Reaction of Nitriles Under Acidic Conditions. Part III. A Facile Synthesis of Thienopyrimidin-4(3*H*)-ones

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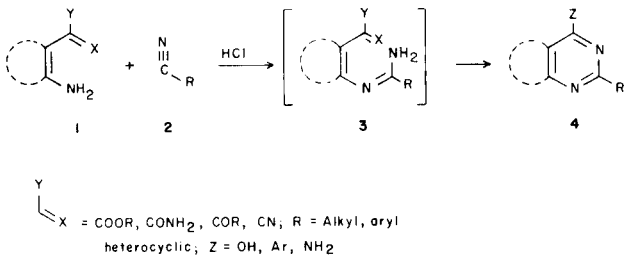
Received July 26, 1983

A variety of thiophene *o*-aminoesters were reacted with cyanates, thiocyanates, cyanamides, acyl cyanides and α-functionalized acetonitrile derivatives to yield the corresponding 2-substituted thienopyrimidin-4(3*H*)-ones.

J. Heterocyclic Chem., **21**, 375 (1984).

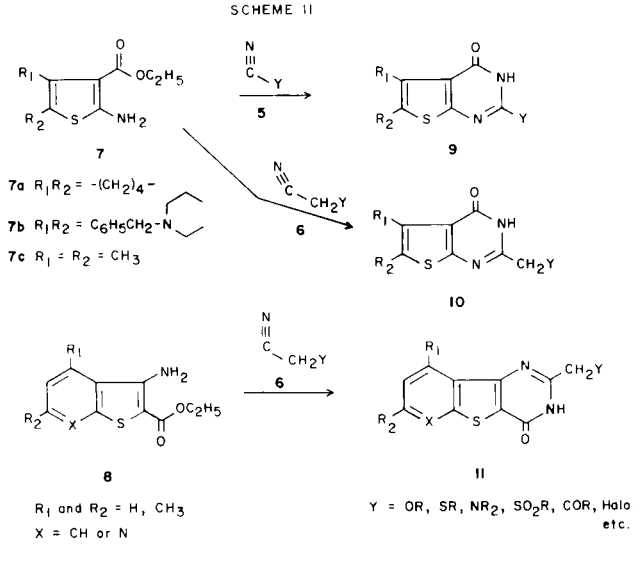
Earlier, a general method of synthesis of condensed pyrimidines has been reported from this laboratory. The method involves the condensation of an *o*-aminocarbonyl compound **1**, such as *o*-aminoketone, ester, amide or a nitrile with an aliphatic, aromatic or heterocyclic nitrile **2** in the presence of dry hydrogen chloride gas [1,2]. The highly reactive nitrilium or imidoyl halide derivatives formed from the nitrile under the acidic conditions employed, presumably, yield the α-functionalized amidines **3** which cyclize intramolecularly to the corresponding condensed pyrimidines **4** (Scheme I).

SCHEME I



A variety of cyanates, thiocyanates, cyanamides, acyl cyanides and α-functionalized acetonitrile derivatives are readily accessible and these are known to undergo addition reactions with nucleophiles under acid catalysis. Therefore, the condensation of these nitrile derivatives with *o*-aminocarbonyl compounds should, in principle, directly lead to the corresponding 2-substituted pyrimidines. Herein, we report the synthesis of 2-substituted- and 2-substituted methyl thienopyrimidin-4-ones **9**, **10**, and **11**, by the reaction of cyanates, thiocyanates, cyanamides **5** and α-functionalized acetonitriles **6** with thiophene *o*-aminoesters **7** and benzo-, and pyridothiophene aminoesters **8** (Scheme II).

SCHEME II

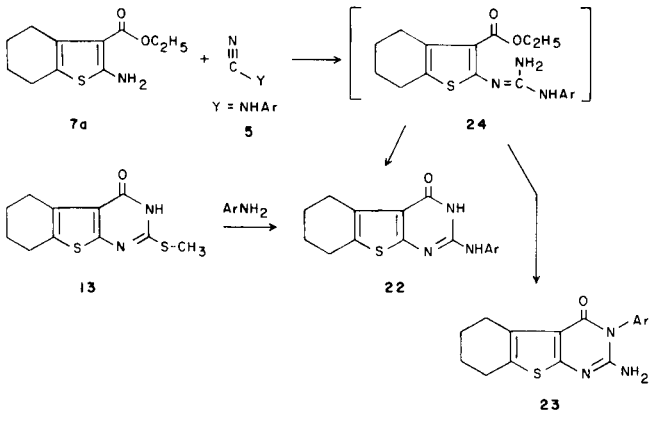


The condensation of phenyl cyanate with aminoester **7a**, in the presence of dry hydrogen chloride gas yielded 2-phenoxythienopyrimidin-4(3*H*)-one **12**, in good yield. Similarly, alkyl and aryl thiocyanates were reacted with **7a** and **7b** to obtain 2-alkylthio and arylthiothienopyrimidin-4(3*H*)-ones **13-17**. Potassium thiocyanate, when reacted with **7a**, afforded 2-mercaptothieno[2,3-*d*]pyrimidin-4(3*H*)-one **18**, identical with the product obtained by the fusion of **7a** with thiourea [3].

Cyanamide, when reacted with **7a**, under similar conditions, yielded 2-aminothieno[2,3-*d*]pyrimidin-4(3*H*)-one **19**, obtained earlier by the reaction of cyanamide with 2-amino-3-carboxamido-4,5,6,7-tetrahydrobenzo[*b*]thiophene in the presence of pyridine hydrochloride at elevated temperature [4].

Similarly, the *N,N*-disubstituted cyanamide, *N*-cyanomorpholine, when reacted with **7a** and **7c**, yielded the 2-morpholinothieno[2,3-*d*]pyrimidin-4(3*H*)-ones **20** and **21**, respectively (Table 1). The condensation between **7a** and *N*-monosubstituted cyanamides should, in principle, give rise to 2-substituted aminothieno[2,3-*d*]pyrimidin-4(3*H*)-ones **22** or 2-amino-3-substituted thieno[2,3-*d*]pyrimidin-4(3*H*)-ones **23**, by the two possible modes of cyclization of the guanidine intermediates **24** (Scheme III).

SCHEME III

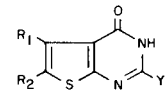


Indeed, isomeric thienopyrimidin-4-ones **25-27** and **29-31** were obtained as the condensation products of aminoester **7a** with *N*-monosubstituted aryl cyanamides **5**. The products obtained by the dilution of the reaction mixture were characterized as 2-amino-3-substituted thieno[2,3-*d*]pyrimidin-4(3*H*)-ones **29-31** (Table 2) and the products obtained by the neutralization of the acidic filtrate were found to be the 2-substituted aminothieno[2,3-*d*]pyrimidin-4(3*H*)-ones **25-27** (Table 1).

While the isomeric thienopyrimidines did not exhibit marked difference in the ultraviolet absorption pattern, the infrared spectra revealed distinct differences in the -NH absorption. 2-Amino-3-substituted thieno[2,3-*d*]pyrimidin-4(3*H*)-ones **29-31** showed stretching frequency corresponding to the primary amino absorption around 3200, 3300 and 3360 cm^{-1}, while isomeric 2-substituted aminothieno[2,3-*d*]pyrimidin-4(3*H*)-ones exhibited only single -NH absorption around 3400 cm^{-1}. The mass spectra of the isomers did not show any significant difference in their degradation patterns. This is not surprising, in view of the fact that the radical initiated cleavage of N3-C4 bond results in identical ions from the isomeric parent ion. While **25** and **26** showed the intense ion peaks at m/e 241, 221 and 180, **29** and **30** revealed ions of high abundance at m/e 240, 220 and 178. The difference in the abundance of the ion of m/e 180 in **25** and **26** and of m/e 178 in **29** and

Table 1

2-Substituted Thieno[2,3-*d*]pyrimidin-4(3*H*)-ones

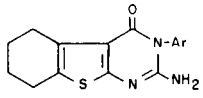


Compound No.	R_1	R_2	Y	Mp °C	% Yield	Recrystallization solvent [a]	Molecular Formula	Molecular Weight	Microanalysis Calcd./Found %C	%H
12	-$(CH_2)_4$-		C_6H_5O-	310-311	70	E-C	$C_{16}H_{14}N_2O_2S$	298 [b]	64.41 64.54	4.73 4.97
13	-$(CH_2)_4$-		CH_3S-	259-260	82	E-C	$C_{11}H_{12}N_2OS_2$	252	52.35 52.49	4.79 4.63
14	-$(CH_2)_4$-		C_2H_5S-	237-239	69	E-C	$C_{12}H_{14}N_2OS_2$	266	54.10 53.85	5.30 5.30
15	-$(CH_2)_4$-		C_6H_5S-	266-267	64	E-C	$C_{16}H_{14}N_2OS_2$	314	61.12 60.77	4.49 4.13
16	-$(CH_2)_4$-		4-$(CH_3)_2N$-C_6H_4S-	266-268	56	M-C	$C_{18}H_{19}N_3OS_2$	357 [b]	60.47 60.13	5.36 5.42
17	-$(CH_2)_2$-N-$(CH_2C_6H_5)CH_2$-		4-$(CH_3)_2N$-C_6H_4S-	243-245	55	E-C	$C_{24}H_{24}N_4OS_2$	448	64.25 64.59	5.39 5.70
18	-$(CH_2)_4$-		HS-	231-233 [c]	60	E-D	$C_{10}H_{10}N_2OS_2$	238	— —	— —
19	-$(CH_2)_4$-		H_2N-	322-323 [e]	68	n-P	$C_{10}H_{11}N_3OS$	221	54.28 54.06	5.01 5.23
20	-$(CH_2)_4$-		Morpholino	338-342 [d]	62	E-C	$C_{14}H_{17}N_3O_2S$	291 [b]	57.71 57.64	5.88 6.23
21	CH_3	CH_3	Morpholino	335-336 [d]	57	B	$C_{12}H_{15}N_3O_2S$	265	54.32 54.67	5.70 6.00
25	-$(CH_2)_4$-		C_6H_5NH-	277-278 [f]	57	E-D	$C_{16}H_{15}N_3OS$	297 [b]	— —	— —
26	-$(CH_2)_4$-		4-$CH_3C_6H_4NH$-	303-304 [h]	45	E-D	$C_{17}H_{17}N_3OS$	311 [b]	65.56 65.25	5.50 5.69
27	-$(CH_2)_4$-		2-ClC_6H_4NH-	333-336	35	Di	$C_{16}H_{14}ClN_3OS$	331.5 [b]	58.16 57.91	4.55 4.25
28	-$(CH_2)_4$-		C_2H_5OCO-	218-220 [g]	66	E-D	$C_{13}H_{14}N_2O_3S$	278	56.10 56.10	5.07 5.17

[a] B = Benzene, C = Chloroform, E = Ethanol, M = Methanol, D = Dimethylformamide, Di = Dioxane, n-P = 1-Propanol. [b] Molecular weight determined by mass spectra. [c] Ref [3], reported mp = 240°. [d] Decomposes. [e] Ref [4], reported mp = 347°. [f] Ref [6], reported mp = 274°, Ref [7], reported mp = 284-286°. [g] Ref [8], reported mp = 219-220°. [h] Ref [6], reported mp = 297°.

Table 2

2-Amino-3-aryl-5,6,7,8-tetrahydrobenzo[*b*]thieno[2,3-*d*]pyrimidin-4(3*H*)-ones

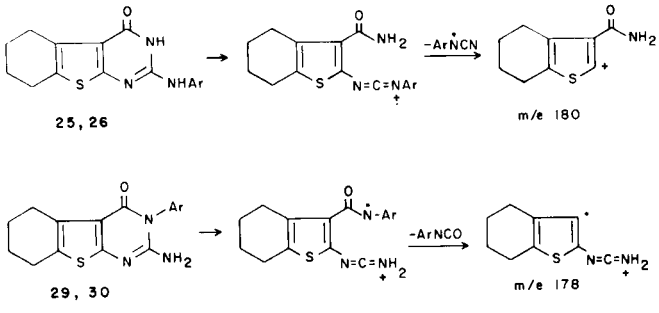


Compound No	Ar	Mp °C	% Yield	Recrystallization solvent [a]	Molecular Formula	Molecular Weight	Microanalysis % C Calcd.	% C Found	% H Calcd.	% H Found
29	C_6H_5-	227-229	20	E-C	$C_{16}H_{15}N_3OS$	297 [b]	64.62	64.46	5.08	5.36
30	4-$CH_3C_6H_4$-	243-245	25	E	$C_{17}H_{17}N_3OS$	311 [b]	65.56	65.53	5.50	5.73
31	2-ClC_6H_4-	283-285	30	E-C	$C_{16}H_{14}ClN_3OS$	311.5	57.91	57.56	4.25	4.45

[a] E = Ethanol, C = Chloroform. [b] Molecular weight determined by mass spectra.

30 may be explained on the basis of the preferential loss of *N*-aryl moiety as Ar-NS:C≡N in **25** and **26** and as Ar-N=C=O in **29** and **30** from the open chain radical cations formed by the C2-N3 bond cleavage of the parent ions as shown in Scheme IV.

SCHEME IV



Moreover, the assignment of structures to **25-27**, received confirmation from their unequivocal synthesis by the reaction of **13** with the corresponding arylamines (Scheme III).

In the reaction of **7a** with aryl cyanamides, it was observed that the yield of 2-substituted aminothieno[2,3-*d*]pyrimidin-4(3*H*)-ones **25-27** were consistently higher than that of the corresponding 2-amino-3-substituted thieno-[2,3-*d*]pyrimidin-4(3*H*)-ones **29-31**. Such isomeric pyrimidine formation has earlier been observed in the condensation of methyl anthranilate with monosubstituted cyanamides [5]. However, a recent publication reports the isolation of 2-arylaminothienopyrimidin-4(3*H*)-ones as the sole product in the condensation of **7a** with aryl cyanamides in the presence of aqueous hydrochloric acid [6].

Ethyl cyanoformate was also found to react normally with **7a** to afford 2-carbethoxythieno[2,3-*d*]pyrimidin-4(3*H*)-one **28**, in good yield. However, the attempted condensation of cyanogen bromide with **7a** gave poor yields of a mixture of products from which the desired 2-bromo-5,6,7,8-tetrahydrobenzo[*b*]thieno[2,3-*d*]pyrimidin-4(3*H*)-one could not be isolated in pure form.

A variety of α-functionalized acetonitrile derivatives **6** such as chloroacetonitrile, aryloxyacetonitriles, arylthioacetonitriles, arylsulfonylacetonitriles, sulfonylaminoacetonitriles, benzoylacetonitrile and ethyl cyanoacetate were found to condense smoothly with the *o*-aminoesters **7** and **8** to yield **32-54** and **55-58** respectively (Table 3 and 4).

Thus, this versatile one pot method of condensation of nitrile derivatives with *o*-aminoesters offers a direct access to the condensed pyrimidin-4-ones of type **9-11**, which are, otherwise, acccessible only through multistep processes.

EXPERIMENTAL

All melting points are uncorrected. Ultraviolet absorption spectra were determined in 95% ethanol or chloroform using Beckman Model 25 spectrophotometer. Infrared spectra were taken in nujol mulls or potassium bromide using Perkin-Elmer 337 Grating spectrophotometer. The nmr spectra were run on a Varian A 60 spectrophotometer. Mass spectra were recorded on Varian Atlas CH-7 mass spectrophotometer at 70 eV ionising beam and using direct insertion probe.

General Procedure for the Preparation of 2-Substituted Thieno[2,3-*d*]-pyrimidin-4(3*H*)-ones and Benzo-, Pyrido- Thieno[3,2-*d*]pyrimidin-4(3*H*)-ones (**12-21, 28, 32-58**).

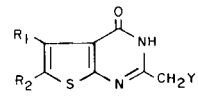
A stream of dry hydrogen chloride gas was passed through a mixture of *o*-aminoester (0.01 mole) and an appropriate nitrile (0.012 mole) in dry dioxane (20 ml) for 4-6 hours. The reaction mixture was poured into ice-water mixture and basified with 10% ammonium hydroxide solution. The precipitate obtained was filtered, dried and crystallized from suitable solvent to obtain the corresponding thienopyrimidin-4(3*H*)-ones. In the reaction of *o*-aminoesters with cyanamides the reaction mixture was refluxed for 4 hours before the dilution with water and usual work up.

Preparation of 2-Arylaminothieno[2,3-*d*]pyrimidin-4(3*H*)-ones (**25-27**) and 2-Amino-3-arylthieno[2,3-*d*]pyrimidin-4(3*H*)-ones (**29-31**).

A stream of dry hyrogen chloride gas was passed through a mixture of 2-amino-3-carbethoxy-4,5,6,7-tetrahydrobenzo[*b*]thiophene-**7a** (0.01 mole) and aryl cyanamide (0.012 mole) in dry dioxane (20 ml) for 4-5 hours, with

Table 3

2-Substitutedmethylthieno[2,3-*d*]pyrimidin-4(3*H*)-ones

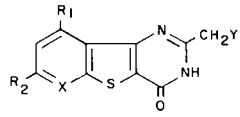


Compound No.	R_1	R_2	Y	Mp °C	% Yield	Recrystallization solvent [a]	Molecular Formula	Molecular weight	Microanalysis Calcd./Found C	H
32	CH_3-	-CH_3	Cl-	246-247	98	E-C	$C_9H_9ClN_2OS$	228.5	47.26	3.97
									47.52	4.19
33	H-	-C_2H_5	Cl-	201-203	95	B	$C_9H_9ClN_2OS$	228.5 [b]	47.26	3.97
									47.49	4.20
34	4-ClC_6H_4-	-H	Cl-	228-230	65	M-C	$C_{13}H_8Cl_2N_2OS$	311.0	50.17	2.59
									50.30	2.91
35	-$(CH_2)_3$-		Cl-	270-272	70	Di	$C_{10}H_9ClN_2OS$	240.5	49.89	3.77
									49.97	3.90
36	-$(CH_2)_2$-N-($CH_2C_6H_5$)CH_2-		4-ClC_6H_4O-	246-247	61	C	$C_{23}H_{20}ClN_3O_2S$	437.5 [b]	63.08	4.60
									63.22	4.83
37	CH_3-	-CH_3	4-ClC_6H_4S-	233-236	59	E-C	$C_{15}H_{13}ClN_2OS_2$	336.5 [b]	53.48	3.89
									53.50	4.14
38	CH_3-	-CH_3	4-$CH_3C_6H_4S$-	191-194	74	E-C	$C_{16}H_{16}N_2OS_2$	316.0	60.73	5.10
									60.95	5.40
39	-$(CH_2)_4$-		4-$CH_3C_6H_4S$-	184-187	75	E-C	$C_{18}H_{18}N_2OS_2$	342.0	63.12	5.30
									63.32	5.59
40	-$(CH_2)_4$-		4-ClC_6H_4S-	188-191	70	E-C	$C_{17}H_{15}ClN_2OS_2$	362.5	56.26	4.17
									56.36	4.40
41	-$(CH_2)_4$-		4-$NO_2C_6H_4S$-	246-248	65	M-C	$C_{17}H_{15}N_3O_3S_2$	373.0	54.67	4.05
									54.72	4.32
42	CH_3-	-CH_3	4-$NO_2C_6H_4S$-	263-266	71	E-C	$C_{15}H_{13}N_3O_3S_2$	347.0	51.86	3.77
									51.94	3.84
43	CH_3-	-CH_3	4-$CH_3C_6H_4SO_2$-	275-278	50	E-C	$C_{16}H_{16}N_2O_3S_2$	348.0 [b]	55.15	4.63
									54.86	4.84
44	-$(CH_2)_4$-		4-$CH_3C_6H_4SO_2$-	260-263	48	E-C	$C_{18}H_{18}N_2O_3S_2$	374.0	57.73	4.85
									58.03	5.15
45	-$(CH_2)_4$-		4-$ClC_6H_4SO_2$-	321-324	50	Di	$C_{17}H_{15}ClN_2O_3S_2$	394.5	51.70	3.83
									52.01	4.06
46	-$(CH_2)_4$-		4-$NO_2C_6H_4SO_2$-	322-325	63	D	$C_{17}H_{15}N_3O_5S_2$	405.0	50.36	3.73
									50.67	4.11
47	CH_3-	-CH_3	$C_6H_5SO_2NH$-	218-221	64	E-C	$C_{15}H_{15}N_3O_3S_2$	349.0	51.56	4.29
									51.86	4.33
48	CH_3-	-CH_3	4-$CH_3CONHC_6H_4SO_2NH$-	261-264	48	E-C	$C_{17}H_{18}N_4O_4S_2$	406.0	50.23	4.46
									50.27	4.63
49	-$(CH_2)_4$-		C_6H_5CO-	251-253	62	Di	$C_{18}H_{16}N_2O_2S$	324.0 [b]	66.64	4.97
									66.58	5.28
50	CH_3-	-CH_3	C_6H_5CO-	269-271	57	Di	$C_{16}H_{14}N_2O_2S$	298.0 [b]	64.41	4.73
									64.78	4.98
51	CH_3-	-$COOC_2H_5$	C_6H_5CO-	243-244	70	Di	$C_{18}H_{16}N_2O_4S$	356.0 [b]	60.66	4.53
									60.95	4.78
52	-$(CH_2)_2$-N-($CH_2C_6H_5$)CH_2-		C_6H_5CO-	239-241	76	Di	$C_{24}H_{21}N_3O_2S$	415.0 [b]	69.37	5.09
									69.16	5.43
53	-$(CH_2)_2$-N-($CH_2C_6H_5$)CH_2-		C_2H_5OCO-	206-207	50	E-B	$C_{20}H_{21}N_3O_3S$	383.0 [b]	62.64	5.52
									62.95	5.85
54	-$(CH_2)_2$-N-($COCH_3$)CH_2-		C_2H_5OCO-	223-224	56	E	$C_{15}H_{17}N_3O_4S$	335.0 [b]	53.72	5.11
									53.76	5.40

[a] B = Benzene, C = Chloroform, D = Dimethylformamide, Di = Dioxane, E = Ethanol, M = Methanol. [b] Molecular weight determined by mass spectra.

Table 4

Benzo- and Pyridothieno[3,2-*d*]pyrimidin-4(3*H*)-ones



Compound No.	R_1	R_2	X	Y	Mp °C	% Yield	Recrystallization solvent [a]	Molecular formula	Molecular weight	Microanalysis %C Calcd.	%C Found	%H Calcd.	%H Found
55	H	H	CH	Cl-	271-273	63	E-D	$C_{11}H_7ClN_2OS$	250.5 [b]	52.70	52.45	2.81	2.89
56	H	H	CH	4-ClC_6H_4O-	291-292	63	E-D	$C_{17}H_{11}ClN_2O_2S$	342.5	59.56	59.71	3.23	3.36
57	H	H	CH	C_2H_5OCO-	234-237	66	E-D	$C_{14}H_{12}N_2O_3S$	288 [b]	58.32	58.55	4.20	4.38
58	CH_3	CH_3	N	Cl-	>360	57	D	$C_{12}H_{10}ClN_3OS$	279.5 [b]	51.52	51.76	3.60	3.30

[a] E = Ethanol, D = Dimethylformamide. [b] Molecular weight determined by mass spectra.

external cooling. The reaction mixture was then heated on a water bath for 4 hours, cooled and poured into ice-water. The solid separated was filtered and washed with water. The filtrate and the combined aqueous washings were treated separately for the isolation of **25-27**.

The solid obtained on filtration was suspeneded in water, basified with 10% ammonium hydroxide solution, filtered and dried. Crystallization from appropriate solvent yielded the products **29-31** characterised as 2-amino-3-arylthieno[2,3-*d*]pyrimidin-4(3*H*)-ones.

The acidic aqueous filtrate was basified with 10% ammonium hydroxide solution. The precipitate obtained was filtered, washed with water and dried. Crystallization from appropriate solvent yielded 2-arylamino-5,6,7,8-tetrahydrobenzo[*b*]thieno[2,3-*d*]pyrimidin-4(3*H*)-ones **25-27**.

General Procedure for the Preparation of 2-Arylamino-5,6,7,8-tetrahydrobenzo[*b*]thieno[2,3-*d*]pyrimidin-4(3*H*)-ones by the Condensation of **13** with Arylamines.

A mixture of **13** (0.01 mole), the corresponding arylamine (0.02 mole) and a drop of concentrated hydrochloric acid was fused at 170-180°, till the evolution of methyl mercaptan ceased. The mixture was cooled and triturated with dilute hydrochloric acid. The solid obtained was filtered washed with water and dried. Crystallization from appropriate solvent yielded 2-arylaminothieno[2,3-*d*]pyrimidin-4(3*H*)-ones.

The compounds thus prepared were identical (mmp, tlc and ir) with **25-27** obtained by the condensation of *o*-aminoester **7a** with aryl cyanamides.

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[9] We wish to thank Dr. S. Selvavinayakam, Hindustan Ciba-Geigy Research Centre, Bombay (India) for microanalysis and spectra, Dr. K. G. Dave, Hindustan Ciba-Geigy Research Centre, for valuable suggestions. We are grateful to Dr. (Miss) B. M. Trivedi, Principal, L. M. College of Pharmacy, for providing facilities to carry out this work. Financial assistance by UGC, New Delhi, India (to S. A.) and CSIR India (to V. S. B.) is gratefully acknowledged.

Table 5

Spectral Data for Thienopyrimidines

Compound	IR cm^{-1}	MS m/e	NMR [a]
12	1660 (C=O)	298 (M^+), 283, 270, 227, 221, 205, 177	—
13	1660 (C=O)	—	—
14	1660 (C=O)	—	—
16	1670 (C=O)	357 (M^+), 298, 236, 222, 205, 177, 151	—
17	1665 (C=O)	—	—
18	1660 (C=O)	—	—
19	3460, 3300 (NH_2), 1640 (C=O)	—	—
20	1660 (C=O)	291 (M^+), 260, 233, 218, 205, 176, 151	—
21	1650 (C=O)	—	—
25	3400 (NH), 1670 (C=O)	297 (M^+), 296, 282, 269, 221, 205, 180, 151	δ 1.77 (4H, m, CH_2 at 5 and 8), 2.67 (4H, m, CH_2 at 6 and 7), 7.2 (5H, m, Ar-H), 8.67 (H, bs, N*H*-Ar), 10.5 (H, bs, CON*H*)
26	3400 (NH), 1680 (C=O)	311 (M^+), 310, 296, 283, 241, 221, 205, 180	—
27	3350 (NH), 1660 (C=O)	—	δ 1.87 (4H, m, CH_2 at 5 and 8), 2.83 (4H, m, CH_2 at 6 and 7), 7.5 (4H, m, Ar-*H*)
28	1740, 1670 (C=O)	—	—
29	3360, 3300, 3200 (NH_2), 1660 (C=O)	297 (M^+), 282, 269, 240, 220, 203, 178	δ 1.67 (4H, m, CH_2 at 5 and 8), 2.57 (4H, m, CH_2 at 6 and 7), 6.2 (2H, bs, NH_2), 7.4 (5H, m, Ar-*H*)
30	3360, 3300, 3200 (NH_2), 1660 (C=O)	311 (M^+), 283, 240, 220, 178	—
31	3350, 3150 (NH_2), 1660 (C=O)	—	δ 1.9 (4H, m, CH_2 at 5 and 8), 2.8 (4H, m, CH_2 at 6 and 7), 7.53 (4H, m, Ar-*H*)
32	1650 (C=O)	230, 228 (M^+), 213, 193, 166, 151	—
33	1670 (C=O)	230, 228 (M^+), 213, 193, 178, 166, 150	δ 1.5 (3H, t, CH_2CH_3), 3.08 (2H, q, CH_2CH_3), 5.13 (H, s, CH_2), 7.58 (H, s, H at C_5)
34	1640 (C=O)	—	—
35	1650 (C=O)	—	—
36	1670 (C=O)	439, 437 (M^+), 403, 360, 346, 318, 310, 282, 218, 176	—
37	1650 (C=O)	338, 336 (M^+), 225, 193, 179, 166, 153	—
38	1660 (C=O)	—	—
39	1690 (C=O)	—	δ 1.93 (4H, m, CH_2 at 5 and 8), 2.3 (3H, s, CH_3), 2.93 (4H, m, CH_2 at 6 and 7)
40	1665 (C=O)	—	δ 1.97 (4H, m, CH_2 at 5 and 8), 2.97 (4H, m, CH_2 at 6 and 7), 4.4 (2H, s, CH_2), 7.37 (4H, m, Ar-*H*)
41	1690 (C=O), 1510 (NO_2)	—	—
42	1670 (C=O), 1510, 1345 (NO_2)	—	—
43	1660 (C=O), 1325, 1170 (SO_2)	348 (M^+), 347, 283, 193, 151, 143, 139	—
44	1670 (C=O), 1325, 1310, 1150 (SO_2)	—	δ 1.93 (4H, m, CH_2 at 5 and 8), 2.47 (3H, s, CH_3), 2.97 (4H, m, CH_2 at 6 and 7), 5.0 (2H, s, CH_2), 7.63 (4H, m, Ar-*H*)
45	1665 (C=O), 1325, 1310, 1150 (SO_2)	—	δ 1.9 (4H, m, CH_2 at 5 and 8), 2.93 (4H, m, CH_2 at 6 and 7), 4.97 (2H, s, CH_2), 7.7 (4H, m, Ar-*H*)
46	1680 (C=O), 1520, 1360 (NO_2), 1300, 1165 (SO_2)	—	—
47	3270 (NH), 1675 (C=O), 1330, 1170 (SO_2)	—	δ 2.53 (6H, s, CH_3 at 5 and 6), 4.73 (2H, s, CH_2), 7.8 (5H, m, Ar-*H*)
48	3500, 3340, 3250, 3100 (NH), 1660 (C=O), 1320, 1160 (SO_2)	—	δ 2.4 (3H, s, CH_3), 2.5 (6H, s, CH_3 at 5 and 6), 4.7 (2H, s, CH_2), 7.86 (4*H*, m, Ar-*H*), 9.0 (H, s, N*H*COCH$_3$)
49	1660, 1630 (C=O)	324 (M^+), 296, 219, 192, 179	—
50	1660, 1630 (C=O)	298 (M^+), 221, 193, 179, 153	—
51	1720, 1680, 1620 (C=O)	356 (M^+), 311, 279, 251, 211	—
52	—	415 (M^+), 338, 324, 296, 219, 192, 179, 151	—
53	1730, 1660 (C=O)	383 (M^+), 338, 310, 292, 264, 218, 191	—
54	1720, 1670 (C=O)	335 (M^+), 292, 290, 264, 246, 218	—
55	1650 (C=O)	252, 250 (M^+), 215, 201, 188, 160, 146	—
57	1720, 1660 (C=O)	288 (M^+), 242, 215, 188, 186, 175, 160	—
58	1660 (C=O)	281, 279 (M^+), 244, 229, 203	—

[a] NMR spectra were taken in trifluoroacetic acid except for the compounds **25** and **29** which were taken in DMSO-d_6.