z =351 which corresponded to the molecular weight of the molecular formula $C_{18}H_{13}N_3S_2O$. Based on the above data, the structure of this reaction product was formulated as the 2-S-methyl formamidopyridine derivative **13**a. The other analog **3**b also, reacted with chloroacetamide(**12**) to give **13**b. The structures of the **13**a,b were established based on IR, ^{1}H-NMR and elemental analyses (c.f. Tables I, II and chart 2). Compounds **13**a,b were cyclized in 10% ethanolic KOH solution. The IR(cm^{-1}) of these cyclization products showed the absence of CN group and instead the newly born bands of NH_2were detected. Their ^{1}H-NMR spectra revealed no signals of S-$\underline{CH_2}$ protons and instead the newly born signals of NH_2 protons were detected. Considering all the above facts,

these reaction products were formulated as 2-formamido-3-aminothieno[2,3-b]pyridine derivatives **14**a,b. (cf. Tables I and II).

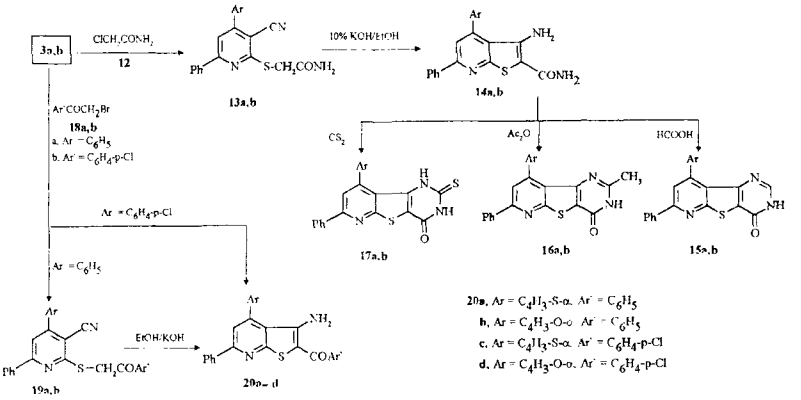

CHART 2

The enaminoamidic moiety in **14**a,b seemed to be an excellent candidate for the synthesis of the other heterocyclic derivatives which were expected to be difficult to obtain via other routs. Thus, it was found that compounds **14**a,b reacted with anhydrous formic acid to give the corresponding pyrido[2′,3′:4,5]thieno[3,2-d]pyrimidine-2-one **15**a,b. The structures of **15**a,b were proved based on ^{1}H-NMR, IR and elemental analyses (cf. Tables I, II and chart 2). Moreover, the mass spectra of **15**a,b gave m/z=361 and 345 respectively and these represented the exact molecular weights of the molecular formulae $C_{19}H_{11}N_3S_2O$ and $C_{19}H_{11}N_3SO_2$ respectively of the assigned structures (cf. chart 2).

Furthermore, each of compound **14**a,b reacted with both acetic anhydride and carbon disulfide to give the reaction products **16**a,b and **17**a,b respectively. The IR(cm^{-1}) of each of **16**a,b and **17**a,b showed the presence of NH, CO and C=S groups. The ^{1}H-NMR spectra revealed signals corresponded to NH protons in addition to pyridine H-5, thienyl, furyl and aromatic protons (cf. Tables I and II). Moreover, mass spectra of **16**a and **17**b gave m/z=375 and 377 which represented the exact molecular weights of the molecular formulae $C_{20}H_{13}N_3S_2O$ and $C_{19}H_{11}N_3S_2O_2$ respectively of the assigned structures (cf. chart 2).

The synthons **3**a,b reacted also with phenacyl bromide derivatives 18a,b. Each of **3**a,b reacted with **18**a to give products formed via the loss of hydrogen bromide. The IR(cm^{-1}) of these reaction products showed the bauds corresponded to the CN and CO groups. The ^{1}H-NMR revealed the signals corresponded to pyridine H-5, S-$\underline{CH_2}$, thienyl, furyl and aromatic protons. These reaction products were formulated as 2-S-methylaroylpyridinethione derivatives **19**a,b (cf. Tables I, II and chart 2).

A further confirmation of **19**a,b structures was achieved via their cyclization in 10% ethanolic KOH to give the corresponding thieno[2,3-b]pyridine derivatives **20**a,b: The structures of **20**a,b were established based on ^{1}H-NMR, IR, and elemental analyses (cf. Tables I and II). It is remarkable to report here that p-chlorophenacyl bromide (**18**b) reacted with each of **3**a,b to give directly the corresponding thieno[2,3-b] pyridine derivatives **20**c,d. All attempts to isolate the corresponding 2-S-methylaroyl pyridinethiones **19**c,d are failed. The IR(cm^{-1}) of each of **20**c,d showed the presence of bands corresponding to CO(ketonic) and NH_2.

Their ^{1}H-NMR (δppm) revealed signals corresponding to pyridine H-5. thienyl. furyl, NH_2 and aromatic protons. Moreover, the mass spectra of **20**c,d gave m/z=446 and 430 respectively which corresponded to the molecular formulae $C_{24}H_{15}N_2S_2OCl$ and $C_{24}H_{15}N_2SO_2Cl$ of the assigned structures **20**c and **20**d respectively(cf. chart 2).

EXPERIMENTAL

All melting points are uncorrected. The IR spectra in KBr discs were recorded on Perkin-Elmer FT-IR type 4 and Pye Unicam SP −1100 spectrophotometer. The ^{1}H-NMR spectra were recorded on Varian EM 390–90 MHz. Gemini 200, Varian NMR spectrophotometer (200 MHz) and Brucker WP-80 spectrometers using $CDCl_3$, DMSO-d6 and $(CD_3)_2CO$ as solvents and TMS as an internal standard. Chemical shifts are expressed as δppm units. Mass spectra were recorded on Hewlett-Packard GC-MS type 2988 series A using DIP technique at 70 eV. Microanalyses were performed at the Microanalytical Center Of Cairo University using Perkin-Elmer 2400 CHN Elemental Analyzer.

Synthesis of 3a,b

A mixture of thiocyanoacetamide (1) (0.01 mole) and thienyl-styryl ketone **2**a (0.01 mole) or furyl-styryl ketone (**2**b) in absolute ethanol (50 mL) con-

taining the catalytic amounts of triethylamine(0.5 mL) was heated under reflux for 8 hours. The reaction mixture was then diluted with water and the solid products were collected by filtration and recrystallized from acetic acid to give **3**a,b respectively (cf. Tables I&II).

Synthesis of 5a-d, 10a-d, 13a,b, 19a,b and 20c,d (general procedure)

A solution of each of **3**a,b(0.01 mole) and chloroacetone(**4**a), α-chloroacetylacetone(**4**b), chloroethylacetate(**8**a), α-chloroethylacetoacetate(**8**b), chloroacetamide(**12**), phenacyl bromide(**18**a) or p-chlorophenacyl bromide (**18**b)(0.01 mole) was heated under reflux in methanolic sodium methoxide (0.01 atom of sodium metal in 30 mL methanol) for 3 hours. The reaction products, obtained from hot solutions or after cooling, were filtered off and recrystallized from the proper solvent to yield **5**a-d, **10**a-d, **13**a,b, **19**a,b and **20**c,d respectively (cf. Tables I and II).

Synthesis of 6a,b, 11a,b, 14a,b and 20a,b (general procedure)

A solution of each of **5**a-d, **10**a-d, **13**a,b or **19**a,b (0.01 mole in ethanol (30 mL) was heated under reflux for 5 hours with 10% KOH(≅ 0.02 mole). The reaction mixture was then cooled, acidified with dilute HCl and the precipitated solid products were filtered off, washed with water, and then recrystallized from the proper solvent to yield **6**a,b, **11**a,b, **14**a,b and **20**a,b respectively (cf. Tables I and II).

Synthesis of 8a,b

A solution of each of **6**a,b(0.01 mole) in concentrated HCl(1 mL) was treated with a cold saturated solution of sodium nitrite(0.02 mole) and then stirred in an ice-cold bath for 1 hours. The solid products obtained were filtered off, washed with water and then recrystallized from the proper solvents to yield 8a,b respectively (cf Tables I and II).

Synthesis of 15a,b and 16a,b

A solution of each of 14a,b(0.01 mole) and formic acid(30 mL) or acetic anhydride(30 mL) was heated under reflux for 5 hours. The solid products,

obtained after cooling ere filtered off and then recrystallized from ethanol to yield **15**a,b and **16**a,b respectively (cf. Tables I and II).

Synthesis of 17a,b

A solution of each of **14**a,b(0.01 mole) in pyridine(30mL) was treated with carbon disulfide(0.01 mole) and then heated under reflux for 4 hours. The reaction mixture was cooled, poured onto ice-cold water and acidified by dilute HCl. The solid product obtained were filtered off and recrystallized from ethanol to yield **17**a,b respectively (cf. Tables I and II).

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